MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

ACADEMIC PROGRAMME HAND BOOK

B.Tech. 2025 - 26

Founder and Builder of Manipal

Padma Shri awardee Dr. T M A Pai
30-04-1898 to 29-05-1979

Manipal is a place born out of one man's dream - Dr. Tonse Madhav Ananth Pai. It is a testimony to the fact that no matter how big a dream is, it can always turn into reality. The once barren hillock is now India's largest education township with more than 24 institutions of learning.

Manipal Academy of Higher Education is the result of the single-minded dedication of the founder Dr. T. M. A. Pai. It was his vision to see the bare hilltop of Manipal transformed into one of the premier centres of learning.

Manipal Academy of Higher Education was founded on one principle; one unshakeable belief - that it must make available the best of education to its students. The last six decades, have seen institutes at Manipal taking meticulous, small steps to build reservoirs of intellectual wealth and academic excellence.

In the process, Manipal Academy of Higher Education has created some of the country's best institutes across diverse streams like medicine, dentistry, engineering, pharmacy, hotel management and communication.

Each institution at Manipal Academy of Higher Education is geared to meet the ever changing demanding standards and to create professionals and citizens of values by inspiring them in multiple ways.

History of the Institute

Manipal Institute of Technology (MIT), one of the premier engineering institutes in India, was among the first self-financed engineering colleges in the country. It was started in 1957 by Padmashee awardee late Dr. T. M. A. Pai, as Manipal Engineering College with an undergraduate course in Civil Engineering.

In 1965, the institute got affiliated to the University of Mysore from Karnataka University. In 1974, it was renamed as Manipal Institute of Technology (MIT). In 1980 it got affiliated to the University of Mangalore. After the creation of the Visveswaraiah Technological University (VTU), MIT along with a number of other engineering colleges in the state got affiliated to the VTU in 1998. As the Manipal Academy of Higher Education (MAHE) had acquired a Deemed University status, MIT became a constituent institution of MAHE in May 2000. In 2003, MIT obtained full academic autonomy and adopted credit system with 10 point grading. With a total student strength of over 9000, MIT has emerged as the largest institute of the University.

MIT currently offers undergraduate programs (B.Tech.) in 21 disciplines and postgraduate courses (M.Tech. /M.Sc/MCA) in 33 different streams and Doctoral programs (Ph.D) in all streams of engineering, basic sciences, humanities and management. Academic programs offered by the institute are approved by AICTE and have been accredited by the National Board of Accreditation (NBA). The institution plays a vital role in producing world-class engineers tuned to the demands of a fast changing global village.

VISION

"Excellence in Technical Education through Research, Innovation and Teamwork"

Leading the way...

Manipal Academy of Higher Education

Dr Ramdas M Pai
Chancellor

Dr Ranjan R Pai
President

Dr H S Ballal
Pro Chancellor

Lt. Gen. (Dr.) M.D. Venkatesh
Vice Chancellor

Dr Narayana Sabhahit
Pro Vice Chancellor
(Technology & Science)

Dr Sharath Rao
Pro Vice Chancellor
(Health Sciences)

Dr Madhu Veeraraghavan
Pro Vice Chancellor
(Management, Law,
Humanities & Social Sciences)

Dr Dilip G Naik
Pro Vice Chancellor

Dr Anand Venugopal
Chief Operating Officer

Dr P Giridhar Kini
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1. ACADEMIC PROGRAMMES

1.1 The institute offers Bachelor of Technology (B.Tech.), Master of Technology (M.Tech.), Master of Science (M.Sc.) and Master of Computer Applications (MCA) programmes of MAHE.

1.1.1 Duration of the B.Tech. programme is 8 semesters.

1.1.2 Duration of M.Tech. ,M.Sc. & MCA programme is 4 semesters.

1.1.3 The maximum duration for a student for complying with the Degree requirement is twice the duration of the academic programme from the date of joining.

2. ADMISSION PROCEDURE

2.1 Undergraduate Programme (B.Tech.):

Eligible students are admitted based on the rank obtained in the All India MAHE Online Entrance Test (MET). Seats are reserved for NRI / Foreign students.

2.2 **Post Graduate Programmes (M.Tech. / MCA / M.Sc.):**

Eligible students are admitted based on the rank obtained in the All India MAHE Online Entrance Test/Merit list. Seats are reserved for NRI / Foreign students.

3. ELIGIBILITY FOR ADMISSION

3.1 Undergraduate Programme (B.Tech.):

3.1.1 Pass in 10+2 or equivalent with Physics, Mathematics and English as compulsory subjects along with Chemistry/ Biotechnology / Biology / any technical vocational subjects as optional; with a minimum of 50% marks taken together in Physics and Mathematics and any one of the optional subjects.

3.1.2 Holders of three years Diploma in Engineering awarded by the Board of Technical Education in Karnataka or equivalent / B.Sc. Degree with Mathematics as one of the subjects; securing an aggregate of at least 50% marks are eligible to join Third semester under lateral entry scheme.

3.1.3 Eligible NRI / Foreign students are admitted based on their qualifying examination performance.

3.2 Post Graduate Programmes:

3.2.1 M.Tech.:

3.2.1.1 BE / B.Tech. in relevant branch with a minimum of 50% aggregate marks in qualifying examination

3.2.1.2 Eligible NRI / Foreign students are admitted based on their qualifying examination performance.

3.2.2 M.Tech. (Part-time):

3.2.2.1 Faculty/Staff sponsored from MAHE only are eligible to do parttime M.Tech. programme.

3.2.2.2 Duration of M.Tech. (Part time) programme is 6 semesters.

3.2.3 MCA:

3.2.3.1 The candidate must have a bachelor's degree in Computer Applications, Computer Science or Information Technology. They should have secured not less than 50% marks in aggregate.

3.2.3.2 Eligible NRI/Foreign students are admitted based on their qualifying examination performance.

3.2.4 M.Sc.

A pass with 50% in aggregate in B.Sc. (subject combination will vary depending upon the course)

4. ACADEMIC PROCESS

4.1 Registration:

4.1.1 Students have to register for the courses with the parent department at the commencement of each semester on the day notified in the academic calendar.

4.2 Pre-registration:

4.2.1 Students need to pre-register for elective courses (both program & open electives) with their department for the next semester as notified in the academic calendar.

4.3 Academic Term:

4.3.1 Semester system of 16-week duration with continuous and comprehensive assessment is followed.

4.3.2 Each semester has a specified course structure.

4.3.3 Two sets of common curricula are followed for the first year B. Tech. programs.

4.3.3.1 Common course structure for all the core branches of Engineering.

4.3.3.2 Common course structure for all the computer science stream branches of Engineering.

4.3.4 The medium of instruction for all courses offered is English.

4.3.5 Eighth semester of B.Tech. programme, fourth semester of MCA programme as well as third & fourth semesters of M.Tech. programme is fully dedicated to project work.

4.4 Course Numbering:

4.4.1 The courses offered by each Department are coded with 3 letters indicating the department offering the course followed by 4 digits.

4.4.2 First digit indicates the level, second digit indicates semester offered ('1': offered in ODD; '2': offered in EVEN; '0': offered in BOTH) and the last two digits indicate the serial number.

DEPARTMENT/PROGRAMME/SCHOOL	CODE
Aeronautical and Automobile Engineering	AAE
Biomedical Engineering	BME
Biotechnology	BIO
Chemical Engineering	CHE
Civil Engineering	CIE
Computer Science and Engineering	CSE/CSS
Inter institute Electives	IIE
Electronics and Communication Engineering	ECE
Electrical and Electronics Engineering	ELE
Inter Professional Elective	IPE
Instrumentation and Control Engineering	ICE
Mechanical and Industrial Engineering	MIE
Mechatronics	MTE
Physics	PHY
Chemistry	CHM
Mathematics	MAT
Humanities and Management	HUM/CSF
Computer Applications	MCA

4.5 Credit Based System:

4.5.1 Each course, theory as well as practical, is expressed in terms of a certain number of credits. The credits are determined by the number of contact hours per week. For theory courses, 1 Hour Lecture / Tutorial per week is assigned 1 Credit, whereas for practical courses 3 contact hours per week is assigned 1 Credit.

4.5.2 Course work in each semester is expressed in terms of a specified number of credits. A student successfully completes a particular semester when he/she earns all the credits of that semester. A student earns full credits for a subject registered if he/she secures letter grade E or higher.

4.5.3 Promotion of a student to higher semesters is based on securing a prescribed minimum number of credits.

4.5.4 It is recommended to incorporate Self Directed Learning (SDL) topics in the courses to train the students for lifelong learning. However, it should not be more than 20% of the syllabus in each course. These topics have to be chosen from available MOOC platforms.

4.6 Assessment:

4.6.1 The academic performance of a student is assessed by the course instructor/s concerned.

4.6.2 The student performance in each theory course is evaluated out of 100 marks, of which 50 marks are for in-semester assessments and 50 marks are for end-semester assessments.

4.6.3 The in-semester assessment in theory courses is based on periodic tests, assignments, quizzes, case presentations, seminars etc. which shall be defined by the course instructor.

4.6.4 The student performance in laboratory courses is also evaluated out of a maximum of 100 marks, and is based on in-semester assessment of 60 marks & examination conducted for 40 marks.

4.6.5 Course Instructors are to give the complete course plan approved by the HoD, at the beginning of the semester. Course plan includes lesson plan & evaluation plan of the course offered.

4.6.6 Course instructors are to give regular feedback on the performance of students.

4.6.7 The performance of a student in a course is reflected in the Letter Grade awarded.

4.7 Attendance Requirements:

4.7.1 All students must attend every lecture, tutorial and practical classes.

4.7.2 A student with less than 75% attendance in individual courses shall not be permitted to write the end semester and makeup examinations in that course and will be given DT letter grade in the course.

4.7.3 The aggregate percentage of attendance of the student during the semester will be entered in his/her grade sheet of that semester.

4.8 Grading System:

4.8.1 10-point grading system shown is used for awarding letter grade in each course.

Letter Grade	A+	A	B	C	D	E	AP	S	F/I/DT/NS
Grade Points	10	9	8	7	6	5	0	0	0

AP: Audit Pass S: Satisfactory F: Failure I: Incomplete DT: Attendance shortage NS: Not Satisfactory

4.8.2 The overall performance of a student in each semester is indicated by the Grade Point Average (GPA) which is the weighted average of the grade points obtained in that semester expressed as

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i},$$

where
n=Number of courses graded per semester
C=Course credits
G=Grade points

4.8.3 The overall performance of the student for the entire programme is indicated by the Cumulative Grade Point Average (CGPA) which is the weighted average of the grade points obtained across all semesters till date

$$CGPA = \frac{\sum_{i=1}^{N} C_i G_i}{\sum_{i=1}^{N} C_i},$$

where
N=Total number of courses graded till date

4.8.3.1 CGPA to marks conversion

As per the University Senate decision, the following guidelines for conversion of CGPA to aggregate marks is recommended for all credit-based programs of Manipal Institute of Technology, Manipal.

Aggregate percentage marks obtained = CGPA * 10.00

4.8.4 Evaluation of Project Work Dissertation/ Thesis

4.8.4.1 Eighth Semester B.Tech.:

4.8.4.1.1 B.Tech. student shall carry out a Project Work for a minimum of 16-week duration.

4.8.4.1.2 The Project Work can be carried out in the institution/industry/ research laboratory or any other institution where facilities exist with approval of the parent Department.

4.8.4.1.3 There will be a mid-semester evaluation of the work done on the project after 8-10 weeks. This evaluation will be done by the department concerned and will be out of 100 marks.

4.8.4.1.4 The final evaluation and viva voce will be conducted after the completion of the project work and submission of the project report, by a panel of examiners including the internal guide.

4.8.4.1.5 In case of external projects, the feedback of the external guide shall be considered during evaluation.

4.8.4.1.6 The end-semester evaluation of the project work is out of 300 marks.

4.8.4.1.7 The grade awarded to the student will be on the basis of the total marks obtained by him / her out of 400 marks.

4.8.4.2 Second year M.Tech. / M.Sc./Fourth Semester MCA:

4.8.4.2.1 A student of M.Tech./ M.Sc. shall carry out a Project Work for a minimum of 36 weeks during the second year of the programme, in the institution/ industry/ research laboratory or any other institution where facilities exist with approval of the parent Department.

4.8.4.2.2 There will be a mid-term evaluation of the work after about 18 weeks by the department concerned. This evaluation will be out of 100 marks.

4.8.4.2.3 In the case of the Fourth Semester MCA students, the minimum project duration is 16 weeks and there will be a mid-term evaluation by the department concerned after about 8-10 weeks.This evaluation will be done by the department concerned and will be out of 100 marks

4.8.4.2.4 The final evaluation will be conducted after the completion of the project work and submission of the dissertation by a panel of examiners consisting of an internal guide.

4.8.4.2.5 In case of external projects, the feedback of the external guide shall be considered during evaluation.

4.8.4.2.6 The end-semester evaluation of the project work is out of 300 marks.

4.8.4.2.7 The grade awarded to the student will be on the basis of the total marks obtained by him / her out of 400 marks.

4.9 Class Committee:

4.9.1 A class committee headed by the Associate Director (Academics) is formed for the first year B.Tech. programme.

The section coordinators, course coordinators and student representatives of all sections will be members of this committee.

4.9.2 For III to VIII Semester of B.Tech. programme and for every semester of M.Tech. & M.C.A. programme, separate class committees are constituted by the Heads of the respective departments. The committee is formed with a senior faculty of the Department as Chairman & Course Coordinators/ Course Instructors of all courses & student representatives as members.

4.9.3 Course Coordinator: If there is more than one section, one of the senior faculty member is nominated by the HOD as Course Coordinator.

4.9.4 Functions of the Class Committee:

4.9.4.1 The class committee will meet thrice in a semester.

4.9.4.2 The first meeting will be held within two weeks from the commencement of the semester in which the course plan, evaluation plan etc. are discussed.

4.9.4.3 The second meeting will be held two weeks after the midterm exam to collect feedback and improve the effectiveness of the teaching learning process. Performance of the students in the assignments/midterm exam may also be analyzed.

4.9.4.4 The Chairman of the class committee should send the minutes of the class committee meeting to the Associate Director (Academics) through the Head of the Department after each class committee meeting.

4.9.4.5 The third meeting is to be held to analyse the performance of the students in all courses of study and grade finalization. However, the student representatives are exempted from this meeting.

4.9.4.6 The Associate Director (Academics) will declare the results after processing.

4.10 Section Committee:

4.10.1 Each section of the first year will have a Section Committee, consisting of the Section Coordinator, faculty members handling both theory and practical classes for that section and student representatives as members.

4.10.2 The Section Coordinator will be a senior faculty member who teaches at least one subject for that section. The Section Coordinators will be nominated by the Associate Director (Academics), who will administer the functioning of all the Section Committees.

4.10.3 The section committee will meet periodically to review the overall effectiveness in the conduct of first year classes.

4.11 Faculty Advisors:

4.11.1 To help the students in planning their courses of study and for general advice regarding academic programmes the Head of the Department will assign one to two senior faculty members in the III semester who will be Faculty Advisors for the batch.

4.11.2 Faculty Advisor for a particular batch will continue till the regular students complete the programme.

4.12 Promotion to Higher Semesters:

4.12.1 B.Tech. Programme:

4.12.1.1 Promotion of a student from an even semester to the next higher (odd) semester is subject to securing the minimum academic performance specified.

4.12.1.2 To be eligible for promotion to the third semester, a student should have earned a minimum of 26 credits at the end of the second semester.

4.12.1.3 To be eligible for promotion to the fifth semester, a student should have earned a minimum of 68 credits at the end of the fourth semester.

4.12.1.4 To be eligible for promotion to seventh semester, a student should have earned a minimum of 110 credits at the end of the sixth semester.

4.12.2 M.Tech. Courses:

4.12.2.1 A student can start the project work at the beginning of the third semester. However, he/she must earn all the credits of the first and second semesters, before submission of the project thesis

4.12.2.2 A part-time M.Tech student can start the project work at the beginning of the third year, but he/she has to earn all the credits of course work, before he/she is permitted to submit the project thesis

4.12.3 M.C.A. Course:

4.12.3.1 Promotion of a student from second semester to third semester is subject to securing a minimum of 29 credits at the end of the second semester.

4.13 Academic Probation and Termination of the registration to the programme:

4.13.1 A student who is not eligible for promotion from an even semester to the next higher semester for reasons of not having earned the prescribed minimum number of credits will be required to discontinue the academic programme temporarily. In such case he/she will be put on academic probation for the next academic year and a warning letter shall be issued.

4.13.2 If a student is repeating a semester/s due to poor academic performance, he/she will also be put on academic probation.

4.13.3 The student put on academic probation shall be periodically monitored and mentored by the faculty advisor. He/she can rejoin the academic programme after fulfilling the academic requirements as in 4.12 at the end of the academic probation.

4.13.4 At the end of the academic probation year, if a student fails to acquire the minimum credits to get promoted to next higher semester, his/her registration for the academic programme shall be terminated.

4.14 Re-joining a Programme:

A student who discontinues the academic programme for any reason and re-joins the programme at a later date shall be governed by the rules, regulations, courses of study and syllabi in force at the time of his/her re-joining the programme.

4.15 End-Semester Examination:

4.15.1 The end semester examination will be conducted only in the courses offered in the current semester.

4.15.2 A student should have appeared for the end-semester examination of the prescribed course of study to be eligible for the award of a passing grade in the course.

4.15.3 Only students with a minimum attendance of 75 % will be permitted to appear for the end semester examination.

4.15.4 A separate minimum of 35% of marks in the end semester examination is essential for awarding a passing grade in a theory course.

4.15.5 For M Tech/M.Sc and MCA programmes, a minimum of 40% of marks in the end semester examination is essential for awarding a passing grade in a theory course.

4.15.6 A student who earns a minimum of 5 grade points (E grade) in a course is declared to have successfully completed the course, and earned the credits assigned to that course.

4.15.7 A course successfully completed cannot be repeated for grade improvement. However, in special cases students may be allowed to reject and repeat the entire semester with the consent of HoD/ Associate Director (Academics).

4.15.8 If a student is eligible for but fails to appear in the end semester examination due to valid reasons, he/she will be awarded an 'I' grade (incomplete) on the grade sheet. However, it needs approval of Associate Director (Academics).

4.16 Make-up examinations:

4.16.1 Make-up examinations will be held at the end of the semester break to help the students who have got F/I grade in the end semester examinations of the courses offered during the semester.

4.16.2 The cut-off marks for grades in the make-up examination will be same as those in the regular end-semester examination.

4.16.3 However, for students who have once failed (F grade) in any course, a maximum of C grade only will be awarded in subsequent examinations irrespective of their performance.

4.16.4 Those who miss regular examinations due to valid reasons (I grade) will be allowed to retain whatever grade they secure in make-up examinations.

4.17 Re-valuation or moderation of answer scripts:

4.17.1 A Student can view the evaluated answer scripts before the publication of results.

4.17.2 Answer script viewing option to the students is facilitated on the campus on a specified date and time after the completion of evaluation.

4.17.3 Only the students are allowed to view the soft copy of answer scripts along with the scheme of evaluation and give their observations in a prescribed format

4.17.4 Moderation or revaluation of answer scripts if any, will be undertaken based on the observations submitted by the students

4.17.5 The results will be published after the moderation or revaluation of answer scripts and no revaluation again after the publication of results

4.18 Re-registration of courses:

4.18.1 Students with F/I/DT Grade are allowed to re-register for subjects of lower semester when they are offered, along with their regular term subjects by paying the prescribed fees.

4.18.2 Students may not be permitted to re-register in courses if there are clashes in the time table.

4.18.3 Students are allowed to register for a maximum of 36 credits in a given semester.

4.18.4 Students are eligible to get actual grades in re-registered courses.

4.18.5 Delayed thesis submission in the final semester / year will necessitate semester re-registration along with a fee of ₹ 10,000 applicable to both UG and PG students.

4.19 Re-registration of courses from SWAYAM/NPTEL MOOC platform

4.19.1 This is applicable to the students with pending courses of lower semester with F/DT grades and eligible for re-registration in a particular semester (ODD/EVEN).

4.19.2 This provision does not deny the option for students to re-register and take up their pending courses available at the institute as per the guidelines indicated in section 4.18

4.19.3 The departments have to identify the courses from SWAYAM/NPTEL MOOC platform, which are equivalent to the courses to be offered to the re-registered students as per the Curriculum during even/odd semester.

4.19.4 It is expected that there has to be at least 70% match between the contents of the approved courses at MIT and their equivalents from SWAYAM/NPTEL platform.

4.19. 5 The identified courses from the platform have to be approved by the BOS and ratified the Academic Council

4.19.6 The students have to register for these courses at SWAYAM/NPTEL platform prescribed by the institute as equivalents to their pending courses of lower semesters and satisfy all the requirements of the prescribed course and complete it successfully.

4.19.7 After successful completion of the course, the students have to submit the certificate of completion indicating the marks and grade provided by the SWAYAM/NPTEL platform, to the institute.

4.19.8 Grading policies of SWAYAM/NPTEL courses shall apply to all Honours and re-registered students.

4.20 Withholding of Results:

Results will be withheld when a student has not paid his/her dues or there is a case of disciplinary action pending against him/her.

4.21 Eligibility for the Award of Degree:

4.21.1 A student will be eligible for the award of the degree if:

4.21.1.1 He/she earns the required number of credits specified for all semesters.

4.21.1.2 He/she has paid all dues to the Institute.

4.21.1.3 No case of disciplinary action is pending against him/her.

4.21.2 Total number of credits required for obtaining:

4.21.2.1 B.Tech. - 160*

* Credit used for CGPA computation: 148. The courses such as Universal Human Values and Professional ethics, Human Rights and Constitution, Open electives and industrial training are excluded from GPA/CGPA computation.

4.21.2.2 M.Tech. - 80

4.21.2.3 M.Sc./MCA - 80

4.21.3 Minimum CGPA for Graduation is 5.0 and the Maximum that can be earned is 10.

4.21.4 However, in the credits system class/rank is not awarded

4.22 Audit Courses:

4.22.1 Students have the option of Auditing additional courses with the consent of the course instructor.

4.22.2 On successful completion, the student will be given 'AP' letter grade.

4.22.3 The grade obtained in an audit course will not be used for computation of CGPA.

4.22.4 Students who have undergone a branch change to the CSE stream must complete CSS 1071: Programming for Problem Solving as a mandatory audit course. The course will be graded and reflected in the grade sheet; however, it will not be considered for GPA/CGPA calculations and will not impact promotion criteria

4.23 Minor Specialization:

4.23.1 Students have the choice of getting a minor specialization along with their degrees by earning 20 credits. in the prescribed set of subjects offered as electives.

4.23.2 The students have to earn 12 credits from the prescribed set of four electives (two courses each in sixth and seventh semesters respectively)under a particular stream of minor specialization.

4.23.3 Students opted for minor specialization have to take up a mini project work in the area of the specialization and successful completion of the same would earn them 8 credits. Therefore, the students opting for minor specialization have to earn 168 credits for obtaining B Tech degree.

4.23.4 The students who do not opt for minor specialization would study four elective courses (two courses each in sixth and seventh semesters respectively) and earn 12 credits after successful completion of them.

4.23.5 Minor specialization shall be mentioned in the VIII semester marks card / Transcript along with CGPA.

5. CREDITS FOR NCC AND STUDENT MAJOR PROJECT

5.1 Credits for NCC:

Three credits against one of the Open Electives for 1-year of active participation. The certificate from the unit head shall be mandatory for the award of credits.

5.2 Student Major project:

5.2.1 Six months of active involvement in any of the institute-approved student major projects shall be considered in lieu of one credit industrial training requirement.

5.2.2 One year of active involvement in any of the institute-approved student major projects shall be considered in lieu of one of the open electives (3 credits) requirement.

5.2.3 The certificate from the faculty coordinator shall be mandated for the award of the credits.

5.2.3 Industry-recognized certificate courses/research projects shall be considered equivalent to the Industrial Training Requirement with the departmental approval.

6. CHANGE OF BRANCH

6.1 Change of branch is allowed on request against vacancies before commencement of the third semester based on academic performance of the student in first year B.Tech.

6.2 Applications for change of branch will be enabled in the second semester as per the academic calendar through the online portal.

6.3 Merit list will be prepared based on the CGPA after the declaration of second semester results.

6.4 Only students who have passed in all the subjects of I & II semesters are eligible for change of branch.

6.5 Students who have secured seats under any scholarship scheme and have opted for branch change will not be eligible for the scholarship from the second year.

6.6 Mutual change of branch is not permitted.

6.7 Students who have undergone a branch change to the CSE stream must complete CSS 1071: Programming for Problem Solving as a mandatory audit course.

7. TRANSFER OF CREDITS

The courses credited elsewhere, in Indian/Foreign University/Institutions/Colleges/certified MOOC by students during their study period at MIT Manipal may count towards the credit requirements for the award of degree. The credit transferred will reduce the number of courses to be registered by the student at MIT. The guidelines of such transfer of credits are as follows:

7.1 Under Graduate and Post Graduate students with consistent academic performance and GPA/CGPA $\geq$ 7 can credit the courses which are approved by Board of Studies (BOS), MAHE during fifth, sixth and seventh semester of UG and second semester or second year of PG at Partner Universities.

7.2 Students are required to identify the subjects from Partner University to be mapped to MIT courses and the department will scrutinize and approve the subjects for credit transfer.

7.3 Credit transferred are not used for GPA/CGPA computation, however, credit transferred are considered for the overall credit requirements of the program.

7.4 Following this, a learning agreement will be prepared and approved for the subjects to be considered for credit requirement and transfer for the exchange semester with acceptance from both universities.

8. B. Tech. HONOURS

8.1 Any student with CGPA $\geq$ 8 at the end of IV semester can opt for B. Tech (Honours). They must maintain a CGPA of $\geq$8.5 at the end of the program.

8.2 A student shall be allowed to secure the required coursework credits (up to 12 credits) either by taking up the courses at M Tech level identified by the departments or through the MOOC courses based on SWAYAM/NPTEL/COURSERA platforms offered by the departments. (one each in V, VI and VII Semester B Tech)

8.3 The Departments may identify the relevant MOOC courses (4 credits each) & get them approved by the respective Board of Studies (BoS) & ratified by the Academic Council of MAHE.

8.4 Institute will be constituting an advisory committee to monitor the progress of the B Tech (Honours) program. With the approval of the above committee, students are allowed to take up Eighth-semester practice school along with their ongoing B Tech (Honours) project.

8.5 All the students opting for B Tech (Honours) have to complete a mandatory 2 credits audit course on Research Methodology and it will be reflected in their Fifth-semester grade sheet as an audit pass (AP). The above course may be offered using available MOOC platforms such as SWAYAM/NPTEL/COURSERA. The syllabus for the above course proposed shall be approved by the respective Board of Studies (BoS) and ratified by the Academic Council of MAHE.

8.6 Student should take up a project work related to the domain resulting in at least ONE Scopus indexed publication from the work, as first author and earn 20 credits (12 as a part of 160 credits for B Tech degree + 8 as a part of 20 credits for B. Tech. Honours)

8.7 Total number of credits to be earned by the student for B Tech honours degree will be 160 + 20 = 180.

8.8 Student should maintain a minimum CGPA of 8.5 at the end of the program.

9. B. Sc. APPLIED SCIENCE (ENGINEERING)

9.1 A student who has completed the maximum period of study (eight years) and not successful in getting the required number of credits to award B Tech degree will be considered for awarding B. Sc. Applied Science degree in the discipline of their Engineering programme.

9.2 The minimum number of credits to be earned by the student for awarding this degree is 130.

10. TERMINATION FROM THE PROGRAMME

A student shall be required to leave the institute without the award of B Tech degree, under the following circumstances.

10.1 If a student fails to earn minimum number of credits required for promotion to the next semester at the end of an academic probation year.

10.2 If a student fails to acquire the requirements for the completion of the degree within the maximum permissible period.

10.3 If a student is absent for more than 6 weeks at a stretch in a semester without sanctioned leave.

10.4 Based on disciplinary action, on recommendation of an appropriate committee and approved by the vice chancellor

FIRST YEAR B Tech CURRICULUM 2022 (Common to all core branches)
PHYSICS CYCLE/GROUP

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	MAT 1171	Engineering Mathematics - I	3	1	0	4	MAT 1271	Engineering Mathematics - II	3	1	0	4
	PHY 1071	Engineering Physics	3	0	0	3	CHM 1071	Engineering Chemistry	3	0	0	3
	CIE 1071	Mechanics of Solids	2	1	0	3	BIO 1071	Biology for Engineers	3	0	0	3
	ECE 1071	Basic Electronics	3	0	0	3	ELE 1071	Basic Electrical Technology	2	1	0	3
	MIE 1071	Basic Mechanical Engineering	3	0	0	3	CSE 1071	Problem Solving using Computers	2	1	0	3
I	HUM 1071	Communication Skills in English	1	0	2	2	CIV 1004	Environmental Studies	1	0	2	2
	IPE 1071	Universal Human Values and Professional Ethics	1	0	0	1	HUM 1072	Human Rights and Constitution	1	0	0	1
	PHY 1081	Engineering Physics Lab	0	0	3	1	CHM 1081	Engineering Chemistry Lab	0	0	3	1
	MIE 1082	Workshop Practice	0	0	3	1	CSE 1081	Problem Solving using Computers Lab	0	0	3	1
	MIE 1181	Engineering Graphics - I	0	0	3	1	MIE 1281	Engineering Graphics - II	0	0	3	1
	IPE ****	Creativity, Problem Solving and Innovation*	1	0	0	--*	IPE ****	Creativity, Problem Solving and Innovation*	1	0	0	--*
			17	**2**	**11**	**22**			**16**	**3**	**11**	**22**
	Total Contact Hours (L + T + P)		**30**				**Total Contact Hours (L + T + P)**		**30**			

*After completing a project work along with other activities which are assessed periodically the students would earn 3 credits which would be considered in lieu of an open elective for Fifth Semester B Tech.

FIRST YEAR B Tech CURRICULUM 2022 (Common to all core branches)
CHEMISTRY CYCLE/GROUP

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 1171	Engineering Mathematics - I	3	1	0	4	MAT 1271	Engineering Mathematics - II	3	1	0	4
	CHM 1071	Engineering Chemistry	3	0	0	3	PHY 1071	Engineering Physics	3	0	0	3
	BIO 1071	Biology for Engineers	3	0	0	3	CIE 1071	Mechanics of Solids	2	1	0	3
	ELE 1071	Basic Electrical Technology	2	1	0	3	ECE 1071	Basic Electronics	3	0	0	3
	CSE 1071	Problem Solving using Computers	2	1	0	3	MIE 1071	Basic Mechanical Engineering	3	0	0	3
	CIV 1004	Environmental Studies	1	0	2	2	HUM 1071	Communication Skills in English	1	0	2	2
	HUM 1072	Human Rights and Constitution	1	0	0	1	IPE 1071	Universal Human Values and Professional Ethics	1	0	0	1
	CHM 1081	Engineering Chemistry Lab	0	0	3	1	PHY 1081	Engineering Physics Lab	0	0	3	1
	CSE 1081	Problem Solving using Computers Lab	0	0	3	1	MIE 1082	Workshop Practice	0	0	3	1
	MIE 1181	Engineering Graphics - I	0	0	3	1	MIE 1281	Engineering Graphics - II	0	0	3	1
	IPE ****	Creativity, Problem Solving and Innovation*	1	0	0	--*	IPE ****	Creativity, Problem Solving and Innovation*	1	0	0	--*
			16	**3**	**11**	**22**			**17**	**2**	**11**	**22**
	Total Contact Hours (L + T + P)		**30**				**Total Contact Hours (L + T + P)**		**30**			

*After completing a project work along with other activities which are assessed periodically the students would earn 3 credits which would be considered in lieu of the open elective for Fifth Semester B.Tech.

FIRST YEAR B.TECH.Curriculum 2022 (Common to all core branches)
(Applicable to students admitted during 2022 and later)

MAT 1171: ENGINEERING MATHEMATICS - I [3 1 0 4]

Matrices: inverse and rank, solution of linear system of equations, eigen value problems. Vector spaces: basis, linear transformations, inner product spaces and orthogonalization. First and higher order differential equations and their solutions, Lagrange's and divided difference interpolation. Numerical differentiation and integration. Solution of algebraic and transcendental equations. Solutions of ordinary differential equations.

References:

1. B.S. Grewal, Higher Engineering Mathematics, 43rd edition, 2015, Khanna Publishers.
2. Kreyzig E, Advanced Engineering Mathematics, 9th edition, 2011, Wiley Eastern, Delhi.
3. David C. Lay, Linear Algebra and applications, 3rd edition, 2009, Pearson Education.
4. Sastry S.S - Introductory methods of Numerical analysis, 5thedn., PHI learning Pvt. Ltd, 2012.
5. Rainville E.D. and Bedient P.E., A short course in differential equations, 8th edition, 2011, Prentice Hall, New York.

PHY 1071: ENGINEERING PHYSICS [3 0 0 3]

Applied optics: Characteristics of Lasers, Einstein's coefficients, He-Ne Laser, Ruby Laser, Semiconductor Laser, Applications of Laser, Principle of optical fibre, Numerical aperture, Fibre types, Attenuation and distortion in fibre, Applications of optical fibres. Introduction to quantum physics: Black body radiation laws, Planck's hypothesis, Overview of photoelectric effect, The Compton effect,Overview of wave particle duality, Quantum particle,Overview of uncertainty principle. Quantum mechanics: An interpretation of quantum mechanics, Particle in a box,Schrodinger equation, Particle in a well of finite height, Tunnelling through a potential barrier and its applications. Molecules and solids: Overview of bonding in solids, Free electron theory of metals, Band theory of solids, Electrical conduction in metals, insulators and semiconductors, Semiconductor devices, Superconductivity. Dielectrics: Polarization in a dielectric materialClausius- Mossotti equation, Frequency dependence of polarization, Applications of dielectric material, Ferroelectric material. Introduction to nanoscience: Surface area to volume ratio, Preparation techniques, Applications.Modern engineering materials: Metallic glasses, Shape memory alloys, Biomaterials

References:

1. Jewett &Serway, PHYSICS for Scientists and Engineers with Modern Physics; 7ThEdition, Cengage Learning.
2. S. Mani Naidu, Engineering Physics. Pearson, Ed. (2014)
3. Ajoy Ghatak and K. Thyagarajan, Introduction to Fiber Optics, 2010, Cambridge University Press.
4. S. P. Basavaraju, Engineering Physics, Subhas Stores, Bangalore – 2
5. Arthur Beiser, Shobhit Mahajan, S Rai Choudhary, Concepts of Modern Physics, 6th Edition, Mc. Graw Hill Company Ltd., New Delhi.
6. S.O. Pillai, and Sivakami, Text book of Engineering Physics, New Age International Publishers. (2013).

CIE 1071: MECHANICS OF SOLIDS [2 1 0 3]

Introduction to engineering mechanics, Rigid body, Force and system of forces, Composition and Resolution of forces, Moment of forces, Varignon's theorem, Couple, Resultant of force system. Conditions of Equilibrium, Space diagram and Free body diagram, Lami's theorem, Equilibrium of concurrent and non-concurrent force systems, Friction. Centroid and Moment of Inertia of simple and composite areas. Introduction to deformable bodies, Mechanical properties of materials, Stress, Strain, Hooke's law. Stress strain behaviour of ductile and brittle material, Factor of safety, Stresses and deformations in prismatic, stepped and tapered bars. Shear stress and strain, Poison's ratio, Volumetric stress and strain, Elastic constants and their relationships. Stresses in thin cylinder, compound bars, Thermal stresses in compound bars. Concepts of bending moment and shear force diagrams.

References:

1. Meriam J. L., Kraige L. G., Engineering Mechanics: Statistics (5e),John wiley & sons, 2007.
2. Beer F. P., Johnston Jr. E. R., Dewolf J. T., Mazurek D. F., Sanghi S., Mechanics of Materials (7e), Tata McGraw-Hill, 2017.
3. Pytel A., Singer F.L., Strength of Materials (4e), HarperCollins College Div, 1987.
4. Bhavikatti S. S., Strength of Materials (4e), Vikas Publishers, 2013.
5. Basavarajaiah B. S., Mahadevappa P., Strength of Materials (3e), Universities Press, 2010.

ECE 1071: BASIC ELECTRONICS [3 0 0 3]

Diode, Zener diode, Applications. Special purpose diodes. MOSFET structure and operations, V-I Characteristics, Large-Signal Model, Amplifier Biasing Techniques, Configurations. Working principle. Operational Amplifier: Block diagram and characteristics, Inverting and Non-Inverting amplifier, OPMAP Applications. Number system: Decimal, binary, octal and Hexa-decimal number systems. One's and two's complements. Weighted and non-weighted codes, Self-complimenting codes, Error detecting and correcting codes. Combinational Circuits, Sequential Circuits. Electronic Communication: modulation techniques, Principle of Sampling and Digitization, Basic Pulse and Digital modulation systems. Principle of Cellular mobile communication and GSM architecture.

References:

1. Robert L. Boylestad, Louis Nashelsky- Electronic Devices & Circuit Theory, 11th Edition, PHI, 2012
2. Behzad Razavi, "Fundamental of Microelectronics", Wiley, 2013.
3. Morris Mano- Digital design, Prentice Hall of India, Third Edition., 2013.
4. George Kennedy, Bernad Davis- Electronic Communication Systems, 4th edition, TMH, 2004.
5. Raj Pandya, "Mobile and Personal Communication Services and Systems", Wiley-IEEE Press, 1999.

MIE 1071: BASIC MECHANICAL ENGINEERING [3 0 0 3]

Properties of Steam and Boilers: Steam properties Working principle of Babcock & Wilcox Boiler. Prime Movers: Classification, working principle of steam, gas and water turbines, Refrigeration: Principle and working of vapour compression refrigeration system, I.C. Engines: Classification, Working of 2-stroke, 4-stroke C.I and S.I Engines Power Transmission: Belt drives, Introduction to rope drive and chain drives, Gear Drives. Machine Tools: Introduction to Lathe, Drilling Machine and operations, Casting and Forging: Two box moulding procedure, moulding sand and its desirable properties, Pattern allowances, Introduction to forging. Welding: Principle of Resistance spot welding, Electric arc welding, TIG, MIG Welding and Oxy-acetylene gas welding, Introduction to soldering and brazing. Automation: Introduction to automation, CNC machines, basic programming, Robotics, robot configuration, application of robotics, pronciples of additive manufacturing.

References:

1. K.R.Gopalakrishna, Text book of elements of Mechanical Engineering, Subhash Publications, Bangalore, 2005.
2. Rajput R. K., Elements of Mechanical Engineering, Fire Wall Media, 2005.
3. B.S. Raghuvanshi, A course in Workshop Technology, Vol.1, Dhanpat Rai & sons, New Delhi, 2005.
4. Groover Mikell P., Automation, Production systems, and Computer-Integrated Manufacturing. Pearson Education India, 2016.
5. HMT Limited, Mechatronics, Tata McGraw Hill Publishing Company Limited, New Delhi.

HUM 1071: COMMUNICATION SKILLS IN ENGLISH [1 0 2 2]

Reading- selected texts on different themes, genres and styles – discussion on universal human values, professionalism and conflicts; Writing - response writing on themes related to human values , academic writing – essay; mechanics of writing–punctuation, functional grammar, and error identification; Oral communication – speech, presentation/Impromptu speeches, Group discussion, Interview techniques, formal/informal communication; Listening-Audio Texts/speeches, listening skills; Communication- in a group and interpersonal communication.

References:

1. Green, D. Contemporary English Grammar Structure and Composition (2nd ed.). Laxmi Publications, 2022
2. Swan, Michael Practical English Usage. Oxford University Press. London, 2014.
3. Markel, M., & Selber, S. A. Technical Communication (Thirteenth ed.). Bedford/St. Martin's, 2020
4. Talbot, F. How to Write Effective Business English: Your Guide to Excellent Professional Communication (3rd ed.). Kogan Page, 2019
5. Raman, M & Sharma S. Technical Communication: Principles and Practice. Oxford University Press. New Delhi, 2014

IPE 1071: UNIVERSAL HUMAN VALUES AND PROFESSIONAL ETHICS [1 0 0 1]

Universal Human Values: Need, Basic Guidelines, Content and Process for Value Education, Understanding Harmony in the Human Being or with oneself, Harmony in the Family and Society, Harmony in the Nature and Existence, Implications of the Holistic Understanding of Harmony on Professional Ethics. Professional Ethics: Moral issues and dilemmas, Models of professional roles, Theories about right action, Self-interest, Customs and Religion. Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisers, Moral Leadership, Code of Conduct, Corporate Social Responsibility.

References:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff: The Impact of Over consumption on the Planet, Our Communities, and Our Health-And How We Can Make It Better by Annie Leonard, Free Press; Reprint edition (22 February 2011)
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Economy of Permanence - J C Kumarappa
6. Rediscovering India - by Dharampal
7. Vivekananda - Romain Rolland (English)
8. Professional Ethics by R. Subramaniam – Oxford Publications, New Delhi.
9. Engineering Ethics by Harris, Pritchard, and Rabins, Cengage Learning, New Delhi.
10. Human Values & Professional Ethics by S. B. Gogate, Vikas Publishing House Pvt. Ltd., Noida.
11. Engineering Ethics & Human Values by M.Govindarajan, S.Natarajan, and V.S.Senthil Kumar-PHI Learning Pvt. Ltd – 2009.
12. Professional Ethics and Human Values by Prof.D.R.Kiran-Tata McGraw-Hill – 2013

PHY 1081: ENGINEERING PHYSICS LAB [0 0 3 1]

Exp. No.	Title
1	Energy Band Gap
2	Fermi Energy of Metal
3	Photoelectric Effect
4	Black Body Radiation
5	Resistivity of Semiconductor by Four Probe Method
6	Hall Effect
7	Determination of Boltzmann Constant
8	Numerical Aperture of OFC
9	Wavelength of Laser using Diffraction Grating
10	Newton's Rings (Demo)
11	Refractive Indices of Uniaxial Crystals (Demo)
12	Michelson's Interferometer (Demo)

References:

1. Physics for Scientists and Engineers with Modern Physics, Vol 2, 6 ed (1982), by Serway & Jewett, Thomson-Brooks /Cole
2. Advanced Practical Physics by Worsnop & Flint, 1961, Asia Publishing House, Bombay
3. Course of Experiments with He-Ne Laser 2001, New Age

International, New Delhi
4. Fundamentals of Optics, Francis Jenkins & Harvey White, 2001, McGraw-Hill Education
5. Semiconductor Measurements and Instrumentation by W.R. Runyan, McGraw-Hill Book Co. (1975)

MIE 1082: WORKSHOP PRACTICE [0 0 3 1]

Mechanical Engineering Practices - Sheet metal, Plumbing exercises, Study of Automotive systems like Transmission and Suspension, Demonstration on the working of Lathe and Drilling machine, Civil Engineering Practices - Material Testing by conducting Tensile test, Shear test and Compression test, Surveying exercises using chain and tape, Prismatic compass, Dumpy level, Electrical and Electronics Engineering Practices – Study of wiring tools, Fuses, Circuit breakers, Lighting sources, Wiring, Electrical energy in Single phase and three phase circuits, Energy tariff calculations. Testing of Electronic components, IC based experiments comprising Digital counter, Buzzer and Musical doorbell, Soldering practice, Building a DC regulated power supply.

References:

1. Hajra Choudhury S. K and Bose S. K, “Elements of Workshop Technology, Vol I”, Media Promoters & Publishing Pvt. Ltd., Mumbai, 2012.
2. Raghuvanshi S.S, “Workshop Technology”, Dhanpat Rai and Sons, Delhi, 2002.
3. Punmia B. C, “Surveying”, Laxmi Publications, Bangalore, 2012
4. Uppal S.L., Electrical Wiring, Estimating and Costing, Khanna Publishers, 1978 5. Bishop Owen, Electronics: A First Course, (2e), NEWNES, An Imprint of Elsevier, 2006.

MIE 1181: ENGINEERING GRAPHICS- I [0 0 3 1]

Geometric construction, Dimensioning, Orthographic projections, Projection of points, Projection of straight lines by rotating line method, Line inclined to one plane & inclined to both planes, Projection of regular plane surfaces by change of position method, Plane inclined to one plane & inclined to both planes, Projection of regular solids by change of position method, Solid inclined to one plane & inclined to both HP & VP.

References:

1. Gopalkrishna K. R. and Sudhir Gopalkrishna "A textbook of Computer Aided Engineering Drawing", 37th Edition, Subhas Stores, Bangalore, 2012.

References:

1. A. Dekker, "Solid State Physics," Macmillan India Ltd., 1957.
2. R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers," vol. 2, 9th ed., Thomson-Brooks/Cole, 2014.
3. W. R. Runyan, "Semiconductor Measurements and Instrumentation," McGraw-Hill Book Company, 1975.
4. J. D. Ryder, "Electronic Fundamentals and Applications," 5th ed., Prentice-Hall of India Private Ltd, 1978.
5. A. K. Ghatak and Thyagarajan, "Introduction to Fiber Optics," Cambridge University Press, 1999.
6. Worsnop & Flint, "Advanced Practical Physics," Asia Publishing House, Mumbai, 1961.
7. F. Jenkins and H. White, "Fundamentals of Optics," McGraw-Hill Education, 2001.

MAT 1271: ENGINEERING MATHEMATICS - II [3 1 0 4]

Mean value theorems, Taylor and Maclaurin's series expansions, indeterminate forms. Partial differentiation, total derivatives, errors and expansions, Taylor's theorem, maxima and minima, Lagrange's method. Infinite series: tests for convergence of series with positive terms, alternating series, power series. Analytical solid geometry: spheres. Cones and cylinders. Multiple integrals and their applications, beta and gamma functions. Laplace transforms: periodic functions, step functions, inverse transforms, convolution, solution of differential equations and applications.

References:

1. B.S. Grewal - Higher Engineering Mathematics, 43rd edition, 2015, Khanna Publishers.
2. N.Piskunov-Differential Calculus, Vol I and II, 1996, Mir Publications .
3. Rainville E.D and BedientP.E ,A short course in differential equations, 8th edition, 2011, Prentice hall, New York.
4. Kreyzig E, Advanced Engineering Mathematics, 8th edition, 2006, Wiley Eastern , Delhi.
5. Shanti Narayan - Differential Calculus, 6th edition, 2014, Shyam Lal Charitable Trust, Delhi

CHM 1071: ENGINEERING CHEMISTRY [3 0 0 3]

Electrochemistry - Electrochemical cells, Energetics of cell reaction, Single electrode potential, Nernst equation, EMF of cell, Calomel electrode, Glass electrod Battery Technology: Classification, requirements of primary and secondary batteries, Li-ion batteries –construction, working and applications, advantages and disadvantages. Fuel Cells–AFC & PEMFC, construction, working, advantages and disadvantages. Metal finishing: Electroplating – polarization, over voltage, decomposition potential, characteristics of good deposit, Factors influencing the nature of the deposit, methods of cleaning the metal surface. Electroplating of Cu & Cr & electroless plating of Cu. Analytical methods - Potentiometry, conductometry, Colorimetry, Beer-Lambert's law and its applications, Principles of flame photometry. Corrosion and its Control - Classification, Electrochemical theory with special reference to rusting of iron, Galvanic series, Factors affecting corrosion, brief account of galvanic, pitting, intergranular and stress corrosion, Corrosion control. Water Technology - Hardness of water, Boiler troubles- scale and sludge formation, priming and foaming, Internal treatment, Softening of water by Hot lime soda process, Desalination of brackish water. Engineering Materials - Polymers: classification, Molecular weight, Correlation of polymer properties with structure Glass transition temperature Liquid crystals: Thermotropic and lyotropic, classification based on structure and phases, Liquid crystal Displays Composites: Classification and properties, Polymer-Matrix Composite. Thin films: Formation, PVD and CVD techniques, comparison and uses. Nanomaterials: Classification, bottom up and top down approach, advantages and disadvantages

References:

1. Jain P.C., Jain M. Engineering chemistry. 16th Edn., Dhanpat Rai and Sons, New Delhi,2015.
2. Fischer T., Materials Science for Engineering Students, Academic Press, London, 2009.

BIO 1071: BIOLOGY FOR ENGINEERS [3 0 0 3]

Bioinspiration: Examples of bioinspiration models used in engineering. Organization and Evolution of living systems: Biological hierarchies, modularity and incremental change, how living systems improves by itself through evolution, Darwin's model, Concepts of evolution, adaptation. Cooperation: Symbiosis, co-evolution, communal benefit, predators and parasites. Communications: Neural and humoral, autonomic nervous system, action potentials. Flow of information in living systems: Mendelian model and its testing, Location of factors and its mode of inheritance, Morgan concept on location of factors, pedigree analysis. Information storage and maintenance in living systems: Discovery of DNA, Griffiths transformation experiment, Chargaff's rule, Meselson and Stahl experiment, Kornberg experiment, structure of DNA, DNA copying mechanism and its proof reading as well as editing, RNA synthesis and processing, Protein synthesis and Genetic code. Building blocks of life: Elements of life and their bonding ability, importance of carbon, elemental replacement, different types of bonds and interactions in biological systems, water and phospholipids as well as their importance in the survival of life, Macromolecules such as carbohydrates and proteins, their structures and enzymes. Case studies: Applications of biology in engineering and lessons to learn from nature, eg., solar energy, recycling, fit form into function, energy optimization, etc.

References:

1. Johnson AT, 2010. Biology for Engineers, CRC Press Inc., USA, ISBN 9781420077636
2. Sadava DE, Hillis DM, Heller HC and Hacker SD, 2017. Life the science of biology, 11th edition, Macmillan Learning, USA ISBN-10: 1-319-01016-4.
3. Urry LA, Cain ML, Wasserman SA, Minorsky PV and Reece JB, 2017. Campbell biology, 11th edition, Pearson ISBN-10: 0134093410

ELE 1071: BASIC ELECTRICAL TECHNOLOY [2 1 0 3]

DC Circuits: Electric circuit elements, source transformation, Network reduction techniques, star-delta transformation; Mesh current analysis, Node voltage analysis, Network Theorems - Thevenin's, Superposition, and Maximum Power Transfer Theorems. RL and RC transients. Magnetic Circuits: MMF, flux, reluctance, the analogy with electric circuits, analysis of series, parallel magnetic circuits, Electromagnetism, Faraday's laws of electromagnetic induction, self and mutual inductance, coupled circuits. Single-phase AC Circuits: Average value and RMS value of sinusoidal and non-sinusoidal waveforms, Sinusoidal AC voltage generation, Phasor representation, Steady-state analysis of RL, RC, and RLC series, and parallel circuits with sinusoidal voltage, impedance diagram, admittance, conductance, susceptance. Power in AC circuits, active power, reactive power, and apparent power, power factor. Resonance: Series and parallel resonance. Three-phase AC Circuits: Generation of 3-phase sinusoidal voltages, phase sequence, star, and delta connections, line and phase voltage, analysis of three-phase circuit with star/delta connected balanced and unbalanced loads, power measurement, two-wattmeter method. Electrical Power System Components (Self-study): Overview of Electrical Power System, Power system components, Generation, Transmission, Distribution, Utilization of Electric Power. Energy measurements, Digital Energy Meter. Electrical Machines: Transformers, DC and AC motors - Principle of Operation, Types, Construction, & Applications.

References:

1. Kothari D. P. & Nagarath I. J., Basic Electrical Engineering (4e), TMH, 2019.
2. Nagasarkar T. K. & Sukhija M. S., Basic Electrical Engineering (3e), OUP, 2017
3. Hughes E., Electrical and Electronic Technology (12e), Pearson, 2016
4. https://nptel.ac.in/courses/108/105/108105053/
5. https://www.coursera.org/learn/electric-power-systems

CSE 1071: PROBLEM SOLVING USING COMPUTERS [2 1 0 3]

Introduction to computing, Importance of Problem solving using computers, Algorithms and Flow charts, Introduction to C language, Simple C programs, Syntax and Logical Errors in compilation, Object and executable code, Data concepts in C, Expressions, Input and output statements, Compound statements, Selection statements, IF, IF-ELSE, Nested IF-ELSE, ELSE-IF Ladder, Switch, WHILE, DO-WHILE and FOR constructs, Control structures, Operators in C, 1-D and 2-D arrays and strings, Searching and sorting, Multidimensional arrays and matrices, Modular programming and recursive functions, Structure and pointers, Defining structures and Array of Structures, Pointer arithmetic, Pointer to structures, Cyber security.

References:

1. Dromey.R. G, How to solve it by computers, Pearson Education, 2007.
2. Brian W. Kernighan and Dennis M. Ritchie, The C Programming language (2e), Pearson India, 2015.
3. Deital. P and Deitel. H. M, C: How to program (9e), Pearson, 2022.
4. Balagurusamy.E, Computing fundamentals and C programming (2e), MC GRAW HILL INDIA, 2017.

CIV 1004 : ENVIRONMENTAL STUDIES [1 0 2 2]

Environment: meaning, objectives, major environmental issues, Sustainable development, Environment as a global concern, Renewable and non-renewable resources – Resource consumption & conservation methods, availability of water resources, Forest, Land and Mineral resources, Energy – Different types of energy, Conventional sources & non-Conventional sources of energy, solar energy, Hydro electric energy, Wind Energy, Nuclear energy, Biomass & Biogas, Fossil Fuels, Hydrogen as an alternative energy, Ecosystem: meaning, structure and functions, biotic and abiotic components, Tropic levels, Energy flow in an ecosystem, Biodiversity, and its conservation – in situ & ex situ, IUCN red list, Environmental Pollution - water, air, land, noise, solid waste, biomedical waste, nuclear pollution, marine pollution, Environmental laws and legislations: Related to general, air, water, biodiversity and forests, Pollution control Boards: Central & State - Roles and responsibilities, Environmental impact assessment (EIA), Disaster Management: Meaning, classification of disasters, Disaster management phases – Disaster management cycle, Emergency response and recovery, Hazardous waste spills and dangers posed, Case studies on Environmental crisis and remedies in Indian scenario, Practical activities related Environmental awareness and its conservation.

References:

1. Mohan Kanda, Disaster Management in India evolution of institutional arrangements & operational strategies. (2017)
2. Y. Anjaneyulu, Introduction to Environmental science (2017).
3. R.K.Trivedy, Handbook of Environmental laws, acts, guidelines, compliances & standards, 3rd edition, 2nd volume. (2017)
4. Benny Joseph, Environmental Studies, Tata McGraw-Hill Publishing Company Ltd., New Delhi (2008).
5. Student guide: Environment Reader for Universities, based on UGC syllabus published by Centre for Science and Environment, (2017).

HUM 1072: HUMAN RIGHTS AND CONSTITUTION [1 0 0 1]

Human Rights Origin and development: Origins and Evolution, classical period, contribution of Magna Carta, American Bill of Rights, the French Revolution declaration of rights, Equality and Fraternity Marxist Revolutions, Liberal Perspective: Locke, Rousseau, Thomas Paine, J. S. Mill, A. V Dicey. Non –violence and community rights in Ancient India, socio-religious reform movement, equality of rights in India, rights of the marginalised India. Classification of human rights: civil and political rights, social and economic rights, cultural and group specific rights. Universal Declaration of Human Rights and fundamental rights of Indian constitution: Human rights and duties in India: constitutional framework, Basic Features of the Constitution of India, Fundamental Rights. Human Rights organisations: International and National: Police and Human Rights, Judiciary and Human Rights, National and State Human Rights Commission & other grievance redressal mechanism. Emerging areas in human rights: Human Rights and Environment, Human Rights and Globalization, Rights of the Women, Rights of the Children, Rights of the Dalit and Tribes, Rights of Minorities, Rights of Old and Disabled, Rights of unorganized Labour & Displaced Persons. Human right violation episodes: International- war, terrorism, racial discrimination, gender violence, genocide; National- poverty, illiteracy, gender discrimination, caste and communal violence. Remedial measures: civil rights protection act, consumer right protection act, right to information act, domestic violence prevention act, environment protection act. Ethical dimension: value education and human rights.

References:

1. Halder, D., & Brahmbhatt, S. S. (2021). Advancement of Human Rights in India: Contemporary and Emerging Challenges. SAGE Publications Pvt. Ltd.
2. Ishay, M. R. (2008). The History of Human Rights: From Ancient Times to the Globalization Era. University of California Press.
3. Juss, S. (2021). Human Rights in India (Routledge Research in Human Rights Law). Routledge.
4. Mahoney, J. (2007). The Challenge of Human Rights: Origin, Development and Significance. Wiley-Blackwell.
5. Mishra, K. (2022). Human Rights in India: Historical Social and Political Perspective. Raj Publication.

CHM 1081: ENGINEERING CHEMISTRY LABORATORY [0 0 3 1]

1. Alkalimetric titration
2. Total hardness of water
3. Estimation of percentage of copper in brass
4. Estimation of weight of iron in haematite
5. Estimation of percentage of manganese dioxide in pyrolusite
6. Estimation of ammonia nitrogen in a fertilizer
7. pKa value of a weak acid by potentiometric titration
8. Conductometric acid – base titration
9. Determination of concentration of copper using colorimeter
10. Determination of coefficient of viscosity of liquid
11. Determination of Chemical Oxygen Demand of water (demonstration)
12. Estimation of sodium by flame photometry (demonstration)

References:

1. Laboratory Manual for Engineering Chemistry Laboratory, M.I.T., 2014.
2. Vogel A.I. Text book of Quantitative Inorganic Analysis, 5th Edition, ELBS, 1998.

CSE 1081: PROBLEM SOLVING USING COMPUTERS LAB [0 0 3 1]

Introduction to computing, Simple C programming, branching control structures, Looping control structures, 1D and 2D array programming, Strings programming, Modular & recursive functions programming – Programs with pointers, structures – MATLAB programming with Simulink

References:

1. Brian W. Kernighan and Dennis M. Ritchie, The C Programming language (2e), Pearson Education, 2015.
2. Deital.P. J and Deitel.H.M, C: How to program (7e), Pearson Education, 2010.
3. Balagurusamy.E, Computing fundamentals and C programming

(1e), MC GRAW HILL INDIA, 2017.

4. Delores Etter, Introduction to MATLAB, Pearson Education India, 2019.
5. Stormy Attaway, Matlab: A practical Introduction to Programming and Problem Solving (4e), Butterworth-Heinemann, Elsevier, 2017.

MIE 1281: ENGINEERING GRAPHICS-II [0 0 3 1]

Section of solids, Sectioning by horizontal, vertical & inclined section planes, solids resting on HP or VP, inclined to one plane, Sectional views and true shape of section, Parallel line development, Radial line development, Development of tray, Isometric projection of simple cut solids, Combined solids, and machine components, Isometric to orthographic conversion, Simple and cut solids, Combined solids and simple machine components.

References:

1. Gopalkrishna K. R. and Sudhir Gopalkrishna "A textbook of Computer Aided Engineering Drawing", 37th Edition, Subhas Stores, Bangalore, 2012.
2. Bhat N. D. and V.M. Panchal "Engineering Drawing", 50th Edition, Charotar Publishing House, Anand, India, 2010.
3. Venugopal K. "Engineering Drawing and Graphics + Auto CAD" Newage International Publishers, Delhi, 2002.
4. Narayana K. L. and Kannaiah P, "Text book on Engineering Drawing" Scitech Publications, Chennai, 2002.
5. Basant Agrawal & Agrawal C M "Engineering Drawing" Tata McGraw Hill, New Delhi, 2010.

FIRST YEAR B.Tech. CURRICULUM 2025 (Common to all CS branches)

PHYSICS CYCLE/GROUP

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 1103	Computational Mathematics - I	3	1	0	4	MAT 1203	Computational Mathematics - II	3	1	0	4
	PHY 1003	Applied Physics for Engineers	3	0	0	3	CHM 1003	Applied Chemistry for Engineers	3	0	0	3
	ECE 1003	Fundamentals of Electronics	2	1	0	3	ELE 1003	Fundamentals of Electrical Engineering	3	0	0	3
	CSS 1001	Programming for Problem Solving	2	1	0	3	CIV 1003	Engineering Mechanics and Smart Buildings	2	1	0	3
	MME 1003	Fundamentals of Mechanical Engineering	3	0	0	3	CSS 1002	Introduction to Object Oriented Programming	3	0	0	3
	HUM 1071	Communication Skills in English	1	0	2	2	CIV 1004	Environmental Studies	1	0	2	2
	IPE 1071	Universal Human Values and Professional Ethics (MLC)	1	0	0	1	CSS 1022	Data Visualisation	1	0	3	2
	HUM 1072	Human Rights and Constitution (MLC)	1	0	0	1	CSS 1023	Introduction to Object Oriented Programming Lab	0	0	3	1
	MME 1021	Workshop Practice	0	0	3	1	MME 1022	Computer Aided Engineering Graphics	0	0	3	1
	CSS 1021	Programming for Problem Solving Lab	0	0	3	1	IPE 4302	Creativity, Problem Solving & Innovation*	1	0	0	--*
	IPE 4302	Creativity, Problem Solving & Innovation*	1	0	0	--*						
			17	**3**	**8**	**22**			**17**	**2**	**11**	**22**
		Total Contact Hours (L+T+P)	**28**					**Total Contact Hours (L+T+P)**	**30**			

*After completing a project work along with other activities which are assessed periodically the students would earn 3 credits which would be considered in lieu of an open elective for Fifth Semester B Tech.

FIRST YEAR B.Tech. CURRICULUM 2025 (Common to all CS branches)
CHEMISTRY CYCLE/GROUP

Year	FIRST SEMESTER						SECOND SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
I	MAT 1103	Computational Mathematics - I	3	1	0	4	MAT 1203	Computational Mathematics - II	3	1	0	4
	CHM 1003	Applied Chemistry for Engineers	3	0	0	3	PHY 1003	Applied Physics for Engineers	3	0	0	3
	ELE 1003	Fundamentals of Electrical Engineering	2	1	0	3	ECE 1003	Fundamentals of Electronics	3	0	0	3
	CSS 1001	Programming for Problem Solving	2	1	0	3	MME 1003	Fundamentals of Mechanical Engineering	2	1	0	3
	CIV 1004	Environmental Studies	3	0	0	3	CSS 1002	Introduction to Object Oriented Programming	3	0	0	3
	CIV 1003	Engineering Mechanics & Smart Building	1	0	2	2	HUM 1072	Communication Skills in English	1	0	2	2
	IPE 1071	Universal Human Values and Professional Ethics (MLC)	1	0	0	1	CSS 1022	Data Visualisation	1	0	3	2
	HUM 1072	Human Rights and Constitution (MLC)	1	0	0	1	CSS 1023	Introduction to Object Oriented Programming Lab	0	0	3	1
	MME 1022	Computer aided Engineering Graphics	0	0	3	1	MME 1021	Workshop Practice	0	0	3	1
	CSS 1021	Programming for Problem Solving Lab	0	0	3	1	IPE 4302	Creativity, Problem Solving & Innovation*	1	0	0	--*
	IPE 4302	Creativity, Problem Solving & Innovation*	1	0	0	--*						
			17	**3**	**8**	**22**			**17**	**2**	**11**	**22**
		Total Contact Hours (L+T+P)	**28**					**Total Contact Hours (L+T+P)**	**30**			

*After completing a project work along with other activities which are assessed periodically the students would earn 3 credits which would be considered in lieu of an open elective for Fifth Semester B Tech.

MAT 1103: COMPUTATIONAL MATHEMATICS-1 [3 1 0 4]

Matrix Algebra: Elementary column and row transformations, Inverse of a matrix by elementary row operations, Echelon form and rank of a matrix, System of linear equations: Consistency, Solution by Gauss elimination, Gauss-Jordan, Jacobi and Gauss-Seidel methods, Eigen values and eigen vectors: Elementary properties, Spectral Matrix Decomposition, Diagonalisation, power of a matrix. Vector Spaces: Generalization of vector concept to higher dimensions, Generalised vector operations, Vector spaces and sub spaces, Linear independence and span, basis. Inner product spaces and Gram-Schmidt process of orthogonalization. Linear transformations. Differential Equations and Applications: Linear differential equations of first and higher order. Solution of homogeneous and nonhomogeneous linear equations using inverse differential operators, method of variation of parameters, and method of undetermined coefficients. Solution of Algebraic and Transcendental Equations: Tracing of parametric curves: Cycloid and related curves. Bisection method, Method of false position, Newton-Raphson method. Solution of System of Non-linear equations using Newton-Raphson method. Interpolation: Finite differences and divided differences. Newton-Gregory and Lagrange's interpolation formulae. Newton's divided difference interpolation formula. Discrete Numerical differentiation, Numerical integration: Trapezoidal rule, Simpson's 1/3rd rule and Simpson's 3/8th rule. Numerical solution of ordinary differential equations: Taylor's series method, Modified Euler's method, Runge-Kutta methods.

References:

1. B.S.Grewal, Higher Engineering Mathematics, 43nd edition, 2015, Khanna Publishers.
2. Kreyzig E, Advanced Engineering Mathematics, 9th edition, 2011, Wiley Eastern ,Delhi.
3. David C. Lay, Linear Algebra and Applications, 3rd edition, 2009, Pearson Education

   Sastry S.S - Introductory methods of Numerical analysis, 5th edn., PHI learning Pvt.Ltd, 2012.
5. Rainville E.D. and Bedient P.E., A short course in differential equations, 8th edition,2011, Prentice Hall, New York.
6. Sheldon Axler, Linear Algebra Done Right, Springer 2014.

MAT 1203: COMPUTATIONAL MATHEMATICS-II [3 1 0 4]

Partial Differentiation: Continuity of functions of two variables, Definition of partial derivative, Euler's theorem on homogeneous functions, Total derivative, Derivatives of composite & implicit functions. Errors and approximations. Taylor's theorem for functions of two variables, Maxima and Minima, Lagrange's method of undetermined multipliers, Linear Regression Models. Multiple Integrals: Definitions of Double and Triple integrals, Evaluation by the change of order of integration, change of variables, Jacobians. Applications to areas and volumes. Beta and Gamma functions and simple problems. Sequences and Series: Convergent sequences, computing sequence limits. Convergence and divergence of an infinite series. Tests: comparison test, ratio test, Cauchy's root test, Raabe's test, Integral test. Alternating series: Leibnitz's theorem, absolute and conditional convergence with problems. Power series. Efficient Computing Techniques: Modular Exponentiation by Repeated Squaring, Modular Multiplicative Inverse, Lucas Theorem to compute nCr, Primality Tests, Sieve of Eratosthenes and its implementation on a computer, Recurrent Problems, The Tower of Hanoi, Lines in the Plane, The Josephus Problem.

Laplace Transforms: Transforms of elementary functions, shifting theorems, Transforms of periodic functions, Unit step function. Inverse Laplace transforms. Convolution and Applications.

References:

1. B.S.Grewal - Higher Engineering Mathematics, 43nd edition, 2015, Khanna Publishers.
2. N.Piskunov-Differential Calculus, Vol I and II, 1996, Mir Publications .
3. Rainville E.D and Bedient P.E. A short course in differential equations, 8th edition, 2011, Prentice hall, New York.
4. Kreyzig E, Advanced Engineering Mathematics, 8th edition, 2006, Wiley Eastern, Delhi.
5. Shanti Narayan - Differential Calculus, 6th edition, 2014, Shyam Lal Charitable Trust, Delhi
6. Karl Beecher, Computational Thinking: A beginner's guide to problem-solving and programming (2017), BCS Publ.
7. Ronald L. Graham, Donald E. Knuth and Oren Patashnik, Concrete Mathematics: A Foundation for Computer Science (2nd Ed.) by (1994), Pearson Publ.

PHY 1003: APPLIED PHYSICS FOR ENGINEERS [3 0 0 3]

Characteristics of Lasers, Spontaneous and Stimulated emission, Einstein's coefficients Population Inversion, He-Ne Laser, Ruby Laser, Semiconductor Laser. Principle of optical fibre, acceptance angle and acceptance cone, Numerical aperture, Step-index and Graded index fibre, single mode and multi-mode fibres, attenuation and distortion in optical fibres. Black body radiation laws, Planck's hypothesis, Overview of photoelectric effect, The Compton effect, derivation of Compton shift equation, Overview of wave particle duality, Davisson and Germer Experiment. Quantum particle, wave packet, phase speed and group speed. The double-slit experiment revisited, Overview of uncertainty principle. The Schrodinger equation, the quantum particle under boundary conditions, particle in a box, Particle in a well of finite height, Tunnelling through a potential barrier and its applications. Dirac ket notation, The postulates of quantum mechanics. Moore's law, Single particle quantum interference, Classical & quantum information comparison. Differences between classical & quantum computing, quantum superposition and the concept of qubit. Properties of a qubit: Mathematical representation. Summation of probabilities, Representation of qubit by Bloch sphere. Quantum Gates: Single Qubit Gates: Quantum Not Gate, Pauli -Z Gate Hadamard Gate, Pauli Matrices, Phase Gate (or S Gate), T Gate. Multiple Qubit Gates: Controlled gate, CNOT Gate, (Discussion for 4 different input states). Representation of, Swap gate, Controlled -Z gate, Toffoli gate.

References:

1. PHYSICS for Scientists and Engineers with Modern Physics, Jewett & Serway, Cengage Learning, 7TH edition
2. Introduction to Fiber Optics, Ajoy Ghatak and K. Thyagarajan, Cambridge University Press, 2010.
3. Engineering Physics, S. P. Basavaraju, Subhas Stores, Bangalore – 2

4. Quantum Computing, Vishal Sahani, McGraw Hill Education, 2007 Edition.
5. Quantum Computation and Quantum Information, Michael A. Nielsen & Isaac L. Chuang, Cambridge Universities Press, 2010 Edition.
6. A text book of Engineering Physics, M N Avadhanulu, P G. Kshirsagar and T V S Arun Murthy, S Chand and Company Ltd. New Delhi-110055, Eleventh edition

CHM 1003: APPLIED CHEMISTRY FOR ENGINEERS [3 0 0 3]

Battery Technology :

Introduction to batteries. Lead-acid batteries, Nickel-metal hydride batteries, Lithium-ion batteries. Limitations and Sustainability Concerns. Case study

Materials Chemistry :

Introduction to polymers. Engineering polymers. Characterisation tools. Polymers for sustainability. Nanomaterials. Liquid Crystal Displays (LCDs). Organic Light-Emitting Diode (OLED) Displays. Emerging Display Technologies. Case study

Chemistry of Electronic Materials :

Classification of materials. Band theory of solids. Classification of sensors, Chemical and Electrochemical sensors. Case study

E-waste generation and management: (self-study topics) :

Environmental contamination through improper e-waste disposal. Case studies. Reimagine, Reduce, Reuse. Hazardous Chemicals in Electronics and Environmental Impact

Virtual Lab :

1. Li ion battery
2. Viscometry
3. Flame photometry
4. Colorimetry
5. pH sensor
6. Circular Economy approach

ECE 1003: FUNDAMENTAL OF ELECTRONICS

Analog Electronics: Rectifiers using diode, Rectifier Capacitor Filter, Zener Regulator, MOSFET amplifiers, Block diagram representation of Op-Amp, Op-Amp parameters, Linear and non - linear applications of Op-Amp. Digital Electronics: Number system classification, One's and two's complements, weighted and non-weighted codes, Self-complimenting codes, error detecting and correcting codes, Boolean algebraic theorems and simplification of Boolean expressions, Basic and Universal logic gates, Implementation of Boolean expressions using logic gates, Standard form of Boolean expression, Simplification of Boolean expressions using K-map and implementation using logic gates, Multiplexers and Demultiplexers, JK, SR, D and T flip-flops, Binary counters, Shift registers, Finite State Machines, Moore's and Mealy model.

References:

1. Robert L. Boylestad, Louis Nashelsky- Electronic Devices & Circuit Theory, 11th Edition, PHI, 2012 2. Behzad Razavi, "Fundamental of Microelectronics", Wiley, 2013. 3. Morris Mano- Digital design, Prentice Hall of India, Third Edition, 2013. 4. George Kennedy, Bernad Davis- Electronic Communication Systems, Fourth edition, TMH, 2004. 5. Raj Pandya, "Mobile and Personal Communication Services and Systems", Wiley-IEEE Press,1999.

CIV 1003: ENGINEERING MECHANICS AND SMART BUILDINGS [2 1 0 3]

Introduction to engineering mechanics, Rigid body, Force and system of forces, Composition, and Resolution of forces, Moment of forces, Varignon's theorem, Couple, Resultant of force system. Conditions of Equilibrium, Space diagram, and free body diagram, Lami's theorem, Equilibrium of concurrent and non-concurrent force systems, Friction.

Introduction to deformable bodies, Mechanical properties of materials, Stress, Strain, Hooke's law. Stress-strain behaviour of ductile and brittle material, Factor of safety, Stresses and deformations in prismatic, stepped, and tapered bars. Shear stress and strain, Poison's ratio, Volumetric stress and strain, Elastic constants and their relationships.

Smart building systems: HVAC, lighting control systems, access control systems, fire alarm notification, video IPTV, audio-visual system, energy, and sustainability. Case study on Building automation. Fundamentals of instrumentation and measuring systems in civil Engineering for recording parameters such as strain, force, displacement, distance, temperature, humidity, and pH. Case studies on the Application of Cloud computing & and IoT in construction safety and security. Fundamentals of Virtual Reality, Augmented Reality and Building Information Modelling, Transitioning of BIM to Digital Twins.

References:

1. Beer F. P., Johnston Jr. E. R., Dewolf J. T., Mazurek D. F., Sanghi S., Mechanics of Materials (7e), Tata McGraw-Hill, 2017.
2. Bhavikatti S. S., Strength of Materials (4e), Vikas Publishers, 2013.
3. James Sinopli, Smart building systems for Architects, owners and builders, Elsevier, Butterworth-Heinemann Publications, 2010
4. A.K.Ghosh, "Introduction to Measurements & Instrumentation", IIIrd, PHI
5. Eastman, C; Teicholz, P; Sacks, R; Liston, K, BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors: NewYork: Wiley. 2011

MME 1003: FUNDAMENTAL OF MECHANICAL ENGINEERING [3 0 0 3]

Principles of Thermodynamics, Laws of Thermodynamics, Principles and modes of heat transfer, Numerical. Properties of Steam: Formation of steam at constant pressure. Numerical. Refrigeration: Principle and working of vapour compression refrigeration system, Concepts and types of Air conditioning system, Numerical; I.C. Engines: Classification, 4 - stroke C.I and S.I Engines, Numerical. Power Transmission: Belt drives, Gear Drives, Numerical. Manufacturing Process: Introduction to Lathe, Drilling Machine and operations, Numerical. Automation and Advanced Manufacturing: Computer-Aided Design (CAD) Basics-Introduction to CAD. Introduction to automation, CNC machines, Robotics, robot configuration, application of robotics, additive manufacturing. Internet of Things (IoT) in Mechanical Systems- Basics of IoT, IoT Applications in Mechanical Engineering.

References:

1. K. R.Gopalakrishna, Text book of elements of Mechanical Engineering, Subhash Publications, Bangalore, 2005.
2. Rajput R. K., Elements of Mechanical Engineering, Fire Wall Media, 2005.
3. Groover Mikell P., Automation, Production systems, and Computer-

Integrated Manufacturing. Pearson Education India, 2016.
4. HMT Limited, Mechatronics, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
5. Maciej Kranz, "Building the Internet of Things: Implement New Business Models, Disrupt Competitors, Transform Your Industry", Wiley, 2016

ELE 1003: FUNDAMENTALS OF ELECTRICAL ENGINEERING [2 1 0 3]

Electric circuit analysis – Ohm's law, Kirchhoff's laws, loop and node analyses, source transformation, star-delta conversion, network theorems to DC circuits; DC Transients – RL, RC and RLC circuits; Single phase AC circuits - sinusoidal steady state analysis – phasors, network theorems, power; resonance; Polyphase circuits – 3 phase circuits.

Magnetic field – Basic laws, magnetic materials, BH characteristics, hysteresis and eddy current losses. Magnetically coupled circuits; Transformers – single phase and auto-transformers. Electro-mechanical energy conversion systems – DC machines, AC Machines, Special machines. (6 Hours) Introduction to Electrical Power Systems: AC and DC systems, Electric power generation, transmission and distribution, utilisation and costing of electricity. Power connections for critical loads, Electric safety.

Introduction to Power Electronics: Power Semiconductor Devices; Power converter classifications; Application: SMPS and UPS Systems, Electric Vehicles, Integration of PV to grid, etc.

References:

1. Nagrath I.J. and D. P. Kothari; Basic Electrical Engineering (4 Ed); Tata McGraw Hill (2019).
2. William H. Hayt, Jack Kemmerly, and Steven M. Durbin; Engineering Circuit Analysis (8 Ed); Tata McGraw Hill (2013).
3. Daniel W. Hart; Power Electronics; McGraw Hill (2011).
4. Debapriya Das; Fundamentals of Electrical Engineering; NPTEL Course – IIT Kharagpur (2018).

CSS 1001: PROGRAMMING FOR PROBLEM SOLVING [2 1 0 3]

Introduction to computing, Importance of Problem solving using computers, Algorithms and Flow charts, From algorithms and flowcharts to programs, Introduction to programming using C language, Simple C programs, Syntax and Logical Errors in compilation, Object and executable code, Data concepts in C, Operators in C, Expressions and Precedence, Input and output statements, Decision Making Statements: IF, IF-ELSE, Nested IF-ELSE, ELSE-IF

Ladder, Switch, Looping Statements: WHILE, DO-WHILE and FOR constructs, Control structures, 1-D, Multidimensional arrays: 2-D arrays and strings, Searching and sorting, Modularization, functions, and recursive functions, Pointers, Pointer arithmetic, Structures: Defining structures, Array of Structures, Pointer to structures, Files Concept.

References:

1. Computer fundamentals and programming in C, "Reema Thareja", Oxford University, Second edition, 2017.
2. Dromey.R. G, How to solve it by computers, Pearson Education, 2007.
3. Brian W. Kernighan and Dennis M. Ritchie, The C Programming language (2e), Pearson India, 2015.
4. Deital. P and Deitel. H. M, C: How to program (9e), Pearson, 2022.
5. Balagurusamy.E, Computing fundamentals and C programming (2e), MC GRAW HILL INDIA, 2017.

CSS 1021: PROGRAMMING FOR PROBLEM SOLVING LAB [0 0 3 1]

Familiarization with programming environment, Simple computational problems using C programming, Problems involving branching control structures, Iterative Problems, 1D array manipulation, 2D array programming (matrices), String operations, Introduction to Modular programming and solving problems using modularization, Recursive functions programming, Programs with pointers, structures, File operations.

References:

1. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
2. Brian W. Kernighan and Dennis M. Ritchie, The C Programming language (2e), Pearson Education, 2015.
3. Deital.P. J and Deitel.H.M, C: How to program (7e), Pearson Education, 2010.
4. Balagurusamy.E, Computing fundamentals and C programming (1e), MC GRAW HILL INDIA, 2017.

CSS 1002: INTRODUCTION TO OBJECT ORIENTED PROGRAMMING [2 1 0 3]

Course Objectives

- To understand complexity of software and clarity on decomposing it in function oriented and object oriented way.
- To design classes and objects and their relations based on problem definition
- To implement the designed solution using an object oriented language.

Programming paradigms, Complexity of software, bringing order to chaos, object model, object oriented design, object oriented analysis, object oriented programming, elements of object model, abstraction, encapsulation, modularity, typing, concurrency, applying the object model, classes, objects, state behavior, simple relationships among objects, The nature of a class, simple relationship among classes, the interplay of classes and objects, building quality classes and objects, classification. Introduction to Input/Output statements in C++, data types, classes, objects, member function overloading, array of objects, passing objects to functions, composition.

References:

1. Brahma Dathan, Sarnath Ramnath, "Object Oriented Analysis, Design and Implementation", (2e) Springer 2015.
2. Grady Booch et.al. "Object oriented design and analysis applications", (3e), Pearson Education, 2009.
3. Bhushan Trivedi, "Programming with ANSI C++", Oxford Press, (2e), 2012.
4. Balagurusamy E, "Object Oriented Programming with C++", (4e) Tata McGraw Hill Education Pvt.Ltd , 2010.

CSS 1023: INTRODUCTION TO OBJECT ORIENTED PROGRAMMING LAB [0 0 3 1]

Modeling using object oriented design and analysis. C++ program writing and execution, Illustration of input,output statements Data types, Variable and arrays, Operators and control statements, Classes and objects, arrays, Passing and returning objects, array of objects, object composition etc.

References:

1. Brahma Dathan, Sarnath Ramnath, "Object Oriented Analysis, Design and Implementation", (2e) Springer 2015.
2. Grady Booch et.al. "Object oriented design and analysis applications", (3e), Pearson Education, 2009.
3. Bhushan Trivedi, "Programming with ANSI C++", Oxford Press, (2e), 2012.
4. Balagurusamy E, "Object Oriented Programming with C++", (4e) Tata McGraw Hill Education Pvt.Ltd , 2010.

MME 1022: COMPUTER AIDED ENGINEERING GRAPHICS [0 0 3 1]

Introduction – Geometrical constructions, Dimensioning and conventions of lines.

Projection of points – Theory of Orthographic projections, Reference planes, Quadrants, Types of quadrants, Conventional representation of first angle projection system, projection of points in the first Quadrant only.

Projection of straight lines – Line parallel to both reference planes, Line perpendicular to either horizontal or vertical or profile plane, Line inclined to horizontal plane, Line inclined to vertical plane, Line inclined to both horizontal and vertical planes, Finding true length and true inclinations.

Projection of plane surfaces – Projections of regular planes (Triangle, Square, Rectangle, Pentagon, Hexagon and Circle), plane resting on edge and corner conditions, Surface inclined to HP and perpendicular to VP, Surface inclined to VP and perpendicular to HP.

Projection of solids – Projection regular solids like prisms & pyramids (Triangle, Square, Rectangle, Pentagon and Hexagon), Cone and cylinder, Solids resting on edge and corner conditions, Axis inclined to HP and parallel to VP, Axis inclined to VP and parallel to HP.

Isometric to orthographic conversion – Orthographic projections of machine components to be drawn.

Isometric projection – Isometric scale, Isometric projection of simple machine components.

CSS 1022: DATA VISUALIZATION [1 0 3 2]

Introduction to Data Science, Exploratory Data Analysis and Data Science Process. Tools for Data Analysis, Arrays and vectorized computation, Summarizing and Computing Descriptive Statistics. Data Loading, Storage and File Formats. Data Wrangling: Hierarchical Indexing, Combining and Merging Data Sets Reshaping and Pivoting. Data Visualization: plots, Data Aggregation and Group operations: Group by Mechanics, Data aggregation, General split-apply-combine, Pivot tables and cross tabulation, Time Series Data Analysis: Date and Time Data Types and Tools, Time series Basics, date Ranges, Frequencies and Shifting, Time Zone

Handling, Periods and Periods Arithmetic, Resampling and Frequency conversion, Moving Window Functions.

References:

1. McKinney, W., Python for Data Analysis: Data Wrangling with Pandas, NumPy and Python. 2nd edition. O'Reilly Media, 2017
2. O'Neil, C., & Schutt, R., Doing Data Science: Straight Talk from the Frontline, O'Reilly Media, 2013
3. B. Root, Python Plotting with Matplotlib. Packt Publishing, 2014.
4. J. VanderPlas, Python Data Science Handbook. O'Reilly Media, 2016.

Department of

Aeronautical and Automobile Engineering

The Department of Aeronautical and Automobile Engineering was established in 2008 with a vision of offering world-class education and cutting-edge research environment. The department strives for a healthy balance between teaching, research & development. Faculty of the department draws upon a long history of technical excellence, innovation and teaching performance, preparing graduates to contribute to the society with technically imaginative and commercially viable solutions. The vision is realised through commitment to educational excellence, to the creation, development and application of the technologies critical to aerospace and automobile engineering. This program aims to promote aeronautical & automobile engineering by establishing close linkages between education, industry and research activities. The department has highly successful Centres of Excellence program to research best practices in unified approach to teaching and learning.

The students will have abundant opportunities for working on projects and internships across the globe, taking advantage of established relationships with aerospace & automotive industries and research institutes. The students showcase their talent by developing several working models and presenting them in various prestigious national and international events. The students have won various awards at national and international level.

> Programs offered

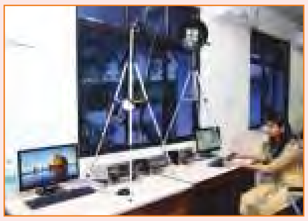
Undergraduate Programs

- B.Tech in Aeronautical Engineering (2008)
- B.Tech in Automobile Engineering (2008)

Postgraduate Programs

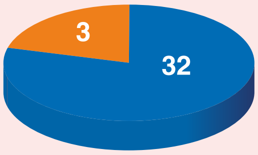
- M.Tech in Automobile Engineering (2016)
- M.Tech in Avionics (2019)
- M.Tech in Defence Technology (2021)
- M.Tech in Applied Computational Fluid Dynamics (2022)

PhD



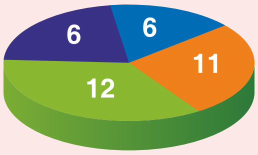
> Faculty Strength

Qualification-wise



- PhD
- M.Tech/ME/M.Sc

Cadre-wise



- Professors
- Associate Professors
- Assistant Professors
- Adjunct Faculty

B TECH AERONAUTICAL ENGINEERING

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2121	Engineering Mathematics - III	2	1	0	3	MAT 2221	Engineering Mathematics - IV	2	1	0	3
	AAE 2121	Introduction to Aircraft Structures	2	1	0	3	AAE 2221	Incompressible Aerodynamics	3	1	0	4
	AAE 2122	Materials and Processing Techniques	3	0	0	3	AAE 2222	Air-Breathing Propulsion	3	0	0	3
	AAE 2123	Engineering Thermodynamics	3	1	0	4	AAE 2223	Linear Control Theory	2	1	0	3
	AAE 2124	Fluid Dynamics	3	1	0	4	AAE 2224	Aircraft Performance	2	1	0	3
	AAE 2125	Introduction to Aerospace Engineering	3	0	0	3	AAE 2225	Advanced Aircraft Structures	3	0	0	3
	AAE 2141	Fluid and Thermal Engineering Lab	0	0	3	1	AAE 2241	Aerodynamics & Propulsion Lab	0	0	3	1
	AAE 2142	Structures Lab	0	0	3	1	AAE 2242	Numerical Computation Lab	0	0	3	1
			16	**4**	**6**	**22**			**15**	**4**	**6**	**21**
	Total Contact Hours (L + T + P)		**26**				**Total Contact Hours (L + T + P)**		**25**			
	FIFTH SEMESTER						**SIXTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	HUM 3021	Engineering Economics and Financial Management	3	0	0	3	HUM 3022	Essentials of Management	3	0	0	3
	AAE ****	Flexible Core 1:	3	0	0	3	AAE ****	Flexible Core 2:	3	0	0	3
	AAE 3121	Flight Dynamics and Control	4	1	0	4	AAE 3221	Aircraft Design	3	1	0	4
	AAE 3122	Compressible Aerodynamics	3	0	0	3	AAE ****	Program Elective I/Minor Specialization	3	0	0	3
	AAE 3123	Avionics and Navigation System	2	1	0	3	AAE ****	Program Elective II/ Minor Specialization	3	0	0	3
	IPE 4302	Open Elective-1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective-2	3	0	0	3
	AAE 3141	Geometric Modelling Lab	0	0	3	1	AAE 3241	Avionics Lab	0	0	3	1
	AAE 3142	Flight Dynamics and Control Lab	0	0	3	1	AAE 3242	Structural Design and Analysis Lab	0	0	3	1
			15	**2**	**6**	**21**			**18**	**1**	**6**	**21**
	Total Contact Hours (L+T+P) + OE		**25**				**Total Contact Hours (L+T+P) + OE**		**25**			
	SEVENTH SEMESTER						**EIGHTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
IV	AAE ****	Program Elective – III/ Minor Specialization	3	0	0	3	AAE 4291	Industrial Training				1
	AAE ****	Program Elective – IV/ Minor Specialization	3	0	0	3	AAE 4292	Project Work/Practice School				12
	AAE ****	Program Elective – V	3	0	0	3	AAE 4293	Project Work (B. Tech Honours) **				20
	AAE ****	Program Elective – VI	3	0	0	3	AAE ****	BTech Honours (Theory 1)** (V Semester)				4
	AAE ****	Program Elective – VII	3	0	0	3	AAE ****	BTech Honours (Theory 2)** (VI Semester)				4
	*** ****	Open Elective-3				3	AAE ****	BTech Honours (Theory 3)** (VII Semester)				4
	AAE 4191	Mini Project (Minor specialization)*				8						
			15	**0**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P) + OE		**15 + 3 = 18**									

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

FLEXIBLE CORE I

AAE 3124: Industrial IoT
AAE 3125: Finite Element Methods
AAE 3126: Rocket Propulsion

FLEXIBLE CORE II

AAE 3222: Machine Learning and AI
AAE 3223: Computational Fluid Dynamics
AAE 3224: Theory of Vibrations

MINOR SPECIALIZATIONS

I. AERODYNAMICS

AAE 4401: Applied Aerodynamics
AAE 4402: Turbomachinery Aerodynamics
AAE 4403: Experimental Aerodynamics
AAE 4404: High Speed Aerodynamics

II. AVIONICS SYSTEM ENGINEERING

AAE 4405: Unmanned Aircraft Systems, Sensors, and Instrumentation
AAE 4406: Antenna Design, Analysis, and its Applications
AAE 4407: Aerospace Embedded Systems, Software, Safety and Security
AAE 4408: Aircraft Communication and Networking

III. SPACE TECHNOLOGY

AAE 4421: Spaceflight Mechanics and Attitude Dynamics
AAE 4422: Spacecraft Systems and Engineering
AAE 4423: Launch Vehicle Systems and Technologies
AAE 4424: Space Data, Products and Services

OTHER PROGRAMME ELECTIVES

AAE 4441: Advanced Propulsion Systems
AAE 4442: Aeroelasticity
AAE 4443: Aircraft Electrical System Design and EMI/EMC Analysis
AAE 4444: Airship Technology
AAE 4445: Aviation Fuels & Combustion
AAE 4446: Aviation Management
AAE 4447: Composite Materials and Structures
AAE 4448: Computer Integrated Manufacturing
AAE 4449: Design of Fixed Wing Unmanned Aerial Vehicle
AAE 4450: Digital Manufacturing
AAE 4451: Electrochemical Energy Storage Systems
AAE 4452: Experimental Mechanics
AAE 4453: Heat Transfer
AAE 4454: Helicopter Engineering
AAE 4455: Industrial Automation and Robotics
AAE 4456: Lean Manufacturing
AAE 4457: Navigation, Guidance and Control
AAE 4458: Non-linear Control Systems
AAE 4459: Numerical Methods for Scientific Computing
AAE 4460: Operations Research
AAE 4461: Optimal Control
AAE 4462: Optimization Techniques in Engineering
AAE 4463: Spaceflight Dynamics
AAE 4464: Spaceflight Mechanics
AAE 4465: Statistical Quality Control and Reliability
AAE 4466: Surrogates and Approximations in Engineering Design
AAE 4467: Systems Engineering
AAE 4468: Total Quality Management
AAE 4469: Wind Energy Engineering

OPEN ELECTIVES

AAE 4311: Introduction to Aerospace Engineering
AAE 4312: Introduction to Avionics and Navigation System

THIRD SEMESTER

MAT 2121: ENGINEERING MATHEMATICS III [2 1 0 3]

Gradient, divergence and curl, Line, surface and volume integrals. Green's, divergence and Stoke's theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, Sine and cosine transforms. Partial differential equation- Basic concepts, solutions of equations involving derivatives with respect to one variable only. solutions by indicated transformations and separation of variables. One-dimensional wave equation, one dimensional heat equation and their solutions. Numerical solutions of boundary valued problems, Laplace and Poisson equations and heat and wave equations by explicit methods.

References:

1. Erwin Kreyszig: Advanced Engineering Mathematics, Wiley Eastern(1985).
2. S.S.Sastry : Introductory Methods of Numerical Analysis, Prentice Hall(1990).
3. B.S.Grewal : Higher Engg. Mathematics, edn., Khanna Publishers(1989)
4. Murray R.Spiegel : Vector Analysis, Schaum Publishing Co(1959).

AAE 2121: INTRODUCTION TO AIRCRAFT STRUCTURES [2 1 0 3]

Introduction to Aircraft Structural Components and their functions, Loads on Airframe, Stresses: Tensile, Compressive and Shear, Determination of Stresses on Inclined Planes, Principal Stresses, Strain. Analysis of Plane Truss – Method of Joints – 3 D Truss -Plane Frames - Composite Beam. Propped Cantilevers-- Fixed- Fixed Beam- Clapeyron's Three Moment Equation - Moment Distribution Method. Strain Energy due to Axial, Bending and Torsional Loads - Castigliano's theorem - Maxwell's Reciprocal Theorem, Unit load Method - Application to Beams, Trusses, Frames, Rings, etc. Euler buckling of columns, Inelastic buckling, Effect of Initial Imperfections, Beam Columns, Stability of Beams under Transverse and Axial Loads. Theory of pure Bending. Torsion of Beams. Theory of symmetrical and unsymmetrical bending of beams. Ductile and Brittle Materials Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory and simple problems of shaft under combined loading. Self-study topics recommended.

References:

1. Ramamurtham, S., Strength of Materials, Dhanpat Rai Publishing Co, New Delhi, (2014).
2. Megson, T.H.G., Aircraft Structures for Engineering Students, Elsevier ltd., (2017).
3. Donaldson B K, Analysis of Aircraft Structures, Cambridge Aerospace Series, McGraw-Hill, (2008).
4. Timoshenko, S., Strength of materials, Vols. I & II, Princeton, D.VonNostrand Co., (1988).
5. Peery, D.J., Aircraft Structures, McGraw–Hill, N.Y., (2011).
6. Rivello, R.M., Theory and Analysis of Flight Structures, McGraw Hill, (1993).

AAE 2122: MATERIALS AND PROCESSING TECHNIQUES [3 0 0 3]

Materials classification. Crystallography SC, FCC, BCC, HCP structures. APF. Miller indices: miller bravais indices, defects. Plastic Deformation of Metals and Alloys. Role of Dislocation; slip and twinning, Solid solution, Hume Rothery's rules, Phase diagrams, Phase and Lever Rules relationship of micro Structure and properties, Isomorphous systems. super alloys and Ashby chart. Introduction to powder metallurgy. Finishing and super finishing processes. Merits and demerits, limitations and applications. Rapid Prototyping techniques. Chip less machining, Internal and external thread rolling, Spline rolling, High Energy rate forming processes, Non-traditional machining techniques, Process principles, Process capabilities, Applications, Advantages and Limitations of Electromagnetic forming, Explosive forming, Magnetic pulse forming, shearing.

References:

1. Raghavan V, Material science and engineering, Prantice Hall India, (2004).
2. Avner Sidney, Introduction to physical metallurgy, Mc Graw Hill International, (1991).
3. Shackelford, Materials science for Engineers. Prantice Hall New Jersey, (1996).
4. Van Vlack, Materials science and Engineering, Addison Wesley, New York, (1989).
5. William D Callister, Material science and engineering, Wiley India, (2007).
6. Michael F Ashby , Material Selection in Mechanical design' Elsevier Science (2016)
7. Kalpakjian S., Manufacturing Engineering and Technology, Addison Wesley Publishing, Delhi, (2000).
8. Degarmopaul, Black & Kohser, Materials and Processes in Manufacturing (8/e), Prentice Hall of India, New Delhi, (2003).
9. Dalela S., Manufacturing Science and Technology" (Vol. II & III), Umesh Publishers, Delhi, (1998).

AAE 2123: ENGINEERING THERMODYNAMICS [3 1 0 4]

Introduction to Thermodynamics-System, Zeroth Law of Thermodynamics, First law applied to a Process – applied to a flow system – Steady Flow Energy Equation- Limitations of the First Law – Thermal Reservoir, Heat Engine, Heat pump , Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM of Second kind, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase – Energy Equation, Availability and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations –Third Law of Thermodynamics, Pure Substances-Mollier Charts, Phase Transformations – Triple point at critical state properties during change of phase, Dryness Fraction – Clausius – Clapeyron Equation Property tables. Mollier charts – Various Thermodynamic processes and energy Transfer – Steam Calorimetry, Ideal and Real gases- Perfect Gas Laws – Equation of State, specific and Universal Gas constants, Deviations from perfect Gas Model – Vander Waals Equation of State – Compressibility charts – variable specific Heats – Gas Tables. Mixtures of perfect Gases – Mole Fraction, Mass friction Gravimetric and volumetric Analysis – Dalton's Law of partial pressure, Avogadro's Laws of additive volumes – Mole fraction , Volume fraction and partial pressure, Equivalent Gas const. And Molecular Internal Energy, Enthalpy, sp. Heats and Entropy of Mixture of perfect Gases and Vapour, theory of psychrometry, Otto, Diesel, Dual Combustion cycles, Sterling Cycle, Atkinson Cycle, Ericcson Cycle, Lenoir Cycle –Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles. Brayton and Rankine cycles – Performance Evaluation – combined cycles, Bell-Coleman cycle, Vapour compression cycle-performance.Self-study topics recommended.

References:

1. Cengel Yunus A and Boles Michael A, Thermodynamics, Tata Mcgraw-Hill (2011)
2. Nag P K, Engineering Thermodynamics, Tata McGraw-Hill (2006)
3. Rajput, R.K., A textbook of Engineering Thermodynamics, Laxmi Publications (2010)
4. Mayhew A. and Rogers B., Engineering Thermodynamics, E.L.B.S. Longman (1994)
5. P L Ballaney, Thermal Engineering, Khanna Publishers (2012)

AAE 2124: FLUID DYNAMICS [3 1 0 4]

Fluid Properties and Fluid Statics: Hydrostatic law, Piezometer, Simple and differential manometers, pressure gauges. Hydrostatic forces on surfaces. Fluid Kinematics: Continuity equation, stream function, velocity potential function. Potential flow-Unifrom, sourse, sink and superimposed flow. Fluid Dynamics: Bernoulli's equation and application, Euler's equation, Flow Measurement devices: Venturimeter, Orifice meter, pitot tube. Dimensional analysis and Similitude. Flow through notches and weirs. Laminar and turbulent flow through pipes, Navier Stokes equation. Boundary layer theory and flow separation. Flow around submerged bodies- lift and drag. Introduction to compressible flow, speed of sound. Self-study topics recommended

References:

1. Yunus A Cengel, and Johm M Cimbala, Fluid Mechanics-Fundamentals and Application, McGraw-Hill, (2013).
2. Bansal R.K., A Text Book of Fluid Mechanics and Fluid Machine, Laxmi Publications,(2010).
3. Frank N white, Fluid Mechanics,McGraw Hill, (2011).
4. Bruce R. Munson, Theodore H. Okiishi, Wade W. Huebsch, Alric P. Rothmayer, Fundamentals of Fluid Mechanics,John Wiley and Sons, New Jersey, (2013).
5. Clayton T. Crowe, Donald F Elger, Barbara C Williams,John A Roberson, Engineering Fluid Mechanics, John Wiley and Sons, New Jersey, (2009).

AAE 2125: INTRODUCTION TO AEROSPACE ENGINEERING [2 1 0 3]

Introduction and Overview of The History of Flight, Fundamental Thoughts, Ballooning, Basic/Constructive Principles of Fluid

Mechanics-Bernoulli's Theorem and Control Volume Approaches, The Sources of all Aerodynamic Forces, Standard Atmosphere, Hydrostatic Equation, Incompressible and Compressible Flows, Elementary Thermodynamics and Isentropic flow, Flow Regimes and Estimation of Viscous, Thermal Effects, Basics of Aerodynamics, Airfoil Nomenclature, Lift, Drag and Moment Coefficient, Infinite vs Finite Wings, Pressure Coefficients, Elements of Airplane Performance, Astronautics, Basics of Propulsion. Orbital Mechanics Self-study topics recommended

References:

1. Anderson Jr. JD, Introduction to Flight, McGraw Hill International Edition, (2012)
2. Dava Newman, Interactive Aerospace Engineering and Design, McGraw Hill International Edition, (2002)
3. A.C. Kermode, Flight without Formulae, Pearson Education (United Kingdom), (1990)
4. Howard D Curtis., Orbital mechanics for Engineering Students, Butterworth Heinemann, (2013)
5. Anderson Jr. JD, Fundamental of Aerodynamics, McGraw Hill International Edition, (2017)

AAE 2141: FLUID AND THERMAL ENGINEERING LAB [0 0 3 1]

Irrigation Lab: Venturi meter, orifice meter, orifice, friction in pipes. Thermal Engineering Lab: Closed cup and open cup flash point and fire point, Saybolt viscometer, redwood viscometer, boys' gas calorimeter. Heat transfer lab: Measurement of emissivity, forced convection, and thermal conductivity in a metal bar.

References:

1. Yunus A Cengel, Fluid Mechanics, Tata McGraw Hill, (2010)
2. Ethirajan Rathakrishnan, Fluid Mechanics An Introduction, PHI publisher, (2013).
3. Kumar K. L., Chand S. & Co, Engineering Fluid Mechanics, (2005)
4. Frank N white, Fluid Mechanics, Mc-Graw Hill, (2011)
5. John F Douglas, Fluid Mechanics, Pearson Educations publishers, (2005)

AAE 2142: STRUCTURES LAB [0 0 3 1]

Experiments based on Tensile, Torsion, Bending, Compression, Fatigue, Impact and hardness properties of different structural materials. Helical spring, Deflection of beams, Poisson ratio calculations, Non-destructive testing.

References:

1. Megson, T.H.G., Aircraft Structures for Engineering Students, 6th edition, Elsevier ltd., (2017)
2. Donaldson, B.K, Analysis of Aircraft Structures – An Introduction (2e), McGraw Hill, (2008)
3. Timoshenko, S., Strength of materials, Vols. I & II, Princeton, D.VonNostrand Co., (1988)
4. Joseph A. Untener and Robert L. Mott, Applied Strength of materials, PHI, (2016)
5. Egor P. Popov, Engineering Mechanics of Solids, PHI, (2004)

FOURTH SEMESTER

MAT 2221: ENGINEERING MATHEMATICS IV [2 1 0 3]

Special Functions: Series solutions of Bessel and Legendre differential equations, Recurrence formulae, generating functions and Orthogonal properties for Jn(x) and Pn(x). Probability, finite sample space, conditional probability and independence, Bayes' theorem, one dimensional random variable: mean and variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least square principle of curve fitting. Distributions: binomial, Poisson, uniform, normal, gamma, chi-square and exponential. Moment generating function, Functions of one dimensional and two-dimensional random variables, Sampling theory, Central limit theorem and applications.

References:

1. Kreyzig E -. Advanced Engineering Mathematics, Wiley Eastern(1999).
2. Meyer P.L. - Introduction to probability and Statistical applications, American Publishing Co.(1965)
3. Hogg & Craig - Introduction of Mathematical Statistics, MacMillan(1975)
4. B. S. Grewal- Higher Engg. Mathematics, Khanna Publishers(1989)

AAE 2221: INCOMPRESSIBLE AERODYNAMICS [3 1 0 4]

Fluid motion Basics:- Streamline, pathline, types of flows, basic aerodynamics forces, boundary layer, Potential flows: stream function, velocity potential, their properties, Inviscid incompressible flows: governing equations, Blasius theorem, boundary layer equations, application of momentum theory, Low speed aerodynamics: airfoils: elementary flows, Kutta Joukowsky theorems, Kutta condition, circulation theorem , Flow over a wing: vortex element, downwash , induced drag, effect of aspect ratio, Conformal transformations, Zhokowsky transformation and its application, Wind Tunnel Techniques.

References:

1. Anderson, J. D., Fundamentals of Aerodynamics, McGraw-Hill International (2011).
2. Houghton, E. L. and Carruthers N.B., Aerodynamics for Engineering Students, Edward Arnold Publishers Ltd., London (2003).
3. Clancy L. J., Aerodynamics, Sterling Book House (2006).
4. L M Milne Thomson, Theoretical Aerodynamics, Courier Corporation (2011).
5. Ethirajan Radhakrishnan, theoretical aerodynamics, John Willey and Sons, Singapore Pte Ltd, (2013)

AAE 2222: AIRBREATHING PROPULSION [2 1 0 3]

Classification of propulsion systems, difference between airbreathing and non-airbreathing systems; types of nozzles, isentropic flow in nozzles, performance parameters of jet engines, factors affecting thrust, engine performance parameters, Ideal and Real Brayton cycles with intercooling, reheating and regeneration, Brayton cycle efficiency, ideal and real Brayton cycles for jet engines, such as, turbojet, turbofan, turboprop and turboshaft engines, Thrust produced by jet engine, specific thrust, TSFC, specific impulse, performance of a turbojet engine, advantages & disadvantages of jet engines, Ramjet engine, classification, construction and working, efficiency of ramjet, advantages & disadvantages, ideal and real cycles, thrust estimation from Ramjet, Pulse jet engines, construction and working, advantages and disadvantages, valved type and valveless pulse jet engines..

References:

1. Kroes Michael J; Wild Thomas W; Aircraft Powerplants, Tata-Mcgraw-Hill, (2010).
2. Hill Philip, Peterson Carl, Mechanics and Thermodynamics of Propulsion, Addison Wesly. (1992).
3. Roy Bhaskar, Aircraft Propulsion, Elsevier, India, (2008).
4. Mattingly J D, Elements of Propulsion - Gas Turbines and Rockets, AIAA Education series, (2006).
5. El-Sayed Ahmed, Aircraft Propulsion and gas Turbine Engines, Taylor and Francis, CRC press, (2008).
6. Saravanamuttoo, H.I.H., Rogers G.F.C., Cohen H. Gas Turbine Theory, Pearson(2001).
7. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, (1999).

AAE 2223: LINEAR CONTROL THEORY [2 1 0 3]

Brief overview of the historical development of Control system theory, Basic terminologies of the control systems, Mathematical modeling of Mechanical and electrical systems to determine the transfer functions. Development of block diagrams from governing differential equations, Rules for reducing the block diagrams, examples of block diagram reduction. Introduction to signal flow graph, Mason's gain formula. Introduction to time domain analysis, types of signals and their mathematical representation. Time domain response of I and II order systems to different types of signals. Error analysis and its impact on the system output. Introduction to frequency domain analysis, Graphical techniques- Bode and Polar plots. Routh Hurwitz stability criteria, Root locus technique. State space techniques.

References:

1. Ogata, K., Modern Control Engineering, Prentice Hall, (2010).
2. Norman S Nise, Control systems Engineering, John Wiley, (2019).
3. Kuo, B.C., Automatic Control System, Prentice Hall, (2014).
4. Gopal. M., Control Systems: Principles and Design, Tata McGraw-Hill, (2012).
5. Nagrath & Gopal, Modern Control Engineering, New Ages International (2014).
6. E. Bryson and Y-C Ho, Applied Optimal Control, Taylor and Francis, e book, (2017)

AAE 2224: AIRCRAFT PERFORMANCE [2 1 0 3]

Atmosphere and Flight Speeds: International Standard Atmosphere; Flight Speeds – IAS, CAS, EAS and TAS.

Review of Aerodynamics and Propulsion: Aircraft Lift and Drag Aerodynamics. Aerodynamic Efficiency. Aircraft Propulsion - Piston Engine - Propeller Aircraft, Turboprop and Turbojet/Turbofan Aircraft, Power and Thrust variation – Altitude and Speed. Specific Fuel Consumption.

Aircraft Performance: Performance Analysis -Steady Level Flight, Stall Speed. Flight Envelope. Climbing and Gliding Performance. Landing and Takeoff Performance. Balanced Field Length. Manoeuvre Load Factor. Level and climb Turn. Loop. Manoeuvre. V-n Diagram. Range and Endurance. Range and Pay Load Trade Off.

Mission Performance: Transport and Fighter Aircraft. Mission Analysis Energy Heights and Unsteady Flights: Energy Climb Performance. Unsteady Flights – Constant Energy Zoom Climb and Transonic Dive.

References:

1. Anderson, Jr, J, D, Aircraft performance and design, McGraw Hill (1999).
2. Anderson, Jr, J, D: Introduction to flight, McGraw Hill (2005).
3. Yechout, T. R: Introduction to aircraft flight mechanics. AIAA (2003).
4. Pamadi, B: Performance, stability, dynamics and control of an airplane, AIAA (2004).
5. RuijgrokG,J,J,: Elements of airplane performance, VSSD (2009).
6. Phillips, W,F,: Mechanics of flight, John Wiley (2010).

AAE 2225: ADVANCED AIRCRAFT STRUCTURES [2 1 0 3]

General types of construction, Types of Structure, Typical Wing and Fuselage Structure-Monocoque, Semi-Monocoque, Honeycomb and Sandwich structure, Aircraft materials, Bending Stresses in Beams of Unsymmetrical Sections. Thin Walled Beams, Concept of Shear Flow, Shear Centre, Elastic axis. With one Axis of Symmetry, With Wall Effective and Ineffective in Bending, Structural Idealization, Shear Flow Variation in Idealized Sections. Bredth – Batho Formula, Single and Multi – Cell Structures. Shear Flow in Single & Multicell Structures under Torsion. Shear Flow in Single and Multicell under Bending with Walls Effective and Ineffective. Buckling of Plates. Loads on an Aircraft – the V-n diagram – Shear Force and Bending Moment Distribution over the Aircraft Wing and Fuselage and other types of Wings and Fuselage, Thin Webbed Beam. With Parallel and non-Parallel Flanges, Shear Resistant Web Beams, Tension Field Web Beams (Wagner's). Composite Materials in Aerospace Applications.

References:

1. Donaldson B.K., Analysis of Aircraft Structures, Cambridge Aerospace Series, McGraw-Hill, (2008)
2. Bruhn E.F., Analysis and Design of Flight Vehicle Structures, Tristate Offset Co., (1980)
3. Peery D.J., Aircraft Structures, McGraw–Hill, N.Y., (2011)
4. Megson T.M.G., Aircraft Structures for Engineering Students, Edward Arnold, (2007)
5. Rivello R.M., Theory and Analysis of Flight Structures, McGraw-Hill, (1993)

AAE 2241: AERODYNAMICS & PROPULSION LAB [0 0 3 1]

Introduction to Wind tunnel and Propulsion labs and familiarizing the apparatus, Introduction to wind tunnel and its calibration, flow over a cylinder, Pressure distribution and flow over symmetric and cambered airfoils, Boundary layer calculations, Calculation of zero lift angle and hot wire anemometer, Calculation of drag of a cylinder and airfoil by using wake survey method, Demonstration of 6 component balance and water tunnel visualization, Performance of mini gas turbine, Axial flow fan performance, Free jet and wall jet experiment, Calculation of burning velocity, forced & natural convection, Performance of convergent nozzle, Bomb calorimeter, propeller test rig experiment.

References:

1. Jewel B Barlow, William H Rae, Alan Pope Low speed wind tunnel testing, Wiley-Interscience, (1999).
2. J.D. Anderson, Fundamental of Aerodynamics, McGraw-Hill Education; (2016).
3. George P. Sutton, Rocket Propulsion Elements, Wiley India Pvt Ltd, (2010).
4. National Aeronautics and Space Administration. 1985. Aeronautical Facilities Catalogue. 1: Wind Tunnels (NASA RP-1132). Washington, D.C. National Academies of Sciences, Engineering, and Medicine. 1992. Aeronautical Technologies for the Twenty-First Century. Washington, DC:The National Academies Press. https://doi.org/10.17226/2035.

AAE 2242: NUMERICAL COMPUTATION LAB [0 0 3 1]

Introduction to MATLAB Programming: Basics of MATLAB programming – Array operations in MATLAB – Loops and execution control – Working with files: Scripts and Functions – Plotting and program output; Approximations and Errors; Numerical Differentiation and Integration; Linear equations; Non-linear equations; Regression and Interpolation; Ordinary differential equation (ODE solvers).

References:

1. Robert J. Schilling and Sandra L. Harries, Applied Numerical Methods for Engineers using MATLAB and C, Thomson Learning Inc., (2000).
2. Brian R Hunt, et al, Guide To MATLAB: For Beginners and Experienced Users, Cambridge University Press, (2011).
3. Fausett L.V., Applied Numerical Analysis Using MATLAB, Pearson Education, (2007).
4. Chapra S.C. and Canale R.P., Numerical Methods for Engineers, McGraw Hill, (2006)
5. william palm, Introduction to MATLAB for Engineers (2010)

FIFTH SEMESTER

HUM 3021: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of Single, Uniform, and Gradient cash flow. Related problems and case studies. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, declining and double declining balance method of depreciation, Sum-of-the-Years Digits, Sinking Fund and Service Output Methods, Case Study. Balance sheet and profit & loss statement. Meaning & Contents. Ratio analysis, financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios, Drawbacks. Safety and Risk, Assessment of Risk and safety, Case study, Risk Benefit Analysis and Reducing Risk.

References:

1. Chan S. Park, "Contemporary Engineering Economics",Pearson Prentice Hall (2007).
2. Thuesen G. J, “Engineering Economics”, Prentice Hall of India, New Delhi (2005).
3. Blank Leland T. and Tarquin Anthony J., “Engineering Economy”, McGraw Hill, Delhi (2002).
4. Prasanna Chandra, “Fundamentals of Financial Management”, Tata McGraw Hill, Delhi (2006).

FLEXIBLE CORE 1

AAE 3124: INDUSTRIAL IOT [3 0 0 3]

Industrial Networks and IIoT: Now and Future Trends, Wireless Communication for the Industrial IoT, IoT-Driven Advances in Commercial and Industrial Building Lighting, Automation Trends in Industrial Networks and IIoT, Security in Decentralised Computing, IoT and Industrial IoT, Intrusion Detection in Industrial Networks via Data Streaming, Technological Aspects of Industry 4.0 and IIoT, Enabling Technologies of IIoT, Applications and Case Studies. Self-Study topics recommended.

References:

1. Ismail Butun, Industrial IoT Challenges, Design Principles, Applications, and Security, Springer (2020).
2. Giacomo Veneri Antonio Capasso Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0, Ingram short title publications (2018).
3. Sandeep Misra, Chandana Roy, Anandarup Mukherjee Introduction to Industrial Internet of Things and Industry 4.0, Taylor and Francis (2021).
4. Alasdair Gilchrist,Industry 4.0: The industrial Internet of Things, Apress (2016).
5. Sudan Jha Usman Tariq, Gyanendra Prasad Joshi Vijender Kumar Solanki, Industrial Internet of Things Technologies, Design, and Applications , Taylor and Francis (2022)

AAE 3125: FINITE ELEMENT METHODS [2 1 0 3]

Introduction: Origin of FEM, Applications, basic steps, differential equations of physical problem, analytical and approximate solution, difference between Fem and Finite Difference Method. Pre-processing, processing and post processing, computational tools etc. Brief matrix notation and operation, advantages and disadvantages of FEM. Finite Element Formulation: Weighted residual method, Rayleigh Ritz Method, principal of minimum potential energy. One-Dimensional FEM: Formulation of one-dimensional element equation (bar/spring element, truss, beam element) 2/3-Dimensional analysis: Plane stress, Plane strain. FE formulation of Constant Strain Triangular and Linear Strain triangular element, FE formulation of 3D element. Practical consideration in Finite Element Modeling: General Considerations, Aspect Ratio and Element Shapes, Use of Symmetry, Sizing of Elements and the h, p, and r Methods of Refinement, Concentrated or Point Loads and Infinite Stress, Connecting (Mixing) Different Kinds of Elements. Equilibrium and Compatibility of Finite Element result, Convergence of Solution, Contact Modelling and large deformation modelling, Self-study topics recommended.

References:

1. Logan D L, First course in the Finite Element Method, Cengage learning, (2016).
2. Sheshu P., Textbook of Finite Element Analysis, PHI Learning Private Limited, (2003)
3. Robert D Cook, David S Malkus, Micheal E Plesha, Concept and Application of Finite Element Analysis, John Wiley and Sons (1989).
4. Singiresu S Rao, The Finite Element Method in Engineering, Elsevier Inc,(2018).
5. Saeed Moaveni, Finite Element Analysis:Theory and application with ANSYS, Prentice Hall(1999).

AAE 3126: ROCKET PROPULSION [2 1 0 3]

Rockets: introduction, classification. Rocket nozzles: C-D nozzle fundamentals, nozzle coefficients, operation regimes, performance, and classification. Chemical rocket propulsion: fundamentals, thrust, exhaust velocity, total and specific impulse, performance parameters. Rocket equation, staging and analysis. Liquid propulsion: Propellant feed mechanism, tanks, injectors and thrust chambers, propellants, and cooling. Solid rockets: Construction, performance relations, propellant grain and configuration, propellant ingredients, burning rate, thrust chamber cooling. Hybrid rockets- construction, propellants, performance analysis.

References:

1. Hill, P. G. and Peterson, C. R., Mechanics and thermodynamics of propulsion, Reading, Massachusetts: Addison Wesley Publishing Company, (1992).
2. Sutton, G. P. and Biblarj, O., Rocket propulsion elements, New York: Wiley Interscience Publications, (2001).
3. Mukunda, H. S., Understanding aerospace propulsion, Bangalore: Interline Publishing, (2004).
4. Ramamurthi K., Rocket Propulsion, Macmillan, (2009).
5. Misra D. P., Fundamentals of Rocket Propulsion, CRC Press, (2017).

AAE 3121: FLIGHT DYNAMICS AND CONTROL [3 1 0 4]

Aircraft Equations of Motion, Modelling of Longitudinal Aerodynamic Forces and Moments in Steady State, Modelling of Longitudinal Aerodynamic Forces and Moments in Perturbed State, Modelling of Lateral Directional Aerodynamic Forces and Moments in Steady state, Modelling of Lateral Directional Aerodynamic Forces and Moments in Perturbed State, Static Stability, Modelling of Longitudinal and Lateral Directional Thrust Forces and Moments in both Steady and Perturbed State, Dynamic Stability, Solutions to Longitudinal Equations, Longitudinal Dynamic Modes and Approximations: Short Period and Phugoid, Lateral Directional Dynamic Modes and Approximations: Spiral, Roll Subsidence and Dutch Roll, sensitivity analysis and Cooper Harper Ratings.

References:

1. M.R. Napolitano" Aircraft Dynamics from Modeling and Simulation", WILEY Publications, (2012).
2. Schmidt L.V. "Introduction to Aircraft Flight Dynamics", AIAA Education Series, (2001).
3. McRuer Det. Al. Aircraft Dynamics and Automatic Control" Princeton University Press, NJ, (2004).
4. Stengel R.F., "Flight Dynamics", Princeton University Press, NJ, (2004).
5. Jan Roskam, "Airplane Flight Dynamics and Automatic Flight Controls", DAR Corporation, (2001).

AAE 3122: COMPRESSIBLE AERODYNAMICS [2 1 0 3]

Fundamentals of compressible fluid dynamics and application to external and internal flows. Quasi-one-dimensional channel flow, extensions, and analysis of multi-dimensional flows in nozzles, diffusers, and inlets. Forces, moments, and loss generation resulting from compressible fluid flow interactions with aerodynamic shapes in subsonic, supersonic, transonic, and hypersonic flight, shock waves, and vortices. Disturbance behavior in unsteady compressible flow.

References:

1. Anderson, J.D., Modern Compressible Flow: With Historical Perspective, McGrawHill, (2002).
2. Liepmann and Roshko, Elements of Gas dynamics, Dover Publications(2013).
3. Philip A Thompson, Compressible-fluid Dynamics, Mc Graw Hill (1971).
4. Robert W. Fox and Alan T. McDonald, Introduction to Fluid Mechanics, John Wiley & Sons (2004).
5. Thompson, P. A. Compressible Fluid Dynamics. Maple Press Company (1984).

AAE 3123: AVIONICS AND NAVIGATION SYSTEMS [2 1 0 3]

Introduction Unmanned Air Vehicle, UAV Instrumentations and Sensors, Introduction to Avionics in aircraft, Organization framework, avionics architectures generation, types of payloads, Cockpit Layout of old and modern aircrafts, Essential and Non-essential Avionics equipments, Displays, Packaging, ARINC and DOD Types, System Cooling, EMI/EMC Requirements; Aircraft Power Systems, Aircraft Embedded Systems, Analog and Digital Communication, Fiber Optic Comm. Antenna and types of antenna, software to design antenna, Satellite Communication, Flight control laws, FBW, Autopilot, FMS, LRU, IMA & Mission Systems, Warning systems, Engine Control. Inertial Sensors and Inertial Navigation Systems, Elements of Navigation Systems, Satellite Navigation Systems, Radar & Mechanics of landing and types Landing Systems. Software Standards-CERT, MISRA, DO178B/C.

References:

1. Cary R. Spitzer: Digital Avionics Handbook-Avionics Development and Implementation , CRC Press, Taylor & Francis Group, (2007).
2. Arjun Singh: Airport Ground Navigation Systems, Tata McGraw Hill Education Pvt. Ltd, (2012).
3. Thomas K. Eismin, Aircraft Electricity and Electronics, Tata McGraw Hill Education Pvt. Ltd, (2014).
4. R.P.G. Collinson: Introduction to Avionics Systems, Springer, (2002).
5. Myron Kayton& Walter R. Fried: Avionics Navigation Systems, Wiley-interscience, (1997).
6. Steven R. Hirshorn, NASA Systems Engineering Handbook, National Aeronautics and Space Administration, (2007).
7. Mohinder S Grewal: Global Navigation Satellite Systems, Inertial Navigation and Integration, John Wiley, (2013).

AAE 3141: GEOMETRICAL MODELLING LAB [0 0 3 1]

Sketcher Exercises- 2D, Part Modelling tool for 3D Modelling of components and Assembly Exercises, Generative Wireframe and Surface for Surface Modelling.

References:

1. Sham R Tickoo “CATIA V5:6R2015 for Designers”, CADCIM Technologies, (2009)
2. JaecheolKoh “Catia V5-6r2014 Surface Design: A Step by Step Guide”, Createspace Independent Publishers, (2015).

AAE 3142: FLIGHT DYNAMICS AND CONTROL LAB [0 0 3 1]

Introduction to control system, Stability analysis of the system using Root locus, Bode plot, Nyquist plot and Polar plot techniques. Airborne vehicle system modelling: Differential Equation, Transfer Function, state space analysis. Familiarization with SIMULINK, Control system toolbox, Aerospace Toolbox, Navigation Toolbox, UAV Toolbox, Communication Toolbox, Mass-Spring-Damper Systems, Classical Control: PID Design, DC Motor position and speed controller, Aircraft pitch control.

References:

1. Brian L. Stevens, Frank L. Lewis, Eric N. Johnson : Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems, Wiley (2025).
2. S. Hasan Saeed: Automatic Control Systems (With Matlab Programs, Arihant (2013)
3. Modeling, Analysis and Design of Control Systems in MATLAB and Simulink. Mathworks Ebook.
4. Robert F. Stengel, Flight Dynamics, 1st edition, Princeton University Press (2004) Rama K. Yedavalli, Flight Dynamics and Control of Aero and Space Vehicles, John Wiley & Sons, Inc.

SIXTH SEMESTER

HUM 3022: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Definition of management and systems approach, Nature & scope. The Functions of managers, Principles of Management. Planning: Types of plans, steps in planning, Process of MBO, how to set objectives, strategies, policies and planning premises, Strategic planning process and tools. Nature and purpose of organizing, Span of management, factors determining the span, Basic departmentation, Line and staff concepts, Functional authority, Art of delegation, Decentralization of authority. HR theories of planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership – leadership behavior & styles, Managerial grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit and Loss control, Control through ROI, Direct, Preventive control. PROFESSIONAL ETHICS - Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories about right action, Self-interest, Customs and Religion, Uses of Ethical Theories. GLOBAL ISSUES - Managerial practices in Japan and USA & application of Theory Z. The nature and purpose of international business & multinational corporations, unified global theory of management, Entrepreneurship and writing business plans. Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisers, Moral Leadership, Code of Conduct, Corporate Social Responsibility.

References:

1. Harold Koontz & Heinz Weihrich ,Essentials of Management, McGraw Hill, New Delhi(2020).
2. Peter Drucker ,The practice of management, Harper and Row, New York(2004).
3. Vasant Desai, Dynamics of entrepreneurial development & management, Himalaya Publishing House(2007).
4. Poornima M Charantimath, Entrepreneurship Development, Pearson Education (2006).

FLEXIBLE CORE 2

AAE 3222: MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE [3 0 0 3]

Define Artificial Intelligence, AI techniques, Difference between AI and Machine learning, Search using BFS and DFS, Hypothesis testing (Confidence intervals, p-value, types of tests), Probability Density Estimation, Entropy and cross-entropy, Linear Algebra, Linear regression, Logistic regression , Clustering, Naive bayes, Decision tree and random forest algorithms, Mixture models, Classification, Bias-Variance Tradeoff, Overfitting, Underfitting, Hyperparameter Tuning, Support Vector machines, Singular value decomposition, Principle component analysis, Artificial neural networks, Biological Neuron, McCulloch-Pitts Neuron Model, Feed forward Network, Hebbian learning rule, Perceptron learning rule, Activation functions, Gradient descent (batch and stochastic), Singe layer perceptrons, XOR problem, Multi-layer perceptrons, Radial basis functions, Regularization methods, Cross validation, Data augmentation, Deep learning, Convolutional neural networks (CNNs), Layers in a CNN, Recurrent neural networks, Transfer learning, Evaluation metrics, Case studies.

References:

1. Stuart J. Russell and Peter Norvig: Artificial Intelligence -A Modern Approach, Pearson, Prentice Hall. Series in Artificial Intelligence, Englewood Cliffs, 2010.

2. Simon Haykin: Neural Networks - A Comprehensive Foundation, Prentice Hall, 1998.
3. Daniel Graupe: Principles of Artificial Neural Networks, World Scientific, 2007.
4. Rich and Knight: Artificial intelligence, Mc Graw Hill India, 2010
5. Jacek M Zurada: Introduction to artificial Neural Systems, West, 1992.
6. Christopher M. Bishop: Neural Networks for Pattern Recognition, Springer, 2007.
7. Aaron Courville, Ian Good fellow and Yoshua Bengio: Deep Learning: Adaptive computation and machine learning, MIT Press, 2017.

AAE 3223: COMPUTATIONAL FLUID DYNAMICS [2 1 0 3]

Derivation of governing equations of fluid dynamics and discussion on characteristic of the governing equations, the initial and boundary conditions. The mathematical behaviour of different classes of partial differential equations. Discretization of governing equations using Finite Difference and Control Volume approach. The basic solution techniques for steady-state and transient equations. Solutions of Diffusion Problems. Numerical methods for steady 1-D convective flow with diffusion. The need for a staggered grid. Discussion on SIMPLE, SIMPLER and PISO algorithms. Implementation of Boundary Conditions in Computational Fluid Dynamics.

References:

1. John D Anderson Jr., Computational Fluid Dynamics- The Basics with Applications, International Edition. McGraw Hill. New York (2013).
2. Suhas V Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere / McGraw Hill New York (2018).
3. Versteeg H. K., Malalasekera W. An Introduction to Computational Fluid Dynamics- The Finite Volume Method, Pearson Education Limited, London (2007).
4. Anderson D. A, Tannehill J. C, and Pletcher R. H., Computational Fluid Mechanics and Heat Transfer, Taylor and Francis Group. New York (2020).
5. Chung T. J., Computational Fluid Dynamics, Cambridge University Press South Asia Edition (2013).
6. Fletcher C. A. J., Computational Techniques for Fluid Dynamics, Springer- Verlag. Berlin, (2012).

AAE 3224: THEORY OF VIBRATIONS [2 1 0 3]

Vibrations terminology, free undamped and damped vibrations, governing differential equations of different systems and computing natural frequencies. Coulomb damping and derivation of differential equation. Forced vibrations harmonic excitation and rotating unbalance. Base excitation and concept of displacement and force transmissibility ratio and isolation. Force vibration with Coulomb damping. Analyzing 2DOF sprig mass undamped system and deriving the natural frequency and concept of mode shapes. Coordinate coupling and numerical examples. Concept of Dynamic vibration and Pendulum absorber. Analysis of MDOF systems, concept of influence coefficients. Determining natural frequency and mode shapes of MDOF systems- by direct approach and numerical methods. Concept of continuous systems. - Vibrations measuring instruments and concept of NVH..

References:

1. Singirisu Rao S, Mechanical Vibration, Pearson Education (2018).
2. Dukkapatti Rao V, Text Book of Mechanical Vibration,Prentice Hall of India Ltd (2012).
3. Daniel Imnan J., Engineering Vibration , Prentice Hall, New Delhi, (2007).
4. Groover G.K., Mechanical Vibrations, Nemchand And Bros, Roorkee, (2009).
5. Thomson W.T., Theory of Vibrations with Applications, Chapman and Hall (2008).
6. C Sujatha, Vibrations and Acoustics-Measurement and Signal analysis, Mc Graw Hill India, (2017).

AAE 3221: AIRCRAFT DESIGN [3 1 0 4]

Overview of the Design Process, Airfoil and Geometry Selection, Design constraint diagram - Thrust-to-Weight Ratio and Wing Loading, Takeoff Weight and Empty weight. Initial Sizing. Control-Surface Sizing, Engine selection; Configuration Layout - Wing, Landing Gear and Engine location. 3 View diagram, Aerodynamic Considerations, Structural Considerations, Vulnerability Considerations, Propulsion and Fuel System Integration, Design Cycle of a New Design – Feasibility, Configuration Design, Detailed Design phases - Aerodynamics, Propulsion, Flight Performance, Structures and Loads, Weight and CG, Group Weights Method, Longitudinal Static Stability and Control, Lateral-Directional Static Stability and Control and Handling Qualities. Design Compliance Matrix.

References:

1. Leland Nicolai, Grant Carichner, Fundamentals of aircraft and airship design, AIAA Educational Series (2010).
2. Daniel P Raymer, Aircraft Design – A Conceptual approach, AIAA series (2018).
3. Lloyd R Jenkinson, Paul Simpkin, Parren Rhodes ,Civil Jet Aircraft Design , AIAA series( )
4. L. R Jenkionson, J.F. Machman, Aircraft Design projects for engineering students ,Butterworth Heinemann (2003)
5. Steven A. Brandt , Randall J. Stiles, John J. Bertin, Ray Whitford ,Introduction to Aeronautics: A Design Perspective, AIAA Education Series (2015).

AAE 3241: AVIONICS LAB [0 0 3 1]

Digital Circuits: Digital Circuit Verification, Microprocessor: Assembly Programming, Embedded Systems–Keil, Vivado, LDRA Tool /DO178B/C, Lab VIEW, Standard, Unmanned Aircraft Systems and Instrumentation, Communication, Autopilot and Payloads, PCB design and manufacturing, Circuit design and simulation, Aircraft Electrical Test Rig and parameter test and analysis EMI/EMC test, Antenna Design, manufacturing and testing, Satellite communication, Testing using VNA, RF Source and Spectrum analyzer. Communication protocols, aircraft databus, Flight Simulator, UAV flying. MATLAB and Simulink.

References:

1. K.V. Shibu: Introduction to Embedded Systems, McGraw Hill Education India Private Limited(2009).
2. C.A. Balanis: Antenna Theory - Analysis and Design , John Wiley, (2016)
3. Michael Barr, Anthony Massa: Programming Embedded Systems, Second Edition with C and GNU Development Tools, O'Reilly Media, (2009)
4. Brian L. Stevens, Frank L. Lewis & Eric N. Johnson: Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems , Wiley-Blackwell, (2015)
5. Roger Hu: PCB Design and Layout Fundamentals for EMC, Independent Publsihed, (2019)
6. Dr. Reinaldo J. Perez: Handbook of Aerospace Electromagnetic Compatibility, IEEE Press, Wiley, (2018)
7. Mike Tooley and David Wyatt: Aircraft Electrical and Electronic Systems: Principles, Operation and Maintenance, Butterworth-Heinemann: Elsevier, (2009)

AAE 3242: STRUCTURAL DESIGN AND ANALYSIS LAB [0 0 3 1]

Analysis of Truss/Link Elements, Beam Elements, Shell Elements, Plane Stress/ Plane Strain analysis, 3D Structural analysis, Thermal Analysis, Modal Analysis, Fluid Flow CFX, Modal analysis.

References:

1. Erdogan Madenci and Ibrahim Guven,The Finite Element Method and Applications in Engineering Using ANSYS, Springer Publications, (2016).
2. Guangming Zhang,Engineering Analysis with Pro/Mechanica and Ansys, College House Enterprises, LLC, (2017).
3. Sham Tickoo, Ansys Workbench 14.0 for Engineers and Designers, Dream Tech Press, US (2013).

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

AAE 4291: INDUSTRIAL TRAINING [0 0 0 1]

Student is to undergo industrial training for a minimum period of 4 weeks during the vacation. After successful completion of training, student is to submit a report to the department and also makes a presentation on training.

AAE 4292: PROJECT WORK / PRACTICE SCHOOL [0 0 0 12]

The student is required to carry out a project work in the institution / industry / research laboratory / institution of higher learning. The minimum duration of the project work/practice school is 16 weeks. As part of project work / practice school, the student is also required to prepare a project report and make a presentation on the work carried out.

PROGRAM ELECTIVES

AAE 4441: ADVANCED PROPULSION SYSTEMS [3 0 0 3]

Introduction to advanced propulsion and aerothermodynamics, limitations of turbojets and turbofans. Need for supersonic combustion; Ramjet engines, working principle, basic consideration, operating principles and performance, basic principle of operation, thrust calculation, efficiency, Inlet types, nozzle considerations, Scramjet, spill-over drag, plume drag. Isolator, combustor, thermal protection, Combined cycle engines-turbo-ramjet, Airturbo-rocket (ATR), ejector ramjet, Liquid-air collection engine (LACE)-need, principle, construction, operation, performance, pulsejet, types and working principle; Nuclear propulsion history, Power, thrust, energy. Nuclear fission-basics, sustainable chain reaction, neutron leakage, control, reflection, prompt and delayed neutrons, thermal stability. Principles and fuel elements. The nuclear thermal rocket engine types, start-up and shutdown.

Electrical propulsion systems, Definitions, thrust equations, performance parameters, Limitations of chemical rocket engines. Electric propulsion systems-structure, types, generation of thrust. Electro static thrusters, electromagnetic thrusters, applications to space missions, pulsed plasma thrusters (PPT) for micro-spacecraft, solar electric propulsion.

Micro-propulsion, application of MEMS, chemical, electric micro-thrusters, principle, description, Propellantless propulsion, teethers, momentum exchange, Photon rocket, beamed energy propulsion, solar, magnetic sails.

References:

1. Ahmed F.El-Sayed ,Aircraft Propulsion and Gas Turbine Engines, CRC Press (2017).
2. Cornelisse, J. W., Schoyer H.F.R. and Wakker, K.F., Rocket propulsion and space flight Dynamics, Pitman, (1979).
3. Turner, M.J.L., Rocket and Spacecraft Propulsion, Springer, (2001).
4. Flack, R. D. ,Fundamentals of Jet Propulsion with Applications, Cambridge University Press(2005).
5. Mattingly J.D.,Elements of Gas Turbine Propulsion, Mc Graw Hill Education(1996).
6. Roy Bhaskar, Aircraft Propulsion,Elseiver, India, (2008)
7. William R Corliss, Propulsion systems for space flight, Mc GrawHill, (1970).
8. Philip Hill, Carl Peterson, Mechanism and Thermodynamics of Propulsion, Pearson, (2010).
9. D P Mishra, Fundamentals of Rocket Propulsion, CRC Press, (2017).
10. William Emrich, Principles of Nuclear Rocket Propulsion, Elsevier, (2016).

AAE 4442: AEROELASTICITY [3 0 0 3]

Introduction to Aeroelastic problems and Aircraft Structures, Deformation of Structures and Influence Coefficients, Energy Methods, Lagrange's Equation, Static Aeroelasticity, Divergence of lifting surfaces, Divergence of a 2D Airfoil, Control Reversal and Effectiveness, Symmetric and Anti-Symmetric Flow Conditions. Effect of Sweep in Divergence, Dynamic Aeroelasticity, Flutter Speed Calculations, Flutter Conics, Buffeting.

References:

1. J Wright and J Cooper, Introduction to Aircraft Aeroelasticity and Load, John Wiley and Sons UK, (2007).

2. R.L.Bisplingshoff, H Ashley, R.L.Halfman, Aeroelasticity, Dover Publications Inc, New York, (1996).
3. Y.C. Fung, An Introduction to the Theory of Aeroelasticity, Dover Publications Inc, New York, (1993).
4. Ulgen Gulcat. Fundamentals of Modern Unsteady Aerdynamics, Springer Publications, (2011).
5. Dowell E.H., Curtiss H.C, Scalan R.H., Sisto F, A Modern Course in Aeroelasticity, Sijthoff and Noordhoff, (1978).

AAE 4443: AIRCRAFT ELECTRICAL SYSTEM DESIGN & EMI EMC ANALYSIS [3 0 0 3]

Overview of Aircraft Electrical System: Electrical fundamentals, Electric Measuring Instruments. Aircraft Batteries and other source, Electrical power generation, conversion, distribution and protection theory and equipment's used, Wiring Installation, Circuit protection, shielding/ screening, power distribution, Aircraft Electrical Systems, Aircraft Lighting Systems, Electrical System Components, Electrical and magnetic field. Introduction to E3 Models and Techniques, Deterministic and Statistical EMC Models, HEMP, HIRF and Lightning, Techniques to Design Robust Lightning Protection Circuits, Pyrotechnic Systems, EMC Testing in aircraft, spacecraft, UAV and flight control, System level testing etc. Charging.

References:

1. Mike Tooley and David Wyatt: Aircraft Electrical and Electronic Systems: Principles, Operation and Maintenance, Butterworth-Heinemann: Elsevier, (2009).
2. Dr.Reinaldo J. Perez: Handbook of Aerospace Electromagnetic Compatibility, IEEE Press, Wiley, (2018).
3. Ian Moir, Allan Seabridge: Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration, Aerospace Series, Wiley, (2011).
4. Thomas K. Eismin: Aircraft Electricity and Electronics, McGraw Hill Education (India) Private Limited, (2014).
5. EHJ Pallett: Aircraft Electrical Systems, PEARSON India Education Services Pvt. Ltd, (1997).
6. Len Buckwalter: Avionics Training: Systems, Installation, and Troubleshooting, Avionics Communications Inc., (2005).

AAE 4444: AIRSHIP TECHNOLOGY [3 0 0 3]

Background and Introduction to LTA systems; Historical Perspectives of LTA Systems; Static Lift Concepts; Static Lift Estimation; Variation of Net Static Lift; Pressure Height Calculations; Envelope Materials and Ground Handling of LTA Systems; Airship Design Methodology; Airship Propulsion Systems and Case studies in Airship Operation; Aerostat Design Methodology; High Altitude Airships and Hybrid LTA systems.

References:

1. Taylor, J. A., Principles of Aerostatics, The Theory of Lighter-Than-Air Aircraft, Createspace Independent Publishing, ISBN13:978-1-49481-053-5, (2014).
2. Khoury, G., ed., Airship Technology, 2nd Edition, Cambridge Aerospace Series, Cambridge University Press, ISBN-13 978-1107019706, (2012).
3. Pant, R. S., Course Material for Design and Development of LTA systems, Curriculum Development Program, IIT Bombay, (2010).
4. Carichner, G. E., and Nicolai, L. M., Fundamentals of Aircraft and Airship Design, Volume 2 – Airship Design and Case Studies, AIAA Education Series, ISBN-13: 978-1600868986, (2013).
5. Hunt, P. V., Advanced Airship Technologies and Design Approaches, AIAA Education Series, ISBN-13 978-1-62410-351-3, (2015).

AAE 4445: AVIATION FUELS AND COMBUSTION [3 0 0 3]

Introduction, different types of fuels (solid, liquid and gaseous) and their properties, storage and handling of fuels, fuel requirements and specifications, cracking, polymerization, Combustion process, basic thermodynamics, stoichiometry, flash and fire points, calorific value, theoretical flame temperature, minimum air requirement for complete combustion, flue and exhaust gas analysis, combustion kinetics, different chemical reactions, laminar and turbulent flames, different burners, combustion emission, combustion in ramjets and scramjets, storage and handling of rocket propellants and explosives.

References:

1. Samir Sarkar: Fuels and Combustion , Universities Press (2009).
2. H. Joshua Philips: Fuels – Solids, liquids and gases, Nabu Press (2011).
3. S.R. Turns: An introduction to combustion – Concepts and applications, Tata McGraw- Hill, (2000).
4. John Griswold: Fuels Combustion and Furnaces, Mc-Graw Hill Book Company Inc., (1946)
5. Fundamentals of Combustion, D P Mishra, University Press, (2010).

AAE 4446: AVIATION MANAGEMENT [3 0 0 3]

An introduction to air transport: Aerospace industry, air transport industry, Historical perspective: Formative period, growth years, maturity, Economics development, General aviation. Regulations and associations: Department of transportation, Federal aviation administrations, Transport security administration. Airline management and organization: Management, organization, staff department, line department, Forecasting methods: purpose of forecasting methods, forecasting methods. Managerial aspects of airlines: Airline passenger marketing, Airline pricing, demand, Air cargo etc.

References:

1. Air Transportaion – A management perspective, Sixth edition John G Wensveen. Ashgate Publishing Limited, ISBN 978-0-7546-7165-7, (2007)
2. Fundamentals of Air Traffic Control, Fourth edition, Nolan, M.S., Thomson Learning, ISBN-13:978-0-534-39388-5, (2004)
3. Air Transportation Systems Engineering, Donohue, G. L. et al., (Editors), AIAA, ISBN 1-56347-474-3, (2003)
4. Avionics Navigation Systems, Keyton, M. and Fried, W. R., John Wiley, ISBN 0-471-54795-6, (2001)
5. Introduction to Flight, John D. Anderson, Jr., Tata McGraw-Hill Publishing Company, Fifth Edition, Fifth Edition,ISBN 13: 978-0-07-066082-3, (2007).

AAE 4447: COMPOSITE MATERIALS AND STRUCTURES [3 0 0 3]

Introduction, Types of matrix materials, Types of synthetic fibers, properties, manufacturing process of fibers, types of manufacturing process of composite laminates, hand lay-up, vacuum bagging, compression molding, autoclave curing, resin transfer molding, Classification of composite materials, Characterization of composite materials, Mechanical behavior of composite materials, Basic terminologies of composites, Review of basic equations of mechanics and materials, Linear elastic model and its application, Stress-strain relations for a unidirectional lamina, Stress-strain relations for isotropic/orthotropic lamina, Effective Modulii of a continuous fibre reinforced lamina, Models based on mechanics of materials, Force-Displacement relations for laminates, Laminate stiffness, Single general orthotropic layer, Inter-laminar stresses, Failure of continuous fiber-reinforced orthotropic lamina, Maximum stress/strain criteria, Tsai-Hill and Tsai-Wu criterion.Self-Study topic is recommended.

References:

1. Mallick, P.K, Fiber-reinforced Composites: Materials, Manufacturing, and Design, CRC Press, (2008).
2. Gibson R. F., Principles of Composite Material, (4e), Mechanics, CRC Press, (2016).
3. Kollar L. P., George S Springer, Mechanics of Composite Structures, Cambridge University Press, (2009).
4. Agarwal B. D., Broutman L. J. and Chandrashekhara K., Analysis and Performance of Fiber Composites, (3e), John Wiley & Sons, (2006).
5. R. M. Jones, Mechanics of Composite Materials, (2e), Taylor & Francis,(2005).
6. Madhujit Mukhopadhyay, Mechanics of Composite Materials and Structures, Orient Longman, (2004).

AAE 4448: COMPUTER INTEGRATED MANUFACTURING [3 0 0 3]

Introduction, Definition of N.C. Machine, Classification, Advantages and disadvantages of N.C. machine, Design consideration of N.C. Machine tools, general construction requirements, Co-ordinate systems, point to point and contour programming, manual method (word address format only), NC programming with interactive graphics, manual data input. Problem with conventional NC, Computer Numerical Control, Direct Numerical Control, Introduction to Robotics, Robot anatomy physical configurations, Manipulator Kinematics, Technical features, programming the robot, robot programming language, end effecters, work cell design, work cell control and interlock, robotic sensor, robotic applications, Part classification and coding, production flow analysis, machine cell design, benefits of group technology, Types of Manufacturing System, Machine Tools and related equipment, Material Handling System, Flexible Manufacturing System, FMS work station, Types of FMS Layouts, Planning the FMS, Computer aided Process planning, Computer integrated planning systems. Material requirement planning. Capacity planning, shop floor control, factory data collection systems, automatic identification systems – Bar code technology, automated data collection systems.

References:

1. Yoram Koren, Computer Control of Manufacturing Systems and Computer Integrated Manufacturing, PHI, New Delhi, (2006).
2. Mikel P Groover, Automation, Production Systems and computer Integrated manufacturing, PHI, New Delhi, (2008).
3. Yoram Koren, Joseph Ben Uri, Numerical Control of Machine Tools, Khanna Publishers, New Delhi, (2005).
4. Mikell P Groover and Emory W Zimmers, Computer Aided Design & Manufacturing, PHI, New Delhi, (2008).
5. Roger Hannam, Computer Integrated Manufacturing: From Concept to Relaisation, Addison Wesley(1997).

AAE 4449: DESIGN OF FIXED WING UNMANNED AERIAL VEHICLE [3 0 0 3]

Introduction: Fixed-wing UAV, Design and Basic Design Parameters; Design Algorithm: Case Study, Mission Requirements, Feasible Design Parameters; Configuration Layout: Airfoil Selection Configuration, Planform Geometry Selection; Weight and C.G. Estimation; Analytical Parameter Estimation; Performance and Stability Analysis; Simulation; Detailed Sizing; Estimation of Inertial Properties Using 3D Modelling; Prototype Fabrication; Wind Tunnel Testing; Aerodynamic Characterization through Wind Tunnel Testing.

References:

1. Andrew J. Keane, András Sóbester, and James P. Scanlan, Small Unmanned Fixed-wing Aircraft Design: A Practical Approach, John Wiley & Sons Ltd., (2017).
2. Mohammad Sadraey, Unmanned Aircraft Design, Morgan and Claypool Publishers, (2017).
3. Randal W. Beard and Timothy W. Mclain, Small Unmanned Aircraft Theory and Practice, Princeton University Press, (2012).
4. Daniel P. Raymer, Aircraft Design: A Conceptual Approach, AIAA Education Series, Sixth Edition, 2018.
5. Nicolai and Carichner, Fundamentals of Aircraft and Airship Design Volume 1 – Aircraft Design, AIAA Education Series, (2010).

AAE 4450: DIGITAL MANUFACTURING [3 0 0 3]

Introduction: definition, features and developments of Digital Manufacturing (DM). Modeling theory and methods of DM science. Computing Manufacturing in DM. Manufacturing informatics in DM. Intelligent manufacturing in DM. Industry 4.0, Industrial IoT, Cyber Physical Systems, M2M technology, Management of Technology in DM. Rapid Manufacturing., Digital Manufacturing Security, Smart Factories. Future Development of DM.

References:

1. Zude Zhou, Shane (Shengquan) Xie Dejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, (2012)
2. Kaushik Kumar, Divya Zindani, J. Paulo Davim (Editors) Digital Manufacturing and Assembly Systems in Industry 4.0 CRC Press, (2020)
3. Antonella Petrillo, Raffaele Cioffi, Fabio De Felice, Digital

Transformation in Smart Manufacturing Intech Publishers Croatia, (2018)
4. Hopkinson N, Hague R. J. M., Dickens P.M. Rapid Manufacturing, John Wiley and sons, (2006)
5. Zhuming Bi, Practical Guide to Digital manufacturing, Springer(2021).

AAE 4451: ELECTROCHEMICAL ENERGY STORAGE [3 0 0 3]

Introduction to Energy storage and battery terminology: History of electrochemical energy storage, Requirement of energy storage, Definitions and measuring methods. Electrochemistry and Thermodynamics: Electrochemical Cell, Faradays law of electrochemistry, Redox potential, Electromotive force, Nernst's law, Electrical double layer, Polarization and over potential. Heat Generation and Porous media. Batteries: Types of batteries, Lead Acid, Nickel metal hydride, Nickel-Zinc batteries, Zinc-air and Redox flow batteries. Li-ion batteries: Operational mechanisms of lithium ion batteries, Properties of electrode material, Dendrite formation. Fuel cells and Super capacitors: Introduction, Types of fuel cells, Proton exchange membrane fuel cell, Alkaline fuel cells, Phosphoric acid fuel cell, Solid oxide fuel cells, Molten carbonate fuel cells, Direct methanol fuel cells. Fundamentals of capacitors, Energy stored, Double layer capacitor, Charging and discharging behaviour of super-capacitors. Basic elements of in Lithium-ion batteries and Fabrication: Introduction, Positive electrodes, Negative electrodes, electrolytes, Current collectors, Manufacturing and packaging.

References:

1. Glaize, Christian, and Sylvie Genies. Lithium batteries and other electrochemical storage systems. John Wiley & Sons, (2013).
2. Sundén, Bengt. Hydrogen, Batteries and Fuel Cells. Academic Press, (2019).
3. Sterner, Michael, and Ingo Stadler, eds. Handbook of energy storage: Demand, technologies, integration. Springer, (2019).
4. Newman, John, and Karen E. Thomas-Alyea. Electrochemical systems. John Wiley & Sons, (2012).
5. Braun, Artur. "Electrochemical Energy Systems." Electrochemical Energy Systems. de Gruyter, (2018).

AAE 4452: EXPERIMENTAL MECHANICS [3 0 0 3]

Overview of experimental stress analysis, Stress analysis - Analytical, Numerical and Experimental approaches, Specific domain of these approaches, Advantages and disadvantages. Stress, Strain and Displacement Fields- Beam under pure bending, Analytical solution, Fringe contours from various experimental methods. Physical Principle of Strain Gauges, Photo-elasticity, Physical principle behind various experimental techniques, Strain Gauges, Photoelasticity, Grids for determining plastic strains. Multi-Scale Analysis in Experimental Mechanics- Review of solid mechanics, definition of free surface, ambiguity in associating the correct value of principal stress direction to the magnitude of the principal stress, Eigen value approach or use of Mohr's circle, Shear distribution in a three-point bend specimen. Self-Study topics recommended

References:

1. Cesar A. Sciammarella, Federico M. Sciammarella, Experimental Mechanics of Solids, John Wiley &Sons, (2012)
2. Emmannuel D Gdoutos, Recent advances in experimental mechanics, Kluwer Academic Publications, (2002)
3. Jerome Molimard: Experimental Mechanics of Solids and Structures, ISTE, John Wiley & Sons, (2016)
4. RivkaGilat, Leslie Bank-Sills, Advances in Mathematical Modelling and Experimental Methods for Materials and Structures, Springer Science, (2010)
5. U C Jindal, Experimental Stress Analysis, Pearson Education India (2012)

AAE 4453: HEAT TRANSFER [2 1 0 3]

Different modes of heat transfer, heat conduction with and without heat generation through slabs, cylinders and spheres, transient heat conduction, different boundary conditions, heat transfer through fins, fin effectiveness and fin efficiency, heat transfer by free and forced convection, classification of fluid flows, internal and external forced convection, mechanism of natural convection, different dimensionless numbers, radiation heat transfer, black body radiation, Kirchhoff's law, Wein's displacement law, radiation view factor, and it's relations, radiation heat transfer between black and non-black surfaces, radiation shield, heat exchangers, parallel and counter-flow heat exchangers, LMTD and effectiveness-NTU methods, boiling and condensation heat transfer. Self-study topics recommended

References:

1. F.P. Incropera, D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley and Sons, (2006).
2. Y.A. Cengel and A.J. Ghajar, Heat and Mass Transfer – Fundamentals and Applications, McGraw Hill Education, (2017).
3. S.P. Sukhatme, A Textbook on Heat Transfer, Universities Press, (2005).
4. P.K. Nag, Heat and Mass Transfer, McGraw Hill Education, (2011).
5. R.C. Sachdeva, Fundamentals of Engineering Heat and Mass Transfer, New Age Internationals, (2017).
6. J. Holman, Fundamentals of Heat and Mass Transfer, McGraw Hill Education, (2017).

AAE 4454: HELICOPTER ENGINEERING [3 0 0 3]

Introduction: Historical Development of Helicopters – Helicopter Configuration – Control Requirements – Types of Rotor Systems – Basic Power Requirements; Introduction to Hovering Theory: Momentum Theory – Blade Element Theory – Combined Blade Element and Momentum theories for non-uniform inflow calculation – Ideal Rotor Vs Optimum Rotor; Vertical Flight: Various flow states of Rotor – Autorotation in Vertical Descent – Ground Flight; Forward Flight: Momentum Theory – Variable Inflow Models – Blade Element Theory – Rotor Reference Planes – Hub Loads – Power variation with forward speed – Rotor Blade flapping Motion: Simple Model.

Self-study topics recommended

References:

1. Leishman, J.G., 'Principles of Helicopter Aerodynamics, Cambridge University Press, (2000).
2. Johnson, W. Helicopter Theory, Princeton Univ. Press, New Jersey, (1980).
3. Johnson, W., Rotorcraft aeromechanics, Cambridge University Press, (2013).
4. Prouty, R.W., Helicopter performance, Stability and Control, R.E. Krieger Pub. Co., Florida, (1990).
5. Seddon, J., Basic Helicopter Aerodynamics, AIAA series, (1990).

AAE 4455: INDUSTRIAL AUTOMATION AND ROBOTICS [3 0 0 3]

Introduction, classification compressors, actuators, flow control valves, direction control valves, Time delay valve, Counter, Solenoids, Sensors, Multiple actuation system, P E convertor, Design of pneumatic and electronic circuits. Introduction to Robotics, Rigid-Body Kinematics, Dynamics of Robots, Trajectory Planning for Flexible Robots, Robotic Sensors, Robot End Effectors, Robot Programming, Industrial Applications.

Architecture of Industrial Automation Systems, Measurement Systems Characteristics, Measurement Systems Characteristics ,Data Acquisition Systems, Data Acquisition Systems, Practice Problems with MATLAB in Rotation matrices, Kinematics: Derivation of Link Transformations, Problem Solving DH Parameters, Forward Kinematics, Inverse Kinematics.

Self-Study topics recommended

References:

1. Joji P, Pneumatic Controls, Wiley India Pvt. Ltd, (2013).
2. Prede G. and Scholz D., Electropneumatics Basic Level, Festo Didactic GMBH & Co, Germany, (2002).
3. Peter Croser, Frank Ebel, Pneumatics Basic Level TP 101, Festo Didactic GMBH & Co, Germany, (2002).
4. A.K. Gupta, S.K. Arora and J. Riescher Westcott: Industrial Automation and Robotics, Mercury Learning and Information (2016).
5. Thomas R. Kurfess, Robotics and Automation Handbook, CRC Press, (2004).
6. Martin Klas Nilsson J. Norberto Pires, Industrial Robotics, Springer, (2007).

AAE 4456: LEAN MANUFACTURING [3 0 0 3]

History of Lean and comparison to other methods – The 7 Wastes, their causes and the effects – An overview of Lean Principles / concepts / tools – Stockless Production. The Tools of Lean Manufacturing: Continuous Flow – Continuous Flow Manufacturing and Standard Work Flow – 5S and Pull Systems (Kanban and ConWIP systems) – Error Proofing and Set-up Reduction – Total Productive Maintenance (TPM) – Kaizen Event examples. Toyota production systems, Ford production systems. Value Stream Mapping – Future State: Key issues in building the Future State Map – Process tips in building the map and analysis of the customer loop, supplier loop, manufacturing loop and information loop – Example of completed Future State Maps – Application to factory simulation – Implementation of lean practices – Best Practices in Lean Manufacturing. House of Lean -5S's and Waste Walks, Visual Management, Value Stream Mapping-Understanding the current state and designing the future state Managing lean enterprise: – Finance, Career ladders, geographic spread and advantages of global enterprise. Additional Interests: Develop VSM Current and Future state diagram using Microsoft Visio or Similar Software Package. Six sigma concepts: History, definitions, Statistical definitions, quality levels, Technical aspects, Six sigma for all: benefits to organizations, customers, suppliers and employers, Design for Six Sigma, DMAIC principles, DMADV principles, merits and demerits.

References:

1. Toyota Production System -An integrated approach to Just in Time – Yasuhiro Monden, – Engineering and Management Press -Institute of Industrial Engineers, (1983)
2. James P Womack, Daniel T Jones, and Daniel Roos, The Machine that changed the World. The Story of Lean Production -Harper Perennial edition, (1991)
3. Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy, Second Edition Hardcover, (2012)
4. Value Stream Mapping: How to Visualize Work and Align Leadership for Organizational Transformation Paperback –by Karen Martin, Mike Osterling, (2016)
5. Lean and Six Sigma – Six Sigma Black Belt Enterprise-Wide Deployment Paper Back by Suvabrata Mitra, (2007)

AAE 4457: NAVIGATION, GUIDANCE AND CONTROL [3 0 0 3]

Introduction of navigation, Inertial sensors and inertial navigation system, multi sensor navigation systems, different types of navigation radar and its types; other types of navigation, satellite based navigation systems, Ground based navigation equipment's, Augmentation and Integration, GPS denied environment, Visual navigation. navigation sensor design and navigation data analysis, Introduction of guidance, guided missiles, classification and systems in missiles. Fundamentals of guidance; Interception and Avoidance; Taxonomy of guidance laws, Classical and empirical guidance laws; guidance laws: pursuit, LOS and PN laws, Applied optimal control and optimal guidance laws; Differential games and pursuit evasion problems; Recent advances in guidance theory; Collision detection and avoidance strategies; Classical & modern control systems, adaptive control application, Artificial intelligence and biological inspired optimization in control systems and its application. Applications to guided missiles, Unmanned aerial vehicles and Mobile robots.

Self-Study topics recommended

References:

1. Mohinder S Grewal: Global Navigation Satellite Systems, Inertial Navigation and Integration, John Wiley, (2013).
2. Zarchan P.: Tactical and Strategic Missile Guidance, AIAA Series, (2007).
3. Katsuhiko Ogata: Modern Control Engineering , Pearson,(2009).
4. Myron Kayton & Walter R. Fried: Avionics Navigation Systems,

Wiley-interscience, (1997).
5. G.M. Siouris: Missile Guidance and Control Systems, Springer Verlag, (2004).
6. Ching-Fang Lin: Modern Navigation, Guidance, and Control Processing, Prentice Hall, (1991).
7. Asher Clark (Editor): Global Navigation Satellite Systems and Their Applications, Larsen and Keller Education, (2017).

AAE 4458: NON-LINEAR CONTROL SYSTEMS [3 0 0 3]

Introduction of linear and nonlinear systems, nonlinear system behaviour, Mathematical preliminaries: open and closed sets, compact set, dense set, Topology, sequence, Continuity of functions, Lipschitz condition, smooth functions, basic linear algebra: Vector space, norm of a vector, normed linear space, inner product space. Well-posedness of ordinary differential equations, Lipschitz continuity and contraction mapping theorem. Phase plane analysis-phase portrait, phase plane analysis of linear and nonlinear system, existence of limit cycle, equilibrium points, linearization and local stability, Direct method, system analysis using Lyapunov direct method, Advance stability theory: Lyapunov stability for autonomous and non-autonomous systems, Linear Time Variant, Instability theorem, function, Barbalat's Lemma, Function analysis. Nonlinear control systems design: Feedback linearization, Backstepping, Input-output stability, Input-to-state stability, Passivity and Dissipativity, Nonlinear observer, Sliding control and adaptive control, Nonlinear control system for multi-input systems, Example-Mass spring damper, Robotics, Spacecraft control, Robot trajectory etc.

References:

1. Slotine, J-J. E. and Li, W.: Applied Nonlinear Control, Prentice-Hall, (1991).
2. Horacio J. Marquez: Nonlinear Control System Analysis and Design John Wiley & Sons, (2003)
3. Kwatny, H. G. and Blankenship: Nonlinear Control & Analytical Mechanics, Birkhauser, (2000).
4. Isidori, Alberto: Nonlinear Control Systems-(3rd edition), Springer-Verlag, (1995).
5. Nijmeijer, H. and H. J. van der Schaft: Nonlinear Dynamical Control
6. Khalil, H. K.: Nonlinear Systems , MacMillan, (1996).
7. Shimkin N.: Nonlinear Control Systems. In: Binder M.D., Hirokawa N., Windhorst U. (eds) Encyclopedia of Neuroscience, (2009).

AAE 4459: NUMERICAL METHODS FOR SCIENTIFIC COMPUTING [3 0 0 3]

Mathematical review and computer arithmetic – numbers and errors; Nonlinear equations; Direct methods for linear systems; Iterative Methods for Linear Systems; Eigenvalues and Eigenvectors – power method, inverse power method, QR method; Approximation Theory – norms, orthogonalization, polynomial approximation, piecewise polynomial approximation, trigonometric approximation, rational approximation, wavelet bases; Numerical Differentiation; Numerical Integration – Romberg Integration, Gauss Quadrature, Adaptive Quadrature; Numerical Ordinary Differential Equations – single step and multi-step methods, Runge-Kutta method, predictor corrector method, stiffness, stability, shooting methods; Introduction to parallel programming – system architectures, shared and distributed memory programming, performance.

References:

1. John A. Trangenstein, 'Scientific Computing - Vol I, II, III, Springer, (2010).
2. Parviz Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, (2010).
3. Steven C. Chapra, Applied Numerical Methods, McGraw Hill, (2012).
4. Walter Gander, Martin J. Gander, Felix Kwok, Scientific Computing, Springer, (2010).
5. A.S. Ackleh, E.J. Allen, R.B. Hearfott, P. Seshiyer, Modern Numerical Analysis, CRC, (2009).
6. Amos Gilat, Vish Subramaniam, Numerical Methods for Engineers and Scientists, Wiley, (2014).

AE 4460: OPERATIONS RESEARCH [3 0 0 3]

Introduction: Evolution of OR, Definitions, scope and applications of OR, Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP): Formulation, graphical solution, simplex method, Revised simplex method, duality in LPP. Transportation Problem: formulation, Initial basic solution, Optimality in transportation problem. Assignment Problem: Formulation and solutions. Traveling salesman problem. Network analysis: PERT and CPM. Queuing theory: M/M/1 and M/M/C queuing models. Dynamic Programming.

References:

1. Hamdy A. Taha, Operations Research- An Introduction, Pearson India (2016)
2. Hillier and Lieberman, Introduction to Operations Research,McGraw Hill International (2017)
3. Vohra N D. Quantitative Techniques in Management, Tata McGraw Hill, (2007)
4. Pannerselvam, Operations Research,Prantice Hall India (2009)
5. Gupta P K, Hira D S, Operations Research S. Chand Publishers (2015).

AAE 4461: OPTIMAL CONTROL [3 0 0 3]

Nonlinear optimization, Formulation of optimal control problems, Parameter optimization versus path optimization, Local and global optima; general conditions on existence and uniqueness. Some basic facts from finite-dimensional optimization, the Euler-Lagrange equation, path optimization subject to constraints, weak and strong extrema, Calculus of variations applied to optimal control, Pontryagin's minimum principle, Optimal control with state and control constraints, Time-optimal control, Singular solutions, Hamilton-Jacobi-Bellman (HJB) equation and dynamical programming, Finite-time and infinite-time state (or output) regulators, Riccati equation and its properties, Tracking and disturbance rejection, Kalman filter and duality, The LQR design, The LQG design, Estimator /Observer design:-MIMO System and SVD, Holonomic & Nonholonomic System Optimal Control, Game Theoretic Optimal Control Design, Signals and system norms.

References:

1. A.E. Bryson and Y.C. Ho: Applied Optimal Control ,Blaisdel., (1975).
2. Naidu D.S: Optimal Control Systems, CRC Press, (2002).
3. Sinha A.: Linear Systems: Optimal and Robust Control, CRC Press, (2007).
4. D. E. Kirk: Optimal Control Theory: An Introduction, Prentice-Hall, (1970). (former textbook on deterministic control, Dover reprinted 2004), (2004).
5. R. F. Stengel: Optimal Control and Estimation, Dover, (1994).
6. Dimitri P. Bertsekas: Dynamic Programming and Optimal Control, Volume I, Athena Scientific, (2005).
7. Richard W. Cottle, Mukund N. Thap: Linear and Nonlinear Optimization, Springer Nature, (2017).

AAE 4462: OPTIMIZATION TECHNIQUES IN ENGINEERING [3 0 0 3]

Introduction to optimization – linear programming – duality and sensitivity analysis – integer programming – non-linear programming – unconstrained optimization – constrained optimization: equality and inequality constraints – optimality conditions and optimization approaches – non-traditional optimization approaches – applications in aerospace engineering.

References:

1. Ravindran, A., Phillips, D. T., and Solberg, J. J., Operations Research: Principles and Practice, Wiley-India (2006).
2. Rao, S. S., Engineering Optimization: Theory and Practices, John Wiley (2009).
3. Winston, W. L., Operations Research: Applications and Algorithms, Cengage Learning (2010).
4. Ravindran, A., Ragsdell, K. M., and Reklaitis, G. V., Engineering Optimization: Methods and Applications, Wiley-India (2006).
5. Deb, K., Optimization for Engineering Design: Algorithms and Examples,PHI Learning (2012).
6. Deb, K., Multi-Objective Optimization Using Evolutionary Algorithms, Wiley-India (2010).

AAE 4463: SPACEFLIGHT DYNAMICS [3 0 0 3]

Basics of System Modeling and Dynamics, Rotational Kinematics and Rigid Body Dynamics, Orbital Determination, Relative motion and Rendezvous, Spacecraft/satellite Attitude, Dynamics and Control, Robust Optimal Maneuvers, Orbital Perturbations, restricted three-body motion, launch vehicle dynamics, Re-entry dynamics, description of the motion and rates of motion of rigid bodies (Kinematics), developing the equations of motion that prediction the movement of rigid bodies taking into account mass, torque, and inertia (Kinetics), non-linear controls to program specific orientations and achieve precise aiming goals in three-dimensional space (Control).

Self-Study topics recommended:

References:

1. William E Wiesel, Spaceflight Dynamics, Mc Graw Hill(2010).
2. Craig A. Kluever, Spaceflight Dynamics, Wiley, (2018)
3. Roger R. Bate, Donald D. Mueller, Jerry E. White, Fundamentals of Astrodynamics, Dover Publications (1971)
4. Bong Wie, Space Vehicle Dynamics and Control, American Institute of Aeronautics and Astronautics, (2008)
5. H Curtis, Orbital Mechanics for Engineering students, Elsevier, (2012).
6. Goldstein, Classical Mechanics, Third Edition, Pearson, (2001).
7. Anton H. de Ruiter, Christopher Damaren James R. Forbes, Spacecraft Dynamics and Control: An Introduction, Wiley, (2013).

AAE 4464: SPACEFLIGHT MECHANICS [2 1 0 3]

Dynamics of Particles: reference frames and rotations – energy, angular momentum; Two Body Motion: equations of motion – Kepler laws – solution to two-body problem – conics and relations – Kepler equation – orbital elements – orbit determination – Lambert Problem – satellite tracking – different methods of solution to Lambert Problem; Non-Keplerian Motion: perturbing acceleration – earth aspherical potential – oblateness – third body effects – atmospheric drag effects – applications of perturbations; Orbit Maneuvers: Hohmann transfer – inclination change maneuvers, combined maneuvers, bi-elliptic maneuvers; Lunar/Interplanetary Trajectories: sphere of influence – methods of trajectory design – restricted three body problem – Lagrangian points.

Self-Study topics recommended

References:

1. Curtis, H, D., Orbital Mechanics for Engineering Students, Elsevier (2009).
2. Chobotov, V.A., Orbital Mechanics, AIAA Education Series (2002).
3. Tewari, A., Atmospheric and Space Flight Dynamics: Modelling and Simulation with MATLAB and Simulink, Birkhuser(2007).
4. Brown, C.D., Spacecraft Mission Design, AIAA Education Series (1998)
5. Wiesel, W.E., Spaceflight Dynamics, McGraw-Hill (1996).
6. Escobal, P.R., Methods of Orbit Determination, Krieger Publication Co. (1976).

AAE 4465: STATISTICAL QUALITY CONTROL AND RELIABILITY [2 1 0 3]

Fundamentals of quality and quality control. Measure of central tendencies. Probability distributions. Tolerance allocation. Control chart for variables and attributes. Process capability analysis and process capability index. Acceptance sampling. Operating characteristic curves. Dodge romig and MIL-STD acceptance sampling tables. Concept of reliability, Reliability systems, maintainability and availability.

References:

1. Montgomery D. C., Introduction to Statistical Quality Control, John Wiley & Sons, New York (2013)
2. Amitav Mitra, Fundamentals of quality control and improvement, Wiley (2008)
3. Grant E.L., Statistical Quality Control, McGraw Hill Publications, New

York (1988)

4. Juran J.M., Quality Planning and Analysis, McGraw Hill Publications, Delhi (1984)
5. Rao S S., Reliability Engineering Pearson Education (2014)

AAE 4466: SURROGATES AND APPROXIMATIONS IN ENGINEERING DESIGN [2 1 0 3]

Introduction: physical versus computational experiments – introduction to engineering optimization – need for surrogates in optimization; Design of Experiments: Sampling plans – Latin squares – Latin hypercubes sampling – stratification – Orthogonal arrays – Hammersley sequences; Surrogates: Polynomial Regression – Radial basis function – Kriging; Using surrogates in design space exploration and exploitation – infill criteria –adaptive sampling.

References:

1. Forrester, A., & Keane, A, Engineering design via surrogate modelling: a practical guide. John Wiley & Sons(2008).
2. Jiang, P., Zhou, Q., & Shao, X. Surrogate model-based engineering design and optimization. Springer(2020)

AAE 4467: SYSTEMS ENGINEERING [3 0 0 3]

Introduction of Systems Engineering, Methodology of system engineering, systems, customer needs and requirements, operational analysis, functional analysis, logical analysis, physical analysis, Heterogeneous solution, system verification and validation, system engineering and product life cycle management, system project management and software system engineering. system engineering principle to avionics system, Existing avionics systems and their functions, new avionics subsystem and their base, project management of avionics engineering, software design, development and integration to system., Avionics Systems Essentials, Design areas of concern to system engineers, FARs, and certification requirements, identify design evaluation criteria and assign weighting values to the evaluation criteria, System requirements System engineering concepts, functional design, trade studies for the best system design...

References:

1. Eugenio Brusa, AmbraCalà, Davide Ferretto: Systems Engineering and Its Application to Industrial Product Development, Part of the Studies in Systems, Decision and Control book series (SSDC, volume 134) (2018).
2. Mo Jamshidi: Systems of Systems Engineering Principles and Applications (1st Edition), CRC Press [First Published 2009, eBook Published 2017] (2017).
3. Boris Cogan: Systems Engineering - Practice and Theory, IN-TECH (March 2012).
4. Blanchard, Benjamin S., and Fabrycky, Wolter J., Englewood Cliffs, N.J: System Engineering and Analysis, Prentice-Hall, (1990).
5. Cary R. Spitzer, Digital Avionics Handbook: -Avionics Development and Implementation (2nd Edition), CRC Press, Taylor & Francis Group, (2007).
6. Defense Systems Management College, Systems Engineering Management Guide, U.S. Government Printing Office, December (1989).

AAE 4468: TOTAL QUALITY MANAGEMENT [3 0 0 3]

Connotations of Quality, Quality Dimensions: Product and Service. The Concept of TQM, Evolution of TQM, Inspection, SQC, QA and TQM. Conventional Quality Management versus TQM. Customer Supplier Focus in TQM, Benefits and Costs of TQM, Historical Perspectives of TQM, Measurement Tools: Check Sheets, Histograms, Run Charts, Scatter Diagrams, Cause and Effect Diagrams, Pareto's Chart, Process Capability Measurement. Analytical Tools: Process Mapping, Regression Analysis, Resource Utilization and Customer Service Analysis, The Five Why's, Overall Equipment Effectiveness. Improvement Tools and Techniques: Kaizen, JIT, Quality Circles, Force Field Analysis, Five S's, Quantitative Techniques: Failure Mode Effect Analysis (FMEA), Statistical Process Control (SPC), Quality Function Deployment (QFD), Design of Experiments (DOE), Kanban and Activity Based Costing (ABC). Taguchi Methods: Quality Loss Function, Orthogonal Arrays, The Concept of Six Sigma, Objectives of Six Sigma, The Frame-Work of Six Sigma Programme, Six Sigma Organization: Roles and Responsibilities, Six Sigma Problem Solving Approach, Implementation of TQM in Service Organization: Framework for Improving Service Quality, Model to Measure Service Quality Programs.

References:

1. John L. W. Beckford,Quality: A Critical Introduction, Routledge Taylor and Frances Group, New York and London(1998)
2. Dale H. Besterfield, Carol Besterfield - Michna, Glen H Besterfield and Mary Besterfield-Sacre, Total Quality Management,PHI, (2006)
3. Ron Basu, Implementing Quality: A Practical Guide to Tools and Techniques, THOMPSON, (2006).
4. Greg Brue, Six Sigma for Managers, TMH, (2002).
5. R. P. Mohanty & R. R. Lakhe, TQM in the Service Sector, Jaico Books(2013)

AAE 4469: WIND ENERGY ENGINEERING [3 0 0 3]

Introduction to wind energy, the wind resource and its characteristics, Wind turbine types, configurations, components, design of machines and wind farms, Wind turbine aerodynamics, Dynamics, aero-servo-elasticity and control of wind turbines, Introduction to off-shore wind, the off-shore environment, support structures, dynamics, Introduction to electrical systems and grid integration. Winds: physical background, energy content, variation in time and in space, geographical resource distribution, influence of terrain, measurement methods, statistical analysis. Turbines: free flow, principles of drag and lift, aerodynamics, design of turbine blades, horizontal and vertical axis wind turbines, Betz' and Glauert's turbine theories, the BEM method, Mechanics: static and dynamic loads (oscillations), rotor dynamics, solid mechanics, mechanical, modelling, aeroelasticity, Design: horizontal and vertical axis wind turbines, blades, control mechanisms, drive train, tower, nacelle, foundation, choice of materials, manufacture, adaptation to different climates, Economy: financing, investment, costs during the lifetime of a wind turbine, value of wind energy, business and market overview, small scale wind power: technology, economy, paths of development

References:

1. Trevor M. Letcher, Wind Energy Engineering, A Handbook for Onshore and Offshore Wind Turbines, Academic Press(2017)
2. J. F. Manwell and J. G. McGowan, A. L. Rogers, WIND ENERGY EXPLAINED Theory, Design and Application, Wiley(2009)
3. Pramod Jain, Wind Energy Engineering, Mc Graw Hill Education(2016)
4. T. Burton, N. Jenkins, D. Sharpe, E. Bossanyi, Wind Energy Handbook, Wiley, (2011).
5. R. Gasch and J. Twele, Wind Power Plants: Fundamentals, Design, Construction and Operation. Springer, (2012)

OPEN ELECTIVES

AAE 4311: INTRODUCTION TO AEROSPACE ENGINEERING [3 0 0 3]

Introduction and Overview of The History of Flight, Fundamental Thoughts, Ballooning, Basic/Constructive Principles of Fluid Mechanics-Bernoulli's Theorem and Control Volume Approaches, The Sources of all Aerodynamic Forces, Standard Atmosphere, Hydrostatic Equation, Incompressible and Compressible Flows, Elementary Thermodynamics and Isentropic flow, Flow Regimes and Estimation of Viscous, Thermal Effects, Basics of Aerodynamics, Airfoil Nomenclature, Lift, Drag and Moment Coefficient, Infinite vs Finite Wings, Pressure Coefficients, Elements of Airplane Performance, Astronautics, Basics of Propulsion. Orbital Mechanics.

References:

1. Anderson Jr. JD, Introduction to Flight, McGraw Hill International Edition, (2012).
2. Dava Newman, Interactive Aerospace Engineering and Design, McGraw Hill International Edition, (2002).
3. A.C.Kermode, Flight without Formulae, Pearson Education (United Kingdom), (1990).
4. Howard D Curtis., Orbital mechanics for Engineering Students, Butterworth Heinemann, (2013).
5. Anderson Jr. JD, Fundamental of Aerodynamics, McGraw Hill International Edition, (2017).

AAE 4312: INTRODUCTION TO AVIONICS AND NAVIGATION SYSTEMS [3 0 0 3]

Introduction to aircraft, Introduction to flight mechanics and flight dynamics of aircraft & Unmanned Air Vehicle, UAV Instrumentations and Sensors, Introduction to Avionics in aircraft, Organization framework, avionics architectures generation, types of payloads, Cockpit Layout of old and modern aircrafts, Displays, Packaging, ARINC and DOD Types, System Cooling, EMI/EMC Requirements; Aircraft Power Systems, Communication, Satellite Communication, Flight control laws, FBW, Autopilot, FMS, LRU, IMA & Mission Systems, Warning systems, Engine Control. Inertial Sensors and Inertial Navigation Systems, Elements of Navigation Systems, Ground based and celestial systems-based navigation systems, Satellite Navigation Systems, Augmentation, Radar & Mechanics of landing and types Landing Systems. Software Standards-CERT, MISRA, DO178B/C etc and avionics system engineering and systems life cycle.

References:

1. R.P.G. Collinson: Introduction to Avionics Systems, Springer, (2002).
2. Arjun Singh: Airport Ground Navigation Systems, Tata McGraw Hill Education Pvt. Ltd, (2012).
3. Thomas K. Eismin, Aircraft Electricity and Electronics, Tata McGraw Hill Education Pvt. Ltd, (2014).
4. Cary R. Spitzer: Digital Avionics Handbook-Avionics Development and Implementation , CRC Press, Taylor & Francis Group, (2007).
5. Bernard Etkin and Lloyd Duff Reid: Dynamics of Flight: Stability and Control, Wiley, (1995).
6. Myron Kayton & Walter R. Fried: Avionics Navigation Systems, Wiley-interscience, (1997).
7. Mohinder S Grewal: Global Navigation Satellite Systems, Inertial Navigation and Integration, John Wiley, (2013).

MINOR SPECIALIZATION: AERODYNAMICS

AAE 4401: APPLIED AERODYNAMICS [2 1 0 3]

Internal flows, boundary layers, turbomachines, external flows, automotive aerodynamics, introduction to compressible flow, flow in a variable-area duct, external flows, shock – expansion theory, supersonic boundary layers, experimental approach, Aerodynamics and prediction of lift, drag, and moments, Effect of aerodynamics on system performance using examples such as projectile motion, aircraft flight, race-car performance, sailboats, and wind turbines, Simulation of system dynamics including aerodynamic effects using examples such air and ground vehicles.

References:

1. Jan Roskam, Methods for Estimating Drag Polars of Subsonic Airplanes, University of Kansa (1973)
2. Hoerner, Fluid Dynamic Drag, Published by the author, (1993)
3. Hoerner and Boerst, Fluid-Dynamic Lift, Published by the author, (1992)
4. Anderson, J. D., Fundamentals of Aerodynamics, McGraw Hill, (2017)
5. Victor L. Peterson and Charles A. Smith ,Applied Aerodynamics: Challenges and Expectations ,NASA(1993)
6. Munson, B.R., Young, D.F., Okiishi, T.H., Fundamentals of Fluid Mechanics, John Wiley and Sons Inc(2018)

AAE 4402: TURBOMACHINERY AERODYNAMICS [2 1 0 3]

Classification and applications of turbomachines, ideal and real performance cycles, Construction features of compressor, principle of operation, enthalpy-entropy diagram, velocity triangles, compressor design parameters, compressor cascade, different losses in compressors, work done factor, 3D flow analysis, vortex energy equation, 2D blade section design, axial flow tracks, compressor characteristics, instabilities in axial compressors, construction and working of axial flow turbines, velocity triangle, different efficiencies, impulse and reaction turbines, losses, turbine cooling, principle of operation of centrifugal compressors, enthalpy-entropy diagram, velocity triangle, losses, construction of radial flow turbines, enthalpy-entropy diagram, velocity triangle, turbine losses.

References:

1. Cohen, H., Rogers, G.F.C., Straznicky, P., Saravanamuttoo, H.I.H. and Nix, A., Gas Turbine Theory, Pearson, (2017).
2. Yahya, S.M., Turbines, compressors and fans, McGraw Hill Education, (2017).
3. Hill P.G, Peterson C.R., Mechanics and thermodynamics of propulsion, Addison Wesley Publishing Company, (1992)
4. Nicholas Cumpsty, Compressor Aerodynamics, Krieger Publications, USA, (2004)
5. Johnson I.A., Bullock R.O., (NASA-SP-36), Axial Flow Compressors, NTIS, (2002)
6. El-Wakil, Powerplant Technology, McGraw Hill Publications, (1984)
7. J.H. Horlock, Axial Flow Compressors: Fluid Mechanics and Thermodynamics, Krieger, (1982)

AAE 4403: EXPERIMENTAL AERODYNAMICS [3 0 0 3]

Experimental Errors, Causes and Types, Statistical Analysis of Experimental data. Wind Tunnels: Types of wind tunnel, components, operation. Shock tubes and other high-speed facilities: shock tunnel, ballistic range, Plasma Arc Tunnel, Rarefied Gas Tunnel. Flow Visualization Techniques – Schlieren, Shadowgraph, Interferometry. Temperature measurement in flow: Thermometry, Thermostats, Thermistors, RTDs, Thermocouples, spectroscopy-based measurements, PLIF. Pressure measurement methods: Manometers, Bourdon gauges, Bellows and Diaphragms, Piezoelectric, Piezo-resistive. Velocity measurements in Flow: Pitot probe, Pitot correction in supersonic flows, hot wire Anemometry. Laser Doppler Velocimetry, Particle Image Velocimetry.

References:

1. G. S. Settles: Schlieren and Shadowgraph Techniques - Visualizing Phenomena in Transparent Media, Springer, (2001)
2. Alan Pope, Kennith L Goin: High speed wind tunnel testing, John Wiley & Sons, New York, (1965)
3. Stefano Discetti and Andrea Ianiro, Experimental Aerodynamics, CRC Press, (2017)
4. Jewel B. Barlow, William H. Rae, Alan Pope: Low-Speed Wind Tunnel Testing, Wiley, (1999)
5. S.P. Venkateshan: Mechanical Measurements , John Wiley & Sons Ltd, (2015)
6. Irvine I Glass, J P Sislian: Non-stationary flows and shock waves, Clarendon Press, Oxford. (1994)

AAE 4404: HIGH SPEED AERODYNAMICS [2 1 0 3]

Mach number regimes, Velocity-Altitude Map, Inclination methods, Inviscid hypersonic flow equations, Approximate methods, Exact methods, Method of characteristics, Viscous Hypersonic flow, Similarity parameters, Self-similar solutions, Applications of self-similar solutions, Reference temperature method, High temperature flows, Hypersonic viscous interactions, Shock-shock/boundary layer interactions, Hypersonic governing equations, Viscous shock layer techniques, Parabolized Navier-Stokes equations, Full Navier-Stokes equations, Hypersonic wind tunnels.

References:

1. John D. Anderson Jr, Hypersonic and High Temperature Gas Dynamics, McGrawHill, (1989)
2. John J Bertin, Hypersonic Aerothermodynamics, AIAA Education Series., Washington DC, (1994)
3. Wallace D. Hayes and Ronald F. Probstein, Hypersonic Flow theory, Academic Press, New York, (1959)
4. Ernst Heinrich Hirschel, Basics of Aerothermodynamics, Springer Verlag Berlin, (2005)
5. Wilbur L. Hankey, Reentry Aerodynamics, AIAA Education series, Washington DC, (1988)

MINOR SPECIALIZATION: AVIONICS SYSTEM ENGINEERING

AAE 4405: UNMANNED AIRCRAFT SYSTEM, SENSORS, AND INSTRUMENTATION [3 0 0 3]

Introduction to Unmanned Aircraft Systems (UAS) and Applications of UAS, Introduction to Design and Selection of the System, Aerodynamics and Airframe Configurations, Characteristics of Aircraft Types, Design Standards, Design for Stealth, PAYLOADS, Communications, Control and Stability, Navigation, Launch and Recovery, Control Stations, Support Equipment, Transportation, Design for Reliability, EMC/EMI of UAS. Introduction to System Development and Certification, System Development, UAV System testing, system -in flight testing, Defence Application.

References:

1. Reg Austin: Unmanned Aircraft Systems UAVs Design, Development and Deployment , A John Wiley and Sons, Ltd., (2010).
2. Jay Gundlach: Designing Unmanned Aircraft Systems: A Comprehensive Approach , AIAA Education Series, (2014).
3. Jay Gundlach: Civil and Commercial Unmanned Aircraft Systems, AIAA Education Series, (2016).
4. Dr David C. Ison: Small Unmanned Aircraft Systems Guide: Exploring Designs, Operations, Regulations, and Economics, Aviation Supplies & Academics Inc, (2017).
5. Douglas M. Marshall et al.: Introduction to Unmanned Aircraft Systems , Taylor & Francis, (2016).
6. F.B. da Silva S.D. Scott M.L. Cummings: Design Methodology for Unmanned Aerial Vehicle (UAV) Team Coordination, MIT Department of Aeronautics and Astronautics, Cambridge, MA 0213, (2007).

AAE 4406: ANTENNA DESIGN ANALYSIS AND ITS APPLICATIONS [3 0 0 3]

Fundamentals of electromagnetic theory. Boundary value problem, Magnetostatic Field, maxwell equations, Fundamentals of Antenna, Basic Antenna and Propagation Theory: Introduction, Characteristics of Electromagnetic Waves, Interaction between Two Wave Polarizations. Characteristics of an Antenna. Propagation. Antennas and Applications. Antennas Placement/Used on Aircraft, Polar Radiation Patterns., Computer Modelling Techniques, Method of Moments, FDTD, UTD, Physical Optics, Hybrid Methods, Radar Cross Section (RCS), RCS Dependency on Polarization, Stealth technology and radar absorbing materials (RAM).

References:

1. Mathew N O Sadiku: Elements of Electromagnetics, Oxford University Press, (2001).
2. C.A. Balanis: Antenna Theory - Analysis and Design , John Wiley, (2016).
3. Thereza Macnamara: Introduction to Antenna Placement and Installation , Wiley, (2010).
4. John D Kraus, Ronald J Marhefka, Ahmad S Khan: Antennas for All Applications , The McGraw Hill Companies, (2008).
5. J. E. Rhodes: Antenna Handbook, Department of The Navy, (2016).
6. Lo, Y.T., Lee, S. W.: Antenna Handbook Theory, Applications, and Design, Springer US, (1988).

AAE 4407: AEROSPACE EMBEDDED SYSTEMS, SOFTWARE, SAFETY AND SECURITY [3 0 0 3]

Introduction to embedded systems, classification, major application, typical embedded systems architecture, systems components, designing embedded system with microcontroller and microprocessor, embedded hardware and firmware design and development-Tools, IDE, Development Tools, Control Systems: Tortoise SVN, etc. Effective software development for aerospace safety and critical application, software development and testing, requirement analysis, SDLC & Fundamentals of Software Testing /Embedded System, Introduction to Coding Standards i.e., CERT C and MISRA C:2012, Top 10 Secure Coding Best Practices, Introduction to Process Standard DO-178C for Avionics, Embedded System, Aircraft embedded systems: computer, OBC, microprocessor and microcontroller in LRUs, communication modules, databus modules..

References:

1. K.V. Shibu: Introduction to Embedded Systems, McGraw Hill Education India Private Limited(2017)
2. E. A. Lee and S. A. Seshia: Introduction to Embedded Systems - A Cyber-Physical Systems Approach, MIT Press, (2017).
3. Kai Qian, David den Haring and Li Cao: Embedded Software Development with C, Springer Science and Business Media, LLC, (2009).
4. Michael Barr, Anthony Massa, Programming Embedded Systems, Second Edition with C and GNU Development Tools 2nd Edition, O'Reilly Media, (2009).
5. Renu Rajani, Pradeep Oak: Software Testing Effective Methods Tools & Techniques, Tata Mcgraw Hill Publishing Co Ltd, (2017).
6. MISRA C and SEI CERT C secure coding standards.

AAE 4408: AIRCRAFT COMMUNICATION AND NETWORKING [3 0 0 3]

Introduction, communication process, source, channel, modulation process, Signals and Signal Space, Amplitude Modulations and Demodulations, Angle Modulation and Demodulation, demodulators or detectors, Performance of communication systems, AM and FM Receiver, sampling theory, Cellular and mobile communication, Security in Next Generation Air Traffic Communication Network, Aircraft communication, Commercial Standard Digital Bus, Data bus, ARINC, Avionics Application Software Standard Interface. Basic functions and facilities of a computer, Computer Systems Hardware, Networking Essentials., Networking Computers, Communications, Data Communications and Transmission Media, RISC processors: ARM and SPARC, VLIW processors, Case study: Aircraft computers, Aircraft Networking, Aircraft Data Network (ADN).

References:

1. B. P. Lathi, Z. Ding: Modern Digital and Analog Communication Systems, Oxford University Press, (2010).
2. Sanjay Sharma: Communication system (Analog and Digital), S.K. Kataria & Sons, (2013).
3. Commercial Standard Digital Bus, Collins General Aviation Division, Rockwell International Corporation, Cedar Rapids, IA, (1991).
4. Dale Stacey: Aeronautical Radio Communication Systems and Networks, John Wiley & Sons, Ltd, (2008).
5. Rob Williams: Computer Systems Architecture - A Networking Approach (2nd Edition), PEARSON Prentice Hall, (2006).
6. Philipp Goedeking: Networks in Aviation: Strategies and Structures, Springer, (2010).

AAE 4421 SPACEFLIGHT MECHANICS AND ATTITUDE DYNAMICS [2 0 1 3]

Introduction to Space Flight Mechanics -historical overview, basics of celestial mechanics, newtonian mechanics and Kepler's laws. Orbital dynamics, orbital elements, types of orbits - (LEO, GEO, HEO, etc.), perturbations and orbital maintenance. Orbital maneuvers - Hohmann transfers, Plane changes and inclination adjustments, rendezvous and docking maneuvers. Interplanetary Trajectories - two-body and multi-body problems, gravity assists, trajectory optimization. Spacecraft attitude dynamics - attitude representation, attitude determination and control, stability, and control systems. Mission design - mission analysis and planning, payload considerations, launch vehicle selection

Lab Component:

- Orbital simulations using software tools
- Hands-on exercises in maneuver planning
- Case studies of real-world space missions
- Design and analysis of space mission scenarios

References:

1. Curtis, Howard D., Orbital Mechanics for Engineers (4e), Elsevier Press, 2013
2. Vallado, David A., Fundamentals of Astrodynamics and Applications (3e), Microcosm Press/Springer, 2007
3. Danby, J. M. A., Fundamentals of Celestial Mechanics, Willmann-Bell, Inc., Richmond, Virginia, USA, 1988
4. Battin, Richard, An Introduction to the Mathematics and Methods of Astrodynamics, AIAA Education Series, AIAA, New York, 1999
5. Wiesel, William E., Spaceflight Dynamics (2e), Tata McGraw Hill Publishing Company Limited, New Delhi, 1996
6. Thomson, William T., Introduction to Space Dynamics, Dover Publication Inc., New York, 1986
7. Claus Weiland., Computational Space Flight Mechanics (1e), Springer Publishers, 2010

AAE 4422 SPACECRAFT SYSTEMS AND ENGINEERING [3 0 0 3]

Introduction to Spacecraft Systems Engineering - overview of spacecraft design lifecycle, role of systems engineering in space missions, challenges and constraints in space system design. Spacecraft Subsystems - propulsion systems, power generation and distribution, thermal control, communication and data handling, TT&C, attitude determination and control. Mission Requirements Analysis - functional and performance requirements, environmental constraints, reliability and safety considerations. Systems Architecture - hierarchical spacecraft architecture, trade-off analysis and optimization, Interface management and compatibility. Spacecraft Integration and Testing - assembly, integration, and testing (AIT) phases, verification and validation processes, test facilities and procedures. Project Management in Space Missions - project planning and scheduling, risk management, budgeting and resource allocation, stakeholder communication and coordination

References:

1. Larson, Wiley, and James Wertz, eds, Space Mission Analysis and Design, Torrance, CA: Microcosm Press, 1999.
2. Larson, Wiley, and Linda Pranke, Human Space Flight: Mission Analysis and Design. Columbus, OH: McGraw-Hill Companies, 1999
3. Eckart, Peter, The Lunar Base Handbook: An Introduction to Lunar Base Design, Development, and Operations. Columbus, OH: McGraw-Hill Companies, 2006.
4. Fartescue, Peter, Swinerd Graham and stark, John., Spacecraft systems engineering (4e), West Sussex John Wiley and Sons 2011

AAE 4423 LAUNCH VEHICLE SYSTEMS AND TECHNOLOGIES [3 0 0 3]

Introduction to Rocket Propulsion - overview of rocketry principles, newton's laws of motion applied to rockets, rocket equation and dynamics, types of rocket engines and propellants. Launch Vehicle Configurations- single-stage and multi-stage rockets, launch vehicle components (stages, payload fairings, etc.), launch site infrastructure and operations. Propulsion Subsystem - thrust generation mechanisms, engine cycles (e.g., solid, liquid, hybrid), engine components and materials. Propulsion Performance Analysis - specific impulse and thrust-to-weight ratio, engine efficiency and performance curves, Trade-offs in engine design. Mission Planning and Optimization - trajectory analysis and optimization, payload mass fraction and launch vehicle sizing, launch window determination and launch site selection. Advanced Propulsion Technologies - electric propulsion systems, nuclear propulsion concepts, ion Propulsion, solar sails, future trends in propulsion technology

References:

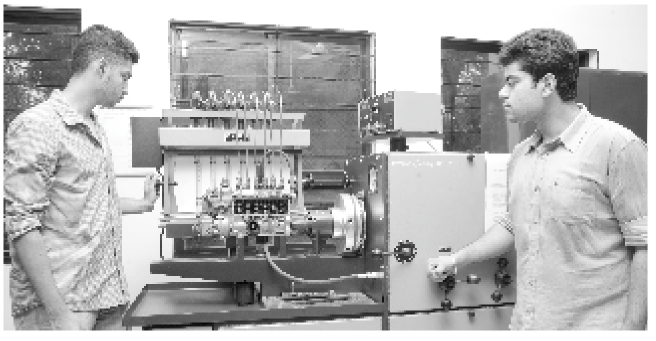
1. Cornelisse et al, 'Rocket Propulsion and Spaceflight Dynamics', Pitman, 1979
2. Thompson, 'Introduction to Space Dynamics', Dover Publications, New York, 1986
3. Hale, 'Introduction to Space Flight', Prentice Hall, 1994
4. Wiesel, 'Spaceflight Dynamics', McGraw-Hill, 1997
5. Walter, 'Astronautics: The Physics of Space Flight', Wiley-VCH, 2012

AAE 4424 SPACE DATA, PRODUCTS AND SERVICES [3 0 0 3]

Introduction to Space Data - Overview of space-based data sources (satellites, probes, etc.), types of space data (remote sensing, telemetry, etc.), importance of space data in various applications (earth observation, climate monitoring, etc.). Satellite Data Acquisition - satellite sensors and platforms, remote sensing techniques (passive vs. active sensing), data transmission and reception. Data Processing Methods- pre-processing techniques (calibration, correction, etc.), image processing algorithms (classification, feature extraction, etc.), time-series analysis methods. Space Data Products and Services - Earth observation products (land cover maps, weather forecasts, etc.), navigation and positioning services (GPS, GNSS, etc.), telecommunications services (satellite internet, satellite TV, etc.). Artificial Intelligence in Space - overview of AI techniques (machine learning, deep learning, etc.), applications of AI in space exploration and research, challenges and opportunities in AI implementation for space applications. implementation of AI in Space Applications - AI algorithms for satellite image analysis (object detection, change detection, etc.), AI-driven data fusion techniques for multi-source data integration, Case studies of AI implementation in space missions (autonomous navigation, anomaly detection, etc.)

References:

1. Jonathan Chipman, Ralph W. Kiefer, Thomas Lillesand., Remote Sensing and Image Interpretation (7e), John Wiley and Sons, 2015
2. P.J. Curran, Principles of Remote Sensing, Longman Publishers, 1985
3. Emilio Chuvieco, Alfredo Huete., Fundamentals of Satellite Remote Sensing (1e), CRC Press T &F, 2009
4. Gérard Maral, Michel Bousquet, Zhili Sun., Satellite Communications Systems: Systems, Techniques and Technology, John Wiley & Sons, 2020
5. Matteo Madi, Olga Sokolova., Artificial Intelligence for Space: AI4SPACETrends, Applications, and Perspectives, CRC Press T & F, 2024



B TECH AUTOMOBILE ENGINEERING

Year	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
	THIRD SEMESTER						**FOURTH SEMESTER**					
II	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	MAT 2121	Engineering Mathematics - III	2	1	0	3	MAT 2222	Engineering Mathematics - IV	2	1	0	3
	AAE 2126	Strength of Materials	2	1	0	3	AAE 2226	Automotive Component Design	3	1	0	4
	AAE 2127	Materials Science and Metallurgy	3	0	0	3	AAE 2227	Manufacturing Techniques & Metrology	3	0	0	3
	AAE 2123	Engineering Thermodynamics	3	1	0	4	AAE 2223	Linear Control Theory	2	1	0	3
	AAE 2128	Fluid Mechanics	3	1	0	4	AAE 2228	Vehicle Transmission Systems	2	1	0	3
	AAE 2129	Basics of IC Engines	3	0	0	3	AAE 2229	Autotronics	3	0	0	3
	AAE 2143	Geometric Modelling Lab	0	0	3	1	AAE 2243	Materials Testing Lab	0	0	3	1
	AAE 2144	Automobile Lab - I	0	0	3	1	AAE 2244	Automobile Lab - II	0	0	3	1
			16	**4**	**6**	**22**			**15**	**4**	**6**	**21**
	Total Contact Hours (L + T + P)		**26**				**Total Contact Hours (L + T + P)**		**25**			
	FIFTH SEMESTER						**SIXTH SEMESTER**					
III	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	HUM 3021	Engineering Economics and Financial Management	2	1	0	3	HUM 3022	Essentials of Management	2	1	0	3
	AAE 3127	Vehicle Chassis Systems	2	1	0	3	AAE 3225	Vehicle Dynamics and Control	3	1	0	4
	AAE ****	Flexible Core - 1	3	0	0	3	AAE ****	Flexible Core - 2	2	1	0	3
	AAE 3128	Heat Transfer	3	1	0	4	AAE ****	Program Elective - I / Minor Specialization	3	0	0	3
	AAE 3129	Electric Vehicle Technology	3	0	0	3	AAE ****	Program Elective - II / Minor Specialization	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective - 2				3
	AAE 3143	Simulation Lab	0	0	3	1	AAE 3243	Automotive Design and Analysis Lab	0	0	3	1
	AAE 3144	Automobile Lab - III	0	0	3	1	AAE 3244	Vehicle Aerodynamics Lab	0	0	3	1
			14	**2**	**6**	**21**			**14**	**2**	**6**	**21**
	Total Contact Hours (L+T+P) + OE		**25**				**Total Contact Hours (L+T+P) + OE**		**25**			
	SEVENTH SEMESTER						**EIGHTH SEMESTER**					
IV	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	AAE ****	Program Elective - III / Minor Specialization	3	0	0	3	AAE 4291	Industrial Training				1
	AAE ****	Program Elective - IV / Minor Specialization	3	0	0	3	AAE 4292	Project Work/Practice School				12
	AAE ****	Program Elective - V	3	0	0	3	AAE 4293	Project Work (B.Tech Honours)**				20
	AAE ****	Program Elective - VI	3	0	0	3	AAE ****	B.Tech Honours (Theory 1)** (V Semester)				4
	AAE ****	Program Elective - VII	3	0	0	3	AAE ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	*** ****	Open Elective - 3				3	AAE ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	AAE 4191	Mini Project (Minor Specialization)*				8						
			15	**5**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P) + OE		**15 + 3 = 18**									

*Applicable to students who opted for minor specialization   **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

FLEXIBLE CORE I

AAE 3124: Industrial IoT
AAE 3125: Finite Element Methods
AAE 3126: Advanced Engine Technology

FLEXIBLE CORE II

AAE 3222: Machine Learning and AI
AAE 3223: Computational Fluid Dynamics
AAE 3224: Theory of Vibrations

MINOR SPECIALIZATIONS

I. AUTOMOTIVE SYSTEM ENGINEERING

AAE 4409: Connected Vehicle Systems
AAE 4410: Advanced Drivetrain Systems
AAE 4411: Engine Tribology
AAE 4412: Actuation Systems

II. VEHICLE SYSTEM DESIGN

AAE 4413: Engine Systems Design
AAE 4414: Automotive Ergonomics
AAE 4415: Fatigue Failure and Analysis
AAE 4416: Noise, Vibrations and Harshness

III. ELECTRIC VEHICLE TECHNOLOGY

AAE 4417: Electrical Vehicle System Engineering
AAE 4418: Energy Storage System and Devices for Electric Vehicles
AAE 4419: Electrical Vehicle Battery and Charging System
AAE 4420: Motors and Drive Systems for Electric Vehicles

OTHER PROGRAMME ELECTIVES

AAE 4447: Composite Materials and Structures
AAE 4448: Computer Integrated Manufacturing
AAE 4450: Digital Manufacturing
AAE 4451: Electrochemical Energy Storage Systems
AAE 4452: Experimental Mechanics
AAE 4455: Industrial Automation and Robotics
AAE 4456: Lean Manufacturing
AAE 4459: Numerical Methods for Scientific Computing
AAE 4460: Operations Research
AAE 4462: Optimization Techniques in Engineering
AAE 4465: Statistical Quality Control and Reliability
AAE 4466: Surrogates and Approximations in Engineering Design
AAE 4468: Total Quality Management
AAE 4471: Automotive Pollution Control
AAE 4472: Automotive Thermal Management Systems
AAE 4473: Crashworthiness and Safety
AAE 4474: Design for Manufacturing
AAE 4475: Earth Moving Equipment and Farm Machinery
AAE 4476: Human Factors in Automotive Engineering
AAE 4479: Metrology & Measurements
AAE 4480: Tyre Technology
AAE 4481: Vehicle Embedded Systems

OPEN ELECTIVES

AAE 4313: Introduction to Automobile Engineering
AAE 4314: Alternatives Fuels for Sustainable Environment

THIRD SEMESTER

MAT 2121: ENGINEERING MATHEMATICS III [2 1 0 3]

Gradient, divergence and curl, Line, surface and volume integrals. Green's, divergence and Stoke's theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, Sine and cosine transforms. Partial differential equation- Basic concepts, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of variables. One-dimensional wave equation, one dimensional heat equation and their solutions. Numerical solutions of boundary valued problems, Laplace and Poisson equations, heat, and wave equations by explicit methods.

References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Eastern, 1985.
2. S.S.Sastry, Introductory Methods of Numerical Analysis, Prentice Hall, 1990.
3. B.S.Grewal, Higher Engg.Mathematics, Khanna Publishers, 1989.
4. Murray R.Spiegel, Vector Analysis, Schaum Publishing Co., 2009.

AAE 2126: STRENGTH OF MATERIALS [3 0 0 3]

Shear force and bending moment diagram; SFD and BMD for standard cases, Stresses in Beam and its theory. Torsion and power transmission. Shaft in series and parallel. Deflection of beams, elastic curve equation, a method to calculate the deflection. Thin and Thick cylinders subjected to internal pressure, Hoop Stress, and longitudinal stress and its effect. Stress in the thick cylindrical shell, the stress in the compound thick cylinder, thick spherical shells.

References:

1. R. K. Bansal, A Textbook of Strength of Materials. Laxmi Publications, 2010.
2. S. S. Bhavikatti, Strength of Materials, 4th Edition. Vikas Publishing House, 2013.
3. S. S. Rattan, Strength of Materials, McGraw-Hill Education (India) Pvt Limited, 2011.
4. R. Subramanian, Strength of Materials, Oxford University Press, 2005.

AAE 2127: MATERIAL SCIENCE AND METALLURGY [3 0 0 3]

Materials classification. Crystallography SC, FCC, BCC, HCP structures. APF. Miller indices: miller bravais indices, Point defects, line defects, surface defects. Plastic Deformation of Metals and Alloys- Mechanisms of plastic deformation, role of Dislocation; slip and twinning, Solid solution, Hume Rothery's rules, Phase diagrams- Phase and Lever Rules relationship of micro Structure and properties, Isomorphous systems, TTT diagram, Heat treatment of steel, Applications of Ferrous alloys, Non-Ferrous Alloys, ceramics and other materials.

References:

1. Raghavan V, Material science and engineering, Prantice Hall India, 2004.
2. Avner Sidney, Introduction to physical metallurgy, Mc Graw Hill

International, 1991.

3. Shackelford, Materials science for Engineers, Prantice Hall New Jersey, 1996.
4. Van Vlack, Materials science and Engineering, Addison Wesley, New York, 1989.
5. William D Callister, Material science and engineering, Wiley India, 2007.

AAE 2123: ENGINEERING THERMODYNAMICS [3 1 0 4]

Introduction to Thermodynamics, Zeroth Law of Thermodynamics – Concept of quality of Temperature – Principles of Thermometry – First law of Thermodynamics – Corollaries – First law applied to a Process – applied to a flow system – Steady Flow Energy Equation- Second Law of Thermodynamics, Clausius Inequality, Entropy, Principle of Entropy Increase – Energy Equation, Availability and Irreversibility – Third Law of Thermodynamics, Pure Substances-Mollier Charts, Phase Transformations – Clausius – Clapeyron Equation Various Thermodynamic processes and energy Transfer – Steam Calorimetry, Ideal and Real gases- Perfect Gas Laws – Equation of State, Compressibility charts – Gravimetric and volumetric Analysis – Dalton's Law of partial pressure, Avogadro's Laws of additive volumes – Psychrometry, Gas cycles- Otto, Diesel, Dual Combustion cycles, Sterling Cycle, Atkinson Cycle, Ericcson Cycle, Lenoir Cycle –Thermal Efficiency, Brayton and Rankine cycles – Performance Evaluation – combined cycles, Bell- Coleman cycle, Vapour compression cycle-performance, Self-study topics recommended.

References:

1. CenegelYunus A and Boles Michael, A Thermodynamics, Tata Mcgraw-Hill, New Delhi, 2011.
2. Nag P K, Engineering Thermodynamics, Tata McGraw-Hill, New Delhi, 2006.
3. R K Rajput, A textbook of Engineering Thermodynamics, Laxmi Publications, New Delhi, 2010.
4. Mayhew A. and Rogers B., Engineering Thermodynamics, E.L.B.S. Longman, London, 1994.
5. P L Ballaney, Thermal Engineering, Khanna Publisher, New Delhi, 2012.

AAE 2128: FLUID MECHANICS [3 1 0 4]

Introduction and basic concepts: Classification of fluid flow, no slip condition, velocity profile, Fluid properties, Fluid Statics: Hydrostatic law, Pascal law definition, Pressure measurement using manometers (simple and differential manometers), Forces acting on plane, curved surfaces submerged inside fluid. Forces acting on solid objects submerged, floating in fluid (Buoyancy). Fluid Kinematics and Kinetics (Fluid Dynamics): Fundamentals of Flow Visualization, Types of Motion or Deformation of Fluid Elements Vorticity and Rotationality, Conservation of Mass Conservation of Momentum Conservation of Energy equation, Mass and Volume Flow Rates, The Bernoulli Equation, differential analysis of fluid flow(Continuity, Navier stokes equations). Dimensional Analysis: Dimensions and Units, Dimensional Homogeneity, Similarity, Buckingham Pi Theorem. Pipe flow: Laminar and Turbulent Flow through pipe, Flow Rate and Velocity Measurement Minor losses, flow rate and velocity measurement. Flow over bodies: Drag and Lift, Friction and Pressure Drag, Parallel Flow over Flat Plates, Flow over Cylinders and Spheres. Introduction to compressible flow: Stagnation properties, speed of sound and Mach number, shock waves and expansion waves, Self-study topics recommended.

References:

1. Yunus A Cengel, and Johm M Cimbala, Fluid Mechanics-Fundamentals and Application, McGraw-Hill, 2013.
2. Bansal R.K., A Text Book of Fluid Mechanics and Fluid Machine, Laxmi Publications, 2010.
3. Frank N white, Fluid Mechanics, McGraw Hill, 2011.
4. Bruce R. Munson, Theodore H. Okiishi, Wade W. Huebsch, Alric P. Rothmayer, Fundamentals of Fluid Mechanics, John Wiley and Sons, New Jersey, 2013.
5. Clayton T. Crowe, Donald F Elger, Barbara C Williams, John A Roberson, Engineering Fluid Mechanics, John Wiley and Sons, New Jersey, 2009.

AAE 2129: BASICS OF IC ENGINES [3 0 0 3]

Fundamental operating principle, IC engine development, components, classification, characteristics of IC engine, combustion in SI and CI engine, SI engine: Introduction, combustion chambers, Modern Engine trends, Miller Cycle, VVIT, Variable Geometry, Tuned intake manifold, ignition system, mixture preparation: carburetion & fuel injection, CI engine: Fuel Supply SI, CI, direct injection system(DI), indirect injection system(IDI), cold starting of engine, fuel injection equipment: injector, injection pump, Types of Injection, GDI,MPFI, Booster jet, Port Injection, Single orifice nozzle, Piezo operated, Solenoid operated, Jerk pump, Distribution pump, CRDI, Scavenging systems – 2 S, inlet & exhaust layouts, Governors, Hartnell, Pickering governors, Turbocharging, Twin turbocharger, Intercooler, Cooling and Lubrication Systems, Engine Testing and Performance, Self-study topics recommended.

References:

1. Ballaney P. L., Theory of Machines, Khanna Publishers, New Delhi, 1998.
2. Richard Stone., Introduction to internal combustion engines, Macmillan Education UK, 2012.
5. Mathur and Sharma, Internal Combustion Engine, Dhanpat rai publications, New Delhi, 2007.
6. Kirpalsingh, Automobile Engineering vol II, Standard publishers, 2014.
7. John B. Heyhood, Internal Combustion Engines Fundamentals, McGraw Hill, 2018.
8. V. Ganesan, IC Engines, Tata McGraw Hill Education Private Limited, India, 2012.

AAE 2143: GEOMETRIC MODELLING LAB [0 0 3 1]

Sketcher Exercises-2D, Part Modelling tool for 3D Modelling of components and Assembly Exercises, Generative Wireframe and Surface for Surface Modelling.

References:

1. Sham R Tickoo, CATIA V5:6R2015 for Designers, CADCIM

Technologies, 2009.
2. JaecheolKoh, Catia V5-6r2014 Surface Design: A Step by Step Guide, Create space Independent Publishers, 2015.

AAE 2144: AUTOMOBILE LAB I [0 0 3 1]

Tools and equipment used in Automotive engine servicing and reconditioning, servicing of intake system, Fuel and lubrication system, piston and connecting rod assembly, Engine Valve Reconditioning, , Cylinder bore reconditioning, crank shaft regrinding, cylinder head reconditioning, Engine tune up and assembling following SOPs.

References:

1. Kirpalsingh, Automobile Engineering, Vol.2, Standard Publishers distributors, 2011.
2. Tom Denton, Automobile Mechanical and Electrical systems, Butterworth-Heinemann publishers, 2011.
3. Dr. N. K. Giri, Automobile Technology, Khanna publishers, 2004.

FOURTH SEMESTER

MAT 2222: ENGINEERING MATHEMATICS IV [2 1 0 3]

Special Functions: Series solutions of Bessel and Legendre differential equations, Recurrence formulae, generating functions and Orthogonal properties for Jn(x) and Pn(x).. Probability, finite sample space, conditional probability and independence, Bayes' theorem, one-dimensional random variable: mean and variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least square principle of curve fitting. Distributions: binomial, Poisson, uniform, normal, gamma, chi-square and exponential. Moment generating function, Functions of one dimensional and two-dimensional random variables, Sampling theory, Central limit theorem and applications.

References:

1. Kreyzig E, Advanced Engineering Mathematics, Wiley Eastern, 1999.
2. Meyer P.L, Introduction to probability and Statistical applications, American Publishing Co., 1965.
3. Hogg & Craig, Introduction of Mathematical Statistics, MacMillan, 1975.
4. B.S.Grewal, Higher Engg.Mathematics, Khanna Publishers, 1989.

AAE 2226: AUTOMOTIVE COMPONENT DESIGN [3 1 0 4]

Introduction to design, general considerations, safety and societal considerations. Theories of failure. Design against static and fluctuating loads. Design of Coil Springs- Helical-cylindrical compression springs. Spring materials, Stresses & deflection of springs subjected to steady and Fluctuating loads. Design of Leaf Springs- Semi elliptic carriage springs. Spur Gears- Standard involute gears, Beam strength of tooth. Stress in gear teeth, Dynamic loads on gear teeth, Wear Strength. Helical Gears- Formative number of teeth, Static, Dynamic and Wear strength. Bevel Gears-Straight teeth bevel gears, Virtual number of teeth, Static, Dynamic and Wear strength. Worm Gears- Nomenclature, Materials, Strength design, Efficiency, Heat dissipation. Sliding Contact Bearings - Journal bearings, Viscosity and lubricants, Somerfield number, Coefficient of friction, Bearing modulus, Heat generation & dissipation. Rolling Contact Bearings- Types of ball and roller bearings, Life rating, Basic capacities, Equivalent load, Loading ratio. Selection of bearing from Manufacturers catalogue. Belt Drives- Power transmission, Flat and V belts, Ratio of belt tensions, Centrifugal tension, belt selection. V-flat drives, Pulleys, Selection of belts and pulleys, Self-study topics recommended.

References:

1. Richard G. Budynass, Keith Nisbett, Shigley's, Mechanical Engineering Design, McGraw-Hill Education, 2015.
2. Robert L. Mott, Machine element in Mechanical Design, Pearson Education, New Jersey, 2004.
3. Robert C. Juvinall, Kurt M. marshek, Fundamentals of Machine Component Design, John Wiley & Sons Inc., 2012.
4. Bhandari V.B, Design of Machine Elements, Tata McGraw-Hill, 2018.
5. Robert L Norton, Machine Design and Integrated approach, Prentice Hall Inc., 2011.

AAE 2227: MANUFACTURING TECHNIQUES & METROLOGY [3 0 0 3]

Introduction, Preparation of powders, Blending, Compaction, Sintering and Finishing operations; Properties of powdered metals - strength, density, ductility, hardness etc., Isostatic pressing, Spark discharge sintering, Lapping, Honing, and Super finishing processes, polishing and buffing, Merits, limits and applications; Chip less machining, Internal and external thread rolling, Spline rolling, High Energy rate forming processes - Introduction, Process principles, Process capabilities, Applications, Advantages and Limitations of - Electromagnetic forming, Explosive forming, Magnetic pulse forming and shearing operations, Sheet metal operations, Extrusion Process, hot & cold extrusion of bars & tubes, impact extrusion, hydrostatic extrusion. The drawing process, drawing of rods, bars, tubes and wires, Characteristics of measuring instruments, elements of an instrument, calibration of instruments, types of error in instruments, selection of instruments, Slip gauges, angle gauges, spirit level, bevel protector, sine bar.

References:

1. Kalpakjian S, Manufacturing Engineering and Technology, Addison Wesley Publishing, Delhi, 2000.
2. Degarmopaul, Black &Kohser, Materials and Processes in Manufacturing, Prentice Hall of India, New Delhi, 2003.
3. Lindberg R.A, Processes and Materials of Manufacture, Prentice Hall of India, New Delhi, 1991.
4. Dalela S, Manufacturing Science and Technology (Vol. II & III),Umesh Publishers, Delhi, 1998.
5. Jain R K, Engineering Metrology, Khanna Publishers, New Delhi, 2003.
3. Beckwith T H, Mechanical Measurements, Addison Wesley, New York, 1990.

AAE 2223: LINEAR CONTROL THEORY [3 0 0 3]

Brief overview of the historical development of Control system theory, Basic terminologies of the control systems, Mathematical modeling of Mechanical and electrical systems to determine the transfer functions. Development of block diagrams from governing differential equations, Rules for reducing the block diagrams, examples of block diagram reduction. Introduction to signal flow graph, Mason's gain formula. Introduction to time domain analysis, types of signals and their mathematical representation. Time domain response of I and II order systems to different types of signals. Error analysis and its impact on the system output. Introduction to frequency domain analysis, Graphical techniques- Bode and Polar plots. Routh Hurwitz stability criteria, Root locus technique. State space techniques.

References:

1. Ogata, K., Modern Control Engineering, Prentice Hall, V edition, 2009.
2. Norman S Nise, Control systems Engineering, John Wiley,2011
3. Kuo, B.C., Automatic Control System, Prentice Hall, 10th edition, 2019
4. Gopal. M., Control Systems: Principles and Design, Tata McGraw-Hill, 2002.
5. Nagrath & Gopal, Modern Control Engineering, New Ages International, 2021.
6. E. Bryson and Y-C Ho: Applied Optimal Control, Taylor and Francis, 2017.

AAE 2228: VEHICLE TRANSMISSION SYSTEM [2 1 0 3]

Introduction, layouts of transmission system, Vehicle Performance, Types of clutch, Design of clutch system, Fluid coupling, Types of gears, Types of Gear box, Gear Ratio calculations, Types of Automatic Transmission System, AMT, Torque convertor, Transfer case, Four wheel drive mechanism, Drive line system, propeller shaft, hooks joint, constant velocity joints, differential gears, gear reduction, limited slip differential, types of rear axle, Transmission system used in two and three wheelers, maintenance aspects of transmission system components, Self-study topics recommended.

References:

1. K.Newton, W.Steeds and T.K.Garret, The Motor Vehicle, Butterworth Heinemann, India, 2004.
2. N.K Giri, Automotive Mechanics, Khanna Publication, New Delhi. 2010.
3. Kirpal Singh, Automobile engineering, Vol.1, Standard Publishers, 2007.
4. Harald Naunheimer, B Bertshae, J Rayborz, W Novak, Automotive Transmission Fundamentals, Selection, Design and Application, Second Edition, Springer, 2010.
5. Yi Zhang, Chris Mi, Automotive Power Transmission Systems, Wiley, 2018.

AAE 2229: AUTOTRONICS [3 0 0 3]

Basic sensor arrangement, Types of sensors such as-Oxygen sensors, Crank angle position sensors-Fuel metering/vehicle speed sensor and knock sensor-Altitude sensor, flow sensor. Throttle position sensors. Solenoids, stepper motors, and relays. Throttle body injection and multi-port or point fuel injection., fuel injection systems, Injection system controls, Types of solid-state ignition systems and their principle of operation, Contact less electronic ignition system, and electronic spark timing control, Battery, starting motor, generator, alternator, dash board units and wiring diagrams, lighting system. Safety systems used in vehicles, Airbag, TCS, Electronic stability program Adaptive suspension system, ABS, Cruise control etc., Digital engine Management System, Self-study topics recommended.

References:

1. Ribbens, Understanding Automotive Electronics, Elsevier, Indian Reprint, 2013.
2. Tom Denton, Automobile Electrical and Electronics Systems, Edward Arnold Publishers, 2000.
3. Barry Hollembeak, Automotive Electricity, Electronics & Computer Controls, Delmar Publishers, 2001
4. Richard K. Dupuy, Fuel System and Emission controls, Check Chart Publication, 2000.
5. Ronald. K. Jurgon, Automotive Electronics Handbook, McGraw-Hill, 1999.

AAE 2243: MATERIAL TESTING LAB [3 0 0 3]

Introduction-Tensile Test, Load-Displacement and Stress-Strain Curves, Torsion Test, Compression Test, Bending Test, Impact Test, Hardness Test, Fatigue and Shear Test, Test on Mechanical Springs, Non-Destructive Testing.

References:

1. Timoshenko, S., Strength of materials, Vols. II, Princeton, D.VonNostrand Co., 2002.
2. Shigley J, Mechanical Engineering Design, McGraw Hill New York, 2011.
3. Mott, Applied Strength of materials, PHI, 2016.
4. Egor P. Popov, Engineering Mechanics of Solids, PHI, 2004.

AAE 2244: AUTOMOBILE LAB-II [3 0 0 3]

Thermo mechanical lab, Lathe operations, turning, taper turning, thread cutting, gear hobbing, CNC programming, Grinding. Determination of viscosity, flash and fire points, compression ratio, valve-timing diagrams, performance test on petrol and diesel engines, Morse test, Refrigeration test rig.

References:

1. M L Mathur and R P Sharma, Internal Combustion Engines, Dhanpat Rai Publications, 2011.
2. V Ganesan, Internal Combustion Engines, Tata McGraw-Hill, 2012.
3. Kalpakjian S, Manufacturing Engineering and Technology, Addison Wesley Publishing, Delhi, 2000.

FIFTH SEMESTER

HUM 3021: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of Single, Uniform, and Gradient cash flow. Related problems and case studies. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical &

functional depreciation, Straight line depreciation, declining and double declining balance method of depreciation, Sum-of-the-Years Digits, Sinking Fund and Service Output Methods, Case Study. Balance sheet and profit & loss statement. Meaning & Contents. Ratio analysis, financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios, Drawbacks. Safety and Risk, Assessment of Risk and safety, Case study, Risk Benefit Analysis and Reducing Risk.

References:

1. Chan S. Park, Contemporary Engineering Economics, Pearson Prentice Hall, 2007.
2. Thuesen G. J, Engineering Economics, Prentice Hall of India, New Delhi, 2005.
3. Blank Leland T. and Tarquin Anthony J., Engineering Economy, McGraw Hill, Delhi, 2002.
4. Prasanna Chandra, Fundamentals of Financial Management, Tata McGraw Hill, Delhi, 2006.

AAE 3127: VEHICLE CHASSIS SYSTEMS [2 1 0 3]

Introduction, layouts of two and three wheeler, passenger cars and commercial vehicle chassis, Types of frames, materials used, load distribution, design of vehicle chassis, Requirement of suspension system, Independent and rigid suspension system, leaf spring, coil spring, shock absorber, Maintenance aspects of vehicle suspension systems, True rolling, Steering mechanisms, Types of steering systems, steering linkages, Power steering systems, Fundamental of braking systems, Types of brakes, Design of drum and disc brakes, leading and trailing shoes, heat dissipation, hydraulic, air, servo, engine, vacuum braking system, Parking brakes, hill hold assist, Types of tyres and wheels, Constructional features and materials.

References:

1. Newton W.Steeds and T.K.Garret, The Motor Vehicle, Butterworth Heinemann, India, 2004.
2. N .K.Giri, Automobile Mechanics, Seventh Edition, Khanna Publishers, Delhi, 2005.
3. Kirpal Singh, Automobile Engineering, Volume 1, Standard Publishers and Distributors, 2007.
4. David C. Barton, John D. Fieldhouse, Automotive Chassis Engineering, Springer, 2018.
5. P.M. Heldt, Automotive Chassis, Chilton & Co, 2012.

AAE 3128: HEAT TRANSFER [3 1 0 4]

Introduction to heat transfer -modes of heat transfer, Conductivity and film coefficient of heat transfer, Thermal diffusivity, Overall heat transfer coefficient, Thermal resistance and conductance. Conduction heat transfer, Linear heat flow through plane wall, composite wall, radial heat flow through cylinder, composite cylinders ,radial heat flow through sphere and composite sphere, Effect of variable thermal conductivity, Critical thickness of insulation, Heat transfer from extended surfaces ,Convection Heat transfer -Application of dimensional analysis to free and force convection, Dimensionless numbers Hydrodynamics and thermal boundary layer ,Boiling heat transfer, Heat Exchanger-Types, overall heat transfer coefficient, fouling or scaling and fouling factor. Logarithmic mean temperature difference, correction factor. Effectiveness and number of transfer units, Radiation-Black bodies, emissive power, the intensity of radiation, heat transfer due to radiation between black bodies and grey bodies.

References:

1. P.K. Nag, Heat and Mass Transfer, Tata McGraw Hill Education Pvt Ltd, New Delhi, 2011.
2. YunusCengel and Afshin Ghajar, Heat and Mass Transfer, Tata McGraw Hill Education Pvt Ltd, New Delhi, 2011.
3. R. K. Rajput, Heat and Mass Transfer, S Chand & Co Ltd. New Delhi, 2006.
4. S K Som, Introduction to Heat Transfer, PHI Learning Pvt Ltd, New Delhi, 2008.
5. J P Holman, Heat Transfer, McGraw Hill, New York, 2010.
6. M L Mathur and R P Sharma, Internal Combustion Engines, Dhanpat Rai publications, New Delhi, 2011.
7. V Ganesan, Internal Combustion Engines, Tata McGraw-Hill Education, New Delhi, 2012.

AAE 3129: ELECTRIC VEHICLE TECHNOLOGY [3 0 0 3]

Overview of electric vehicles, hybrid vehicles, hybrid and electric vehicle components, vehicle mass and performance, electric motor and engine ratings, EV and ICEV comparison, vehicle kinetics, dynamics of vehicle motion, propulsion power, velocity and acceleration. Tyre road force mechanics, Propulsion system design. Electric and hybrid vehicle architecture, Hybrids based on degree of hybridization. Plug in hybrid electric vehicle. Power train component sizing. Electric machine fundamentals, DC machines, Three phase AC machines. Induction machines. Permanent magnet machines. Switched reluctance machines. Power electronic switches. DC/DC converters. Case studies on EVs and HEVs, Self-study topics recommended.

References:

1. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2021.
2. James D Halderman, Hybrid and Alternative Fuel Vehicles, Pearson Education, 2012.
3. Allen E. Fuhs, Hybrid Vehicles and the Future of Personal Transportation, CRC Press, 2009.
4. Mehrdad Ehsani, Yimin Gao, Ali Emadi, Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, 2009.
5. John German, Hybrid-Powered Vehicles, Second Edition, SAE International,2011.

FLEXIBLE CORE I -A

AAE 3124: INDUSTRIAL IOT [3 0 0 3]

Industrial Networks and IIoT: Now and Future Trends, Wireless Communication for the Industrial IoT, IoT-Driven Advances in Commercial and Industrial Building Lighting, Automation Trends in Industrial Networks and IIoT, Security in Decentralised Computing, IoT and Industrial IoT, Intrusion Detection in Industrial Networks via Data Streaming, Technological Aspects of Industry 4.0 and IIoT, Enabling Technologies of IIoT, Applications and Case Studies, Self-study topics recommended.

References:

1. Ismail Butun, Industrial IoT Challenges, Design Principles, Applications, and Security, Springer, 2020.
2. Giacomo Veneri Antonio Capasso Hands-On Industrial Internet of Things: Create a powerful Industrial IoT infrastructure using Industry 4.0, Ingram short title publications, 2018.
3. Sandeep Misra, Chandana Roy, Anandarup Mukherjee Introduction to Industrial Internet of Things and Industry 4.0, Taylor and Francis, 2021.
4. Sabina Jeschke, Christian BrecherHoubing Song, Danda B. Rawat Editors Industrial Internet of Things Cyber Manufacturing Systems, Springer, 2016.
5. Dr. Guillaume Girardin, Antoine Bonnabel, Dr. Eric Mounier, Technologies Sensors for the Internet of Things Businesses & Market Trends 2014 -2024,Yole Development Copyrights,2014.

FLEXIBLE CORE I -B

AAE 3126: ADVANCED ENGINE TECHNOLOGY [3 0 0 3]

Introduction to combustion process – Classification of flames, Auto ignition temperature, Combustion in SI and CI engines, Automobile pollution, analysis and control, Euro and BS standards for engines emissions, regulated and secondary pollutants, formation, factors affecting the pollutants in SI and CI engines, Emission analysis, control techniques, Introduction: solid fuels, gaseous fuels, liquid fuels, SAE rating of fuels, Availability and Suitability to Piston Engines, Concept of conventional fuels, potential alternative fuels - Ethanol, Methanol, DEE/DME - Hydrogen, LPG, Natural gas, Producer gas, Bio gas and Vegetable oils. Alternative power plants for modern automobiles, HCCi engines, PCCi engines, Lean burn engines, stratified charge engines, dual fuel engines, Variable compression ratio engines, sterling engine, rotary combustion engine, New techniques in engine development, Tuned intake systems, acoustic supercharging, cylinder deactivation, displacement on demand, VVT-I, closed loop control system, VGT, Miller cycle operation, Atkinson cycle operation, Self-study topics recommended.

References:

1. Colin R. Ferguson, Allan T. Kirkpatrick, Internal Combustion Engine Applied Thermosciences, Wiley, 2015.
2. Richard Folkson, Alternative fuels and advanced vehicle technologies for improved environmental performance, Woodhead Publishing Limited, 2014.
3. N.K.Giri, Automobile Mechanics, Seventh Edition, Khanna Publishers, Delhi, 2005.
4. R. K. Rajput, Non-Conventional Energy Sources and Utilisation, Chand Publishers,2012.
5. Jack Erjavec, Martin Restoule,Stephen Leroux, Rob D. Thompson, Automotive Technology A Systems Approach, Nelson Education Limited, 2015.

FLEXIBLE CORE I -C

AAE 3125: FINITE ELEMENT METHODS [3 0 0 3]

Introduction: Origin of FEM, Applications, basic steps, differential equations of physical problem, analytical and approximate solution, difference between Fem and Finite Difference Method. Preprocessing, processing and post processing, computational tools etc. Brief matrix notation and operation, advantages and disadvantages of FEM. Finite Element Formulation: Weighted residual method, Rayleigh Ritz Method, principal of minimum potential energy. One-Dimensional FEM: Formulation of one-dimensional element equation (bar/spring element, truss, beam element) 2/3-Dimensional analysis: Plane stress, Plane strain. FE formulation of Constant Strain Triangular and Linear Strain triangular element, FE formulation of 3D element. Practical consideration in Finite Element Modeling: General Considerations, Aspect Ratio and Element Shapes, Use of Symmetry, Sizing of Elements and the h, p, and r Methods of Refinement, Concentrated or Point Loads and Infinite Stress, Connecting (Mixing) Different Kinds of Elements. Equilibrium and Compatibility of Finite Element result, Convergence of Solution, Contact Modelling and large deformation modelling, Self-study topics recommended.

References:

1. Logan D L, First course in the Finite Element Method, Cengage learning, 2016.
2. Sheshu P., Textbook of Finite Element Analysis, PHI Learning Private Limited, 2003.
3. Robert D Cook, David S Malkus, Micheal E Plesha, Concept and Application of Finite Element Analysis, John Wiley and Sons, 1989.
4. Singiresu S Rao, The Finite Element Method in Engineering, Elsevier Inc, 2018.
5. Saeed Moaveni,Finite Element Analysis:Theory and application with ANSYS, Prentice Hall, 1999.

AAE 3143: SIMULATION LAB [0 0 3 1]

Numerical Computation - Familiarization with MATLAB, Representation of scalars, vectors and matrices, Basic 2D and 3D plot, Locating the roots of equations, Numerical differentiation and integration, Solution of linear and non-linear differential equations, Matrix factorization, Curve fitting, introduction to control system, Stability analysis using Root locus, Bode plot, Nyquist plot and Polar plot techniques, Familiarization with SIMULINK, Control system toolbox, vehicle dynamics toolbox, vehicle network toolbox, communication toolbox, automated driving toolbox, Navigation Toolbox Mass-Spring-Damper Systems, Suspension system modelling, IC Engine modelling, Cruise control, DC Motor position, Motor speed controller, Introduction to electric and hybrid vehicles.

References:

1. Robert J. Schilling and Sandra L. Harries, Applied Numerical Methods for Engineers using MATLAB and C, Thomson Learning Inc., 2000.
2. Brian R Hunt, et al, Guide To Matlab: For Beginners And Experienced Users, Cambridge University Press, 2011.
3. Fausett L.V, Applied Numerical Analysis Using MATLAB, Pearson Education, 2007.

AAE 3144: AUTOMOBILE LAB III [0 0 3 1]

Automotive transmission system layouts, clutch, Gearbox, Final drive and differential, steering system, EV and HEV performance testing, wheel balancing, spark plug testing, Head light beam aiming, testing of starter and alternator, wiper motor.

References:

1. Kirpal Singh, Automobile engineering – Vol.2, Standard Publishers distributors, 2011.
2. Tom Denton, Automobile Mechanical and Electrical systems, Butterworth-Heinemann publishers, 2011.
3. Dr. N. K. Giri, Automobile Technology, Khanna publishers, 2004.

SIXTH SEMESTER

HUM 3022: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Definition of management and systems approach, Nature & scope. The Functions of managers, Principles of Management. Planning: Types of plans, steps in planning, Process of MBO, how to set objectives, strategies, policies and planning premises, Strategic planning process and tools. Nature and purpose of organizing, Span of management, factors determining the span, Basic departmentation, Line and staff concepts, Functional authority, Art of delegation, Decentralization of authority. HR theories of planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership – leadership behavior & styles, Managerial grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit and Loss control, Control through ROI, Direct, Preventive control. PROFESSIONAL ETHICS - Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories about right action, Self-interest, Customs and Religion, Uses of Ethical Theories. GLOBAL ISSUES - Managerial practices in Japan and USA & application of Theory Z. The nature and purpose of international business & multinational corporations, unified global theory of management, Entrepreneurship and writing business plans. Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisers, Moral Leadership, Code of Conduct, Corporate Social Responsibility.

References:

1. Harold Koontz & Heinz Weihrich, Essentials of Management, McGraw Hill, New Delhi, 2020.
2. Peter Drucker, The practice of management, Harper and Row, New York, 2004.
3. Vasant Desai, Dynamics of entrepreneurial development & management, Himalaya Publishing House, 2007.
4. Poornima M Charantimath, Entrepreneurship Development, Pearson Education, 2006.

AAE 3225: VEHICLE DYNAMICS AND CONTROL [3 1 0 4]

Introduction to Vehicle Dynamics, Vehicle Coordinates systems, 1 D vehicle dynamics. Forces acting on vehicle for different configurations, level road, gradient, maximum acceleration, numerical, front and rear wheel braking, all wheel braking, car with trailer, car on banked road, brake balance. Rolling resistance, Mechanism of force generation in Tyres, hysteresis, Longitudinal slip, cornering properties, camber thrust, slip, camber stiffness, conicity & Plysteer, Tire stiffness, Tire vibrations, influence of speed, load, tire pressure on various tire parameters. Aerodynamics of a car, pressure distribution on a vehicle, Aerodynamic forces, drag force, lift force, coefficients, numerical, aerodynamic aids, side force, yawing moment, crosswind sensitivity, Wind tunnels, Measuring devices, Self-study topics recommended.

References:

1. Thomas Schuetz, Hucho.W.H, Aerodynamic of Road vehicles, SAE International, 2016.
2. Mark Gleason, Vehicle aerodynamics design and technology, Society of Automotive Engineers, Incorporated, 2001.
3. Joseph Katz, Automotive Aerodynamics, Wiley Publications, New York, 2016.
4. Thomas D. Gillespie, Fundamentals of Vehicle Dynamics, Revised Edition, R506, Technology & Engineering publication, 2021.
5. Reza N. Jazar, Vehicle Dynamics: Theory and Application by, Springer Science Business Media, LLC, 2008.
6. H. B. Pacejka, Tire and Vehicle Dynamics, 1st Edition Butterworth-Heinemann publication, 2012.
7. Georg Rill: Road Vehicle Dynamics, Fundamentals and Modeling, 1st Edition, CRC press publication, 2012.

FLEXIBLE CORE II- A

AAE 3222: MACHINE LEARNING AND AI [3 0 0 3]

Define Artificial Intelligence, AI techniques, Difference between AI and Machine learning, Search using BFS and DFS, Hypothesis testing (Confidence intervals, p-value, types of tests), Probability Density Estimation, Entropy and cross-entropy, Linear Algebra, Linear regression, Logistic regression , Clustering, Naive bayes, Decision tree and random forest algorithms, Mixture models, Classification, Bias-Variance Tradeoff, Overfitting, Underfitting, Hyper parameter Tuning, Support Vector machines, Singular value decomposition, Principle component analysis, Artificial neural networks, Biological Neuron, McCulloch-Pitts Neuron Model, Feed forward Network, Hebbian learning rule, Perceptron learning rule, Activation functions, Gradient descent (batch and stochastic), Singe layer perceptrons, XOR problem, Multi-layer perceptrons, Radial basis functions, Regularization methods, Cross validation, Data augmentation, Deep learning, Convolutional neural networks (CNNs), Layers in a CNN, Recurrent neural networks, Transfer learning, Evaluation metrics, Case studies.

References:

1. Stuart J. Russell and Peter Norvig: Artificial Intelligence -A Modern Approach, Pearson, Prentice Hall. Series in Artificial Intelligence, Englewood Cliffs, 2010.
2. Simon Haykin: Neural Networks - A Comprehensive Foundation, Prentice Hall, 1998.
3. Daniel Graupe: Principles of Artificial Neural Networks, World Scientific, 2007.
4. Rich and Knight: Artificial intelligence, Mc Graw Hill India, 2010
5. Jacek M Zurada: Introduction to artificial Neural Systems, West, 1992.
6. Christopher M. Bishop: Neural Networks for Pattern Recognition,

Springer, 2007.
7. Aaron Courville, Ian Goodfellow and Yoshua Bengio: Deep Learning: Adaptive computation and machine learning, MIT Press, 2017.

FLEXIBLE CORE II- B

AAE 3223: COMPUTATIONAL FLUID DYNAMICS [3 0 0 3]

Derivation of governing equations of fluid dynamics and discussion on characteristic of the governing equations, the initial and boundary conditions. The mathematical behaviour of different classes of partial differential equations. Discretization of governing equations using Finite Difference and Control Volume approach. The basic solution techniques for steady-state and transient equations. Solutions of Diffusion Problems. Numerical methods for steady 1-D convective flow with diffusion. The need for a staggered grid. Discussion on SIMPLE, SIMPLER and PISO algorithms. Implementation of Boundary Conditions in Computational Fluid Dynamics.

References:

1. John D Anderson Jr., Computational Fluid Dynamics- The Basics with Applications, International Edition. McGraw Hill. New York, 2013.
2. Suhas V Patankar, Numerical Heat Transfer and Fluid Flow, Hemisphere / McGraw Hill New York, 2018.
3. Versteeg H. K., Malalasekera W. An Introduction to Computational Fluid Dynamics- The Finite Volume Method, Longman Scientific & Technical. England, 2007.
4. Anderson D. A, Tannehill J. C, and Pletcher R. H., Computational Fluid Mechanics and Heat Transfer, Taylor and Francis Group. New York, 2020.
5. Chung T. J., Computational Fluid Dynamics, Cambridge University Press South Asia Edition, 2003.
6. Fletcher C. A. J., Computational Techniques for Fluid Dynamics, Vol I and Vol II., Springer- Verlag. Berlin, 2012.

FLEXIBLE CORE II- C

AAE 3224: THEORY OF VIBRATIONS [3 0 0 3]

Vibrations terminology, free undamped and damped vibrations, governing differential equations of different systems and computing natural frequencies. Coulomb damping and derivation of differential equation. Forced vibrations harmonic excitation and rotating unbalance. Base excitation and concept of displacement and force transmissibility ratio and isolation. Force vibration with Coulomb damping. Analyzing 2 DOF spring mass undamped system and deriving the natural frequency and concept of mode shapes. Coordinate coupling and numerical examples. Concept of Dynamic vibration and Pendulum absorber. Analysis of MDOF systems, concept of influence coefficients. Determining natural frequency and mode shapes of MDOF systems- numerical methods. Concept of continuous systems. - Vibrations measuring instruments and concept of NVH.

References:

1. Singirisu Rao S, Mechanical Vibration, Pearson Education, Delhi, 2004.
2. Dukkapatti Rao V, Text Book of Mechanical Vibration, Prentice Hall of India Ltd, 2016.
3. Daniel Imnan J., Engineering Vibration, Prentice Hall, New Delhi, 2001.
4. Groover G.K., Mechanical Vibrations, Nemchand And Bros, Roorkee, 2014.
5. Thomson W.T., Theory of Vibrations with Applications, Chapman and Hall, 2011.
6. Seto W.W., Theory and Problems in Mechanical Vibration, MGH, Singapore, 1989.
7. C Sujatha, Vibrations and Acoustics-Measurement and Signal analysis, Mc Graw Hill, India, 2009.

AAE 3243: AUTOMOTIVE DESIGN AND ANALYSIS LAB [0 0 3 1]

Analysis of Truss/Link Elements, Beam Elements, Shell Elements, Plane Stress/ Plane Strain analysis, 3D Structural analysis, Thermal Analysis, Modal Analysis, Fluid Flow, Acoustic analysis.

References:

1. Erdogan Madenci and Ibrahim Guven, The Finite Element Method and Applications in Engineering Using ANSYS, Springer Publications, 2016.
2. Guangming Zhang, Engineering Analysis with Pro/Mechanica and Ansys, College House Enterprises, LLC, 2017.
3. Sham Tickoo, Ansys Workbench 14.0 for Engineers and Designers, Dream Tech Press, US, 2013.

AAE 3244: VEHICLE AERODYNAMICS LAB [0 0 3 1]

Calibration of wind tunnel, drag measurement of cylinder, Flow visualization, Lift calculation of a symmetrical and cambered aero foil, Boundary layer calculations, Wake survey method, six component balance, Analysis of air flow over a vehicle shape.

References:

1. Thomas Schuetz, Hucho.W.H, Aerodynamic of Road vehicles, SAE International, 2016.
2. Mark Gleason, Vehicle aerodynamics design and technology, Society of Automotive Engineers, Incorporated, 2001.

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

AAE 4291: INDUSTRIAL TRAINING [0 0 0 1]

Student is undergoing industrial training for a minimum period of 4 weeks during the vacation. After successful completion of training, student is submitting a report to the department and also makes a presentation on training.

AAE 4292: PROJECT WORK / PRACTICE SCHOOL [0 0 0 12]

The student is required to carry out a project work in the institution / industry / research laboratory / institution of higher learning. The minimum duration of the project work/practice school is 16 weeks. As part of project work / practice school, the student is also required to prepare a project report and make a presentation on the work carried out.

MINOR SPECIALIZATION: VEHICLE SYSTEM DESIGN

AAE 4413: ENGINE SYSTEMS DESIGN [3 0 0 3]

Principle parts of an I C Engine, systems of engine, working overview. Features of cylinders, dry and wet liners, design of a cylinder, cylinder thickness, bore and stroke, flange and stud design, thickness of cylinder head, problems on cylinder and head design. Function, Materials, Constructional details and design considerations for a piston, design procedure considering the gas loads, thickness at head, open end, barrel, land, grooves, skirt, design of piston rings and piston pin. Problems on piston design. Functions, materials, types, forces acting on connecting rods, design of connecting rod small end, large end, shank, big end cap and bolts, problems on connecting rod design. Functions, materials and manufacture, forces acting, bearing pressure and stresses in shafts, types of crank shafts, design of centre crank shaft and over hung crank shaft. Different types of mechanisms, valve requirements, materials, design, thickness of valve disc, stem diameter, valve lift. Function, types, materials, design of fly wheels. Hybrid engine components; operation; load/kerb ratio, critical design parameters, Electric vehicles; battery components; selection of battery material; principle of operation; Hybrid vs Electric; Current trends; future scope; Case studies.

References:

1. V B Bhandari, Design of Machine Elements, Tata Mcgraw Hill Education, 2010.
2. Newton K, Steeds W, Garrett TK, The Motor Vehicle, SAE Publications, 2004.
3. V Ganesan, Internal Combustion Engines, Tata Mc Graw hill publishing co ltd, 2008.
4. Mahadevan & K. Balaveera Reddy, Design Data Handbook, CBS Publishers & Distributors, 2009.

AAE 4416: NOISE VIBRATIONS AND HARSHNESS [3 0 0 3]

Overview of the subject, Fundamentals of Vibrations. Basics of acoustics: Sound pressure, Particle Velocity and Intensity, Energy density and Sound Power: Decibels and Sound level and combination of decibel levels. 1-D wave equation and 3-D wave equation. Directivity of sound-Line sources, Reflection, refraction, scattering and diffraction: Ray Acoustics, Energy acoustics. Making basic noise measurements: the sound level meter, recording sound, the decibel scale, and frequency and time weightings. Exterior noise: assessment and control- Pass-by noise homologation, EC noise homologation. Noise source ranking using shielding techniques. Interior noise: Noise path analysis, Measuring the sound power of IC engines and other vehicle noise sources. The effects of engine speed and load on noise, measuring Engine noise, engine noise source ranking. Aerodynamic (wind) noise and Brake noise, Rattle, squeak and Tizz noise. Control of sound through absorption within porous materials.

References:

1. Thomson W.T., Theory of Vibrations with Application, Chapman and Hall, 2011.
2. C Sujatha, Vibrations and Acoustics-Measurement and Signal analysis, Mc Graw Hill India, 2009.
3. Matthew Harrison,Vehicle Refinement: Controlling Noise and Vibration in Road Vehicles, Mathew Harrison Publication, 2004.
4. Malcolm J. Crocker, Handbook of Acoustics, John Wiley & sons Publication, 1993.
5. Malcolm J. Crocker, Handbook of Noise and Vibration Control, John Wiley & sons Publication, 2007.

AAE 4415: FATIGUE FAILURE AND ANALYSIS [3 0 0 3]

Strength of materials and kinds of failure, importance of failure analysis, procedure for failure analysis, precautions in actual failure analysis, initiation and propagation of fatigue cracks, final fracture, case study on the failure analysis, failure of crane head hanger, wire rope, transmission shaft crank of breaker, fastening screw, gears, piping valves, failure starting from welds in machines and equipment, failure of rolls and rail joints.

References:

1. Knott J.F., Fundamentals of Fracture Mechanics, Butterworth & Co., (Publishers) Ltd., London, 1983.
2. Barrois W. and Ripley L., Fatigue of Aircraft Structures, Pergamon Press, Oxford, 1983.
3. Sih C.G., Mechanics of Fracture, Vol.1 Sijthoff and Noordhoff International Publishing Co., Netherland, 1989.
4. Shin-ichi Nishida, Failure analysis in engineering application. Butterworth- Heinemann Ltd publication, 1991.
5. Brock D., Elementary Engineering Fracture Mechanics, Noordhoff International Publishing Co., London, 1994.
6. Charles R. Brooks, Ashok Choudhury, Failure analysis of engineering materials, McGraw-Hill Education, 2002.Yung-Li Lee
7. Jwo Pan,Richard Hathaway,\Mark Barkey, Fatigue Testing and Analysis Theory and Practice, Elsevier Science, 2011.\
8. Campbell F. C., Fatigue and Fracture Understanding the Basics, ASM International, 2012.

AAE 4414: AUTOMOTIVE ERGONOMICS [3 0 0 3]

Ergonomics in vehicle design, ergonomics approach, problem-solving methodologies, the importance of ergonomics, Use of anthropometry in designing vehicles, biomechanics consideration in seat design, seat design consideration related to driver accommodation, Vehicle packaging, package layout, driver package development procedure, Controls, and display interfaces, Introduction to field view, types of field view, the forward field of view and evaluation, mirror design issue, methods of measuring field of view, other visibility issues, Introduction, a problem during entry and exit, vehicle feature and dimensions related to entry and exit, method of evaluating entry and exit.

References:

1. Vivek D Bhise, Ergonomics in the automotive design process, CRC Press Publications, 2012.
2. Nikolaos Gkikas, Automotive ergonomics – Driver vehicle interaction, CRC Press Publication, 2013.
3. Mark R Lehto, James R Buck, Introduction to human factors and ergonomics for engineers, Taylor and Francis Group publication, 2008.

MINOR SPECIALIZATION: AUTOMOTIVE SYSTEM ENGINEERING

AAE 4409: CONNECTED VEHICLE SYSTEMS [3 0 0 3]

Communication Fundamentals, Communication technologies and protocols, Communication Between Sensors and Systems, Local Interconnect Network, Controller Area Network, Intra-vehicular communications, Inter-vehicular communications, IEEE standards, wired and wireless communication, Navigation systems: GPS and RADAR Fundamentals, Infotainment system, co-operative driving, connected and autonomous vehicles in smart cities, smart vehicles, intelligent roadways, Case study on modern vehicles, Autonomous vehicles.

References:

1. Gilbert Held, Inter and Intra Vehicle Communications, Auerbach Publications, 2008.
2. Tao Zhang, Luca Delgrossi, Vehicle Safety Communications Protocols, Security, and Privacy, Information Communication technology series, 2012.
3. Mohamed Kassab, Communication Technologies for Vehicles, Springer, 2015.
4. Florian Solzbacher, Jürgen Valldorf, Wolfgang Gessner, Advanced Microsystems for Automotive Applications, Springer Berl Heidelberg, 2003.
5. Hussein T. Mouftah, Melike Erol-Kantarci, and Sameh Sorour, Connected and Autonomous Vehicles in Smart Cities, CRC Press, 2020.
6. Radovan Miucic, Connected Vehicles, Intelligent Transportation Systems, Springer, 2020.

AAE 4410: ADVANCED DRIVETRAIN SYSTEMS [3 0 0 3]

Outlines of Power Trains, Power train layout and components, Performance features of Vehicle Transmissions. Arrangement of transmission in vehicle, transmission format and design, epicyclic gear, commercial vehicle transmission, transfer gearbox and power take-off, final drives, differential gears, inter wheel and inter axle differentials, differential locks, constant velocity joints, types of reaxles and shafts. Construction and operation of Torque Converter, Characteristic curves of Hydrodynamic Clutches, Input/output characteristics, Torque Converter test diagram, Automatic gearboxes, Dual clutch transmission, types, mechanism, continuously variable transmission, Four wheel and all wheel drive mechanism.

References:

1. Robert Fischer, Automotive transmission book, Springer International Publishing Switzerland, 2015.
2. Design Practices: Passenger Car Automatic Transmissions, AE-18, SAE, Warrendale, 1994.
3. YiZhang, ChrisMi, Automotive power transmission systems, Wiley, 2018.
4. Gisbert Lechner, Harald Naunheimer, Automotive Transmissions: Fundamentals, Selection, Design and Application, Springer- Verlag Berlin Heidelberg, New York, 1999.
5. Fenton J., Handbook of Automotive Powertrain and Chassis Design, Professional Engineering Publishing, London, 1998.

AAE 4411: ENGINE TRIBOLOGY [3 0 0 3]

History of Tribology, relevance of subject, Tribology in industry, Friction, Laws of Friction, Theories of Friction, Types of Friction, Effects of friction, Wear, Causes of Wear, Types of Wear, Wear Prevention. Testing of Friction and Wear – debris analysis, testing methods and standards. Lubrication, Physical properties of lubricants, composition, additives, SAE/ISO classification, Lubrication Principles, Lubrication regimes, Stribeck Curve, Hydrodynamic, EHL, Mixed and Boundary Lubrication. Lubrication of bearings, Friction forces and power loss in a lightly loaded journal bearing, Petroff's equation, Practical applications of lubrication models in engines, Components of IC Engine Subjected to Friction and Wear, Surface texturing in Automotive engines, Grease lubrication in automobiles, Bio Lubricants in Automobiles. Tribological components in Electric Vehicles - Motor, Rolling bearings, Brushes, Transmission, Gears, Seals, Lubricating oils, Greases, Tyres, Self-study topics recommended.

References:

1. G. W. Stachowiak and A. W. Batchelor, Engineering Tribology, Butterworth-Heinemann, 2016.
2. B. C. Majumdar, Introduction to Tribology in bearings, Wheeler Publishing, 2010.
3. PrasantaSahoo, Engineering Tribology, PHI Learning Private Ltd, New Delhi, 2011.
4. Harish Hirani, Fundamentals of engineering tribology with applications, Cambridge University Press, 2016.
5. B. Bhushan, Introduction to Tribology, John Wiley & Sons, Inc., New York, 2002.

AAE 4412: ACTUATION SYSTEMS [3 0 0 3]

Introduction, classification compressors, actuators, flow control valves, direction control valves, Time delay valve, Counter, Solenoids, Sensors, Multiple actuation system, P E convertor, Design of pneumatic and electronic circuits, Properties of hydraulic fluids, Power pack, Hydraulic Pumps and Motors, Performance of pumps, Accumulator, Application of accumulator, Hydraulic valves, Flow control, directional control and pressure control valves Design of hydraulic circuits.

References:

1. Joji P, Pneumatic Controls, Wiley India Pvt. Ltd, (2013)
2. Majumdar S.R, Pneumatic Systems Principles and Maintenance, Tata McGraw Hill, New Delhi, (2000)
3. Majumdar S.R, Oil Hydraulic Systems Principles and Maintenance, Tata McGraw Hill, New Delhi, (2005)
4. Prede G. and Scholz D., Electropneumatics Basic Level, Festo Didactic GMBH & Co, Germany, (2002)
5. Peter Croser, Frank Ebel, Pneumatics Basic Level TP 101, Festo Didactic GMBH & Co, Germany, (2002).

MINOR SPECIALIZATION: ELECTRIC VEHICLE TECHNOLOGY

AAE 4417: ELECTRICAL VEHICLE SYSTEM ENGINEERING [3 0 0 3]

Introduction to Electric Vehicle, History of EV, Concept, Principle, Types of electric vehicles, Battery Electric Vehicle (BEV), Hybrid Electric Vehicle (HEV), Plug-in Hybrid Electric Vehicle (PHEV), Fuel Cell Electric Vehicle (FCEV), Benefits of Electric Vehicles. Foundations & Supporting

Infrastructure, power Electric Motors and Power Convertors, Fundamental of Drives and DC Machines, DC Machine Drives and Control of EV Using DC Machine. Alternative vehicle architectures, hybrid-based architecture; Series-parallel architecture, EV powertrain Sizing, HEV powertrain Sizing, Electric Machines, Simple Machines, DC Machines, 3-Phase AC machines, Power Electronic Converters, DC to DC converters, Electric Motor Drivers, DC drivers, AC drivers. Control of AC machines, Hybrid vehicle control strategy. Controller Designing Embedded systems for Electric Vehicles, Sensors used in EV vehicles.

References:

1. Ashok Jhunjhunwala, Prabhjot Kaur, Kaushal Kumar, L Kannan, Fundamentals of Electric vehicles: Technology & Economics, NPTEL Course, IIT Madras.
2. Emanuele Crisostomi, Robert Shorten, Sonja & Fabian Wirth, Electrical and Plug-in Hybrid Vehicle Network, Optimization and Control, Taylor & Francis Group, (2018).
3. Iqbal Husain, Electric and Hybrid Vehicles: Design Fundamentals, Taylor & Francis Group, (2018).
4. Ali Emadi, Advanced Electric Drive Vehicles, Taylor & Francis Group, (2018).

AAE 4418: ENERGY STORAGE SYSTEM AND DEVICES FOR ELECTRIC VEHICLES [3 0 0 3]

Principles of Operation of Cells and Batteries; Electrochemical Principles and Reactions; Factors Affecting Battery Performance; Battery Design; Primary Batteries; Secondary Batteries: Advanced Lead-acid, Ni-based and lithium ion batteries (Fundamentals, Materials, Electrode preparation, Battery Assembly, Testing, Failure Analysis, Safety issues); Flow Batteries; Next Generation Batteries; Fuel cells, Supercapacitors, Selection and Application of energy storage systems for UPS, Solar, Telecom, Aerospace, Grid and Electric Vehicle Systems. Electric Vehicle Supply Equipment/devices - Different types of EV charger connectors, single-phase or three-phase socket, SAE J1773, CHAdeMO standard - DC fast charging, SAE J1772 Combo, Cords and Cables, Earthing, Lightning Protection of Electric Vehicle Charging, Residual current device (RCD), National & International EV Standard Codes - IEC applicable for EVSE.

References:

1. Kirby W. Beard. Linden's Handbook of Batteries, Fifth Edition (McGraw-Hill Education, 2019).
2. Vladimir S. Bagotsky, Alexander M. Skundin and Yury M. Volfkovich (A.N. Frumkin Institute of Physical Chemistry and Electrochemistry of the Russian Academy of Science, Russia) Electrochemical Power Sources: Batteries, Fuel Cells, and Supercapacitors" By, John Wiley & Sons Inc, New Jersey, USA, 2015, 372 pages, ISBN: 978-1-118-46023-6.
3. Ying-Pin Chen, Sajid Bashir, Jingbo Louise Liu, Nanostructured Materials for Next Generation Energy Storage and Conversion: Advanced Battery and Supercapacitors, Springer Nature, 10-Oct-2019 - Technology & Engineering – 472.
4. Smart Charging Solutions for Hybrid and Electric Vehicles, Sulabh Sachan, Sanjeev Kumar, Padmanaban , Sanchari Deb, wiley.
5. Charging Architectures for Electric and Plug-In Hybrid Electric Vehicles, Sebastian Rivera, Samir Kouro, Springer.

AAE 4419: ELECTRICAL VEHICLE BATTERY AND CHARGING SYSTEM [3 0 0 3]

Types of batteries, Lead Acid, Nickel metal hydride, Nickel-Zinc batteries, Zinc-air and Redox flow batteries. Li-ion batteries: Operational mechanisms of lithium ion batteries, Properties of electrode material, Dendrite formation. Introduction to EV Charging technology, types of charging station, benefits of stations, requirement of Charging stations, safety precautions, description, components require for charging stations. Onboard charging and Off-board charging, AC charging vs DC charging, Conductive Charging - AC & DC, Inductive Charging Static, Inductive Charging Dynamic, AC charging - Type 1,2,3, DC charging - Chademo, Tesla, CCS, Fast charging and its limitations, Energy consumption, Guidelines on Charging Infrastructure, Smart charging and applications, Introduction of Vehicle to grid (V2G) technology, Introduction of Wireless charging of EV, On-road charging of EV, Battery swap technology, Solar-powered EVs.

References:

1. Smart Charging Solutions for Hybrid and Electric Vehicles, Sulabh Sachan, Sanjeev Kumar, Padmanaban,Sanchari Deb, wiley.
2. Charging Architectures for Electric and Plug-In Hybrid Electric Vehicles, Sebastian Rivera, Samir Kouro, springer.
3. Electric Vehicle Integration via Smart Charging, Vahid Vahidinasab, Behnam Mohammadi-Ivatloo, springer.
4. Glaize, Christian, and Sylvie Genies.Lithium batteries and other electrochemical storage systems (1e). John Wiley and Sons, (2013).

AAE 4420: MOTORS AND DRIVE SYSTEMS FOR ELECTRIC VEHICLES [3 0 0 3]

Introduction to Electrical Machines: Transformers: Types of transformers; Single phase transformers - Three phase transformers. Induction Machines: Three phase Induction motor, Single phase induction motor, DC Machines: DC generators, DC Motors. BLDC motors – working principle and control. Synchronous Machines: Alternators –Synchronous motors: Power System Analysis: Single line diagram, per unit concept, selection and change of base quantities, Measurements & Instrumentation: Electrical instrumentation, characteristics, electromagnetic interference, Bridge circuits for R, L and C measurements, Modern Transducers for R, L and C measurements, Fundamentals of Electric Drives: components, dynamics, multi-quadrant operation, equivalent moment of inertia and torque, nature and classification of load torque, steady state stability; classes of motor duty. DC Drives: single phase and three phase-controlled rectifier fed dc drives controlled freewheeling, speed torque characteristics, waveforms, expressions for voltage, current, speed, torque and power. Design and analysis of non-isolated dc-dc converters, operation and steady state performance of buck, boost, buck-boost, cuk, SEPIC, Performance analysis of converters using DC Transformer model; DC-DC converters with isolation- Fly back converter, Forward converter, push-pull converter, half bridge and full bridge DC-DC converters; Resonant Converters, Control techniques-Voltage feed forward PWM control, current mode control, digital pulse width modulation control; Converter modelling- equivalent circuit modelling of converters, Closed loop converter design – PID design issues. Introduction to Electric Vehicles: Impact of modern drive-trains; Conventional Vehicles: vehicle power source characterization; Electric Drive-trains: Basic concepts, power flow control, topologies; Electric Propulsion unit: Introduction, Configuration and control of DC Motor drives, Induction Motor drives, Permanent Magnet Motor drives, Switch Reluctance Motor drives; Sizing the drive system: Sizing the propulsion motor, power electronics, energy storage technology, Communications.

References:

1. Kothari D. P. & Nagrath I. J., Electric Machines (4e), TMH, 2013.
2. Clayton A. E. & Hancock N. N., Performance and Design of Direct Current Machine s, CBS, 2004.
3. Krishnan R., Permanent Magnet Synchronous and Brushless DC Motor Drives, CRC Press, 2009.
4. Dubey G. K., Fundamentals of Electric Drives (2e), CRC Press, 2002.
5. Nagrath I.J. & D.P.Kothari, Modern Power System Analysis (2e), TMH, 2013.
6. K Sawhney, A course in electrical & electronic measurement and instrumentation, Dhanpat Rai & Sons, 2014.

PROGRAM ELECTIVES

AAE 4471: AUTOMOTIVE POLLUTION CONTROL [3 0 0 3]

Introduction, overview and objectives, Historical background Regulatory test procedures (European cycles), Regulatory test procedures (European cycles), Effects of pollutants on human life, European / Bharat stage Emission norms, Evaporative losses, analysis of particulates, Pollution from SI engines and C I engines- Mechanism & formation of various pollutants, Study of engine and operating variables, Pollution from SI and CI engines, Soot in CI engines. Factors affecting emissions in Compression Ignition engines, Fuel requirements in SI and CI engines, Knock and its measurement in SI and CI engines, Engine Variants: Lean Burn engines, Stratified charge engines, GDI, CRDI and HCCI. Instrumentation for pollution measurements: Non Desruprsive Infrared analyzers, ORSAT, Flame ionization detector, Smoke meters, Particulate measuring systems, Alternative Fuels- Classification, Vegetable oil and biodiesel, their production, Thermo chemical method of bio-conversion-combustion, Direct Energy conversion methods - Conversion of thermal energy into electricity, chemical energy into electrical energy.

References:

1. Ganesan V., Internal Combustion Engines, Tata Mcgraw-hill Education, New Delhi, 2012.
2. Mathur M. L. and Sharma R. P., Internal Combustion Engines, Dhanpat Rai Publications, New Delhi, 2011.
3. Colin R Ferguson and Allan T Kirkpatric, Internal Combustion Engines, Wiley India Ltd, New Delhi, 2004.
4. Willard W Pulkrabek, Engineering Fundamentals of Internal Combustion Engines, PHI learning Pvt Ltd, New Delhi, 2004.
5. Sukatme S. P., Solar Energy Principles of Thermal Collection and Storage, Tata Mc Graw Hill Education, New Delhi, 2005.

AAE 4472: AUTOMOTIVE THERMAL MANAGEMENT SYSTEMS [3 0 0 3]

Automobile air conditioning, air conditioning requirements, air distribution system, refrigeration system, analysis of vapor compression cycle, determining the COP of refrigeration system, evaporator compressor, condenser, hoses and fitting, refrigerant. Battery thermal management systems, requirements of battery thermal management systems, types air cooled, water cooled, PCM cooled, heat pipes, merits and demerits of each of them, some of the battery thermal management system used in EV, Environmental considerations.

References:

1. Yunus Cengel and Afshin Ghajar, Heat and Mass Transfer, Tata Mcgraw Hill Education Pvt Ltd, New Delhi, 2011.
2. N. K. Giri, Automobile Mechanics, New Delhi, 2008.
3. Ibrahim Dincer, Thermal Management of Electric Vehicle Battery Systems, Jhon Wiley and Sons Ltd, United Kingdom, 2017.
4. Steven Daly, Automotive Air conditioning and climate control systems, Elsevier Ltd., United Kingdom, 2006.
5. W P Jones, Air conditioning Engineering, Elsevier Ltd., United Kingdom, 2005.

AAE 4447: COMPOSITE MATERIALS AND STRUCTURES [3 0 0 3]

Introduction, Types of matrix materials, Types of synthetic fibers, properties, manufacturing process of fibers, types of manufacturing process of composite laminates, hand lay-up, vacuum bagging, compression molding, autoclave curing, resin transfer molding, Classification of composite materials, Characterization of composite materials, Mechanical behavior of composite materials, Basic terminologies of composites, Review of basic equations of mechanics and materials, Linear elastic model and its application, Stress-strain relations for a unidirectional lamina, Stress-strain relations for isotropic/orthotropic lamina, Effective Modulii of a continuous fibre reinforced lamina, Models based on mechanics of materials, Force-Displacement relations for laminates, Laminate stiffness, Single general orthotropic layer, Inter-laminar stresses, Failure of continuous fiber-reinforced orthotropic lamina, Maximum stress/strain criteria, Tsai-Hill and Tsai-Wu criterion. Self-Study topic is recommended.

References:

1. Mallick, P.K, Fiber-reinforced Composites: Materials, Manufacturing, and Design, CRC Press, 2008.
2. Gibson R. F., Principles of Composite Material, Mechanics, CRC Press, 2016.
3. Kollar L. P., George S Springer, Mechanics of Composite Structures, Cambridge University Press, 2009
4. Agarwal B. D., Broutman L. J. and Chandrashekhara K., Analysis and Performance of Fiber Composites, John Wiley & Sons, 2006
5. R. M. Jones, Mechanics of Composite Materials, Taylor & Francis, 2005.
6. Madhujit Mukhopadhyay, Mechanics of Composite Materials and Structures, Orient Longman, 2004.

AAE 4448: COMPUTER INTEGRATED MANUFACTURING [3 0 0 3]

Introduction, Definition of N.C. Machine, Classification, Advantages and disadvantages of N.C. machine, Design consideration of N.C. Machine tools, general construction requirements, Co-ordinate systems, point to point and contour programming, manual method (word address format only), NC programming with interactive graphics, manual data input. Problem with conventional NC, Computer Numerical Control, Direct Numerical Control, Introduction to Robotics, Robot anatomy physical configurations, Manipulator Kinematics, Technical features, programming the robot, robot programming language, end effecters, work cell design, work cell control and interlock, robotic sensor, robotic applications, Part classification and coding, production flow analysis, machine cell design, benefits of group technology, Types of Manufacturing System, Machine Tools and related equipment, Material Handling System, Flexible Manufacturing System, FMS work station, Types of FMS Layouts, Planning the FMS, Computer aided Process planning, Computer integrated planning systems. Material requirement planning. Capacity planning, shop floor control, factory data collection systems, automatic identification systems – Bar code technology, automated data collection systems.

References:

1. Yoram Koren, Computer Control of Manufacturing Systems and Computer Integrated Manufacturing, PHI, New Delhi, (2006).
2. Mikel P Groover, Automation, Production Systems and computer Integrated manufacturing, PHI, New Delhi, (2008).
3. Yoram Koren, Joseph Ben Uri, Numerical Control of Machine Tools, Khanna Publishers, New Delhi, (2005).
4. Mikell P Groover and Emory W Zimmers, Computer Aided Design & Manufacturing, PHI, New Delhi, (2008).
5. Roger Hannam, Computer Integrated Manufacturing: From Concept to Relaisation,Addison Wesley(1997).

AAE 4473: CRASHWORTHINESS AND SAFETY [3 0 0 3]

Introduction: Motor Vehicle Safety, the Automobile Structure, Materials, Crashworthiness, Crashworthiness Goals, Crashworthiness Requirements. Achieving Crashworthiness, Crashworthiness Tests, Crashworthiness Models Requirements, Design of Vehicle Structures for Crash Energy Management. Vehicle-to-Vehicle Frontal Collisions, Preliminary Relationships in Head-on Frontal Collision, Finite Element Analytical Techniques and Applications to Structural Design, Historical Background, Overview of Explicit FE Technology, Explicit Integration, Shell Element, Fundamental Principles for Vehicle/Occupant Systems Analysis, Barrier Collision, Compatibility Between Restraint System and Vehicle Front Structure, Supplemental Airbag Restraint System (SARS), Restrained Occupant Models (Analytical Approach), Human Body Modeling, Lumped Mass Models, Multi-Body Models, Finite Element Models, Injury Biomechanics from Head to Foot, Injury Mechanisms, Head Injury Mechanisms, Neck Injury Mechanisms, Compression Injuries.

References:

1. Paul Du Bois Clifford C. Chou Bahig B. FiletaTawfik B. Khalil Albert I. King Hikmat F. Mahmood Harold J. Mertz JacWismans, Vehicle Crashworthiness and Occupant Protection, Automotive Applications Committee American Iron and Steel Institute Southfield, Michigan, 2004.
2. CAE Methods for Vehicle Crashworthiness and Occupant Safety, and Safety-critical Systems, SAE special publication: Society of Automotive Engineers, 2004.
3. Narayan Yoganandan, Alan M. Nahum, John W. Melvin, Accidental Injury: Biomechanics and Prevention, The Medical College of Wisconsin Inc, 2015.
4. Jorge A.C. Ambrosio, Crashworthiness: Energy Management and Occupant Protection, Springer-Verlag Wein publication New York, 2001.

AAE 4474: DESIGN FOR MANUFACTURING [3 0 0 3]

Introduction, manufacturing a product realisation process, Design a series of activities from abstract to concrete, Factors influencing product design, Morphology of Design Process, Challenges in Product Development, Design for Part Interchangeability. Design Tolerances to Meet Process Capability, Producibility requirements in design, Understanding and distinguish various manufacturing processes, General assembly guidelines for design for mechanical components, Design for Serviceability, Ergonomics, Safety, Assembly systems.

References:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston A. Knight, Product Design for Manufacture and Assembly, CRC Press, 2011.
2. James G. Brala, Design for Manufacturability Handbook, McGraw Hill, New York, 1999.
3. O. Molloy, Steven Tilley, E.A. Warman, Design for Manufacturing and Assembly: Concepts, Architectures and Implementations, Springer Books, 1998.
4. C. Poli, Design for Manufacturing- A structured approach, Volume1; Buttworth-Heinneman, Elsevier publications, 2001

AAE 4450: DIGITAL MANUFACTURING [3 0 0 3]

Introduction: definition, features and developments of Digital Manufacturing (DM). Modeling theory and methods of DM science. Computing Manufacturing in DM. Manufacturing informatics in DM. Intelligent manufacturing in DM. Industry 4.0, Industrial IoT, Cyber Physical Systems, M2M technology, Management of Technology in DM. Rapid Manufacturing., Digital Manufacturing Security, Smart Factories. Future Development of DM.

References:

1. Zude Zhou, Shane (Shengquan) XieDejun Chen, Fundamentals of Digital Manufacturing Science, Springer-Verlag London Limited, 2012.
2. Kaushik Kumar, Divya Zindani, J. Paulo Davim (Editors) Digital Manufacturing and Assembly Systems in Industry 4.0 CRC Press, 2020.
3. Antonella Petrillo, Raffaele Cioffi, Fabio De Felice, Digital Transformation in Smart Manufacturing Intech Publishers Croatia, 2018.
4. Hopkinson N, Hague R. J. M., Dickens P.M. Rapid Manufacturing, John Wiley and sons, 2006.
5. ZhumingBi,Practical Guide to Digital manufacturing, Springer, 2021.

AAE 4475: EARTH MOVING EQUIPMENT AND FARM MACHINERY [3 0 0 3]

Basics of I C engine, Super charger and Turbo chargers, Transmission system, Suspension and braking system, Special purpose Tyres, Classification of earth moving equipment, under carriage units, bulldozer, excavators, dredgers, graders, compaction equipment, calm shell, cranes, Hydraulic control system and valves, Types of tractors, Tillage Equipment, Types of Sprayers, Maintenance aspects of earth moving equipment.

References:

1. S C Sharma, Construction Equipment and Management, Khanna Publishers, 2013.
2. Newton K and Steeds, Motor Vehicle, W. Butter Worths & Co., Publishers Ltd, 2004.
3. N.K. Giri, Automobile Mechanics, Khanna Publications, New Delhi, 2003.
4. Robert. L. Peurifoy, Clifford J. Schexnayder, A viad Shapira, Construction Planning, Equipment, and Methods, McGrawHill Higher Education, 2006.
5. Harris Pearson Smith, Farm Machinery and Equipment, Tata McGRAW HILL Publishers, 2020.

AAE 4451: ELECTROCHEMICAL ENERGY STORAGE [3 0 0 3]

Introduction to Energy storage and battery terminology: History of electrochemical energy storage, Requirement of energy storage, Definitions and measuring methods. Electrochemistry and Thermodynamics: Electrochemical Cell, Faradays law of electrochemistry, Redox potential, Electromotive force, Nernst's law, Electrical double layer, Polarization and over potential. Heat Generation and Porous media. Batteries: Types of batteries. Li-ion batteries: Operational mechanisms of lithium-ion batteries, Properties of electrode material, Dendrite formation. Fuel cells and Super capacitors: Introduction, Types of fuel cells. Fundamentals of capacitors, Energy stored, Double layer capacitor, Charging and discharging behaviour of supercapacitors. Basic elements of in Lithium-ion batteries and Fabrication: Introduction, Positive electrodes, Negative electrodes, electrolytes, Current collectors, Manufacturing and packaging, Self-study topics recommended.

References:

1. Glaize, Christian, and Sylvie Genies. Lithium batteries and other electrochemical storage systems, John Wiley and Sons, 2013.
2. Sundén, Bengt. Hydrogen, Batteries and Fuel Cells, Academic Press, 2019.
3. Sterner, Michael, and Ingo Stadler, eds.Handbook of energy storage: Demand, technologies, integration, Springer, 2019.
4. Newman, John, and Karen E. Thomas-Alyea. Electrochemical systems, John Wiley and Sons, 2012.
5. O'hayre, Ryan, Suk-Won Cha, Whitney Colella, and Fritz B. Prinz. Fuel cell fundamentals, John Wiley and Sons, 2016.

AAE 4452: EXPERIMENTAL MECHANICS [3 0 0 3]

Overview of experimental stress analysis, Stress analysis – Analytical, Numerical and Experimental approaches, Specific domain of these approaches, Advantages and disadvantages. Stress, Strain and Displacement Fields- Beam under pure bending, Analytical solution, Fringe contours from various experimental methods. Physical Principle of Strain Gauges, Photo-elasticity, Physical principle behind various experimental techniques, Strain Gauges, Photoelasticity, Grids for determining plastic strains. Multi-Scale Analysis in Experimental Mechanics- Review of solid mechanics, definition of free surface, ambiguity in associating the correct value of principal stress direction to the magnitude of the principal stress, Eigen value approach or use of Mohr's circle, Shear distribution in a three point bend specimen. Self-Study topics recommended

References:

1. Cesar A. Sciammarella, Federico M. Sciammarella, Experimental Mechanics of Solids, John Wiley & Sons, 2012.
2. Emmannuel D Gdoutos, Recent advances in experimental mechanics, Kluwer Academic Publications, 2002.
3. Jerome Molimard, Experimental Mechanics of Solids and Structures, ISTE, John Wiley & Sons, 2016.
4. Rivka Gilat, Leslie Bank-Sills, Advances in Mathematical Modelling and Experimental Methods for Materials and Structures, Springer Science, 2010.
5. U C Jindal, Experimental Stress Analysis, Pearson Education India, 2012.

AAE 4476: HUMAN FACTORS IN AUTOMOTIVE ENGINEERING [3 0 0 3]

Human compatible Automobile Design, vehicle cabin design, instruments and display, riding comfort and fatigue, vehicle interior environment, driving and non-driving tasks, driver model and driving behavior measurement, driving assistance systems, elderly drivers, future of automotive ergonomics, ergonomics and human factor in automobile design and development process, driving behavior measurement, comfort and quality, occupant comport during the vehicle run, comfort of the seat, acoustic comfort, cabin and air quality.

References:

1. Guy H. Walker, Neville A. Stanton, Paul M. Salmon, Human Factors in Automotive Engineering and Technology, Ashgate publisher, 2015.
2. Motoyuki Akamatsu, Handbook of Automotive Human Factors, Taylor & Francis Group, 2021.
3. Paul M. Salmon , Human Factors Methods and Accident Analysis-Practical Guidance and Case Study Applications, Ashgate publisher, 2020.
4. Jediah R. Clark, Neville A. Stanton, Kirsten Revell, Human-Automation Interaction Design Developing a Vehicle Automation Assistant, CRC Press, 2021.

AAE 4455: INDUSTRIAL AUTOMATION AND ROBOTICS [3 0 0 3]

Introduction, classification compressors, actuators, flow control valves, direction control valves, Time delay valve, Counter, Solenoids, Sensors, Multiple actuation system, P E convertor, Design of pneumatic and electronic circuits. Introduction to Robotics, Rigid-Body Kinematics, Dynamics of Robots, Trajectory Planning for Flexible Robots, Robotic Sensors, Robot End Effectors, Robot Programming, Industrial Applications. Architecture of Industrial Automation Systems, Measurement Systems Characteristics, Measurement Systems Characteristics ,Data Acquisition Systems, Data Acquisition Systems, Practice Problems with MATLAB in Rotation matrices, Kinematics: Derivation of Link Transformations, Problem Solving DH Parameters, Forward Kinematics, Inverse Kinematics. Self-Study topics recommended.

References:

1. Joji P, Pneumatic Controls, Wiley India Pvt. Ltd, 2013.
2. Prede G. and Scholz D., Electropneumatics Basic Level, Festo Didactic GMBH & Co, Germany, 2012.
3. Peter Croser, Frank Ebel, Pneumatics Basic Level TP 101, Festo Didactic GMBH & Co, Germany, 2012.

4. A.K. Gupta, S.K. Arora and J. Riescher Westcott, Industrial Automation and Robotics, Mercury Learning and Information, 2016.
5. Thomas R. Kurfess, Robotics and Automation Handbook, CRC Press, 2004.
6. Martin Klas Nilsson J. Norberto Pires, Industrial Robotics, Springer, 2007.

AAE 4456: LEAN MANUFACTURING [3 0 0 3]

History of Lean and comparison to other methods – The 7 Wastes, their causes and the effects – An overview of Lean Principles / concepts / tools – Stockless Production. The Tools of Lean Manufacturing: Continuous Flow – Continuous Flow Manufacturing and Standard Work Flow – 5S and Pull Systems (Kanban and ConWIP systems) – Error Proofing and Set-up Reduction – Total Productive Maintenance (TPM) – Kaizen Event examples. Toyota production systems, Ford production systems. Value Stream Mapping – Future State: Key issues in building the Future State Map – Process tips in building the map and analysis of the customer loop, supplier loop, manufacturing loop and information loop – Example of completed Future State Maps – Application to factory simulation – Implementation of lean practices – Best Practices in Lean Manufacturing. House of Lean -5S's and Waste Walks, Visual Management, Value Stream Mapping-Understanding the current state and designing the future state Managing lean enterprise: – Finance, Career ladders, geographic spread and advantages of global enterprise. Additional Interests: Develop VSM Current and Future state diagram using Microsoft Visio or Similar Software Package. Six sigma concepts: History, definitions, Statistical definitions, quality levels, Technical aspects, Six sigma for all: benefits to organizations, customers, suppliers and employers, Design for Six Sigma, DMAIC principles, DMADV principles, merits and demerits.

References:

1. Yasuhiro Monden, Toyota Production System - An integrated approach to Just in Time, Engineering and Management Press - Institute of Industrial Engineers, 1983.
2. James P Womack, Daniel T Jones, and Daniel Roos, The Machine that changed the World. The Story of Lean Production -Harper Perennial edition, 1991.
3. Gemba Kaizen: A Commonsense Approach to a Continuous Improvement Strategy, Second Edition Hardcover, 2012.
4. Karen Martin, Mike Osterling, Value Stream Mapping: How to Visualize Work and Align Leadership for Organizational Transformation Paperback,2016.
5. SuvabrataMitra, Lean and Six Sigma – Six Sigma Black Belt Enterprise-Wide Deployment Paper Back, 2007.

AAE 4479: METROLOGY & MEASUREMENTS [3 0 0 3]

Comparators: Johansson's Mikrokater, Sigma comparator, Mechanical - Optical comparator, Zeiss "Ultra – Optimeter", Pneumatic comparators – Derivation for Range, Sensitivity, Limits, Fits and Tolerances: Terminology, Grades of Tolerances, Letter symbols for tolerances, Fits – definition, types of fits – Clearance, Interference and Transition, System of fits – Hole basis and Shaft basis, Gauges; Taylor's principle for design of gauges – Statements and explanation, Gauge Maker's tolerance – as per 3rd system (present British standards), Types of gauges – Plug gauge, Ring gauge, Taper plug gauge, Taper Ring gauge and Snap gauge, Optical measuring instruments: Interference of 2 rays, Optical flats description, evaluation of flatness, Measurement of Form Errors: Screw Threads: Definitions of elements of external screw threads, Pitch errors in threads: Progressive, Periodic and Drunken threads, Surface Texture measurement: Definitions - I, II, III, IV order (including their causes), Roughness and Waviness, Lays, Symbols used in surface finish, Gear measurement: Gear terminology, Errors in gears – Composite error (Parkinson's rolling gear tester), Tooth thickness – Gear tooth vernier callipers

References:

1. Les Kirkup and Bob Frenkel, An Introduction to Uncertainty in Measurement, Cambridge University Press, 2006.
2. Mark A. Curtis and Francis T. Farago, Handbook of Dimensional Measurement, Industrial Press, 2014.
3. David Whitehouse, Surfaces and their measurement, Butterworth-Heinemann, 2004.
4. Gene R. Cogorno, Geometric Dimensioning and Tolerancing for Mechanical Design, McGraw-Hill, 2012.
5. Bryan R. Fischer, Mechanical Tolerance Stack-up and Analysis, CRC Press, 2004.

AAE 4459: NUMERICAL METHODS FOR SCIENTIFIC COMPUTING [3 0 0 3]

Mathematical review and computer arithmetic – numbers and errors; Nonlinear equations; Direct methods for linear systems; Iterative Methods for Linear Systems; Eigenvalues and Eigenvectors – power method, inverse power method, QR method; Approximation Theory – norms, orthogonalization, polynomial approximation, piecewise polynomial approximation, trigonometric approximation, rational approximation, wavelet bases; Numerical Differentiation; Numerical Integration – Romberg Integration, Gauss Quadrature, Adaptive Quadrature; Numerical Ordinary Differential Equations – single step and multi-step methods, Runge-Kutta method, predictor corrector method, stiffness, stability, shooting methods; Introduction to parallel programming – system architectures, shared and distributed memory programming, performance.

References:

1. John A. Trangenstein, 'Scientific Computing - Vol I, II, III, Springer, 2010.
2. Parviz Moin, Fundamentals of Engineering Numerical Analysis, Cambridge, 2010.
3. Steven C. Chapra, Applied Numerical Methods, McGraw Hill, 2012.
4. Walter Gander, Martin J. Gander, Felix Kwok, Scientific Computing, Springer, 2010.
5. A.S. Ackleh, E.J. Allen, R.B. Hearfott, P. Seshiyer, Modern Numerical Analysis, CRC, 2009.
6. Amos Gilat, VishSubramaniam, Numerical Methods for Engineers and Scientists, Wiley, 2014.

AAE 4460: OPERATIONS RESEARCH [3 0 0 3]

Introduction: Evolution of OR, Definitions, scope and applications of OR, Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP): Formulation, graphical solution, simplex method, Revised simplex method, duality in LPP. Transportation Problem: formulation, Initial basic solution, Optimality in transportation problem. Assignment Problem: Formulation and solutions. Traveling salesman problem. Network analysis: PERT and CPM. Queuing theory: M/M/1 and M/M/C queuing models. Dynamic Programming.

References:

1. Vohra N.D.: Quantitative Techniques in Management, Tata McGraw Hill Publishing co. Ltd., New Delhi, 2017.
2. HamdyTaha, Operation Research, an Introduction, Pearson, 2016.
3. Hiller, Liberman, Introduction to Operations Research, McGraw HIll International, 2017.
4. Gillet B.E, Operations Research Tata McGraw Hill, 2000.
5. Gupta, Hira, Operations Research S. Chand & Co., 2018.
6. Don T. Phillips, A. RavindranAnd James J. Solberg, Operations research: principles and practice Wiley, 2007.

AAE 4462: OPTIMIZATION TECHNIQUES IN ENGINEERING [3 0 0 3]

Introduction to optimization – linear programming – duality and sensitivity analysis – integer programming – non-linear programming – unconstrained optimization – constrained optimization: equality and inequality constraints – optimality conditions and optimization approaches – non-traditional optimization approaches – applications in aerospace engineering.

References:

1. Ravindran, A., Phillips, D. T., and Solberg, J. J., Operations Research: Principles and Practice, Wiley-India, 2006.
2. Rao, S. S., Engineering Optimization: Theory and Practices, John Wiley, 2009.
3. Winston, W. L., Operations Research: Applications and Algorithms, Cengage Learning, 2010.
4. Ravindran, A., Ragsdell, K. M., and Reklaitis, G. V., Engineering Optimization: Methods and Applications, Wiley-India, 2006.
5. Deb, K., Optimization for Engineering Design: Algorithms and Examples, PHI Learning, 2012.
6. Deb, K., Multi-Objective Optimization Using Evolutionary Algorithms, Wiley-India, 2010.

AAE 4465: STATISTICAL QUALITY CONTROL AND RELIABILITY [3 0 0 3]

Fundamentals of quality and quality control. Measure of central tendencies. Probability distributions. Tolerance allocation. Control chart for variables and attributes. Process capability analysis and process capability index. Acceptance sampling. Operating characteristic curves. Dodge romig and MIL-STD acceptance sampling tables. Concept of reliability, Reliability systems, maintainability and availability.

References:

1. Montgomery D. C., Introduction to Statistical Quality Control, John Wiley & Sons, New York, 2013.
2. Amitav Mitra, Fundamentals of quality control and improvement, Wiley, 2008.
3. Grant E.L., Statistical Quality Control, McGraw Hill Publications, New York, 1988.
4. Juran J.M., Quality Planning and Analysis, McGraw Hill Publications, Delhi, 1984.
5. Rao S S., Reliability Engineering Pearson Education, 2014.

AAE 4466: SURROGATES AND APPROXIMATIONS IN ENGINEERING DESIGN [3 0 0 3]

Introduction: physical versus computational experiments – introduction to engineering optimization – need for surrogates in optimization; Design of Experiments: Sampling plans – Latin squares – Latin hypercubes sampling – stratification – Orthogonal arrays – Hammersley sequences; Surrogates: Polynomial Regression – Radial basis function – Kriging; Using surrogates in design space exploration and exploitation – infill criteria –adaptive sampling.

References:

1. Forrester, A., & Keane, A., Engineering design via surrogate modelling: a practical guide. John Wiley & Sons, 2008.
2. Jiang, P., Zhou, Q., & Shao, X., Surrogate model-based engineering design and optimization. Springer, 2020.

AAE 4468: TOTAL QUALITY MANAGEMENT [3 0 0 3]

Connotations of Quality, Quality Dimensions: Product and Service. The Concept of TQM, Evolution of TQM, Inspection, SQC, QA and TQM. Conventional Quality Management versus TQM. Customer Supplier Focus in TQM, Benefits and Costs of TQM, Historical Perspectives of TQM, Measurement Tools: Check Sheets, Histograms, Run Charts, Scatter Diagrams, Cause and Effect Diagrams, Pareto's Chart, Process Capability Measurement. Analytical Tools: Process Mapping, Regression Analysis, Resource Utilization and Customer Service Analysis, The Five Why's, Overall Equipment Effectiveness. Improvement Tools and Techniques: Kaizen, JIT, Quality Circles, Force Field Analysis, Five S's, Quantitative Techniques: Failure Mode Effect Analysis (FMEA), Statistical Process Control (SPC), Quality Function Deployment (QFD), Design of Experiments (DOE), Kanban and Activity Based Costing (ABC). Taguchi Methods: Quality Loss Function, Orthogonal Arrays, The Concept of Six Sigma, Objectives of Six Sigma, The Frame-Work of Six Sigma Programme, Six Sigma Organization: Roles and Responsibilities, Six Sigma Problem Solving Approach, Implementation of TQM in Service Organization: Framework for Improving Service Quality, Model to Measure Service Quality Programs.

References:

1. John L. W. Beckford, Quality: A Critical Introduction, Routledge Taylor and Frances Group, New York and London, 2016.
2. Dale H. Besterfield, Carol Besterfield - Michna, Glen H Besterfield and Mary Besterfield-Sacre, Total Quality Management, PHI, 2006.
3. Ron Basu, Implementing Quality: A Practical Guide to Tools and Techniques, THOMPSON, 2006.
4. Greg Brue, Six Sigma for Managers, TMH, 2002.
5. R. P. Mohanty& R. R. Lakhe, TQM in the Service Sector, Jaico Books, 2001.

AAE 4480: TYRE TECHNOLOGY [3 0 0 3]

Introduction to tyre technology, tyre construction, mission profile and design envelope, dimension and nomenclature, tire speed and load rating, secondary factor influencing tyre design, tyre types, tire tread technology, tread compounds, tread design parameter, foot print pressure, radius, wear mechanism, tyre casting construction, tyre in liner, tyre inflation pressure loss rate, tyre inra-carcass pressure, nitrogen inflation and new technology, tyre reinforcement, cord construction, fabric production, cord to rubber compound adhesive, bead wire, radial tyre materials technology and rubber compounding, tyre testing and performance, FMVSS testing, tyre proving ground, commercial fleet programs, Future trends.

References:

1. Brendan Rodgers, Tire engineering – An introduction, CRC Press, 2020.
2. Bireswar Banerjee, Tyre Retreading, Walter de Gruyter Publishers,2019.
3. Saikat Das Gupta, Rabindra Mukhopadhyay, Krishna C. Baranwal, Anil K. Bhowmick, Reverse Engineering of Rubber Products Concepts, Tools, and Techniques, Taylor & Francis, 2013.
4. Hans B. Pacejka, Tire and Vehicle Dynamics, Third Edition, Butterworth-Heinemann, 2012.
5. M. S. Evans,Tyre Compounding for Improved Performance, iSmithersRapra Publishing - Science, 2002.

AAE 4481: VEHICLE EMBEDDED SYSTEMS [3 0 0 3]

Introduction to embedded systems, Designing embedded system with microcontroller and microprocessor, Microcontroller Architecture, programming, embedded hardware and firmware design and development-Analog and Digital Components, Tools-EDA, OrCAD, PCB, embedded firmware development languages, IDE, ECU and ECU Software Development: Automotive Grade Microcontrollers, Safety Critical Microcontrollers, Microcontrollers with Built in CAN Interface, Software Development Tools, Automotive Systems Overview-overview, vehicle category, subsystems, Communication & Lighting, Future Trends in Automotive Embedded Systems, Automotive Embedded System Design, Advanced Trends in Automotive Electronics. Verification and Validation: V & V process, Softwares Tools, Types of Test and standards and diagnostic interface etc.

References

1. K.V. Shibu, Introduction to Embedded Systems, McGraw Hill Education India Private Limited, 2017.
2. Nicolas Navet(Editor) and Francoise Simonot-Lion(Editor), Automotive Embedded Systems Handbook (First Edition) (Industrial Information Technology), CRC Press, 2009.
3. John F. Kershaw, Ed.D. and James D. Halderman, Automotive Electrical and Electronic Systems, Pearson Education, 2007.
4. Edward A. Lee and Sanjit A. Seshia, Introduction to Embedded Systems, A Cyber-Physical Systems Approach, MIT Press, ISBN 978-0-262-53381-2, 2017.
5. Eric Armengaud, Allan Tengg et al, Automotive Embedded Systems, Springer, 2011.
6. Wilfried Voss, A Comprehensible Guide to Controller Area Network, Copperhill Media Corporation, 2005.

AAE *** AUTOMOTIVE PRODUCT DESIGN & DEVELOPMENT [3 0 0 3]

Introduction to Automotive Engineering- History, evolution of automotive design and trend. Introduction to Automotive Design development process, milestones, department and cross functional teams, regulations. Concept generation- Pre-study, Design requirements, constraints, concept sketching, evaluation, feasibility analysis for design, cost and market. Vehicle architecture- packaging, platform design engine and powertrain placement, suspension selection. Detail design- Bill of materials, CAD modelling simulation, DFM, DFA, DFS, CAE tools for strength and durability component and system level, design verification. Materials for automotive components, major manufacturing process, supplier evaluation and selection, logistics, Prototype, Start of production, master build, Crash analysis, NVH simulation and testing, testing and validation, after market activities and technologies

References:

1. Introduction to Modern Vehicle Design, Julian Happian-Smith, Butterworth-Heinemann,Reed Educational and Professional Publishing Ltd 2002
2. Automotive Engineering-Powertrain, chassis system and Vehicle body, David A Crolla, Butterworth-Heinemann is an imprint of Elsevier
3. Product Design & Development, Karl T Ulrich, Steven D Eppinger, Mc Graw Hill
4. Automotive Product Development A Systems Engineering Implementation, Vivek D Bhise

OPEN ELECTIVES

AAE 4314: ALTERNATIVES FUELS FOR SUSTAINABLE ENVIRONMENT [3 0 0 3]

Introduction: Introduction, Energy security, Environmental pollution Need for alternate fuels. Methanol: Methanol Production, Properties of methanol, Methanol and Gasoline blend, Combustion and Emission Characteristics in engine, Vegetable oils: properties, Methods to use in engines, performance and emission studies, Natural Gas, LPG: LPG and CNG Properties, LPG conversion systems required to use in engines – performance in SI & CI engines. Merits and Demerits of LPG, advantages, and challenges of CNG. Hydrogen: Energy Carrier, Hydrogen Production, Hydrogen Properties, Hydrogen in Fuel Cells, Hydrogen storage. Electric vehicles: Introduction, the principle of electric vehicles, Construction of Electric Vehicles, Charging Electric Vehicle Batteries, Vehicle Tests, Self-study topics recommended.

References:

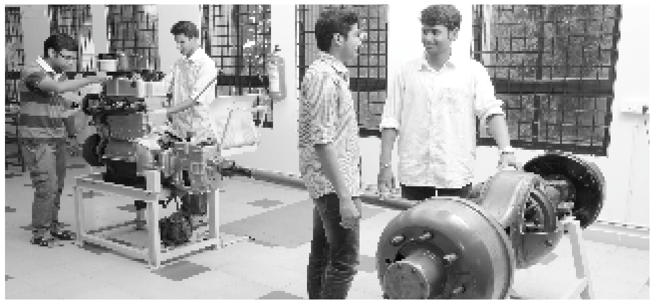
1. Ramadhas, Arumugam S, Alternative fuels for transportation, Taylor and Francis, 2011.
2. Hordeski, Michael Frank, Alternative fuels: the future of hydrogen, CRC Press, 2020.
3. Richard, L, Alternative Fuels Guidebook Properties, Storage, Dispensing and Vehicle Facility Modifications, Society of Automotive Engineers (SAE), 1997.
4. Singh, Akhilendra Pratap, Alternative Fuels and Their Utilization Strategies in Internal Combustion Engines, Springer Singapore, 2020.
5. Karim, Zainal Ambri Abdul, and Shaharin Anwar Bin Sulaiman, eds. Alternative Fuels for Compression Ignition Engines, Springer, 2018.

AAE 4313: INTRODUCTION TO AUTOMOBILE ENGINEERING [3 0 0 3]

Introduction, Engine classification, parts and nomenclature of the engine, valve timing diagram, automotive systems such as types of fuel supply, types of cooling, types of Ignition, types of lubrication, types of transmission, types of suspension, modern safety aspects, tyres & wheels, starting and lighting systems.

References:

1. Dr Kirpal Singh, Automobile Engineering Vol 1 and Vol 2, Standard Publishers Distributors, 2016.
2. M L Mathur and R P Sharma, Internal Combustion Engines, Dhanpat Rai Publications, New Delhi, 2011.
3. V Ganesan, Internal Combustion Engines, Tata Mcgraw-hill Education, New Delhi, 2012.



Department of
Biomedical Engineering

Biomedical Engineering is a fascinating multidisciplinary field in which the principles of engineering are applied to solving problems in medicine, & gaining a deeper insight into life-sciences, towards providing an overall enhancement to health care. The Biomedical Engineering program was started at the MIT in 1989 with a P. G Program (M. Tech.), and subsequently a U.G. program (B. Tech.) was added in 1992. The proximity of the reputed Kasturba Medical College and Kasturba Hospital under the same umbrella of Manipal Academy of Higher Education offers a unique platform for training students in several fields, and renders the Biomedical Engineering program a very special one. Currently, the Department provides a variety of modern facilities to help the students acquire an in-depth technical knowledge in various topics in the field of Biomedical Engineering. The department encourages research activities in the students for which the physiological signal acquisition lab, Medical devices lab, Biomaterials & Tissue Engineering lab and Cell culture lab are set up for the purpose. Areas of interest of the Faculty at the department include: Medical Imaging, Image Processing, and Physiological Signal Processing, Biomedical Instrumentation, Medical Devices, Nanotechnology Biomaterials and Medical Informatics. In summary, it has something to offer to everyone. Presently, the Headquarters of the Biomedical Engineering Society of India (BMESI) is at the Dept. of Biomedical Engineering.

> Programs offered

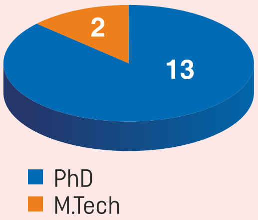
Undergraduate Program
- B.Tech in Biomedical Engineering (1992)

Postgraduate Program
- M.Tech in Biomedical Engineering (1989)
- M.Techin Biomedical Engineering (Medical Informatics) (2022)

PhD

> Facult Strength

Qualification-wise



Cadre-wise

B.TECH. BIOMEDICAL ENGINEERING

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
II	MAT 2122	Engineering Mathematics - III	2	1	0	3	MAT 2223	Engineering Mathematics - IV	2	1	0	3
	BME 2121	Anatomy and Physiology	3	0	0	3	BME 2221	Basic Clinical Sciences - I	4	0	0	4
	BME 2122	Electronics Circuits	3	0	0	3	BME 2222	Biomedical Instrumentation	3	0	0	3
	BME 2123	Digital System Design	2	1	0	3	BME 2223	Biomechanics	3	0	0	3
	BME 2124	Network Analysis	2	1	0	3	BME 2224	Microcontrollers	3	0	0	3
	BME 2125	Signals and Systems	3	0	0	3	BME 2225	Digital Signal Processing	3	1	0	4
	BME 2141	Basic Programming Lab	0	0	3	1	BME 2241	Signal Processing Lab	0	0	3	1
	BME 2142	Electronics Circuits Lab	0	0	6	2	BME 2242	Microcontroller Lab	0	0	3	1
			15	**3**	**9**	**21**			**18**	**2**	**6**	**22**
	Total Contact Hours (L + T + P)		**27**				**Total Contact Hours (L + T + P)**		**26**			
	FIFTH SEMESTER						**SIXTH SEMESTER**					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
III	HUM 3021	Engg Economics and Financial Management	2	1	0	3	HUM 3022	Essentials of Management	2	1	0	3
	BME 3121	Basic Clinical Science - II	4	0	0	4	BME ****	Flexible Core - 2 (A2/B2)	3	0	0	3
	BME 3122	Medical Devices	3	0	0	3	BME 3221	Digital Image Processing	4	0	0	4
	BME 3123	Biomaterials	3	0	0	3	BME ****	Program Elective – I / Minor Specialization	3	0	0	3
	BME ****	Flexible Core - 1 (A1 /B1)	3	0	0	3	BME ****	Program Elective - II / Minor Specialization	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective - 2	3	0	0	3
	BME 3141	Biomaterials Lab	0	0	3	1	BME 3241	Digital Signal Processing Lab	0	0	3	1
	BME 3142	Biomedical Instrumentation Lab	0	0	3	1	BME 3242	Digital Image Processing Lab	0	0	3	1
			18	**1**	**6**	**21**			**18**	**1**	**6**	**21**
	Total Contact Hours (L+T+P)		**25**				**Total Contact Hours (L+T+P)**		**25**			
	SEVENTH SEMESTER						**EIGHTH SEMESTER**					
	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
IV	BME ****	Program Elective - III / Minor Specialization	3	0	0	3	BME 4291	Industrial Training				1
	BME ****	Program Elective - IV / Minor Specialization	3	0	0	3	BME 4292	Project Work / Practice School				12
	BME ****	Program Elective - V	3	0	0	3	BME 4293	Project Work (B.Tech Honours)**				20
	BME ****	Program Elective - VI	3	0	0	3	BME ****	B.Tech Honours (Theory 1)** (V Semester)				4
	BME ****	Program Elective - VII	3	0	0	3	BME ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	*** ****	Open Elective - 3	3	0	0	3	BME ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	BME 4191	Mini Project (Minor Specialization)*				8						
			18	**0**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P)		**18**									

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

FLEXIBLE CORE - 1

BME 3124: Artificial Neural Networks(A1)

BME 3125: Basics of Cell and Molecular Biology (B1)

FLEXIBLE CORE - 2

BME 3222: Machine learning (A2)

BME 3223: Electrical and magnetic materials (B2)

MINOR SPECIALIZATION

I. BIOMATERIALS

BME 4401: Introduction to Biomedical nanotechnology

BME 4402: Biomaterial Characterization Techniques

BME 4403: Bio-fabrication

BME 4404: Drug Delivery

II. INFORMATICS

BME 4405: Artificial Intelligence

BME 4406: Biomedical Signal Processing

BME 4407: Decision Support system

BME 4408: Medical Imaging

Other Program Electives

BME 4441: Bio-statistics

BME 4442: Bio electromagnetism

BME 4443: Biometrics

BME 4444: Embedded Systems

BME 4445: Fuzzy Logic Systems

BME 4446: Health Care Management

BME 4447: Pattern Recognition

BME 4448: Physiological Control Systems

BME 4449: Prosthetics

BME 4450: Rehabilitation Engineering

BME 4451: Telemedicine

BME 4452: Tissue Engineering

BME 4453: Virtual Reality

Open Electives

BME 4311: Bio-medical Instrumentation

BME 4312: Bio-Mechanics

BME 4313: Rehabilitation Engineering

BME 4314: Introduction of Materials in Medicine

BME 4315: Introduction to Nanotechnology and Characterization Techniques

BME 4316: Nanomedicine

THIRD SEMESTER

MAT 2122: ENGINEERING MATHEMATICS – III [3 0 0 3]

Linear Algebra: Systems of Linear Equations, Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings, Affine Spaces. Analytic Geometry: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations. Matrix Decompositions: Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation Fourier Series and Transforms: Periodic function, Fourier Series expansion. even and odd functions, functions with arbitrary periods, Half range expansionsFourier transform, basic properties, Parseval's identity and applications

References:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. Grewal B.S. - Higher Engineering Mathematics, Khanna Publishers, 43rd edition, 2015
3. Stephen H. Friedberg Lawrence E Spence, Arnold J Insel, Elementary Linear Algebra: A Matrix Approach Introduction to Linear Algebra, Second Edition, 2019.
4. David Lay, Steven Lay, Judi McDonald, Linear Algebra and Its Applications, Pearson, 2019.
5. Gilbert Strang, Introduction to Linear Algebra, Fifth Edition (2016), Wellesley-Cambridge Press.
6. Mordechai Ben-Ari, Mathematical Logic for Computer Science, Third Edition, Springer.
7. Narayanan, Ramaniah and Manicavachagom Pillay, Advanced Engineering Mathematics, Vol 2 and 3, Vishwanthan Publishers Pvt Ltd. 1998
8. Erwin Kreyszig, Advanced Engineering Mathematics, 5th Edition., Wiley Eastern, 1985

BME 2121: ANATOMY AND PHYSIOLOGY [3 0 0 3]

PARTA: ANATOMY

Skeletal System: Types of bone, classification, Structure of bone, Blood supply, Cartilage: Type, Structure in brief, Joints: Classification, Structure of synovial joint, Major joints of the body. Muscle tissue: Types, Structure of skeletal muscle, Types of muscles, Brain: Parts, Brain stem, Ventricles, CSF, Meninges, Cranial nerves (names and functions only). Spinal cord: Gross features and structures, Spinal nerve, Nerve endings and receptors, Autonomic nervous system. Sensory system: Eye, Ear, Skin. Heart: Pericardium, Chambers, Blood supply Organs. Respiratory system: Parts, Trachea, Lungs. G I Tract: Parts, Stomach, Intestine, Liver, and Pancreas. Urinary system, Male and Female reproductive organs, and Endocrine glands.

Reference:

Sampath Madhyastha, Manipal Manual of Anatomy, CBS Publishers & Distributors, Edition 3, 2016.

PART-B PHYSIOLOGY

Basic concepts: Body fluid compartments; Nerve-Muscle physiology: Physiology of neuron, Membrane potential, Autonomic nervous system, Skeletal Muscle-Structure, Neuromuscular transmission, Excitation contraction coupling, Electromyogram [EMG]; Blood: Components and functions, Hemostasis, Blood groups; Cardiovascular system: Functional anatomy, Origin of heart beat, Electrocardiogram (ECG),Heart sounds, Biophysical aspects of circulation, Cardiac output, Blood pressure; Respiratory system: Functional anatomy, Mechanics of respiration, Lung volumes and capacities, Gas exchange, Regulation of respiration; Excretory system: Functions of kidneys, Urine formation, Micturition, Thermoregulation; Central nervous system: General organization of nervous system, Synaptic transmission, Sensory receptors, Sensory pathways, Motor system, Electroencephalogram (EEG) and sleep; Special senses: Optics of eye, pitch and intensity discrimination of sound

References:

1. Basics of Medical Physiology, 4th edition, D. Venkatesh, H.H.Sudhakar
2. Manipal Manual of Medical Physiology,1st edition, C. N. Chandra Shekar

BME 2122: ELECTRONIC CIRCUITS [3 0 0 3]

Field Effect transistors: JFET and MOSFETs, biasing of field effect transistors, JFET and MOSFET small signal amplifiers, and oscillators. Operational amplifiers: characteristics, differential amplifiers, offset voltages and currents, linear applications of Op-Amps, Instrumentation amplifier, active filters, integrators and differentiators, non-linear applications of Op-Amps: Multivibrators, Schmitt trigger and function generators. The Timer IC 555 and its applications: Multivibrators, voltage to frequency converters, tone burst generators etc. IC voltage regulators: Fixed, adjustable and variable power supplies, switching regulators. Data converters: Analog-to-Digital Converters (ADC) and Digital-to-Analog Converters (DAC).

References:

1. R. L Boylestad, L. Nashelsky, “Electronic Devices and Circuit Theory”, 11th Edition, Pearson India Education Services, 2015.
2. Ramakanth A Gayakwad, “Op Amps and Linear Integrated Circuits”, Prentice Hall, Edition 4, 2000.
3. Jacob Millman, Christos C Halkias and Chetan D Parikh, “Integrated Electronics”, 2nd Edition, McGraw Hill, 2009.
4. Sergio F, “Design with Op Amps and Analog Integrated Circuits”, McGraw Hill, 2002.
5. William D. Stanley, “Operational Amplifiers with Linear Integrated Circuits”, 4thEdition, Pearson Education, 2007.

BME 2123: DIGITAL SYSTEM DESIGN [2 1 0 3]

Combinational logic circuits: Overview of Algebraic simplification of Boolean expressions and realization using logic gates, minimization using Karnaugh map, Combinational circuit design using MSI chips: Multiplexers, demultiplexers, encoders, decoders, Arithmetic circuits: Half adder, full adder, adder-subtractor, ripple carry and carry look ahead adders, ALU; Sequential logic circuits: Overview of flipflops; Counters and Shift registers. Logic families and their characteristics: TTL families, CMOS families, CMOS logic; Introduction to CMOS, CMOS gates and circuits. CMOS based combinational logic cells, Transmission Gates, Sequential Logic Cells, Data path logic cells, Data path elements, Examples (Adders/ multiplication). Combinational Circuits Design, Shannon's expansion theorem, design of Sequential circuit. CAD tool based digital system design, Design flow, Design styles: Full-custom IC, Semi-custom IC, ASIC (Application Specific Integrated Circuit), Types of ASICs, Programmable ASICs and logic cells, Programmable Logic Devices (PLD's) and applications, Programmable Array Logic, Complex Programmable Logic Devices (CPLD's), elements of CPLD, Example, Mask-programmable Gate Array (MPGA's), FPGA's architectures, Example, and applications.

References:

1. Roth C. H., Fundamentals of logic design, Thomson Brooks, Australia, Edition 5, 2007.
2. Morris Mano, Digital logic and computer design, Pearson, New Delhi, 2013.
3. Stephen Brown, Zvonko Vranesic, “Fundamentals of Digital Logic with Verilog Design”, 3rd Edition, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2014.
4. Charles Roth, Lizy Kurian John, ByeongKil Lee, “Digital System Design Using Verilog”, Cengage Learning US, 2016.
5. M.J.S. Smith, “Application Specific Integrated Circuits”, Pearson, New Delhi, 2002.
6. J. Bhaskar “Verilog Primer”, 3rd Edition, Addison Wesley Longman Singapore Pvt Ltd., 2005.
7. M. Morris Mano and Michael D. Cilleti, “Digital Design with Introduction to Verilog HDL", 5th Edition, Pearson, New Delhi, 2013.

BME 2124: NETWORK ANALYSIS [3 1 0 4]

Network equations: (Basic concepts of Network), Coupled circuits. Resonant circuits, Property of duality in networks. Network Theorems: Superposition, Reciprocity, Millman's theorems, Thevinin's and Norton's theorems, Maximum Power transfer theorem, Laplace transformation and its application: Definition, Basic theorems in Laplace transformation, properties of Laplace transforms, inverse Laplace transforms, partial fraction expansion, initial and final value theorems, Shifting theorems, step, ramp and delayed functions. Solution of RL, RC, RLC networks using Laplace transformation method, Laplace transform of periodic and non-periodic signal. Transient behaviour and Initial conditions in networks: Behaviour of circuit elements under switching condition and their representation. Evaluation of initial and final conditions in RL, RC and RLC circuits for AC and DC excitations. Frequency response of the elements. Linear wave shaping: Response of RC & RL circuits to step, pulse, square wave, ramp and exponential inputs, compensated attenuators. Two port network and network functions: Open circuit impedance parameters, short circuit admittance parameters, Transmission parameters, Hybrid parameters, relationship between two port parameters, Parallel connection of two port networks, series connection of two port networks, cascade connection of two port networks.

References:

1. M E Van Valkenburg, “Network Analysis”, Prentice Hall of India, New Delhi, Edition 3, 2007.
2. Joseph A Edminister, “Theory and Problems of Electric circuits”, McGraw Hill, Edition 5, 2001.
3. C.L. Wadhwa, “Network Analysis and Synthesis”, New Age International (P)Limited, Publishers, New Delhi, Edition 3, 2007.
4. Jacob Millman and Herbert Taub, “Pulse, Digital and Switching Waveforms” Mcgraw-Hill Book Company, New Delhi, 1992.
5. Engineering Circuit Analysis | 8th Edition by William H. Hayt , Jack Kemmerly , Steven M. Durbin

BME 2125: SIGNALS AND SYSTEMS [3 0 0 3]

Introduction to signals; Representations of continuous and discrete-time signals, Some special signals; Introduction to systems, system properties, Continuous time and discrete time Linear shift-invariant (LSI) systems, Frequency analysis of signals and systems, Fourier series representation, the Fourier Transform, The Discrete-Time Fourier Transform (DTFT) and the Discrete Fourier Transform (DFT), The Laplace Transform for continuous time signals and systems, The z-Transform for discrete time signals and systems, Sampling Theorem and its implications. Spectrum of sampled signals. Reconstruction: ideal interpolator, zero-order hold, first-order hold, and so on. Aliasing and its effects. Relation between continuous and discrete time systems.

References:

1. A.V. Oppenheim, A.S. Willsky and I.T. Young, "Signals and Systems", Pearson Education India, 2nd Edition, 2015.
2. Simon Haykin and Van Veen, “Signals and Systems”, John Wiley, 2014.
3. Hwei Hsu, Schaum's Outline of Signals and Systems, McGraw-Hill Education, 3rd edition, 2013.
4. M. J. Roberts, Signals and Systems - Analysis using Transform methods and MATLAB, McGraw-Hill Education, 2nd Edition, 2011.

BME 2141: BASIC PROGRAMMING LAB [0 0 3 1]

Programming in Python

Variables, expressions and statements, Conditional execution and iterations, creating functions and File handling, Plots in Python - Different types of plots, subplots and data visualization with Python, Linear algebra - Vectors, Matrices, basic matrix operations, Solving linear equations, example scripts and exercises.

References:

1. Hans-Petter Halvorsen. Python for science and engineering. Hans-Petter Halvorsen – a Blog about Technology, 2019, https://www.halvorsen.blog/
2. Sinan Kalkan, Onur Tolga Sehitoglu, and Gokturk Ucoluk. Programming with Python for Engineers. 2021, https://ceng240.github.io/

BME 2142: ELECTRONIC CIRCUITS LAB [0 0 6 2]

Analog electronics: To conduct experiments related to the characteristics of FET and MOSFETs. FET amplifiers. Oscillators – RC Phase shift, Wein Bridge, Hartley and Colpitts Oscillators. Digital Electronics: Combinational circuits- Arithmetic Circuits, Multiplexers, Decoder, comparator, Sequential circuits- Counters, Shift Registers, PLDs. Integrated Circuits: Op-amp linear applications – Adder, Subtractor, Integrator, Differentiator, and voltage – to – current converter. Op-amp Non-linear applications – Comparators, square wave generator, multi-vibrators, function generators, oscillators, precision rectifiers. Binary weighted and ladder type DACs. IC voltage regulators, and Timer IC applications.

References:

1. R.L Boylestad, L. Nashelsky, “Electronic Devices and Circuit Theory”, 11th Edition, Pearson India Education Services, 2015.
2. Jacob Millman, Christos C Halkias and Chetan D Parikh, “Integrated Electronics”, 2nd Edition, McGraw Hill, 2009.
3. C. H. Roth, “Fundamentals of Logic Design”, 7th Edition, CL Publication, 2015.
4. Morris Mano, “Digital Logic and Computer Design”, Pearson education, 2016.
5. Ramakanth A Gayakwad, “Op Amps and Linear Integrated Circuits”, Prentice Hall, Edition 4, 2000.

FOURTH SEMESTER

MAT 2223 : ENGINEERING MATHEMATICS – IV [3 0 0 3]

Probability and Distributions: Construction of a Probability Space, Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem, Summary Statistics and Independence, Distributions: Binomial, Poisson, uniform, normal, Chi-square and exponential distributions. Multivariate Random variables and Stochastic Process:Two and higher dimensional random variables, covariance, correlation coefficient. Moment generating function, functions of one dimensional and two-dimensional random variables. Static probabilities: review and prerequisites generating functions, difference equations. Dynamic probability: definition and description with examples. Markov chains, transition probabilities. Vector Calculus: Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Backpropagation and Automatic Differentiation, Higher-Order Derivatives, Linearization and Multivariate Taylor Series. Optimization: Basic solution, Convex sets and function, Simplex Method, Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers.

References:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. P L Meyer, Introductory Probability and Statistical Applications, Addison Wiley.
3. Medhi. J. Stochastic Processes, Wiley Eastern.
4. Murray R. Spiegel, Vector Analysis Theory and Problems, Schaum's Outline Series, 2019.
5. Hamdy A. Taha, “Operations Research: An Introduction”, 8thEdn., Pearson Education (2008).

6. Sheldon M. Ross, Introduction to Probability Models Eleventh Edition Elsevier.
7. E. S. Page, L. B. Wilson, An Introduction to Computational Combinatorics, Cambridge University Press.
8. Bhat U R, Elements of Applied Stochastic Processes, John Wiley.

BME 2221: BASIC CLINICAL SCIENCES I [4 0 0 4]

PART-A: CARDIOLOGY

Heart structure and function – overview, Details of cardiovascular physiology – blood flow (circulation), Detail anatomy of human heart, principles of cardiovascular measurements-blood pressure, cardiac output, etc. Heart valves, Prosthetic heart valves – evolution, detail structure, functions and applications, Open heart surgery and Heart lung machines, Basics of 12-lead Electrocardiography – Einthoven's triangle, ECG potentials – generation and conduction, conduction system, Applications of ECG in cardiac clinics, Normal and abnormal ECGs, Diagnostic applications, Interpretation of ECG, Cardiac pacing. Assisted cardiac devices-concepts and applications from biomedical engineering perspective, Holter monitor. Cardiac Interventional hardware (Guide wires,catheters,stents)

References:

1. Kim E. Barrett, "Ganong's Review of Medical Physiology", McGraw Hill, Edition 24, 2012.
2. C. C. Chatterjee S, "Human Physiology", CBS Publisher, Edition 11, 2016.
3. Leo Schamroth Text book of electrophysiology
4. William Grossman-Interventional cardiology

PART-B: ANAESTHESIOLOGY

This course will provide an overview of basic physical principles and their applications in anaesthesia and intensive care. It will begin with the description of general and regional anaesthetic techniques fundamental to the practice of anaesthesia before going on to describe the anaesthesia machine, medical gas supply systems and intravenous drug delivery systems. The principles of equipment used in pain therapy will be discussed. Finally, students will learn about mechanical ventilation with special emphasis on mechanical ventilators and nebulizers. Humidifiers, Baby Incubators, Central oxygen supply. Principles of operation theatre tables and lights, phototherapy, surgical diathermy.

References:

1. M.K. Bykes and M.D. Vickers, "Measurements in Anesthesia", Blackwell, 1981.
2. Mushin, "Automatic ventilation of lung", Blackwell, 1970.

PART- C: SPEECH & HEARING

Introductory Lectures on Anatomy of the vocal tract and the ear; Audiometers, Middle ear analyzer, Evoked potentials, OAE, Hearing aids, Cochlear implants, ALD, Hearing aid analyzer, Electro Glottography, AAC, Introduction to speech assessment, DSP, Assessment of voice and fluency, Voice and fluency therapy assessment, Artificial larynx, Spirometry, Speech synthesis, Practical demonstration.

References:

1. Saunders, "Community based Rehabilitation", ISBN 0-7020-1941-0. London, 1997.

PART-D: ORTHOPAEDICS

Bioengineering aspects of fracture management: Structure of bone-gross, Microscopic biochemical fractures: Types, Mechanism of injury, Normal Healing of Fractures, Treatment of fractures: General principles, Closed methods, External fixation and Internal fixation, Biomechanics of internal fixation and description of external fixators, Bioengineering principles of internal fixation, Intramedullary nails, Plates, and Screws. The concepts of load bearing, load sharing and stress shielding by implants, Piezo electricity and electrical stimulation for bone healing, Bioengineering aspects of joint diseases, Structure of joints: Fibrous, Cartilaginous, Synovial, Lubrication of joints and the functions of articular cartilage, Degeneration of cartilage, Degenerative arthritis and Rheumatoid arthritis, Joint replacement, hip, knee, shoulder, small joints. Biomaterials: Requirements of implant materials and biocompatibility, Material implants: Materials in external appliances, Materials in prosthetics, Materials in Orthotics, Bioengineering principles of management of paralytic problems, Gait analysis, Orthotics, Principles of tendon transfer, Bioengineering principles of amputation and prosthetics, Upper limb prosthesis, Lower limb prosthesis.

References:

1. Victor H Frankel and Margareta Nordin, "Basic Biomechanics of the skeletal system". Lea and Febiger, 1980.
2. M. Dena Gardiner, "The principles of exercise therapy", CBS press, Edition 4, 1985.

BME 2222: BIOMEDICAL INSTRUMENTATION [3 0 0 3]

Biomedical transducers: Classification and Selection; Pressure Transducers: Resistive, capacitive, Inductive & Piezo-electric transducers, Photoelectric transducers & its types; Thermal transducers & its types; Electrodes & Amplifiers: Principles of working and their characteristics, Half- cell potential, Types of electrodes, Electrode-Electrolyte model; Physiological Signals & Measurements: Basics of ECG, EMG, EEG, PCG, blood pressure & blood flow and the instrumentation for measuring these signals; Cardiac Pacemakers: Types of pacemakers, Modes of triggering, Pacemaker power supplies, pacemaker codes; Defibrillators: AC and DC defibrillators, Types of electrodes and their features, cardioverters; Lasers: Basic principles, types of lasers and their medical applications; X-ray systems, Fluoroscopic system, principles of tomography;Electrical Hazards & Safety: Safety code standards, Micro and Macro shock and its physiological effects, Methods of electrical safety.

References:

1. Webster JG, Eren H, "Measurement, Instrumentation, and Sensors Handbook" CRC press; Edition 2, 2018.
2 John G Webster, "Medical Instrumentation Applications and Design", John Wiley and Sons, New York, Edition 5, 2020.

2. R S Khandpur, “Handbook of Biomedical Instrumentation”, McGraw Hill, Delhi, Edition 3, 2014.
3. L A Geddes, L E Baker, “Principles of Applied Medical Instrumentation”, Wiley India, New Delhi, Edition 3, 2008.
4. Richard Aston, “Principles of biomedical Instrumentation and measurement”, Merrill, New York, 1991.
5. Joseph J Carr, John M Brown, “Introduction to Biomedical Equipment technology”, Prentice Hall, New Jersey, Edition 4, 2003.

BME 2223: BIOMECHANICS [3 0 0 3]

Bio-fluid mechanics: Viscosity, classification of fluids, blood rheology, fundamental method for measuring viscosity, rheology of blood in micro-vessels, mechanical model of cardiovascular system, relationship among blood velocity, blood pressure and blood vessel diameter in the vascular tree, resistance against blood flow, types of blood flow, prosthesis-related complications attributable to valve fluid dynamics. Mechanics of breathing, physical aspects of alveoli, diffusion, airway resistance. Connective tissue mechanics: structure and biomechanical properties of collagen, tendon, ligament & cartilage; composition, structure and biomechanical properties of bone, bone fracture and failure mechanics, skeletal muscle tissue properties and functions, skeletal muscle architecture, force generation in the muscle, role of skeletal muscle, force-velocity relationship in skeletal muscle, joint flexibility. Human movement mechanics: linear kinematics-kinematic parameters, fundamental concepts of gait, projectile motion, linear kinematics of walking & running, angular kinematics- types of angles, lower extremity joint angles, angular motion relationships, relationship between linear and angular motion, angle-angle diagrams, linear kinetics- laws of motion, types of forces, representation of forces acting on a system, angular kinetics- Newton's laws of motion (angular analogs), center of mass calculation, Rotation and Leverage, Pulley systems, Analysis using Newton's laws of motion.

References:

1. Lee Waite and Jerry Fine, Applied Biofluid Mechanics, McGraw-Hill Education, Second Edition, 2017, USA.
2. C. Ross Ethier, Craig A. Simmons, Introductory Biomechanics, Cambridge University Press, First Edition, 2009, New York, USA.
3. W. Mark Saltzman, Biomedical Engineering: Bridging Medicine and Technology, Cambridge University Press, Second Edition, 2015, USA.
4. Joseph Hamill and Kathleen M. Knutzen, Biomechanical Basis of Human Movement, Lippincott Williams & Wilkins, Third Edition, 2008, Philadelphia, USA.
5. Susan J. Hall, Basic Biomechanics, McGraw-Hill International Editions, Seventh Edition, 2014, Singapore.

BME 2224: MICROCONTROLLERS [3 0 0 3]

Introduction to the Microprocessor and microcontrollers, Microcontroller architectures. CISC Microcontroller- The Intel 8051 Microcontroller: Hardware architecture and software architecture, Programming. RISC Microcontroller – The ARM Cortex-M3 Microcontroller: Hardware architecture and software architecture, Programming. Interfacing: External memory, UART, Keyboard, Display, ADC and DAC interfaces, temperature monitoring system, Stepper motor interface, and Real-Time-Clock (RTC) interface.

References:

1. Kenneth J. Ayala, “8051 Microcontrolelr and Embedded System Using Assembly and C”, 2nd Edition, Cengage Learning, New delhi, 2009.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, “8051 Microcontroller and Embedded System Using Assembly and C”, 2nd Edition, Pearson Education, New Delhi, 2013.
3. Joseph Yiu, “The definitive Guide to the ARM Cortex-M3”, 2nd Edition, Elsevier, 2010.
4. Steve Furber, “ARM System-On-Chip Architecture”, 2nd Edition, Pearson Education, New Delhi, 2012.

BME 2225: DIGITAL SIGNAL PROCESSING [3 1 0 4]

Introduction to Discrete time signal and systems. Z Transform: Definition and properties, region of convergence, inverse Z transform, transfer function, poles and zeros, application of Z transforms to discrete-time systems, representation of systems – signal flow graph, realization of a z-domain transfer function; relation between s-plane and z-plane. Discrete Fourier Transform: properties, linear convolution using the DFT,

References:

1. Ronald W. Schafer, Alan V. Oppenheim, Discrete-Time Signal Processing, PEARSON 3rd Edition, 2014.
2. Dimitris G Manolakis, John G. Proakis, Digital Signal Processing: Principles, Algorithms, and Applications, PEARSON, 4th Edition, 2007.
3. Sanjit K. Mitra, Digital Signal Processing: A Computer - Based Approach, McGraw Hill Education; 4th Edition, 2013.

BME 2241: SIGNAL PROCESSING LAB [0 0 3 1]

Signal Processing in MATLAB

Introduction, Convolution, Discrete Fourier Transform and its properties, Simple filter design, FIR and IIR filters - design and implementation, Periodogram, Waveform analysis, event detection in biomedical signals.

References:

1. Houcque, David. "Introduction to Matlab for engineering students." Northwestern University 1 2005.
2. Mohindru, P., & Mohindru, P., MATLAB and SIMULINK (A Basic Understanding for Engineers). Cambridge Scholars Publishing, 2020.

BME 2242: MICROCONTROLLERS LAB [0 0 3 1]

Familiarization of the 8051 microcontroller Simulation tool and trainer kits, and experiments based on the 8051 microcontrollers. Familiarization of ARM programming tools and ARM kits and experiments based on ARM Cortex-M3 Microcontroller. Interfacing experiments based on the 8051 and ARM Cortex-M3 microcontrollers.

References:

1. Kenneth J. Ayala, “8051 Microcontroller and Embedded System Using Assembly and C”, 2nd Edition, Cengage Learning, New Delhi, 2009.
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, “8051 Microcontroller and Embedded System Using Assembly and C”, 2nd Edition, Pearson Education, New Delhi, 2013.
3. Joseph Yiu,“The definitive Guide to the ARM Cortex-M3”, 2nd Edition, Elsevier, 2010.

FIFTH SEMESTER

HUM 3021: ENGG ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Nature and significance, Micro & macro differences, Law of demand and supply, Elasticity & equilibrium of demand & supply. Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of single, Uniform gradient cash flow. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, declining balance method of depreciation, Sum-of-the-years digits method of depreciation, sinking fund and service output methods, Introduction to balance sheet and profit & loss statement. Ratio analysis - Financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios.

References:

1. Prasanna Chandra (2005), “Fundamentals of Financial Management”, Tata Mc-Graw Hill Companies, New Delhi.
2. James L Riggs, David D Bedworth and Sabah U Randhawa, (2004), “Engineering Economics”, Tata McGraw – Hill Publishing Company Ltd, New Delhi
3. T. Ramachandran (2001), “Accounting and Financial Management”, Scitech Publications Pvt. Ltd. India.
4. Eugene F. B. & Joel F. H. (2009), “Fundamentals of Financial Management”, 12th ed., Cengage Learning Publisher.
5. M. Y. Khan & P. K. Jain (2008), “Financial Management”, 5th edition Tata McGraw Hill Publication, New Delhi.
6. Thuesen G.J (2005), “Engineering Economics” Prentice Hall of India, New Delhi.
7. Blank Leland T. Tarquin Anthony J. (2002), “Engineering Economy”, McGraw Hill, Delhi.
8. Chan S. Park, (2013), “Fundamentals of Engineering Economics”, 3rd edition, Pearson Publication.

BME 3121: BASIC CLINICAL SCIENCES – II [4 0 0 4]

PART-A: RADIOTHERAPY

Principles of radiation oncology and cancer radio therapy, LET and RBE, Radio sensitivity and Radio resistance tumors and tissues, Clinical definition of tumor radio sensitivity, Classification of tumors according to cell Radio sensitivity, Cell survival theory, Cell cycle kinetics and age response function, Cell survival curves, Oxygen effect, OER,Cell repair-sublethal and potentially damage repair. Radio curability of tumors, Therapeutic ratio, Normal tissue tolerance dose, Modification of radiation response, Physical, Chemical and Biomedical modifiers, Radiation biology stages of radiation actions, Physical stage LEI-RBE, Physiochemical reactions, Chemical stage. Radioactive effect of important Biological macromolecules, Radiation on cell site in cells, DNA repair process, Effects of radiation on cell cycle process, Cell death survival curves, Oxygen effect, Fractionation, Biological effects of Radiation, Radioactive protection, Acute Radiation syndromes, Somatic effects LD-50, Cause of radiation death - skin - blood and blood forming organs, Reproductive organs, Embryo-Late effects of Radiation, Radiation carcinogenesis, Leukemogenesis, Cataract, Genetic effects, Hazards and permissible exposures, maximum permissible occupational doses, Hazards in various branches of radiation, Protective lines of defense, Protective measures, Physical measurements and medical investigations.

References:

1. Meredith W J, Massey J B, Fundamental Physics of Radiology, John Wright, Edition 3, 1977.
2. Johns H E, Cunningham John Robert, The Physics of Radiology, Charle C Thomas, Edition 4, 1983.
3. Romesh Chandra, Introduction to Nuclear Medicine.

PART B: RADIOLOGY

X-ray tube, Target material, focal spot, size, shape of filament rotating anode, cooling of target tube, Interaction of X-ray with matter, Use of filters, scattered rays, quality of X-rays, HVL, CONES, Grids, Photographic effects on X-ray film, density, contrast, distortion, Speed of X-ray film, Fluorescent & Intensifying screen, Computed Tomography; Image Intensifier, Digital Subtraction Angiography, Radiation hazards & protective measures; X-Ray Exposure Parameters; Ultrasonography, Principles of Magnetic Resonance Imaging; Brachy Therapy.

References:

1. Thomas S. Curry, James E. Dowdey, Robert C. Murray, "Christensen's Physics of Diagnostic Radiology", Illustrated Edition, Lippincott Williams and Wilkins, 1990.
2. Joseph Selman", The fundamentals of Imaging Physics and Radiobiology", 9th Edition, Charles C. Thomas, 2000.
3. Penelope Allisy-Roberts, Jerry R Williams, "Farr's Physics of Medical Imaging", Illustrated Edition, Elsevier Health Sciences, 2007.

PART C: NEUROLOGY

Introduction to neurology; Review of the structure, development, and function of the nervous system: Central, peripheral and autonomic nervous system, Part of the brain structure, The motor system, Sensation, Cranial nerves. Functional topography of brain. Spinal cord, Consciousness, Higher functions, somatosensations, Neurons and glia, membrane potential, postsynaptic potential, action potential, signal transductions, neurotransmitters, synaptic transmissions, neural plasticity- LTP and LTD, Motor spinal control, cortical and subcortical motor control, Sleep and its disorders, Diagnostic investigations, Electroencephalography, Computerized Axial Tomography, Radioactive brain scanning, Angiography, Pneumoencephalography, The motor unit recording, The methods of Electro diagnosis, Neuromuscular stimulation, Electromyography, Clinical Applications, Diseases of muscle, Motor neuron disorders, The electrical study of reflexes, The silent period, The F Response, The H Reflex, The Axon reflexes, Disorders of neuromuscular transmission.

References:

1. Victor Maurice, Adams Raymond D, Principles of Neurology, McGraw Hill, Edition 5, 1993.
2. Erodal, Neuroanatomy.
3. Lance and Moleod, Physiological approach to Clinical Neurology

PART D: OPHTHALMOLOGY

Physiology of Eye: Structure of eye, function, Generation of signals and transmission to brain Electrophysiology, Aqueous humor production: Intraocular pressure fluctuations. Equipment Used: Vision testing equipment (Computerized & Manual.), Snellens's Chart, Keratometer, Refractometer, Colour Vision, Eye Examination equipment: Slit lamp biomicroscope & Camera, Fundus Camera, Opthalmoscope – Direct & Indirect, Retinoscope, Tonometers - contact & Noncontact, Perimeters – Listers, Bjerrums, Octopus, and Goldmann, Ophthalmodynamometers, Ultrasound Scanners, Synoptophore + Hesschart, Electromagnet, Lathes, Specialized equipment used in treatment:Argon laser, Nd-YAG Laser, Contact Lenses, Intraocular Lenses, Operating Microscope, Cryosurgical equipment, Vitrectomy instrument.

References:

1. Tandon, Radhika, Parson Diseases of the Eye, Elsevier, Edition 21, 2010.
2. Duke Elder, System of Ophthalmology, Vol. VII, Mosby, St. Louis, 1965.

BME 3122: MEDICAL DEVICES [3 0 0 3]

Respiratory measurements and aids: Principle of Impedance Pneumography & Pneumotachograph; Ventilators, Impulse Oscillometry, Clinical Laboratory Instrumentation: Spectrophotometry, Auto analysers, Electrosurgical units: Principle of working, modes of operation, Risks and the safety measures associated with ESU. Ultrasonography: Interaction of ultrasound with tissues, scanning modules, echocardiograph, Endoscopes, Neonatal instrumentation: Incubators, Apnea monitors and neonatal ventilators (High frequency ventilators (HFO); Anaesthesia equipment, Lithotripsy, Heart-Lung Machine: Qualitative requirements, Functional details of the types of blood oxygenators, Hemodialysers: Type of exchangers, Hemodialysis machine; Principles and applications of Thermograph, Blood cell counter; General constraints in design of medical instrumentation systems, Regulation of medical devices: Types of Standards & regulatory requirements.

References:

1. John G Webster, "Medical Instrumentation Applications and Design", John Wiley and Sons, New York, 5th Edition, 2020.
2. R S Khandpur, "Handbook of Biomedical Instrumentation", McGraw Hill, Delhi, 3rd Edition, 2014.
3. L A Geddes, L E Baker, "Principles of Applied Medical Instrumentation", Wiley India, New Delhi, 3rd Edition, 2008.
4. Joseph J. Carr, John M Brown, "Introduction to Biomedical Equipment Technology", Prentice Hall, New Jersey, 4Th Edition, 2003.
5. Richard Aston, "Principles of biomedical Instrumentation and measurement", Merrill, New York, 1991.

BME 3123: BIOMATERIALS [3 0 0 3]

Introduction to Bio-materials: definition of biomaterials, requirements and its uses, classification of biomaterials, performance of biomaterials Types of biomaterials: Metallic Biomaterials- introduction, types - Stainless steel, Co-Cr alloys, Ti alloys, dental metals and other metals, corrosion behavior. Ceramic Biomaterials: introduction, Classification - Non-absorbable or relatively bioinert bio ceramics. Biodegradable or Resorbable ceramics. Bioactive or surface reactive ceramics. Polymeric Biomaterials: introduction, polymerization and its types, basic structure, classification solid state properties, discussion on different class of synthetic non-degradable polymers Biodegradable Polymeric Biomaterials, Biologic Biomaterials: Tissue Derived Biomaterials; Composite Biomaterials: introduction, structure, types, properties and applications. Implantable Medical devices: (a) Orthopaedics-joint replacement, bone defects, bone fracture, cartilage defects, (b) Cardiovascular system- arteries and veins, Heart valve prostheses-introduction, causes, mechanical and bioprosthetic heart valves. (c) eyes and ears-contact lenses, IOL, cochlear implant, (d) dentistry, maxillofacial and craniofacial – dental implants, craniofacial reconstruction, (e) general soft tissue repair Biomaterials for regenerative medicine-background, tissue engineering templates, types of template materials, fabrication route

References:

1. Joseph D Bronzino, "The Biomedical Engineering Handbook", 3rd Edition, CRC press, USA, 2006.
2. Park Joon Bu, "Biomaterials Science and Engineering", Plenum Press, University of Michigan, 1984.
3. Buddy D Ratner & Allen S Hoffman, "Biomaterials Science and Introduction to Materials in Medicine", 3rd Edition, Academic Press, Canada, 2012.
4. David Williams, Essentials Biomaterials Science, Cambridge university press, 2013.
5. Lisa A Pruitt and A M Chakravartula, Mechanics of Biomaterials, Cambridge, 2011

BME 3141: BIOMATERIALS LAB [0 0 3 1]

Preparation of hydroxyapatite bio ceramic particles, Characterization of hydroxyapatite particles by X-ray powder diffraction (XRD), Synthesis of ZnS nanoparticles by reverse micelle method, Synthesis of ZnS nanoparticles by reverse micelle method, Characterization of ZnS nanoparticles by UV Vis absorption spectroscopy, Preparation of alginate micro beads and encapsulation and release study of food colour, Characterization of Alginate beads by Fourier Transform Infrared Spectroscopy (FTIR), Thawing frozen cells and starting a new batch of culture, Sub culturing of confluent cells: splitting, counting and seeding cells, Freezing cells for long term storage in liquid nitrogen

References:

1. William D. Callister, Jr., David G. Rethwisch, Materials Science and Engineering: An Introduction, 9th Edition, Wiley, 2014.
2. Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons, Biomaterial science- An introduction to Materials in medicine, 3rd edition, Academic press, 2012.
3. T. Pradeep, A Textbook of Nanoscience and Nanotechnology, McGraw Hill Education, 1st edition, 2017.

BME 3142: BIOMEDICAL INSTRUMENTATION LAB [0 0 3 1]

Design and realize bioelectric amplifier, filters for biomedical applications, Pacemaker circuit; Study the characteristics of thermal transducers- RTD, Thermocouple; Optical sensors- LDR, Photodiode and Phototransistor; pressure transducers, Inductive and Capacitive transducers, bio-signal acquisition using Physiography, Familiarization of Audiometer, Defibrillator and Recording of ECG using Electrocardiograph.

References:

1. Ramakanth A Gayakwad, “OPAMPS and Linear Integrated Circuits”, Prentice Hall, 4Th Edition, 2015.
2. John G Webster, “Medical Instrumentation Applications and Design”, John Wiley and Sons, New York, 3rd Edition, 2011.
3. Richard Aston, “Principles of biomedical Instrumentation and measurement”, Merrill, New York, 1991.

SIXTH SEMESTER

HUM 3022: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Definition of management and systems approach, Nature & scope. The functions of managers. Corporate social responsibility. Planning: Types of plans, Steps in planning, Process of MBO, how to set objectives, Strategies, Policies & planning premises. Strategic planning process and tools. Nature & purpose of organising, Span of management, Factors determining the span, Basic departmentation, Line & staff concepts, Functional authority, Art of delegation, Decentralization of authority. HR planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership- leadership behaviour & styles, Managerial grid. Basic control process, Critical control points & standards, Budgets, Non-budgetary control devices. Profit & loss control, Control through ROI, Direct, Preventive control. Managerial practices in Japan & USA, Application of Theory Z. The nature & purpose of international business & multinational corporations, Unified global theory of management. Entrepreneurial traits, Creativity, Innovation management, Market analysis, Business plan concepts, Development of financial projections.

References:

1. Harold Koontz & Heinz Weihrich (2012), “Essentials of Management”, McGraw Hill, New Delhi.
2. Peter Drucker (1993), “Management: Tasks, Responsibilities and Practices”, Harper and Row, New York.
3. Peter Drucker (2004),“The Practice of Management”, Harper and Row, New York.

BME 3221: DIGITAL IMAGE PROCESSING [4 0 0 4]

Review of signals, systems & transforms; 2D signals & systems, 2D DFT and its computation. Image perception – the human vision system, psycho-visual experiments, monochrome vision model, temporal properties. Image compression – the discrete cosine transforms (DCT), properties, computation, practical compression algorithm. Image Enhancement: Point operations – Histogram modification, Histogram equalization; Spatial filtering: linear filters & the median filter. Edge Detection, Hough transform – detection of straight lines and curves in images; Invariant descriptors: Fourier Descriptor, Moment-based invariants; Morphological Image Processing techniques, Thresholding, Connected Component Labeling.

References:

1 R.C. Gonzalez and R.E. Woods, Digital Image Processing, 4th Edition, Pearson Education Inc., 2017.

2 Jae S. Lim, Two-dimensional Signal and Image Processing, Prentice-Hall, Englewood Cliffs, New Jersey, 1990.

3 A.K. Jain, Fundamentals of Digital Image Processing, Prentice-Hall, 1989, Fourth Indian Reprint.

BME 3241: DIGITAL SIGNAL PROCESSING LAB [0 0 3 1]

Signal Processing in MATLAB

Introduction, Basic sequences and operations, Discrete Time System and its properties, Convolution, Discrete Fourier Transform and its properties, Simple filter design, FIR and IIR filters - design and implementation

References:

1. Houcque, David. "Introduction to Matlab for engineering students." Northwestern University 1 2005.
2. Mohindru, P., & Mohindru, P., MATLAB and SIMULINK (A Basic Understanding for Engineers). Cambridge Scholars Publishing, 2020.

BME 3242: DIGITAL IMAGE PROCESSING LAB [0 0 3 1]

Image Processing in Python

Introduction, Image processing - Display and Simple Manipulations, Contrast Enhancement and Discrete Fourier Transform of an Image, Image filtering - Spatial and Frequency domain filtering, Discrete Cosine Transform of an Image - examples and exercises with CT/MRI data, Geometrical Transformation of an Image - Applications, Radon Transform

References:

1. Hans-Petter Halvorsen. Python for science and engineering. Hans-Petter Halvorsen – a Blog about Technology, 2019, https://www.halvorsen.blog/
2. Sinan Kalkan, Onur Tolga Sehitoglu, and Gokturk Ucoluk. Programming with Python for Engineers. 2021,

https://ceng240.github.io/

3. Jan Erik Solem. Programming Computer Vision with Python: Tools and algorithms for analyzing images. " O'Reilly Media, Inc.", 2012.

FLEXIBLE CORE1 (A - Informatics/B- Materials):

BME 3124: ARTIFICIAL NEURAL NETWORKS (A1) [3 0 0 3]

Fundamental concepts: neuron models and basic learning rules, Pattern and data, biological foundations of neural network, Components, and topology of artificial neural network. Basic network properties: Activation functions, computational properties of nodes, learning methods, Training and Testing. Single layer networks, Perceptron, Feed forward neural networks, Supervised Learning networks, Multilayer neural networks, Associative memory networks, training algorithm for pattern association, pattern correction, pattern retrieval, Feedback neural networks, analysis of pattern clustering, Recurrent neurodynamical systems, Unsupervised learning network: Maxnet, Kohonen Self-organizing feature Map and Special networks. Deep learning network: Introduction, Example, Functional units of ANN for object recognition, Neural network for medical diagnosis: Bio-signal Analysis, recognition of diagnostic information from brain MRI images, ANN for digital pathology application.

References:

1. Simon O. Haykin, “Neural Networks and Learning Machines”, 3rd Edition, Perason, Prentice Hall, New Delhi, 2019
2. Sathish Kumar, “Neural Networks - A Classroom Approach”, McGraw Hill, 2nd Edition 2017.
3. S. N. Sivanandam, and S. N. Deepa, “Principles of Soft Computing”, Wiley India Pvt. Ltd., New Delhi, 2011.
4. B Yegnanarayana, Artificial Neural Networks, Prentice Hall India, New Delhi,2001.
5. Emmanuel C. Ifeachor, Piotr S Szczepaniak, Paulo J. G. Lisboa, “Artificial Neural Networks in Biomedicine”, Springer-Verlag London, 2000.
6. D L Hudson and M E Cohen, “Neural Networks and Artificial Intelligence for Biomedical Engineering”, IEEE Press Series on Biomedical Engineering, IEEE Press, IEEE Publications, U.S, 2000.
7. Utku Kose, Omer Deperlioglu, D. Jude Hemanth, Deep Learning for Biomedical Applications, ISBN 9780367422509, CRC Press, 2021
8. E. Golden Julie, Y. Harold Robinson, S. M. Jaisakthi. Handbook of Deep Learning in Biomedical Engineering and Health Informatics, CRC Press,2022

BME 3125: BASICS OF CELL AND MOLECULAR BIOLOGY (B1) [3 0 0 3]

Basic properties of cells, different classes of cells, prokaryotic and eukaryotic cells, the chemical basis of life, nature of biological molecules, types of biological molecule, cellular metabolism, structure and function of the plasma membrane, interactions between cells and their environment, cytoplasmic membrane systems: structure, function, and membrane trafficking, the cytoskeleton and cell motility, the nature of the gene and the genome, gene expression: from transcription to translation, the cell nucleus and the control of gene expression, DNA replication and repair, cellular reproduction, cell signaling and signal transduction: communication between cells, cancer, the immune response, techniques in cell and molecular biology,

References:

1. Karp G. Cell and molecular biology: concepts and experiments. John Wiley & Sons; 2009 Oct 19.
2. Alberts B, Bray D, Hopkin K, Johnson AD, Lewis J, Raff M, Roberts K, Walter P. Essential cell biology. Garland Science; 2015.
3. Rastogi SC. Cell and molecular biology. New Age International; 2006.
4. Chandar N, Viselli S. Cell and molecular biology. Lippincott Williams & Wilkins; 2012 Aug 14

FLEXIBLE CORE2 (A - Informatics/B- Materials):

BME 3222: MACHINE LEARNING (A2) [3 0 0 3]

Introduction: Basic Concepts-Supervised Learning, Discriminative Algorithms. Supervised learning:Supervised learning setup, LMS, Linear Algebra, Logistic regression. Perceptron. Exponential family, Generative learning algorithms. Gaussian discriminant analysis. Naive Bayes approach, Support vector machines, Vectorization. Practice ML advice: Bias/variance tradeoff, Model selection and feature selection, Evaluating and debugging learning algorithms, Practical advice on structuring an ML project, Convex Optimization. Deep Learning: NN architecture, Forward/Back propagation, Vectorization, Other optimization tricks, Evaluation Metrics. Unsupervised learning: Clustering. K-means, EM. Mixture of Gaussians, Factor analysis, PCA (Principal components analysis), ICA (Independent components analysis). Reinforcement learning and control:MDPs. Bellman equations, Value iteration and policy iteration, Linear quadratic regulation (LQR), LQG, Q-learning. Value function approximation.

References:

1. Christopher Bishop, Pattern Recognition and Machine Learning (Information Science and Statistics), Springer; 1st Edition. 2006. Corr. 2nd Print, 2011.
2. Stephen Marsland, Machine Learning: An Algorithmic Perspective, Chapman and Hall/CRC, 2nd Edition, 2014.
3. Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd Edition, New York, NY: Wiley-Interscience, 2007.

BME 3223: Electrical and Magnetic materials (B2) [3 0 0 3]

Atomic structure and interatomic bonding, metals, semiconductors, insulators. Conductivity of metals and semiconductors- Drude model, dependence on temperature and composition, Matthiessen's rule. Insulating materials, Inorganic, organic, liquid and gaseous insulators. Dielectrics: Introduction to Dielectric polarization and classification – Clausius-Mossotti relation. Dielectric Breakdown: Mechanism of breakdown in gases, liquids and solids – basic theories including Townsend's criterion, Streamer mechanism, suspended particle theory, intrinsic breakdown, electro-mechanical breakdown- Factors influencing Ageing of insulators- Application of vacuum insulation- Breakdown in high vacuum. Ferroelectricity, piezoelectricity. Magnetic Materials: Magnetization of matter, Classification of magnetic materials - Curie-Weiss law- Hard and soft magnetic materials– Ferrites. Optical

Properties: Light Interactions with Solids, Refraction, Reflection, Transmission, Absorption, Luminescence, Lasers, Photoconductivity.

Self-Directed Learning:

1. Dielectrics: Introduction to Dielectric polarization and classification – Clausius-Mossotti relation. Duration: 1Hr
2. Optical Properties: Light Interactions with Solids, Refraction, Reflection, Transmission, Absorption, Luminescence, Lasers, Photoconductivity. Duration: 36 Min.

References

1. William D. Callister, Jr., David G. Rethwisch, Materials Science and Engineering: An Introduction, 9th Edition, Wiley, 2014.
2. Dekker A.J., Solid state physics, Macmillan publishers India, 2012
3. James F. Shackelford, Introduction to Materials Science for Engineers, 8th edition, Pearson, 2014

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

BME 4291: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry

BME 4292: PROJECT WORK/PRACTICE SCHOOL

The project work may be carried out in the institution/industry/ research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out, before the department committee as part of project evaluation.

MINOR SPECIALIZATIONIN BIOMATERIALS

BME 4401: INTRODUCTION TO BIOMEDICAL NANOTECHNOLOGY [3 0 0 3]

Introduction nanotechnology: Nanomaterials- classifications, synthesis methods, nanostructured system by self-assembly, biomimetic and biomolecular recognition assembly, surface functionalization of nanoparticles, nanocomposites. Characterization tools for nanomaterials and Nano systems- structural and chemical characterization techniques. Properties of nanomaterials: - mechanical properties, optical properties, surface plasmon resonance, quantum size effects, introduction to nanoelectronics. Nanotechnology for drug delivery, nanotechnology for diagnosis, prognosis, and disease status: - biomedical imaging, biosensors and drug delivery. Therapeutic nanotechnology, nanotechnology for implant materials and tissue engineering, cosmetics, nanotechnology safety concerns. Self-Directed

BME 4291: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry

BME 4292: PROJECT WORK/PRACTICE SCHOOL

The project work may be carried out in the institution/industry/ research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out, before the department committee as part of project evaluation.

MINOR SPECIALIZATIONIN BIOMATERIALS

BME 4401: INTRODUCTION TO BIOMEDICAL NANOTECHNOLOGY [3 0 0 3]

Introduction nanotechnology: Nanomaterials- classifications, synthesis methods, nanostructured system by self-assembly, biomimetic and biomolecular recognition assembly, surface functionalization of nanoparticles, nanocomposites. Characterization tools for nanomaterials and Nano systems- structural and chemical characterization techniques. Properties of nanomaterials: - mechanical properties, optical properties, surface plasmon resonance, quantum size effects, introduction to nanoelectronics. Nanotechnology for drug delivery, nanotechnology for diagnosis, prognosis, and disease status: - biomedical imaging, biosensors and drug delivery. Therapeutic nanotechnology, nanotechnology for implant materials and tissue engineering, cosmetics, nanotechnology safety concerns.

Self-Directed Learning:mechanical properties, optical properties, surface plasmon resonance, quantum size effects, Duration: 3Hr

References:

1. Guozhong Cao, Nanostructures and nanomaterials Synthesis, Imperial Press, 2011.
2. Neelina H. Malsch, Biomedical nanotechnology, CRC Press, 2005.
3. G.A. Ozin and A.C. Arsenault, Nanochemistry: A chemical approach to Nanomaterials, Royal Society of Chemistry, 2005.
4. Kenneth E. Gonsalves, Craig R. Halberstadt, Cato T. Laurencin, Lakshmi S. Nair, Mott, Biomedical Nanostructures,Weily-Blackwell, 1st edition, 2008.
5. Jun Li, Nianqiang Wu, Biosensors based on Nanomaterials and nanodevices, CRC Press, 1st edition, 2014.
6. T. Pradeep, A Textbook of Nanoscience and Nanotechnology,

McGraw Hill Education, 1st edition, 2017.

7. Challa S. S. R. Kumar, Josef Horms, CsrolaLeuschner, Nanofabrication Towards Biomedical Application: Techniques, Tools, Applications and impact, Wiley- VCH, 1st edition, 2015.

BME 4402: BIOMATERIAL CHARACTERIZATION TECHNIQUES [3 0 0 3]

Physical and chemical characterization of Biomaterials: optical microscopy, UV-Vis spectroscopy, fluorescence spectroscopy, transmission electron microscope (TEM), scanning electron microscope (SEM), scanning tunneling microscope (STM), atomic force microscope (AFM), X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FT-IR), dynamic light scattering (DLS), contact angle, gas adsorption, mass spectroscopy, chromatography. Thermal characterization of biomaterials: thermogravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC). Surface Characterization of Biomaterials: X-ray photoelectron spectroscopy (XPS), auger electron spectroscopy (AES), secondary ion mass spectroscopy (SIMS), light microscopy and confocal microscopy.

References

1. Amit Bandhyopadhya and Susmita Bose, Characterization of Biomaterials, Elsevier, 2013.
2. Douglas B. Murphy, Fundamentals of light microscopy and electronic imaging, Wiley-Liss, Inc. USA, 2001.
3. B.D. Cullity and S.R. Stock, Elements of X-ray diffraction, Prentice Hall, Inc. USA, 2001.
4. D.B. Williams and C. Barry Carter, Transmission electron microscopy 4 volumes, Springer, USA, 1996.
5. Gerhard Huebschen Iris Altpeter, Ralf Tschuncky Hans-Georg Herrmann, Materials Characterization Using Nondestructive Evaluation (NDE) Methods, Elsevier, 2016.
6. M. Jaffe, W. Hammond, P. Tolias, T. Arinzeh, Characterization of Biomaterials, Elsevier, 2012.
7. Crankovic GM. ASM Handbook, Volume 10: Materials Characterization. ASM International; 1986.

BME 4403: BIO FABRICATION [3 0 0 3]

Biomaterials: polymers, bio inks, tissue-derived matrices, tissue engineering and bio fabrication description of extracellular matrix, bio printing, inorganic powder printing, stereo lithography, selective laser sintering, melt electro spinning writing, self-healing hydrogel system, polymers in 3D printing, introduction to rheology, 3D printing history, techniques, applications, CAD/CAM, 3D modelling, Medical imaging to printing, 3D printing techniques: additive manufacturing, 3D printing in the clinic: devices and implants Cell printing, Applications: cartilage, liver, cardiovascular system, organ-on-a-chip, in vitro models, Nano/micro fabrication techniques: Photolithography, Soft lithography-micro-stamping, stencil patterning, and microfluidic patterning, Electron beam lithography, Focused ion beam lithography, Colloid mono layer lithography, Molecular self-assembly, Electrically induced nano patterning,

References:

1. Aleksandr Ovsianikov, James Yoo, Vladimir Mironov, 3D Printing and Bio fabrication, Springer, 2018, ISBN 978-3-319-45445-0
2. Zhang et al., 3D Bioprinting and Nanotechnology in Tissue Engineering and Regenerative Medicine. 1st edition, ISBN 9780128005477.
3. Forgacs et al., Biofabrication - Micro- and Nano-fabrication, Printing, Patterning and Assemblies, 1st Edition, ISBN 9781455728527
4. Marc J. Madou, Fundamentals of Microfabrication and Nanotechnology, 2011, 3rd edition, CRC Press, ISBN 0849331803
5. Guozhong Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, 2nd edition ISBN 9789814324557

BME 4404: DRUG DELIVERY [3 0 0 3]

Drug delivery system: overview, dosage form-tablet, capsule, parenteral etc. classification of drug delivery system, chemically controlled system, diffusion-controlled system, controlled release mechanism-Membrane reservoir system, Matrix system, swelling controlled release system, biodegradable controlled release system Fundamental aspects of drug delivery: introduction of pharma cokinetics and pharma codynamics, diffusive transport, diffusion in heterogeneous system, passage of drug through membrane drug release kinetics from different bio polymer matrices Pharmacokinetics: common routes of systemic drug administration, drug absorption, bio availability, determinants of bio availability- disintegration, dissolution, drug distribution, drug elimination. Matrix based drug delivery system: Delivery materials, polymer-based matrices; hydrogels- drug carriers, transdermal and trans-mucosal drug delivery system, measuring in vitro diffusions, measuring controlled release kinetics, drug targeting approaches, bio compatibility aspects of matrices Immunity and immunological preparations: immunity, types, immunological preparations; bacterial vaccines, vaccines containing living viruses, vaccines containing toxoids Fundamentals of vaccine delivery

References:

1. B. Wang, T. J. Sahaan, R. A. Soltero, Drug Delivery: Principles and applications, John Wiley & Sons Inc., 2016.
2. L Shargel, S Wu-Pong, A Yu, Applied Biopharmaceutics & Pharmacokinetics, 6th Edition, The McGraw Hill, 2005.
3. S. Rosenbaum, Basic Pharmacokinetics and Pharmacokinetics, Wiley, 2011.
4. Juergen Siepmann, Ronald A. Siegel, Michael J. Rathbone (Editors), Fundamentals and Applications of Controlled Release Drug Delivery, Springer, 2012.
5. Eric P. Holowka, Sujata K. Bhatia, Drug Delivery-Materials Design and Clinical Perspective, Springer, 2014.
6. David Williams, Essentials of Biomaterials Science, Cambridge University press, 2014.

MINOR IN INFORMATICS

BME 4405: ARTIFICIAL INTELLIGENCE [3 0 0 3]

Basics of Artificial Intelligence (AI), Healthcare IT and the Growing Need for AI Operations, AI Healthcare Operations (Clinical): Clinical Impact of AIOps, Design and Innovation, AIOps for Healthcare Delivery, Clinical AI, AIOps. Deploying AI in practice, Real world applications of AI in medicine., Automation, Workflow, Process, and Intelligence Design Security, Ethics of intelligence, Policy and law, confidentiality, privacy aspects of medical software development, The future of AI,The Convergence of Healthcare AI Technology. Case studies: AI for Electronic Health Records Data, AI and 2D Medical imaging data, 3D Medical imaging data, AI to wearable device data.

References:

1. Robert Shimonski, AI in healthcare, Wiley, 2020
2. Arjun Panesar, Machine learning & AI for healthcare, 1st Edition, Apress,2019
3. Ankur Saxena, Shivani Chandra, Artificial intelligence and machine learning in healthcare, 2021.

BME 4406: BIOMEDICAL SIGNAL PROCESSING [3 0 0 3]

Review of Probability theory, random variables and stochastic processes; Spectral estimation techniques; Estimation of the autocorrelation and power spectrum density (PSD): Nonparametric methods of power spectrum estimation: The Periodogram & its modifications, The Welch method, Biomedical applications. Cepstrum analysis: The cepstrum, power cepstrum, complex cepstrum, Biomedical applications; Adaptive Filters: Weiner filter, Adaptive noise canceling, Principles of adaptive noise canceling with LMS and RLS adaptation algorithm. Adaptive line enhancer, principles of adaptive line enhancer using the LMS and GAL algorithm and Biomedical engineering applications. Parametric methods of power spectrum estimation: AR modeling – The Yule-Walker method and least square method of parameter-estimation; selection of AR model order; Autoregressive Moving Average (ARMA) modeling; Adaptive methods of estimating the PSD, Biomedical engineering applications.

References:

1. John G. Proakis and Dimitris G. Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, Pearson, 4th edition, 2007
2. Simon Haykin, “Adaptive Filter Theory”, Pearson, 5th edition, 2013
3. M. Akay, “Biomedical signal processing”, Academic press, 1994.
4. Rangaraj M Rangayyan, “Biomedical Signal Analysis”, John Wiley and Sons, Illustrated edition, 2015.

BME 4407: DECISION SUPPORT SYSTEMS [3 0 0 3]

Computer-based Clinical Decision Support: Overview, Status, and Challenges, Features of CDSS, Mathematical Foundations of Decision Support Systems, Data Mining and Clinical Decision Support Systems, Usability and Clinical Decision Support, Architectures for Clinical Decision Support. Role of Quality Measurement and Reporting Feedback as a Driver for Care Improvement, Decision support delivered using the outpatient electronic health record, Knowledge for Clinical Decision Support: Statistical and Machine Learning Techniques, Evidence-Based Medicine, statistical methods in meta-analysis, Meta-analysis of complex datasets. Big Data and Population-Based Decision Support, Clinical Decision Support for Personalized Medicine, Decision Rules and Expressions, Formal methods for modelling. Best Practices for Implementation of Clinical Decision Support, National Policies on the Use of Clinical Decision Support, Ethical and Legal Issues in Decision Support, Evaluation of Clinical Decision Support, Adoption of Clinical Decision Support system, Decision Support for Patients, Diagnostic Decision Support Systems, Applications.

References:

1. Decision Making in Health and Medicine, MyriamHunink and Paul Glasziou, 6th printing 2007; Publisher: Cambridge University Press
2. Clinical Decision Support Systems: Theory and Practice, Berner, Eta S. (Ed.), 2nd ed., 2007, Publisher: Springer, Health Informatics Series (springer.com NOT springerpub.com)
3. Osheroff, Pifer, Teich, Sittig, Jenders, 2005; Publisher: Health Information and Management Systems Society (HIMSS)
4. Robert Greenes, Clinical Decision Support, The Road to Broad Adoption, 2nd Edition - March 26, 2014, eBook ISBN: 9780128005422, Hardcover ISBN: 9780123984760, Elsevier

BME 4408: MEDICAL IMAGING [3 0 0 3]

Review of signals, systems & transforms; 2D signals & systems; Medical Imaging: Imaging modalities and their applications; Computed tomography (CT): mathematical basis, the Radon transform & the central slice theorem; Image reconstruction from projections: the Direct Fourier Method, convolution back projection (CBP) algorithm, Algebraic Reconstruction Techniques (ART); reconstruction from fan-beam projections; Extension to 3D – cone-beam CT, spiral CT. Tomosynthesis; X-rays: utility, generation and detection; X-ray CT systems. Emission CT: principles, Positron emission tomography (PET); attenuation correction in ECT; Ultrasound in clinic: benefits/risks, Basics of Ultrasound - review, Ultrasound imaging; Contrast enhanced ultrasound imaging; Motion artifacts in ultrasound imaging. Clutter filtering; elastography, plane wave imaging; Magnetic resonance imaging: Principles of data-generation, resolving the tissues, resolving the spatial locations, and extension to 2D. Resolution & Field of View; Data sampling and the concept of bandwidth.

References:

1. R.C Gonzalez and R.E. Woods, Digital Image Processing, 4Th Edition, Pearson Education Inc., 2017.
2. A.K. Jain, Fundamentals of Digital Image Processing, Prentice-Hall, 1989, Fourth Indian Reprint.
3. A.C. Kak and M. Slaney, Principles of Computerized Tomographic Imaging, SIAM's Classics in Applied Mathematics, Philadelphia, SIAM, 2001.
4. Kline Jacob, Handbook of Biomedical Engineering, Academic Press, 1988.
5. Carol M. Rumack, Deborah Levine, Diagnostic Ultrasound, 5Th Edition, Elsevier, 2017.
6. Thomas L. Szabo, Diagnostic Ultrasound Imaging: Inside Out, 2nd Edition, Elsevier, 2014.
7. James A. Zagzebski, Essentials Of Ultrasound Physics, 2nd Edition, Mosby, 2010.
8. Barbara S. Hertzberg, William D. Middleton, Ultrasound: The Requisites, EBook (Requisites in Radiology), 2015.
9. HH Schild, “MRI made easy”, Schering AG, Berlin, 1990.

PROGRAM ELECTIVES

BME 4441: BIOSTATISTICS [3 0 0 3]

Introduction, Summarizing Quantitative Data, Summarizing Categorical Data; Prevalence, Incidence, Relative Risk, Risk Difference, Sampling Bias, Confidence Intervals, Study Design, Probability & Screening; Probability distributions: Binomial & Normal Distributions, Sampling Distributions, Confidence Intervals. Hypothesis Test: Introduction, One-sample proportion, Chi-square test, t tests, Continued MCW, Power and Sample Size. Correlation & Regression, Multiple Regression, Regression to the Mean MCW.

References:

1. Sullivan, L.M., Essentials of biostatistics for the health sciences, 3rd Edition, Jones & Bartlett Learning, 2018.
2. Machin, Campbell and Walters, Medical Statistics, 4th ed., Wiley, 2007.
3. Motulsky, H., Intuitive Biostatistics: A nonmathematical guide to statistical thinking, 3rd Edition, Oxford University Press, New York, 2014.
4. Utts, J and Heckard, R., Mind on statistics, 5th Edition, Cengage Learning, USA.

BME 4442: BIOELECTRO MAGNETISM [3 0 0 3]

Introduction: Fundamental physical knowledge and electrostatic and magnetic field equations. Fundamentals of bio electromagnetism. Vector Analysis, Electrical Sources and Fields, Introduction to Membrane Biophysics, Action Potentials, Volume Conductor Fields, Bioelectric sources and conductive environment. Electrodynamics of bioelectrical fields. Concepts of bioelectrical and bio magnetic measurement. Measurement methods, modelling and simulation techniques. Bioelectric Sources and Conductors and their Modelling Anatomical and Physiological Basis of Bio electromagnetism - Nerve and Muscle Cells, Subthreshold Membrane Phenomena, Active Behavior of the Membrane, Synapses, Receptor Cells, and Brain, The Heart, Volume Source and Volume Conductor, Source-Field Models, Bidomain Model of Multicellular Volume Conductors, Electronic Neuron Models Theoretical Methods in Bioelectromagnetism, Theoretical Methods for Analyzing Volume Sources and Volume Conductors, Theory of Biomagnetic Measurements, Electric and Magnetic Measurement of the Neural tissue and the Heart Electroencephalography, Magnetoencephalography, 12-Lead ECG System, Vector cardiography Lead Systems, Other ECG Lead Systems, The Basis of ECG Diagnosis, Magnetocardiography

References:

1. Computational Cardiology: Modeling of Anatomy, Electrophysiology, And Mechanics by Frank Sachse. Springer-Verlag New York, Inc. Secaucus, NJ, USA
2. Bioelectromagnetism by Jaakko Malmivuo and Robert Plonsey. Good too and very cheap-free in fact on the web site http://www.bem.fi/book/
3. Mathematical Physiology by James Keener and James Sneyd. Springer Verlag. (great all-around book on modeling and simulation in physiology).
4. Mathematically Modeling the Electrical Activity of the Heart: From Cell to Body Surface and Back by Andrew Pullan. World Scientific Publishing Company (September 30, 2005)

BME 4443: BIOMETRICS [3 0 0 3]

Basic image operations, Interpolation, Special filters, enhancement filter, Edge detection, thresholding, localization. Introduction of biometric traits and its aim, Biometric system, authentication, physiological and behavioral properties, Identification and verification, Threshold, Score distribution, FAR and FRR, System design issues - Expected overall error, EER, ROC curve, DET curve, FAR/FRR curve. Existing Biometric Technologies: Fingerprints, Face, Iris, Hand Geometry, Ear, Voice, Retina, Gait. Introduction to physiological and behavioral biometrics in hospitals or care units, Biometric authentication based on ECG, EMG, and Phonocardiograph (PCG) signals. Multimodal identification and Verification system, normalization strategy, Fusion methods, Biometric system security. Face and ECG Based Multimodal Biometric Authentication.

References:

1. Girija Chetty and Jucheng Yang, Advanced Biometric Technologies, InTech, 2011.
2. Jain, A.K., Ross, A., Nandakumar, K. Introduction to Biometrics. Springer; 2011.
3. David Zhang, Fengxi Song, Zhizhen Liang, Yong Xu, Advanced Pattern Recognition Technologies with Applications to Biometrics (Premier Reference Source), Medical Information Science Reference; 1st edition, 2009.
4. Ruud M. Bolle, Sharath Pankanti, Nalini K. Ratha, Andrew W. Senior, Jonathan H. Connell Guide to Biometrics, By, Springer, 2009.
5. Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd Edition, New York, NY: Wiley-Interscience, 2007.
6. Rafael C. Gonzalez, Richard Eugene Woods, Digital Image Processing using MATLAB, 2nd Edition, Tata McGraw-Hill Education, 2010.

BME 4444: EMBEDDED SYSTEMS [3 0 0 3]

Introduction to Embedded systems, processor and memory organization, Devices, Serial & Parallel buses for device networks, Device drivers and interrupt servicing mechanisms. Programming concepts, and embedded programming in C. Real-Time Operating systems and Task Scheduling algorithms. Hardware Software Co-simulation: Co-simulation approaches, Embedded System Development Life Cycle (EDLC). Representative Embedded systems.

References:

1. Peckol James K, “Embedded Systems”John Wiley and Sons, New Delhi, 2013.
2. Valvano Jonathan W, “Embedded Systems”, Jonathan W.V, U. K., 2014.
3. Frank Vahid and Tony Givargis, “Embedded system Design – A Unified Hardware/Software Introduction”, Wiley India Pvt. Ltd, 2014.
4. Tim Wilmshurst, “An Introduction to the design of Small-Scale Embedded Systems” Palgrave, New York, 2003.
5. Shibu K.V, “Introduction to Embedded Systems”, TMH, New Delhi, 2010.

BME 4445: FUZZY LOGIC SYSTEMS [3 0 0 3]

Introduction to Fuzzy Sets and Fuzzy Logic: Crisp Sets, Fuzzy Sets, Linguistic variables, Membership functions, Set theory operations on Crisp and Fuzzy sets, Relations and Compositions, Hedges, Extension Principles, Crisp logic, Fuzzy logic, Sources of Uncertainty, small applications. Membership functions: Type-1 Membership functions, Type-2 Membership functions, Multivariable Membership functions, Case studies. Singleton and Non-Singleton Type-1 Fuzzy logic systems: Introduction, Rules, Fuzzy Inference Engine, Fuzzification and its effect on Inference, Defuzzification, Fuzzy basis functions, Universal approximators, Designing FLSs, Case studies. Type-2 Fuzzy Sets: Operations on and Properties of Type-2 Fuzzy Sets, Type-2 Relations and Compositions, Type reduction. Type-2 Fuzzy Logic Systems: Singleton Type-2 FLSs, Type-1 Non-singleton Type-2 FLSs, Type-2 Non-singleton Type-2 FLSs, Respective Case Studies.

References

1. Jerry M. Mendel, Uncertain Rule-based Fuzzy Logic System: Introduction and New Directions, Springer; 2nd Edition, 2017.
2. Timothy J. Ross, Fuzzy Logic with Engineering Applications, Wiley, 3rd Edition, 2011.
3. George J. Klir, Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall, Facsimile Edition, 1995.

BME 4446: HEALTH CARE MANAGEMENT [3 0 0 3]

Introduction: ABC of Hospital Administration, Principles of Management Human Resources: Motivation, Time Management, Leadership and Supervision, Nursing Services, Effective Communication, Conflicts, Monitoring and Control, Public Relations, Medical Social Service department, Professional Hazards, Clinical Services: Indoor Services, Outpatient Department, Casualty and Emergency Wing, Intensive Care areas, Operating room and post-operative units, Support Services: Laboratories, Blood Bank, Radiology Services, Pharmacy, Central sterile supply department, Medical Record department, Materials Management, Housekeeping and maintenance, Linen and laundry, Dietary Services, Hospital Information system and computerization, Security and safety, Finance and Budget, Costing, Medical Ethics, Law and medical profession, Hospital acquired infections, Waste disposal, Quality assurance and medical audit, Disaster Management.

References:

1. Colonel (Retd) B.M.Sakharkar , Principles of Hospital Administration and Planning , Jaypee Brothers.
2. C M Francis, Hospital Administration, Jaypee Brothers Edition 2, 1995.
3. S L Goel, R Kumar, Hospital Administration and Management, Vol 1,2,3, Deep & Deep.
4. Humble John W, Management By Objectives in Action, McGraw Hill, 1970.

BME 4447: PATTERN RECOGNITION [3 0 0 3]

Introduction to Pattern Recognition (PR) system; Application domains, Feature, Feature space, Class, Feature vector, Classifier, Classification and approaches, Design cycle; Linear Regression, Logistic Regression & General Linear Model; Introduction to Statistical decision making, Bayesian Decision Theory: continuous and discrete features, Multiple features, conditionally independent features, Maximum likelihood estimation, Decision boundaries, unequal costs of error, Estimation of error rates, the leaving one-out technique. Non-Parametric Techniques: K-nearest neighbourhood estimation, clustering: Hierarchical clustering, Agglomerative clustering algorithm, Single, Average and Complete linkage algorithms, Partitional clustering, K means, Ward's algorithm, Problems. Gaussian Mixture Models – with Expectation Maximization algorithm, Principal Component Analysis; Introduction to Neural Networks; performance analysis of a classifier.

References:

1. Earl Gose, Richard, Johnson Baugh and Steve Jost, “Pattern recognition and Image analysis”, Prentice Hall, New Delhi, 2002.
2. Schalkoff Robert J, “Pattern recognition”, John Wiley & Sons, New York, 1992.
3. Richchard O Duda, Peter E. Hart, David G. Strok, “Pattern Classification”, 2nd Edition, Wiley, Singapore, 2005.
4. S. N. Sivanandam, S. Sumathi and S. N. Deepa, “Introduction to Neural Networks using MATLAB 6.0”, TATA McGRAW HILL, New Delhi, 2006
5. S. N. Sivanandam, and S. N. Deepa, “Principles of Soft Computing”, 2nd Edition, Wiley India Pvt. Ltd, New Delhi, 2011
6. Sara Moein, “Medical Diagnosis Using Artificial Neural Networks”, IGI Publications, USA,2014
7. Volker Schmid Anke Meyer-BaeseSchmid Meyer-Baese “Pattern Recognition and Signal Analysis in Medical Imaging”, 2nd Edition, Academic Press, 2014.

BME 4448: PHYSIOLOGICAL CONTROL SYSTEM [3 0 0 3]

Introduction to physiological modeling: Introduction; Multi-scale organization of living organisms: cell to organ Homeostasis. Examples of physiological control systems. Review of linear systems concepts, Fourier series: Modeling signals using Fourier series, Deterministic and stochastic signals and systems. Mathematical tools: Basic concepts of control systems; Open vs. closed loop Steady state and transient analysis of control systems. Linear model's vs nonlinear models Distributed vs. lumped parameter models Compartment models. Cardiovascular and Respiratory system: Circulatory system. Key events in the cardiac cycle. Blood pressure and flow, vascular impedance. Lumped parameter models, windkessel model of circulation Cardiac mechanics. Respiratory mechanics, lung models. Nervous system: Anatomy and physiology of nerves Action potentials, Hodgkin-Huxley model. Musculoskeletal system: Muscle anatomy and physiology. How muscles contract, Hill model of muscle contraction, Muscle stretch reflex. Eye Movement Model: Types of Eye movement, Eye movement system and Wetheimer's saccade eye model. Robinson's Model, Oculomotor muscle model, Linear Reciprocal Innervations Oculomotor Model.

References:

1. Michael C. K. Khoo, Physiological Control Systems: Analysis, Simulation and Estimation, Wiley IEEE Press, 1999.
2. John D. Enderle, “Model of Horizontal eye movements: Early models of saccades and smooth pursuit”, Morgan & Claypool Publishers, 2010.

BME 4449: PROSTHETICS [3 0 0 3]

Familiarity with the operation/working principles of various prosthesis used in neural and urological applications Soft Tissue Replacements: Cardiac Anatomy and Pathophysiology, mechanical and bioprosthetic heart valves, Artificial heart and cardiac assist devices, vascular prosthesis: stent grafts Hard Tissue Replacements: Bone structure, cortical and cancellous bone, viscoelastic properties. Fracture and fixators, healing of bones. Joint replacements -Hip and knee implants, dental implants: introduction, artificial dental implants, implant fixations

Neural Prostheses: Origins of the field of neural prostheses, Motor prosthesis: Neuromuscular Stimulation for Control of Limb Movement, Sensory prosthesis: Visual, auditory (cochlear implant) and tactile Artificial Kidney: Structure and function of the kidney, Kidney disease, Renal failure, Mass transfer in dialysis, Clearance, Permeability, Membranes, Hemofiltration Artificial Pancreas: Structure and function of pancreas. Endocrine pancreas & insulin secretion. Diabetes, insulin therapy, insulin administration systems, implantable insulin pumps (artificial pancreas) Orthopaedic and Urologic prosthesis

References:

1. Andrej Kral, Felix Aplin, Hannes Maier, 'Prostheses for The Brain', Academic Press, 2021.
2. Joseph D Bronzino, “The Biomedical Engineering Handbook”, Third Edition, 2006, CRC press, USA.
3. Gerald E. Miller, 'Artificial organs', Morgan & Claypool Publishers, 2006.
4. Finn WE, LoPresti PG, editors. Handbook of neuroprosthetic methods. CRC Press; Dec 16, 2002.

BME 4450: REHABILITATION ENGINEERING [3 0 0 3]

Introduction to rehabilitation engineering in general.: The need and importance of rehabilitation engineering, Different categories of rehabilitation needed for the society, Understanding different stages through which rehabilitation has to be implemented on a case to case basis, A brief review of different physical disabilities: Definition of physical disability and its quantitative assessment, Concept of compensation for disabilities and importance of assistive devices, Popularly available assistive technology in general, Quantification of disability , methods and it's need , feasibility in the rehabilitation process for assistive technology, Categories of popularly available assistive devices; Special emphasis on the physical disability like disability on leg, hand etc., Relevance about the knowledge requirement about the biological signals in rehabilitation engineering, Important features of EMG, MMG signals in rehabilitation engineering, Need and importance of models; Different modeling tools and techniques in rehabilitation engineering, Significance modeling in assessing the disability of individuals, Popular models used for assessing disability, Electronic hardware used for assistive technology: Utility of micro controller in the development of assistive devices, Knowledge about the characteristic of human locomotion and its relevance in rehabilitation engineering, Dynamics of human organs, it's parameters, its utility in assistive limb technology, Possible case studies of different developed assistive devices.

References:

1. Joseph D Bronzino, THE Biomedical Engineering Handbook, VOL11, CRCPRESS, Edition 2, 2000
2. John G. Webster, Albertm. Cook, Willis J Tompkins, GREGG C Vanderheiden, Electronic devices for Rehabilitation, Chapman and Hall Ltd, 1985.
3. John Enderle, Dusan Blanchard, Joseph Bronzino, Introduction to Biomedical Engineering, Academic press,2000.
4. Arthur C Guyton, Textbook of Medical Physiology, Edition 9, 1996

BME 4451: TELEMEDICINE [3 0 0 3]

History of Telemedicine, Block diagram of telemedicine system, origin and development of Telemedicine, Benefits and limitations of Telemedicine; Data & Signal, transmission impairments & channel capacity, Guided & Unguided transmission media, transmission of digital signal and analog signal; Analog modulation techniques: AM & FM, analog to digital conversions and digital modulation techniques like ASK, FSK, PSK and DPSK; Multiplexing techniques: TDM & FDM, Multiple access techniques: TDMA, FDMA & CDMA; Types of Network; Switching techniques: Circuit switching and Packet switching; Types of wireless network like Bluetooth, Wi-Fi, Zig Bee, Satellite network etc.; Data Security and Standards: Encryption, Cryptography, digital signature, biometric security; Ethical and legal aspects of Telemedicine; Applications of Telemedicine: Teleradiology, telepathology, teleoncology, and other applications including videoconferencing.

References:

1. Behrouz A Forouzan,“Data Communication and Networking”, McGraw Hill Education (India) Pvt. Ltd., 5th Edition, 2013.
2. Shashi Bhushan Gogia, “Fundamentals of telemedicine and telehealth”, Academic Press, ist Edition, 2019.
3. Bernard Fong, A.C.M. Fong, C.K. Li, “Telemedicine technologies: Information technologies in Medicine and telehealth”, John Wiley & Sons, UK, 2011.
4. Olga Ferrer-Roca, M.Sosa Ludicissa, Handbook of Telemedicine, IOS Press 2002.
5. Konstantina S.Nikita, Handbook of Biomedical Telemetry, John Wiley & Sons, 2014.
6. A.C. Norris, Essentials of Telemedicine and Telecare, John Wiley & Sons, 2002.
7. R S Khandpur, “Telemedicine technology and applications”, PHI Learning Pvt. Ltd, New Delhi, 2017.

BME 4452: TISSUE ENGINEERING [3 0 0 3]

Introduction: Basic definition, Structural and organization of tissues: epithelial, connective tissues. Sterilization Process: Introduction, different sterilization methods: physical, chemicals; applications. Morphogenesis, Generation of Tissue in the Embryo: introduction, different germ layers, cardiac cell development, blood vessels development, skin tissue development; development of bone and cartilage, future development. Cellular Signaling: introduction, cellular signaling in skin, bone cartilage biology; understanding and implementing principles of cell signaling in tissue engineering. Stem Cell: introduction, types, self-renewal, differentiation, embryonic stem cell: isolation, properties; adult stem cells: isolation, properties, stem cell niche, future perspective. Cell and Tissue Culture: introduction, cell harvest, selection, expansion, differentiation, co-culture, source, types of tissue culture (animal), cell lines, culture media, maintenance of cell in vitro. Scaffolds: polymer, natural polymer for tissue engineering, degradable materials, various type of scaffold, cell –matrix interaction, ECM. Methods to monitor tissue re-modeling Engineering tissues (like skin, cartilage, bone).

References:

1. Satya Prakash, D.S. Tim, Stem cell bioengineering and tissue engineering microenvironment, World Scientific, 2012.
2. Endarle, Blanchard & Bronzino, Introduction to Biomedical Engineering, Academic press, 1998.
3. C.W. Patrick Jr., A. G. Mikos, L.V. Mcintire, Frontiers in tissue engineering, Pergamon, Elsevier, 1998.
4. C.V. Blitterswijk, Tissue Engineering, Academic Press, 2008.
5. B.O. Palsson and S N Bhatia, Tissue Engineering, Pearson Prentice Hall, 2004.
6. David Williams, Essentials Biomaterials Science, Cambridge University Press, 2014.
7. Julia Polak,(Ed), Advances in Tissue Engineering, Imperial College Press, 2008.

BME 4453: VIRTUAL REALITY [3 0 0 3]

Definition and goals of Extended Reality, historical perspective, different applications of VR (news, sports, entertainment, surgery, training etc.)Psychology of VR: Place illusion, plausibility illusion, embodiment illusion Graphics in VR: Transformations, 3D audio, Tracking in VR (Tilting/Yawing/SfM), general outline of content creation in VR Interaction in VR: Natural Interaction, Magic/Active/Passive Interaction, Teleportation in VR, Virtual Navigation, redirected walking, walk-in-place, Interacting with objects in VR, hyper-natural interaction, evaluation metrics, physics-based interaction, state machines User interfaces in VR: Abstract Interfaces, Diegetic/Non-diegetic interfaces, gestural interaction, issues in VR interaction User Interfaces in Unity3D: Unity gesture plugin, Bespoke VR Virtual Characters in VR, Body Animation in VR, Facial Animation, Social VR

References:

1. Grigore C. Burdea, Philippe Coiffet, Virtual Reality Technology, Wiley 2016
2. Alan Craig, William Sherman and Jeffrey Will, Developing Virtual Reality Applications, Foundations of Effective Design, Morgan Kaufmann, 2009.
3. John Vince, “Virtual Reality Systems “, Pearson Education Asia, 2007.

BME 4454 HEALTH INFORMATION SYSTEMS [3 0 0 3]

Introduction to Health Information Systems; Healthcare Data; Healthcare Data Standards, and Quality; Patient Data and Health Records; Basic Security Principles; Health Information Privacy; Health Information Security and Confidentiality; HIPAA; Electronic Medical Records (EMR); Electronic Health Records (EHR); Computerized Physician Order Entry (CPOE); Patient Monitoring Systems; Imaging Systems – PACS, DICOM, and VNA; Clinical Decision Support Systems (CDSS); Practice Management; Laboratory Information Management Systems (LMIS); Electronic Prescribing Systems (ePrescribe); Pharmacy Management Systems; Telemedicine; Mobile Healthcare; Patient Web Portals; Health Information Ethics; Health Information Technology; Health Information Exchange; Interoperability – HL7, FHIR; Healthcare Standards, Medical Regulatory and Compliance; Medical Education; Health Informatics; Public Health Informatics; Public Health Surveillance; Big Data and Healthcare Analytics; Clinical Data Warehouses; Web-enabled Technology Applications; System Development Life Cycle; Security of Electronic Data and Networks; Emerging Technologies in Healthcare; Electronic Health Record Standards in India.

References:

1. Health Informatics: Practical Guide, 8th Edition, August, 2022, Editor, William Hersh, M.D., online https://dmice.ohsu.edu/hersh/informaticsbook/
2. Gordon Brown, Kalyan S Pasupathy, Timothy B Patrick, Health Informatics: A Systems Perspective, Second Edition, Health Administration Press (May 28, 2018), ISBM-13 978-1640550056
3. William R. Hersh (Author), Robert E. Hoyt, Health Informatics: Practical Guide Seventh Edition, May 22, 2018, Publisher Lulu.com, ISBN-13: 978-1387642410

OPEN ELECTIVES:

BME 4311: BIOMEDICAL INSTRUMENTATION [3 0 0 3]

Biomedical transducers: Classification and Selection; Pressure Transducers: Resistive, capacitive, Inductive transducers & Piezo-electric, Photoelectric transducers & its types; Thermal transducers & its types; Electrodes & Amplifiers: Principles of working and their characteristics, Half- cell potential, Types of electrodes, Electrode-Electrolyte model, Amplifiers for biomedical instrumentation; Physiological Signals & Measurements: Basics of ECG, EMG, EEG, PCG, blood pressure & blood flow and the instrumentation for measuring these signals; Cardiac Pacemakers: Types of pacemakers, Modes of triggering, Pacemaker power supplies, pacemaker codes; Defibrillators: AC and DC defibrillators, Types of electrodes and their features, cardioverters; Lasers: Basic principles, types of lasers and their medical applications; X-ray systems, Fluoroscopic system, principles of tomography;Electrical Hazards & Safety: Safety code standards, Micro and Macro shock and its physiological effects, Methods of electrical safety.

References:

1. John G Webster, “Medical Instrumentation Applications and Design”, John Wiley and Sons, New York, 3rd Edition, 2011.
2. R S Khandpur, “Handbook of Biomedical Instrumentation”, McGraw Hill, Delhi, 3rd Edition, 2014.
3. L A Geddes, L E Baker, “Principles of Applied Medical Instrumentation”, Wiley India, New Delhi, 3rd Edition, 2008.
4. Richard Aston, “Principles of biomedical Instrumentation and measurement”, Merrill, New York, 1991.
5. Joseph J Carr, John M Brown, “Introduction to Biomedical

Equipment technology", Prentice Hall, New Jersey, 4th Edition, 2003.

BME 4312: BIOMECHANICS [3 0 0 3]

Basic terminology, Anatomical movement descriptors. Skeletal considerations for movement: Composition & Structure of bone, mechanical properties of bone, bone fracture & failure mechanics. Muscular considerations for movement: Skeletal muscle tissue properties, function and structure, Force generation in the muscle, Role of muscle, Force-velocity relationships in skeletal muscle, Joint flexibility. Fundamental concepts of gait. Linear Kinematics: kinematic parameters, projectile motion, linear kinematics of walking and running. Angular Kinematics: types of Angles, lower extremity joint angles, angular motion relationships, relationship between linear and angular motion, angle-angle diagrams. Linear Kinetics: laws of motion, types of forces, representation of forces acting on a system. Angular Kinetics: Newton's laws of motion (angular analogs), center of mass calculation, rotation and leverage, pulley system, analysis using Newton's laws of motion. Application of Aerodynamics in Sports: aerodynamic drag force - effects of drag on the body and objects in sport- activities, aerodynamic lift force - lift force acting on shapes and surfaces, effects of lift on projected objects, the Magnus effect. Application of Hydrodynamics in Aquatics: buoyancy and floatation, floating ability of the human body, types of floaters, different floating positions of the human body, resistive & propulsive forces in swimming skills, Swimming efficiency and speed.

References:

1. Joseph Hamill and Kathleen M. Knutzen, Biomechanical Basis of Human Movement, Lippincott Williams & Wilkins, Fourth Edition, 2014, Philadelphia, USA.
2. Susan J. Hall, Basic Biomechanics, McGraw-Hill International Editions, Seventh Edition, 2014, Singapore.
3. Peter M. McGinnis, Biomechanics of Sport and Exercise, Human Kinetics, Third Edition, 2013, USA.
4. P. Grimshaw and A. Burden, Sport & Exercise Biomechanics, Taylor & Francis Group, First Edition, 2007, UK.
5. Ellen Kreighbaum, Katharine M Barthels, Biomechanics-A Qualitative Approach for studying Human Movement, Allyn and Bacon Publishers, Fourth Edition, 1995, USA.

BME 4313: REHABILITATION ENGINEERING [3 0 0 3]

Introduction to rehabilitation engineering and assistive technology: principles, engineering concepts in sensory rehabilitation, motor rehabilitation and communication disorders. Orthopedic prosthetics & orthosis in rehabilitation technology: fundamentals of design of upper and lower extremity prosthetic and orthotic devices, applications. Mobility aids: mobility aids for the blind, discussion of design and function of robotic aids, wheel chairs. Sensory augmentation & substitution: visual, auditory and tactile sensory augmentation & substitution. Conversion aids for non-vocal physically impaired persons: characteristics and design considerations for conversion aids, biofeedback in communicative disorders, artificial larynx. Principles and applications of electrical stimulation: artificial electrical stimulation of nerves and muscles, applications. Conceptual frameworks, education and quality assurance.

References:

1. Joseph D. Bronzino and Donald R. Peterson, "The Biomedical Engineering Handbook", volume II, CRC press, fourth edition, 2015.
2. John G. Webster, Albert M. Cook, Willis J. Tompkins, Gregg C. Vanderheiden, "Electronic devices for Rehabilitation", John Wiley & Sons Inc, second edition, 1989.
3. John Enderle and Joseph Bronzino, "Introduction to Biomedical Engineering", academic press, third edition, 2011.
4. Rory A. Cooper, "An introduction to Rehabilitation Engineering", Taylor and Francis Inc, first edition, 2007.

BME 4314: INTRODUCTION OF MATERIALS IN MEDICINE [3 0 0 3]

Structure, properties and performance of materials: nature of materials, molecular assembly; bulk properties; surface properties; elasticity and viscoelasticity Classes of materials used in medicine: versatility of materials, Polymers –synthetic, natural, Metal, Ceramics, Composites, Hydrogels, medical fibers, porous materials, biomimetic materials. Characterization of materials-contact angle, spectroscopy Background concept of biological system: biological environment, biology in medicine, cells and surfaces, signaling pathways Host reaction to Materials: biological responses to materials, inflammation, foreign body response, device related infection Biological testing of Materials: testing materials, biocompatibility, blood-material interaction Application of materials in Medicine and functional tissue engineering: orthopedic, dental, ophthalmic, burn dressing, sutures, implants and inserts, tissue engineering templates

References:

1. Buddy D Ratner & Allen S Hoffman, Biomaterials Science, 3rd Edition, 2012, Academic Press, Canada.
2. David Williams, Essentials Biomaterials Science, 2014, Cambridge university press. ISBN:978052189908-6
3. Mark Meyers and Krishnan Chawla, Mechanical Behaviour of Materials, 2nd Ed, Cambridge University Press, 2009 ISBN: 978-0-521-18620-9
4. Lisa A. Pruitt and Ayyana M. Chakravartula, Mechanics of Biomaterials Fundamental Principles for Implant Design, Cambridge university Press 2011
5. M. Jaffe, W. Hammond, P.Tolias and T. Arinzeh, Characterization of biomaterials, Woodhead Publishing Limited, 2013

BME 4315: INTRODUCTION TO NANOMATERIALS & CHARACTERIZATION TECHNIQUES [3 0 0 3]

Introduction nanotechnology: Nanomaterials- classifications, synthesis methods, surface functionalization of nanoparticles, nanocomposites. Properties of nanomaterials: - mechanical properties, optical properties, magnetic properties. Characterization tools for nanomaterials and nanosystems- structural and chemical characterization techniques. Physical and chemical characterization of Nanomaterials: Transmission electron microscope (TEM), scanning electron microscope (SEM), scanning tunneling microscope (STM), atomic force microscope (AFM), X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FT-IR), dynamic light scattering (DLS), Mass spectroscopy, chromatography. Thermal characterization of nanomaterials: Thermogravimetric analysis (TGA), differential thermal analysis (DTA), differential scanning calorimetry (DSC). Surface Characterization of nanomaterials: X-ray photoelectron spectroscopy (XPS), auger electron spectroscopy (AES), secondary ion mass spectroscopy (SIMS), Raman spectroscopy, electron energy loss spectroscopy (EELS) and ultraviolet spectroscopy. Self-Directed Learning:Properties of nanomaterials: -mechanical properties, optical properties,;Duration: 3Hr

References:

1. Guozhong Cao, Nanostructures and nanomaterials Synthesis, Imperial Press 2011.
2. G.A. Ozin and A.C. Arsenault, Nanochemistry: A chemical approach to Nanomaterials, Royal Society of Chemistry, 2005.
3. T. Pradeep, A Textbook of Nanoscience and Nanotechnology, McGraw Hill Education, 1st edition, 2017.
4. P. M. Ajayan, L. S. Schadler, P. V. Braun, Nanocomposite Science and Technology, Wiley-VCH; 1 edition.

BME 4316: NANOMEDICINE [3 0 0 3]

This course gives an overview of nanotechnology and its applications in the field of medicine. The course includes: fundamental concepts in nanotechnology, fundamental concepts in cell, molecular and tissue biology, nanoparticles and their synthesis, nanotechnology platforms, characterization of nanomaterials, Nano pharmaceuticals, Nano-biosensors and diagnostics, role of nanotechnology in biological therapies, Nano devices for medicine and surgery, application in orthopaedics, cardiology, microbiology, ophthalmology, imaging, role of nanotechnology in regenerative medicine and tissue engineering, Nano toxicity, case studies in Nanomedicine.

References:

1. Jain KK, Jain KK. The handbook of nanomedicine. NJ: Humana Press; 2008.
2. Tibbals HF. Medical nanotechnology and nanomedicine. Crc Press; 2017.
3. Torchilin V, Amiji MM, editors. Handbook of materials for Nano medicine. Pan Stanford Publishing; 2011.
4. Prasad PN. Introduction to nanomedicine and Nano bioengineering. John Wiley & Sons; 2012 Jun 19.

Department of Biotechnology

The Department of Biotechnology launched B.Tech. program in Biotechnology, from the year 2005. The department also offers M.Tech in Industrial Biotechnology and full time PhD courses. The objective of the courses is to mold our students with all the technical skills needed for employment in the diverse areas of biotechnology, especially industry and research based careers. The curricula of the programs provide an equal weightage to the core principles of biological sciences, computational analysis and process engineering principles applied to biotechnology. Flexibility in the course curriculum is offered by means of providing minor specialization in the areas of environmental and pharmaceutical biotechnology. Being a multidisciplinary campus, the students have the advantage of conducting research in frontier areas of core life sciences, pharmaceutical sciences and medical biotechnology in the constituent institutions of MAHE.

Equipped with a total of thirteen laboratories, the department offers hands-on experience in most aspects of biotechnology. This course has been designed to provide the students with both theoretical knowledge and practical skills to keep pace with latest developments and to cater to the needs of industrial biotechnology sector. As regards the faculty composition, nearly 95% of our faculty members are doctorates and the rest are actively pursuing the same. The core competencies of our faculty lie in the fields of environmental biotechnology, bioinformatics, drug delivery, biopolymers, biofuels, animal and plant tissue culture.

> Programs offered

Undergraduate Program

- B.Tech in Biotechnology (2005)

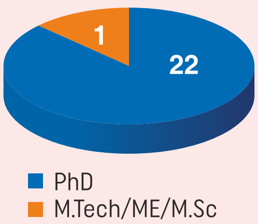
Postgraduate Program

- M.Tech in Industrial Biotechnology (2009)
- M.Sc Computational Molecular Sciences (2025 -2026)

PhD

> Faculty Strength

Qualification-wise



Cadre-wise

B.TECH. BIOTECHNOLOGY

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2124	Engineering Mathematics - III	2	1	0	3	MAT 2224	Engineering Mathematics - IV	2	1	0	3
	BIO 2121	Biochemistry	3	0	0	3	BIO 2221	Chemical and Biochemical Engineering Thermodynamics	2	1	0	3
	BIO 2122	Microbiology	3	0	0	3	BIO 2222	Downstream Processes - I	2	1	0	3
	BIO 2123	Celland Molecular Biology	3	0	0	3	BIO 2223	Genetic Engineering	3	0	0	3
	BIO 2124	Fluid Flow Operations	2	1	0	3	BIO 2224	Principles of Heat and Mass Transfer	2	1	0	3
	BIO 2125	Bioprocess Calculations	2	1	0	3	BIO 2225	Immunology	3	0	0	3
	BIO 2141	Biochemistry Lab	0	0	3	1	BIO 2241	Unit Operations Lab	0	0	6	2
	BIO 2142	Microbiology Lab	0	0	6	2	BIO 2242	Molecular Biology and Genetic Engineering Lab	0	0	6	2
			15	**3**	**9**	**21**			**14**	**4**	**12**	**22**
	Total Contact Hours (L + T + P)		**27**				**Total Contact Hours (L + T + P)**		**30**			
	FIFTH SEMESTER						**SIXTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	HUM 3021	Engineering Economics and Financial Management	2	1	0	3	HUM 3022	Essentials of Management	2	1	0	3
	BIO 3121	Bioinformatics	3	0	0	3	BIO 3221	Animal and Plant Biotechnology	3	0	0	3
	BIO 3122	Bioprocess Engineering	2	1	0	3	BIO 3222	Bioethics and Intellectual Property Rights	3	0	0	3
	BIO 3123	Bioreaction Engineering	2	1	0	3	BIO ****	Program Elective - I / Minor Specialization	3	0	0	3
	BIO 3124	Downstream Processes - II	2	1	0	3	BIO ****	Program Elective - II / Minor Specialization	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective - 2	3	0	0	3
	BIO 3141	Bioinformatics Lab	0	0	3	1	BIO 3241	Bioreaction Engineering and Cell Culture Lab	0	0	6	2
	BIO 3142	Downstream Processing and Bioprocess Engineering Lab	0	0	6	2	BIO 3242	Modeling and Simulation Lab	0	0	3	1
			15	**3**	**9**	**21**			**18**	**0**	**9**	**21**
	Total Contact Hours (L+T+P)		**27**				**Total Contact Hours (L+T+P)**		**27**			
	SEVENTH SEMESTER						**EIGHTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
IV	BIO ****	Program Elective - III / Minor Specialization	3	0	0	3	BIO 4291	Industrial Training				1
	BIO ****	Program Elective - IV / Minor Specialization	3	0	0	3	BIO 4292	Project Work				12
	BIO ****	Program Elective - V	3	0	0	3	BIO 4293	Project Work (B.Tech Honours)**				20
	BIO ****	Program Elective - VI	3	0	0	3	BIO ****	B.Tech Honours (Theory 1)** (V Semester)				4
	BIO ****	Program Elective - VII	3	0	0	3	BIO ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	*** ****	Open Elective - 3	3	0	0	3	BIO ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	BIO 4191	Mini Project (Minor Specialization)*				8						
			18	**0**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P)		**18**				**Total Contact Hours (L+T+P)**		**13**			

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

MINOR SPECIALIZATIONS

I. ENVIRONMENTAL BIOTECHNOLOGY

BIO 4401: Bioremediation
BIO 4402: Biological Treatment of Wastewater
BIO 4403: Biofuels Engineering
BIO 4404: Solid Waste Management

II. PHARMACEUTICAL BIOTECHNOLOGY

BIO 4405: Biomaterials & Drug Delivery Engineering Principles
BIO 4406: Biopharmaceutical Engineering
BIO 4407: Biological Therapeutics
BIO 4408: Molecular Modeling & Drug Design

OTHER PROGRAM ELECTIVES

BIO 4441: Bioprocess Control
BIO 4442: Bioprocess Equipment Design
BIO 4443: Bioprocess Modelling and Simulation in Biotechnology
BIO 4444: Biostatics and Design of Experiments
BIO 4445: Computational Biology
BIO 4446: Food process Engineering and Technology
BIO 4447: Genomics and Proteomics
BIO 4448: Health Diagnostics
BIO 4449: Metabolic Engineering
BIO 4450: Protein Engineering

Open Electives

BIO 4311: Introduction to Bioinformatics
BIO 4312: Body, Mind, and Medicine
BIO 4313: Bioinspired Design for Engineers

THIRD SEMESTER

MAT 2124: ENIGINEERING MATHEMATICS III [2 1 0 3]

Periodic Functions, odd and even functions, Euler's formulae. Half range expansions, Harmonic analysis. Fourier integrals & transforms, Parseval's identity. Functions of complex variable. Analytic function, C-R equations, differentiation, Integration of complex function, Cauchy's integral formula. Taylor's and Laurent Series, Singular points, Residues, Cauchy's residue theorem. Conformal mappings, bilinear transformations. Gradient, divergence and curl, their physical meaning and vector identities. Line, surface and volume integrals. Green's theorem, divergence and Stokes' theorem, applications. Formation, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of Variables. Derivation of one dimensional wave equation (vibrating string) and its solution by using the method of separation of Variables. D'Alembert's solution of wave equation. Derivation of one dimensional heat equation using Gauss divergence theorem and solution of one dimensional heat equation. Solution by separation of variables.

References:

1. Eewin Kreyszig, Advanced Engineering Mathematics, (7e),1993, John Wiley & Sons, Inc.
2. Murray R.Spiegel : Vector Analysis, (2e), 2009, Schaum Publishing Co.
3. Grewal. B.S: Higher Engg. Mathematics, (43e), 2014, Khanna Publishers.
4. Ramana B.V., Engineering Mathematics, (2e), 2007, Tata McGraw Hill Publishing Company limited.

BIO 2121: BIOCHEMISTRY [3 0 0 3]

Introduction to Biochemistry, Scope, and objectives. Carbohydrates: Classification, general properties in reference to glucose, cyclic structure mutarotation, biological importance of monosaccharides, disaccharides and polysaccharides, interconversion of sugars, Lipids: classification of lipids, simple lipids, compound lipids, derived lipids, miscellaneous - with examples. Types of fatty acids. Biosynthesis and degradation of fatty acids, Proteins: classification, structure, and properties of amino acids, structure of proteins, secondary, tertiary, and quaternary structure, nature and function of enzymes, Km and Vmax. Interconversion of amino acids, Nucleic acids: Structure of Nucleic acids – DNA, RNA, biosynthesis and degradation of purines and pyrimidines, inborn errors of metabolism and associated disorders.

References:

1. Albert L Lehninger. Principles of Biochemistry. 8th edition W.H. Freeman, 2021
2. Donald Voet. Biochemistry. John Wiley & Sons, 5th edition, 2018
3. Stryer. Biochemistry. 9th edition, W.H.Freeman & Co Ltd, 2019

BIO 2122: MICROBIOLOGY [3 0 0 3]

Introduction to Microbiology, Scope and objectives. Microbial diversity and taxonomy: Prokaryotes and Eukaryotes, Types of Microorganisms, Bacteria, Viruses, Fungi, Protozoans & Helminthes, Microbiological Techniques: Study of microscopes, Sterilization Techniques, Structure, Functions and Replication of Microorganisms: Bacteria, Viruses, Fungi, Algae, Protozoans, Medical Microbiology: Common diseases caused by microbes, Microbial insecticides, enzymes: Bacillus thuringinesis, Sphaericus, Popilliae, Baculoviruses, Food industry: Microbial spoilage of food and its control; food preservatives

References:

1. Michael Pelczar, Jr. Microbiology, 5th Edition, McGraw Hill Education, 2001.
2. Dorothy Wood, Joanne Willey, Kathleen Sandman. Prescott's Microbiology, 12th Edition, McGraw Hill Education, 2022

BIO 2123: CELL AND MOLECULAR BIOLOGY [3 0 0 3]

Introduction to cells: Cell organelles, Membrane structure, Visualizing cells by fluorescence microscopy. Cytoskeleton: Structure of cytoskeletal filaments, Assembly of tubulin and actin subunits to create polar filaments. Regulation of cytoskeletal filaments. Molecular motors. Cell behavior in relation to cytoskeleton. Central Dogma. Control of gene expression: DNA-binding motifs of gene regulatory proteins. Molecular genetic mechanisms that create specialized cell types. Mechanisms and principles of cell communication. Cell cycle and its regulation: Brief introduction to cell cycle. Cell cycle control system. Apoptosis. Cancer. Specialized tissues, stem cells and tissue renewal: Epidermis and its renewal by stem cells, Blood vessels, lymphatics and endothelial cells, Renewal by multipotent stem cells. Blood cell formation, Genesis, modulation, and regeneration of skeletal muscle.

References:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (Eds). Molecular Biology of the cell. (5e), Garland Science, 2008
2. Harvey Lodish, Arnold Ber, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. Molecular cell biology. (8e), Scientific American Books, W. H. Freeman, New York, 2016

BIO 2124: FLUID FLOW OPERATIONS [2 1 0 3]

Review of fluid statics, fluid dynamics, Types of flow; Newtonian and non-Newtonian fluids; Shear stress; Viscosity; Classification of fluids. Basic equations of fluid flow – continuity equation, Bernoulli's equation, Flow rate and velocity measurements- Orifice, Venturimeter and Pitot tube. Reynolds number and friction factor, Hagen Poiseuille equation. Flow through a bed of solids – Ergun, Kozeny Carmen and Blake Plumer equation. Agitation and mixing of liquids.

References:

1. McCabe & Smith. 2017. Unit Operations of Chemical Engineering. 7th Edition. McGraw Hill
2. Yunus A Cengel, John M Cimbala. 2018. Fluid Mechanics-Fundamentals and applications, 4th Edition. McGraw Hill.
3. Christie John Geankoplis. 2015. Transport Processes and Separation Process Principles (Includes Unit Operations) 4th Edition. Pearson.
4. Badger and Banchero. 1995. Introduction to Chemical engineering. McGraw Hill.

BIO 2125: BIOPROCESS CALCULATIONS [2 1 0 3]

Bioprocess Development: An Interdisciplinary Challenge, Biotechnology and Bioprocess Engineering, Introduction to Engineering Calculations, Physical Variables, Dimensions and Units, Unit conversion, Presentation and Analysis of Data, plotting graphs using excel, Steady state material balances, Law of Conservation of Mass, Material Balances with Recycle, By-Pass and Purge Streams, Stoichiometry of microbial growth and product formation, Basic Energy Concepts, Intensive and Extensive Properties, General Energy-Balance Equations, Procedure For Energy-Balance Calculations Without Reaction, Energy-Balance Equation For Cell Culture.

References:

1. Pauline Doran. 1995. Bioprocess Engineering Principles. Academic Press.
2. David M. Himmelblau 1989 Basic Principles and Calculations in Chemical Engineering. Prentice Hall of India (P) Ltd.

BIO 2141: BIOCHEMISTRY LAB [0 0 3 1]

This laboratory deals with both qualitative and quantitative analysis of biomolecules such as carbohdrates, proteins, lipids and nucleic acids. The estimation of carbohydrates is done qualitatively by Osazone test and the reducing sugars are analysed using Dinitrosalicylic acid (DNS) method. Besides, the estimation of glucose is done by both DNS method as well as by enzymatic (GOD/POD) method. Simple polysaccharides such as starch is estimated by Iodine method. The specific activity of amylase is also done. Proteins are estimated by Lowry's and Bradford's methods. Amino acids are estimated by Sorenson'stitrimetric method. Estimation of cholesterol by Zak's method, and spectrophotometric detection of DNA/RNA are also introduced.

References:

1. David T Plummer Introduction to Practical Biochemistry. Mc Graw Hill Publication 2017
2. Keith Wilson and Walker Principles and Techniques of Practical Biochemistry. Cambridge University Press 2000.

BIO 2142: MICROBIOLOGY LAB [0 0 6 2]

Experiments are based on the preparation of broth and agar media for the growth of bacterial species. Pure culture techniques (streak, pour and spread) are taught to isolate and sub-culture a specimen obtained from natural sources. Experiments are also designed to learn how to stain and view different types of microbes using a compound microscope. A basic set of biochemical tests are also performed to identify and differentiate between certain microbial classes. A biochemical test is also conducted to check the extent of contamination of a milk sample.

References:

1. James G. Cappuccino, Chad Welsh, Microbiology A Laboratory Manual, 11th Global Edition, Pearson, 2017
2. Ronald M. Atlas. Handbook of Microbiological Media, 4th Edition, CRC Press, 2010

FOURTH SEMESTER

MAT 2224: ENIGINEERING MATHEMATICS IV [2 1 0 3]

Formation of Linear Programming problem, Graphical method, Simplex method, Penalty cost and two-phase methods. Finite sample spaces, conditional probability and independence, Bayes' theorem. One dimensional random variable, mean, variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least squares principles of curve fitting. Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential. Finite difference expressions for first and second order derivatives (ordinary and partial). Solution of BVP's in ODE. Classification of second order linear partial differential equations. Numerical solutions of two-dimensional Laplace and Poisson equations by standard five-point formula. Solution of one-dimensional heat and wave equations by explicit methods. Crank-Nicolson method. Finite element method, Introduction, simple applications. Difference equations representing physical systems, the z transforms, properties of z transforms, initial and final value theorems, solution of difference equations by the method of z transforms, convolution theorem.

References:

1. Eewin Kreyszig, Advanced Engineering Mathematics, (7e), 1993, John Wiley & Sons, Inc.
2. Meyer P.L., Introduction to probability and Statistical applications, (2e), 1970, American Publishing Co.
3. Hamdy A Taha - Operation research, (7e), 2002, Pearson Education, Inc.
4 Grewal B.S - Higher Engineering Mathematics, (43e), 2014, Khanna Publishers.
5. Sastry S.S - Introductory methods for Numerical Analysis, (5e), 2012, PHI Learning Private Limited.

BIO 2221: CHEMICAL AND BIOCHEMICAL ENGINEERING THERMODYNAMICS [2 1 0 3]

Introduction – Scope and definition, First law of Thermodynamics, Joule and Joule-Thomson Coefficient. Definition of enthalpy, different thermodynamic processes, Second law of thermodynamics – Statements of second law, Carnot's engine, entropy, entropy change of ideal gas. Thermodynamic properties of fluid – Property relations for homogenous phases, Solution thermodynamics – Fundamental property relation, Chemical potential and Phase Equilibria, Partial molal properties. Ideal gas mixtures, Fugacity, Activity, residual and excess properties. Single component two phase system, two component phase equilibrium. Chemical reaction equilibrium – Reaction Co-ordinate, Standard Gibb's Energy change and Equilibrium constant. Colligative Properties of solutions: freezing point depression, boiling point elevation, Vapor pressure lowering, osmotic pressure. Thermodynamics of Biochemical reactions – Free energy calculations

References:

1. J. M. Smith, H.C. Van Ness and M.M. Abbott. Introduction to Chemical Engineering Thermodynamics, McGraw Hill International (7e) 2010
2. Silbey, Alberty, Bawendi.Physical Chemistry, Wiley India (4e), 2004
3. Donald T. Haynie. Biological Thermodynamics,Cambridge University Press, 2001

BIO 2222: DOWNSTREAM PROCESSES-I [2 1 0 3]

Fundamentals of downstream processing, High-value & Low-value bioproducts, Cell Disruption & Types, Flocculation, Sedimentation, Centrifugation & Types, Filtration, Membrane-based separation, Ultrafiltration, Reverse Osmosis, Precipitation with Salts, Organic solvents, Fundamentals of Extraction, Types, Reverse Micellar, Super-critical fluid Extraction.

References:

1. B. Sivasankar. Bioseperations: Principles and Techniques. PHI Learning Pvt. Ltd., 2006
2. Raja Ghosh, Principles of Bioseparations Engineering. World Scientific Publishing Company., 2006.
3. Belter P.A., Cussler E. and Wei Shan Hu. Bioseparation – Downstream processing for Biotechnology. Wiley Interscience Pub, 1988.

BIO 2223: GENETIC ENGINEERING [3 0 0 3]

Structure and Organization of Nucleic Acids. DNA Repair, Mutagenesis and Mutations: Biochemical mechanisms of DNA Repair, Types of Mutations. Basics of Recombinant DNA Technology: Introduction to cloning, vectors. Enzymes in Genetic Engineering. Nucleic Acid Hybridization and DNA Libraries: Production and Labelling of Gene Probes, Southern and Northern Blotting, in situ hybridization, Construction of Genomic and cDNA libraries, Screening approaches. Molecular Analysis and Amplification Methods: PCR, RFLP, RAPD, RACE. Applications of Recombinant DNA Technology: SNPs, VNTRs and their application, CRISPR-CAS, Methods of DNA Transfection to plants and animals, Gene Therapy, Recombinant vaccines, DNA Vaccines, in vivo Expression Technology.

References:

1. David Friefelder. Molecular Biology. Jones and Bartlett Publishers Inc., 1987
2. Jocelyn E. Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick. Lewin's Genes XII. Jones and Bartlett Publishers Inc., 2017
3. James D. Watson, Michael Gilman, Jan A. Witkowski, Mark Zoller. Recombinant DNA. W. H. Freeman, 1992
4. Sandy B. Primrose, Richard M. Twyman and Robert W. Old. Principles of Gene Manipulation. Wiley-Blackwell Publishers, 2002
5. Desmond S.T. Nicholl. Introduction to Genetic Engineering. Cambridge University Press, 2012
6. T. A. Brown. Gene Cloning and DNA Analysis: An Introduction. Wiley-Blackwell, 2010

BIO 2224: PRINCIPLES OF HEAT AND MASS TRANSFER [2 1 0 3]

Various modes of heat transfer, Conduction –Fourier's law, Convection – Natural and forced convection Co-current and countercurrent types of flow, LMTD, overall coefficient determination of film coefficients, Heat transfer with phase change, Radiation; Diffusion, Mass transfer and its significance, Fick's law of diffusion and Concept of mass transfer coefficients; two film theory and mass transfer resistance; dimensionless numbers, Stagewise contacting of phases- single, cross current and countercurrent, Gas absorption, Vapor Liquid Equilibrium (VLE), Flash distillation.

References:

1. Pauline M. Doran, “Bioprocess Engineering Principles”, Academic Press, 1995
2. Robert E. Treybal, “Mass Transfer Operations”, McGraw-Hill, 1980
3. Mc Cabe, Smith and Peter Harriott, Unit Operation of Chemical Engineering, McGraw Hill Publisher, 7th Edition, 2017

BIO 2225: IMMUNOLOGY [3 0 0 3]

Introduction to Immunotechnology, Scope and objectives, The Immune System Innate: Introduction to Innate Lymphatic circulation, Inflammation, Complement System, The Immune System Adaptive: Adaptive Antigen presenting cells, Langerhans cells- their origin, B-cell Immunity- classes and subclasses, Genetic control of antibody types, Immune diseases and detection methods Autoimmunity, Infections, FACS, western blotting, Immunofluorescence, RIA, ELISA, Chemiluminescence.

References:

1. Charles A. Janeway, Paul Travers, Mark Walport, Mark Shlomchik. Immunobiology: The Immune System in Health & Disease. Sixth Edition, 2005
2. Roitt I. Essential Immunology. Blackwell Scientific Publications, 1991
3. Richard Goldsby, Thomas J. Kindt, Barbara A. Osborne. Kuby Immunology. 2006

BIO 2241: UNIT OPERATIONS LAB [0 0 6 2]

Unit operations laboratory curriculum comprises of experiments based on fluid flow and heat transfer. Fluid flow experiments are based on flow measurement, flow dynamics in pipes and fittings and particle dynamics under fluid flow. Heat transfer experiments aim to estimate heat transfer coefficients and thermal conductivity of metals and insulators.

References:

1. Pauline M. Doran. Bioprocess Engineering Principles, Academic Press, 1995
2. McCabe & Smith. Unit Operations of Chemical Engineering. McGraw Hill, 1993

BIO 2242: MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB [0 0 6 2]

Molecular Biology and Genetic Engineering Lab (Space or gap is needed Biology and Genetic. Currently in the given handbook it is mentioned as Molecular Biologyand Genetic Engineering Lab)

References:

1. Sandy B. Primrose, Richard M. Twyman and Robert W. Old. Principles of Gene Manipulation, Wiley-Blackwell Publishers, 2002
2. Benjamin Lewin. Genes VII. Oxford University Press, 2003

FIFTH SEMESTER

HUM 3021: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of Single, Uniform, and Gradient cash flow. Related problems and case studies. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, declining and double declining balance method of depreciation, Sum-of-the-Years Digits, Sinking Fund and Service Output Methods, Case Study. Balance sheet and profit & loss statement. Meaning & Contents. Ratio analysis, financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios, Drawbacks. Safety and Risk, Assessment of Risk and safety, Case study, Risk Benefit Analysis and Reducing Risk.

References:

1. Chan S. Park, "Contemporary Engineering Economics",Pearson Prentice Hall (2007).
2. Thuesen G. J, “Engineering Economics”, Prentice Hall of India, New Delhi (2005).
3. Blank Leland T. and Tarquin Anthony J., “Engineering Economy”, McGraw Hill, Delhi (2002).
4. Prasanna Chandra, “Fundamentals of Financial Management”, Tata McGraw Hill, Delhi (2006).

BIO 3121: BIOINFORMATICS [3 0 0 3]

Bioinformatics overview; Computational biology and bioinformatics; The digital code of life; Introduction to biological sequence databases; The evolutionary basis of sequence alignment; Detecting ORFs; protein Vs nucletotide sequence alignment; Global and Local alignments; Substitution Matrices; Gaps and Gap penalties; Dynamic programming algorithm; Statistical and Biological significance; Introduction to computational biology; Multiple Sequence Alignment; sequence assembly: Overlap-Layout-Consensus approach; Repetitive elements, assembly issues; PCR Primer Design; Gene finding; Graph theory; chemical graphs and amino acid comparisons; Hierarchial levels of macromolecules; Special structures of nucleic acids, Motifs and domains; symmetry of proteins; HP-lattice model; Secondary structure; Molecular visualization; Protein structure-function relationships; Protein modeling; Structure validation; Evolution; Morphology based cladogram; Building Phylogenetic Trees; Phylogenetic Networks; Bioinformatics: future aspects

References:

1. David W Mount. 2004. BIOINFORMATICS: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press
2. Andreas D Baxevanis, Gary D. Bader, David S. Wishart. 4th Edn, 2020. BIOINFORMATICS. Wiley Interscience.

BIO 3122: BIOPROCESS ENGINEERING [2 1 0 3]

Introduction to Enzymes and Enzyme catalyzed reactions: Nature and function of enzymes, Michaelis-Menten Equation – derivations, types of enzyme inhibition, kinetics. Media Design and Sterilization: Fermentation processes, Medium requirements for fermentation processes - examples of simple and complex media, Batch and continuous heat sterilization. Transport Phenomena in Bioreactors: Immobilization methods, Immobilized enzyme/cell kinetics: effectiveness factor derivations; Oxygen transfer in submerged fermentation processes: OTR, OUR calculations, kLa estimations. Kinetics of Microbial Growth and Product Formation: Microbial cell kinetics, Monod model; Growth associated and non-growth associated product formation kinetics.

Reference:

1. Michael L Shuler and Fikret Kargi. 2008. Bioprocess Engineering: Basic Concepts. Prentice-Hall of India Pvt Ltd.
2. Pauline M. Doran. 2012. Bioprocess Engineering Principles. 2nd Edition. Academic Press.
3. PF Stanbury, S. Hall, A. Whitaker. 2017. Principles of Fermentation Technology. 3rd Edition, Elsevier Science Publishers.
4. Levenspiel, O. 2006. Chemical Reaction Engineering. 3rd Edition. John Wiley.

BIO 3123: BIOREACTION ENGINEERING [2 1 0 3]

Reaction Kinetics: Rate equation, elementary, non-elementary reactions and kinetic modeling, Analysis of experimental batch reactor data-integral and differential analysis, Ideal Reactors: Design for homogeneous reaction system-batch, stirred tank and plug flow reactors, Multiple reactor system-size comparison, recycle reactor, Bioreactor Design and Analysis: Batch reactor performance with Monod cell growth kinetics, Chemostat performance analysis with Monod kinetics, Fed-batch reactor, Non-ideal reactors: Residence time distribution (RTD), E & F-curves, RTD for ideal CSTR and PFR, Macro and Micro fluids, Conversion in non-ideal flow reactors

References:

1. Octave Levenspiel. Chemical Reaction Engineering. John Wiley & Sons, 3rd edition,2003
2. Harvey W.Blanch and Douglas S. Clark. Biochemical Engineering CRC Press, 1997
3. Michael L Shuler and Fikret Kargi. Bioprocess Engineering: Basic Concepts. Prentice-Hall of India Pvt Ltd.2008

BIO 3124: DOWNSTREAM PROCESSING-II [2 1 0 3]

Theories of adsorption – Adsorption isotherms and calculations, and models, adsorption in fixed beds, Pressure Swing Adsorption (PSA); Chromatography – principles of chromatographic separation and Plate theory, HPLC and GC, Various types of Chromatographic practices, Retention time, Capacity, band broadening, Size exclusion, Ion Exchange and Affinity chromatography; Electrophoresis; Crystallization, Supersaturation, Yield Calculation, Meir's and Oswald's Theorems; Drying-theory, Equilibrium and batch drying curve, calculations.

References:

1. Roger Harrison, Paul Todd, Scott Rudge and Demetri Petrides, Bioseparations Science and Engineering, Oxford University Press, 2nd Edition, 2003
2. Belter P.A., Cussler E. and Wei Shan Hu. Bioseparation – Downstream processing for biotechnology, Wiley Interscience Pub, 1988.
3. Asenjo J. and Dekker M, Separation Processes in Biotechnology, CRC Press, 2020.
4. McCabe & Smith, Unit Operations of Chemical Engineering, McGraw Hill Inc, 7th Edition , 2017
5. R.E. Treybal, Mass transfer, McGraw Hill, 1981

BIO 3141: BIOINFORMATICS LAB [0 0 3 1]

This laboratory introduces a pragmatic approach on sequence retrieval, alignment, and analysis such as similarity search including pairwise and multiple alignment, basics of PERL programming, primer design, molecular phylogeny with various algorithms such as NJ, UPGMA, FM & ME, secondary structure prediction, structure visualization and analysis, structure alignments to explore homology as well as distant relationship, protein homology-based modeling, and structure validations.

References:

1. David W Mount. 2004. BIOINFORMATICS: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press
2. Andreas D Baxevanis, Gary D. Bader, David S. Wishart. 4th Edn, 2020. BIOINFORMATICS. Wiley Interscience.

BIO 3142: DOWNSTREAM PROCESSING AND BIOPROCESS ENGINEERING LAB [0 0 6 2]

Experiments are based on aqueous two phase based separation, extraction of intracellular proteins, precipitation of proteins, ultrafiltration, separation of solids from slurry using leaf filter and sedimentation. In Bioprocess Engineering lab experiments are based on estimation of enzyme kinetics, optimum temperature, pH and evaluation of the type of inhibition during enzyme catalyzed reactions.

References:

1. Cussler, E. L., et al. Bioseparations : downstream processing for biotechnology. United Kingdom, Wiley, 1988.
2. Asenjo, Juan A.. Separation Processes in Biotechnology. United States, CRC Press, 2020.
3. Michael L Shuler and FikretKargi. Bioprocess Engineering: Basic Concepts. Prentice-Hall of India Pvt Ltd 2008.

SIXTH SEMESTER

HUM 3022: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Definition of management and systems approach, Nature & scope. The Functions of managers, Principles of Management. Planning: Types of plans, steps in planning, Process of MBO, how to set objectives, strategies, policies and planning premises, Strategic planning process and tools. Nature and purpose of organizing, Span of management, factors determining the span, Basic departmentation, Line and staff concepts, Functional authority, Art of delegation, Decentralization of authority. HR theories of planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership – leadership behavior & styles, Managerial grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit and Loss control, Control through ROI, Direct, Preventive control. PROFESSIONAL ETHICS - Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories about right action, Self-interest, Customs and Religion, Uses of Ethical Theories. GLOBAL ISSUES - Managerial practices in Japan and USA & application of Theory Z. The nature and purpose of international business & multinational corporations, unified global theory of management, Entrepreneurship and writing business plans. Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisers, Moral Leadership, Code of Conduct, Corporate Social Responsibility.

References:

1. Harold Koontz & Heinz Weihrich, Essentials of Management, McGraw Hill, New Delhi(2020).
2. Peter Drucker, The practice of management, Harper and Row, New York(2004).
3. Vasant Desai, Dynamics of entrepreneurial development & management, Himalaya Publishing House(2007).
4. Poornima M Charantimath, Entrepreneurship Development, Pearson Education (2006).

BIO 3221: ANIMAL AND PLANT BIOTECHNOLOGY [3 0 0 3]

Animal and Plant Biotechnology (Space or gap is needed Animal and. Currently in the given handbook it is mentioned as Animal and Plant Biotechnology)

Reference:

1. Dixon R.A. and Gonzales. Plant Cell Culture: A Practical Approach, IRL Press. 1995
2. Lindsey K. and Jones M.G.K. Plant Biotechnology in Agriculture, Prentice Hall, 1990
3. Singh K. Intellectual property rights on biotechnology, BCIL, New Delhi, 2001
4. M.Butler -Animal Cell Culture and Technology' Second Edition (2004) BIOS Scientific Publisher, New York.
5. R Ian Freshney Culture of animal cells: A manual of Basic techniques and Specialized applications, Wiley Blackwell Press

BIO 3222: BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS [3 0 0 3]

Biotechnology and Bioethics, Hazardous materials, Handling and disposal, Good laboratory practice, regulatory guidelines for biotechnology research, ethical concerns and issues in biological research, Intellectual Property Rights, various types, protecting IPR, Patent, types, Patent system in India and United States of America, Filing of patent application, Patenting in biotechnology and biopharma, Patenting life forms, Copyright, Trademark, Trade secrets, Geographical Indications, Protection of traditional knowledge

Reference:

1. Ashok K. M., & Mohd I. A., (2008). Intellectual property rights, 1st ed., Serials Publications New Delhi.
2. Campbell A. V., (2013). Biothics: The Basics, Routledge (Taylor and Francis group). London and New York
3. Padma Nambisan (2017). An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology. Academic Press, London
4. Richard Stim A., (2014). Patent, Copyright and Trademark: An Intellectual property desk reference. 13th ed. Sheridan, USA
5. Vallero D. A., (2007). Biomedical ethics for Engineers. Academic Press, London

BIO 3241: BIOREACTION ENGINEERING AND CELL CULTURE LAB [0 0 6 2]

Bioreaction Engineering laboratory experiments are based on the growth kinetics of bacterial species in a shake flask and fed-batch cultures with various carbon sources. Also experiments are designed to evaluate the performance of various bioreactors such as stirred tank reactor (STR) and fluidized bed reactor (FBR) and packed bed reactor (PBR) with immobilized enzymes. In cell culture, lab experiments are based on culture media preparation and the growth of animal and plant cells.

References:

1. Octave Levenspiel. Chemical Reaction Engineering. John Wiley & Sons, (3e), 2003
2. Harvey W. Blanch and Douglas S. Clark. Biochemical Engineering, CRC Press, 1997
3. John Villadsen. Bioreaction Engineering Principles. (3e), springer publishers 2011.
4. Dixon R.A. and Gonzales. Plant Cell Culture: A Practical Approach, IRL Press. 1995
5. Lindsey K. and Jones M.G.K. Plant Biotechnology in Agriculture, Prentice Hall, 1990

BIO 3242: MODELING AND SIMULATION LAB [0 0 3 1]

In Bioprocess control lab experiments are designed to study about the controllers (P, PI, PD & PID), advanced control system, control valves, first order system & second order system (inherent/multi capacity processes) with different inputs which usually appears in the process industries.

References:

1. Gonzales, R. A., and Dixon, R. A.. Plant Cell Culture: A Practical Approach. United States, Oxford University Press, 2004.
2. Lindsey, K.. Plant Biotechnology in Agriculture. N.p., Richard Dennis Publications, 1991.
3. Shuler, Michael L., and Kargi, Fikret. Bioprocess Engineering: Basic Concepts. India, Pearson., 2015.

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

BIO 4291: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

BIO 4292: PROJECT WORK/PRACTICE SCHOOL

The project work may be carried out in the institution/industry/ research laboratory or any other competent institution. The duration of the project work shall be a minimum of 16 weeks, which may be extended to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. A student must make a presentation on the work carried out before the department committee as part of project evaluation.

MINOR SPECIALIZATIONS

I. ENVIRONMENTAL BIOTECHNOLOGY

BIO 4401: BIOREMEDIATION [3 0 0 3]

Introduction: Advantages & disadvantages of bioremediation; Microbial ecology and metabolism: Factors influencing Growth and Biodegradation, Modelling Growth & Biodegradation, Redox reactions, Metabolism of Organic & Inorganics, Phototrophic Metabolism, Cometabolism; Mechanisms of Biodegradation: Biodegradation of Hydrocarbons, Halogenated Aliphatics& Aromatics; Bioremediation processes: In situ Remediation of Aquifers & Soils, Solid Phase Bioremediation – Land Treatment & Composting, Slurry-Phase & Vapor phase Bioremediation – Biofilters & Biotrickling filters; Biotreatment of Metals: Microbial Transformation of Metals; Bioleaching; Phytoremediation: Phytoremediation of organics, metals & inorganics, Phytoextraction, Rhizofiltration, Phytostabilization

References:

1. Martin Alexander, "Biodegradation and Bioremediation", Academic press. 1999
2. John. T. Cookson, Jr., "Bioremediation engineering; design and application" McGraw Hill, Inc. 1995
3. Eweis, Ergas, Chang and Schroeder. "Bioremediation Principles" McGraw-Hill Series in Water Resources and Environmental Engineering, 1998

BIO 4402: BIOLOGICAL TREATMENT OF WASTE WATER [3 0 0 3]

Need for wastewater treatment; Characterization of wastewater-Biological- BOD, COD, TOC, MPN, and Bacterial count; BOD kinetic parameter fitting by Least square, Fujimoto, Daily difference, Thomas and Moments-Methods; Physical characterization such as solids, Turbidity, and Chemical characterizations. Bacterial metabolism in treatment, Decomposition of organic compounds in Ecosystem, Biology, Mass energy balance for Aerobic respiration, and Anaerobic respiration, General considerations for Aerobic Vs. Anaerobic treatment, Kinetic aspects, Hydrolysis of cellulose-biological aspects, Anaerobic degradation of lignocellulose and cellulose, proteins, fats; Various types of anaerobic treatment reactors-UASB and its variations, calculation of biogas by Buswell equation, Nitrification and denitrification processes, and Anammox process, Biological Phosphorus removal processes.

References:

1. Metcalf and Eddy.Wastewater Engineering - Treatment, Disposal and Reuse. Tata McGraw Hill Publishing Co. Ltd, 1991
2. Rao C.S.Environmental Pollution Control Engg. New Age International (P) Ltd. Publishers, 1991
3. Jordening H.J. and Winter J. Environmental Biotechnology: Concepts and Applications. Wiley-VCH Verlag GmbH & Co., 2005

BIO 4403: BIOFUELS ENGINEERING [3 0 0 3]

Various feedstock for different kinds of Biofuels; Biochemical pathways; Life Cycle Analysis (LCA) of various biofuels, Various process technologies for bioethanol production; Microorganism selection; Comparison of various bioethanol processes; Biodiesel from Seeds and Waste cooking oils, Acid base, enzyme catalyzed transesterification process; Biodiesel from Microalgae and various contemporary technologies and their comparisons; Hydrogen production by enzymes and various microorganisms, Inhibition effects of Hydrogen production; Biogas production from various sources and process technologies

References:

1. Caye M. Drapcho, Nghiem PhuNhuan and Terry H. Walker, "Biofuels Engineering Process Technology", Mc Graw Hill Publishers, New York, 2008
2. Jonathan R.Meilenz (Ed.), "Biofuels – Methods and Protocols (Methods in Molecular Biology Series)", Humana Press, New York, 2009
3. Lisbeth Olsson (Ed.). "Biofuels (Advances in Biochemical Engineering/Biotechnology Series)", Springer-Verlag Publishers, Berlin, 2007

BIO 4404: SOLID WASTE MANAGEMENT [3 0 0 3]

Introduction to solid waste management: Waste generation in technological society, integrated solid waste management; Types and Composition of solid wastes; Physical, chemical and biological properties of MSW; Properties and classification of Hazardous wastes; transformations of Hazardous waste constituents found in MSW. Collection of solid waste, Separation and Processing and Transformation of solid waste, Transfer and Transport, Disposal of solid wastes and residual matter; Biological and chemical conversion technologies: Solid waste management and planning issues; Implementation of solid waste management options; planning, siting and permitting of waste management facilities.

References

1. Theisen, Hilary, et al. Integrated Solid Waste Management: Engineering Principles and Management Issues. India, McGraw-Hill

Education (India) Private Limited, 2014.

2. William D Robinson, The solid waste handbook: A practical guide, John Willy & sons, 1986.

II. PHARMACUETICAL BIOTECHNOLOGY

BIO 4405: BIOMATERIALS AND DRUG DELIVERY ENGINEERING PRINCIPLES [3 0 0 3]

Properties of materials & classes of materials used in Medicine, Host reaction to biomaterials and their evaluation, testing biomaterials, degradation of materials in the biological environment, application of materials in medicine & dentistry, implants & devices, basics of artificial organs. Introduction to drug administration and drug effectiveness, Diffusion and drug dispersion, diffusion in biological systems, drug permeation through biological barriers, drug transport by fluid motion, pharmacokinetics of drug distribution. Drug delivery systems: drug modification, controlled drug delivery systems. Some case studies in drug delivery.

References:

1. Drug Delivery, W. Mark Saltzman , Oxford University Press, 2001
2. Pharmaceutical Biotechnology, Gary Walsh, Wiley Publication
3. Buddy Ratner, Allan Hoffman, Frederick Schoen, Jack Lemon. Biomaterial Science: An introduction to materials in medicine, Academic press, Elsevier publication, (3e), 2012
4. Joon Park, Lakes R.S. Biomaterials: An Introduction, Springer publication, (3e), 2007
5. Pharmaceutical Biotechnology, K. Sambhamurthy and AshutoshKar, Newage International Pvt Ltd Publisher.2016

BIO 4406: BIOPHARMACEUTICAL ENGINEERING [3 0 0 3]

Introduction – Development of drugs and pharmaceutical industry organic therapeutic agents. Drug Metabolism and Pharmaco-Kinetics – physico chemical principles, radioactivity, action of drug on human bodies. Important Unit Processes and their applications. Manufacturing Principles of different type of tablets. Analytical methods and test for various drugs and pharmaceuticals, packaging techniques – quality control. Health Biotechnology - health care products, edible vaccines, nutrition value of foods. Health bioinformatics - microbes and human health, biotechnology kits to monitor day to day human health.

References:

1. Heinrich Klefenz. Industrial pharmaceutical biotechnology, Wiley-VCH, 2002
2. Susanna Wu-Pong, Yongyut Rojanasakul, and Joseph Robinson. Biopharmaceutical drug and design and development. Humana Press, 2010

BIO 4407: BIOLOGICAL THERAPEUTICS [3 0 0 3]

History of vaccine and immunotherapy development, Antibody based therapeutics, Chimeric antigen receptor engineering and clinical studies, Introduction of molecular biology and history, oligonucleotide therapy (siRNA, miRNA, shRNA, antisense RNA), Development of gene transfer tools – viral and non-viral vectors, Gene therapy for genetic diseases, infectious diseases, Gene therapy clinical trials, Basic concept of cancer treatment and immune response, Cancer vaccines and preclinical studies, Immune checkpoint regulation and cancer treatment, Gene therapy for cancer, Introduction to Stem Cells, Stem cell-based therapies, Ethical considerations.

References:

1. Friedman T. 1999. The Development of Human Gene Therapy. Cold Spring Harbor, NY: Cold Spring Harbor Lab. Press.
2. Knipe DM, Howley PM, eds. 2001. Fields Virology. Philadelphia, PA: Lippincott Williams & Wilkins.
3. Hackett NR, Crystal RG. 2000. Adenovirus vectors for gene therapy. In Gene Therapy, ed. NS Templeton, DD Lasic, pp.17-39. New York: Marcel Dekker
4. Lanza, R., Gearhart, J., Hogan, B., Melton, D., Pedersen, R., Thomas, E.D. and Thomson, J.A. eds., 2005. Essentials of stem cell biology. Elsevier.
5. Owen, J.A., Punt, J. and Stranford, S.A., 2013. Kuby immunology p. 574. New York, NY, USA:: WH Freeman.

BIO 4408: MOLECULAR MODELING AND DRUG DESIGN [3 0 0 3]

General concepts of Pharmacology – Bioavailability, Pharmacokinetic and pharmacodynamics. Drug Design – Computational Drug Discovery, Binding interactions, Lipinski's rule of five (RO5), SMILES, Molecular Descriptors – chemical, topological and geometrical descriptors. Molecular Modeling –1D, 2D and 3D analyses. Computer Simulation Methods – Molecular Dynamics methods, Binding affinity calculations & conformational analysis, QSAR. Design New Molecules – De novo ligand design, Similarity search - Virtual screening, Molecular docking – SNPs and Pharmacogenomics, Toxicology, Clinical trials, Regulatory affairs & Patenting.

References:

1. Leach A.R. Molecular Modelling Principles and Applications. Longman, 2001
2. Haile J.M. Molecular Dynamics Simulation Elementary Methods. J. Wiley and Sons, 1997
3. Patrick, Graham L..An Introduction to Medicinal Chemistry. United Kingdom, OUP Oxford, 2013.

OTHER PROGRAM ELECTIVES

BIO 4441: BIOPROCESS CONTROL [3 0 0 3]

Measurement and signal transmission of process parameters – Flow, Pressure, Temperature, Level, pH, DO, density and viscosity; Mathematical modeling of chemical and bioprocesses; Introduction to Laplace Transforms, Development of Transfer functions. Dynamic behavior of first and second order processes; Introduction to feedback controllers, feedforward and ratio controller, final control elements and controller tuning; Block diagram representation, Stability of closed loop control systems -Routh stability criterion, Root locus diagrams.

References:

1. Seborg D. E., Edgar T.F. and Mellichamp D.A. Process Dynamics and control, John Willey & Sons, 2004
2. Stephanopoulos G. Chemical Process Control: An Introduction to Theory and Practice. Prentice Hall International, 1983
3. Riggs J.B. and Nazmul Karim M.Chemical and bioprocess control. Ferret Publisher, 2008

BIO 4442: BIOPROCESS EQUIPMENT DESIGN [3 0 0 3]

Design of pressure vessels: Codes and standards, Design factors, Classification of pressure vessels; design considerations; design of vessels under internal and external pressure. Design of fermenters: Mixing in Fermenters, Power Requirements for Newtonian, Non-Newtonian broths and Gassed Fluids. Design criteria for batch fermenter, and chemostat. Scale-up of fermenters. Heat Exchanger Design: Type of heat exchangers, energy balances in heat exchanger, Heat transfer in fermenters, and process design of shell and tube heat exchangers.

References:

1. Richardson, and Sinott R.K. Chemical Engineering Vol. 6, J.F. Pergamon Press, 2005
2. Joshi M.V. Process Equipment Design, McMillan India, 2005
3. PF Stanbury, S. Hall, A. Whitaker. 2017. Principles of Fermentation Technology. 3rd Edition, Elsevier Science Publishers.
4. Bjorn K. Lydersen, Nancy A D'elia and Kim L. Nelson. Bioprocess Engineering-Systems, Equipment and Facilities, A Wiley Interscience Publication, 1994
5. Unfired Pressure Vessel Code BIS 2825
6. Code for Shell & Tube heat exchangers BIS 4503
7. Chemical Engineer's Handbook by Perry

BIO 4443: BIOPROCESS MODELLING AND SIMULATION IN BIOTECHNOLOGY [3 0 0 3]

Definition of modeling and simulations detailed applications and limitations; Classification of models and how to build model; Principles of formulation of models; Fundamentals Laws; Energy equations; Exercises in formulation of lumped and distributed parameter models; Several examples involving algebraic equations, ordinary differential equations, and integral equations; Formulation of batch distillation problem with ideal solution law; Draining time for different types of tanks – Formulation and solution; Batch, Semi-batch and continuous bioreactor formulation of models; Structured and unstructured models; Segregated and non-segregated models; Numerical problems; Numerical techniques for the solution of bioprocess models – Gauss-Jacobi and special methods, Method of bisection, Regular-false, Wegstein method, Newton – Raphson method, 4th order Range-Kutta method; Examples in Bioprocesses system.

References:

1. Himmelblau, David Mautner. Process Analysis and Simulation. United States, University of Texas at Austin, 1975.
2. Ramirez, W. Fred. Computational Methods for Process Simulation. United Kingdom, Elsevier Science, 1997.
3. Mathews, John H., and Fink, Kurtis K..Numerical Methods Using Matlab. United Kingdom, Pearson Education, Limited, 2010.
4. Bequette, B. Wayne. Process Control: Modeling, Design, and Simulation. India, Prentice Hall PTR, 2003.

BIO 4444: BIOSTATISTICS AND DESIGN OF EXPERIMENTS [3 0 0 3]

Introduction to statistics: Descriptive and inferential statistics. Measures of central tendency Measures of spread. Probability distributions, Hypothesis testing. Linear & quadratic models, regression coefficients, estimation using least squares method. Introduction to statistical design: Introduction to factorial designs, 2k factorial design, main effects, interaction effects Screening designs: Fractional factorial designs, Plackett-Burmann screening designs. Model reduction, model assumption checking, residual plots. Optimization designs: Response surface methodology – concepts & methods, central composite designs and Box-Behnken design.

References:

1. Montgomery Douglas C. Design and analysis of experiments, John Wiley, 2013
2. Lawson John & Erjavec John. Modern Statistics for Engineering and Quality Improvement, Thomson, 2001
3. Panda T., Theodore T. and Kumar R.A. Statistical Optimization of Biological Systems. CRC Press, 2015
4. Rosner B. Fundamentals of Biostatistics, (5e), Duxbury Thomson Learning, 2000

BIO 4445: COMPUTATIONAL BIOLOGY [3 0 0 3]

Algorithms and complexity, Algorithm Design Techniques, Data Storage, Relational Databases, Biological Data Types, Biological Data Mining, Machine learning Methods, Biological data mining tools, Hidden Markov Models, Artificial Neural Networks, Clustering, Nucleotide and Protein Sequence Analysis, Dynamic Programming Algorithm, Multiple Sequence Alignment Algorithms, Phylogenetic Algorithms, Gene Expression Analysis, Heuristic Algorithms, Identification of Functional Sites in Sequences, Pattern Matching, Gene and Domain Prediction, Restriction Mapping, Genome Rearrangement, Genome Assembly, Protein secondary structure prediction methods and algorithms, RNA structure, RNA secondary structure prediction, Structure File Formats, Structure Similarity Search, Basis of Structural Alignment, Set & Graph theory, Graph Algorithms, Chemical Graphs, Protein Graphs and Networks.

References:

1. Neil Jones & Pavel Pevzner, "Introduction to Bioinformatics Algorithms", MIT Press, 2004.
2. Heitor Silvério Lopes & Leonardo Magalhães Cruz, "Computational Biology and Applied Bioinformatics", InTech, 2011.
3. Dongqing Wei, Qin Xu, Tangzhen Zhao, Hao Dai, Bryan Bergeron, "Advance in Structural Bioinformatics", Springer, 2014.
4. David W Mount, "BIOINFORMATICS: Sequence and Genome Analysis", Cold Spring Harbor, 2001.

BIO 4446: FOOD PROCESS ENGINEERING AND TECHNOLOGY [3 0 0 3]

Introduction to Food Processing: Biotechnology in relation to the food industry; nutritive value of food; types of microorganisms associated with food - their sources, types and behavior. Food Spoilage & Preservation: Microbial Spoilage of Vegetables, Fruits, Fresh and Processed Meats, Poultry and Seafood. Food Preservation: Food Preservation Using Irradiation, Food Preservation with Low Temperatures, Food Preservation with High Temperatures, Preservation of Foods by Drying. Biotechnology in Food Industry: Characteristics of Food Industry. Food manufacturing & processing, common additives, bioorganic additives, spoilage, prevention of spoilage, storage and preservation through biotechnological means. Food Industry: Basal metabolic rate, influences on nutritional status, dietary strategies for individuals, diet for specific groups, Market Place, ecologically sustainable production, risks and benefits of biotechnology to food industry. Unit Operations in Food Processing: Unit operations applied to the food processing industry – Fluid flow applications, Heat transfer applications, Centrifugation, Filtration, Extraction, Membrane separations, Evaporation, Distillation, Absorption, Size reduction, Mixing, Drying, and Crystallization.

References:

1. Roger, A., Gordon, B. and John, T. 1989. Food Biotechnology. Cambridge University Press
2. Golden, David A., et al. Modern food microbiology. India, Springer, 2005.
3. W Lindsay. 1988. Biotechnology – Challenges for the flavor and food industry. Elsevier Applied Science.
4. Earle, R. L..Unit Operations in Food Processing. United Kingdom, Elsevier Science, 2013.

BIO 4447: GENOMICS AND PROTEOMICS [3 0 0 3]

Genomics and proteomics are newer fields in modern biology which help us to understand the living organisms as a whole. These two fields were developed based on the concepts that existed before but now they have been applied to high throughput techniques. Genomics is mainly concerned with the organization of genes and genomes, the mapping of genomes, genome sequencing, and the annotation of genomes. Proteomics deals with proteins expressed in a cell at different times, post-translational modifications, protein–protein interactions, etc. This course covers the important techniques that are used in genomics and proteomics. Investigation of these latest techniques and their applications in various fields will help undergraduate students enhance their current perception on biology.

References:

1. Benjamin Lewis. 2003. Genes VIII. Oxford University Press.
2. Smith D. W. 1994. Biocomputing Informatics and the Genome Projects. Academic Press.
3. Jonathan Pevsner. 2015. Bioinformatics and Functional Genomics. Wiley Blackwell
4. Daniel Liebler. 2002. Introduction to Proteomics. Humana Press

BIO 4448: HEALTH DIAGNOSTICS [3 0 0 3]

Introduction to Health diagnostics, Importance, and applications, Infectious diseases, Parasitic diseases, Viral diseases, Genetic disorders, Neurological diseases, Immune disorders, Genes & Disease, Antimicrobial resistance, New technologies in Diagnostics, DNA based diagnostics methods, Biochemical diagnostics methods, Cell-based diagnostics methods, Antibody markers, CD Markers, FACS, HLA typing, Bioassays, Immunodiagnostics methods, Antigen-Antibody Reactions, Conjugation Techniques, Antibody Production, Case studies related to bacterial, viral and parasitic infections, Diagnosis of infectious diseases, respiratory diseases, Viral disease, bacterial diseases, enteric diseases, parasitic diseases and mycobacterium diseases, Phage display, immunoassays, and FACs.

References:

1. Patrinos, G. P., Ansorge, W. J. and Danielson, P.B. (2016) Molecular Diagnostics, Academy Press
2. Burtis, C. A., & Bruns, D. E. (2014). Tietz Fundamentals of clinical chemistry and molecular diagnostics. Elsevier Health Sciences.
3. Tille, P. (2015). Bailey & Scott's diagnostic microbiology. Elsevier Health Sciences.
4. McPherson, R. A., & Pincus, M. R. (2021). Henry's clinical diagnosis and management by laboratory methods E-book. Elsevier Health Sciences.
5. Turgeon, M. L. (2018). Linne & Ringsrud's Clinical Laboratory Science E-Book: Concepts, Procedures, and Clinical Applications. Elsevier Health Sciences.

BIO 4449: METABOLIC ENGINEERING [3 0 0 3]

Introduction – Jacob Monod model, catabolite regulation, glucose effect, cAMP deficiency, feedback regulation. Synthesis of Primary Metabolites –Alteration of feedback regulation, limiting accumulation of end products, metabolites. Biosynthesis of Secondary Metabolites –Precursor effects, prophophase, idiophase relationship, enzyme induction & producers of secondary metabolites. Bioconversions – Advantages, specificity, yields, co-metabolism, avoidance of product inhibition, mixed or sequential bioconversions, conversion of insoluble substances. Regulation of Enzyme Production – Strain selection, improving fermentation, recognizing growth cycle peak, catabolite repression, mutants resistant to repression.

References:

1. Gregory Stephanopoulos, Aristos Aristidou, Jens Nielsen. Metabolic engineering. Academic Press Inc.1998
2. Stanbury, Peter F, et al. Principles of Fermentation Technology. Germany, Elsevier Science, 2016.

BIO 4450: PROTEIN ENGINEERING [3 0 0 3]

Basic structural principles of protein, protein structure and function, protein prediction, target molecules for protein engineering, de novo protein design, protein folding and flexibility, kinetic factors, folding pathways, chaperonins, GroEL-GroES assisted folding, protein conformational changes, protein kinase, serpin, calmodulin, serine protease. Protein analysis and characterization, computational methods, and applications. Incorporation of unnatural amino acids into proteins, engineering stable proteins, phage display, directed evolution, targeted mutagenesis, rational protein design. Role of protein engineering in vaccine development and humanized antibodies.

References:

1. Branden C, Tooze R. 1993. Introduction of Protein structure. Garland.
2. Stefan L, Uwe TB. 2012. Protein Engineering Handbook 2nd edition. Wiley-VCH
3. Huimin Z, Sang YL, Jens N, Gregory S. 2021. Protein Engineering: Tools and Applications. Wiley-VHC
4. Wong TS, Tee KL. 2020. A practical guide for protein engineering. 1st Edition. Springer cham.

OPEN ELECTIVES

BIO 4311: INTRODUCTION TO BIOINFORMATICS [3 0 0 3]

Introduction to Bioinformatics, Central dogma of biology, Digital code of life, Biological database searching and analysis. Data sources connected through internet access, biomedical literature search. Information retrieval and interpretation, with practical considerations. Sequence analysis methods, phylogenetic analysis, Protein secondary structure prediction, 3D structures visualization, and modeling (with some practical considerations). Genome annotation and Genome compression methods.

References:

1. Lesk, Arthur M.. Introduction to Bioinformatics. United Kingdom, Oxford University Press, 2019.
2. Ouellette, B. F. Francis, and Baxevanis, Andreas D..Bioinformatics: a practical guide to the analysis of genes and proteins, 3rd ed. India, Wiley India Pvt. Limited, 2009.
3. Brown, Stuart M.. Bioinformatics: A Biologist's Guide to Biocomputing and the Internet. United States, Eaton, 2000.

BIO 4312: BODY, MIND AND MEDICINE [3 0 0 3]

Explanation of human body and its evaluation to the present form. How different cultures interpreted human body: energy centers, energy chakras. Explanation of mind and different aspects of it. Subconscious, conscious mind and their effect during the different stages of human growth. How it has reached the present form. Interaction of mind and body and its effect on human development and growth. The different interpretation of human body by allopathy medicine, Ayurveda medicine and Chinese medicine.

References:

1. Amit Goswami, The quantum doctor, Jaico Publishing House, 2011
2. Bruce H. Lipton, The Biology of Belief: Unleashing the Power of Consciousness, Matter and Miracles, ReadHowYouWant.com, 2010
3. Firstenberg A, The invisible Rainbow: The history of electricity and life, Chelsea Green Publishing, 2020

BIO 4313: BIOINSPIRED DESIGN FOR ENGINEERS [3 0 0 3]

Basic biological principles, design and working relationship in biological systems, Bioinspiration engineering, methodology and approach for Bioinspiration and biomimetics. Adhesion in biological systems, natural super-hydrophobic and hydrophilic substances, understanding chemical and physical processes in biological systems and its application in bioinspired engineering. Morphing and actuation in plants; lubrication and movement in biological systems, multimodal locomotion, propulsion features of biological systems, design of flying objects in biology and its application in aeronautical designs. Navigation, communication, automation, shock absorption and mechanics of biological systems and its application in designs of engineering, mathematical modelling in plants and animals, Future trends in bioinspiration engineering.

References

1. Ashok K Goel, Daniel A McAdams and Robert B. Stone 2014. Biologically Inspired Design Computational Methods and Tools, Springer-Verlag London.
2. Hashemi Farzaneh, Helena, Lindemann, Udo 2019. A practical guide to bioinspired design. Springer.
3. Christopher Jenkins, 2011. Bio-Inspired Engineering Momentum press, New York
4. Brebbia CS, 2010. Design and Nature V. Comparing design in nature with science and engineering. WIT Press, UK

Department of

Chemical Engineering

Chemical Engineering explores the processing of materials and production or utilization of energy through chemical and/or biochemical routes. Chemical engineers design, innovate, research and troubleshoot processes and play a key role in the sectors of energy, agricultural chemicals, materials, pharmaceutics and biochemical processes, food and FMCG. Chemical engineers make use of their expertise in environmental remediation and find solutions to providing clean air, soil, water and sanitation. The scope of Chemical Engineering extends to design of greener products and processes.

The Department of Chemical Engineering was established in the year 1969 and celebrated its golden jubilee in 2019. The department has well equipped laboratories and research facility. It has qualified faculty with competencies in the following areas:

- Process Modeling and Simulation
- Fluid and Fluid-Solid Operations
- Drug Delivery Systems
- Environmental Pollution Control
- Catalysis and Nanotechnology
- Computational Fluid Dynamics
- Process Control
- Renewable Energy
- Advanced Materials

> Programs offered

Undergraduate Program

- B.Tech in Chemical Engineering (1969)

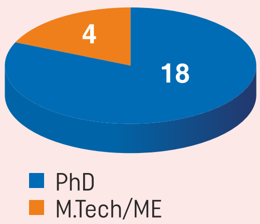
Postgraduate Program

- M.Tech in Chemical Engineering (2009)

PhD

> Faculty Strength

Qualification-wise



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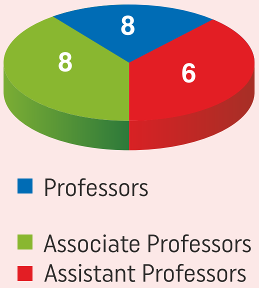


B.TECH. CHEMICALENGINEERING

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2124	Engineering Mathematics - III	2	1	0	3	MAT 2224	Engineering Mathematics - IV	2	1	0	3
	CHE 2121	Chemical Engineering Thermodynamics	3	1	0	4	CHE 2221	Particle Technology	2	1	0	3
	CHE 2122	Chemical Process Calculations	2	1	0	3	CHE 2222	Mass Transfer - II	2	1	0	3
	CHE 2123	Momentum Transfer	3	1	0	4	CHE 2223	Chemical Reaction Engineering	3	1	0	4
	CHE 2124	Mass Transfer - I	2	1	0	3	CHE 2224	Pollution Control and Safety in Chemical Industry	2	1	0	3
	CHM 2121	Physical and Organic Chemistry	3	1	0	4	CHE 2225	Heat Transfer Operations	2	1	0	3
	CHM 2141	Physical and Organic Chemistry Lab	0	0	3	1	CHE 2241	Momentum Transfer Lab	0	0	3	1
							CHE 2242	Numerical Methods for Chemical Engineers Lab	0	0	3	1
			15	**6**	**3**	**22**			**13**	**6**	**6**	**21**
	Total Contact Hours (L + T + P)		**24**				**Total Contact Hours (L+T+P) + OE**		**25**			
	FIFTH SEMESTER						**SIXTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	HUM 3021	Engineering Economics and Financial Management	2	1	0	3	HUM 3022	Essentials of Management	2	1	0	3
	CHE 3121	Process Dynamics and Control	3	1	0	4	CHE****	Flexible Core - 1 (A1/B1)	2	1	0	3
	CHE 3122	Process Modelling and Simulation	2	1	0	3	CHE ****	Flexible Core - 2 (A2/B2)	3	1	0	4
	CHE 3123	Process Design of Chemical Equipment	2	1	0	3	CHE****	Program Elective - I / Minor Specialization	3	0	0	3
	CHE 3124	Transport Phenomena	2	1	0	3	CHE****	Program Elective - II / Minor Specialization	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective - 2	3	0	0	3
	CHE 3141	Heat Transfer Lab	0	0	3	1	CHE 3241	Process Modelling and Simulation Lab	0	0	3	1
	CHE 3142	Mass Transfer Lab	0	0	3	1	CHE 3242	Reaction Engineering and Process Control Lab	0	0	3	1
			15	**4**	**6**	**21**			**17**	**2**	**6**	**21**
	Total Contact Hours (L+T+P) + OE		**25**				**Total Contact Hours (L+T+P) + OE**		**25**			
	SEVENTH SEMESTER						**EIGHTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
IV	CHE ****	Program Elective - III / Minor Specialization	3	0	0	3	CHE 4291	Industrial Training				1
	CHE ****	Program Elective - IV / Minor Specialization	3	0	0	3	CHE 4292	Project Work				12
	CHE ****	Program Elective - V	3	0	0	3	CHE 4293	Project Work (B.Tech Honours)**				20
	CHE ****	Program Elective - VI	3	0	0	3	CHE ****	B.Tech Honours (Theory 1)** (V Semester)				4
	CHE ****	Program Elective - VII	3	0	0	3	CHE ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	CHE ****	Open Elective - 3	3	0	0	3	CHE ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	CHE 4191	Mini Project (Minor Specialization)*				8						
			18	**0**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P) + OE		**18**									

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

FLEXIBLE CORE- A

CHE 3221: Chemical Process Industries (A1)
CHE 3223: Chemical Reactor Theory (A2)

FLEXIBLE CORE- B

CHE 3222: Computer-Aided Simulations in Chemical Process Plants(B1)
CHE 3224: Artificial Intelligence and Machine Learning in Chemical Engineering (B2)

MINOR SPECIALIZATIONS:

I. PETROLEUM ENGINEERING

CHE 4401: Oil and Gas Reservoir Engineering
CHE 4402: Petroleum Refinery Engineering (Theory & Lab)
CHE 4403: Natural Gas Engineering
CHE 4404: Process Integration for Petroleum Industries

II. POLLUTION CONTROL ENGINEERING

CHE 4405: Industrial Waste Water Engineering (Theory & Lab)
CHE 4406: Solid and Hazardous Waste Management
CHE 4407: Air Pollution Monitoring and Control
CHE 4408: Environmental Impact Assessment and Management Plan

III. RENEWABLE ENERGY ENGINEERING

CHE 4409: Renewable Energy
CHE 4410: Solar Energy
CHE 4411: Fuel Cell and Hydrogen Energy
CHE 4412: Bio Energy Engineering

OTHER PROGRAMME ELECTIVES

CHE 4441: Advanced Process Control
CHE 4442: Applied Interfacial Engineering
CHE 4443: Clean Technologies in Process Industries
CHE 4444: Energy Engineering
CHE 4445: Green Processes
CHE 4446: Industrial Safety and Risk Management
CHE 4447: Introduction to Biochemical Engineering
CHE 4448: Materials Science and Engineering
CHE 4449: Membrane Science and Technology
CHE 4450: Molecular Modelling and Simulation
CHE 4451: Non Newtonian Fluid Flow in Process Industries
CHE 4452: Petrochemicals
CHE 4453: Process Data Analysis
CHE 4454: Process Instrumentation
CHE 4455: Project Engineering
CHE 4456: System Identification
CHM 4441: Analytical Techniques and Instrumentation

OPEN ELECTIVES

CHE 4311: Industrial Pollution Control
CHE 4312: Risk and Safety Management in Industries
CHE 4313: Water Treatment Technology
CHE 4314: Introduction to Petroleum Engineering

THIRD SEMESTER

MAT 2124: ENGINEERING MATHEMATICS-III [2 1 0 3]

Fourier series and transforms: Periodic Functions, odd and even functions, Euler's formulae. Half range expansions, Harmonic analysis. Fourier integrals & transforms, Parseval's identity. Complex Variable: Functions of complex variable. Analytic function, C-R equations, differentiation, Integration of complex function, Cauchy's integral formula. Taylor's and Laurent Series, Singular points, Residues, Cauchy's residue theorem. Conformal mappings, bilinear transformations. Vector Calculus: Gradient, divergence and curl, their physical meaning and vector identities. Line, surface and volume integrals. Green's theorem, divergence and Stokes' theorem, applications. Partial differential equations: Formation, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of Variables. Derivation of one dimensional wave equation (vibrating string) and its solution by using the method of separation of Variables. D'Alembert's solution of wave equation. Derivation of one dimensional heat equation using Gauss divergence theorem and solution of one dimensional heat equation. Solution by separation of variables.

References :

1. Eewin Kreyszig, Advanced Engineering Mathematics, 7th edition, 993, John Wiley & Sons, Inc.
2. Murray R.Spiegel : Vector Analysis,2nd edition, 2009, Schaum Publishing Co.
3. B.S.Grewal: Higher Engg.Mathematics, 43rd edition, 2014, Khanna Publishers.
4. Ramana B.V., Engineering Mathematics, 2nd edition, 2007, Tata McGraw Hill Publishing Company limited.

CHE 2121: CHEMICAL ENGINEERING THERMODYNAMICS [3 1 0 4]

Basic concepts and definition: internal energy, work, heat, equilibrium, reversible process, intensive and extensive function. First law of thermodynamics for non-flow and flow process, Volumetric properties of pure fluids: PVT behaviour of pure substances, ideal gas law, isobaric, isothermal, adiabatic and Polytropic process. equation of state for real gases, the principles of corresponding states, compressibility factors. Second law of thermodynamics: Spontaneous process, qualitative difference between heat and work, Kelvin Plank statement, Clausius statement, Carnot principle, irreversibility, entropy, third law of thermodynamics. Thermodynamic relations: Classification of thermodynamic processes, fundamental property relations, Maxwell's relations and their applications, modified equations for U, H and S, relationship between Cp and Cv, Gibbs Helmholtz equations, Clausius Clapeyron equation. Phase equilibria: Thermodynamic properties of pure substances: Fugacity and Fugacity Coefficients, Activity and Activity Coefficients, partial molar properties, chemical potential, Gibbs-Duhem equation, Property changes of mixing. Chemical reaction equilibria: criteria of equilibrium, reaction stoichiometry, effect of temperature on equilibrium constant, Relation of equilibrium constants to composition: gas-phase reactions, liquid-phase reactions, equilibrium conversions for single reactions

References:

1. K.V.Narayanan, A Text Book of Chemical Engineering Thermodynamics, Second Edition, Prentice Hall of India, 2013.

2. J.M Smith, H.C.Van Ness and M.M.Abbot, Introduction to Chemical Engineering Thermodynamics,(7e), McGraw Hill, 2004.
3. T.E. Daubert, Chemical Engineering Thermodynamics, McGraw –Hill, 1985.
4. Y.V.C.Rao, Chemical Engineering Thermodynamics, Universities Press, 1997.

CHE 2122: CHEMICAL PROCESS CALCULATIONS [2 1 0 3]

Units and dimensions – Conversion of units; Physico-chemical properties of compounds and mixtures, Chemical equations and stoichiometry; Properties of gases and mixtures –Ideal and real gases calculations; Humidity and Saturation – Humidity charts and their use; Material balances involving unit operations and unit processes – Material balances with recycle, bypass and purge; Energy and energy balances – Balances on non-reactive and reactive systems, Heat capacities, Heat of reaction, formation and combustion, Standard state, Hess law, Adiabatic reaction temperature and theoretical flame Temperature.

References:

1. David M. Himmelblau, James B. Riggs, Basic Principles and Calculations in Chemical Engineering, 8th Edition, Pearson Education, Inc. 2012.
2. Richard Felder, Ronald W. Rausseau, Lisa G. Bullard, Elementary Principles of Chemical Processes, 4th Edition, John Wiley and Sons, 2018.
3. A. Hougen, K.M. Watson and R.A. Ragatz, Chemical Process Principles, Part – I, John Wiley and Asia Publishing Co. 1970.
4. K.V. Narayana, B. Laxmikutty, Stoichiometry and Process Calculation, 2nd Edition, PHI Learning Pvt. Ltd. Delhi, 2017

CHE 2123: MOMENTUM TRANSFER [3 1 0 4]

Properties of fluids –- Fluid statics – Static pressure, Introduction to fluid flow – Types of flow – Rheological classification- Basic equations of fluid flow – Continuity equation – One dimensional Euler and Bernoulli equation and applications – Flow measurement– Hagen-Poiseuille equation - Turbulence – velocity profile and shear stress – Darcy equation – Fluid flow past immersed bodies –Flow of fluids thorough bed of solids –Fluidization —Dimensional analysis – Flow of compressible fluids – Fluid transportation machinery, Pneumatic conveyance – Agitation and mixing of liquids

References:

1. Warren McCabe, Julian Smith & Peter Harriott "Unit Operations in Chemical Engineering", (7e), McGraw-Hill, NY,2017
2. J F Ricardson & J H Harker with J R Backhurt "Coulson and Richardson's Chemical Engineering" – Vol. I, Asian Books, New Delhi, 6e, 2006,
3. L. Bryce Andersen Alan S. Foust, Leonard A. Wenzel, Curtis W. Clump, Louis Maus, "Principles of Unit Operations", (2e), John Wiley and Sons, NY, 2015
4., Badger, Walter L.; Banchero, Julius T.; Bancheo, Julius T. " Introduction to Chemical Engineering", Tata McGraw Hill, Singapore, 1e, 2017,

CHE 2124: MASS TRANSFER -I [2 1 0 3]

Introduction to mass transfer operations, Diffusion and mass Transfer: Molecular diffusion in fluids and solid, mass transfer coefficients, interphase mass transfer coefficient. Gas Liquid Operations: Equipment for gas liquid operations, Gas absorption. Solid-Fluid Operations: Crystallisation, Adsorption, Drying.

References:

1. Treybal, R.E. Mass Transfer Operations (3e), McGraw Hill Education, 2017.
2. McCabe, W., Smith, J., Harriott, P., Unit Operations of Chemical Engineering (7e), McGraw Hill Education, 2017.
3. Dutta, B.K., Principles of Mass Transfer and Separation Processes, Prentice Hall India Learning Private Limited, 2006.

CHM 2121: PHYSICAL AND ORGANIC CHEMISTRY [3 1 0 4]

Thermodynamic treatment of solutions, Ideal mixtures, Partial molal quantities, Liquid-vapor free energies, vapour pressure and solution properties, colligative properties. Phase diagrams, Phase rule, Surface tension and vapor pressure, Immiscible liquids, Eutectic formation, solid compound formation, Boiling point diagrams, Distillation, adsorption of gases, and liquids. Electroanalytical methods:- Basic principles and applications of conductometric, potentiometric titrations., Chemical Kinetics, First-order and second order rate equations ,Half-life,, Stereochemistry, Constitutional isomerism - Geometrical isomerism, Optical isomerism,, Reaction intermediates, Structure, Stability and reactions of free radicals, Carbocations, carbanions and carbenes, Strength of organic acids and bases and Factors affecting that, Structure of benzene and aromaticity, Effect of substituents in mono and disubstituted benzene. Classification of Heterocyclic compounds, Basicity, Sources, structure and properties of monosaccharides, disaccharides and polysaccharides, Classification, Synthesis of amino acids and proteins, Physical and chemical properties. of Peptides, Color tests of proteins, Enzymes - Theories of enzymatic actions, Properties, Applications in industry, Theories of dyes - Bathochromic and Hypsochromic shift, Classification of dyes based on applications and

References:

1. B.R. Puri, L.R. Sharma, M.S. Pathania, Principles of Physical Chemistry, 48th edition, Vishal Publications, Jalandhar, 2021.
2. P. Atkins, J. de Paula, Physical Chemistry, 11th edition, Oxford Publication, New York, 2018.
3. D. A. Skoog, D. M. West, F. J. Holler, S. R. Gouch, Fundamentals of Analytical Chemistry, 9th edition, Cengage Learning Andover, 2014.
4. G.M. Barrow, Physical Chemistry, 5th edition, Tata McGrow-Hill Education private limited, New Delhi, 2007.
5. I.L. Finar, Organic Chemistry, Vol I, 6th edn. Pearson Education, Singapore, 2012.

CHM 2141: PHYSICAL AND ORGANIC CHEMISTRY LAB [0 0 3 1]

Physical Chemistry: Titration using conductometric method, potentiometric method, Percentage composition of binary mixture using viscometer and Abbe's refractometer, Bimolecular kinetics. Organic Chemistry: Preparation of m-dinitrobenzene, benzoic acid, and salicylic acid; Determination of the % purity of phenol and acetic acid.

FOURTH SEMESTER

MAT 2224: ENGINEERING MATHEMATICS-IV [2 1 0 3]

Optimization Techniques: Formation of Linear Programming problem, Graphical method, Simplex method, Penalty cost and two phase methods. Probability & Random variables: Finite sample spaces, conditional probability and independence, Bayes' theorem One dimensional random variable, mean, variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least squares principles of curve fitting. Probability distributions: Binomial, Poisson, uniform, normal, gamma, Chi-square and exponential. Numerical methods: Finite difference expressions for first and second order derivatives (ordinary and partial).Solution of BVP's in ODE. Classification of second order linear partial differential equations. Numerical solutions of two dimensional Laplace and Poisson equations by standard five point formula. Solution of one dimensional heat and wave equations by explicit methods. Crank-Nicolson method. Finite element method, Introduction, simple applications. Z transform: Difference equations representing physical systems, the z transforms, properties of z transforms, initial and final value theorems, solution of difference equations by the method of z transforms, convolution theorem.

Reference :

1. Erwin Kreyszig, Advanced Engineering Mathematics, 7th edition, 1993, John Wiley & Sons, Inc.
2. Meyer P.L., Introduction to probability and Statistical applications, 2nd edition, 1970, American Publishing Co.
3. Hamdy A Taha - Operation research, 7th edition, 2002, Pearson Education, Inc.
4. Grewal B.S - Higher Engineering Mathematics, 43rd edition, 2014, Khanna Publishers.
5. Sastry S.S - Introductory methods for Numerical Analysis, 5th edition, 2012, PHI Learning Private Limited.

CHE 2221: PARTICLE TECHNOLOGY [2 1 0 3]

Particle size analysis, Sphericity of particle, Shape factor, Specific surface area and specific number of particle in the sample mixture, Sieve methods of analysis, Ideal and actual screen, Effectiveness and capacity of screen, Screening equipment, Size reduction, Energy relationships, Size reduction equipment, Crushers, Grinders, Separation based on motion of particle through fluids, Settling, Free and hindered settling, Terminal settling velocity of solid particles, Classifier, Sedimentation, Clarifier, Design of continuous thickener, Filtration and Centrifugation operation.

References:

1. Warren L. McCabe, Julian C. Smith, and Peter Harriott, Unit Operations of Chemical Engineering (7e), McGraw Hill Publication, NY, 2017.
2. Alan S. Foust, Leonard A. Wenzel, Curtis W. Clump, Louis Maus, and L. Bryce Andersen, Principles of Unit Operations, (2e), John Wiley and Sons, NY, 2015.
3. Walter L. Badger and Julius T. Banchero, Introduction to Chemical Engineering, Tata McGraw-Hill, NY, 2017.
4. J.M. Coulson, J.R. Richardson J.R. Backhurst, and J.H. Harker, Chemical Engineering –Volume 2, Particle Technology and Separation Processes, (6e), 2019.

CHE 2222: MASS TRANSFER II [2 1 0 3]

Phase equilibrium, vapour liquid equilibrium, phase diagrams for binary solutions, dew point and bubble point calculations, T-xy, P-xy diagrams, deviations from ideality, azeotropes and its types, Distillation: binary component distillation- Flash vaporization, simple distillation, steam distillation, multicomponent distillation: Flash vaporization, simple distillation, Multi stage tray towers: Ponchon and Savarit & McCabe and Thiele. Liquid-Liquid Extraction: Liquid Equilibria, separation of solute by stage-wise, cross current and continuous contact of solvent. Solid-Liquid Extraction: Introduction, applications, cross current and counter current leaching.

References:

1. Treybal R.E., Mass Transfer Operations (3e), McGraw Hill Education, 2017.
2. McCabe W., Smith J., Harriott P., Unit Operations of Chemical Engineering (7e), McGraw Hill Education, 2017.
3. Dutta B.K., Principles of Mass Transfer and Separation Processes, Prentice Hall India Learning Private Limited, 2006.

CHE 2223: CHEMICAL REACTION ENGINEERING [3 1 0 4]

Elementary and Non elementary reaction kinetics, Kinetics of homogeneous chemical reactions, Rate expressions, Temperature dependence of rate, differential, integral, half-life and total pressure method. Isothermal reactor design, Design of batch, semi-batch, CSTR and PFR, Reactors in series or/and parallel, Recycle reactor, Series and parallel reactions in flow reactors, Product distribution, Yield and selectivity, Maximizing the desired product in parallel, series reactions, series-parallel reactions and Denbigh reactions. Enzymatic Reaction - Michaelis-Menten Kinetics, Competitive and Non-competitive inhibition, Microbial Fermentation- substrate limiting and product limiting- batch/ plug flow and mixed flow fermentors.

References:

1. Fogler S. H., Elements of Chemical Reaction Engineering, Pearson; 6th edition 2020
2. Levenspiel O., Chemical Reaction Engineering (3e), Wiley; Third edition ,2006.
3. Rawlings J.B. and Ekerd, J.G., Chemical Reactor Analysis and Design Fundamentals, Nob Hill Pub, Llc; 2nd edition ,2013
4. Smith, J.M, Chemical Engineering Kinetics (3e), McGraw-Hill, 3rd edition
5. Davis M.E., Davis R.E., Fundamentals of Chemical Reaction Engineering (1e), Dover Publications Inc.; Illustrated edition. 2012
6. Missen R.W., Mims C.A., Saville B.A., Introduction to chemical reaction engineering and kinetics, John Wiley & Sons Inc.

CHE 2224: POLLUTION CONTROL AND SAFETY IN CHEMICAL INDUSTRY [2 1 0 3]

Biosphere- Nutrient and hydrologic cycles. Types of pollution and pollution control aspects in general and environmental legislation. Evaluation and characterisation of air and water pollutants. Treatment methods for air, water pollution. Sludge treatment and disposal. Principles of air pollution Plume behaviour- Meteorological factors affecting air Pollution. Pollution control aspects in specific chemical industry.Scientific and engineering aspects of safety in industries-considerations.

References:

1. Mahajan S.P.,"Pollution Control in Process Industries", Tata Mc Graw Hill, 2008.
2. Rao C.S., "Environmental Pollution Control Engineering" (2e), New Age International Publishers, 2006.
3. Cavaseno V, "Industrial Air Pollution Engineering", McGraw Hill, NY, 1980

CHE 2225: HEAT TRANSFER OPERATIONS [2 1 0 3]

Mechanism of heat transfer; Heat transfer flux and resistance. Thermal conductivity; Fourier's law of conduction; Conduction through the plane, cylindrical and spherical and composite walls. Natural and forced convection; Individual film and overall heat transfer coefficients; Convection in laminar and turbulent flows. Heat exchanger: Types of heat exchangers; Co-current and counter-current flows; Evaporators; Radiant energy distribution, Black body; Emissive power; Exchange of energy between two surfaces; Radiosity, Spectral Irradiation.

References:

1. F.P. Incropera and D.P. Dewitt – Introduction to Heat and Mass Transfer, 7th Edition (Wiley), 2007
2. McCabe and Smith –Unit Operations of Chemical Engineering, 7th edition
3. Donald Q Kern- Process Heat Transfer, McGraw Hill, 2017.
4. William Henry McAdams- Heat Transmission, 3rd Edition, McGraw Hill.

CHE 2241: MOMENTUM TRANSFER LAB [0 0 3 1]

Bernoulli's Experiment – Calibration of flow meters, flow through circular pipe, annulus, v-notch, packed bed and fluidized bed – Centrifugal pump characteristics.

CHE 2242: NUMERICAL METHODS FOR CHEMICAL ENGINEERS LAB [0 0 3 1]

Chemical engineering problems related to Process Calculations, Momentum Transfer, Heat Transfer and Mass Transfer-I will be solved using numerical methods such as Bisection method, False position method, Secant method, Newton-Raphson method, Linear Algebraic Equations, Runge-Kutta method, Predictor-Corrector method, Shooting method, Finite difference method, Crank-Nicholson method; Bender Schmidt method with the help of computer software such as MATLAB and EXCEL.

FIFTH SEMESTER

HUM 3021: ENGG ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Nature and significance, Micro & macro differences, Law of demand and supply, Elasticity & equilibrium of demand & supply. Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of single, Uniform gradient cash flow. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, declining balance method of depreciation, Sum-of-the-years digits method of depreciation, sinking fund and service output methods, Introduction to balance sheet and profit & loss statement. Ratio analysis - Financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios.

References:

1. Prasanna Chandra (2005), "Fundamentals of Financial Management", Tata Mc-Graw Hill Companies, New Delhi.
2. James L Riggs, David D Bedworth and Sabah U Randhawa, (2004), "Engineering Economics", Tata McGraw – Hill Publishing Company Ltd, New Delhi
3. T. Ramachandran (2001), "Accounting and Financial Management", Scitech Publications Pvt. Ltd. India.
4. Eugene F. B. & Joel F. H. (2009), "Fundamentals of Financial Management", 12th ed., Cengage Learning Publisher.
5. M. Y. Khan & P. K. Jain (2008), "Financial Management", 5th edition Tata McGraw Hill Publication, New Delhi.
6. Thuesen G.J (2005), "Engineering Economics" Prentice Hall of India, New Delhi.
7. Blank Leland T. Tarquin Anthony J. (2002), "Engineering Economy", McGraw Hill, Delhi.
8. Chan S. Park, (2013), "Fundamentals of Engineering Economics", 3rd edition, Pearson Publication.

CHE 3121: PROCESS DYNAMICS AND CONTROL [3 1 0 4]

Introduction to process control: components of control system, control relevant process modelling; Laplace Transform; Linearization; Transfer function models: effect of poles, zeros and time delays on system response; Dynamics of First, Second and Higher order systems; Control system instrumentation; Introduction to Feedback control: effect of proportional, integral and derivative action, responses of P, PI and PID controllers; Controller selection, design and tuning; Stability analysis of closed loop systems, Frequency response: Bode diagrams; Nyquist Plot; Multivariable and advanced control strategies

References:

1. Stephanopoulos G., Chemical Process Control: An Introduction to Theory and Practice (1e), Pearson Education India, 2015.

2. Seborg D.E., Edgar T.F., Mellichamp D.A., Doyle III F. J., Process Dynamics and Control (4e), John Wiley and Sons, 2016.
3. Coughanowr D.R., LeBlanc E.S., Process Systems Analysis and Control (3e), McGraw Hill, 2009.
4. Marlin T.E., Process Control: Designing of Processes and Control Systems for dynamic performance (2e), Mc Grew Hill, 2000.
5. Bequette B.W., Process Control, Modelling, Design and Simulation, Prentice Hall International, 2003.

CHE 3122: PROCESS MODELLING AND SIMULATION [2 1 0 3]

Models and model building, principles of model formulation, precautions in model building, Classification of models. Lumped parameter Models: steady and unsteady state- tank model, Reaction – kinetic systems, Vapour –liquid equilibrium operation. Distributed parameter models (steady state): solution of split boundary value problems, counter current heat exchanger, tubular reactor with axial dispersion, Distributed parameter models (unsteady state, one dimension): Finite difference method, convection problems- explicit and implicit centred difference methods; diffusive problems- Crank Nicolson finite difference scheme, heat exchanger, gas absorbers and dynamics of tubular reactor with dispersion.

References:

1. Ramirez W.F., Computational Methods in Process Simulations (2e), Butterworth publishers, 1997.
2. Franks R.E., Modelling and simulation in Chemical Engineering, John Wiley & Sons, 1972.
3. Hangos K., Cameron I., Process Modelling and Model Analysis, Academic Press, 2001.
4. Ramakrishna D., Population Balance-Theory and Applications to Particulate systems in Engineering (1e), Academic Press, 2000.

CHE 3123: PROCESS DESIGN OF CHEMICAL EQUIPMENT [2 1 0 3]

Introduction to mechanical design, Vessel classification, design codes and general design consideration, Design of cylindrical and spherical vessels under internal pressure, Design of heads and closures . Design of cylindrical and spherical vessels under external pressure. Design of shell and tube heat exchangers, Design of condensers, Design of single and multiple effect evaporators, design of distillation columns & absorption columns.

References:

1. Coulson and Richardson's Volume 6, Chemical Engineering design (4e), Elsevier Butterworth-Heinemann Publishers, 2005.
2. Kern D.Q., Process Heat transfer, McGraw-Hill Publishers, 2017.
3. Joshi M.V., Mahajani V.V., Process Equipment Design (4e), MacMillan Publishers, 2009
4. Indian Standard for unfired pressure vessel, IS 2825-1969
5. Indian Standard for Heat Exchangers, BIS 4503-1967
6. Bhattacharya B.C., Introduction to Chemical Equipment Design – Mechanical aspects, CBS Publishers, 2017.
7. Brownell L.E., Young E.H., Process Equipment Design, Wiley Publications, 2009.

CHE 3124: TRANSPORT PHENOMENA [2 1 0 3]

Prediction of transport coefficients: viscosity, thermal conductivity and diffusivity and their dependence with temperature, pressure and composition. Kinetic theories of viscosity, thermal conductivity and diffusivity. Shell balance for momentum, energy and mass transfer: unidimensional velocity-temperature and concentration profiles momentum, energy and mass flux at the surface. Introduction to general transport equations for momentum, energy and mass transfer in Cartesian –cylindrical and spherical co-ordinates- solutions in one dimension. Velocity, temperature, concentration distribution with more than one independent variable

References:

1. Bird R.B., Stewart W.E., Lightfoot E.W., Transport Phenomena (2e), John-Wiley, 2006
2. Brodkey R.S., Hershey C.,Transport Phenomena- A unified approach, McGraw Hill Book Company, 2003
3. Slattery J.C., Advanced Transport Phenomena, Cambridge University Press, 2012
4. Geankoplis C.J, Transport Process and Unit Operation (3e) , Prentice-Hall , 2015

CHE 3141: HEAT TRANSFER LAB [0 0 3 1]

Experiments are based on the following topics: conduction, convection, radiation, overall heat transfer coefficient, dirt resistance calculation. Surface renewable coefficients, bare and finned tube heat exchangers, film and drop condensation.

CHE 3142: MASS TRANSFER LAB [0 0 3 1]

Experiments are based ob following topics: Vapour-liquid equilibria, Simple distillation – vaporization and thermal efficiency of steam distillation – distillation under total reflux in a packed column – studies in batch adsorption – diffusivity by Stephen's method – mass transfer coefficient in dissolution of solid – liquid-liquid extraction –simple and cross flow leaching – experimental determination of liquid-liquid equilibrium data – drying of solids in fluidized bed dryer – extraction of solute in packed bed column – crystallization process in an batch crystallizer – tray efficiency of bubble cap distillation column

SIXTH SEMESTER

HUM 3022: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Definition of management and systems approach, Nature & scope. The functions of managers. Corporate social responsibility. Planning: Types of plans, Steps in planning, Process of MBO, how to set objectives, Strategies, Policies & planning premises. Strategic planning process and tools. Nature & purpose of organising, Span of management, Factors determining the span, Basic departmentation, Line & staff concepts, Functional authority, Art of delegation, Decentralization of authority. HR planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership- leadership behaviour & styles, Managerial grid. Basic control process, Critical control points & standards, Budgets, Non-budgetary control devices. Profit & loss control, Control through ROI, Direct, Preventive control. Managerial practices in Japan & USA, Application of Theory Z. The nature & purpose of international business & multinational corporations, Unified global theory of management. Entrepreneurial traits, Creativity, Innovation management, Market analysis, Business plan concepts, Development of financial projections.

References:

1. Harold Koontz & Heinz Weihrich (2012), "Essentials of Management", McGraw Hill, New Delhi.
2. Peter Drucker (1993), "Management: Tasks, Responsibilities and Practices", Harper and Row, New York.
3. Peter Drucker (2004),"The Practice of Management", Harper and Row, New York.

CHE 3221: CHEMICAL PROCESS INDUSTRIES [3 0 0 3]

Indian industry - A brief review- Industrial gases. Chloralkali industry. Hydrochloric acid, Soda ash. Fertilizer industry: Ammonia, Nitric acid, Urea. Oils, fats and waxes: Hydrogenation of oil, Soaps and detergents, Glycerin recovery. Petroleum industry. Pulp and paper - Pulping methods, black liquor – Paper and paperboard. Sugar and starch: Sugar – Starch and modified starches, Glucose – Fermentation, Industrial alcohol – Absolute alcohol – Acetone and Butanol. Polyethylene – Viscose rayon, Nylon 6 and Nylon 66. Natural and synthetic rubber

References:

1. Charles E. Dryden, Outlines of Chemical Technology, Edited and Revised by M. Gopala Rao and Marshall Sittig, Affiliated East Press Ltd., 3rd Edn., 1997.
2. Austin G.T., Shreve's Chemical Process Industries, 5th Edn, McGraw-Hill, 2017.
3. Groggins, P .H, Unit processes in organic synthesis Tata McGraw-Hill, 2004.

CHE 3222: COMPUTER-AIDED SIMULATIONS IN CHEMICAL PROCESS PLANTS [2 1 0 3]

Introduction to steady-state flow sheeting and the design process. Steady state process simulation using sequential modular approach and equation-oriented approach. Convergence of tear streams. Introduction to process simulation, computerized physical properties calculations, thermodynamic property analysis, flowsheet features, simulation of simple units – Mixers/Splitters, Pressure Changers, Heater, Reactors, Design and rating of Heat Exchangers, Design of Distillation Column and Column Internals. Model Analysis Tools: Optimization and Sensitivity, Flow sheeting Options: Design Specifications, Simulation of Plant-wide Structure /Chemical Plants. Case studies.

References

1. Process Flow sheeting, Westerberg A. W., Hutchison H. P., Motard R. L. and Winter P., Cambridge University Press, 2011.
2. Process Plant Simulation, Babu B. V., Oxford University Press, 2004.
3. Introduction to Software for Chemical Engineers, Mariano Martin Martin, CRC Press, 2015.
4. "ASPEN PLUS® Chemical Engineering Applications", Kamal I. M. Al-Malah, Wiley, 2017.
5. Advanced CO2 Capture Technologies, Absorption, Adsorption, and Membrane Separation Methods, Shin-ichi Nakao, Katsunori Yogo, Kazuya Goto, Teruhiko Kai, Hidetaka Yamada, Springer, 2019.

CHE 3223: CHEMICAL REACTOR THEORY [3 1 0 4]

RTD in chemical reactors, distribution functions and models. Temperature effects, Design of adiabatic/non-adiabatic and non-isothermal batch and flow reactors, Optimum temperature progression, multiple steady states. Heterogeneous reactions, Rate equations, F-S non-catalytic reactions, models, Kinetic regimes, Heterogeneous catalysis, classification of catalysts, Kinetics of heterogeneous solid catalyzed gas reactions, Mathematical models, mechanism, External transport processes, Intra pellet mass transfer, Multiphase reactors kinetics and design.

References:

1. Scott Fogler, H, Elements of Chemical Reaction Engg – PH- 6th Edition- 2020.
2. Octave Levenspiel, Chemical Reaction Engineering, Wiley & Sons - 3rd Edition, 2021.
3. Rawlings J.B. and Ekerd, J.G., Chemical Reactor Analysis and Design Fundamentals, Nob Hill – 2nd Edition, 2022.
4. Smith, J.M, Chemical Engineering Kinetics, 3rd edition, McGrawl-Hill, International student edition
5. Mark E Davis, Robert E Davis, Fundamentals of Chemical Reaction Engineering, 1st edition, McGrawl-Hill, 2003
6. Ronald W. Missen, Charles A. Mims, Bradley A. Saville; Introduction to chemical reaction engineering and kinetics, John Wiley & Sons, Inc.

CHE 3224: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING IN CHEMICAL ENGINEERING [3 1 0 4]

Introduction to AI & ML, supervised and unsupervised learning. Linear regression, Cost/Objective function. Gradient descent algorithm, Linear regression with multiple variables-gradient descent algorithm. Classification, objective function of logistic regression. Concept of regularization. Neural networks. Bias-Variance trade-off, Support vector machines, Clustering algorithm. Orthogonal projection, PCA, PLS. An algorithm developed and analyzed in MATLAB / PYTHON software. Application in process system engineering.

References:

1. Stephen Marsland, "Machine Learning" , Second edition CRC Press, 2014
2. Steven L. Brunton and J. Nathan Kutz, "Data-Driven Science and Engineering: Machine Learning, Dynamical Systems, and Control" Edn., 2, Cambridge University Press; 2022.
3. Alpaydin Ethem, "Introduction to Machine Learning", Edn. 2, PHI, New Delhi.
4. Shalev-Shwartz Shai;Ben-David Shai, "Understanding machine learning", Cambridge Univerwity Press, 2017.
5. Saikat Dutt, Subramanian Chandramouli and Amit Kumar Das, "Machine Learning" 1st edition, Pearson, 2018.

CHE 3241: PROCESS MODELLING AND SIMULATION LAB [0 0 3 1]

Experiments based on simulation of steady state – flash drum, reactors, distillation column, absorber, heat exchanger and chemical plants using ASPEN PLUS. Simulation of unsteady state operation of chemical plants using ASPEN DYNAMICS

CHE 3242: REACTION ENGINEERING AND PROCESS CONTROL LAB [0 0 3 1]

Experiments based on the following topics: Homogeneous non-catalytic liquid phase kinetic studies using batch reactor, semi-batch reactor, PFR and CSTR. Studies on recycle reactor. RTD Studies in PFR and CSTR-Dynamic response of systems: first order non-linear, thermometric; second order non-interacting and interacting by introducing a step input. Linearization of a non-linear system and comparison of dynamic response with the actual response, Valve characteristics, Studies on P, PI, and PID controllers; control of systems with cascading and ratio effects.

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

CHE 4291: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester to the end of seventh semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

CHE 4292: PROJECT WORK

The project work may be carried out in the institution/industry/research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out before the department committee as part of project evaluation.

MINOR SPECIALIZATIONS

I. PETROLEUM ENGINEERING

CHE 4401: OIL AND GAS RESERVOIR ENGINEERING [3 0 0 3]

Basic concepts of reservoir engineering: calculation of hydrocarbon volumes, fluid pressure regimes, recovery factor, volumetric gas reservoir, hydrocarbon phase behaviour; PVT analysis for oil: definition of parameters, fluid sampling, laboratory testing; Material balance applied to oil reservoirs; reservoir drive mechanisms, solution gas drive, gas cap drive, natural water drive; Darcy's law and applications: fluid potential, radial steady state flow, well stimulation, two phase flow: effective and relative permeability; Radial flow differential equation, conditions of solution; application of the stabilized inflow equations; enhanced oil recovery.

References:

1. Dake L. P., Fundamental of Reservoir Engineering, Elsevier, 2007.
2. Smith H. C., Tracy G. W., and Farrar R. L., Applied Reservoir Engineering: Volume I and II, OGCI, 2008.
3. Satter A., Baldwin J., and Jespersen R., Computer-Aided Reservoir Management, Pennwell, 2000.
4. Ahmed Tarek, Reservoir Engineering Handbook (4e), Gulf professional publishers, 2010.

CHE 4402: PETROLEUM REFINERY ENGINEERING (THEORY AND LAB) [2 0 3 3]

Crude oil origin, composition, characterization and classification; Refinery products and test methods; Design of crude oil distillation column; Refinery processes: thermal, catalytic, and hydrocracking, catalytic reforming, isomerization, alkylation, polymerization, lube oil processing, coking, hydro treatment, gas processing.

Laboratory: Experiments are based on determination of vapour pressure, flash point, fire point, pour point, smoke point, aniline point, viscosity, viscosity index, calorific value, carbon residue, softening point, and penetration index of petroleum fractions.

References:

1. James G Speight, The Chemistry and Technology of Petroleum (4e), CRC Press, 2006.
2. Nelson W. L., Petroleum Refining Engineering (4e), McGraw-Hill, 1974.
3. Bhaskara Rao B. K., Modern Petroleum Refining Processes (5e), Oxford & IBH, 2009.
4. Meyers R. A., Handbook of petroleum refining processes (3e), McGraw-Hill, 2004.

CHE 4403: NATURAL GAS ENGINEERING [3 0 0 3]

Types of natural gas resources; properties of natural gas; gas reservoir deliverability; construction of IPR curve, well deliverability testing; well bore performance; choke performance: sonic and subsonic flow; well deliverability: nodal analysis, production forecast; Natural gas processing: gas- liquid separators, low temperature separation; gas sweetening & dehydration; measurement and transportation; liquid loading, hydrate cleaning and pipeline cleaning; advances in natural gas production engineering.

References:

1. Guo B., Ghalambor A., Natural Gas Engineering Handbook, Gulf Publishing Company, 2nd Edition - 2012
2. Katz D. L., Lee R. L., Natural Gas Engineering, McGraw Hill, 1990.
3. Guo B., Lyons W. C., Ghalambor A., Petroleum Production Engineering: A Computer Assisted Approach, 1st Edition, Elsevier, 2007.
4. Ahmed T., McKinney P. D., Advanced Reservoir Engineering, Elsevier, 1st Edition – 2004.

CHE 4404: PROCESS INTEGRATION FOR PETROLEUM INDUSTRIES [3 0 0 3]

Understand the importance of energy integration in a petroleum industry, Energy integration, Focus on Pinch Analysis, Key Steps of Pinch Technology, Basic Elements of Pinch Technology: Grid diagram, Composite curve, Problem table algorithm, Grand composite curve. Heat Exchanger Network (HEN): Energy targeting, Area targeting, Number of units targeting. Designing of HEN: Pinch design methods, Heuristic rules, Stream splitting, Design of maximum energy recovery (MER); Heat Integration of Equipment's.

References:

1. Kemp I. C., Analysis and Process Integration: A User Guide on Process Integration for the efficient use of energy (2e), Butterworth-Heinemann (Elsevier) publisher, 2007.
2. Smith R. M., Chemical Process: Design and Integration, John Wiley & Sons, 2005.
3. Biegler, L. T.; Grossmann I. E.; Wasterberg, A. W., Systematic Methods of Chemical Process Design, Prentice Hall, New-Jersey, 1997.

II. POLLUTION CONTROL ENGINEERING

CHE 4405: INDUSTRIAL WASTEWATER ENGINEERING (THEORY AND LAB) [2 0 3 3]

Wastewater treatment quality criteria and effluent standards, Preliminary treatment processes, Primary treatment process, Biological treatment processes, microbial kinetics, nitrification and denitrification, Activated Sludge process, trickling filters and rotating biological contactors, advanced treatment processes Advanced treatment processes, Concept of zero liquid discharge. Lab may include tests for water/wastewater quality like pH, turbidity, DO, COD, BOD, TOC, total solids, fixed solids, dissolved solids, fluoride, residual chlorine, determination of particulate matter (PM2.5 and PM10) in air, desiccant dehumidifiers.

References:

1. Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse (5e), McGraw Hill, 2013.
2. Edwards J. D., Industrial Waste Water Treatment: A Guide Book (1e), CRC Press, 2019.
3. Patwardhan A. D., Industrial Waste Water Treatment, Prentice Hall India, 2009.
4. Ranade V. V., Bhandari V. M., Industrial Wastewater Treatment, Recycling and Reuse (2e), Prentice Hall India, 2017.
5. Droste R. L., Theory and Practice of Water and Wastewater Treatment, John Wiley & Sons, 2018.
6. Larry .D. Benefield, Clifford W. Randall "Biological process design for wastewater treatment", Prentice Hall publishers,1989

CHE 4406: SOLID AND HAZARDOUS WASTE MANAGEMENT [3 0 0 3]

Classification of solid wastes, Functional elements of Solid Waste Management (SWM), Regulatory aspects of SWM, Waste Characteristics, Environmental and health effects, Solid waste storage and collection, Transfer stations, Waste Processing techniques, Source reduction, recycle and recovery, Sanitary landfill, Landfill liners, Leachate and landfill gas management, Composting, Biogasification, Incineration, Introduction to Hazardous Waste Management (HWM), Guidelines for (HWM), International regulatory framework for HWM, Characterization of hazardous wastes, Packing and labelling of hazardous wastes, Storage, transport and disposal of hazardous wastes, Concept of Integrated waste management.

References:

1. Tchobanoglous G., Theisen H., Eliassen R., Solid Wastes: Engineering Principles and Management Issues, McGraw Hill, 1977.
2. Freeman H. W., Standard Handbook of Hazardous waste Treatment and Disposal (2e), McGraw Hill, 1997.
3. McBean E. A., Rovers F. A., Farquhar G. J., Solid Waste landfill Engineering and Design, Prentice Hall, 1995.
4. Lees F., Lees' Loss Prevention in the Process Industries: Hazard identification, assessment and control (3e), Butterworth-Heinemann, 2004.
5. Rao M. N., Sultana R., Kota S. H., Solid and Hazardous Waste Management: Science and Engineering (1e), B S Publications (imprinted by Elsevier), 2016.

CHE 4407: AIR POLLUTION MONITORING AND CONTROL [3 0 0 3]

The earth's atmosphere, structure and composition, air pollution history, sources and emissions, meteorology and instruments, gas sampling, atmospheric motion and pollutant transport, , atmospheric stability, gas phase chemistry and photochemical smog, air pollution monitoring, aerosols and particulate matter, SOx, NOx, VOCs, CO2, CO, particulate matter and their reduction, exposure and health effects, climate change, air pollution modelling, fixed box, Gaussian plume models

References:

1. Air Pollution, M N Rao and H V N Rao, McGraw Hill Education Pvt Ltd 2013
2. Martin Crawford, Pollution control theory, McGraw Hill, NY, 1976
3. Joe LedBetter, Air Pollution Part A & B, Marcel and Dekker, 1972
4. S. M. Khopkar, Environmental pollution Monitoring and control, New age Int, ND -2004
5. K.E Noll and T.L.Miller, Air Monitoring survey design, (1e), Ann Arber Science, 1977

CHE 4408: ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT PLAN [3 0 0 3]

Environmental impact assessment (EIA), history, Environmental movements, EIA laws and acts, EIA Methodologies, Adhoc methods, matrix methods, Network method etc., Cost/benefit Analysis, EIA 1994, 2006,2020, Methodology for the assessment of ground water, air, soil, water, case studies.

Environmental management - principles, problems and strategies, Environmental audit, introduction to ISO and ISO 14000, Life cycle assessment, Triple bottom line approach, Ecological foot print, Carbon trading, Sustainable development, case studies.

References:

1. L. W. Canter, Environmental Impact Assessment, (2e), McGraw-Hill, 1997
2. Environmental Impact Assessment Methodologies, by Y. Anjaneyulu, B.S. Publication, Sultan Bazar, Hyderabad (2006).
3. Environmental Impact Assessment, New age publishers, Barathwal 2012

III. RENEWABLE ENERGY ENGINEERING

CHE 4409: RENEWABLE ENERGY [3 0 0 3]

Solar radiation, measurement and estimation; empirical relations, solar collectors and types, Solar drying, Active and passive heating and cooling of buildings, Solar thermal power generation, and Solar pond. wind power density, power in a wind stream, wind turbine efficiency, solidity, HAWT, VAWT, and tower design. Biomass classification, handling of biomass. Biogas technology, Pyrolysis, and Gasification techniques. Hydroelectric power plants, types and components, site feasibility studies.

References:

1. Goswami D.Y., Frank Kreith, Jan. F. Kreider, "Principles of Solar Engineering", 3rd Edition, Taylor & Francis.2015.
2. Mukund & Patel R., Wind and Solar Power Systems., 3rd Edition, Taylor & Francis, 2021.
3. Chakravarthy A, "Biotechnology and Alternative Technologies for Utilization of Biomass or Agricultural Wastes", Oxford & IBH publishing Co 1989.

CHE 4410: SOLAR ENERGY [3 0 0 3]

Solar spectrum, Solar radiation data, collection of solar energy, Flat plate collectors, parabolic collectors, compound parabolic collectors, Solar air heater, Solar water heater, Solar concentrators, characteristic parameters, types of concentrators materials in concentrators, Solar cooking, Solar drying, Solar distillation and solar refrigeration, Solar Chimney, Solar thermal power generation, Central Power Station System, Distributed PV System, Standalone PV system, grid Interactive PV System, hybrid solar PV system, materials for solar PV cells.

References:

1. Sukhatme. S.P., J.K.Nayak "Solar Energy", 4th edition,Tata McGraw Hill Publishing Company Ltd., New Delhi,2017.
2. Tiwari. G.N., Solar Energy – "Fundamentals Design, Modelling & Applications", Narosa Publishing House, New Delhi, 2020.
3. Chetan Singh Solanki, Solar Photovoltaics, "Fundamentals, Technologies and Applications", PHI Learning Private Limited, New Delhi, 2015.
4. John R. Balfour, Michael L. Shaw, Sharlave Jarosek., "Introduction to Photovoltaics", Jones & Bartlett Publishers, Burlington, 2011.
5. D. Yogi Goswami, Frank Kreith, Jan. F. Kreider, "Principles of Solar Engineering", 2nd edition, Taylor & Francis, 2000
6. Garg.H.P, Prakash .J, "Solar Energy Fundamentals and Applications", Tata McGraw-Hill, 2005.
7. Duffie J. A and Beckman, W.A., "Solar Engineering of Thermal Process", John Wiley,2006.

CHE 4411: FUEL CELL & HYDROGEN ENERGY [3 0 0 3]

Hydrogen energy - Hydrogen: Hydrogen production methods, Fuel cell BASICS, Fuel cell thermodynamics, Fuel cell types, Fuel Cell Performance, Activation, Ohmic and Concentration over potential, Fuel cell design and components, Overview of intermediate/high-temperature fuel cells, Current issues in fuel cells

References:

1. Larminie J. and Dicks A., Fuel Cell Systems Explained, 2nd Edition, Wiley (2003)
2. Xianguo Li, Principles of Fuel Cells, Taylor and Francis (2005)
3. Srinivasan S., Fuel Cells: From fundamentals to Applications, Springer (2006)
4. O'Hayre, S.W.Cha, W.Colella and F.B.Prinz, Fuel Cell Fundamentals, Wiley (2005)
5. Bard A.J. and.Faulkner L.R, Electrochemical Methods: Fundamentals and Applications, 2nd Edition, Wiley 2000.
6. Faghri A and Zhang Y., Transport Phenomena in Multiphase Systems, Elsevier 2006.

CHE 4412: BIO ENERGY ENGINEERING [3 0 0 3]

Biomass sources and classification, Characteristics preparation, Chemical composition and properties of different biomass materials and bio-fuels. Sugarcane molasses and other sources for fermentation ethanol. Sources and processing of oils and fats for liquid fuels. Energy plantations. Briquette of loose biomass, drying storage and handling of biomass. Biogas technology, Feedstock for biogas production, Aqueous waste containing biodegradable organic matter, animal residues, microbial and biochemical aspects, operating parameters for biogas production, kinetics and mechanism, dry and wet fermentation. Digesters for natural applications, High rate digesters for industrial waste water treatment. Bio-ethanol and bio-diesel technology, Production of fuel ethanol by fermentation of sugars, gasohol as a substitute for petro, Trans-esterification of oils to produce bio-fuels, Pyrolysis and gasification of biomass, Thermochemical conversion lignocelluloses biomass, Biomass processing for liquid fuel production, Pyrolysis of biomass. Pyrolysis regime, effect of particle size, temperature and products obtained, Thermo-chemical gasification principles, Effect of pressure temperature and introduction of steam and oxygen. Combustion of biomass and co-generation systems, Combustion of woody biomass. Theory, calculation and design of equipment. Co-generation in biomass processing industries, Combustion of rice husk, use of bagasse for cogeneration.

References:

1. A Chakraverthy, Biotechnology and alternative technologies for utilization of biomass or agricultural wastes, (1e), Oxford & IBA, New Delhi. 1989.
2. K M Mittal, Biogas systems: Principles and applications, (1e), New Age International Publishers (P) Ltd. 1996.
3. P. Venkata Ramana, S. N. Srinivas, Biomass energy systems, (1e),Tata energy Research Institute New Delhi, 1996.

PROGRAM ELECTIVES

CHE 4441: ADAVANCED PROCESS CONTROL [2 1 0 3]

Review of classical control, Enhancement of single loop control performance and MIMO system analysis: A brief review of classical control concepts, Design of feed forward and ratio controls, Study of cascade control system. Design of Time delay compensator (Smith predictor). Interaction Analysis in MIMO systems. RGA Analysis. Design of De-couplers. Introduction to adaptive control strategy. State space representation of continuous time systems & its analysis: Review of Matrix algebra, State space representation of continuous time systems. Development of state space models. Analysis of state space models. Linearization of nonlinear system, Concept of Controllability and Observability. Controller design using pole placement approach. Stability of linear control system. (Jury's stability criteria and Eigen value approach). Models for computer control: Introduction to discrete time system and analysis using Z-transform. Development pulse transfer function. Discrete state space representation. Stability of linear discrete systems. Design of experiments for development of control relevant models. Models for computer control from input-output data. Discrete dynamic models, Impulse response models and step response models. Parameter estimation problem. Parameter estimation of Black box models (i.e. ARX, ARMAX Models). State Estimator & model predictive control: Development of model based control. Design of State estimation and Observers, soft sensors, recursive least square estimation, Kalman Filter, linear quadratic optimal control (LQOC), model predictive control (MPC). Introduction to statistical process control.

References:

1. Seborg D.E., Edgar T.F., Mellichamp, Process dynamics and control, (2e), John Wiley & sons, 2004
2. Harmon Ray W., Babatunde Ogunnaike. Process dynamics, modeling and control, Oxford University press. 1994
3. Ogata K., Discrete Time Control systems (2e), Pearson Education, 2005.
4. Astrom K. J. and Wittermark B., Computer-Controlled Systems: Theory and Design (3e) Prentice Hall; 1996
5. Tangirala A. K., Principles of System Identification: Theory and Practice, CRC Press, 2005.
6. Lennart Ljung, System Identification: Theory for the users (3e), Prentice Hall; 2005.

CHE 4442: APLLIED INTERFACIAL ENGINEERING [3 0 0 3]

General introduction of colloids and interfaces, the role of mixing and entropy, Colloid stability, colloid behavior at surfaces, Experimental interrogation of colloids and surfaces, Understanding adsorption at surfaces (Thermodynamics of interfaces), and its application, Self –assembly of Amphiphiles (surfactants), Particles at interfaces and Applications, Novel fabrication of nano structured particles and applications, Electron transfer across interfaces and applications, Latest trends in interfacial science and latest innovation in interfacial engineering applications.

References:

1. Hiemenz, P. C, Rajagopalan, R., Principles of Colloid and Surface Chemistry, (3e), Marcel Dekker, New York, 1997.
2. Rosen M. J., Surfactants and Interfacial Phenomena, Wiley-Interscience Publication, New York, 1978.
3. Adamson, A. W. Gast, A. P., Physical Chemistry of Surfaces, Wiley-Interscience, New York, 1997.
4. Evans D. F., Kakan Wennerstrom, The Colloidal Domain: Where Physics, Chemistry, Biology, and Technology Meet (Advances in Interfacial Engineering), Wiley-VCH, 1999
5. Israechvili J., Intermolecular & Surface Forces (2e), Academic Press,1992

CHE 4443: CLEAN TECHNOLOGIES IN PROCESS INDUSTRIES [3 0 0 3]

Introduction: Chemical technology and environmental concerns, environmental impact of chemicals, half-life and fate of chemicals, life-cycle assessment of chemicals, concept of clean technology. Evaluation of Technology: Evaluation of existing process technologies of ammonia, sulphuric acid, caustic soda, rayon, pulp and paper, leather, plastics, polymers and organic chemicals. Analysis of raw materials, intermediates, final products, bye-products and waste generation; Emissions and effluents from the process plants and their ultimate fate. Technology Modification: Modification in processes, use of new catalysts, waste to wealth approach, recycling, and reuse technologies in chemical process industries (petroleum, petrochemical, pulp and paper, chlor-alkali, sugar and distillery). Alternative Technology: Alternative raw materials; Low temperature, low pressure and energy-efficient routes for the manufacture of caustic soda, leather, plastics, pulp and paper and rayon; Use of CO2 for valuable chemicals. Advanced Technology: Development of biodegradable end-products of polymers and plastics, eco-friendly technologies for oil extraction and chemical manufacturing.

References:

1. Schaltegger S., Bennett M., Burritt R.L. and Jasch C.M., “Environmental management Accounting for Cleaner Production”, Springer, 2008.
2. Freeman H.M., Puskas Z. and Olbina R., “Cleaner Technologies and Cleaner Products for Sustainable Development”, Springer, 1995.
3. Mukhopadhyay P.K. and Roy T.K., “Ecofriendly and Clean Technologies” Indian National Academy of Engineering, 1997.
4. Johansson A., “Clean Technology”, CRC Press, 1992.
5. Kafarov V.V., “Wasteless Chemical Processes”, Mir, 1985.
6. Guisnet M. and Gilson J.P., “Zeolites for Cleaner Production”, World Scientific. 2002.

CHE 4444: ENERGY ENGINEERING [3 0 0 3]

Classification. characterisation and testing of solid liquid and gaseous fuels. Theories on the origin and processing of solid and liquid fuels. Gaseous fuels- manufacture and properties. Terminology and types of combustion techniques - calculation of air requirement, grates, burners and stokers. Furnaces- Classification, construction and types used in process industries. Energy scenario in India, renewable sources of energy. Energy audit and energy conservation in different sectors.

References:

1. Sharma, S.P., Chander Mohan, “Fuels and Combustion”, Tata McGraw-Hill, .
2. Saha, A.K., “Combustion Engineering and Fuel technology”, Oxford Press.

3. Gilchrist, J.D., "Fuels, Furnaces and Refractories", Pergamon Press,
4. Manson L. Smith, Keri W. Stinson, "Fuels and Combustion", McGraw-Hill,

CHE 4445: GREEN PROCESSES [3 0 0 3]

Introduction: Definition, the twelve basic principles of green chemistry. Green synthetic methods: Microwave synthesis, electro-organic synthesis, The design and development of environmentally friendly chemical pathways: challenges and opportunities. High-yield and zero-waste chemical processes. Representative processes. Materials for green chemistry and technology: Catalysis, environmental friendly catalysts, Bio-catalysis, biodegradable polymers, alternative solvents, ionic liquids Bio-energy: Thermo-chemical conversion: direct combustion, gasification, pyrolysis and liquefaction; Biochemical conversion: anaerobic digestion, alcohol production from biomass; Chemical conversion process: hydrolysis and hydrogenation; Biophotolysis: Hydrogen generation from algae biological pathways; Storage and transportation; Applications

References:

1. Mikami K., Green Reaction Media in Organic Synthesis, Wiley-Blackwell 2005.
2. Koichi T., Solvent-free Organic Synthesis Green chemistry, Wiley-VCH; 2003
3. Maartje F. K. and Thierry M., Supercritical Carbon Dioxide: in Polymer Reaction Engineering Green Chemistry, Wiley VCH 2005
4. Alvise P., Fulvio Z., and Pietro T., Methods and Reagents for Green Chemistry: An Introduction, Wiley Inter science 2007
5. Lancaster M,Green Chemistry, RSC 2002
6. Stanely E. Manahan, Green Chemistry and the Ten Commandments of Sustainability, ChemChar 2005
7. David T. A. and David R. S., Green Engineering: Environmentally conscious Design of Chemical Processes, Prentice Hall PTR 2001
8. Roger A. S., Isabel A., and Hanefeld U., Green Chemistry and Catalysis , Wiley VCH, 2007
9. James V. B., Heat Conduction Using Green's Function (Series in Computational and Physical Processes in Mechanics and Thermal Sciences) Taylor & Francis, 1992

CHE 4446: INDUSTRIAL SAFETY AND RISK MANAGEMENT [3 0 0 3]

Management of safety in Industry- Concept of Safety, Applicable areas, unsafe actions & Conditions. Safety Committee - Membership, Functions & Scope of Safety committee. Guidelines for safeguarding personnel. Safety education and training-Safety managements, fundamentals of safety tenets, measuring safety performance, motivating safety performance, legal aspects of industrial safety, safety audits. Disaster Management - Designing, Importance & implementation of Disaster Control Action Plan; Hazard identification methodologies, risk assessment methods-PHA, HAZOP, MCA, ETA, FTA, Consequence analysis, Probit Analysis. Hazards in work places. Worker's exposures to hazardous chemicals. Hazards peculiar in industries.

References:

1. F.P.Lees, Loss prevention in process industries, 2/e, Butterworth-Heinemann,. 1996
2. W.Handley, Industrial Safety hand book, 2/e, McGraw- Hill, 1977
3. King R W;Magid J, Industrial hazards and safety hand book, Butterworth, London, 1980.

CHE 4447: INTRODUCTION TO BIOCHEMICAL ENGINEERING [3 0 0 3]

Introduction; Principles of Microbiology; Chemicals of Life: Carbohydrates, Amino acids, Proteins, Lipids, Nucleic acids; Cell Nutrients, Growth Media; Kinetics of enzymes; Inhibition, production, purification, immobilization and application of enzymes; Metabolic pathways and energetic of the cell: Glucose, Nitrogen, and Hydrocarbon metabolism; Overview of biosynthesis, Anaerobic metabolism, Autotropic metabolism; Transport across cell membranes; Cell growth: Batch growth and Quantification of growth kinetics

References:

1. Bailey J.S., Ollis D.F., Biochemical Engineering Fundamentals (2e), McGraw-Hill, 2017
2. Shuler M.L., Kargi F., Delisa M., Bioprocess Engineering: Basic Concepts (3e), 2017
3. Blanch H.W., Clark D.S., Biochemical Engineering (2e), CRC Press, 1997

CHE 4448: MATERIALS SCIENCE AND ENGINEERING [2 1 0 3]

Historical perspective, scope of materials science and engineering, atomic structure and interatomic bonding, Lattices, basic idea of symmetry, Bravais lattices, unit cells, crystal structures, crystal planes and directions, co-ordination number. Single crystals, polycrystalline, non-crystalline, nanocrystalline materials. Imperfections in solids: point defects, line defects, surface defects. Solid solutions, phases, phase diagrams. Diffusion phenomenon, phase transformations. Strengthening mechanisms. Classification of materials, properties of materials. Structure, properties and applications of different metals and alloys, ceramics and polymers.

References:

1. Callister W. D. Materials Science and Engineering, an Introduction, John Willey and Sons Inc. Singapore 2014
2. Raghavan. V., Physical Metallurgy: Principle and Practice, Prentice Hall India Pvt Ltd, 2004.
3. Dieter G. E, Mechanical Metallurgy, 3rd Ed, Mcgraw Hill, London, 2017.

CHE 4449: MEMBRANE SCIENCE AND TECHNOLOGY [3 0 0 3]

Membrane preparation and structure, membrane permeability, flow pattern and classification: micro filtration, ultra filtration, nano filtration, reverse osmosis, electrodyalysis, dialysis, membrane modules and plant configuration, liquid separation: pervaporation, vacuum membrane distillation, transport through membrane, solution diffusion model and Donnan equilibrium, Kimura-Sourirajan model, Spiegler and Kedem model, Extended Nernst-Planck model. Gas separation: complete mixing model (binary and multi component) for gas separation, cross flow model, counter current flow model, single stage membrane separation, multistage membrane separation and analogy with multi component distillation, differential permeation with point permeate withdrawal, bubble point type curve, dew point type curve. Membrane reactor: perovskite type, bio catalytic membrane reactor, application of membrane in separation of optical isomers of valued bioactive materials. Transport through bio membrane like kidney.

References:

1. E. J. Hoffman, Membrane separations Technology: single-stage, Multistage, and Differential Permeation, (1e), Gulf Professional Publishing, 2003
2. M.H.V. Mulder, Membrane Separation, (1e), Springer Publ. -2007
3. K.S. Scott, Robert Hughes (Editors), Industrial Membrane Separation Technology, (1e), Blackie Academic & Professional Chapmann & Hall, Glasgaw, 1996

CHE 4450: MOLECULAR MODELLING AND SIMULATION [2 1 0 3]

Introduction to molecular modelling, potential energy surfaces, molecular orbital theory, density functional theory, molecular mechanics and force fields, introduction to programming methods and algorithms used in the course, molecular dynamics simulations, molecular dynamics of hard spheres, periodic boundaries, ensembles, Monte Carlo simulations, free energy calculations, phase equilibria calculations, interfacial properties, rare events.

References:

1. M. P. Allen & D. J. Tildesley Computer Simulation of Liquids, Oxford University Press, 1987.
2. Daan Frenkel & Berend Smit Understanding Molecular Simulation, 2nd Ed. Elsevier 2002.
3. Anthony Stone, The Theory of Intermolecular Forces, 2nd Ed. Pearson, 2013.
4. Andrew Leach; Molecular Modelling – Principles and Applications, 2nd Ed. Prentice Hall, 2001

CHE 4451: NON-NEWTONIAN FLUID FLOW IN PROCESS INDUSTRIES [3 0 0 3]

Classification of fluid behaviour and types of non-Newtonian fluids and their mathematical model representation, Rheometry for non-Newtonian fluids: capillary, rotational, normal stress, controlled stress, yield stress rheometers, Generalized Reynolds number of power law and Bingham plastic fluids and pressure drop calculation of Power law fluids and Bingham plastic fluids in pipes. Flow of Power law fluids in noncircular pipes, Flow regimes of gas –non-Newtonian fluids in pipes.

References:

1. Chhabra R. P. and Richardson J. F., Non-Newtonian flow in the process Industries, Butterworth and Heinemann, 1999.
2. McCabe W., Smith J., Harriott P., Unit Operations of Chemical Engineering (7e), McGraw Hill Education, 2017.
3. Carreau P. J., DeKee D. C. R., Chhabra R. P., Rheology of Polymeric Systems: Principles and Applications, Hanser Publishers, 1997.

CHE 4452: PETROCHEMICALS [3 0 0 3]

General introduction – Economics and future prospects of petrochemicals – Energy crisis and petrochemical industry – Sources and classification of petrochemicals

First generation petrochemicals – Alkanes – Alkenes and alkynes – BTX aromatics – Diene base petrochemicals

Second generation petrochemicals – Synthesis gas – Methanol – Formaldehyde – Chloromethanes – Ethanol – Acetaldehyde – Acetic acid – Acetic anhydride – Isopropyl alcohol – Ethylene oxide – Propylene oxide – Acetone – Vinyl chloride – Phenol – Aniline – Styrene

Third generation petrochemicals – Plastics – Rubber – fibres – olefinic polymers – Polyethylene – Polypropylene – Poly-isobutylene – Diene polymers – Polybutadiene – Neoprene – Polyisoprene – SBR – Synthetic fibres

References:

1. Maiti, S., Introduction to Petrochemicals, Oxford and IBH Publishing Co. Ltd., 1992
2. B K Bhaskar rao, A text on Petrochemicals, Khanna Publishers (5e), 2015
3. Saikat Mitra and Om Prakash Gupta, Elements of Petrochemical Engineering, Khanna Publishing House, 2017

CHE 4453: PROCESS DATA ANALYSIS [2 1 0 3]

Fundamental Statistical Analysis and Multivariate Linear Regression Analysis: Fundamental statistical analysis, Simple regression analysis, Multiple regression analysis, Parameter estimation, grey model, black box model, Statistical properties of linear regression Analysis of variance, Determine model adequacy, Statistical inferences based on multivariate linear regression models ,Weighted least squares. Nonlinear Regression Analysis: linearization through data transformation, nonlinear regression, Statistical analysis of nonlinear, regression, Determine model adequacy, Statistical inferences based on nonlinear regression models, Linear versus nonlinear regression. Design of Experiments: Strategies for experimentation, Single factor experiments, Two-level factorial experiments, Fractional factorial design, multiple level factorial experiments, Analysis of variance, Interpretation of results from experiments. Selected Advanced Topics: Response surface methods for optimal experimentation decision making, Statistical quality Control, Introduction to control monitoring charts. Laboratory exercises includes: Computational Experiment & Pilot-scale Experiments (laboratory experiments on linear and nonlinear regression analysis)

References:

1. Montgomery D.C., Design and Analysis of Experiments (8e), Wiley,2012.
2. Montgomery D.C. and Runger G.C., Applied Statistics and Probability for Engineers.1994
3. Box G.E.P., Hunter W.G. and Hunter J.S., Statistics for Experimenters, John Wiley & Sons, 1978.

CHE 4454: PROCESS INSTRUMENTATION [3 0 0 3]

Functions and Elements of measuring instruments: Static and Dynamic characteristics, Errors in measuring instruments. Temperature measurement: Filled system thermometers, Metallic expansion thermometers, Resistance thermometers, Thermistors, Thermocouples, Radiation pyrometers, Temperature transducers. Pressure measurement: Mechanical pressure instruments – Manometers, Elastic type pressure gauge; Electrical methods of pressure measurements; Strain gauge, Capacitance pressure transducer, Potentiometric, Piezoelectric, Magnetic, Optical pressure transducers. Vacuum sensors: Mechanical vacuum gauges, Thermal vacuum gauges, Ionization gauges. Flow measurement: Variable Head type flow meters: Orifice meters, Venture meters, Flow nozzle, Pilot tube, Variable area flow meters, Differential pressure transmitters, Quantity meters, Mass flow meters, Electrical flow meters: Electro-magnetic, Ultrasonic, Laser Doppler, Vortex shedding flow meter, Anemometer. Level measurement: Gauge glass, Float, Displace and Torque type, Air purge/bubbler type, Level measurements by electric methods: Resistance, Capacitance, Radiation, Ultrasonic, Microwave, Optical, Radar, and Laser. Density measurement: Displacement & float type, Hydrometers, Ultrasonic and Sonic, Radiation densitometers, Gas densitometers. Viscosity measurement: Capillary, Efflux cup, Falling ball, Float, Rotational, Gyrating, Vibrating rod, Plastometers Humidity measurement: Dry & wet bulb Psychrometer, Hair Hydrometers, Thin film capacitance, Humidity sensor, Dew-point Hydrometers.

References:

1. K Krishnaswamy, S Vijayachitra, Industrial Instrumentation, New Age International (P) Limited, 2005.
2. Donald Eckman, Industrial Instrumentation, Wiley Eastern Limited.
3. S K Singh, Industrial Instrumentation & control, Tata McGraw Hill Educational Private Limited, 2009.

CHE 4455: PROJECT ENGINEERING [3 0 0 3]

Preliminary data on projects; Process engineering, Block flow diagram, Process flow diagram, Piping and instrumentation diagram, Pilot plants, General considerations for plant location and layout, piping design, Project engineering management, Project scheduling and its importance, PERT and CPM techniques, Piping design, plant utilities, insulation, instrumentation, safety in chemical plant, Gantt chart, Optimum project design, optimum production rates, selected examples such as heat exchangers, pumps , vessels, evaporators, and driers.

References:

1. Howard F. Rase, M.H. Barrow, Project Engineering of Process Plants, John Wiley, 1968
2. Warren Sieder, J.D. Seader, Daniel Lewin, Product and Process Design Principles, John Wiley, 2004
3. Peters M. S, Klaus D. T., Ronald E. W., Plant Design and Economics for Chemical Engineers, McGraw- Hill, 2003
4. Gavin T. & Ray S., Chemical Engineering Design-Principles, Practice and Economics of Plant and Process Design, Butterworth and Heinemann (Elsevier), 2020.

CHE 4456: SYSTEM IDENTIFICATION [2 1 0 3]

Introduction to Identification and models for linear Deterministic systems: Motivation, Incentives in model developments, Benefits, System identification –Terminology and notation, types of models, System identification procedure. Modelling example using MATLAB. Mathematical description of process models: Definition of model, classification of models, Input excitation types, Criteria for input excitation. Sampling and discretization: Sampled data system, zero order hold, sampler, sampling criteria. Examples using MATLAB. Models for discrete Time LTI systems: Transfer function operator and transfer function, Convolution models, Response models- Finite Impulse Response (FIR) Model, Step Response Models, state space descriptions, Forma of state space representation, controllability, observability, example in MATLAB for estimating LTI models. Stability of linear discrete systems. Examples using MATLAB. Models for Random Process: Introductory remarks, Random variables, Random signals and processes, Application of time series analysis, Time domain analysis, Models for linear stationary processes, MA, AR models. Examples using MATLAB. Estimation Methods: Least square estimators, linear least square, weighted least square, output error models, and equation error models, Predictions: one step ahead predictor, L-step ahead predictor. Identification of time series parametric models: ARX, ARMAX. Examples using MATLAB.

References:

1. Tangirala A. K., Principles of System Identification: Theory and Practice, CRC Press, 2005
2. Ljung L., System Identification: Theory for the users (3e), Prentice Hall, 2005.
3. Astrom K. J. and Wittermark B., Computer-Controlled Systems: Theory and Design (3e), Prentice Hall, 1996
4. Seborg D.E., Edgar T.F., Mellichamp, Process dynamics and control (2e), John Wiley & sons, 2004
5. Harmon Ray W., Babatunde Ogunnaike. Process dynamics, modelling and control, Oxford University press. 1994
6. Ogata K., Discrete Time Control systems (2e), Pearson Education, 2005.

CHM 4441: ANALYTICAL TECHNIQUES AND INSTRUMENTATION [3 0 0 3]

Spectroscopic methods of analysis: Properties of EMR, General features of spectroscopy, types of molecular spectra, Interaction of EMR with matter, Instrumentation, Applications, Theory, Instrumentation and applications of Microwave, Raman, Infrared, UV-Visible, NMR spectroscopic techniques. Chromatographic Techniques: General concepts, Classification, Principles, Experimental techniques of CC, HPLC, TLC, GC and their applications. Electroanalytical methods: Basic principles and applications of conductometric, potentiometrictitrations.

References

1. D.A. Skoog, J. Holler, F.T.A. Nieman, Principles of instrumental analysis, 5th Edn, Saunders, Philadelphia, 1992
2. D.A. Skoog, D.M. West and F.J. Holler, Fundamentals of analytical

Chemistry, 5th Edn, Saunders college Publishing, Philadelphia, 1988

3. Vogel's Textbook of Quantitative Chemical Analysis, GH Jeffery, John Wiley & Sons Inc, 5th Edn, 1989

OPEN ELECTIVES

CHE 4311: INDUSTRIAL POLLUTION CONTROL [3 0 0 3]

Symbiosis between man and environment, Nutrient and hydrologic cycles, Types of pollution, Legislation to environmental pollution, Phases involved in establishment of plant monitoring and control system, Evaluation and characterization of wastewater, Treatment methods, Concept of Zero Liquid Discharge, Sludge treatment and disposal, Solid waste management, Noise pollution and control, E-waste – sources and effects, e-waste management, Ambient air and stack gas sampling, Analysis of air pollutants, Plume behaviour, Meteorological factors affecting air pollution, Equipment for control and abatement of air pollution, Pollution from automobiles – control mechanisms.

References:

1. Mahajan S.P., Pollution Control in Process Industries, Tata McGraw Hill, 1990
2. Rao C.S., Environmental Pollution Control Engineering, Wiley Eastern, 1992.
3. Noel De Nevers, Air pollution Control Engineering, (2e), McGraw-Hill, 1999
4. Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, (2e), McGraw-Hill, 2002

CHE 4312: RISK AND SAFETY MANAGEMENT IN INDUSTRIES [3 0 0 3]

Safety in plants: Hazard analysis, damage minimization, fires, fire extinguishers, handling, contamination removal, reduction methods, personal protective devices, Plant and personal safety. Pressure vessels, handling and transportations of liquids and gases under high pressure, explosive chemicals and handling. First aid principles and methods, plant inspection. Engineering design for safety considerations. Hazards in work places, workers' exposure to hazardous chemicals, threshold limit values of chemicals, engineering control of hazards and accidents due to fire, explosives and natural causes in different industries. Safety management, safety performance, motivation of employees, supervisors, managers and management, legal aspects of safety.

References:

1. Willie Hammer, Dennis Price, Occupational Safety Management and Engineering, Prentice Hall, fifth edition
2. Safety Analysis: Principles and Practice in Occupational Safety, Harms-Ringdahl, Lars,CRC Press; 2nd edition (19 September 2019)
3. Muir G.D, Hazards in Chemical Laboratory, (2e), The Chemical Society, London, 2nd edition
4. Handley W., Industrial Safety Handbook, McGraw-Hill Companies; 2nd Revised edition

CHE 4313: WATER TREATMENT TECHNOLOGY [3 0 0 3]

Water demand per capita, drinking water standards (BIS and WHO), drinking water treatment–Nalgonda process. Water distribution networks, Sanitary and storm sewerage systems, Wastewater treatment quality and quantity estimation, Preliminary treatment, Primary treatment, Biological treatment processes, advanced treatment processes, concept of zero liquid discharge, wastewater disposal in receiving bodies, water recycling and reuse.

References:

1. Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse (5e), McGraw Hill, 2013. 2. Edwards J. D., Industrial Waste Water Treatment: A Guide Book (1e), CRC Press, 2019.
3. Patwardhan A. D., Industrial Waste Water Treatment, Prentice Hall India, 2009.
4. Ranade V. V., Bhandari V. M., Industrial Wastewater Treatment, Recycling and Reuse (2e), Prentice Hall India, 2017.
6. Droste R. L., Theory and Practice of Water and Wastewater Treatment, John Wiley & Sons, 2018.
7. Hammer, M.J., Water and Wastewater Technology –SI Version, (2e), John Wiley and Sons, 2012.
8. Larry .D. Benefield, Clifford W. Randall “Biological process design for wastewater treatment”, Prentice Hall publishers,1989.

CHE 4314: INTRODUCTION TO PETROLEUM ENGINEERING [3 0 0 3]

Overview and history of the petroleum industry – Petroleum reserves, production and consumption statistics of the world; Crude oil – Origin, exploration techniques, drilling operations and components, crude oil composition, classification and properties; Reservoir – types, and properties of reservoir, various reservoir drive mechanisms and recovery methods, estimation of oil and gas in place, enhanced oil recovery (EOR) methods; Fundamentals of refinery, major operations and processes; Refinery products and test methods.

Reference:

1. John R. Fanchi, Richard L. Christiansen, Introduction to Petroleum Engineering. (1e) Wiley, 2016
2. Mark J. Kaiser, Arno de Klerk, James H. Gary, Glenn E. Handwerk, Petroleum Refining Technology, Economics and Markets, (6e), CRC Press, 2019
3. O.P. Gupta, Elements of Petroleum Refinery Engineering, Published by Khanna Publishing House, 2019
4. Ahmed Tarek, Reservoir Engineering Handbook, (5e), Gulf professional publishers, 2018.
5. Uttam R. Chaudhuri, Fundamentals of Petroleum and Petrochemical Engineering, CRC Press 2011.
6. L. P. Dake, Fundamental of Reservoir Engineering, Elsevier, 2011.
7. Wilbur L. Nelson, Petroleum Refining Engineering, (4e), McGraw-Hill, 1990.

Department of
Civil Engineering

Civil Engineering Department was established in the year 1957 with the inception of Manipal Institute of Technology. In the 67 years of its glorious existence, the Civil Engineering Department has evolved into one of the most matured and full-fledged departments in the institute.

The Undergraduate and Postgraduate program course curriculum have been designed aptly to cater to the ever expanding demands of research and industry, by continuously soliciting feedback from all stake holders. The department upholds excellent interaction with reputed academics in specialized areas, and also with industry professionals at national and international levels.

The department has created a platform for exchanging research ideas by organizing conferences, workshops, and seminars from time to time. The department ardently fosters the industry-academia collaborations by conducting invited lectures by eminent industry professionals. B.Tech (Civil Engg) program has consistently received accreditation by the National Board of Accreditation in the year 2001 for a period of 5 years, and in the year 2008 for a period of 3 years, in 2019 for a period of 3 years, and also in 2025 for a period of 3 more years.

> Programs offered

Undergraduate Program

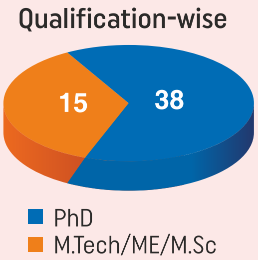
- B.Tech in Civil Engineering (1957)

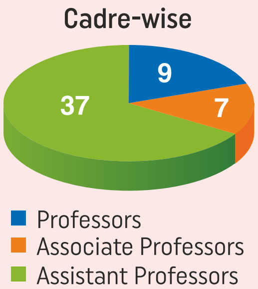
Postgraduate Programs

- M.Tech in Construction Engineering and Management (1989)
- M.Tech in Structural Engineering (1992)
- M.Tech in Environmental Engineering (2010)
- MSc in Geology (2015)

PhD

> Faffiliation Strength





B.TECH. CIVIL ENGINEERING

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2125	Engineering Mathematics - III	2	1	0	3	MAT 2225	Engineering Mathematics – IV	2	1	0	3
	CIE 2121	Fluid Mechanics	3	1	0	4	CIE 2221	Geotechnical Engineering	3	0	0	3
	CIE 2122	Surveying	2	1	0	3	CIE 2222	Transportation Engineering	4	0	0	4
	CIE 2123	Building Materials	3	0	0	3	CIE 2223	Basic Reinforced Concrete Design	2	1	0	3
	CIE 2124	Mechanics of Structures	3	1	0	4	CIE 2224	Wastewater Management	3	0	0	3
	CIE 2125	Water Supply Engineering	3	0	0	3	CIE 2225	Water Resource Engineering	2	1	0	3
	CIE 2141	Fluid Mechanics Lab	0	0	3	1	CIE 2241	Surveying Practice	0	0	3	1
	CIE 2142	Material Testing Lab	0	0	3	1	CIE 2242	Environmental Engineering Lab	0	0	3	1
			16	**4**	**6**	**22**			**16**	**3**	**6**	**21**
	Total Contact Hours (L + T + P)		**26**				**Total Contact Hours (L+T+P)**		**26**			
	FIFTH SEMESTER						**SIXTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	HUM 3022	Essentials of Management	2	1	0	3	HUM 3021	Engineering Economics and Financial Management	2	1	0	3
	CIE 3121	Basic Structural Steel Design	2	1	0	3	CIE ****	Flexible Core - 2 (A2/B2/C2)	3	1	0	4
	CIE 3122	Applied Soil Engineering	2	1	0	3	CIE ****	Flexible Core - 3 (A3/B3/C3)	3	0	0	3
	CIE 3123	Estimation, Costing and Project Management	3	1	0	4	CIE ****	Program Elective – I / Minor Specialization	3	0	0	3
	CIE ****	Flexible Core - 1 (A1/B1/C1)	3	0	0	3	CIE ****	Program Elective – II / Minor Specialization	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective - 2	3	0	0	3
	CIE 3141	Soil Mechanics Lab	0	0	3	1	CIE 3241	Building Design and Modelling	0	0	3	1
	CIE 3142	Computer Aided Structural Analysis and Design Lab	0	0	3	1	CIE 3242	Structural Detailing and Drawing	0	0	3	1
			16	**3**	**6**	**21**			**17**	**2**	**6**	**21**
	Total Contact Hours (L+T+P) + OE		**25**				**Total Contact Hours (L+T+P)**		**25**			
	SEVENTH SEMESTER						**EIGHTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
IV	CIE ****	Program Elective - III / Minor Specialization	3	0	0	3	CIE 4291	Industrial Training				1
	CIE ****	Program Elective - IV / Minor Specialization	3	0	0	3	CIE 4292	Project Work				12
	CIE ****	Program Elective - V	3	0	0	3	CIE 4293	Project Work (B.Tech Honours)**				20
	CIE ****	Program Elective - VI	3	0	0	3	CIE ****	B.Tech Honours (Theory 1)** (V Semester)				4
	CIE ****	Program Elective - VII	3	0	0	3	CIE ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	*** ****	Open Elective - 3	3	0	0	3	CIE ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	CIE 4191	Mini Project (Minor Specialization)*				8						
			18	**0**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P) + OE		**18**									

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

FLEXIBLE CORE-A

STRUCTURAL DESIGN

CIE 3124: Design of Pre-Stressed Concrete Structures (A1)
CIE 3221: Advanced Mechanics of Structures (A2)
CIE 3223: Design of Reinforced Concrete Structures (A3)

FLEXIBLE CORE-B

SUSTAINABLE CONSTRUCTION

CIE 3125: Precast Technology (B1)
CIE 3222: Contemporary Construction Practices and Sustainability (B2)
CIE 3224: Engineering Practice & Ethics (B3)

FLEXIBLE CORE-C

MULTI-MODAL TRANSPORTATION INFRASTRUCTURE

CIE 3126: Highway Planning, Design & Construction
CIE 3225: Airports & Seaports Engineering
CIE 3226: Metro Rail Transportation Systems & Construction

MINOR SPECIALIZATION

I. BUILDING CONSTRUCTION AND MANAGEMENT

CIE 4401: Advances in Concrete Technology
CIE 4402: Building Codes and Functional Services
CIE 4403: Construction Materials and Quality Management
CIE 4404: Contract Management

II. ENVIRONMENTAL ENGINEERING

CIE 4405: Air Pollution and Control
CIE 4406: Industrial Wastewater Treatment
CIE 4407: Solid Waste Management
CIE 4408: Integrated Management of Watershed Ecology

III. STRUCTURAL ENGINEERING

CIE 4409: Structural Dynamics
CIE 4410: Design of Steel Structures
CIE 4411: Finite Element Method of Analysis
CIE 4412: Design of Foundation and Earth Retaining Structures

IV. TRANSPORTATION ENGINEERING

CIE 4413: Urban Mass Transport System
CIE 4414: Urban Transport Planning
CIE 4415: Pavement Material and Design
CIE 4416: Traffic Systems and Engineering

V. ADVANCED PRACTICES IN CONSTRUCTION

CIE 4417: Formwork Engineering Practices
CIE 4418: Deep Excavations, Foundations&Tunnels
CIE 4419: Building Information Modelling in Construction
CIE 4420: Sustainability Practices in Design of Building

VI. INTEGRATED BUILDING SYSTEM DESIGN

CIE 4421: Pre-Engineered Buildings
CIE 4422: Mechanized Construction Techniques
CIE 4423: Integrated Approach to Building Services
CIE 4424: Concrete Building Systems Design

OTHER ELECTIVES

CIE 4441: Bridge Engineering
CIE 4442: Coastal Engineering
CIE 4443: Disaster Management & Mitigation
CIE 4444: Elements of Earthquake Engineering
CIE 4445: Engineering Geology
CIE 4446: Environmental Impact Assessment and Auditing
CIE 4447: Fecal Sludge and Septage Management
CIE 4448: Geo-environmental Engineering
CIE 4449: Ground Improvement Techniques
CIE 4450: Hydraulics and Hydraulic Machines
CIE 4451: Non-Destructive Testing of Concrete Structures
CIE 4452: Remote Sensing and GIS
CIE 4453: Soil Reinforcement and Geosynthetics
CIE 4454: Valuation of Real Properties
CIE 4455: Water Resources Planning and Management
CIE 4456: Bridge Engineering Design & Practices
CIE 4457: Geospatial Techniques in Practice
CIE 4458: Project Management for Professionals

OPEN ELECTIVES

CIE 4311: Air and Noise Pollution
CIE 4312: Contract Management for Engineers
CIE 4313: Environmental Management
CIE 4314: Geology for Engineers
CIE 4315: Introduction to Remote Sensing and GIS
CIE 4316: Strength of Materials

THIRD SEMESTER

MAT 2125: ENGINEERING MATHEMATICS III [2 1 0 3]

Gradient, divergence and curl. Line, surface and volume integrals. Green's, Gauss divergence and Stokes' theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, sine and cosine transforms. Partial differential equation- Basic concepts, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of variables. One dimensional wave equation, one dimensional heat equation and their solutions. Introduction to probability: finite sample space, conditional probability and independence. Bayes' theorem, one dimensional random variables: Mean and variance. Two and higher dimensional random variables: mean, variance, correlation coefficient and regression

References:

1. Murray R. Spiegel, Vector Analysis, Schaum Publishing Co., 1959.
2. Erwin Kreyszig, Advanced Engineering Mathematics, (9e), Wiley Eastern, 2006.
3. P. L. Meyer, Introduction to Probability and Statistical Applications, (2e), Oxford and IBH Publishing, Delhi, 1980.
4. B. S. Grewal, Higher Engineering Mathematics, (43e), Khanna Publishers, 2014.

CIE 2121: FLUID MECHANICS [3 1 0 4]

Introduction, Fluid Properties and Classification of Fluid, Pressure and its Measurement, Hydrostatics, Buoyancy, Kinematics of Fluid Motion, Dynamics of Fluid Motion, Ideal Fluid Flow, Laminar Flow Through Pipes, Turbulent Flow Through Pipes, Flow Measurement, Flow in open Channels

References:

1. Streeter V.L. and Wiley E.B, Fluid Mechanics, McGraw Hill book Co., New York. 1998
2. Modi P.N. and Seth S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi. 2005
3. Bansal R. K, Fluid Mechanics and Hydraulic Machines, Laxmi Publishers, New Delhi. 2010
4. Jain A.K., Fluid Mechanics, Khanna Publishers, New Delhi. 2002
5. Garde R.J., Fluid Mechanics through problems, New age international Pvt. Ltd., Publishing, New Delhi. 2003
6. Garde R.J., Fluid Mechanics through problems, New age international Pvt. Ltd., Publishing, New Delhi. 2003

CIE 2122: SURVEYING [2 1 0 3]

Introduction, distance and direction measurement, Levelling, contouring, theodolites, tachometric surveying, traverse, construction surveys, underground Surveys, hydrographic Survey, Modern Surveying Techniques: Electronic Distance Measurement (EDM), Photogrammetry, introduction to remote sensing, global positioning systems (GPS), and Geographic Information Systems (GIS), drone surveying.

References:

1. Punmia B.C, Surveying, Vol. I and II, Lakshmi Publishers, New Delhi, 2015.
2. Duggal S.K, Surveying, Vol. I and II, Tata Mcgraw Hill – Publishing Co. Ltd, New Delhi, 2017
3. Arora K.R, Surveying, Vol.(I, II, III), Standard Book house, New Delhi, 2015.
4. Kanetkar T.P and Kulkarni S.V, Surveying and levelling parts 1 and 2, Pune Vidyarthi Griha Prakashan, 2008.
5. Thomas Norman, Surveying, Edward Arnold Publishers (ELBS), Budapest, 2009.

CIE 2123: BUILDING MATERIALS [3 0 0 3]

Materials for Concrete I (The fillers) - types of aggregates, functional requirements, and standard specification for quality control, Materials for Concrete II (the binders) - describe types of cement, chemical composition, and physical properties and standard specification for quality control, Concrete - Mix proportioning guidelines as per IS 10262:2019 for standard concrete and concrete with SCMs, introduction to various codes – ACI and EN, properties of concrete – Fresh and hardened, Building materials for masonry - types of masonry, functional requirements, standard specification for quality control, conventional masonry, Building materials for flooring, roofing, doors, windows, and paints - functional requirements and standard specification for quality control

References:

1. Singh, Gurcharan, Building Construction and Materials, Raj sons Publications Pvt. Ltd., 2019.
2. Shetty, M. S and A. K. Jain. Concrete Technology (Theory and Practice), 8e. S. Chand Publishing, 2019.
3. Chudley, Roy, and Roger Greeno building construction handbook, Routledge, 2016.
4. Mehta, P. Kumar, and Paulo JM Monteiro, concrete microstructure, properties, and materials, 2017.
5. Neville, A. M., and J. J. Brooks, Concrete Technology, third Indian reprint, (2003).
6. Relevant Handbooks: National Building Code, IS 10262:2019, IS 456:2000
7. Relevant Indian standards

CIE 2124: MECHANICS OF STRUCTURES [3 1 0 4]

Analysis of determinate Trusses, Bending and shear stresses, Torsion in the circular shaft, Stability of columns, Stresses on inclined planes, Strain Energy, Deflections of statically determinate beams using Macaulay's method, Moment-area method, and Conjugate beam method. Deflection in beams, simple frames, and trusses by strain energy method-Unit load method, and Castigliano's method.

References:

1. Timoshenko, Strength of Materials, Vol. I & Vol. II , CBS Publishers and distributers, New

2. Delhi, 2002.
3. James M Gere and Stephen P Timoshenko, Mechanics of Materials , CBS Publishers and
4. Distributers, New Delhi, 2004.
5. Basavarajaiah and Mahadevappa , Strength of Materials, CBS Publishers, 2001.
6. Reddy C.S., Basic structural analysis, Tata McGraw Hill, New Delhi, 2004.
7. Ramamrutham and Narayanan, Strength of Materials, Dhanpat Rai Publishers, 1989.

CIE 2125: WATER SUPPLY ENGINEERING [3 0 0 3]

Introduction, Quantity of water required, different sources of water, conveyance of water, Quality of water, drinking water standards, Treatment of water, design considerations, Filtration, Disinfection, Other treatment methods, desalination, Distribution methods of water, service reservoirs and their capacity, Pipe appurtenances, wastage of water, corrosion of pipes and its prevention.

References:

1. Manual on water supply and treatment CPHEEO, Ministry of Urban development, New Delhi, 1991.
2. Garg S.K., Environmental Engineering-I, Khanna Publishers, New Delhi, 1999,.
3. Birdie G.S., Water Supply and Sanitary Engineering, Dhanpath Rai and Sons, New Delhi, 1987.
4. B.C. Punmia, A.K.Jain, A.K. Jain, Water Supply Engineering, environmental engineering, Laxmi publication, New Delhi, 1995
5. P. N Modi, Water Supply Engineering, Standard book house, New Delhi, 2018

CIE 2141: FLUID MECHANICS LABORATORY [0 0 3 1]

Calibration of Triangular Notch, Rectangular Notch, Cippoletti Notch, Venturimeter, Orifices, Mouth pieces, Orifice meter, Broad crested weir, Curved weir, Ogee weir, Plug Sluice, Determination of Friction factor of pipes, Experiment on Venturi flume, Standing wave flume, Demonstration of Parshall Flume.

References:

1. Modi P.N. and Seth S.M., Hydraulics and Fluid Mechanics Standard Book House, New Delhi.2005
2. Jain A.K., Fluid Mechanics, Khanna Publishers, New Delhi 2002
3. Streeter V.L and Wiley E.B., Fluid Mechanics, McGraw Hill Co. New York 1998
4. Bansal R. K. Fluid Mechanics and Hydraulic Machines, Laxmi Publishers, New Delhi 2010

CIE 2142: MATERIAL TESTING LAB [0 0 3 1]

Tests to determine the mechanical properties of mild steel and cast iron, Tests to determine the hardness of various metals, impact test on mild steel, Tests to determine the physical and mechanical properties of bitumen, Tests to determine physical properties of conventional and alternative aggregates, Tests to determine physical, properties of cement (OPC and Blended), Tests to determine mechanical properties of hardened concrete, Test on masonry and flooring tiles, Demonstration

References:

1. Bowels J.E., Foundation Analysis and Design, (4e), McGraw-Hills Book Company, 1998.
2. Punmia B.C., Jain AK and Jain AK ., Soil Mechanics and Foundations, (17e), Laxmi Publications Pvt. Ltd., 2017
3. Arora K.R., Soil Mechanics and Foundation Engineering, (7e), Standard, Publishers and Distributors, 2011.
4. Murthy V.N.S., A Text Book of Soil Mechanics and Foundation Engineering, CBS Publishers & Distributors-New Delhi, 2008.
5. Gopal Ranjan and. Rao A.S.R., Basic and Applied Soil Mechanics, New Age International Pvt. Limited, Publishers, 2016.

FOURTH SEMESTER

MAT 2225: ENGINEERING MATHEMATICS IV [2 1 0 3]

Numerical solutions of partial differential equations by finite difference methods, five-point formula, Laplace Poisson Equations, Heat equation, Crank Nicolson's method, Wave equation., Introduction to calculus of variations, geodesics, isoperimetric problems, approximate methods, Weighted Residual Approach, Least square method. Application of Finite Difference technique: Statically determinate and indeterminate beams, Buckling of columns. Introduction to Tensor Analysis, Distributions: binomial, Poisson, uniform, normal, gamma, chi-square and exponential. Moment generating function, Functions of one dimensional and two dimensional random variables, Sampling theory, Central limit theorem and applications. Optimization Techniques: Introduction to Linear programming, Formation of Linear Programming problem, solution by graphical method, Simplex method. Two phase simplex method, Transportation problems.

References:

1. M Rajasekaran S, Numerical methods for Science and Engineering, Wheeler and Co. Pvt. Ltd., Allahabad, 1992.
2. Sastry S.S., Introductory methods of Numerical Analysis, Prentice Hall of India, New Delhi. 1995.
3. A. R. Mitchel and R. Wait, Finite Element Methods in Partial Differential Equations, John Wiley, 1997.
4. P. L. Meyer, Introduction to Probability and Statistical Applications,(2e), Oxford and IBH Publishing, Delhi, 1980.
5. Hamdy A. Taha, Operation research, (8e), PHI, 2007.
6. S. Narayanan, T. K. Manicavachagom Pillay, G. Ramanaiah, Advanced mathematics for engineering students, S. Viswanathan Pvt.. Ltd., 1985.

CIE 2221: GEOTECHNICAL ENGINEERING [3 0 0 3]

Introduction, Soil structure, Clay minerals, Index properties of soil, Total, effective and neutral stresses, Flow through soil, Seepage through soils, Compaction of soil, Stress distribution in soil, consolidation of soil, Shear strength of soil - Direct shear, Triaxial, Unconfined compression and vane shear tests, Drained, undrained and consolidated undrained tests and their applications.

References:

1. Bowels J.E., Foundation Analysis and Design, (4e), McGraw-Hills Book Company, 1998.
2. Punmia B.C., Jain AK and Jain AK ., Soil Mechanics and Foundations, (17e), Laxmi Publications Pvt. Ltd., 2017
3. Arora K.R., Soil Mechanics and Foundation Engineering, (7e), Standard, Publishers and Distributors, 2011.
4. Murthy V.N.S., A Text Book of Soil Mechanics and Foundation Engineering, CBS Publishers & Distributors-New Delhi, 2008.
5. Gopal Ranjan and. Rao A.S.R., Basic and Applied Soil Mechanics, New Age International Pvt. Limited, Publishers, 2016.

CIE 2222: TRANSPORTATION ENGINEERING [4 0 0 4]

Geometric design of highways cross-sectional elements, sight distances, horizontal and vertical alignments. Tractive resistance and Geometric design of railway Track – Speed and Cant. Concept of airport runway length, calculations, and corrections; taxiway and exit taxiway design. Highway materials – desirable properties and tests; Desirable properties of bituminous paving mixes; Design factors for flexible and rigid pavements; Design of flexible and rigid pavement using IRC codes. Traffic studies on flow and speed, peak hour factor, accident study, statistical analysis of traffic data; Microscopic and macroscopic parameters of traffic flow, fundamental relationships; Traffic signs; Signal design by Webster's method; Types of intersections; Highway capacity.

References:

1. Khanna S.K and Justo C.E.G, Highway Engineering, (10e), Nemchand and Brothers, Roorkee, 2015.
2. Kadiyali L.R, Traffic Engineering and Transportation Planning (5e), Khanna Publisher, New Delhi, 2000.
3. Yoder E.J, Principles of Pavement Design, John Wiley and Sons, Inc., New York, 1975.
4. Yang H Huang, Pavement Analysis and Design, Prentice Hall, 2003.
5. Saxena S. C and Arora S. P, A Text Book of Railway Engineering, (8e), Dhanpat Rai Publications, Ltd., New Delhi, 2017.
6. Khanna S. K, Arora M. G and Jain S. S, Airport Planning and Design, (6e), Nemchand and Brothers, Roorkee, 1999.
7. Horenjeff, R and McKelvey, F, Planning and Design of Airports, (4e), Mc Graw Hill Company, New York, 1994.
8. Ashford, N and Wright, P.H, Airport Engineering, (3e), John Wiley and Sons, New York, 1992.

CIE 2223: BASIC REINFORCED CONCRETE DESIGN [2 1 0 3]

Introduction to RCC structures, and design philosophy. Limit state method, Stress-strain characteristics for concrete and steel, stress block parameters for collapse, and limit state of serviceability. Design of rectangular beams, flanged beams, design for shear and torsion. Design of one-way and two-way slabs. Limit state of collapse in compression, Design of axially loaded short and slender R.C. columns, uniaxial and bi-axial bending using SP16 hand book. Design of isolated footings.

References:

1. Karve S.R and Shah V.L, Limit State Theory and Design of Reinforced Concrete, Structures Publications, 8th edition- reprint, Pune, 2018.
2. Varghese P.C, Limit State Design of Reinforced Concrete, Prentice Hall of India, New Delhi, 1999.
3. Shah H.J, Reinforced concrete, Vol. I, Charotar Publishing house, Anand, 2005.
4. IS: 456 – 2000, Code of practice for plain and reinforced concrete, Bureau of Indian Standards, New Delhi.
5. SP-16 – 1984, Design aids for reinforced concrete IS 456. Bureau of Indian Standards, New Delhi

CIE 2224: WASTE WATER MANAGEMENT [3 0 0 3]

Introduction, Quantity of sanitary sewage and storm sewage, Construction of sewerage system, Characteristics of sewage, Treatment of sewage, Unit processes, Disposal of sewage, IS standards for sewage disposal, Land disposal, Low cost sewage treatment, Methods of disposal, Industrial Effluent Treatment, concept CETP and zero effluent system.

References:

1. Garg S. K, Environmental Engineering- II, Volume – II, Khanna Publishers, New Delhi, 2014.
2. Birdie G.S, Water Supply and Sanitary Engineering, Dhanpat Rai and Sons, New Delhi, 1987.
3. Metcalf and Eddy Inc, Wastewater Engineering - Treatment and Reuse, 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 2003
4. Karia G.L, and Christian R.A, Wastewater Treatment Concepts and Design Approach, Prentice Hall of India Pvt. Ltd., New Delhi, 2001
5. IS Standards 2490 - 1974 , 3360 – 1974, 3307 – 1974, Indian Standard Institution, Manak Bhavan, New Delhi.
6. Manual on sewage and sewage treatment CPHEO, Ministry of Urban development, New Delhi.
7. Standard Methods – APHEA, American Public Health Association, 1015 fifteenth street, NW Washington DC.

CIE 2225: WATER RESOURCES ENGINEERING [2 1 0 3]

Introduction, Hydrology – precipitation, evapotranspiration, infiltration & runoff, flood studies and hydrographs, Estimation of reservoir capacity and planning, Hydraulic structures- dams- classification & design of gravity dam, Diversion head works-components; Bligh's Creep Theory

References:

1. Viessman and Knapp, Introduction to Hydrology, Harper and Row Publishers, Singapore. 1989
2. H.M.Raghunath, Hydrology, Wiley Eastern publications, Delhi. 1985
3. Modi.P.N, Irrigation, water resource and water power, Standard book house publications, Delhi. 1988
4. R. K. Sharma, T. K. Sharma, Irrigation Engineering, S.Chand and Co., New Delhi. 2002
5. Santhosh Kumar Garg, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, Delhi. 1998.

CIE 2241: SURVEYING PRACTICE [0 0 3 1]

Levelling, Theodolite, Construction surveying, Tacheometric surveying, Curve setting (using theodolite), Surveying using Total Station: operation of instrument, Traversing, Introduction to open source GIS software, Working with open-source GIS software, Working with maps.

References:

1. Punmia B.C, Surveying, Vol. I and II, Lakshmi Publishers, New Delhi, 2015.
2. Duggal S.K, Surveying, Vol. I and II, Tata Mcgraw Hill – Publishing Co. Ltd, New Delhi, 2017
3. Arora K.R , Surveying, Vol.(I, II, III), Standard Book house, New Delhi, 2015.
4. Kanetkar T.P and Kulkarni S.V, Surveying and levelling parts 1 and 2, Pune Vidyarthi Griha Prakashan, 2008.
5. Thomas Norman, Surveying, Edward Arnold Publishers (ELBS), Budapest, 2009.

CIE 2242: ENVIRONMENTAL ENGINEERING LAB [0 0 3 1]

Determination of solids, Determination of Turbidity, Determination of optimum dosage of coagulant using Jar test, Determination of alkalinity, acidity and pH, Determination of calcium, magnesium and total hardness, Determination of chlorides and percentage available chlorine in bleaching powder, Determination of dissolved oxygen, BOD and COD, Determination of residual chlorine and chlorine demand, Determination of Iron and Fluorides, Determination of Ammonical Nitrogen and Nitrates, Determination of MPN, Demonstration of high volume sampler and sound lever meter, Demonstration of determination of oil, grease and sulphates.

References:

1. Standard Methods for the Examination of Water and Waste Water – ALPHA – AWWA – WPCF
2. Sawyer and Mc Carty, Chemistry for Environmental Engineering, McGraw Hill, New York, 1994.
3. IS – 3025 – 1964 – Methods of Sampling and Test (physical and chemical) for water Used in Industry, IIT New Delhi.
4. Drinking water standards, IS – 10500-2012.

FIFTH SEMESTER

HUM 3022: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Principles of Management- Planning, Definition of management and systems approach, Nature & scope. The Functions of managers. Planning- Types of plans, steps in planning, Process of MBO, how to set objectives, strategies, policies and planning premises, Strategic planning process and tools. Organizing- Nature and purpose of organizing, Span of management, factors determining the span, staffing - Basic departmentation, Line and staff concepts, Functional authority, Art of delegation, Decentralization of authority. HR theories of planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership – leadership behavior & styles, Managerial grid. Controlling - Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit and Loss control, Control through ROI, Direct, Preventive control. Professional ethics - Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories about right action, Self-interest, Customs and Religion, Uses of Ethical Theories. Global issues - Managerial practices in Japan and USA & application of Theory Z. The nature and purpose of international business & multinational corporations, unified global theory of management. Ethics - Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisers, Moral Leadership, Code of Conduct, Corporate Social Responsibility

References:

1. Harold Koontz & Heinz Weihrich (2012), "Essentials of Management", Mc Graw Hill, New Delhi.
2. Peter Drucker (2004), "The Practice of Management", Harper And Row, New York.
3. Vasant Desai (2007), "Dynamics of Entrepreneurial Development & Management", Himalaya Publishing House.
4. Poornima M Charantimath (2006), "Entrepreneurship Development", Pearson Education.
5. Govindarajan M, Natarajan S, Senthil Kumar V S (2004), "Engineering Ethics", Prentice Hall Of India, New Delhi.
6. Mike W. Martin And Ronald Schinzinger (2003), "Ethics in Engineering", Tata Mcgraw Hill, New Delhi.
7. R. S. Nagarazan. (2004), "A Text Book on Professional Ethics and Human Values", New Age International Publishers, New Delhi.

CIE 3121: BASIC STRUCTURAL STEEL DESIGN [2 1 0 3]

Introduction, difference in the design of steel and RCC structures. Limit state method of design. Bolted connection, efficiency of joint, eccentric bolted connection. Welded connections, eccentric connections. Tension Members, tension splices. Compression members. Design of column splices, design of simple column base. Flexure member, laterally supported and laterally unsupported beams, effective length of beams, warping and torsional restrains.

References:

1. Duggal S.K., Limit State Design of Steel Structures, Tata McGraw Hill education private Limited – New Delhi 2008.
2. Subramanian N., Design of Steel Structures, Oxford university New Delhi 2008.
3. IS 800-2007, General construction of steel in code of practice, Bureau of Indian Standards, New Delhi.
4. SP-6 (Part I) 1964, Structural Steel Sections. Bureau of Indian Standards, New Delhi

CIE 3122: APPLIED SOIL ENGINEERING [2 1 0 3]

Soil Exploration, Earth pressure at rest, active and passive conditions, Stability of slopes - Finite and infinite slopes, Bearing capacity of shallow footings, Pile foundations, Pile driving, Load carrying capacity of a single pile using static formula, Group action and Negative skin friction, Settlement of pile foundations, Under-reamed piles and bored compaction piles.

References:

1. Bowels J.E, Foundation Analysis and Design, (4e), McGraw Hills Book Company, 1998.
2. Punmia B.C, Jain AK and Jain AK, Soil Mechanics and Foundations, (17e), Laxmi Publications Pvt. Ltd., 2017
3. Arora K.R, Soil Mechanics and Foundation Engineering, (7e), Standard, Publishers and Distributors 2011.
4. Murthy V.N.S, A Text Book of Soil Mechanics and Foundation Engineering, CBS Publishers and Distributors, New Delhi, 2008.
5. Gopal Ranjan and Rao A.S.R, Basic and Applied Soil Mechanics, New Age International Pvt. Limited, 2016.
6. IS 6403: 1981 (Reaffirmed 2002) Code Of Practice For Determination of Bearing Capacity of Shallow Foundations
7. IS: 2911 - 1980 (Reaffirmed 2000) Code Of Practice For Design And Construction of Pile Foundations
8. IS:2131 - 1981 (Reaffirmed 1997) Method for Standard Penetration Test for Soils

CIE 3123: ESTIMATION, COSTING AND PROJECT MANAGEMENT [3 1 0 4]

Estimation and Costing- purpose and methods, listing item of work for a given building plan; Rate Analysis- for the listed item of work; Quantity take-off- for buildings and roads; Project management- preparing final estimate and BOQ; Introduction to Construction Planning- classification, WBS, objectives and steps in planning; Construction Project management- scheduling using Gantt chart, ADM and PDM network analysis, CPM, time-cost optimization, and resource allocation; Project updating and control- updating flow chart and EVA.

References:

1. M. Chakraborti., Estimating, Costing, Specification and Valuation in Civil Engineering, (16e) ,2003.
2. B.N. Dutta, Estimating and Costing in Civil Engineering, (16e), UBS Publishers' Distributors Ltd, 2000.
3. CPWD, Manual for Standard Specification and Rate Analysis
4. IS 1200: Part 1 to 16: Method of measurement of building and civil engineering work

CIE 3124: DESIGN OF PRE-STRESSED CONCRETE STRUCTURES [3 0 0 3]

Introduction, prestressing systems, and material properties. Losses in prestress. Analysis of prestressed concrete members. Limit state of collapse in flexure and shear. Limit state of serviceability. Transmission of pre-stress in pre-tensioned and post-tensioned members. Analysis of Composite Sections.

References:

1. Krishna Raju N, Pre-stressed Concrete, (5e) ,Tata McGraw Hill, , New Delhi, 2012.
2. Dayaratnam P, Pre-stressed Concrete Structures, (7e), Oxford and IBH Publications, New Delhi, 2017.
3. Mallick S. K. and Gupta A. P., Pre-stressed Concrete, (3e), Oxford and IBH, New Delhi, 1982.
4. Lin T.Y. and Ned. Burns H, Design of Pre-stressed Concrete Structures, John Wiley and Sons, New York, 2017.
5. IS:1343-2012, Code of Practice for Prestressed concrete, Bureau of Indian Standards, New Delhi.

CIE 3125: PRECAST TECHNOLOGY [3 0 0 3]

Introduction to Prefabrication- types, necessity, applicability, modular coordination; Precast Concrete- components, code provisions, various prestressing systems; Substructure and support system- precast foundations, precast elements, relevant construction techniques, transportation and erection of components at the site; Roof and Wall systems-types of roof and wall materials, joinery, transportation and erection of prefabricated roof and wall components; Precast Components- stairs, toilets, doors, windows, furniture units, composites.

References:

1. Elliott, Kim S. Precast concrete structures. Crc Press, 2019.
2. Lin, Tung Yen, and Ned Hamilton Burns, Design of prestressed concrete structures, 1981.
3. Raju, N. Krishna. Prestressed concrete, Tata McGraw-Hill Education, 2006.
4. Bruggeling, A. S. G and G. F. Huyghe, Prefabrication with concrete, CRC Press, 1991.
5. Glover, Charles William, Structural Precast Concrete. [with illustrations.], CR Books, 1964.
6. Richardson, John George, Precast concrete production, 1973.
7. Bachmann, Hubert, and Alfred Steinle, Precast concrete structures, Berlin: Ernst and Sohn, 2011.
8. IS 10297-1982: Indian standard code of practice for design and construction of floors and roofs using precast reinforced / prestressed concrete ribbed or cored slab units.

CIE 3126: HIGHWAY PLANNING, DESIGN & CONSTRUCTION [3 0 0 3]

Introduction and Subgrade Materials, Pavement Materials, Principles and Design of Pavements, Plants and Machinery, Planning for Pavement Construction, Construction Practices of Flexible and Rigid Pavement.

References:

1. Relevant IRC and ISCodes of Practices, MoRTH Specification
2. Course content on LMS of L&T EduTech

CIE 3141: SOIL MECHANICS LAB [0 0 3 1]

Determination of moisture content, specific gravity, Atterberg limits, In-situ unit weight, Sieve analysis, Coefficient of permeability by constant head and variable head permeameter, Standard compaction test, Use of proctor needle, Triaxial shear test, Unconfined compression test, Direct shear test, Vane shear test, Determination of CBR, Demonstration of Plate laod test, Cone penetration test and hydrometer analysis.

References:

1. Relevant IS codes
2. Bowles J.E, Engineering properties of soil and their measurement, (2e), McGraw – Hill Book Company, New York, 1986.
3. Lambe T.W, Soil testing for Engineers, John Wiley and Sons, INC.
4. Cheng Liu and Jack B. Evett, Soil properties, Testing, Measurement and Evaluation, Prentice-Hall, Inc. Englewood Cliffs, New Jersey, 1987

CIE 3142: COMPUTER AIDED STRUCTURAL ANALYSIS & DESIGN LAB [0 0 3 1]

Modelling, analysis and design of statically determinate structure and indeterminate structures such as plane trusses, plane frames and space frames for gravity and lateral loads using computer aided structural analysis & design software.

References:

1. Sharma T.S, STAAD Pro. V8i for beginners – with Indian examples (1e), Notion Press, 2014
2. Rajendran D, Analysis and Design of a Multistorey Building using STAAD.Pro and E-TABS (with Manual Calculation) (1e), Designtech Publishers, 2016
3. Bentley, STAAD Pro. – Technical Reference Manual, Retrieved from https://communities.bentley.com/cfs-file/__key/telligent-evolution-components-attachments/13-275895-00-00-00-24-18-/Technical_5F00_Reference_5F00_V8i.pdf 2012
4. Computers and Structures, Inc., CSI Analysis Reference Manual, Retrieved from http://docs.csiamerica.com/ manuals/ etabs/ Analysis

SIXTH SEMESTER

HUM 3021: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Nature and significance, Micro & macro differences, Law of demand and supply, Elasticity & equilibrium of demand & supply. Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of single, Uniform gradient cash flow. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with the return, Rate of return method, an Incremental approach for the economic analysis of alternatives, Replacement analysis. Break-even analysis for single product and multi- product firms, Break-even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight-line depreciation, Declining balance method of depreciation, Sum-of-the-years digits method of depreciation, Sinking fund and service output methods, Costing and its types – Job costing and Process costing, Introduction to balance sheet and profit & loss statement. Ratio analysis - Financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios Safety and Risk- Assessment of Safety and Risk, Risk Benefit Analysis and Reducing Risk, Respect for Authority.

References:

1. Prasanna Chandra, Fundamentals of Financial Management, Tata McGraw Hill Companies, New Delhi. 2005.
2. James L. Riggs, David D. Bedworth and Sabah U. Randhawa., Engineering Economics, Tata McGraw – Hill Publishing Company Ltd, New Delhi 2004.
3. Thuesen G. J & Thuesen H. G., Engineering Economics, Prentice Hall of India, New Delhi 2005.
4. Blank Leland T. Tarquin Anthony J., Engineering Economy, McGraw Hill, New Delhi 2002.
5. Chan S. Park., Contemporary Engineering Economics, Pearson Education, Inc 2010.
6. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.
7. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004
8. Charles B. Fleddermann, “Engineering Ethics”, Pearson, Prentice Hall, New Jersey, 2012.

CIE 3221: ADVANCED MECHANICS OF STRUCTURES [3 1 0 4]

Introduction, degrees of freedom, degree of redundancy, law of conservation of energy. Analysis of three hinged arches and two hinged arches. Analysis of propped cantilever, fixed and continuous beams by strain energy and consistent deformation methods. Analysis of beams and frames using slope deflection, and moment distribution methods. Analysis of continuous beams by three moment theorem. Plastic Analysis, determination of collapse loads using statical and kinematic methods for beams and frames structures. Rolling loads and Influence lines: Introduction to influence line diagram, application of Muller Breslau's Principle. Introduction to stiffness matrix.

References:

1. Reddy C.S, Basic structural Analysis, Tata McGraw Hill, New Delhi, 2010.
2. Ramamrutham S,Theory of Structures, Dhanpat Rai Publishing Company, New Delhi, 2014.
3. Rao Prakash D.S, Structural Analysis, Universities Press, India, 1997.
4. Hibbeler RC, Structural analysis, Pearson Education, United States, 2015.
5. Daniel L Schodak, Structures, Pearson Education, United States, 2015

CIE 3222: CONTEMPORARY CONSTUCTION PRACTICES AND SUSTAINABILITY [3 1 0 4]

Construction practices- precast structures, tunnels, formwork systems, MIVAN technique, walls, panels, scaffolds; 3-D printers in construction; Management of construction equipment- classification, factors in equipment selection, cost of ownership and operation, maintenance, and end-of-life; various construction equipment-demonstration presentation; Concept of sustainability- definition, 5Rs, sustainability goals, embodied energy, life cycle energy usage, net-zero energy buildings; Life cycle analysis of material sustainability- concepts of LCA and LCC, LCA methodology, carbon footprint, emissions in building construction, case studies; Introduction to green building rating systems- LEED, GRIHA and IGBC, case studies.

References:

1. Arora, S.P and Bindra, S.P, A Text Book of Building Construction, Dhanpat Rai Publications, New Delhi, 2005.
2. Varghese P.C, Building Constructions, Prentice Hall, 2007.
3. Sharma and Kaul, Building Construction, S. Chand and Company, New Delhi, 1998
4. Peurifoy R.L, Schexnayder, J.C, and Shapira, A, Construction Planning, Equipment and Methods, Tata McGraw Hill, New Delhi, 2010.
5. Sharma S.C. Construction Equipment and Management, Khanna Publishers, New Delhi, 2013.
6. Adler A, Armstrong, J, Azerbegi R, Guy G.B, Fuller S.K, Kalin M, Karolides A, Lelek M. Lippiatt B, Macaluso J, Spencer E, Waier P, Walker A, Green Building: Project Planning and Cost Estimating, Second Edition, RS Means, Reed Construction Data, Inc, 2006.
7. Hendrickson C.T, Lave L. B and H.S, Matthews H.S, Environmental Life Cycle Assessment of Goods and Services: An Input-Output Approach, Resources for the Future Press, 2006.
8. Liv Haselbach, The Engineering Guide to LEED-New Directions (Green Source): Sustainable construction, McGraw-Hill Professional, 2008.
9. Martin Melaver and Phyllis Mueller, The green building bottom line: The real cost of sustainable building, McGraw-Hill Professional, 2008.
10. Indian Green Building Council, Green building rating system: New construction and major renovations (LEED-India NC) reference guide version 1.0, Confederation of Indian Industry, CII-Sohrabaji Godrej Green Business Centre, Hyderabad, 2007.
11. The Energy and Resources Institute Press, Green Rating for Integrated Habitat Assessment (GRIHA), Ministry of New and Renewable Energy and The Energy and Resources Institute

CIE 3225: AIRPORTS & SEA PORTS ENGINEERING

Commercial Airport Master Planning(ICAO), Airside and Landside Infrastructure Planning, Terminal Buildings, Runway and Taxiway Design, Navigational Aids, Flexible and Rigid Airfield Pavement Construction, Overview of Marine Structures, Port Operation and Components, Dredging, Shore Protection and Reclamation Work, Design Considerations and Functional Requirements of Marine Structures, Break water and Berthing Structures.

References:

E-resources: L&TEduTechLMS

CIE 3223: DESIGN OF REINFORCED CONCRETE STRUCTURES [3 0 0 3]

Design of staircases spanning along traverse and longitudinal direction, Design of waist slabs. Foundations, types of foundations, design of combined footing - slab, slab and beam types, raft foundation. Retaining walls, design of cantilever and counterfort retaining walls. Design of circular and rectangular water. Design of rectangular underground water tanks. Design of flat slabs by direct design method.

References:

1. Unnikrishna Pillai, Devadas Menon, Reinforced Concrete Design, (3e), Tata McGraw Hill Publishing Company Limited, New Delhi, 2009.
2. Shah H. J, Reinforced Concrete, Vol. II, (6e), Charotar Publishing House Pvt. Ltd, Anand, Gujarat, 2012.
3. Varghese P. C, Design of Reinforced Concrete Foundations, PHI Learning Private Limited, New Delhi, 2010.
4. Varghese P. C, Advanced Reinforced Concrete Design, PHI Learning Private Limited, New Delhi, 2011.
5. IS:456 – 2000, Code of practice for plain and Reinforced concrete, Bureau of Indian Standards, New Delhi.
6. SP-16 – 1984, Design Aids for Reinforced concrete IS 456, Bureau of Indian Standards, New Delhi.

CIE 3224: ENGINEERING PRACTICE AND ETHICS [3 0 0 3]

Professional practice – roles of various stakeholders, theories of professional ethics, professional responsibility, professional ethics, conflict of interest, gift vs bribery, environmental breaches, negligence, deficiencies in state-of-the-art, vigil mechanism, whistle blowing, protected disclosures, sustainability, un sustainable development goals, sustainable practices and techniques in construction , green credentials and ratings , EIA, privacy of contract, various types of contract and their features, industrial and labouracts, safety and risk – assessment of safety and risk – risk benefit analysis and reducing risk – government regulator's approach to risks

References:

1. Kibert, Charles J. Sustainable construction: green building design and delivery. John Wiley & Sons, 2016.
2. Fox, Warwick, ed. Ethics and the built environment, Routledge, 2012.
3. Montoya, Michael. Green building fundamentals, Prentice Hall, 2010.
4. Leffers, M. Regina. Sustainable Construction and Design, Pearson Education, 2010.
5. American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application.
6. Ostwald, Michael J, Warwick Fox A Theory of General Ethics: Human Relationships, Nature, and the Built Environment, Nexus Network Journal, Birkhäuser Basel, 2008. 195-198.
7. B.S. Patil, Legal Aspects of Building and Engineering Contracts

CIE 3226: METRO RAIL TRANSPORTATION SYSTEMS & CONSTRUCTION

Transit oriented development, Planning of Metros, MEP systems in Metros, Contracts and Quality, Elevated stations and via ducts, Underground stations and tunnels, Earth retaining systems, Analysis and design of stations (STAAD.Pro) and diaphragm walls, Future trends in transportation.

References:

1. Indian Standard code-IS456
2. E-learning content on L&T EduTech Platform

CIE 3241: BUILDING DESIGN AND MODELLING LAB [0 0 3 1]

Drawing plan, section and elevation of various types of foundations, types of doors and windows, understanding statutory requirements in planning the building, design, drawing and modelling of buildings using drafting application software.

References:

1. Subramanian N, Design of Reinforced Concrete Structures (1e), Oxford University Press, 2013.
2. Shah H.J, Reinforced Concrete – Vol. 1(Elementary Reinforced Concrete) (11e), Charotar Publishing House Pvt. Ltd., 2016
3. Chandra R, Gehlot V, Elements of Limit State Design of Concrete Structures, Scientific Publishers, 2004
4. Gambhir M. L, Fundamentals of Structural Steel Design (1e), Tata McGraw Hill Publishing Co. Ltd, 2013
5. IS: 456 – 2000, Code of practice for plain and Reinforced concrete, Bureau of Indian Standards, New Delhi.
6. SP-16 – 1984, Design Aids for Reinforced concrete IS 456. Bureau of Indian Standards, New Delhi
7. IS 800-2007, General construction of steel in code of practice, Bureau of Indian Standards, New Delhi.
8. SP-6 (Part I) 1964, Structural Steel Sections. Bureau of Indian Standards, New Delhi

CIE 3242: STRUCTURAL DETAILING AND DRAWING LAB [0 0 3 1]

Detailing of singly and doubly reinforced rectangular beams, one way slabs, two-way slabs, and continuous beams, detailing of dog legged staircase, detailing of circular tank and rectangular tank, detailing of isolated footing and combined footing, design and detailing of cantilever retaining wall, beam-to-beam and beam-to-column connections in steel buildings, detailing of flat slabs.

References:

1. Subramanian N, Design of Reinforced Concrete Structures (1e), Oxford University Press, 2013.
2. Shah H.J, Reinforced Concrete – Vol. 1(Elementary Reinforced Concrete) (11e), Charotar Publishing House Pvt. Ltd., 2016
3. Chandra R, Gehlot V, Elements of Limit State Design of Concrete Structures, Scientific Publishers, 2004
4. Gambhir M. L, Fundamentals of Structural Steel Design (1e), Tata McGraw Hill Publishing Co. Ltd, 2013
5. IS: 456 – 2000, Code of practice for plain and Reinforced concrete, Bureau of Indian Standards, New Delhi.
6. SP-16 – 1984, Design Aids for Reinforced concrete IS 456. Bureau of Indian Standards, New Delhi
7. IS 800-2007, General construction of steel in code of practice, Bureau of Indian Standards, New Delhi.
8. SP-6 (Part I) 1964, Structural Steel Sections. Bureau of Indian Standards, New Delhi.

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

CIE 4291: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester to the end of seventh semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

CIE 4292: PROJECT WORK

The project work may be carried out in the institution/industry/research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out before the department committee as part of project evaluation.

MINOR SPECIALIZATION

PROGRAM ELECTIVES

CIE 4401: ADVANCES IN CONCRETE TECHNOLOGY [3 0 0 3]

Understanding structure of concrete - Macrostructure and Microstructure, Understanding the role of various phases of concrete - mechanism of strength development and deformation characteristics of early and later age concrete Admixtures - Mineral and Chemical admixtures, Advancements in designing sustainable concrete - sustainable materials – design principles, durability, guidelines and case examples, Design principles of concretes for general Applications - High strength concrete and self-compacting concrete - IS 10262:2019, ACI and EFNARC guidelines, Design principles of special concrete with suitability and applications, Performance-based design approach for sustainable construction - Prescriptive and performance-based approach for concrete - EN and South African standards for understanding performance-based approach, the durability of concrete and durability indicators.

References:

1. Mehta, P. Kumar and Paulo JM Monteiro, Concrete microstructure, properties, and materials, 2017.
2. Neville, Adam M, Properties of Concrete, 4th, London Pearson Education Limited 443.846, 2011
3. Page, Chris L, and Mary M, Page, eds. The durability of concrete and

cement composites, Elsevier, 2007.

4. Thomas, Michael, Supplementary cementing materials in concrete, CRC Press, 2013.

CIE 4402: BUILDING CODES AND FUNCTIONAL SERVICES [3 0 0 3]

Introduction to National Building Code- scope and building requirements; fire and safety; design, and construction-wind and earthquake safe designs; general building services- design requirements; engineering services in a building as a system; building maintenance- planning and standards; environmental factors- thermal performance, functional design, and energy management.

References:

1. National Building Code of India, 2005
2. SP 64 (2001), SP 7 (2005), Bureau of Indian Standards
3. KutEuring David, Illustrated enyclopedia of building services, E and F N Spon, London, 1993.
4. Building Services Research Information Association, Building services material handbook, E and FN Span, London, 1987.
5. Chadderton David V, Building services engineering, E and FN Span, London, 1991.
6. Shear Mel A , Handbook of building maintenance management, Reston Publishing, Reston, 1983.
7. Miller Elmo J, Blood Jerome W, Modern maintenance management, Taraporevala, Bombay, 1971.
8. Newbrough E T, Effective maintenance management, MGH New York, 1967.
9. Cowan Henry J, Solar energy applications in the design of buildings, Applied Science Publishers, London, 1980.
10. Durrant D W, Interior lighting design, Lighting Industry Federation, London, 1977.
11. Watson Lee, Lighting design handbook, Mc Graw Hill, New York, 1990

CIE 4403: CONSTRUCTION MATERIALS AND QUALITY MANAGEMENT [3 0 0 3]

Introduction to the concept of material management- classical v/s integrated approach; selective inventory control-meaning and methods of inventory control; codification and standardization- R-series, 1-2-5 series, M-series, various codification methods; material planning budgeting and procuring- preparing an MRP; purchase management- tackling price fluctuation, purchase under uncertainty; foundations of Total Quality Management- TQM philosophy, QA/QC, quality tools, ISO 9000 quality systems.

References:

1. Gopal Krishnan P, Sundaresan M, Material Management Integrated Approach, Prentice Hall India, New Delhi, (1992)
2. Datta A.K, Material Management and Inventory Control: Principles and Practice, Jaico Publishing House, Bombay, 1988.
3. Woodside Gayle, Aurrichio Patrick ISO 14001, Auditing manual Mc-Graw Hill, New Delhi, 2000.
4. Bhat Sridhara K, Total Quality Management, Himalaya Publication House, Mumbai, 2007.
5. Oakland John S TQM, Text with cases, Butterworth- Heinemann, Oxford, 2006.

CIE 4404: CONTRACT MANAGEMENT [3 0 0 3]

Introduction to contracts-legal validity of a contract, features, classification, comparison; Tendering process-documents, preparation, evaluation, award of contract, issues in tendering; Administration /Performance of a contract- duties of contracting parties, advances, settlement of claims, extras and variations, social obligations; Breach of contract- types, consequences, and remedies; Dispute resolution-judicial and non-judicial methods, features, working principle, and significance of the award, and case studies; International contracts.

References:

1. Prakash V. A, Contracts Management in Civil Engineering Projects, NICMAR, 1997.
2. Patil B. S, Civil Engineering Contracts and Estimates, University Press, 2009.
3. John G. Betty, Engineering Contracts, McGraw Hills, 1993.
4. Albett Robert W, Engineering Contracts and Specifications, John Willey and Sons, New York, 1961.
5. Vaid K.N, Global perspective on International Construction Contracting Technology and Project Management, NICMAR, Mumbai, 1998.

CIE 4405: AIR POLLUTION AND CONTROL [3 0 0 3]

Introduction, chemical reactions in atmosphere, meteorology variables, general characteristics of stack plumes, effects of air pollution on human health, animals, plants and materials, global effects of air pollution, air quality and emission standards, air pollution index, industrial plant location and planning, sampling, analysis and control, particulate control technologies, gaseous emission control technologies.

References:

1. Rao H.V.N and Rao M.N, Air pollution, Tata Mc Graw Hill, New Delhi, 1989.
2. Rao C.S, Environmental Pollution control, Wiley Eastern Ltd. New Delhi, 1995.
3. Wark Kenneth and Wamer C.F, Air Pollution, its Origin and Control, Harper and Row, 1981
4. Sincero. A. P and Sincero G.A, Environmental Engineering, Prentice Hall, 1995
5. Air Pollution - Sampling and Analysis – APHA, 1977.

CIE 4406: INDUSTRIAL WASTE WATER TREATMENT [3 0 0 3]

Introduction, Industrial wastewater and environmental impacts, regulatory requirements for treatment of industrial wastewater, industrial waste survey, treatment of industrial waste water, oil separation, flotation, precipitation, heavy metal removal, refractory organics separation by adsorption, aerobic and anaerobic biological treatment, management of treatment plants, quality requirements for wastewater reuse, industrial reuse, practical application in industries.

References:

1. Eckenfelder, W.W, Industrial Water Pollution Control, Mc-Graw Hill, 2000.
2. Frank Woodard, Industrial waste treatment Handbook, Butterworth Heinemann, New Delhi, 2001.
3. Paul L. Bishop, Pollution Prevention: Fundamentals and Practice, Mc-Graw Hill International, Boston, 2000.
4. Nelson, L Nemerrow, Industrial wastewater Pollution, Addison-Wesley Publishing Company, 2000.
5. Mahajan S.P, Pollution Control in Process Industries, Tata McGraw Hill Publishing Company, 1998

CIE 4407: SOLID WASTE MANAGEMENT [3 0 0 3]

Introduction, classification, characterization, composition and properties of solid wastes, waste generation collection and transportation, separation, storage and processing at source, material recovery facility, collection routes optimization, transfer station, processing and recycling, incineration process and other methods of processing, landfills- types, design of landfills, siting of wastes management facilities.

References:

1. Tchobanoglous, G, Theisen, H and Vigil, S. A. Integrated solid waste management, McGraw-Hill international edition, Civil Engineering Series, 1993.
2. Bhide and Sundaresan, Solid Waste Management in Developing Countries – Indian National Scientific Documentation Centre, New Delhi, 2000.
3. Ramachandra T.V, Management of Municipal Solid Waste, Commonwealth of Learning, Canada and Indian Institute of Science, Bangalore, 2006.

CIE 4408: INTEGRATED MANAGEMENT OF WATERSHED ECOLOGY [3 0 0 3]

Watershed characteristics, watershed deterioration; Management plan, People's participation; Land Capability Classification, Capability ratings, improvements, land-use practices; Soil-Water-Plant relationship, Maintaining soil fertility, salinity, alkalinity, reclamation; Water Conservation methods for cropland, Small storage structures; Soil Erosion problems, Conservation method

References:

1. E. M. Tideman, Watershed Management: Guidelines for Indian Conditions, Omega Scientific Publishers, 1996.
2. Ghanashyamdas Das, Hydrology and Soil Conservation Practices, Prentice Hall, India, 2009.
3. Rajvir Singh, Watershed Planning and Management, Yash Publishing House, 2016.
4. Pau A. Debarry, Watersheds – Processes, Assessment and Management, John Wiley and Sons, 2004.
5. V. P. Singh and Donald K. Frevert, Watershed Models, Taylor & Francis, 2010.

CIE 4409: STRUCTURAL DYNAMICS [3 0 0 3]

Introduction, types of dynamic problems, D'Alembert's principle, principle of virtual work. Single Degree of Freedom Systems: Components of the system, un-damped and damped free vibrations, logarithmic decrement, Forced vibrations due to harmonic excitation – steady state and transient response, transmissibility, vibration isolation, evaluation of damping – half power band width method. Response of SDOF system to impulsive loading. Multi-Degree of Freedom Systems: Equations of motion, un-damped and damped free vibration, Eigenvalues and Eigen vectors, orthogonality conditions.

References:

1. Rao, S.D, Mechanical Vibrations, 3rd edn, Addison Wesely, NewYork, 1995.
2. Chopra A.K, Dynamics of structures – Theory and application to Earthquake Engineering, Prentice - Hall of India Pvt. Ltd. New Delhi, 2001
3. Seto, Mechanical vibrations, Schuam's Outline Series, McGraw Hill, Book Co, NewYork, 1964.
4. Paz. M, Structural Dynamics, 2nd ed, C.B.S. Publishers and Distributors, New Delhi, 2004
5. Mukhopadhay, Vibrations of structures and structural systems, Oxford and IBH, New Delhi, 2000.
6. Biggs J.M, Introduction to structural dynamics, McGraw Hill publications, 1964
7. Clough and Penzien, Dynamics of structures, McGraw Hill publications, 1993
8. Humar, J.C, Dynamics of structures, Prentice hall, N.J, 2002.

CIE 4410: DESIGN OF STEEL STRUCTURES [3 0 0 3]

Introduction, elements of plate girders with stiffeners. Plate girder end panel design, plate girder bearing stiffener, load carrying stiffener and intermediate web stiffeners design, welded connections design. Design of Gantry girder, Gantry girder section check for fatigue strength. Design of compression member subjected to combined axial and uniaxial bending. Design of flexural members for unsymmetrical bending. Design of light gauge steel members. Axially loaded compression members of light gauge steel members, laterally supported beams in light gauge steel members. Introduction to prefabricated steel structures and their applications.

References:

1. Duggal S.K, Limit State Design of Steel Structures, Tata McGraw Hill education private Limited, New Delhi, 2008.
2. Subramanian N, Design of Steel Structures, oxford university New Delhi, 2008.
3. IS 800-2007, General construction of steel in code of practice, Bureau of Indian Standards, New Delhi.
4. SP-6 (Part I) Structural Steel Sections, Bureau of Indian Standards, New Delhi, 1964
5. IS 801-1975, Code of practice for use of cold framed light gauge steel, Bureau of Indian Standards, New Delhi.

CIE 4411: FINITE ELEMENT METHOD OF ANALYSIS [3 0 0 3]

Introduction, theory of elasticity, constitutive relationships, plane stress, and plane strain. Concept of an element, displacement models, and shape functions for different types of elements. Variational method of formulation- minimization of potential energy approach. Application of finite element method to analyze pin jointed and rigid jointed structures. Application of finite element method to analyze plane stress and plane strain problems using three-noded triangular element and isoparametric four-noded element.

References:

1. Zinkiewiecz O.C, The Finite Element Method, (3e), Tata McGraw Hill Book Co, New Delhi, 1979.
2. Desai C.S and Abel J.E, Introduction to the Finite Element Method, (1e), CBS publications, New Delhi, 1987.
3. Krishnamoorthy C.S, Finite Element Analysis, (2e), Tata McGraw Hill Publishing Company Ltd, New Delhi, 1987.
4. Bathe K.J, Finite Element Procedures in Engineering Analysis, (2e), Prentice Hall Engle Wood, Cliffs, New Jersey, 1997.

CIE 4412: DESIGN OF FOUNDATION AND EARTH RETAINING STRUCTURES [3 0 0 3]

Bearing capacity - Brinch Hansen's, Meyerhoff's, Skempton's and Vesic's bearing capacity equations, Piles subjected to lateral loads- Broms theory, Sheet piles, Retaining walls- cantilever and counterfort, Cofferdams, Well Foundation-Bearing capacity, Lateral stability, Foundations in expansive soils , Machine Foundations.

References:

1. Bowles J.E, Foundation Analysis and Design, McGraw Hill, New York, 1997
2. Winterkorn H.F and Fange H.Y., Foundation Engineering Hand book, Van Nostand Reinhold Company, New York, 1991
3. Teng W.C, Foundation Design, Prentice Hall of India, New Delhi, 1981.
4. Swami Saran., Analysis and Design of Substructures, (2e), Oxford and IBH Publishers, 2015
5. Srinivasalu P and Vaidyanathan C.V, Hand Book of Machine Foundations, Tata McGraw Hill, 1987.

CIE 4413: URBAN MASS TRANSPORT SYSTEM [3 0 0 3]

Recent trends in transit, mass transportation characteristics, demand characteristics- spatial, temporal and behavioural characteristic. Modes of public transport and comparison, public transport travel characteristics, trip chaining, technology of bus, rail, rapid transit systems, basic operating elements. Planning objectives, principles, considerations, transit lines types, geometry and characteristics, transit routes and their characteristics, timed transfer networks, prediction of transit usage, evaluation of network, accessibility considerations. Components of scheduling process, determination of service requirements, scheduling procedure, marginal ridership, crew scheduling. Design of bus stops, design of terminals – principles of good layout, types of layout, truck terminal, depot location, twin depot concept, crew facilities and amenities. Objectives in transit fare determination, fare collection, fare structures, special higher and lower fares, fare level.

References:

1. Kristhi and Lal, Transporation Engineering, (3e), PHI, Delhi, 2008.
2. Dickey, J.W, et. al., Metropolitan Transportation Planning, TMH edition, 2002.
3. Vuchic V.R, Urban Public Transportation System and Technology, Prentice Hall, 2007.
4. Agarwal M.K, Urban Transportation in India, INAE, Allied Publishers Ltd, 1996.

CIE 4414: URBAN TRANSPORT PLANNING [3 0 0 3]

Scope of the subject, system approach to transport planning, definition of study area, zoning and Types of Surveys. Trip purpose, factors governing trip generation and attraction, analysis of trip generation and attraction – regression and category analysis. O-D Matrix, growth factor methods – uniform factor, average, fratar and furness methods, synthetic methods – gravity model, tanner model, intervening opportunities model and competing opportunities models. Purpose of traffic assignment, principles, assignment technique – all or nothing assignment, multiple route assignment, capacity restraint assignment, diversion curves. Factors affecting modal split, modal split in the planning process, probit and logit analysis. Selection of land-use transport model, lowry derivative models, Garin-Lowry model.

References:

1. Kadiyali L.R, Traffic Engineering and Transportation Planning, (6e), Khanna Publisher, New Delhi, 2000
2. JotinKhisty C and Kent Lal B, Transporation Engineering-An Introduction, (3e), New Delhi
3. Papacostas C S, Fundamentals of Traffic Engineering,- (3e), Prentice Hall, 2002.
4. M.J.Bruton, Introduction to Transportation Planning – Hutchinson, London Ltd, 1975.
5. B.G.Hutchinson, Introduction to Urban System Planning, Mc Gra Hill, 1974

CIE 4415: PAVEMENT MATERIAL AND DESIGN [3 0 0 3]

Introduction, design wheel load, strength properties of mineral aggregates, Design of Flexible Pavement-Stress in flexible pavements, IRC design method, Bituminous Materials- test on bitumen and bituminous materials, mix design, Design of Rigid Pavement- Westergaard's design factors, critical load position and stress computation, design of tie bars and spacing of dowel bars, Design of cement concrete mixes- BIS method of cement concrete mix design, Stabilized Roads- mechanical stabilization, soil-lime stabilization, soil bitumen stabilization, Design of Runway Pavement- Requirements, types of pavements, Pavement Failure and Evaluation- Types of failure in flexible and rigid pavements, structural evaluation of pavements

References:

1. Khanna S.K and Justo C.E.G, Highway Engineering, (10e), Nemchand and Bros., Roorkee, 2015.

2. Kadiyali L.R and Lal N.B, Prinicples and Practices of Highway Engineering, (4e), Khanna Publisher, New Delhi, 2003.
3. E.J. Yoder, Principles of Pavement Design, (2e), John Wiley and Sons, Inc., New York, 1975.
4. Yang H. Huang, Pavement Analysis and Design, Prentice Hall, 2003.
5. IRC 37 2018 – Guidelines for the design of flexible pavements.
6. IRC 58 2015 – Rigid pavement design.

CIE 4416: TRAFFIC SYSTEM AND ENGINEERING [3 0 0 3]

Traffic Engineering Studies- speed and delay study, traffic volume study, relation between speed, passenger car unit and level of service, Traffic Flow Analysis- Lighthill and Whitham's theory, law of conservation of vehicles, bottleneck and Greenberg's extension of law of continuity. Design of Traffic Facilities- Vehicular movements at intersections and conflict points, design of Channelizing islands, T, Y and AT-grade crossings, Road Accidents Analysis- mathematical equations in accident analysis, Design of Traffic Control System- Principles of signal design, regulation of speed at different zones (areas) and intersections, Design of Road Lighting System-Laws of illumination, light at intersections, rotaries, bridges and in tunnels.

References:

1. Papacostas C S, Fundamentals of Traffic Engineering, Prentice Hall, 1990.
2. Jotin Khisty C and Lall, Transportation Engineering, (3e), Prentice Hall, 2000.
3. Khanna S.K and Justo C.E.G, Highway Engineering, (10e), Nemchand and Bros., Roorkee, 2015.
4. Kadiyali L.R, Traffic Engineering and Transportation Planning, (5e), Khanna Publisher, New Delhi, 2000.

CIE 4417: FORMWORK ENGINEERING PRACTICES

Types of formwork, Codes & standards, Formwork planning & monitoring, Analysis, design of formwork systems, Detailed drawing of formwork systems, Bill of quantities, Formwork failures & remedies

References:

1. IS14687:1999 Guidelines for false work for concrete structures
2. ACI347-04 Guideto Formwork for Concrete
3. Concrete pressure on formwork (R108D)-CIRIA
4. DIN18218 Pressure of fresh concrete on vertical formwork
5. IS456:Plain and Reinforced Concrete-Code of Practice
6. IS:8002007 General Construction in Steel-Code of Practice
7. IS:3991963 Classification of Commercial Timbers and their Zonal Distribution
8. IS:8831994 Design of Structural Timber in Building-Code of Practice
9. IS:49901993 Plywood for concrete shuttering work
10. IS:2750 1964 Steel Scaffoldings
11. IS1161:2014 Covers Steel Tubes for Structural Purposes
12. Course content on LMS of L&T EduTech

CIE 4418: DEEP EXCAVATIONS, FOUNDATIONS &TUNNELS

Construction, design & case studies of boredcast in-situpile,drivencast in-situpile,precast drivenpiles, precast concrete piles in pre-boredholes & under reamed piles, Methods of load testing, Overview of spun piles, helical piles, micro piles, CFA piles, steel piles, Quality Checks for Pile Foundation, Software analysis using PLAXIS2D, Challenges faced during execution.

References:

1. Indian Standard code-IS456,
2. Guidance on embedded retaining wall design CIRIA-C760 CRC Press
3. M. Ramachandran, “Metro Rail Projects in India” - A Study in Project Planning” 2011, Oxford University Press
4. E-learning content on L&T EduTech Platform

CIE 4419: BUILDING INFORMATION MODELLING IN CONSTRUCTION

Evolution of BIM, Introduction to BIM, Design authoring using Revit, Visualization, Interference/clash check using Revit, Documentation & Common Data Environment(CDE), Level of Development, Field BIM, Introduction to 5D & Asset Information Model(AIM)

References:

1. ISO19650 Building Information Modelling(BIM)
2. L&TEduTechLMS

CIE 4420: SUSTAINABILITY PRACTICES IN DESIGN OF BUILDINGS

Climatology, Heat gain through building elements, Comfort in building (Thermal,visual and Acoustics), Energy management system, Building Life Cycle Assessment, Stages in green project management, Green building rating system, Web tools - Solar rooftop calculator and ECONIWAS

References:

- Course content on LMS of L&TEduTech

CIE 4421: PRE-ENGINEERED BUILDINGS

Introduction to PEB, Materials used in PEB and its specifications, Components and Loads on a PEB, Connections in PEB and Codes of Practice, Design of a PEB warehouse and Industrial PEB structure, Base connection, Drawings in a PEB, Stakeholders of a PEB & Fabrication, Erection and Execution aspects.

References:

1. IS800:2007,IS1893,IS875(Part1-5),SP6,NBC(Part1&2):2016
2. Course content on LMSofL & TEduTech

CIE 4422: MECHANIZED CONSTRUCTION TECHNIQUES

Formwork Basics, Various Types of Formwork-Vertical Applications, Horizontal Applications, Planning, Monitoring and Design Concepts in Formwork, Quantity takeoff and Cost Estimation, Modular and Special formwork, Construction Equipment and its management, Heavylifts, Hydraulic systems and design, Application of Hydraulics, Lift Plan and Alternative Methodologies.

References:

1. Jha, K.N., Formwork for Concrete Structures, First Edition, McGrawHill.2012
2. Construction Planning, Equipment and Methods" by Robert Peurifoy and Clifford J Schexnayder
3. E-learning content on L&TEduTech Platform

CIE 4423: INTEGRATED APPROACH TO BUILDING SERVICES

Building Power Distribution & Schemes, Power Distribution Transformer, Diesel Generator Set, High Voltage & Medium Voltage Panels, Distribution Boards(DB), Lighting Fixtures & Control System, Lighting Types & Calculations, Substation Building, Air Conditioning Introduction & Psychrometry, Pressurization Systems, Chilled Water System & Air Handling Units, Fire Protection System Basics, Pump and Sump Capacity Calculation, Life Safety Importance, Smoke Control & Fire Zoning, Plumbing Engineering, Water Demand for Occupancies, Water Treatment Units, Storm Drainage System, Extra Lowvoltage for infrastructure and its principles.

References:

- Course content on LMS of L&T EduTech

CIE 4424: CONCRETE BUILDING SYSTEMS DESIGN

ISCodes & NBC, Design Basis Report, Structural Modelling & coordination, Calculations for gravity and Lateral loads, Structural scheme setting, Analysis in software-ETABS & SAFE, RCC Design including Flat slab & Shear wall, Detailing, Bill of quantities.

References:

1. IS456,IS1893,IS875(Part1-5),SP16,SP34,IS13920
2. National Building Code Vol 1&2:2016
3. L&T EduTech LMS

OTHER ELECTIVES

CIE 4441: BRIDGE ENGINEERING [3 0 0 3]

Introduction, classification, and importance. Investigation for bridge, design discharge linear waterway, economical span, scour depth. Traffic projection, choice of bridge type. Standard specification for road bridge: IRC bridge code, types of loading. Pipe culverts. Types of substructures, bridge bearings, piers and masonry abutments, foundation, wing walls. Concrete bridges: tbeam reinforced concrete bridges and prestressed concrete bridges. RCC slab bridge.

References:

1. T. R. Jagadeesh and M.A Jayaram, Design of Bridge Structures, Prentice Hall of India Pvt. Ltd, New Delhi, 2009
2. D.J.Victor, Essentials of bridge engineering, Oxford & IBH Publishing Co. Pvt. Ltd, 2019.
3. Ponnusamy S, Bridge Engineering, Tata McGraw Hill Publishing Co, New Delhi , 2008
4. Whitney, C.S, Bridges, Greenwich House,1983
5. Singh, V.P Wells and Caissons, Nemchand and Sons,1979
6. N.K.Raju, Design of bridges, Oxford and IBH Publishing Co. Pvt. Ltd, 2019.
7. Indian Road Congress Codes No.5, 6,18,21,24, Jamnagar House, Shah Jahan Road, New Delhi.

CIE 4442: COASTAL ENGINEERING [3 0 0 3]

Introduction to coastal engineering, Origin of coasts, Coastal process, wind, waves, Coastal erosion and Coastal protection work, littoral drift, Seawalls and bulkheads, Groins, Jetties, off-shore breakwaters, artificial beach nourishment, Environmental impact assessment, Port Planning, Harbour structures: Berthing structures, Breakwaters: types and rubble mound breakwater design

References:

1. Dominic Reeve, Coastal Engineering, (3e), CRSC press, 2018
2. S. Narasimhan, S. Kathiroli, Nagendra Kumar B, Harbour and coastal Engineering, Volume I & II, National Institute of Ocean Technology, NIOT, Chennai, Ocean and Coastal Engineering Publications, 2002.
3. William kamphuis J, Introduction to coastal engineering and management, (2e), world scientific publishing company, 2009.
4. Robert M Sorensen, Basic coastal engineering, (3e), Springer publication, 2005. 98
5. Coastal Engineering Manual (CEM), U.S.Army Corps of Engineer, Vicksburg, Miss, 2012.
6. Brunn P., Port Engineering Gulf, publishing Company, 1981.

CIE 4443: DISASTER MANAGEMENT & MITIGATION [3 0 0 3]

Natural disasters and their classification, definition and scales of disaster, definition of vulnerability, methodologies of vulnerability assessment, evaluation, building types, micro and macro methods, rehabilitation- physical and social infrastructure- structural and functional deterioration, design criteria, materials and techniques, predictive performance models, impact of climate change, flood control and management, drought monitoring, remote sensing application.

References:

1. Chen, A.Y, Pena-Mora, F and Ouyang, Y. (2010). A collaborative GIS framework to support equipment distribution for civil engineering disaster response operations, Automation in Construction
2. Ghosh, G. K. (2006) Disaster Management, Delhi: A.P.H. Publishing Corporation
3. UNDP (2016) Disaster Risk Management Training Manual, 2016.
4. Reiter, L (2001), Earthquake Hazard Analysis, Issues and Insights, Columbia University Press.
5. G. Bankoff, G. Frerks, D. Hilhorst (eds.) (2003). Mapping Vulnerability: Disasters Development and People. ISBN ISBN 1-85383-964-7.

CIE 4444: ELEMENTS OF EARTHQUAKE ENGINEERING [3 0 0 3]

Introduction, elastic rebound theory of earthquake, seismic zoning map of India, earthquake magnitude and intensity, liquefaction of soils, seismic effects on various structures, response spectrum, Equivalent static load method (IS 1893), base shear and its distribution. Ductile detailing of RC frames as per IS 13920 (1993). Retrofitting and rehabilitation of structures, various techniques to control seismic response. Case studies related to seismic damages and damage mitigation strategies.

References:

1. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, Prentice-Hall of India Private Limited, New Delhi, 2006
2. Murty, C.V.R, Earthquake Tips- Learning Earthquake Design and Construction, National Information Centre of Earthquake Engineering, IIT Kanpur, 2005

3. Varghese. P. C, Advanced reinforced concrete design, Prentice-Hall of India Private Limited, New Delhi, 2005
4. IS:1893 (part 1)- 2002, Criteria for earthquake resistant design of structures, Bureau of Indian Standards, New Delhi
5. IS: 13920 – 1993, Ductile detailing of reinforced concrete structures subjected to seismic forces- code of practice, Bureau of Indian Standards, New Delhi

CIE 4445: ENGINEERING GEOLOGY [3 0 0 3]

Introduction, Physical Geology: Origin of Earth, Interior structure of Earth. Seismology, Plate Tectonics, Earthquakes. Tsunamis. Introduction to minerals and rocks. Engineering properties of important rocks used as building materials. Weathering of rocks, Soil forming processes. Landforms and processes associated with river, wind, and groundwater. Structural Geology, Groundwater, .Engineering Geology,, Landslides. Remote sensing & GIS and their applications in Civil Engineering, Geophysical methods –Seismic and electrical methods for subsurface investigations, engineering solutions to control climate change.

References:

1. Parbin Singh, Engineering Geology, S.K. Kataria and Sons, New Delhi. 2002
2. Mukherjee P.K., A text book of Geology, World Press, Kolkata 2003
3. Venkata Reddy D., Engineering Geology for Civil Engineering, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi 1995

CIE 4446: ENVIRONMENTAL IMPACT ASSESSMENT AND AUDITING [3 0 0 3]

Introduction, procedure of EIA in India. Conceptual approach in EIA, Impact identification, Description of affected environment, indices and indicators for describing affected environment, Prediction and assessment of impacts, socio-economic impacts, Public participation in environmental decision making, Preparation of EIA report, Environmental monitoring, EIA case study, Environmental audit.

References:

1. Barbara Caroll,. Environmental Impact Assessment Handbook: A Practical Guide for Planners, Developers and Communities. Thomas Telford, London, 2002.
2. Canter, L.W, Environmental Impact Assessment, (2e), McGraw-Hill, 1996.
3. Christopher Wood, Environmental Impact Assessment: A Comparative Review. Prentice Hall, New Jersey, 2003.
4. Riki Therivel, Peter Morris,. Methods of Environmental Impact Assessment, Spon Press, London, 2001.

CIE 4447: FECAL SLUDGE AND SEPTAGE MANAGEMENT [3 0 0 3]

Introduction, classification and types of sanitation systems, selection of sanitation systems, Characterization of fecal sludge, Collection and transport of fecal sludge, Manual collection, manually operated mechanical collection, fully mechanised collection, Kinetics of sludge utilization, MichaelisMenten Equation, Treatment of fecal sludge, End use technology options, steps for planning septage management, Institutional Frameworks, case studies.

References:

1. Strande, L, Ronteltap, M and Brdjanovic, D, Faecal Sludge Management: Systems Approach for Implementation and Operation, IWA Publising, London, 2014.
2. MoUD, National Policy on Fecal Sludge and Septage Management (FSSM), Ministry of Urban Development, New Delhi, 2017
3. MoUD, Primary report on Fecal Sludge and Septage Management (FSSM), Ministry of Urban Development, New Delhi, 2014.
4. Rohilla S K, Luthra B, Bhatnagar A, Matto M and Bhonde U, Septage Management: A Practitioner's Guide, Centre for Science and Environment, New Delhi, 2017.

CIE 4448: GEO-ENVIRONMENTAL ENGINEERING [3 0 0 3]

Introduction, Geoenvironmental Problems, Regulations and Practice, Composition and Properties of Soils and Wastes, Subsurface Flow and Contaminant Transport, Subsurface contamination, In-situ waste containment, Waste Containment Liner Systems, Leachate Collection and Removal Systems, Waste Containment System Liner Design, Final Cover Systems, Contaminated Site Investigation and Risk Assessment, Soil and Groundwater Remediation Technologies, Beneficial Use Of Waste Materials: Recycling, Case studies.

References:

1. Sharma, H.D and Reddy, K.R, Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies, John Wiley and Sons, Inc, 2004.
2. Sharma, H.D and Lewis, S.P, Waste Containment Systems, Waste Stabilization, and Landfills: Design and Evaluation, John Wiley and Sons, Inc, 1994.
3. Qian, X, Koerner, R.M, and Gray, D.H, Geotechnical Aspects of Landfill Design and Construction, Prentice Hall, 2002.
4. Daniel, David E, Geotechnical Practice for Waste Disposal, Chapman and Hall, 1993.

CIE 4449: GROUND IMPROVEMENT TECHNIQUES [3 0 0 3]

Introduction to ground improvement techniques, mechanical modification, hydraulic modification, physical and chemical modification, thermal modification, modification by inclusions.

References:

1. M.R. Hausmann, Engineering Principles of Ground Modifications, (3e), McGraw Hill Publishing Co, 2002.
2. Moseley M.P, Ground Improvement, (2e), Blackie Academic and Professional, Boca Taton, Florida, USA, 2007.
3. Robert M. Koerner, Designing with Geosynthetics, (2e), Prentice Hall New Jersey, USA, 2000
4. Purushotham Raj, Ground Improvement Techniques, Laxmi Publications, New Delhi, 2016.
5. Das B.M, Principles of Foundation Engineering, CENGAGE Learning, 2010

CIE 4450: CHANNEL HYDRAULICS & HYDRAULIC MACHINES [3 0 0 3]

Fundamentals of Open Channel Flow, Gradually Varied Flow, RapidlyVaried flow, Design of Stable Channels, Impulse Momentum

Principle and Its Applications, hydro power plants, Hydraulic turbines, classification of turbines, general Principles of working of Pelton, Francis and Kaplan turbines, Hydraulic Pumps, Classification, work done and efficiencies, pumps in series and pumps in parallel, specific speed, Reciprocating Pumps.

References:

1. VenTe Chow, Open Channel Flow, McGraw Hill Company Ltd., NewYork, 1985
2. Subramanya K., Flow in Open Channels, Tata McGraw Hill Publishing Company, New-Delhi, 2005
3. Modi P.N. and Seth S.M, Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 2005
4. Bansal R. K. Fluid Mechanics and Hydraulic Machines, Laxmi Publishers, New Delhi. 2010

CIE 4451: NON-DESTRUCTIVE TESTING OF CONCRETE STRUCTURES [3 0 0 3]

Introduction: - Importance and need of non-destructive testing, Visual Inspection Technique: Introduction, tools, procedure of visual inspection, applications of visual inspection, Schmidt Rebound Hammer Testing: Fundamental principle, procedure and applications, Ultrasonic Testing: Ultrasound pulse echo, velocity versus rebound number curves, Acoustic Emission Testing: Fundamental principle, Kaiser effect and facility ratio, Carbonation Depth Measurement Test: Fundamental principle, range and limitations, Half-Cell Electrical Potential Method: Fundamental principle and procedure, Resistivity Measurement: - Fundamental principles and procedure, applications, Electromagnetic Methods of Testing Concrete: Fundamental principles, range and limitations of electromagnetic testing method, work or site calibration. Radiographic Testing: Fundamental principles and applications Ground Penetrating Radar: Fundamental principle, application, interpretation of GPR, advantages and limitations of GPR techniques.

References:

1. J.H.Bungey, The Testing of Concrete in Structures, 4th edition, Surry University Press, 2006.
2. Guidebook on Non-Destructive Testing Of Concrete Structures, Training Course Series No. 17, International Atomic Energy Agency, Vienna, 2002.
3. Christiane Maierhofer, Hans-Wolf Reinhardt and GerdDobmann, Non-Destructive Evaluation of Reinforced Concrete Structures, Vol. 1 & 2, 1st edition, Woodhead Publishing Limited, 2010.
4. V.M. Malhotra and N.J. Carino, Handbook On Non-destructive Testing of Concrete, 2nd, CRC Press, 2003.

CIE 4452: REMOTE SENSING AND GIS [3 0 0 3]

Introduction, Basic concepts of Remote sensing, Physics of Remote sensing Orbits, Concept of Spatial, spectral, radiometric and temporal resolution, Visual interpretation, basics of Digital Interpretation of images, application of Toposheet in base map preparation, Fundamentals of GIS, Objectives, Components of GIS, contributing disciplines and technologies, Raster, Vector, Definitions of Triangular irregular network (TIN) and Digital Elevation Model (DEM), Indian satellite program, Launch vehicles, Exercise on Remote sensing and GIS applications in Civil Engineering

References:

1. Lilles and T. M., and Kiefer, R.W. Remote Sensing and Image interpretation, (6e), of John Wiley & Sons 2000
2. John R. Jensen, Introductory Digital Image Processing: A Remote Sensing Perspective, (2e), 1995
3. Sabins, F. F. Jr, “Remote Sensing Principles and Image interpretation”, W. H. Freeman & Co. 1978
4. Allan Brimicombe, “GIS Environmental Modeling and Engineering”, Taylor & Francis, 2003

CIE 4453: SOIL REINFORCEMENT AND GEOSYNTHETICS [3 0 0 3]

Introduction, concept of reinforced soil, different types of geosynthetics, properties and tests on geosynthetics, design of reinforced soil retaining walls, design of reinforced earth foundations, reinforced soil slopes, soil nailing techniques, pavement application, drainage and filtration applications of geosynthetics, construction of landfills using geosynthetics.

References:

1. Koerner. R.M, Designing with Geosynthetics, (5e), Prince Hall Publication, USA, 2005.
2. Sivakumar Babu G. L., An introduction to Soil Reinforcement and Geosynthetic, Universities Press, Hyderabad, 2009
3. Swami Saran, Reinforced Soil and its Engineering Applications, I. K. International Pvt. Ltd, New Delhi, 2006.
4. G.V. Rao, P.K Banerjee, J.T. Shahu, G.V. Ramana., Geosynthetics - New Horizons, Asian Books Private Ltd, New Delhi, 2004.
5. Jones CJEP, Earth reinforcement and Soil structures, Thomas Telford Publishing, London, 1996.

CIE 4454: VALUATION OF REAL PROPERTIES [3 0 0 3]

Introduction- purpose, forms, and factors; Outgoings; Depreciation; Rent; Methods of valuation; Valuation of land with buildings- case studies, valuation of agricultural/farmlands; Rights and liabilities of lessor and lessee, leasehold properties, freehold properties, year's purchase, capitalized value, obsolescence, amortization; Easements.

References:

1. Banerjee D. N, Principles and Practice of Valuation, Eastern law house, 1998.
2. Roshan H, Namavathi, Professional Practice, Lakhani Book Depot, 2001.
3. Mitra A.K, Theory and Practice of Valuation, Eastern law house, year
4. Rao Gopinath C H, Valuation Practices of Immovable Properties, Edition 12, C H Gopinath Rao, Chennai, 2002.
5. Tedkay, Assessment, and Renovation of Concrete Structures, Longman Scientific and Technical, Harlow, England, 1992.
6. Jagadisa R, Structural Failures- Case Histories, Gcford and IBH Publishing Co. Ltd, New Delhi, 1995.
7. Raikar R.N, Diagnosis and Treatment of Structures in Distress, R & D Centre Structural Designers and Consultants Pvt. Ltd., Vashi, New Bombay, 1994.

CIE 4455: WATER RESOURCES PLANNING & MANAGEMENT [3 0 0 3]

Capability & requirements of multipurpose projects, steps involved in planning, common pitfalls. Data collection importance, storage, retrieval; Extrapolation of data, Simulated data, Conjunctive-use management; Reservoir Planning & Operation, Reservoir capacity, Yield determination, Demand patterns, Optimal reservoir operation, Rule curves; Canal Management Need & Inadequacies, Planning canal systems, Canal regulation; River Training methods & structures; Economics of Water Resource Projects, Cost-Benefit analysis, Apportionment of total cost, Economic & Financial efficiency, Project selection; Socio-Legal & Environmental Aspects Riparian rights, Environmental aspects, Sustainable development.

References:

1. Loucks, D.P. and Eelco van Beek. Water resources systems planning and management: An introduction to methods, models and applications, UNESCO. 2005
2. Vedula, S. and Mujumdar, P.P. Water resources systems: Modeling techniques and analysis, Tata McGraw Hill, New Delhi 2005.
3. Mays, L.W. and Tung, Y.K.. Hydro systems engineering and management, McGraw Hill, USA 1992.
4. Simonovic, S.P. Managing water resources: Methods and tools for a systems approach, UNESCO publishing, France 2009. Jain, S.K. and Singh V. P. Water Resources Systems Planning and Management, Elsevier 2003.

CIE 4456: BRIDGE ENGINEERING DESIGN & PRACTICES

Design Loads on Bridges according to IRC code, Grillage and Transverse Analysis using STAAD.Pro, Single Cell Box Culvert, Beam & Slab type Super-structure, Bearings, Pier Capandpier, Pile & Well Foundation, Composite Plate Girder Bridge, Construction stage monitoring, Periodic inspection methods, Erection Methods-Segmental, Balanced Cantilever and Cable Stayed Bridges.

References:

1. Relevant Indian Road Congress (IRC) codes and Ministry of Road Transport & Highway (MORT) Specifications
2. Course content on LMS of L&T EduTech

CIE 4457: GEOSPATIAL TECHNIQUES IN PRACTICE

Geospatial technology Survey & mapping, Sensors & scanners, Platforms,Satellite positioning, Stockpile quantity estimation, Subsurface investigation & bathymetry survey, Spatial analysis & GIS database, Decision support systems, Future trends.

References:

- L&TEduTech, LMS

CIE 4458: PROJECT MANAGEMENT FOR PROFESSIONALS

Project management fundamentals & methodology, Emerging trends, Scope management, Scheduling, Costing & estimation, Quality management, Project risk management, Communication & negotiation, Resource management, MS Project.

References:

1. Project management institute, Guide to the Project Management Body of Knowledge (PMBOK® Guide), seventh edition/2022.
2. Course content on LMS of L&T EduTech

OPEN ELECTIVES

CIE 4311: AIR AND NOISE POLLUTION [3 0 0 3]

Introduction, sources and classification of pollutants, Air pollution meteorology, Inversions, stability conditions, Global effects of air pollution, Air quality and emission standards, air pollution index, Industrial plant location and planning, Sampling, analysis and control, Particulate emission control technologies, Noise Pollution, sources, effects and control measures, Noise Impact Analysis, Air and noise legislations.

References:

1. Rao H.V.N and Rao M.N, Air pollution, Tata Mc Graw Hill, New Delhi, 1989.
2. Rao C.S, Environmental Pollution control, Wiley Eastern Ltd. New Delhi, 1995.
3. Wark Kenneth and Wamer C.F, Air Pollution, its Origin and Control, Harper and Row, 1981
4. Sincero. A. P and Sincero G.A, Environmental Engineering, Prentice Hall, 1995
5. Air Pollution - Sampling and Analysis – APHA, 1977.

CIE 4312: CONTRACT MANAGEMENT FOR ENGINEERS [3 0 0 3]

Introduction to contracts, Types of contracts, Tendering process, Dispute resolution, Conciliation, International contracts / contracts with international funding: International Competitive Bidding, Domestic Preference, FIDIC Documents, Conditions, Currency of Bid and Payment, Escalation in Foreign Currency, Financing of projects, Applicable Law and Settlement of Disputes, International Arbitration.

References:

1. Prakash V. A., Contracts Management in Civil Engineering Projects, NICMAR 1997
2. Patil B. S., Civil Engineering Contracts and Estimates, University Press 2009.
3. John G. Betty, Engineering Contracts, McGraw Hills 1993
4. Vasavada B. J Engineering Contracts and Arbitration, (Self Stability of columns, Slenderness ratio, failure by buckling, Euler's Publication by Jyoti B.` Vasavada) 1997.
5. Albett Robert W., Engineering Contracts and Specifications, John Willey and Sons, New York. \(1961
6. VaidK.N.,Global perspective on International Construction Contracting Technology & Project Management, NICMAR, Mumbai. 1998

CIE 4313: ENVIRONMENTAL MANAGEMENT [3 0 0 3]

Introduction, sustainability and sustainable development, environmental management system, Environmental ethics, Environmental Impact Assessment, Life cycle assessment, ISO 14000, Environmental auditing, corporate environmental management product design for the environment, Environmental economics and environmental design-application, Case studies.

References:

1. Ramachandra T.V, Environmental Management, IISC Bangalore, 2012
2. Lohani B.N, Environmental Quality Management, South Asian Publishers, New Delhi, 1984
3. MOEF, Government of India, Carrying Capacity Based Developmental Planning Studies for the National Capital Region, 1995-96.
4. Chanlett, Environmental Protection, McGraw Hill Publication, New York, 1973
5. Environmental Laws-MOEF, Government of India

CIE 4314: GEOLOGY FOR ENGINEERS [3 0 0 3]

Introduction, Physical Geology: Origin of Earth, Interior structure of Earth. Seismology, Plate Tectonics, Earthquakes. Tsunamis. Introduction to minerals and rocks. Engineering properties of important rocks. Weathering of rocks, Soil forming processes. Landforms and processes associated with river, wind, and groundwater. Structural Geology, Groundwater, .Engineering Geology, Landslides, Remote

References:

1. Parbin Singh, Engineering Geology, S.K. Kataria and Sons, New Delhi. 2002
2. Mukherjee P.K., A text book of Geology, World Press, Kolkata 2003
3. Venkata Reddy D., Engineering Geology for Civil Engineering, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi 1995

CIE 4315: INTRODUCTION TO REMOTE SENSING AND GIS [3 0 0 3]

Introduction, Basic concepts and physics of remote sensing, Image composition, different types of resolutions, image correction, and noise removal, Image enhancement, visual interpretation, Fundamentals of GIS, exercise on remote sensing and GIS application, definitions of Triangular Irregular Network (TIN) and Digital Elevation Model (DEM) exercises in GIS, Indian satellite program, launch vehicles, exercise on RS and GIS applications.

References:

1. Lillesand T. M., and Kiefer, R.W. Remote Sensing and Image interpretation, (6e), of John Wiley & Sons 2000
2. John R. Jensen, Introductory Digital Image Processing: A Remote Sensing Perspective, (2e), 1995
3. Sabins, F. F. Jr, “Remote Sensing Principles and Image interpretation”, W. H. Freeman & Co. 1978
4. Allan Brimicombe, “GIS Environmental Modeling and Engineering”, Taylor & Francis, 2003

CIE 4316: STRENGTH OF MATERIALS [3 0 0 3]

Introduction. Shear Force and Bending Moment in Beams. Bending and Shear Stresses in Beams. Slope and Deflection of statically determinate beams by Macaulay's method. Torsion in Circular Shaft: Introduction, pure torsion, assumptions, derivation of torsion equation for circular shafts, torsional rigidity and polar modulus, power transmitted by a shaft, application numerical. Compound Stresses, Mohr's circle of stresses, numerical problems. Columns and Struts.

References:

1. Basavarajaiah B.S and Mahadevappa P, Strength of Materials, University Press (India) Pvt. Ltd., 2010.
2. Ferdinand P. Beer, E. Russell Johnston and Jr.John T. D., Mechanics of Materials, (3e), Tata McGraw-Hill, 2012.
3. Andrew Pytel, Singer F. L, Strength of Materials Harper and Collins 1987.
4. Young D. H, Timoshenko S.P, Elements of Strength of Materials, East West Press Pvt. Ltd., 2014.
5. Bansal R.K, A Textbook of Strength of Materials, Laxmi Publications, 2014.
6. Rattan S.S, Strength of Materials, McGraw Hill Education (India) Pvt. Ltd., 2013.

School of Computer Engineering

The School of Computer Engineering offers B.Tech degree program in Computer Science Engineering, 6 M.Tech programs, a MCA program and a Ph.D program.. The School is aimed at providing in-depth technical knowledge and opportunities for innovation and research in Computer Engineering with well-equipped computer facilities and dedicated faculty. The School has collaborations with various industries and offers research projects and electives to students. The faculty and students of the School work in diverse areas of Computer Science with emphasis on the emerging, interdisciplinary, cutting-edge areas of High Performance Computing System Computer Vision, Software Engineering, Knowledge Engineering, Computer Network, Security, Machine Learning and Data Science. Students are encouraged to participate in co-curricular and extracurricular activities. The School coordinates the activities of the student clubs such as IE(CSE), Linux Users Group, ACM student chapter, Data Alchemists etc. Students of the School are placed in reputed industries like Microsoft, Amazon, Deloitte, Goldman Sachs, Oracle, Cisco, Samsung etc.

> Programs offered

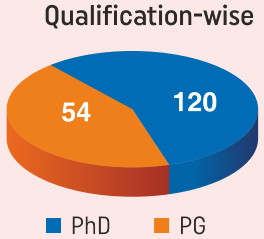
Undergraduate Programs

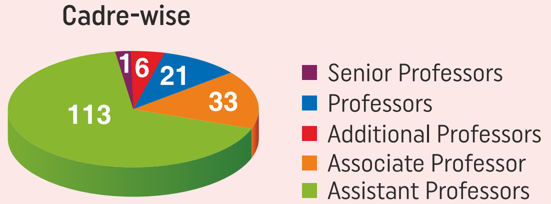
B.Tech. in Computer Science and Engineering

Postgraduate Programs

- M.Tech. in Computer Science and Engineering
- M.Tech. in Computer Science and Engineering (Information Security)
- M.Tech. in Computer Science and Engineering (Networks)
- M.Tech. Computer Science and Engineering (Data Sciences)
- M.Tech. Computer Science and Engineering (Artificial Intelligence and Decision Science)
- M.Tech. Computer Science and Engineering (Cyber Security)
- MCA

> Faculty Strength





Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2101	Discrete Mathematical Structures	3	0	0	3	MAT 2201	Probability and Optimization	3	1	0	4
	CSS 2101	Data Structures	3	1	0	4	CSS 2201	Database Systems	3	0	0	3
	CSS 2102	Data Communication and Computer Networks	3	1	0	4	CSS 2202	Design & Analysis of Algorithm	3	0	0	3
	CSS 2103	Data Analytics	3	1	0	4	CSS 2203	Introduction to Artificial Intelligence	2	1	0	3
	CSS 2104	Digital Systems and Computer Organization	3	1	0	4	CSS 2204	Operating Systems	3	0	0	3
	CSS 2111	Data Structures Lab	0	0	3	1	CSS 2211	Operating Systems Lab	1	0	2	2
	CSS 2112	Digital Systems lab	0	0	3	1	CSS 2212	Database Systems Lab	1	0	3	2
							CSS 2213	Object-Oriented Software Development Lab				
			15	**4**	**6**	**21**			**15**	**3**	**9**	**22**
		Total Contact Hours (L+T+P)	**25**					**Total Contact Hours (L+T+P)**	**27**			

Year	FIFTH SEMESTER						SIXTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	HUM 3101	Essentials of Management	3	0	0	3	HUM 3201	Engineering Economics and Financial Management	3	0	0	3
	CSS 3101	Finite Automata and Compiler Design	3	1	0	4	CS0 32XX	CS Specialization (S4)	3	0	3	4
	CSO 31XX	CS Specialization (S1)	3	0	3	4	CSO 32XX	CS Specialization (S5)	3	0	3	4
	CSO 31XX	CS Specialization (S2)	3	0	3	4	CSP 44xx	Program Elective 1/ Minor 1	3	0	0	3
	CSO 31XX	CS Specialization (S3)	3	0	3	4	CSP 44xx	Program Elective 2/ Minor 2	3	0	0	3
	IOE 33XX	Open Elective – 1 (MLC)	3	0	0	3	IOE 33XX	Open Elective – 2 (MLC)	3	0	0	3
									1	0	3	2
			18	**1**	**9**	**22**			**18**	**0**	**6**	**20**
		Total Contact Hours (L+T+P)	**28**					**Total Contact Hours (L+T+P)**	**24**			

Year	SEVENTH SEMESTER						EIGHTTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	CSP 44xx	Program Elective 3/ Minor 3	3	0	0	3	CSS 4289	Internship (MLC)				1
	CSP 44xx	Program Elective 4/ Minor 4	3	0	0	3	CSS 4998	Capstone Project				12
	CSP 44xx	Program Elective 5	3	0	0	3	CSS 4999	Capstone Project (Honours) ^				20
	CSP 44xx	Program Elective 6	3	0	0	3	CSS 50XX	Honours Course 1 ^				4
	CSP 44xx	Program Elective 7	3	0	0	3	CSS 50XX	Honours Course 2 ^				4
	IOE 33XX	Open Elective – 3 (MLC)	3	0	0	3	CSS 50XX	Honours Course 3 ^				4
	CSP 4199	Minor Specialization Project*	3	0	0	3						
			18	**0**	**0**	**18/26***						**13/33***
		Total Contact Hours (L+T+P)		**18**				**Total Contact Hours (L+T+P)**				

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

LIST OF SPECIALIZATIONS

A. ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

CSO 3101: Foundations of Computer Vision
CSO 3102: Machine Learning
CSO 3103: Parallel Computer Architecture and Programming
CSO 3201: Deep Learning and Applications
CSO 3202: Natural Language Processing

B. NETWORKS AND IOT

CSO 3111: Embedded Systems and IoT
CSO 3112: Network Protocols and Programming
CSO 3113: Cloud Computing
CSO 3211: Network Security
CSO 3212: Wireless Communication and Networking

C. DATA SCIENCE

CSO 3121: Data Privacy and Security
CSO 3102: Machine Learning
CSO 3103: Parallel Computer Architecture and Programming
CSO 3201: Deep Learning & Applications
CSO 3222: Generative AI

D. SOFTWARE ENGINEERING

CSO 3131: Software Design Technology
CSO 3132: DevOps - Using AI
CSO 3133: Full Stack Application Development
CSO 3231: Human Computer Interaction
CSO 3232: Knowledge and Data Engineering

E. CYBER SECURITY

CSO 3141: Number Theory and Cryptography
CSO 3142: Essentials of Cyber Security
CSO 3143: Incident Response and Threat Intelligence
CSO 3241: Cyber Law, Cyber Crime and Cyber Ethics
CSO 3242: Applied Cryptography

F. QUANTUM COMPUTING

CSO 3151: Fundamentals of Quantum Computing
CSO 3152: Quantum Algorithms
CSO 3153: Quantum Communications & Quantum Networks
CSO 3251: Advanced Quantum Algorithms
CSO 3252: Industrial Applications of Quantum Computing

LIST OF MINOR SPECIALIZATIONS

I. MULTIMODAL DATA ANALYTICS

CSP 4401: Information Retrieval
CSP 4402: Graph Analytics
CSP 4403: Image and Video Analysis
CSP 4404: Social Network Analysis

II. HEALTH CARE ANALYTICS

CSP 4405: Health Informatics
CSP 4406: Bioinformatics
CSP 4407: Medical Image Processing
CSP 4408: Biostatistics

List of Program Electives

CSP 4409: Internet of Things and Applications
CSP 4410: Augmented and Virtual Reality
CSP 4411: Conversational AI
CSP 4412: Fundamentals of iOS
CSP 4413: iOS Application Development
CSP 4414: Blockchain Technology
CSP 4415: Wireless Technologies
CSP 4416: Foundations of Quantum Computing
CSP 4417: Reinforcement Learning
CSP 4418: Mobile Application Development
CSP 4419: Foundations and Ethics of Generative AI
CSP 4420: Prompt Engineering
CSP 4421: Product Management
CSP 4422: Enterprise Data Architecture
CSP 4423: Optimization Techniques
CSP 4424: Cyber Forensics
CSP 4425: Deep Learning
CSP 4426: Machine Learning Tools & Technology
CSP 4427: Web Technologies
CSP 4428: Game Theory and Applications
CSP 4429: Explainable AI
CSP 4430: User Interface Engineering
CSP 4431: Semantic Web
CSP 4432: Big Data Analytics
CSP 4433: Graph Database

THIRD SEMESTER

MAT 2101: DISCRETE MATHEMATICAL STRUCTURES [3 0 0 3]

Boolean Algebra: Partial ordering sets, Lattices–simple properties, Boolean algebras, Boolean polynomials: Disjunctive normal form (DNF) and Conjunctive normal form (CNF). Elementary configuration: Permutations and Combinations (basics), Generating function, Applications of Principle of inclusion and exclusion, Partitions, compositions, Fikes ordering of permutations. Graph theory: Basic definitions, properties, Eulerian graphs, Hamiltonian graphs, Trees and Properties, Matrices associated with graphs, Algorithms for finding shortest path. Group theory: Groups-subgroups, group of symmetries and applications, Cyclic groups, Cosets, Lagrange's Theorem. Propositional and Predicate Calculus: Well-formed formula, Connectives, Quantifications, Inference theory of Propositional and Predicate calculus. Matrix Decompositions: Prerequisites, QR, LU and SVD, and Applications.

References:

1. C. L. Liu: Elements of Discrete Mathematics, 2nd edition, 2007, Mc Graw Hill, New Delhi.
   https://pdfcoffee.com/elements-of-discrete-mathematics-liu-c-l--pdf-free.html
2. J. P. Trembaly and R. Manohar: Discrete Mathematics Structures with application to computer science, 2012,Tata Mc Graw Hill.
   https://www.academia.edu/37284735/Discrete_Mathematical_Structures_with_Applications_by_Manohar_pdf
3. E. S. Page and L. B. Wilson: An introduction to computational combinatorics, edn., 1979, Cambridge Univ. Press.
4. Narasingh Deo: Graph theory with Applications to computer science, Dover Publications, 2016. Originally published: Englewood Cliffs, New Jersey: Prentice-Hall, Inc.,1974. https://www.shahucollegelatur.org.in/Department/Studymaterial/sci / it/BCS/FY/book.pdf
5. F. Harary, Graph Theory, Narosa Publishing House, New Delhi, Second edition, 1990, Reprint 2013.
   https://users.metu.edu.tr/aldoks /341/Book%201%20(Harary).pdf
6. David C. Lay, Linear Algebra & Its Applications, Pearson Pub. 2016. https://home.cs.colorado.edu/~alko5368/lecturesC SCI2820/mathbook.pdf
7. Alan Tucker, Applied Combinatorics, Wiley Publishers, 2012. https://www.isinj.com/mtusamo/Applied%20Combinatorics%20(6th%20Edition)%20by%20Alan%20Tucker%20Wiley%20(2012).pdf
   https://onlinecourses.nptel.ac.in/noc24_ma26/preview
8. Introduction to Group Theory
   https://nptel.ac.in/courses/111106086
9. Discrete Mathematics

CSS 2101: DATA STRUCTURES [3 1 0 4]

Arrays, Sparse Matrix, Pointers and array of Pointers, Recursion, Memory allocation functions, Structures and array of structures, Linear Search, Binary Search, Merge sort and quick sort, Singly Linked List and Chains, Doubly Linked Lists, Circular Linked Lists, Linked Lists with Header Node, Applications using linked lists, Polynomials, Additional List Operations, Stacks, Queues, Circular Queues, Priority Queues and their Representation, Double Ended Queue, Input/Output Restricted Queues, Evaluation of Expression, Infix, Postfix and Prefix expressions and their conversions, Linked stacks and Linked Queues. Representation of Trees, Binary Trees, Expression tree, Binary Tree Traversals, Additional Binary Tree Operations, Threaded Binary Trees, Binary Search Trees - Definition, searching a Binary Search Tree, Inserting into and Deletion from Binary Search Tree, AVL trees, Red-Black Trees, Introduction, Definitions, Graph Representations, Depth First Search, Breadth First Search.

References:

1. Behrouz A. Forouzan, Richard F. Gilberg, A Structured Programming Approach Using C,(3e), Cengage Learning India Pvt. Ltd, India, 2007.
2. Ellis Horowitz, Sartaj Sahani, Susan Anderson and Freed, Fundamentals of Data Structures in C, (2e), Silicon Press, 2007.
3. Richard F. Gilberg, Behrouz A. Forouzan, Data structures, A Pseudocode Approach with C, (2e), Cengage Learning India Pvt. Ltd, India, 2009.
4. Tenenbaum Aaron M., Langsam Yedidyah, Augenstein Moshe J., Data structures using C, Pearson Prentice Hall of India Ltd., 2007.
5. Debasis Samanta, Classic Data Structures, (2e), PHI Learning Pvt. Ltd., India, 2010.
   https://onlinecourses.swayam2.ac.in/cec25_hs62/preview
6. [Introduction to Data Structures, Punjabi University, Patiala].

CSS 2102: DATA COMMUNICATION AND COMPUTER NETWORK [3 1 0 4]

Introduction to data communication, Digital and analog signals, Line coding, Modulation schemes, Multiplexing, Transmission media. Introduction to computer network, Protocol, Layered architecture, Topology and network devices, Data link layer services, Error detection and correction, Flow control, Access control: CSMA/CD, Ethernet Frame, Network layer services, IP addressing, IP datagram, Fragmentation, Options. Routing protocols. ARP, ICMP, Transport layer services-TCP, UDP. Application layer services- DNS, DHCP, HTTP, etc.

References:

1. Behrouz A. Forouzan, TCP/IP Protocol Suite, 4th Edition, Tata McGraw Hill 2017.
2. Behrouz Forouzan, Introduction to data communication & networking (5e), Tata McGraw Hill, New Delhi-2017.
3. William Stallings, Data & Computer Communications (10e), Pearson Education Inc., Noida, 2017.
4. Andrew S. Tanenbaum, Computer Network, 5th Edition Prentice Hall of India Pvt Ltd 2016.
5. Larry L. Peterson, Bruce S. Davie, Computer Networks, 6th Edition, 2020.
   NPTEL LINK:https://nptel.ac.in/courses/106105183

CSS 2103: DATA ANALYTICS [3 1 0 4]

Introduction to Analytics: Descriptive, Predictive, Prescriptive Analytics, steps in data analytics projects. Data exploration: Data sources, data collection, sampling distributions, data types, describing data using measures of central tendency, distributions, data tabulation, and visualization. case studies. Data Preparation: Data Cleaning, Data Imputation, Multivariate data analysis using- correlation, hypothesis tests, ANOVA, and confidence intervals. Feature Engineering, Data Integration, Data Transformations, Dimensionality reduction, PCA Recommender Systems: Generating Association Rules using Apriori Algorithm, Measures of Pattern Interestingness, Metrics-Support, Confidence, Lift, cosine similarity. Collaborative Filtering Techniques-User-based Similarity and Item-based Similarity. Time Series: basics, time zones, period arithmetic, moving window functions. Case studies

References:

1. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data: A Practical Guide to Exploratory Data Analysis and Data Mining, John Wiley Publication, Second Edition, 2014.
2. Jiawei Han, Micheline Kamber, Jian Pei, Data Mining Concepts and Techniques Morgan Kaufmann Publishers, Third Edition, 2012.
3. U. Dinesh Kumar, Business Analytics: The Science of Data-Driven Decision Making, Second Edition, Wiley Publications, 2021
4. Joel Grus, "Data Science from Scratch: First Principles with Python", O'Reilly Media, 2019.
5. Anil Maheshwari, Data analytics: A comprehensive guide to data analysis and decision-making, Wiley Publications, 2021. https://archive.nptel.ac.in/courses/110/106/110106072/
6. Introduction to Data Analytics. https://onlinecourses.nptel.ac.in/noc21_cs45/preview
7. Data Analytics with Python.

CSS 2104: DIGITAL SYSTEMS AND COMPUTER ORGANIZATION [3 1 04]

Digital Systems: Simplification of logical expressions-K-Map simplification, Incompletely specified functions, Multilevel NAND and NOR Circuits. Arithmetic operations-addition of unsigned and signed numbers, BCD adder, Fast adder, Array multiplier. Combinational circuits- Multiplexer, Decoder, Encoder, Arithmetic comparison circuits. Sequential circuits- Flip-Flops, Design of synchronous sequential circuits, Ripple counter, Registers, Shift registers, Ring counter, Johnson counter, Programmable Logic Devices

Computer Organization: Instruction Set Architecture- Memory location, addresses and operations, Instructions and Instruction Sequencing, Addressing modes, RISC and CISC. Arithmetic Logic Unit- Multiplication of signed numbers, Booth's algorithm, Division, IEEE standard floating-point representation, Floating point arithmetic. Control Unit- Hardwired and micro-programmed approach for booths multiplier. Memory System- Cache memories, Magnetic hard disk. Basic Input/Output- I/O Device Interface, Program-Controlled I/O, Interrupts. Parallel processing- Pipelining, Hardware Multithreading, Vector Processing, Shared-Memory Multiprocessors, Cache Coherence.

References:

1. Stephen Brown and Zvonko Vranesic, Fundamentals of Digital Logic with Verilog Design (3e), Tata McGraw Hill 2014.
2. Morris Mano M. and Michael D. Ciletti., Digital Design: With an introduction to the Verilog HDL (5e), PHI Learning 2007.
3. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Computer Organization and Embedded Systems, (6e), McGraw Hill Publication, 2017.
4. Mohammed Rafiquzzaman and Rajan Chandra, Modern Computer Architecture, Galgotia Publications Pvt. Ltd., 2015.
5. Ronald J. Tocci, Neal S. Widmer and Greegory L Moss,Digital Systems: Principles and Applications(12e),Pearson Education India, 2017.
6. William Stallings,Computer Organization and Architecture, (10e), Pearson, 2017

CSS 2111: DATA STRUCTURES LAB [0 0 3 1]

Solving Problems Using Arrays, Pointers and Dynamic Memory Allocation Functions, Ragged Arrays, Structures, Solving Problems Using Recursion (Sorting And Searching), Linked List Concepts - Singly And Doubly Linked Lists, Circular Singly And Circular Doubly Linked Lists, Linked List Applications, Implementation of Stack Using Arrays And Linked Lists, Stack Applications, Implementation of Queue Using Arrays And Linked Lists, Queue Applications, Tree Concepts - Binary Tree And Binary Search Tree, AVL Tree , and Tree Applications.

References:

1. Behrouz A. Forouzan, Richard F. Gilberg, A Structured Programming Approach Using C,(3e), Cengage Learning India Pvt. Ltd, India, 2007.
2. Ellis Horowitz, Sartaj Sahani, Susan Anderson and Freed, Fundamentals of Data Structures in C, (2e), Silicon Press, 2007.
3. Richard F. Gilberg, Behrouz A. Forouzan, Data structures, A Pseudocode Approach with C, (2e), Cengage Learning India Pvt. Ltd, India, 2009.
4. Tenenbaum Aaron M., Langsam Yedidyah, Augenstein Moshe J., Data structures using C, Pearson Prentice Hall of India Ltd., 2007.
5. Debasis Samanta, Classic Data Structures, (2e), PHI Learning Pvt. Ltd., India, 2010.

CSS 2112: DIGITAL SYSTEMS LAB [0 0 3 1]

Simulation of Logic Circuits Using Verilog: Simplification of Expressions using Kmap: SOP and POS Forms, Multilevel NAND, NOR Circuits, Arithmetic Circuits: Half Adder, Full Adder, Multi-Bit Adder/Subtractor, BCD Adder, Multiplexers, Decoders and Encoders, Latches and Flip-Flops: D, JK, and T Flip-Flops, Registers: Shift Register, Design of sequential circuits.

References :

1. Stephen Brown and Zvonko Vranesic, Fundamentals of Digital Logic with Verilog Design, (3e), Tata McGraw Hill, 2014
2. Morris Mano M., Digital Design, (5e), PHI Learning 2007

FOURTH SEMESTER

MAT 2201: PROBABILITY AND OPTIMIZATION [3 0 0 3]

Axioms of probability, Baye's theorem - Applications, One dimensional and Two-dimensional random variables, mean and variance, properties, Chebyshev's inequality, Correlation Coefficient, Markov Chains, Distributions: Discrete and Continuous, Binomial, Poisson, exponential, Normal and Chi-square, Moment generating function, properties. Functions of random variables - One-Two dimensional, Jacobians. Sampling theory: Central limit theorem, Point estimation, Maximum Likelihood Estimator. Hypothesis: significance level, Chi square test. Gradients of Matrices: Useful Identities for Computing Gradients, Backpropagation and Automatic Differentiation. Constrained Optimization.

References:

1. P. L. Meyer: introduction to probability and statistical applications, 2nd edition, 1980, oxford and ibh publishing, delhi.https://pdfcoffee.com/pl-meyerpdf-pdf-free.html
2. Miller, freund and johnson, probability and statistics for engineers, 8thedn., phi, 2011. http://ndl.ethernet.edu.et/bitstream/123456789/33524/1/richard%20a.%20johnson18.pdf
3. Hogg and craig, introduction to mathematical statistics, 6th edn,2012, pearson education,new delhi.
   https://minerva.it.manchester.ac.uk/~saralees/statbook2.pdf
4. Ross sheldon m, introduction to probability and statistics for engineers and scientists, elsevier, 2010. https://minerva.it.manchester.ac.uk/~saralees/statbook3.pdf
5. Marc peter deisenroth, a. Aldo faisal, cheng soon ong, mathematics for machine learning, cambridge university press, 2020. Https://mml-book.github.io/book/mml-book.pdf
6. J. Medhi, stochastic processes, third edition, new age international, 2009.
   https://pdfcoffee.com/qdownload/stochastic-processes-by-jyotiprasad-medhipdf-pdf-free.html
   https://nptel.ac.in/courses/111101004
7. Introduction to probability theory
   https://onlinecourses.nptel.ac.in/noc22_ma81/preview
8. Introduction to probability theory and statistics
   https://nptel.ac.in/courses/111105039
9. Optimization.

CSS 2201: DATABASE SYSTEMS [3 1 0 4]

Database-System Applications, Database Languages, Relational Databases, Database Design, Data Storage and Querying, Database Architecture, Database Schemas,Keys, File Organization , Organization of Records in Files, Relational Query Languages, Relational Operations, SQL Data Definition, SQL Data Types and Schemas, Integrity Constraints, Set Operations, Aggregate Functions, Overview of SQL Query Language, Basic Structure of SQL Queries, Join Expressions, Overview of Query Processing, Measure of Query Cost, Selection Operation, Sorting, Join Operation, Other Operations, Overview of the Design Process, The Entity-Relationship Model, Extended E-R Features, Reduction to Relational Schemas, Features of Good Relational Design, Atomic Domains and Normalization, Transaction Concept, Failure Classification, Storage, Recovery and Atomicity, Recovery algorithm.

References:

1. Silberschatz, Korth, Sudarshan, Database System Concepts, (7e), McGrawHill,New York, 2011.
2. Pramod J Sadalage, Martin Fowler, NoSQL Distilled, Addison-Wesley, 2013.
3. Ramez Elmasri and Shamkant Navathe, Durvasula V L N Somayajulu, Shyam K Gupta, Fundamentals of Database Systems, (6e), Pearson Education, United States of America, 2011.
4. Thomas Connolly, Carolyn Begg, Database Systems – A Practical Approach to Design, Implementation and Management, (4e), Pearson Education,England, 2005.
5. Peter Rob, Carlos Coronel, Database Systems–Design, Implementation and Management, (10e), Course Technology, Boston, 2013.
6. https://onlinecourses.nptel.ac.in/noc25_cs40/preview Introduction to Database Systems

CSS 2202: DESIGN AND ANALYSIS OF ALGORITHMS [3 1 0 4]

Fundamentals of Algorithms, Important Problem Types, Analysis of algorithm efficiency. Analysis Framework: Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non-recursive and Recursive Algorithms. Brute force Techniques, Divide and Conquer, Decrease and Conquer: Insertion Sort, Depth First Search, Breadth First Search, Topological Sorting. Transform and Conquer: Presorting, BST, Heapsort. Space and Time tradeoffs: Input Enhancement in String Matching. Dynamic Programming: Warshall's and Floyd's Algorithms, The Knapsack Problem. Greedy Techniques: Prim's, Kruskal's and Dijkstra's Algorithm, Huffman Trees. Coping with limitations of algorithmic power, P, NP, and NP-complete Problems, Backtracking: n–Queens problem, Hamiltonian Circuit Problem, Subset–Sum Problem. Branch and Bound: Assignment Problem, Knapsack Problem, TSP.

References:

1. Anany Levitin, Introduction to the Design and Analysis of Algorithms, (3e), Pearson Education, 2017
2. Ellis Horowitz and Sartaj Sahni, Computer Algorithms/C++, (2e), University Press, 2007.
3. Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, Introduction to Algorithms, (2e), PHI, 2006
4. Kleinberg, Jon, and Tardos, Éva. Algorithm Design. United Kingdom, Pearson, 2013.
5. https://archive.nptel.ac.in/courses/106/105/106105164/

CSS 2203: ARTIFICIAL INTELLIGENCE [3 0 0 3]

Introduction: What is Artificial Intelligence (AI)? Turing test, history and the state of the art of AI. Intelligent Agents: How agents should act, mapping, agents and environments, structure of intelligent agents. Problem Solving and Search Techniques: Search state space representation, production systems, problem and production system characteristics, uninformed and heuristic search techniques. Logical Agents: The wumpus world environment, propositional logic, propositional theorem proving, agents based on propositional logic. Using Predicate Logic: Representing instances and ISA relationship, compatible functions and predicates. Knowledge Representation: Ontological engineering, knowledge representation using predicate calculus, knowledge engineering process. Quantifying Uncertainty and Probabilistic Reasoning: Probability and Bayes' theorem, design and development of tutorials on expert systems, expert system shells, knowledge acquisition.

References:

1. Stuart Russell and Peter Norvig, Artificial Intelligence A Modern Approach (3e), Pearson Education, Third Edition, 2010.
2. Elaine Rich, Kevin Knight, Shivashankar B. Nair, Artificial Intelligence (3e), Tata McGraw Hill, 2010.
3. Saroj Kaushik, Artificial Intelligence, Cengage Learning Publications, First Edition, 2011.
4. Don W. Patterson, Introduction to Artificial Intelligence and Expert Systems, PHI Publication, 2006.
   https://nptel.ac.in/courses/106105079
5. [Title of NPTEL Course: Artificial Intelligence (Prof. P. Dasgupta), IIT Kharagpur, India]
   https://nptel.ac.in/courses/106102220
6. [Title of NPTEL Course: An Introduction to Artificial Intelligence (Prof. Mausam), IIT Delhi, India]

CSS 2204: OPERATING SYSTEMS [3 0 0 3]

Introduction to operating systems, Operating system services, Operating system structure, System calls, Process management: Process concept, Threads, Inter-process communication, CPU Scheduling, Process synchronization, Handling deadlocks: Deadlock characterization, Deadlock detection, Prevention, Avoidance and recovery, Memory management: Main memory, Swapping, Contiguous memory allocation, Paging, Segmentation, Virtual memory: Demand paging, Page replacement, Thrashing, Allocating kernel memory, Storage management: File management, Disk scheduling, Case study on Unix based operating system: Design principles, Kernel modules, Basic concepts of real time operating systems: Classification of real time systems, Microkernels, Scheduling.

References:

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts, (10e), Wiley, 2018.
2. William Stallings, Operating Systems: Internals and Design Principles (9e), Pearson, 2017. Phillip A Laplante, Seppo J Ovaska, Real time systems design and analysis, (4e), Wiley, 2013.
3. Rajib Mall, Real time systems: Theory and Practice, (2e), Pearson, 2009.
4. https://onlinecourses.nptel.ac.in/noc24_cs108/preview Operating System Fundamentals.

CSS 2211: OPERATING SYSTEMS LAB [0 0 3 1]

Demonstrate the working of UNIX-based operating systems by experimenting with shell commands and developing shell scripts. This includes file handling and advanced searching tools, combining the preliminary shell commands to create useful scripts. Develop applications that utilize POSIX inter-process communication system calls. Implement CPU scheduling algorithms, synchronization, memory and deadlock management tools.

References:

1. Richard Blum, Christine Bresnahan, Linux Command Line Shell Scripting Bible, (3e), Wiley, 2018.
2. Silberschatz A., Galvin P.B.& Gagne G., Operating System Concepts, (10e)Wiley, 2012.

CSS 2212: DATABASE SYSTEMS LAB [0 0 3 1]

Data Definition Language, Data manipulation language, Basic database query operations, Integrity Constraints in SQL, Nested subqueries, Join Operations, Views, PL/SQL Basics, Exception Handling, Cursors, Stored procedures, Functions, Packages, Trigger, and project on design and development of application based on database concepts.

References:

1. Silberschatz, Korth, Sudarshan, Database System Concepts, (7e)McGrawHill, 2011.
2. Ivan Bayross, SQL, PL/SQL, (3e) , BPB Publications
3. Satish Asnani, Oracle Database 11g, PHI, 2010.
4. Scott Urman, ORACLE – PL/SQL Programming, Oracle Press.

FIFTH SEMESTER

HUM 3101: ESSENTIALS OF MANAGEMENT [3 0 0 3]

Introduction to Business, Classification of Industries, Importance of management for an engineer, Manager Roles External Environment, Social Responsibility of managers, Ethics in managing, International Business, Strategies and Policies, Strategic Planning Process & tool, Span of Management, Departmentation, Recruitment, Selection, Induction, Orientation. Leadership and Motivational tools and Techniques, Group Decision, Communication, Management Control Techniques

References:

1. Robbins, S. P., Coulter, M., & DeCenzo, D. A. (2022). Fundamentals of Management (11th ed.). Pearson.
2. Jones, G. R., & George, J. M. (2022). Essentials of Contemporary Management (9th ed.). McGraw-Hill Education.
3. Koontz, H., Weihrich, H., & Cannice, M. V. (2020). Essentials of Management: An International, Innovation, and Leadership Perspective (11th ed.). McGraw Hill Education (India) Private Limited.

CSS 3101: FINITE AUTOMATA AND COMPILER DESIGN [3 1 0 4]

Languages, Regular Expressions, Finite Automata – DFA, NFA. Conversion of Regular Expression to NFA, NFA to DFA. Context Free Grammars and Parsing, Derivation, Parse Trees, Push Down Automata, Introduction to Language Processors, The Structure of a Compiler, Lexical Analysis: Role of the Lexical Analyzer, Input Buffering, Specifications and Recognition of Tokens, Writing a Grammar, Top Down Parsing, Bottom Up Parsing, Introduction to LR parsing, More powerful LR Parsers, Syntax-Directed Translation: Syntax-Directed Definitions, Application of Syntax-Directed Translation, Intermediate Code Generation: Variants of Syntax Trees, Three Address Code, Code Generation: Issues in Design of Code Generator, Basic Blocks and Flow Graphs, Introduction to LEX and YACC.

References:

1. Peter Linz, an Introduction to Formal Languages and Automata, (6e), Jones & Bartlett Learning, 2019.
2. Alfred V. Aho, Monica S. Lam, Ravi Sethi, Jeffrey D. Ullman, Compilers Principles, Techniques and Tools, (2e), Pearson Education, 2010.
3. J E Hopcroft, Rajeev Motwani & Jeffrey D Ullman, Introduction to Automata Theory, Languages and Computation, (3e), Pearson Education, 2006.
4. Kenneth C. Louden, Compiler Construction - Principles and Practice, (1e), Thomson, 2007.
5. John R. Levine, Tony Manson, Doug Brown, LEX & YACC, (2e), O Reilly Media, 2012.
6. https://onlinecourses.nptel.ac.in/noc21_cs07/preview
   Compiler Design
7. https://onlinecourses.nptel.ac.in/noc21_cs19/preview:
   Introduction to Automata, Languages and Computation

SIXTH SEMESTER

HUM 3201: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [3 0 0 3]

Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of single, uniform, and gradient cash flow, Related problems and case studies. Bases for comparison of alternatives: present worth, future worth, annual worth and rate of return method, Replacement analysis. Concepts of breakeven analysis and its use in multiple alternative evaluation. Physical & functional depreciation, Straight line depreciation, Declining and double declining balance method of depreciation, Financial statements and its analysis using ratios, Methods of describing project risk: sensitivity analysis, break-even and scenario analysis.

References:

1. Park, C. S. (2023). Contemporary Engineering Economics, 7th Edition. Pearson Higher Education & Professional Group.
2. B Blank, L. T., & Tarquin, A. (2017). Engineering Economy. United Kingdom: McGraw-Hill Education.
3. Riggs, J. L., Bedworth, D. D., & Randhawa, S. U. (2017). Engineering economics. 4th Edition, Tata McGraw Hill Edition.
4. White, J. A., Case, K. E., Pratt, D. B., LaScola Needy, K., & Grasman, K. S. (2020). Fundamentals of Engineering Economic Analysis. United Kingdom: Wiley.

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING SPECIALIZATION

FIFTH SEMESTER

CSO 3101: FOUNDATIONS OF COMPUTER VISION [3 0 3 4]

Introduction to computer vision and its applications, Components of an Image Processing System, Elements of Visual Perception, Gray level transformations Filtering in spatial and frequency domain, Image transformations and Colour models, Edge Detection methods (Laplacian detectors and Canny edge detector), Points and patches, Harris corner detector, Histogram of Gradients, Difference of Gaussian detector, SIFT, Colour and Texture, Feature based alignment, least squares and RANSAC, Camera models, Camera calibration, Stereo vision, Stereo correspondence, Epipolar geometry, Optical flow, Lucas Kanade method, KLT tracking method, Mean shift method, Dense motion estimation, object detection and recognition, OCR – case study.

Abstract Syllabus (Integrated lab):

Introduction to Computer Vision Library: OpenCV Installation, Basics of Library, Image and Video Data Manipulation: Reading Images and Videos, Image Enhancement Techniques: Filtering in spatial Domain, Feature Extraction: Edge Detection, Image Descriptors such as ORB, LBP, SIFT. Finding Correspondence, Camera Calibration, Stereo Vision: Depth Estimation, Tracking: Optical Flow, KLT, Mean shift.

References:

1. Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd Edition, Springer 2022
2. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, 4th Edition, Pearson 2018
3. David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach, PHI learning, 2015
4. Jan Erik Solem, Programming Computer Vision with Python, O'Reilly, 2012
5. Prof. M. K. Bhuyan “Computer Vision and Image Processing - Fundamentals And Applications”, NPTEL course noc25_ee13. https://onlinecourses.nptel.ac.in/noc25_ee13/preview
6. Prof. Vineeth N Balasubramanian, “Deep Learning for Computer Vision”, NPTEL course noc21_CS93.
   https://onlinecourses.nptel.ac.in/noc21_cs93/preview

CSO 3102: MACHINE LEARNING [3 0 3 4]

An Overview of Statistical Learning. The Trade-Off Between Prediction Accuracy and Model Interpretability, Supervised Versus Unsupervised Learning, Regression Versus Classification Problems, Assessing Model Accuracy, Overfit, Underfit. Simple Linear Regression, Gradient Descent Method, Multiple Linear Regression. An Overview of Classification, Logistic Regression, Sigmoid Function, Cost Function, Gradient Descent, Naïve Bayes, K-NN, Performance metrics: Confusion Matrix, Precision and Recall & ROC curve. Well-Posed ML problems, Data representation, The Crisp-DM Model. The Basics of Decision Trees, Measures of Impurity for Evaluating Splits in Decision Trees, ID3, C4.5, and CART Decision Trees. Maximal Margin Classifier, Support Vector

Classifiers, Support Vector Machines, Support Vector Machines and Kernels and Numerical examples. Clustering Methods. Rationale, Generating Diverse Learners, Voting, Bagging, Boosting.

Abstract syllabus (Integrated lab):

Understanding basics of Machine Learning programming using python, Fundamental mathematical concepts required for Machine Learning, Preparation of data for Machine Learning algorithms and Principal Component Analysis (PCA), Naïve Bayes classifier, K-Nearest Neighbour classifier, Linear, Multilinear and Polynomial Regressions, Logistic Regression, Support Vector Machines, K-Means Clustering, Hierarchical Clustering, Decision Trees.

References:

1. Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, An Introduction to Statistical Learning with Applications in Python, second edition, Springer, New York, 2021
2. Gopinath Rebala · Ajay Ravi, Sanjay Churiwala, An Introduction, to Machine Learning, Springer 2019.
3. M. Gopal, Applied Machine Learning, McGraw Hill Education, 2018
4. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, second edition, Springer, 2008.
5. Parteek Bhatia, Machine Learning with Python Principles and Practical Techniques, Cambridge University Press, 2024.
   https://nptel.ac.in/courses/106106139
6. NPTEL: Introduction to Machine Learning, by Dr.Balaraman Ravindran IIT Madras

CSO 3103: PARALLEL COMPUTER ARCHITECTURE AND PROGRAMMING [3 0 3 4]

Introduction: Need of Parallelism; Forms of Parallelism (SISD, SIMD, MISD, MIMD); Moore's Law and Multicore; Amdahl's Law; Speedup and performance; Programming paradigms: Shared and Distributed; PRAM Architecture Model. Shared Memory Programming: Introduction to OpenMP; OpenMP Program constructs; Execution Model and Directives; Message Passing Programming: MPI Basics; Point-to-point communications; Collective Communications; GPU Architecture: Architecture of modern GPU; Kernel function and thread organization; CUDA program structure; Transparent Scalability and Synchronization; GPU memory organization; Memory optimizations in CUDA.

Abstract Syllabus (Integrated lab):

Implement shared memory programs using OpenMP; Implement distributed memory programs using MPI; Implement GPU programs using CUDA.

References:

1. V.Rajaraman, C. Siva Ram Murthy, “Parallel Computers Architecture and Programming” Prentice-Hall India, 2016.
2. D. Kirk and W. Hwu , “Programming Massively Parallel Processors –A Hands-on approach”, Elsevier Inc.,(4e), 2023.
3. Michael J. Quinn, “Parallel Programming in C with MPI and OpenMP”, McGraw Hill Edition, 2003.
4. Michael J. Quinn, “Parallel Computing” McGraw Hill Edition, 2005

NPTEL Links:

1. https://www.open-mpi.org/doc/
2. https://www.openmp.org/
3. https://developer.nvidia.com/

SIXTH SEMESTER

CSO 3201: DEEP LEARNING AND APPLICATIONS [3 0 3 4]

Introduction to Deep Learning & Architectures, Machine learning basics, Neural Networks basics, Feed Forward Neural Networks, Machine Learning Vs. Deep Learning, Representation Learning, Width Vs. Depth of Neural Networks. Activation Functions, Regularization and Optimization for Deep Learning, Convolutional Neural Networks Architectural, Popular CNN Architectures: ResNet, AlexNet. Transfer Learning: Transfer learning Techniques, Variants of CNN: DenseNet, PixelNet. Sequence Modelling: Recurrent and Recursive Nets, Recurrent Neural Networks, Bidirectional RNNs. Encoder-decoder sequence to sequence architectures, BPTT for training RNN, Long Short Term Memory Networks. Auto Encoders, Regularized Autoencoders , stochastic Encoders and Decoders, Contractive Encoders, Variational Auto Encoders, Deep Generative Models, Introduction to Transformers

Abstract Syllabus (Integrated lab):

Introduction to tensors, Computational graphs, Deep Learning Library in PyTorch, Deep Feed-forward Neural Networks, Convolutional Neural Network, Transfer Learning, Regularization for Deep Neural Networks, Recurrent Neural Networks, Long-Short Term Memory (LSTM), Encoder-Decoders, Variational Auto Encoders, Generative Adversarial Networks (GANs)

References:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, “ Deep Learning”, MIT Press, 2017.
2. Eli Stevens, Luca Antiga, and Thomas Viehmann, Deep Learning with PyTorch, Manning, 2020
3. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
4. Umberto Michelucci “Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks” Apress, 2018.
5. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.
6. Deep Learning - Course, By Prof. Prabir Kumar Biswas | IIT Kharagpur, 12 Weeks
7. Deep Learning - IIT Ropar - Course, By Prof. Sudarshan Iyengar, Prof. Padmavati | IIT Ropar, Punjab Engineering College (Deemed to be University), 12 Weeks
8. Machine Learning And Deep Learning - Fundamentals And Applications - Course, By Prof. M. K. Bhuyan | IIT Guwahati, 12 Weeks

CSO 3202: NATURAL LANGUAGE PROCESSING [3 0 3 4]

Introduction, Text Normalization, Edit Distance, N-gram Language Models, Part-of-Speech Tagging, Hidden Markov Models, Formal Grammars of English, Parsing with Context-Free Grammars, Statistical

Parsing. Naive Bayes, Text Classification, and Sentiment, Logistic Regression, Vector Semantics and Embeddings, Neural Networks and Neural Language Models, Sequence Labeling for Parts of Speech and Named Entities, RNNs and LSTMs, Transformers and Large Language Models, Fine-tuning and Masked Language models, Prompting, In-Context Learning, and Instruct Tuning, Applications: Machine Translation and Question answering.

Abstract Syllabus (Integrated lab):

Text Normalization, Edit Distance, N-gram Language Models, Part-of-Speech (POS) Tagging, Formal Grammar and Parsing with Context-Free Grammars, Statistical Parsing, Text Classification, Vector Semantics and Embeddings, Neural Language Models, Sequence Labeling for POS and Named Entity Recognition (NER), RNNs and LSTMs, Transformers and Large Language Models

References:

1. Daniel Jurafsky & James H. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with Language Models, (3e), Pearson, 2024.
2. Nitin Indurkhya, Fred J. Damerau, Handbook of Natural Language Processing, Second Edition, Chapman & Hall/CRC, 2010
3. Eisenstein, Jacob, Introduction to Natural Language Processing, First Edition, MIT Press, 2019.
4. Uday Kamath, John Liu, and James Whitaker, Deep Learning for NLP and Speech Recognition, 1st Edition, Springer, 2019.
5. NPTEL: Natural Language Processing By Prof. Pawan Goyal, IIT Kharagpur
6. NPTEL: Deep Learning for Natural Language Processing By Prof. Pawan Goyal, IIT Kharagpur

NETWORKS AND IOT SPECIALIZATION

FIFTH SEMESTER

CSO 3111: EMBEDDED SYSTEMS & IOT [3 0 3 4]

An overview of Computer Architecture, overview of ARM-Cortex- M Architecture, CISC versus RISC, The RISC and ARM design philosophy, ARM addressing modes, Data transfer instructions, Arithmetic and logical instructions, Shift and rotate instructions, Branch and conditional branch instructions, Function call and return, Stack, Recursive functions, Conditional execution, Assembly language programming, Input/output I/O) programming, Timer/counter programming, I/O interfacing : LED, LCD, Keyboard, Stepper motor, ADC, PWM, UART, Nested Vectored Interrupt Controller (NVIC), External hardware interrupts, IO interrupts.Basic building blocks of an IOT Device, Exemplary Device: Raspberry Pi, interfaces, Programming Raspberry Pi with Python, IOT communications.

Abstract Syllabus (Integrated lab):

Familiarization of data transfer from code segment to data segment and from data segment to data segment, Arithmetic operations, Logical instructions, Branch instructions, Code conversion from hexadecimal to decimal and decimal to hexadecimal, Packing and unpacking of ASCII digits, Sorting using selection sort and bubble sort techniques, Searching using linear and binary search techniques, Recursion, I/O interfacing of LEDs, LCD, keyboard, 7 segment display, ADC, PWM., I2C and RTC In addition to the above list of experiments, students are required to develop a mini project using mbed LPC1768board, Programming Raspberry Pi with Python, IOT communications.

References:

1. Jonathan W.V., Embedded systems: Real-time interfacing to ARM Cortex-M microcontrollers, 8th Edition, Createspace Independent Publishing Platform, July 2021.
2. Wilmshurst T., Fast and Effective Embedded System Design applying the ARM mbed, Elsevier, 2017.
3. Jonathan W.V., Embedded systems: Introduction to Arm(r) Cortex-M Microcontrollers, 6th Edition,Createspace Independent publishing platform, Jan 2019.
4. UM10360, LPC 176x/5x User Manual, NXP Semiconductors, Rev. 3.1, 2014.
5. Joseph V., A definitive Guide to ARM Cortex-M3 and Cortex-M4 processors, 3rdEdition, Elsevier, 2014.
6. Muhammad A.M, Sarmad N., Sepehr N., Shujen C., ARM Assembly Language Programming & Architecture, 2nd Edition, Wiley, 2016.
7. NPTEL/SWAYAM Reference: https://onlinecourses.nptel.ac.in /noc22_cs93/preview

CSO 3112: NETWORK PROTOCOLS AND PROGRAMMING [3 0 3 4]

Queuing model, Switching, VLAN, Inter VLAN Routing, STP, Ether channel, Stateless Address Autoconfiguration, First Hop Redundancy Protocol, WLAN, IPV6, WAN, Integrated and Differentiated Services, Multiprotocol Label Switching, Socket Introduction, Socket Address Structures, Value-Result Arguments, Elementary TCP Sockets, Network Security, Virtual Private Network and IP Security.

Abstract Syllabus (Integrated lab):

Packet Tracer- Introduction to CISCO Packet Tracer, Basic Configuration, Routing Protocols, DHCP and NAT; Socket programming-Basic, Files, Database, Multi Client- Server Environment and Application Development.

References:

1. W. Richard Stevens, Bill Fenner, Andrew M. Rudoff, UNIX Network Programming Volume 1,3rd Edition, Addison Wesley 2011.
2. William Stallings, High Speed Networks and Internet, 2nd Edition, Pearson Education New Delhi 2002.
3. James F. Kurose and Keith W. Ross, Computer Networking: A Top-Down Approach, 7th Edition, 2017
4. Scott Empson and Cheryl Schmidt, Routing and Switching Essentials, 2014
5. Todd Lammle, CCNA Routing and Switching Study Guide, John Wiley & Sons,2013
6. NPTEL/SWAYAM Reference*https://onlinecourses.nptel.ac.in/ noc21_cs18/preview & NPTEL: Computer Science and Engineering - NOC:Computer Networks and Internet Protocol

CSO 3113: CLOUD COMPUTING [3 0 3 4]

Introduction: Cloud computing delivery models and services, Challenges, Cloud Infrastructure: Amazon, Google, Microsoft Azure, Open Source Platforms, Services in Cloud: Service Oriented Architecture, REST, Cloud resource virtualization: Types of virtualization, Understanding hypervisors, Virtual Machines, Dockers Containers, Virtualization at Compute, Storage and Network level, Resource Management and Scheduling: Policies and Mechanisms, Scheduling, Business Continuity and Cloud management: Fault Tolerance, Replication Methods, Cloud Security: Virtual machine security, Access control and identity management, Cloud Tools: Eucalyptus, OpenNebula/OpenStack, CloudSim,

Abstract Syllabus (Integrated lab):

Introduction to the AWS, Google Cloud and Microsoft Azure Portal and Services ;Setting up account and basic navigation, creation of a VM on each of the platforms and installing and running a High Level Language Program, Developing a web application and hosting on cloud. Running a database, deploying an application, creating a network on any one of these 3 platforms. Openstack, Eucalyptus installation and working. Introduction to cloud sim and installation, Running built in examples and analyzing. Running SJF Scheduling algorithm on cloud simulator.

References:

1. Dan C Marinescu, Cloud Computing Theory and Practice, 2nd Edition, 2017
2. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Mastering Cloud Computing, 2nd Edition, McGraw Hill 2017
3. Sehgal, Naresh Kumar, and Pramod Chandra P. Bhatt, Cloud Computing: Concepts and Practices, 1st Edition, Springer, 2018
4. Barrie Sosinsky, Cloud Computing Bible, 1st Edition, Wiley Publishing Inc., 2011.
5. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, 1st Edition, McGraw Hill 2017
6. Mark C Chu-Carroll, Code in the Cloud, 1st Edition, Pragmatic Bookshelf, 2011.
7. NPTEL/SWAYAM Reference: https://onlinecourses.nptel.ac.in/noc21_cs14/preview

SIXTH SEMESTER

CSO 3211: NETWORK SECURITY [3 0 3 4]

Introduction to Information and Network Security, Symmetric-Key Ciphers: Classical and Modern encryption techniques, Block ciphers, Advanced Encryption Standard, Uses block ciphers, Asymmetric-Key Cryptographic Ciphers, Principles of public key cryptosystems, Number theory concepts, Uses of primes, Message Integrity and Message Authentication, Cryptographic hash functions, Application of cryptographic hash functions, Digital Signature, Key Management, Entity Authentication, Transport Level Security, IP security, VPN, System Security concepts, Firewalls, Network Intrusion detection and prevention systems, SET, Multimedia Security ,Advanced Encryption Concepts.

Abstract Syllabus (Integrated lab):

Explore vulnerabilities of Windows, and Linux, Installation and maintenance of firewalls, Network-based and host-based intrusion detection systems (IDS) and prevention, Developing a security policy for an enterprise network to enable students to acquire the experience of starting from scratch and designing a functioning security system for an enterprise. Create network scenario on various smart city models and check for vulnerability.

References :

1. William Stallings, Cryptography and Network Security: Principles and Practice ,7th edition,Pearson Publications, 2016.
2. Behrouz A. Forouzan, Debdeep Mukhopadhyay, Cryptography and Network Security ,2nd Edition (Revised), Tata McGraw-Hill Education India, 2010.
3. Borko Furht, Darko Kirovski, Multimedia Encryption and Authentication Techniques and Applications ,1st edition, Taylor and Francis,2019.
4. Xun Yi, Russell Paulet, and Elisa Bertino, Homomorphic Encryption and Applications ,1st edition, Springer Publishing Company, Incorporated, 2014.
5. Brij B. Gupta, Mamta, Secure Searchable Encryption and Data Management,1st edition, Taylor and Francis,2021.
6. NPTEL / SWAYAM course reference: https://onlinecourses.nptel.ac.in/noc25_ee54/preview.

CSO 3212: WIRELESS COMMUNICATION AND NETWORKING [3 0 3 4]

Introduction to Wireless Systems, Electromagnetic (EM) Spectrum, Antenna and Propagation, Line of Sight and Non Line of Sight, Fading, Link Budget Analysis, Cellular Concepts, 5G Networks, Architecture of 5G Networks, 5G Spectrum, Channel assignments, Handoff strategies, Improving Coverage & Capacity, Wireless channels, Statistical channel models, Channel Coding- forward error correction (FEC) coding, Advanced Modulation and Coding techniques (MFSK, QPSK, OFDM, NOMA), Multiple access techniques, OFDM, Diversity, Beamforming, Modelling of MIMO fading channels, LPWAN - Emerging Wireless Technologies: LoRa, Sigfox, IoT, NB-IoT.

Abstract Syllabus (Integrated lab):

Basics of Network Simulation - Platform required to run network simulator; Simulating a Local Area Network ; Measuring Network Performance- Network Performance Evaluation ; Simulating a Wi-Fi Network ; Simulating a WiMAX Network; Simulating a Mobile Adhoc Network; Simulating a Wireless Sensor Network ; Setting up a Bluetooth Network ; Setting up a ZigBee Network

References:

1. Harri Holma, Takehiro Nakamura, and Antti Toskala, 5G Technology 3GPP New Radio, JohnWiley& Sons Ltd, 2020.
2. Larry Peterson and OMguz Sunay, 5G Mobile Networks: A Systems Approach, Morgan & Claypool 2020.
3. Upena Dalal, Wireless communication and Networks (1e), Oxford 2015.

4. Andrea Molisch , Wireless Communications (3e), John Wiley & Sons Ltd. 2022.
5. Andrea Goldsmith, Wireless Communications (2e), Cambridge University press. 2012.
6. Theodore S. Rappaport, Wireless Communications Principles and Practice, 2nd Edition, Pearson Education India, 2010.
7. NPTEL/SWAYAM Reference: https://onlinecourses.nptel.ac.in/noc21_ee66/preview

SOFTWARE ENGINEERING SPECIALIZATION

FIFTH SEMESTER

CSO 3131: SOFTWARE DESIGN TECHNOLOGY [3 0 3 4]

Introduction to Software Engineering, Software Processes, Agile Software Development, Requirement Engineering, Requirements Modelling (Scenario-based), Requirements Modelling (Class-based), Requirements Modelling (Behavior, Patterns, and Web/Mobile Apps), Design Concepts, Architectural Design, Pattern Based Design, Component Level Design, User Interface Design, Data Design; Software Testing Strategies, Testing Conventional Applications: W&B, Testing Web Apps and Mobile Apps, Review Techniques, Software Configuration Management, Risk Management.

Abstract Syllabus (Integrated lab):

Design and Analysis of model for small scale software development using UML tools, Verification and exploring of testing tools (CO – 2, 3, 4)

References:

1. Pressman R. S., Software Engineering A practitioner's approach, 9th Edition, McGraw Hill, 2020.
2. Somerville Ian, Software engineering, 10th Edition, Pearson Education, 2019.
3. Booch G., Rumbaugh J., Jacobson I., The Unified Modelling Language User Guide, 2nd Edition, Pearson, 2017.
4. Rajib Mall, Fundamentals of Software Engineering, 5th Edition, PHI Learning, 2018.

NPTEL Links:

Software Engineering, IIT Kharagpur: https://nptel.ac.in/courses/106105182 Software Project Management, IIT Kharagpur: https://nptel.ac.in /courses/106105218.

CSO 3132: DEVOPS USING AI [3 0 3 4]

Introduction to DevOps life cycle, DevOps tools, AI in DevOps, Version Control System, GIT, workflow, commands, GITHUB, branching and merging, collaborating, Continuous Integration, Jenkins, creating and scheduling job, Jenkins pipeline, Jenkinsfile, Containerizing the applications, Docker life cycle, commands, dockerhub, dockerfile, Docker volume, Docker Networking, Docker compose, Kubernetes components, Kubernetes architecture, commands, Namespace, ingress, Application deployment in kubernetes, Configuration management, Ansible architecture, Setting up master slave using ansible, Ansible playbook, modules, Vault, Notify and handler, Roles, Continuous Monitoring, AI in DevOps lifecycle, AI tools in DevOps, AI-driven Testing, AI-powered Predictive Analytics.

Abstract Syllabus (Integrated lab):

Setting up a public Git repository and exploring key Git commands such as clone, fork, pull, push, and commit for effective version control, Implementation of a continuous integration (CI) pipeline using Jenkins for web applications. Containerizing applications with Docker and deploying them on a Kubernetes cluster, Automation using Ansible, creating playbooks to configure servers for application deployment.

References:

1. Pradeep chintale, DevOps Design Patterns, First Editions,BPB Publications, 2024.
2. Scott Chacon and Ben Straub, Pro Git, 2nd Edition, Apress, 2024.
3. Mitesh Soni, Jenkins Essentials(2e), Packt Publishing Limited, 2017.
4. Continuous Delivery with Docker and Jenkins, Rafal Leszko, Packt Publications, Second Edition, 2019.
5. Jamon Camisso, Hanif Jetha, Katherine Juell, Kubernetes for Full-Stack Developers,2020
6. Gaurav shah, ansible Playbook Essentails, Packt Publishing Limited,2015

NPTEL Links :

https://nptel.ac.in/courses/128106012

CSO 3133: FULL STACK APPLICATION DEVELOPMENT [3 0 3 4]

Front-End Web UI frameworks and Tools: Bootstrap 4, CSS and JavaScript component, Node.js, NPM and task runners, Progressive Web Applications, Front-End Web Development with React: JavaScript ES6, Reactstrap for Bootstrap 4-based responsive UI design, react router, Flux architecture, redux, REST API, Front-End JavaScript Framework with Angular: Typescript, Angular material, Flex-layout for responsive design, components, Data binding, Angular router, Angular animation support and Angular testing, Server-side development with NodeJS, Express and MongoDB.

Abstract Syllabus (Integrated lab):

Bootstrap 4, CSS, Task runners, Progressive Web Application with Next.js, Front-End Web Development with React, Integration of REST API, Front-End JavaScript Framework with Angular, Angular application, Data binding and components, Angular router, Angular animation, RxJS, HTTP Client in Angular with REST API, Server-side development with NodeJS, Express and MongoDB-CRUD operations and authentication.

References:

1. Shama Hoque, Full-Stack React Projects: Modern web development using React 16, Node, Express, and MongoDB, Ingram Publishers, 2018
2. Chris Northwood, The Full Stack Developer: Your Essential Guide to the Everyday Skills Expected of a Modern Full Stack Web Developer, 1st Edition, 2018
3. Frank Zammetti, Modern Full-Stack Development: Using TypeScript, React, Node.js, Webpack, and Docker, 1st Edition, 2020
4. Ethan Brown, Learning JavaScript: JavaScript Essentials for Modern Application Development, O'Reilly Media, 2020.
5. Tal Ater, Building Progressive Web Apps, O'Reilly Media, 2017.

6. Jayden Reed, Next.js by example: Step-by-step guides to building modern web apps, Kindle ed. Independently published, 2024.

NPTEL Links:

1. Introduction to Modern Application Development, https://nptel.ac.in/courses/106106156
2. Modern Application Development, Persistent Computing Systems & CMI, https://nptel.ac.in/courses/106106222
3. Web Technology, https://onlinecourses.swayam2.ac.in/nou25_cs09/preview
4. Web Based Technologies and Multimedia Applications, https://onlinecourses.swayam2.ac.in/nou25_cs03/preview

SIXTH SEMESTER

CSO 3231: HUMAN COMPUTER INTERACTION [3 0 3 4]

Contexts for HCI: Human, Computer, Interaction, Design Process: Interaction Design, Design Rules, Navigation Design, Principles of good design and designers: Usability, Guidelines, Golden Rules, User Support, Patterns, Accessibility, User Experience Design: UX Design Process, Visual Design Principles and processes, UI Design and Implementation, Usability Evaluation Techniques: Different measures for evaluation, Usability heuristics and the principles of usability testing, Cognitive models: Models and Architectures; Case Study: AR/VR and Multimedia, Tools: Unity, Figma.

Abstract Syllabus (Integrated lab):

User-centered design, usability principles, interaction models. Prototyping: Low/high-fidelity prototypes, wireframing, iterative design. Research Methods: Surveys, usability testing. Accessibility: WCAG and auditing tools. Evaluation: Heuristic evaluation, cognitive walkthroughs. Advanced Topics: VR/AR interfaces, Design and evaluation of interactive systems.

References:

1. Alan Dix, Janet E. Finlay, Gregory D. Abowd, and Russell Beale, Human-Computer Interaction, 3rd Edition, Pearson Education India, 2017.
2. Elvis Canziba, Hands-On UX Design for Developers, 1st Edition, Packt, 2018.
3. Samit Bhattacharya, Human-Computer Interaction: User-Centric Computing for Design, 1st Edition, McGraw-Hill, 2019.
4. Ben Shneiderman, Catherine Plaisant, Maxine Cohen and Steven Jacobs, Designing the User Interface: Strategies for Effective Human-Computer Interaction, 6th Edition, Addison-Wesely, 2017.
5. Jeffrey Rubin and Dana Chisnell. Handbook of Usability Testing: How to Plan, Design, and Conduct Effective Tests. 2nd Edition, Wiley, 2014.
6. Yvonne Rogers, Helen Sharp and Jenny Preece, Interaction Design: Beyond Human - Computer Interaction, 5th Edition, John Wiley & Sons Inc, 2019.

NPTEL Links:

1. Introduction to Human Computer Interaction." NPTEL, https://archive.nptel.ac.in/courses/106/106/106106177/
2. Human Computer Interaction NPTEL IITm, https://nptel.ac.in/courses/106103115

CSO 3232: KNOWLEDGE AND DATA ENGINEERING [3 0 3 4]

Data Warehousing, Multi-dimensional data model, OLAP operations, Warehouse schema, Data Warehousing Architecture, Warehouse server, Metadata, OLAP Engine, Data Warehouse Backend Process. Data Preprocessing, Data cleaning, Data Integration and transformation, Data reduction, Sampling, Discretization and concept hierarchy generation, Segmentation by natural partitioning. Introduction to Data mining, Association rules mining, market based analysis, Apriori Algorithm, Dynamic item set counting algorithm, FP-tree growth Algorithm. Knowledge graphs (KG): Definition – DIKW Pyramid – Linked Data and Knowledge Graphs – Anatomy – Construction of KG: Data modelling – Integrating data – Data extraction and transformation – Embedding techniques for knowledge graphs – Building – Querying. Implementation of KG using Neo4j. Ontology engineering: Introduction, classification, development, learning. Web engineering: information distribution and integration , Semantic Web , RDF and Linked Open Data , Social Web and semantics.

Abstract Syllabus (Integrated lab):

ETL, Association rules mining Building – Querying. Implementation of KG using Neo4j, RDF, SPARQL., mini project.

References:

1. Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques (4e), Morgan Kauffmann Publishers, 2022
2. Arun K Pujari, Data Mining Techniques (4e), Universities Press India, 2016
3. Maria Keet, An Introduction to Ontology Engineering, College Publications, 2018
4. Tom Heath, Christian Bizer, Linked Data Evolving the Web Into a Global Data Space, Morgan & Claypool

NPTEL Links :

1. Data mining, prof Pabitra Mishra, IIT Kharagpur, https://archive.nptel.ac.in

DATA SCIENCE SPECIALIZATION

CSO 3121: DATA PRIVACY AND SECURITY [3 0 3 4]

Security: Security Architecture, Security Attacks, Services and Mechanisms, Model for Data Security, Introduction to Cryptography: Classical Encryption techniques, Symmetric Encryption, Number Theory: Divisibility, Modular arithmetic, Congruences, Chinese Reminder Theorem, Public-key cryptography and Message Authentication, Hash Functions, Digital Signatures, Key Distribution and Authentication, System Security, Key Distribution and Authentication, Intrusion Prevention and Detection Systems, Cyber Security. Secure Software Development Life Cycle. Data Privacy: Introduction to data privacy, privacy attacks and types, access control models and types, privacy policies, their specifications, privacy in different domains- medical, financial, Anonymization and Differential Privacy: Introduction, Differential Privacy with Laplace Mechanism and Gaussian noise, Building Privacy into Data Pipelines: Design privacy measures, Data sharing workflow, Data Collection, Privacy-Aware Machine Learning and Data Science: Introduction, usage and open source libraries.

Abstract syllabus (Integrated lab):

Applied exercises in modular arithmetic, congruences, and Chinese Reminder Theorem using python libraries. Lab-based experimentation with public-key cryptography algorithms. Practical applications of message authentication, hash functions, digital signatures, and secure key distribution methods. Designing threat modelling and incident responses. Practical application of machine learning for data security using open-source python libraries

References :

1. William Stallings, Cryptography and Network Security: Principles and Practice, 7th Edition, Pearson Education, 2017.
2. William Stallings, Network Security Essentials: Applications and Standards, 6th Edition, Pearson Education, 2014.
3. Atul Kahate, Cryptography and Network Security, 3rd Edition, Tata McGraw-Hill Publishing Company Limited, 2013.
4. Katharine Jarmul, Practical Data Privacy-Enhancing Security and Privacy of Data, O'Reilly Media, Inc, April 2023.
5. Ronald Leenes, Rosamunde van Brakel, Serge Gutwirth, De Hert, Paul, Data Protection and Privacy: The Age of Intelligent Machines (Computers, Privacy and Data Protection), Hart Publishing (December 28, 2017).
6. Altice labs, Secure Software Development Life Cycle, White paper, Version 1.0, August 2023.
7. Patrick McBride and Edward P. Moser, Secure System Development Life Cycle (SDLC), security staff, 2000.

NPTEL courses:

1. Cryptography and Network Security, by Dr. Debdeep Mukhopadhyay, IIT Kharagpur: https://nptel.ac.in /courses/106105031
2. NOC: Cyber Security and Privacy, by Prof. Saji K Mathew, IIT Madras: https://nptel.ac.in/courses/106106248

CSO 3102: MACHINE LEARNING [3 0 3 4]

An Overview of Statistical Learning. The Trade-Off Between Prediction Accuracy and Model Interpretability, Supervised Versus Unsupervised Learning, Regression Versus Classification Problems, Assessing Model Accuracy, Overfit, Underfit. Simple Linear Regression, Gradient Descent Method, Multiple Linear Regression. An Overview of Classification, Logistic Regression, Sigmoid Function, Cost Function, Gradient Descent, Naïve Bayes, K-NN, Performance metrics: Confusion Matrix, Precision and Recall & ROC curve. Well-Posed ML problems, Data representation, The Crisp-DM Model. The Basics of Decision Trees, Measures of Impurity for Evaluating Splits in Decision Trees, ID3, C4.5, and CART Decision Trees. Maximal Margin Classifier, Support Vector Classifiers, Support Vector Machines, Support Vector Machines and Kernels and Numerical examples. Clustering Methods. Rationale, Generating Diverse Learners, Voting, Bagging, Boosting.

Abstract syllabus (Integrated lab) :

Understanding basics of Machine Learning programming using python, Fundamental mathematical concepts required for Machine Learning, Preparation of data for Machine Learning algorithms and Principal Component Analysis (PCA), Naïve Bayes classifier, K-Nearest Neighbour classifier, Linear, Multilinear and Polynomial Regressions, Logistic Regression, Support Vector Machines, K-Means Clustering, Hierarchical Clustering, Decision Trees.

References:

1. Gareth James, Daniela Witten, Trevor Hastie, and Robert Tibshirani, An Introduction to Statistical Learning with Applications in Python, second edition, Springer, New York, 2021
2. Gopinath Rebala · Ajay Ravi, Sanjay Churiwala, An Introduction, to Machine Learning, Springer 2019.
3. M. Gopal, Applied Machine Learning, McGraw Hill Education, 2018
4. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, second edition, Springer, 2008.
5. Parteek Bhatia, Machine Learning with Python Principles and Practical Techniques, Cambridge University Press, 2024.
   https://nptel.ac.in/courses/106106139
6. NPTEL: Introduction to Machine Learning, by Dr. Balaraman Ravindran IIT Madras

CSO 3103: PARALLEL COMPUTER ARCHITECTURE AND PROGRAMMING [3 0 3 4]

Introduction: Need of Parallelism; Forms of Parallelism (SISD, SIMD, MISD, MIMD); Moore's Law and Multicore; Amdahl's Law; Speedup and performance; Programming paradigms: Shared and Distributed; PRAM Architecture Model. Shared Memory Programming: Introduction to OpenMP; OpenMP Program constructs; Execution Model and Directives; Message Passing Programming: MPI Basics; Point-to-point communications; Collective Communications; GPU Architecture: Architecture of modern GPU; Kernel function and thread organization; CUDA program structure; Transparent Scalability and Synchronization; GPU memory organization; Memory optimizations in CUDA.

Abstract Syllabus (Integrated lab)

Implement shared memory programs using OpenMP; Implement distributed memory programs using MPI; Implement GPU programs using CUDA.

References:

1. V.Rajaraman, C. Siva Ram Murthy, "Parallel Computers Architecture and Programming" Prentice-Hall India, 2016.
2. D. Kirk and W. Hwu , "Programming Massively Parallel Processors –A Hands-on approach", Elsevier Inc.,(4e), 2023.
3. Michael J. Quinn, "Parallel Programming in C with MPI and OpenMP", McGraw Hill Edition, 2003.
4. Michael J. Quinn, "Parallel Computing" McGraw Hill Edition, 2005

References:

1. https://www.open-mpi.org/doc/
2. https://www.openmp.org/
3. https://developer.nvidia.com/

SIXTH SEMESTER

CSO 3201: DEEP LEARNING AND APPLICATIONS [3 0 3 4]

Introduction to Deep Learning & Architectures, Machine learning basics, Neural Networks basics, Feed Forward Neural Networks, Machine Learning Vs. Deep Learning, Representation Learning, Width Vs. Depth of Neural Networks. Activation Functions, Regularization and Optimization for Deep Learning, Convolutional Neural Networks Architectural, Popular CNN Architectures: ResNet, AlexNet. Transfer Learning: Transfer learning Techniques, Variants of CNN: DenseNet, PixelNet. Sequence Modelling: Recurrent and Recursive Nets, Recurrent Neural Networks, Bidirectional RNNs. Encoder-decoder sequence to sequence architectures, BPTT for training RNN, Long Short Term Memory Networks. Auto Encoders, Regularized Autoencoders , stochastic Encoders and Decoders, Contractive Encoders, Variational Auto Encoders, Deep Generative Models, Introduction to Transformers

Abstract Syllabus (Integrated lab):

Introduction to tensors, Computational graphs, Deep Learning Library in PyTorch, Deep Feed-forward Neural Networks, Convolutional Neural Network, Transfer Learning, Regularization for Deep Neural Networks, Recurrent Neural Networks, Long-Short Term Memory (LSTM), Encoder-Decoders, Variational Auto Encoders, Generative Adversarial Networks (GANs)

References:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, " Deep Learning", MIT Press, 2017.
2. Eli Stevens, Luca Antiga, and Thomas Viehmann, Deep Learning with PyTorch, Manning, 2020
3. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
4. Umberto Michelucci "Applied Deep Learning. A Case-based Approach to Understanding Deep Neural Networks" Apress, 2018.
5. Kevin P. Murphy "Machine Learning: A Probabilistic Perspective", The MIT Press, 2012.
6. Deep Learning - Course, By Prof. Prabir Kumar Biswas | IIT Kharagpur, 12 Weeks
7. Deep Learning - IIT Ropar - Course, By Prof. Sudarshan Iyengar, Prof. Padmavati | IIT Ropar, Punjab Engineering College (Deemed to be University), 12 Weeks
8. Machine Learning And Deep Learning - Fundamentals And Applications - Course, By Prof. M. K. Bhuyan | IIT Guwahati, 12 Weeks

CSO 3222: GENERATIVE AI [3 0 3 4]

Introduction to Natural Language Processing: Overview of NLP and its applications, Challenges in language understanding. Basic Text Processing: Tokenization, Text Normalization, Edit-Distance, Regular Expressions. Morphology and Syntax: English Morphology, Finite-State Morphological Parsing, Stemming, Lemmatization. Language Models and Smoothing: N-gram Language Models, Evaluating Language Models, Smoothing Techniques. Vector Semantics and Word Embeddings: Word Vectors, Word2Vec, GloVe, Semantic Similarity. Parts of Speech and Tagging: English Word Classes, Part-of-Speech Tagging, Hidden Markov Models. Named Entity Recognition (NER): NER Tagging, Sequence Labeling Models.Transformer Architecture: Self-Attention Mechanism, Positional Encoding, Multi-head Attention. Pre-trained Language Models: BERT, GPT Series, T5, Large Language Models. Fine-Tuning and Transfer Learning: Fine-Tuning Strategies, Parameter-Efficient Methods, Domain Adaptation. Prompt Engineering and In-Context Learning: Prompt Design, Zero-Shot and Few-Shot Learning, Instruction Tuning. Applications of Large Language Models: Chatbots and Dialogue Systems, Question Answering Systems, Summarization, Machine Translation, Text Generation. Advanced Topics in Large Language Models: Scaling Laws, Efficient Training and Inference, Reinforcement Learning from Human Feedback (RLHF), Model Compression (Knowledge Distillation, Quantization, Pruning), Retrieval-Augmented Generation (RAG), Multimodal Models. Ethical Considerations and Responsible AI: Bias and Fairness in LLMs, Privacy Concerns, Model Explainability. Case Studies and Projects: Developing a Custom Chatbot using GPT Models, Fine-Tuning BERT for NER, Implementing Machine Translation with Transformers.

Abstract Syllabus (Integrated lab):

Introduction to tensors, Computational graphs, Text preprocessing using Pytorch libraries, Simple NLP applications like sentiment analysis, named entity recognition, text summarization. Implement basic Transformer model in PyTorch for Neural Machine Translation, Fine-tuning Hugging Face transformer models for NLP tasks. Experiments with prompt structures, contextual cues, and few-shot learning techniques to improve pre-trained LLM model responses. Updating the knowledge base of a pretrained LLM using RAG.

References:

1. Daniel Jurafsky and James H Martin. Speech and Language Processing, 2e, Pearson Education, 2009
2. Jay Alammar and Maarten Grootendorst,"Hands-On Large Language Models", O'Reilly Media, 2024
3. Lewis Tunstall , Leondro von Werra ,Thomas Wolf, Natural Language Processing with Transformers: Building Language Applications with Hugging Face, O'Reilly Media, 2023
4. Denis Rothman,"Transformers for Natural Language Processing",Packt Publishing, 2024
5. Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, (1e), O'Reilly Media, 2009

NPTEL Course:

1. Generative AI and Large Language Models by Naveen Kumar Bhansali, IIM Bangalore, https://onlinecourses.swayam2.ac.in /imb24_mg116/preview

CYBER SECURITY SPECIALIZATION

CSO XXXX: NUMBER THEORY AND CRYPTOGRAPHY [3 0 3 4]

INTRODUCTION: Number Theory Concepts, Divisibility and Factorization: Divisibility, Greatest Common Divisors, Euclidean Algorithm, Primes: Prime Numbers, Unique Prime Factorization. The Theory of Congruences: The concept of congruences, Congruence

Classes, Applications of Congruences, solving (single) linear congruence, Solving system of linear congruence, the Chinese Remainder Theorem. Fermat's Theorem and Euler's Generalization: Fermat's Little Theorem. The general case: Euler's theorem. Algebraic structures: The Euclidean Algorithm, Finite Fields of The Form GF(p). Linear Congruence. Cryptography: Introduction Terminology, Classical Cryptography, types of traditional ciphers, Introduction to security and security of traditional ciphers, Introduction to security issues of modern ciphers, Symmetric-key cryptography, Information Security - Confidentiality, Integrity & Availability – Authentication, Authorization & Non- Repudiation, Symmetric Ciphers:: Conventional Encryption: Attacks on Encryption Schemes, Modes of Operation, Multiple Encryption, Introduction to DES, Triple- DES, AES,RC4.

Abstract Syllabus (Integrated lab):

Implementation of selected number theory algorithms and traditional ciphers such as shift cipher, affine cipher, vignere cipher etc.,,Demonstration of symmetric conventional cryptographic techniques, Demonstration of symmetric classic cryptographic techniques ,Traditional Ciphers, Design and implementation of homomorphic encryption techniques, Demonstration and implementation of secure communication using standard

References :

1. William Stallings, Cryptography and Network Security: Principles and Practice, (7e), Prentice Hall, 2020.
2. Behrouz A. Forouzan and Debdeep Mukhopadhyay, Cryptography and Network Security, (2e), McGraw Hill, 2008.

CSO XXXX: ESSENTIALS OF CYBER SECURITY [3 0 3 4]

Introduction to Security Trends: The Computer Security Problem - Targets and Attacks - Approaches to Computer Security - Ethics - Basic Security Terminology - Security Models. Operational and Organizational Security: Policies, Procedures, Standards, and Guidelines - Security Awareness and Training - Interoperability Agreements - The Security Perimeter - Physical Security - Environmental Issues - Wireless - Electromagnetic Eavesdropping - People—A Security Problem - People as a Security Tool. Cryptography: introduction to modern cryptographic Algorithms – Introduction to Hashing Functions - Symmetric Encryption - Asymmetric Encryption - Quantum Cryptography- Introduction to crypto analysis. Authentication and Remote Access: User, Group, and Role Management - Password Policies - Single Sign-On - Security Controls and Permissions - Preventing Data Loss or Theft. The Remote Access Process - Remote Access Methods. Intrusion detection. Standards/frameworks for cyber security, security standards, risk management, cyber security strategic thinking and incident handling

Abstract Syllabus (Integrated lab):

Understanding Cybersecurity Tools, Packet Sniffing and Analysis, Intrusion Detection and Prevention, Implementing Hashing Algorithms, Quantum Cryptography Simulation, Password Cracking and Security Analysis, Web Application Security Testing.

References :

1. Anand Shinde, “Introduction to Cyber Security Guide to the World of Cyber Security”, Notion Press, 2021.
2. Nina Godbole, Sunit Belapure, “Cyber Security: Understanding Cyber Crimes, ComputerForensics and Legal Perspectives”, Wiley Publishers, 2011.

CSO XXXX: INCIDENT RESPONSE AND THREAT INTELLIGENCE [3 0 3 4]

Introduction to Incident Response and Threat Landscape: Overview of IR lifecycle phases, Incident classification and severity levels, Legal and regulatory considerations. Types of threats: APTs, ransomware, insider threats, Threat intelligence sources and feeds, Case studies of notable incidents. Log Analysis and Event Correlation: Identifying anomalies and patterns. SIEM tools and log aggregation, Collecting volatile data, Memory analysis and timeline creation, Prioritizing incidents, Assessing impact and scope. Developing hypotheses, Leveraging threat intelligence, Conducting network and host-based hunts. Containment and Eradication: Isolating affected systems. Removing malware and persistence mechanisms. Attribution and TTPs: Understanding nation-state adversaries. Tactics, techniques, and procedures (TTPs). Creating Incident Reports: Communicating findings to stakeholders. Legal and compliance requirements.

Abstract Syllabus (Integrated lab):

Case studies of notable incidents. Log Analysis and Event Correlation: Identifying anomalies and patterns. SIEM tools and log aggregation, Collecting volatile data, Memory analysis and timeline creation.

References :

- Incident Response & Computer Forensics (Third Edition), Jason T. Luttgens, Matthew Pepe, Kevin Mandia, McGraw-Hill Education, Third Edition (Published in 2014), ISBN-10: 0071798684

CSO XXXX : CYBER LAW, CYBER CRIME AND CYBER ETHICS [3 0 3 4]

Cybercrimes and related offences and penalties: Introduction to Cybercrimes, Classification of cybercrimes, Distinction between cyber-crime and conventional crimes, Provisions in Indian Laws in dealing with Cyber Crimes and its critical analysis, Information Technology Act, 2000, Penalties under IT Act, Offences under IT Act. Legal Recognition of Electronic Records and Electronic Evidence, Digital Signature Certificates, Securing Electronic records and secure digital signatures, Duties of Subscribers - Role of Certifying Authorities. Cyber- crimes under the Information Technology Act,2000 - Cyber-crimes under International Law - Hacking Child Pornography, Cyber Stalking. Copyrights, Software, Copyrights vs Patents debate, Authorship and Assignment Issues, Copyright in Internet, Multimedia and Copyright issues - Software Piracy. History, Overview of developments in Information Technology and Defining E-Commerce, Understanding Ethical, Social and Political issues in E- Commerce.

Abstract Syllabus (Integrated lab):

Legal Analysis of Digital Contracts, Tracing Cybercrime Incidents, Analyzing Digital Evidence, Simulating a Phishing Attack Scenario, Analyzing Ethical Issues in E-Commerce, Understanding Copyright and Piracy

References :

1. The Information Technology Act, 2000 Bare Act with Short Notes, Universal Law
2. Publishing Co., New Delhi
3. Justice Yatindra Singh: Cyber Laws, Universal Law Publishing Co., New Delhi
4. Farouq Ahmed, Cyber Law in India, New Era publications, New Delhi

CSO XXXX: APPLIED CRYPTOGRAPHY [3 0 3 4]

ASYMMETRIC ENCRYPTION: Asymmetric key generation techniques – Public key cryptographic systems, Applications of asymmetric encryption methods – RSA and variants, Attacks on RSA, Rabin Cryptosystem, Elgamal Cryptosystem, Elliptic Curve Cryptography, Homomorphic encryption and types. Key Establishment and Key Management, Diffie-Hellman Key Exchange, Attacks on Diffie Hellman, Digital Signatures, Elgamal Digital Signature Scheme, RSA Digital Signatures Scheme, Schnorr Digital Signature Scheme, NIST Digital Signature Algorithm, Elliptic Curve Digital Signature Algorithm, RSA-PSS Digital Signature Algorithm, Authentication Protocol, Hash Functions and MAC: Standard hashes (MD5, SHA-1, SHA-256/384/512, RIPEMD-160), Birthday Attack, Collision freeness and recent attacks, Message Authentication Code (MAC) Algorithms. Network and Internet Security: Transport Layer Security, IP Security, Email Security, SECURITY PRACTICE & SYSTEM SECURITY

Abstract Syllabus (Integrated lab):

Implementation and demonstration of asymmetric cryptographic systems, Demonstration of hashing and message digest techniques. Design and implementation of homomorphic encryption techniques. Demonstration and implementation of secure communication using standard crypto libraries. Implementation of smart card-based server/client applications Demonstration of authentication techniques. Developing cryptographic algorithms for industrial applications. Developing cryptographic algorithms for innovative applications.

References :

1. William Stallings, Cryptography and Network Security: Principles and Practice, (7e), Prentice Hall, 2017.
2. Behrouz A. Forouzan and Debdeep Mukhopadhyay, Cryptography and Network Security,(2e), McGraw Hill, 2008.

OTHER COURSES WITH LABS

CSS XXXX: PRINCIPLES OF CRYPTOGRAPHY [3 0 3 4]

Computer Security Concepts, Attacks, Services, Mechanisms, Classical Encryption Techniques - Symmetric Cipher Model, Substitution and Transposition Techniques, Block Ciphers and DES, Strength of DES, Block Cipher Design Principles. Advanced Encryption Standard, Block Cipher Modes of Operation, Pseudorandom Number Generation, Stream Ciphers, RC4, Euclidean Algorithm, Modular Arithmetic, Prime Numbers, Fermat and Euler theorems, Testing for Primality, Chinese Remainder theorem, Discrete Logarithms, Public Key Cryptography-Principles, RSA, D-H Key Exchange, ElGamal System, Elliptic Curve over primes, ECC, Cryptographic Hash Functions. Requirements, SHA3, Hash Functions based on Cipher Block Chaining, Message Authentication Codes, MACs Based on Hash Functions and Block ciphers, Digital Signatures -RSA, ECDSA, ElGAmal, Schnorr, Digital Signature Scheme, RSA-PSS Digital Signature Algorithm.

Abstract syllabus (Integrated lab) :

Implement number theoretic algorithms such as Euclidian, Inverses in congruences, Chinese Remainder Theorem, Modular Exponentiation, Classical ciphers, modern symmetric key ciphers asymmetric key ciphers, Hashing, MAC and digital signature algorithms. C/C++ could be used for implementation of the algorithms.

References:

1. William Stallings, Cryptography and Network Security: Principles and Practice, (8e), Prentice Hall, 2023.
2. Behrouz A. Forouzan and Debdeep Mukhopadhyay, Cryptography and Network Security, (3e), McGraw Hill, 2015.
3. Atul Kahate, Cryptography and Network Security, (4e),Tata McGraw-Hill Publishing, 2019.
4. Johnathon Katz and Yehuda Lindell, Introduction to Modern Cryptography, (3e), CRC Press, 2021.
5. Bruce Schneier, Applied Cryptography-Protocols, Algorithms, and source code in C, (2e), John Wiley & Sons, Inc., 2017.
6. https://onlinecourses.nptel.ac.in/noc25_cs31/preview
   Foundations of Cryptography.

CSS XXXX: SOFTWARE ENGINEERING [3 0 3 4]

Evolution from an art form to an engineering discipline, Software development Projects, Exploratory style of software development, Emergence of software Engineering, Notable changes in software development practices. Computer Systems Engineering. Waterfall model and its extensions, Rapid Application Development, Agile development models, Spiral Model, A Comparison of different Life Cycle models, Cohesion and coupling, Layered arrangement of modules, Approaches to software design. Overview of SA/SD methodology, Structured analysis, Developing the DFD Model of a system, Structured Design,. Basic object-orientation concepts, UML diagrams, Use case model, Class diagrams, Interaction diagrams, Activity Diagram, State chart diagram, , An Object-Oriented Analysis and Design (OOAD) Methodology, Software Documentation, Testing, Unit Testing, Black-Box testing, White-Box Testing, Debugging, Program Analysis tools, Regression testing.

Abstract Syllabus (Integrated lab):

Rational Rose, Star UML, SRS, SRS of Case Study, Code Generation, Project Implementation, Use Cases, SOLID Principles, Class Diagrams, Interaction Diagrams, Package Diagrams, Component Diagrams, Deployment Diagrams, NUnit, Junit.

References :

1. Rajib Mall, Fundamentals of Software Engineering (5e), PHI Learning, 2019.
2. Hans Van Vliet, Software Engineering: Principles and Practice (3e), Wiley India, 2012.
3. Roger S. Pressman, Software Engineering - A Practitioner's Approach (7e), McGrawHill International Edition, 2010.
4. Bernd Bruegge, Allen H. Dutoit, Object-Oriented Software Engineering using UML Patterns and Java (2e) , Pearson Publication, 2011.
5. Ian Sommerville, Software Engineering (9e), Addison-Wesley, 2011.
6. https://onlinecourses.nptel.ac.in/noc20_cs68/preview

CSS XXXX: CLOUD COMPUTING AND DEVOPS [3 0 3 4]

Introduction to cloud computing, evolution, characteristics, comparison with traditional computing, benefits and challenges, business impact, security considerations, deployment models: public, private, community, hybrid clouds. Service Models: IaaS, PaaS, SaaS. Virtualization Fundamentals, Hypervisors, SOA Principles, Cloud Security Model: Confidentiality, integrity, availability (CIA), Threats & Vulnerabilities, Legal & Compliance Issues: Data governance, privacy laws, risk assessment frameworks, Performance Monitoring & Disaster Recovery, Introduction to DevOps, Benefits, Agile, DevOps Lifecycle, Principles and Practices, CI/CD, Microservices Architecture, Infrastructure as Code (IaC), Tools, Introduction to Source Version Control & Workflows, Containerizing applications with Docker, Container Orchestration using Kubernetes, Monitoring and Logging, Real-World Applications of DevOps.

Abstract Syllabus (Integrated lab):

Setting up Git and GitHub, Initializing repositories, creating branches, making commits, Managing pull requests, Building Docker images and running containers, Managing multi-container applications using Docker Compose, Deploying a containerized application on Kubernetes, Setting up GitHub actions, Configuring a GitHub pipeline for Continuous Integration, Automating code builds, Setting up monitoring for a deployed application, Integrating Prometheus for metrics collection, Visualizing metrics with Grafana.

References:

1. Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, Cloud Computing: Concepts, Technology, Security and Architecture, Pearson, 2023
2. Rajkumar Buyya, James Broberg & Andrej Goscinski, Cloud Computing, Principles & Paradigms, Wiley Publication, 2011
3. Mikael Krief, Learning DevOps(2e), Packt Publishing, 2022
4. Karl Matthias, Sean P. Kane, Docker: Up & Running: Shipping Reliable Containers in Production(3e), O'Reilly Media, 2023
5. Kelsey Hightower, Brendan Burns, Joe Beda, Kubernetes – Up and Running, Shroff Publishers & Distributors Pvt. Ltd, 2022
6. NIST Cloud Computing Standards https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.500-291r2.pdf
7. Cloud computing By Prof. Soumya Kanti Ghosh | IIT Kharagpur https://onlinecourses.nptel.ac.in/noc21_cs14.

MINOR SPECIALIZATIONS

I. MULTIMODAL DATA ANALYTICS

CSP XXXX: INFORMATION RETRIEVAL [3 0 0 3]

Boolean Retrieval Model, Term vocabulary and Postings lists, Dictionaries and tolerant retrieval, Index Construction, Blocked sort based indexing, Single Pass in memory indexing, Distributed indexing, Dynamic Indexing, Index Compression, Dictionary compression, postings compression, Vector Space Model, Parameter and zone indexes, Term frequency & weighting- Inverse document frequency, tf-idf weighting, Vector space model for scoring, Evaluation in IR, Result snippets, Relevance Feedback and Query Expansion, Latent Semantic Indexing, Web Search Basics, Near duplicates and shingling, Web Crawling and Indexes, Distributing indexes, Link Analysis, Page Rank.

References :

1. Christopher D. Manning, Prabhakar Raghavan, Hinrich Schütze, Introduction to Information Retrieval, Cambridge University Press, 2008.
2. Stefan Buettcher, Charles L. A. Clarke, Gordon V. Cormack, Information Retrieval: Implementing and Evaluating Search Engines, MIT Press, 2016.
3. David A. Grossman, Ophir Frieder, Information Retrieval: Algorithms and Heuristics, Springer, 2004.

CSP XXXX: GRAPH ANALYTICS [3 0 0 3]

Introduction to Knowledge graphs: Definition and significance in data analysis, Key concepts: Nodes, edges, triples, and graph-based data models, Knowledge graphs vs. traditional databases, Real-world applications, Semantic foundation: Ontologies, taxonomies, and vocabularies, Overview of semantic web standards for graph based analytics, Modeling and Design: Modeling knowledge graphs, Ontology Design and Semantic Standards, Knowledge graph construction: Domain discovery, Named entity recognition, Web information extraction, Relation extraction, Non traditional information extraction, Knowledge graph completion: Instance matching, statistical relational learning, Representation learning for knowledge graph, Accessing knowledge graphs: Reasoning and retrieval, structured querying, question answering, Knowledge graph ecosystem: linked data, Knowledge graphs and ontologies in science, knowledge graph for domain specific social impact.

References:

1. Mayank Kejriwal, Craig A. Knoblock, Pedro Szekely, Knowledge Graphs: Fundamentals, Techniques, and Applications, MIT Press, 30 Mar 2021
2. Grigoris Antoniou and Frank van Harmelen, A Semantic Web Primer, The MIT Press, 2nd Edition, 2008.
3. Pascal Hitzler et al, Foundations of Semantic Web Technologies, Chapman & Hall, 2009.
4. Ian Robinson, Jim Webber & Emil Eifrem, Graph Databases, published by O'Reilly,2015
5. Jesus Barrasa, Amy E. Hodler, Jim Webber, Knowledge Graphs, O'Reilly Media, Inc.,2021
6. Jesus Barrasa, Jim Webber, Building Knowledge Graphs, O'Reilly Media, Inc.2023

CSP XXXX: IMAGE AND VIDEO ANALYSIS [3 0 0 3]

Introduction to Digital Image Processing: Image Formation, Sampling, and Quantization, Image representation, Color models, Color transformations; Operations on Images Basic Gray Level Transformations, Histogram Processing, Convolution, Linear and Non-Linear filter, Fourier Transforms, Morphological Image processing; Feature extraction and Matching: Edge and Corner detection, Scale Invariant Features, Feature Descriptors, Feature Matching; ImageSegmentation: Thresholding, Region-based Segmentation, Color-Based and Texture-Based Image Segmentation, Advanced Image Segmentation Techniques; Introduction to Digital Video Processing: Video representation and formats, Compression Techniques, Motion Estimation and Optical flow, Background subtraction; Video Segmentation and Tracking: Background Modeling, Motion Segmentation; Tracking algorithms; Kalman Filter, Mean-shift; Video Analysis and Action recognition: Scene understanding, motion-based recognition, and video-based rendering. Case studies on: Medical Image Segmentation, Autonomous Driving, Traffic Monitoring, Human Activity Recognition.

References:

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, (4e), Pearson Education, 2018.
2. Richard Szeliski, Computer Vision: Algorithms and Applications, (2e), Springer, 2022.
3. David A. Forsyth, Jean Ponce, Computer Vision: A Modern Approach, (2e), Prentice Hall, 2002.
4. A Murat Tekalp, Digital Video Processing, Prentice Hall, 2nd Edition, 2015.
5. Mark Nixon and Alberto S. Aquado, Feature Extraction & Image Processing for Computer Vision, Third Edition, Academic Press, 2012
6. https://onlinecourses.nptel.ac.in/noc25_ee13, Computer Vision and Image Processing - Fundamentals And Applications by Prof. M. K. Bhuyan, IIT Guwahati

CSP XXXX: SOCIAL NETWORK ANALYSIS [3 0 0 3]

Introduction to Social Web, Nodes, Edges, Basic definitions, Types of networks, Layouts, Visualizing network features, Network structures and Measures, The role of Tie strength, Measuring Tie strength and its network structures, Link prediction, entity resolution, Propagation in networks, Introduction to social influence, Influence related statistics, social similarity and influence, Homophily, Existential Test for social influence, influence maximization in viral marketing, Introduction to community discovery, Types of communities, Community detection methods, The Kernighan-Linalgorithm, Agglomerative algorithms, spectral algorithms, multi-level graph partitioning, Evaluation of community detection methods, Anomaly detection in networks, Large-scale social network analysis applications and case studies, Emerging trends and issues.

References :

1. Jennifer Golbeck., Analysing the Social Web, Morgan Kaufmann publications, 2013
2. Charu C. Aggarwal, Social Network Data Analytics, Springer publications, 2011
3. Chakraborty T, Social Network Analysis, Wiley India Pvt. Ltd., 2021
4. David Easley and Jon Kleinberg, Networks, Crowds and Markets, Cambridge University Press, 2010
5. John Scott,Social Network Analysis, (3e), Sage publications limited,2013
6. https://nptel.ac.in/courses/106106239,NOC:Social Network Analysis
7. https://nptel.ac.in/courses/106106169, NOC:Social Networks

II. HEALTH CARE ANALYTICS

CSP XXXX: HEALTH INFORMATICS [3 0 0 3]

Fundamentals to Healthcare Informatics: Data, Information, and Knowledge Hierarchy; Types and Properties of Healthcare Data; Data Quality and Cleaning; Healthcare Databases and its implementation; Data Warehousing in Healthcare; Health care information system:Meta-Modelling - Three-Layer Graph-Based Metamodel (3LGM2) – Domain Layer, Logical Tool Layer and Physical Tool Layer; Electronic Health Records; Application Systems - Patient Administration Systems, Medical Documentation and Management Systems, Computerized Provider Order Entry (CPOE) Systems, Radiology Information Systems (RIS) and PACS; Architectural Styles in Healthcare Informatics; Aspects of Interoperability – Health Level 7; Standards - Clinical Document Architecture (CDA), DICOM, Clinical Data Interchange Standard Consortium; Integrating Healthcare Enterprise; Security and Privacyof Healthcare Informatics: Ethical consideration in Healthcare; Privacy law -HIPPA; Protected Health Informatics; Security Measures: De-identification of Healthcare Data, Data Compression Technique and its applications; Application of Healthcare Informatics: Introduction to Telemedicine; Disease Management – Role of informatics in managing chronic diseases; Mobile Health (mHealth) – Tools, trends, and future directions.

References:

1. Hoyt, R. E., & Yoshihashi, A. K. (2014). Health Informatics: practical guide for healthcare and information technology professionals. Lulu.com.
2. Wager, K. A., Lee, F.W., & Glaser, J. P. (2021). Health care information systems: a practical approach for healthcare management. John Wiley & Sons.
3. McCaffery, P. (2020). An introduction to healthcare informatics: building data-driven tools. Academic Press.
4. Nelson, R., & Staggers, N. (2013). Health Informatics: An interprofessional approach. Elsevier Health Sciences.
5. https://nptel.ac.in/courses/110104095
   Economics of Health and Health Care, IIT Kanpur
6. https://www.medvarsity.com/courses/certificate-course-in-healthcare-informatics
   Healthcare Informatics

CSP XXXX: BIOINFORMATICS [3 0 0 3]

Introduction to Bioinformatics, Central dogma of biology, Digital code of life, Database sequence search: BLAST and FASTA, The modular nature of proteins, Optimal alignment methods-Simple alignments, Global and

Local Alignments, Gap Penalties, Substitution patterns, Molecular Clocks, Phylogenetics, Distance Based methods for Phylogenetics, Character based methods for Phylogenetics, Parsimony, Molecular Phylogenies, Genomics and Gene Recognition: Prokaryotic Genome, Eukaryotic Genomes. Amino acids, algorithms for Protein folding, Protein and RNA Structure Prediction, Artificial Intelligence and Machine Learning in Bioinformatics, Drug Discovery.

References:

1. Dan E. Karne, Michael L Raymer, Fundamental Concepts of Bioinformatics, 2006, Pearson Education, Springer, 2024
2. Vijai Singh Ajay Kumar, Advances in Bioinformatics, Springer Nature, 2024
3. Arthur M. Lesk. Introduction to Bioinformatics, Oxford University Press, 2002
4. Stuart M. Brown. BIOINFORMATICS: A biologists guide to biocomputing and the internet, NYU Medical Center, 2000
5. https://nptel.ac.in/courses/102106065
   Bioinformatics: Algorithms and Applications

CSP XXXX: MEDICAL IMAGE PROCESSING [3 0 0 3]

Digital Image Acquisition: X-Ray Imaging, Magnetic Resonance Imaging, Ultrasound. Image Enhancement: Measure of Image Quality, Contrast, Resolution and Edge enhancement, Noise Reduction. Feature Detection: Edge Tracking, Hough Transform, Corners, Blobs, SIFT and SURF Features, MSER, Saliency and Gist, Bag of Features. Segmentation: Principles and Basic Techniques, Segmentation in Feature Space, Segmentation as a Graph Problem. Registration and Normalization, Classification and Clustering, Validation: Measure of Quality, The Ground Truth. Applications of Deep learning to medical image analysis. Case studies: Disease classification, lesion and organ segmentation.

References:

1. Introduction to Medical Image Analysis, Rasmus R. Paulsen , Thomas B. Moeslund
2. Guide to Medical Image Analysis Methods and Algorithms, Klaus D. Toennies
3. David A forsyth& Jean ponce Computer vision – A modern Approach, Prentice Hall, Pearson Education India; Edition: Second
4. R. C. Gonzalez, R. E. Woods. Digital Image Processing. Pearson, Inc., Edition-Fourth
5. Bernd Jahne and Horst HauBecker, Computer vision and Applications, Academic press, 2000.
6. https://onlinecourses.nptel.ac.in/noc22_bt34/preview

   Medical Image Analysis

CSP XXXX: BIOSTATISTICS [3 0 0 3]

Foundations of Biostatistics: Data and types of data, Scale of measurements, Introduction to data distributions. Population, Sample, Central Limit Theorem, Standard Error, Confidence Intervals. Measures of central tendency, Standard normal curve, Measure of dispersion, Review of descriptive statistics, Summarizing Data, Data Presentation techniques. Hypothesis framing, Role of probability in decision making, test of significance, p-values and statistical inference. Inferential statistics, Parametric and Non-parametric, Correlation tests. Epidemiological Study Designs: observational, Experimental study designs, Clinical trials, Screening designs: Fractional factorial designs, Plackett-Burmann screening designs. Sampling and Sample size: Probabilistic sampling techniques, Non- Probabilistic Sampling techniques, Estimation of sample size: Descriptive studies and Comparative studies. Applied Regression Analysis and Survival Analysis: Multiple regression analysis, logistic regression analysis, Cox Proportional Hazards Regression Analysis, Survival analysis-Censoring, survival function, survival curve.

References:

1. Sullivan, L.M., Essentials of biostatistics for the health sciences, 3rd edition, Jones & Bartlett Learning, 2018.
2. Machin, Campbell and Walters, Medical Statistics, 4th edition, Wiley, 2007.
3. Motulsky, H., Intuitive Biostatistics: A nonmathematical guide to statistical thinking, 3rd edition, Oxford University Press, New York, 2014.
4. Utts, J and Heckard, R., Mind on statistics, 5th edition, Cengage Learning, USA.
5. David S. Moore , William I. Notz, Michael A. Fligner , Statistics in practice , W. H. Freeman publication, 1st edition, 2014.
6. Antonisamy B, Premkumar PS, Christopher S. Principles and Practice of Biostatistics-E-book: Principles and Practice of Biostatistics-E-book. Elsevier Health Sciences; 2017 May 8.
7. https://onlinecourses.nptel.ac.in/noc20_bt11/preview
   Biostatistics and Design of experiments By Prof. Mukesh Doble | IIT Madras.

PROGRAM ELECTIVES

CSP XXXX: IoT AND ITS APPLICATIONS [3 0 0 3]

Introduction to IoT – Definition & Evolution, Physical and Logical Design, Functional Blocks, Machine-to-Machine (M2M) Communication, and Layered Architecture, Protocols and Standards – IEEE 802.15.4, LoRaWAN, ZigBee, NB-IoT, IPv6, 6LoWPAN, Constrained Networks, MQTT, CoAP, HTTP, AMQP, DDS, and OPC-UA, Hardware Platforms and Data Acquisition Techniques – Raspberry Pi, Arduino, ESP8266, Various Sensors, Real-Time data Processing and Management, Cloud Infrastructure for IoT, Edge Computing, Fog computing and Everything-as-a-Service (XaaS) Models, IoT Networking and Power Efficiency – LPWAN and BLE, IoT Applications – Smart Homes, Industrial Automation, Industry 4.0, Smart Agriculture, Healthcare, Smart Cities, Security, Wearable Devices, and Urban Development.

References:

1. "Internet of Things: Principles and Paradigms" – Rajkumar Buyya, Amir Vahid Dastjerdi (Morgan Kaufmann, 2016)
2. "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things" – David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry (Cisco Press, 2017)
3. "The Internet of Things: Key Applications and Protocols" – Olivier Hersent, David Boswarthick, Omar Elloumi (Wiley, 2012)

4. "Internet of Things: A Hands-On Approach" – Arshdeep Bahga, Vijay Madisetti (Universities Press, 2015)
5. "Internet of Things: Architecture, Design Principles and Applications" – Rajkamal (McGraw Hill Higher Education)
6. "Cloud Computing and IoT: A Technology Perspective" – Velte, Toby, Anthony Velte (McGraw Hill, 2019)
7. "Industrial IoT (IIoT): Concepts, Methodologies, Tools, and Applications" – IGI Global
8. "Smart Cities, Smart Future: Showcasing Tomorrow" – Mike Barlow, Cornelia Levy-Bencheton
9. "IoT in Healthcare and Ambient Assisted Living" – Zaigham Mahmood
10. "LPWAN Technologies for IoT and M2M Applications" – Benoît Hilt, Cuong Pham (Elsevier, 2020)
11. https://onlinecourses.nptel.ac.in/noc22_cs53/preview (Nptel Course)

CSP XXXX: AUGMENTED AND VIRTUAL REALITY [3 0 0 3]

Introduction of Virtual and Augmented reality: Definition, scope History of Early VR and Commercial VR Technologies, VR Industry Growth and Applications, The 3 I's of Virtual Reality (Immersion, Interaction, Imagination),Differences Between AR, VR, MR, and XR, AR/VR System Components and Interaction: Components of a VR System: Hardware & Software, AR Display Technologies: Optical See-Through & Video See-Through Displays, Multimodal Interfaces: Gesture, Haptic, and Auditory Interfaces, Perception Requirements and Characteristics in AR/VR, Input Devices: 3D Position Trackers, Navigation & Manipulation Interfaces, Output Devices: Graphics Displays, Sound Displays, Haptic Displays, Computer Vision and Tracking for Augmented Reality: Natural Feature Tracking: Marker-Based and Markerless AR, Simultaneous Localization and Mapping (SLAM) in AR, Optical and Sensor-Based Tracking, Outdoor Tracking Techniques in AR, Real-Time Rendering Pipeline for AR Applications, VR System Architectures and Modeling: Computing Architectures for VR: Workstation-Based and Distributed Systems, Parallel Processing for Real-Time VR Applications, Graphics pipeline - Overview and Transformations, Geometric and Kinematics Modeling for VR Environments, Physical and Behavioral Modeling in VR, The Rendering Pipeline in VR and Optimization Techniques, AR/VR Development and Applications: AR/VR Development Tools: Unity3D, Unreal Engine, Vuforia, ARKit, ARCore, Application Development Process: Scene Creation, Interactions, and Physics, Programming for AR/VR: Scripting in C# (Unity) and Blueprints (Unreal), Use Cases: Gaming, Healthcare, Education, Engineering, Retail, and Entertainment, Ethics and Challenges in AR/VR Development, Future Trends and Research in AR/VR: Cloud-Based and 5G-Enabled AR/VR Applications, AI and Machine Learning in AR/VR Experiences, AR/VR in the Metaverse and Social Media Integration, Haptic Feedback and Brain-Computer Interfaces (BCI), Research Challenges and Opportunities in AR/VR

References:

1. Dieter Schmalstieg & Tobias Hollerer, Augmented Reality: Principles & Practice, 2nd Edition, Addison-Wesley, 2023.
2. Steven M. LaValle, Virtual Reality, Cambridge University Press, 2021.
3. Jesse Glover & Jonathan Linowes, Complete Virtual Reality and Augmented Reality Development with Unity, Packt Publishing, 2021.
4. Grigore C. Burdea & Philippe Coiffet, Virtual Reality Technology, 2nd Edition, Wiley-IEEE Press, 2006.
5. Tony Parisi, Learning Virtual Reality: Developing Immersive Experiences and Applications, O'Reilly Media, 2015.
6. Steve Aukstakalnis, Practical Augmented Reality: A Guide to Technologies and Human Factors, Addison-Wesley, 2016.
7. NPTEL Online Course: Virtual Reality and Augmented Reality – https://nptel.ac.in/courses/106106138

CSP XXXX: CONVERSATIONAL AI (NLP) [3 0 0 3]

Introduction to Conversational AI & NLP: Overview of Conversational AI and its applications, Basics of Natural Language Processing (NLP), History and evolution of chatbots and virtual assistants, Components of a Conversational AI system, Rule-based vs. ML-based vs. Hybrid chatbots. Conversational AI Architectures: Sequence-to-sequence models and their limitations, Attention Mechanism in Conversational AI, Transformer-based architectures for dialogue (BERT, GPT, T5), Dialogue Management Systems. Advanced NLP Techniques for Chatbots: Transfer Learning in NLP, Intent Recognition & Slot Filling, Dialogue Management Systems (Rule-based vs. ML-based), Enhancing Conversational AI: Speech-to-Text & Text-to-Speech Integration, Context Handling and Multi-Turn Dialogues, Custom NLU pipelines and integrating with APIs. Evaluation, Challenges, and Ethics: Evaluation Metrics for Conversational AI, Challenges in Conversational AI and Future Trends. End-to-end conversational AI Development, Deployment.

References:

1. Daniel Jurafsky & James H. Martin, Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition with Language Models, (3e), Pearson, 2024.
2. Andrew R. Freed, Conversational AI:Chatbots that work, Manning, 2021
3. Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python, (1e), O'Reilly Media, 2009
4. Steven Bird, Ewan Klein, Edward Loper, Natural Language Processing with Python – Analysing Text with natural language toolkit, O'Reilly Media, 2009
5. Chris Manning, Hinrich Schutze, Foundations of Statistical Natural Language Processing, MIT Press, Cambridge, 1999.
6. NPTEL: Applied Natural Language Processing By Prof. Ramaseshan R | CMI

CSP XXXX: FUNDAMENTALS OF iOS [3 0 0 3]

Swift Lessons: Installations, iCloud Service, Introduction to Swift and Playgrounds, Constants Variables and Data Types, Operators and Control Flow, Strings, Functions, Structures, Structures, Classes and Inheritance, Classes and Inheritance, Collections, Loops, Optionals, Type Casting and Inspection, Guard, Scope, Enumerations, Constants.

SDK Lessons: Documentation, Building, Running and Debugging an app, Interface Builder Basics, Strings, Introduction to UIKit, Displaying Data, Controls in Action, Auto Layout and Stack Views, Segues and Navigation Controllers, Tab Bar Controllers, View Controller Life Cycle, Building Simple Workflows

Guided Projects: Light, about me, Calculator, Apple pie, personality quiz.

References: Develop in Swift Fundamentals, Xcode 13, by Apple Corporation, USA

CSP XXXX: iOS APPLICATION DEVELOPMENT [3 0 0 3]

Tables and Persistence: Protocols, App life Cycle, MVC, Scroll views, table views, intermediate table views, system view controllers, saving data, complex input screens.

Working with Web: Closures, Extensions, Practical Animations, working with HTTP, URL session, JSON and Concurrency

Advanced Data display: Swift generics, collection views, dynamic data, compositional layout, advanced layout

Guided projects: List, Restaurant, Habits.

References:

1. Develop in Swift Data Collections, Xcode 13, by Apple Corporation, USA.

CSP XXXX: BLOCKCHAIN TECHNOLOGY [3 0 0 3]

Introduction to Blockchain: Definition, History and evolution of Blockchain, Features of Blockchain, Blockchain Architecture, Types of Blockchain, Potential of Blockchain and Myths, Decentralization in Practice and Decentralized Web. Cryptographic Primitives, Blockchain Data Structure and Consensus Mechanisms. Overview of Ethereum and its architecture, Ethereum Virtual Machine, Smart contracts and its development environment, Smart Contracts with Remix IDE, Overview of DApps, DApps development. Hyperledger and Permissioned Blockchain: Overview of Hyperledger frameworks, tools and building blocks, Hyperledger Fabric Model, Chaincode. Case Studies: Application of Blockchain in finance, healthcare, agriculture, IoT, supply chain, logistics, smart grid, smart cities, data management and e-governance.

References:

1. Kumar M V, Manoj, Annappa B, Thomas Likewin, Addya Sourav Kanti, and Niranjanamurthy M. Blockchain Technology and Applications(1e), CRC Press, 2024.
2. S. Shukla, M. Brahmbhatt, P. Tiwari, Blockchain Technology and Applications, Wiley, 2020.
3. Bashir, Imran, Mastering Blockchain: A Deep Dive into Distributed Ledgers, Consensus Protocols, Smart Contracts, DApps, Cryptocurrencies, Ethereum, and More(3e),Packt Publishing, 2020.
4. Ritesh Modi, Solidity Programming Essentials: A Beginner's Guide to Build Smart Contracts for Ethereum and Blockchain, Packt Publishing, 2018.
5. S.Kulkarni, Hands-On Blockchain with Hyperledger: Building Enterprise-Ready Applications, Packt Publishing, 2020.
6. https://onlinecourses.nptel.ac.in/noc22_cs44/preview Blockchain Technology & Applications.

CSP XXXX: WIRELESS TECHNOLOGIES [3 0 0 3]

Introduction to Wireless Networks: Evolution, Challenges, Introduction to Wireless Communication, Electromagnetic spectrum, Spectrum regulation, Wireless propagation, Modulation techniques, Multiple access for wireless systems, Cellular concept, Wireless services Ubiquitous Connectivity, Types of Wireless Networks, Analog Cellular Systems, AMPS, DAMPS, GSM, 3G Spectrum allocation, CDMA, WCDMA, 4G and Beyond, OFDM, Fixed Wireless Networks. IEEE 802.16, WLAN, applications, topology, requirements, Physical and MAC layers, IEEE 802.11a,b and g, Ad Hoc Networks: topology, Ad Hoc routing, VANETs, The 5G Internet, 5G Mobile Networks, SDL: IMS architecture, IMS Call Flow, services within IMS.

References:

1. R Nicopolitidis et al, Wireless networks, Wiley, first, 2011
2. Jonathan Rodriguez, Fundamentals of 5G Mobile Networks, Wiley, 2015
3. Kaveh Pahlavan, Prashant Krishnamurthy, "Principles of Wireless Networks", Prentice Hall, 2011
4. William Stallings ,"Wireless Communication and Networking", PHI, 2014
5. https://archive.nptel.ac.in/courses/106/105/106105160/ Wireless Networks

CSP XXXX: FOUNDATIONS OF QUANTUM COMPUTING [3 0 0 3]

Introduction to Quantum computation, Quantum bits, Single qubit operations, Postulates of quantum mechanics, Quantum Measurement, Bell states, EPR Paradox, No Cloning Theorem, Quantum Gates, Single qubit gates, Pauli Gates, Hadamard gate, Quantum Circuits, Multi-qubit gates, CNOT gate, Toffoli Gate, Fredkin Gate, Universal quantum gates, Quantum Key Distribution, Superdense coding and Quantum Teleportation, Quantum Parallelism and entanglement, The quantum Fourier transform (QFT), Walsh-Hadamard transformation, Quantum search algorithms, Grover's Search Algorithm, Deutsch Algorithm, Deutsch-Jozsa Algorithm, Bernstein-Vazirani Algorithm, Simon's Algorithm, Shor's Factorization algorithm, Quantum error correcting codes. Overview of Qiskit- IBM quantum computing open-source tool, SDL: Designing quantum circuits and implementing quantum algorithms using Qiskit.

References :

1. M. Nakahara and T Ohmi, "Quantum Computing From Linear algebra to Physical Realizations" CRC press 2008.
2. Michael A Nielsen, and Isaac L. Chuang "Quantum Computation & Quantum Information", (10e), Cambridge University Press, 2011.
3. https://onlinecourses.nptel.ac.in/noc19_cy31/preview Quantum Computing

CSP XXXX: REINFORCEMENT LEARNING [3 0 0 3]

The Reinforcement Learning Problem: Reinforcement Learning, Elements, Limitations and Scope, Multi-arm Bandits, Finite Markov Decision Processes: The–Environment Interface, Goals and Rewards Returns, Unified Notation for Episodic and Continuing Tasks, The Markov Property, Decision Processes, Optimality, Dynamic Programming - Policy Evaluation, Improvement, Iteration, Asynchronous Dynamic Programming, Generalized Policy Iteration, Efficiency, Monte Carlo Methods and Temporal-Difference Learning: Monte Carlo Prediction, Estimation of Action Values, Control, Off-policy Prediction via Importance Sampling, Incremental Implementation, TD Prediction, Advantages, Optimality, TD Control, Q-Learning, Approximate Solution Methods On-policy Approximation, Value Prediction, Gradient-Descent Methods, Linear Methods, Introduction to Deep Reinforcement Learning, Actor-Critic Methods, Applications

References:

1. Sutton, R. S., & Barto, A. G., Reinforcement Learning: An Introduction, 2nd Edition, MIT Press, 2020
2. Stefano V. Albrecht , Filippos Christianos, Lukas Schfer, Multi-Agent Reinforcement Learning: Foundations And Modern Approaches, MIT Press, 2024
3. Warren B. Powell, , Reinforcement Learning and Stochastic Optimization: A Unified Framework for Sequential Decisions, Wiley & Sons, 2022
4. Maxim Lapan, Deep Reinforcement Learning Hands-On, Packt, 2018 NPTEL: Reinforcement Learning, By Prof. Balaraman Ravindran | IIT Madras

CSE XXXX: MOBILE APPLICATION DEVELOPMENT [3 0 0 3]

Understanding Flutter and its features, Introduction to Dart programming language, Widgets and their properties, Building layouts with Flutter, Handling user input and gestures, Navigation stacks and routes, Passing data between screens, Implementing bottom navigation bars and drawer menus, Understanding state in Flutter, Managing state with setState, Using state management libraries like Bloc, Making HTTP requests in Flutter, Working with RESTful APIs, Storing data locally with shared preferences, Using SQLite for local database storage, Implementing data caching strategies, Introduction to Firebase services, Authentication with Firebase Auth, Working with Firestore for real-time database, Integrating Firebase Cloud Messaging for push notifications, Writing unit tests and widget tests, Debugging techniques and tools in Flutter, Performance profiling and optimization strategies, App distribution.

References:

1. R. Payne, Flutter App Development: How to Write for iOS and Android at Once, 2nd ed. Razeware LLC, 2023.
2. raywenderlich Tutorial Team, M. Katz, K. D. Moore, and V. Ngo, Flutter Apprentice (Third Edition): Learn to Build Cross-Platform Apps. Razeware LLC, 2022.
3. T. Bailey and A. Biessek, Flutter for Beginners - Third Edition: Cross-Platform Mobile Development from Hello, World! to App Release with Flutter 3.10+ and Dart 3.x, 3rd ed. Packt Publishing, 2023.
4. M. L. Napoli, Beginning Flutter: A Hands-On Guide to App Development. Wiley, 2019
5. Flutter Documentation. [Online]. Available: https://docs.flutter.dev.

CSP XXXX: FOUNDATIONS AND ETHICS OF GENERATIVE AI [3 0 0 3]

Introduction; Generative Modeling, Deep Learning, Variational Encoders, Generative Adversarial Networks, Autoregressive Models, Normalizing Flow Models, Energy-Based Models, Diffusion Models, Transformers, Music Generation, World Models, Multimodal Models, Ethical Issues in Generative AI. Ethical vs unethical use of Generative AI, professional and creative integrity while using AI to produce work. Complying with copyright laws, intellectual property. Effect of Data privacy on content generation. Transparency. Eliminating bias in outputs. Third-party fact-checking. Tangible benefits and risks of ethical GenAI use.

References:

1. David Foster, Generative Deep Learning: Teaching Machines to Paint, Write, Compose and Play, 2nd Edition, O'Reilly, 2023.
2. Jakub Langr, and Vladimir Bok, GANs in Action: Deep Learning with Generative Adversarial Networks, Manning, 2019
3. Joseph Babcock, and Raghav Bali, Generative AI with Python and TensorFlow 2: Create images, text, and music with VAEs, GANs, LSTMs, Transformer models, Packt, 2021.
4. Altaf Rehmani, Generative AI for Everyone, Bluerose Publishers Pvt. Ltd, 2024
5. Oliver Caelen and Marie-Alice Blete, Developing Apps with GPT-4 and ChatGPT, O'Reilly, 2023.
6. Generative AI and Large Language Models (8 weeks) By Naveen Kumar Bhansali | Indian Institute of Management Bangalore (IIMB).
   https://onlinecourses.swayam2.ac.in/imb24_mg116/preview
7. Introduction to Large Language Models (LLMs) (12 weeks) By Prof. Tanmoy Chakraborty, Prof. Soumen Chakraborti | IIT Delhi, IIT Bombay. https://onlinecourses.nptel.ac.in/noc25_cs45/preview

CSP XXXX: PROMPT ENGINEERING [3 0 0 3]

Module-1: Introduction to Prompt Engineering and Its History, Principles of Prompt Design, Emotion and Tone Management in Prompt Design, User-Centered Design, Creative Thinking and Problem-Solving Techniques, Cultural and Linguistic Diversity in Prompt Design, Ethics and Responsibility in Prompt Engineering, Accessibility and Inclusivity in Prompt Design, Prompt Types and Custom Prompt Techniques: Open-Ended, Close-Ended, Instructional, and Contextual Prompts, Prompt Techniques: Zero-Shot, Few-Shot, Chain-of Thought, Tree of Thoughts Prompts and Fine-Tuning LLM Responses, Persuasion and Rhetorical Techniques in Prompt Engineering, Communication Strategies in Prompt Engineering, Feedback and Revision for Prompt Analysis, Evaluation and Development Suggestions on Prompts. Module-2: Contextual Understanding, Advanced Applications of Prompt Engineering for Understanding and Crafting Specialized Prompts for Industry Spesific Applications, Enhancing Learning through Effective Educational Prompts, Ensuring Compliance and Accuracy in Legal and Regulatory Prompts, Prompt Engineering Applications For Creating & Engaging Prompts for Media, Marketing, and Advertising, Understanding Psychological and Sociological Factors in Prompt Design, Algorithmic Thinking and Structural Design in Prompts, Data and Information Management in Prompt Design, Multimodal Prompts: Integrating Multiple Data Sources for Enhanced Interactions, Visual, Musical, and Auditory Prompts, Prompts for Risk and Crisis Management, Prompts for Global Communication and Collaboration, Evaluation and Testing Processes in Prompt Design, Preparation for Innovative Technologies and Trends in the Future of Prompt Design and Development.

References:

1. Zisan Cihangir ISIN, Hilal FIDAN, Tamer ISIN, Dr. Mustafa Kemal TOPCU, Prompt Engineering 101, Amazon.com, Inc, 2024
2. Nathan Hunter, The Art of Prompt Engineering with ChatGPT A Hands-On Guide (Learn AI Tools the Fun Way!), Amazon.com, Inc , 2023

3. James Phoenix and Mike Taylor, Prompt Engineering for Generative AI, O'Reilly Media Inc, 2024
4. Russel Grant, PROMPT ENGINEERING AND CHATGPT, Amazon.com, Inc, 2024
   https://www.udemy.com/course/mastering-ai-powered-prompt-engineering-with-ai-models/?couponCode=NVDIN35
5. Prompt Engineering [Master Prompt Engineering In 2025 With New AI Models]
   https://www.coursera.org/learn/prompt-engineering
6. Prompt Engineering [Prompt Engineering for ChatGPT].

CSP XXXX: PRODUCT MANAGEMENT [3 0 0 3]

Introduction to Product Management, Market Research and Customer Insights, Ideation and Concept Development, User-Centered Design and Usability Testing, Product Requirement definition, Road mapping and Prioritization, Product Development and Agile Execution, Pricing Strategies and Revenue Models, Product Metrics and Success Measurement, Taking Product to Market, Post-Launch Analysis and Iteration, Cross Functional Collaboration and Leadership, Ethics in Product Management, Product Strategy and Competitive Analysis, Product Marketing and Customer Acquisition, Product Lifecycle Management and Growth

References:

1. Karl T. Ulrich & Steven D. Eppinger, “Product Design and Development”, (7e), McGraw Hill,2020.
2. Hans-Bernd Kittlaus, Software Product Management: The ISPMA-Compliant Study Guide and Handbook, (2e), Springer, 2022
3. David A. Aaker, Strategic Market Management(12e), Wiley, 2023
4. Alistair Croll & Benjamin Yoskovitz, Lean Analytics: Use Data to Build a Better Startup Faster, (1e), O'Reilly Media, 2013.
5. Dan Olsen, The Lean Product Playbook: How to Innovate with Minimum Viable Products and Rapid Customer Feedback, (1e), Wiley2015.
   https://onlinecourses.swayam2.ac.in/imb19_mg01/preview
6. New Product Development, Indian Institute of Management Bangalore.

CSP XXXX: ENTERPRISE DATA ARCHITECTURE [3 0 0 3]

Introduction to Enterprise Architecture:- Overview, core elements, Structure of enterprises, Introduction to Enterprise Data Architecture (EDA), Evolution of architecture, Monolithic systems – Mainframes. N-tier Architecture:- Introduction to N-tier architecture, Application Layer, Data Layer – Structured and Unstructured Data, Communication Layer, Hands-on N-tier architecture.. Service oriented architecture and Micro services:- Service oriented architecture, Web Services, Introduction to Microservices, Components of Microservices, Containers, Orchestration, Mesh, API Design, Data Handling, Architectural principles, Effectiveness of SoA. Data Models and Data governance: - Introduction to Data Models, Performance considerations, rendering, performance testing and monitoring, Disaster Recovery strategies, Fault Tolerance and Recovery, data-sharding, de-duplication in-memory computing, Scaling, Data governance, Security, privacy, value and risk, Repository and Support Tool. Architecture for Modern Technologies: - Hardware, Polycloud, Modern communication, Architecture for AI systems Enterprise Architectural frameworks: Zachman Framework and TOGAF

References :

1. Andy Graham, The Enterprise Data Model: A framework for enterprise data architecture, Koios Associates Ltd, 2nd edition, 2012.
2. Charles D. Tupper, Data Architecture: From Zen to Reality, Morgan Kaufmann, 1 edition, 2011.
3. Scott A. Bernard , An Introduction to Enterprise Architecture, AuthorHouse, 3rd edition.
4. https://www.opengroup.org/togaf, TOGAF, The Open Group

CSP XXXX: OPTIMIZATION TECHNIQUES [3 0 0 3]

Linear Programming: Problem Formulation, Linear Programming (LP) in standard form, Graphical Solution, Simplex Method, Big M Method. Transportation and Assignment Model: Transportation problem formulation, optimal solution, unbalanced transportation problem, degeneracy, Assignment problem, Hungarian Problem. Network Analysis: Graphs, Network and Flows, Minimum cost flow Models, Sources, Sinks Max Flow - Min Cut Theorem, CPM and PERT Networks. Inventory: Introduction, Single Item, Deterministic model, Purchase Inventory model with one price, break and multiple price breaks. Dynamic Programming: Introduction, Forward and backward recursions, Bellman's Principle of Optimality. Equipment Replacement Model, Allocation Problem, Inventory Models. Decision Theory: Decision under certainty: Analytic Hierarchy Process (AHP), decision under risk: decision trees, expected value criterion, Variations of the Expected value criterion, decision under uncertainty: Laplace, MinMax, Savage, Hurwicz method. Game Theory: Introduction, Minmax – Maxmin pure strategies, Optimal solution of two person zero sum games, solution of mixed strategy games, 2 x 2 games, 2 x n games, m x 2 games. Heuristics and approximation algorithms: approximation algorithms for Travelling Salesman Problem (TSP), Vertex cover problem.

References:

1. Taha H, Operation Research: An Introduction, 10th Edition, McMillan, 2017.
2. Rardin, Ronald L., Optimization in Operations Research, Pearson Education (2005)
3. Ravindra K. Ahuja, Thomas L. Magnanti, James B. Orlin, Network Flows: Theory, Algorithms, and Applications, Pearson New International Edition, 2014.
4. Teofilo F. Gonzalez, Handbook of Approximation Algorithms and Metaheuristics, Chapman & Hall/CRC Computer and Information Science Series, 1st Edition, 2007.
5. S.S. Rao, Engineering Optimization: Theory and Practice, New Age International Pvt. Ltd., New Delhi, 2013.
6. NPTEL course: Optimization from fundamentals, By Prof. Ankur A. Kulkarni, https://onlinecourses.nptel.ac.in/noc21_me10/preview

CSP XXXX: CYBER FORENSICS [3 0 0 3]

Understanding the Digital Forensics Profession and Investigations: - An Overview of Digital Forensics, Preparing for Digital Investigations, Procedures for Private-Sector High-Tech Investigations. The Investigator's Office and Laboratory:- Understanding Forensics Lab Accreditation Requirements, Data Acquisition, Validating Data Acquisitions Processing Crime and Incident Scenes, Current digital forensics tools, Network Forensics and email investigation, Exploring the Role of E-mail in Investigations, Exploring the Roles of the Client and Server in E-mail, Investigating E-mail Crimes and Violations, Understanding E-mail Servers, Using Specialized E-mail Forensics Tools. Report Writing for High-Tech Investigations, Expert Testimony in Digital Investigations and ethics, Understanding the Importance of Reports, Guidelines for Writing Reports, Generating Report Findings with Forensics Software Tools, Preparing for Testimony, Testifying in Court, Preparing for a Deposition or Hearing, Preparing Forensics Evidence for Testimony, Applying Ethics and Codes to Expert Witnesses.

References:

1. Bill Nelson, Amelia Phillips, Guide to Computer Forensics and Investigations: Processing Digital Evidence, Fifth Edition, CENGAGE Learning, 2015.
2. John R. Vacca, Computer Forensics, Computer Crime Scene Investigation, 3rd Revised Edition, Jones and Bartlett Publishers, Inc., 2019.
3. Keith J. Jones, Richard Bejtiich, Curtis W. Rose, Real Digital Forensics, Addison Wesley Pearson Education, 2006.
4. NPTEL Course: Digital Forensics, By Dr. Jeetendra Pande, https://onlinecourses.swayam2.ac.in/nou22_cs05/preview

CSP XXXX: SEMANTIC WEB [3 0 0 3]

Semantic Web web technologies, a layered approach, RDF-data model, syntaxes, RDFS-adding semantics, RDF schema, RDF and RDF schema in RDFS, Axiomatic schematics for RDF and RDF schema, Direct inference system for RDF and RDFS, Querying Semantic Web – SPARQL, Ontology Languages- OWL2, Ontology Design and Management, Current Applications of the Semantic Web.

References:

1. Grigoris Antoniou, Paul Groth, Frank van Harmelen, Rinke Hoekstra, and Eric Yu, A Semantic Web Primer, 3rd Edition, MIT Press, 2012.
2. Peter Szeredi, Gergely Lukacsy, Tamas Benko, and Zsolt Nagy, The Semantic Web Explained, Cambridge University Press, 2014
3. Liyang Yu, Introduction to the Semantic Web and Semantic Web Services, CRC Press, 2019
4. Elisa F.Kendall, Deborah L.McGuinness, Ying Ding, and Paul Groth, Ontology Engineering, Morgan & Claypool Publishers, 2019
5. NPTEL course: Artificial Intelligence: Knowledge Representation And Reasoning, By Prof. Deepak Khemani,https://onlinecourses.nptel.ac.in /noc24_cs14/preview

CSP XXXX: DEEP LEARNING [3 0 0 3]

Introduction to Deep Learning: Motivation, History and Applications of Deep Learning, Machine Learning Vs. Deep Learning; Fundamental of Neural Networks: Artificial Neuron, Perceptron Model, Perceptron Learning, Multi-layer Network of Perceptrons, Artificial Neural Networks, Activation Functions, Loss functions, Gradient Descent, Backpropagation, Deep Neural Networks. Optimization of Neural Networks: Bias-variance trade-off, Underfitting and Overfitting, Regularization, Batch normalization, Weight initialization strategies, Learning rate schedulers, Optimizers. Convolutional Neural Networks: Convolution, Stride and Padding, Pooling, Properties of CNN, Classical CNN architectures for Image Classification. Sequence Models: RNN, LSTM, GRU, Encoder-Decoder architecture, Attention mechanism, Sequence models for Neural Machine Translation. Representational Learning: Stacked autoencoders, Denoising autoencoders, Sparse autoencoders, Contractive Autoencoders, Convolutional Autoencoders, Variational Autoencoders, Deep Generative Models, Introduction to Transformers

References:

1. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press 2016.
2. Charu C. Aggarwal, "Neural Networks and Deep Learning", Springer 2018.
3. Eli Stevens, Luca Antiga, and Thomas Viehmann, “Deep Learning with PyTorch”, Manning, 2020
4. Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017
5. https://onlinecourses.nptel.ac.in/noc24_cs114, Deep Learning by Prof. Sudarshan Iyengar, IIT Ropar
6. https://onlinecourses.nptel.ac.in/noc25_ee13, Computer Vision and Image Processing - Fundamentals And Applications by Prof. M. K. Bhuyan, IIT Guwahati

CSP XXXX: MACHINE LEARNING TOOLS AND TECHNOLOGY [3 0 0 3]

Supervised Machine Learning: Algorithms and Applications-Introduction, Supervised Machine Learning, Linear and Logistic Regression, Support Vector Machines, Decision Tree, Machine Learning Applications in Daily Life. Zonotic Diseases Detection Using Ensemble Machine Learning Algorithms- Introduction, Bayes Optimal Classifier, Bootstrap Aggregating (Bagging), Bayesian Model Averaging (BMA), Bayesian Classifier Combination (BCC), Bucket of Models, Stacking, Efficiency Analysis. Model Evaluation-Introduction, Model Evaluation, Metric Used in Regression Model, Confusion Metrics, Correlation, Natural Language Processing (NLP), Additional Metrics, Summary of Metric Derived from Confusion Metric, Metric Usage, Pro and Cons of Metrics. The Significance of Feature Selection Techniques in Machine Learning- Introduction, Significance of Pre-Processing, Machine Learning System, Feature Extraction Methods, Feature Selection, Merits and Demerits of Feature Selection. Detection of Diabetic Retinopathy Using Ensemble Learning Techniques-Introduction, Related Work, Methodology, Data Pre-Processing, Feature Extraction, Learning, Proposed Models, Experimental Results and Analysis. Machine Learning and Deep Learning for Medical Analysis—A Case Study on Heart Disease Data-Introduction, Related Works, Data Pre-Processing, Feature Selection, ML Classifiers Techniques, Hyperparameter Tuning, Dataset Description, Experiments and Results. Predictive Analysis on

Online Television Videos Using Machine Learning Algorithms-Introduction, Overview of Video Analytics, Machine Learning Algorithms, Proposed Framework, Feature Selection, Classification, Online Incremental Learning, Results and Discussion. Application of Machine Learning Algorithms With Balancing Techniques for Credit Card Fraud Detection:A Comparative Analysis-Introduction, Methods and Techniques, Results and Discussion. Measuring Urban Sprawl Using Machine Learning- Introduction, Literature Survey, Remotely Sensed Images, Feature Selection, Classification Using Machine Learning Algorithms, Results, Discussion and Conclusion.

References :

1. Pradeep Singh, Fundamentals and Methods of Machine and Deep Learning-Algorithms, Tools and Applications, second edition, Scrivener Publishing, WILEY, 2022
2. M. Gopal, Applied Machine Learning, McGraw Hill Education, 2018
3. Ethem Alpaydin, Introduction to Machine Learning, 2nd edition, MIT Press. 2010
4. Peter Harrington, Machine Learning in Action, Manning Publications, 2012.
5. Andreas C. Müller & Sarah Guido, Introduction to Machine Learning with Python, O'Reilly Media Inc., 2017
6. Gopinath Rebala · Ajay Ravi, Sanjay Churiwala, An Introduction, to Machine Learning, Springer 2019.
7. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, The Elements of Statistical Learning: Data Mining, Inference, and Prediction, second edition, Springer, 2008.
8. https://nptel.ac.in/courses/106106202

MACHINE LEARNING TOOLS AND TECHNOLOGY
[Machine Learning]

CSP XXXX: WEB TECHNOLOGIES [3 0 0 3]

Introduction to World Wide Web, Protocols and Programs, Application and Development Tools, Web Design, Introduction to HTML 5, Tags and simple HTML forms, Meta tags, Frames, Style Sheets: CSS formatting, Introduction to JavaScript, Client-Side Scripting, Advanced Scripting, JavaScript Objects, JavaScript ES6, DOM and Web browser environments, DHTML, Combining HTML and CSS, Ajax, HTTP/HTTPS, Restful APIs, XML and JSON, Server-Side Scripting with PHP, NoSQL, Introduction to MongoDB, CRUD Operations.

References:

1. DT Editorial Services, HTML 5 Black Book, 2nd Edition, DreamTech Press, 2016
2. Powell. Thomas A., JavaScript: The Complete Reference
3. lemay. Laura, rafecolburn, jenniferkyrnin, Mastering HTML, CSS & JavaScript Web, BPB Publication, 2016
4. Vishvajeet. Sisodia, Basic of Web Design, HTML, CSS3, Centrum Press, 2014
5. Karl Seguin, The Little MongoDB Book (https://www.openmymind.net/ mongodb.pdf)
6. https://onlinecourses.swayam2.ac.in/nou25_cs09/preview Web Technology

CSP XXXX: GAME THEORY AND APPLICATIONS [3 0 0 3]

Introduction to Game Theory, Strategic Interactions, Types of Games, Non-Cooperative Game Theory: Key Notions in Game Theory, Extensive-Form Games, Normal-Form Games, Dominant Strategy Equilibria, Pure Strategy Nash Equilibrium, Mixed Strategy Nash Equilibria, Utility Theory, Matrix Games, Bayesian Games, Cooperative Game Theory: Correlated Strategies and Correlated Equilibria, Two Person Bargaining Problem, Coalitional Games with Transferable Utility, Core of Coalition Games, Shapley Value and other Solution Concepts in Game Theory, Fundamentals of Mechanism Design, VCG Mechanisms, Introduction to Algorithmic Game Theory, Price of Anarchy, Applications in Computing.

References:

1. Y. Narahari, Game Theory and Mechanism Design, IISc Press and World Scientific, 2020.
2. Michael Maschler, Eilan Solan, and Schmuel Zamir, Game Theory, Cambridge University Press, 2nd Edition, 2020.
3. Dario Bauso, Game Theory with Engineering Applications, SIAM, Philadelphia, 2016.
4. Eva Tardos, Noam Nisan, Tim Roughgarden, and Vijay V. Vazirani, Algorithmic Game Theory, Cambridge University Press, 2007.
5. https://onlinecourses.nptel.ac.in/noc22_cs77/preview Introduction to Game Theory and Mechanism Design:

CSP XXXX: EXPLAINABLE ARTIFICIAL INTELLIGENCE [3 0 0 3]

Introduction; Pre-model Interpretability and Explainability: EDA, Feature engineering; Model Visualization Techniques and Traditional Interpretable Algorithms: Model validation and evaluation, Classification model visualization, Traditional interpretable algorithms, Model Interpretability: Interpretable vs. explainable algorithms, Ensemble-based explainable machines, Rule-based techniques, Scoring system; Post-Hoc Interpretability and Explanations; Explainable Deep Learning: Visualizing Neural Networks, Interpretability of Transformer Models, Intrinsic, Perturbation, Gradient/Backpropagation; Fairness, Bias and Interpretability: Fairness Metrics, Bias Mitigation in AI Models; Explainability in Different Applications Domains

References:

1. Uday Kamath, and John Liu, Explainable Artificial Intelligence: An Introduction to Interpretable Machine Learning, Springer, 2021
2. Christoph Molnar, Interpretable Machine Learning, Shroff Publishers, 1st Edition, 2024
3. Wojciech Samek, Grégoire Montavon, Andrea Vedaldi, Lars Kai Hansen, and Klaus-Robert Müller, Explainable AI: Interpreting, Explaining and Visualizing Deep Learning, Springer, 2019
4. Serg Masis, Interpretable Machine Learning with Python, Packt Publishing Ltd, 2021
5. https://www.coursera.org/specializations/explainable-artificial-intelligence-xai (XAI)
6. https://onlinecourses.nptel.ac.in/noc24_cs132/preview (Responsible and Safe AI Systems)

CSP XXXX: USER INTERFACE ENGINEERING [3 0 0 3]

Goal-Directed Design : A Design Process for Digital Products, Understanding the Problem: Design Research, Modeling Users: Personas and Goals, Setting the Vision: Scenarios and Design Requirements, Designing the Product: Framework and Refinement, Making Well-Behaved Products: A Basis for Good Product Behavior, Digital Etiquette, Optimizing for Intermediates, Orchestration and Flow, Reducing Work and Eliminating Excise, Metaphors, Idioms, and Affordances, Preventing Errors and Informing Decisions, Designing for Different Needs, Interaction Details: Designing for Mobile and Other Devices, Designing for the Web, Design Details: Controls and Dialogs

References:

1. Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, About Face: The Essentials of Interaction Design, 4th Edition, Wiley, 2014.
2. Yvonne Rogers, Helen Sharp, Jennifer Preece, Interaction Design: Beyond Human-Computer Interaction, 6th Edition, Wiley, 2023.
3. Masaaki Kurosu (Editor), Human-Computer Interaction. Design and User Experience Case Studies, 1st Edition, Springer, 2021
4. Don Norman, The Design of Everyday Things, Revised Edition, Basic Books, 2013.
5. Steve Krug, Don't Make Me Think: A Common Sense Approach to Web and Mobile Usability, 3rd Edition, New Riders, 2013.
6. William Lidwell, Kritina Holden, Jill Butler, Universal Principles of Design, 2nd Edition, Rockport Publishers, 2010.
7. https://onlinecourses.nptel.ac.in/noc23_ar24/preview Introduction To Interaction Design by IIT Roorkee

CSP XXXX: BIG DATA ANALYTICS [3 0 0 3]

Overview of Big Data: Big Data Definition, Big Data Types, Analytics, Industry Examples of Big Data. Distributed and Parallel Computing for Big Data, Hadoop, Cloud Computing and Big Data, In-memory Computing Technology for Big Data, Big Data Stack, Virtualization and Big Data. Hadoop: Hadoop & Hadoop EcoSystem, Moving Data in and out of Hadoop, Inputs and outputs of MapReduce, Hadoop Architecture, HDFS, Common Hadoop Shell commands, NameNode, Secondary NameNode, and DataNode. Hadoop MapReduce paradigm, Map and Reduce tasks, Job, Task trackers , Algorithms using map reduce, Examples of Map Reduce (Word count problem, Matrix-Vector Multiplication), YARN & Zookeeper, Hadoop Cluster Setup & Hadoop Configuration. Hive Architecture, Comparison with Traditional Database, HiveQL - Querying Data - Sorting and Aggregating, Map Reduce Scripts, Joins & Subqueries, HBase concepts, Advanced Usage, Schema Design & Indexing - PIG, Zookeeper. Spark: RDD's in Spark, Data Frames & Spark SQL, Spark Streaming, MongoDB, NoSQL

References:

1. Chris Eaton, Dirk Deroos et al., "Understanding Big data", McGraw Hill, 2012.
2. Boris lublinsky, Kevin t. Smith, Alexey Yakubovich, "Professional Hadoop Solutions", Wiley, ISBN: 9788126551071, 2015.
3. Tom White, "HADOOP: The definitive Guide", O Reilly 2012.
4. Aven Jeffrey, "Data Analytics with Spark Using Python", Big Data, First Edition, Pearson Paperback, November 2018.

NPTEL:

1. Prof. Rajiv Misra, IIT Patna, "Big Data Computing", https://onlinecourses.nptel.ac.in/noc20_cs92/preview
2. Prof. Sandeep Singh Rawat, Indira Gandhi National Open University, New Delhi, "Data Science and Big Data",https://onlinecourses.swayam2.ac.in/nou25_ma07/preview

CSP XXXX: GRAPH DATABASE [3 0 0 3]

Introduction to graph theory, Graph types, Graph data structures, Graph storage and models, Resource Description Framework (RDF), Labelled Property Graph (LPG), Traversal Algorithms (BFS, DFS), Shortest Path Algorithms (Dijkstra, Bellman-Ford), Minimum Spanning Tree (Kruskal, Prim), Community Detection (Louvain), Graph Pattern Matching, Graph databases, Overview of Popular Graph Databases (Neo4j, TigerGraph, Amazon Neptune), Advanced Graph Technology: TigerGraph, Architecture of TigerGraph , Data Modelling in TigerGraph , Data Query Using GSQL, Data/Graph Visualizations using TigerGraph Insights, Graph Algorithms in TigerGraph, Graph Neural Networks (GNNs), Applications of Graphs in AI/ML, Graph-Based Learning Algorithms Integration of Graphs with LLMs, Graph Embedding, Industry Use Cases of TigerGraph

References:

1. Lee, Nguyen, Chang, Graph-Powered Analytics and Machine Learning with TigerGraph, O'Reilly Media, Inc, 2023.
2. Gosnell, Broecheler, The Practitioner's Guide to Graph Data: Applying Graph Thinking and Graph Technologies to Solve Complex Problems, O'Reilly Media, Inc, 2020.
3. Negro, Eifrem, Graph-Powered Machine Learning, Manning,2021.
4. Robinson, Webber, EiFrem, Graph Databases O'Reilly Media, Inc, 2013.
5. Ma, Tang, Deep Learning on Graphs, Cambridge University Press, 2021.

Department of Electrical & Electronics Engineering

Established in the year 1960, the Department of Electrical & Electronics Engineering has been at the forefront to produce well-groomed graduates, possessing sound technical skills and innovative ideas to cater to the ever growing demands of the industry. The department is backed by a team of motivated, dedicated and experienced teachers with expertise in key domains such as Power Systems, Power Electronics, Signal Processing, Illumination Technology, Renewable Energy, Electric Vehicle Technology, Artificial Intelligence, Data Analytics, etc.

The undergraduate program of the department offers a unique blend of core and elective courses. The laboratory exercises and mini projects are carefully designed to ensure synchronism with the curriculum, and exposure to relevant Software & Hardware packages related to the field of learning. The curriculum design enables the graduates to embark on a professional career or pursue higher studies in their area of interest.

The department also offers two post – graduate programs; M.Tech in Electric Vehicle Technology and M.Tech in Power Electronics & Drives. The department has well equipped and state of the art laboratories, such as Power & Energy Systems Lab (sponsored by Schneider Electric), Power Electronics Lab, Solid State Drives Lab, Lighting Lab. Research and Consultancy takes place in core competency area of the department such as Power Systems, Engergy Systems, Power Electronics, Renewable Energy, Control Systems, Lighting.

> Programs offered

Undergraduate Program

- B.Tech in Electrical & Electronics Engineering (1960)

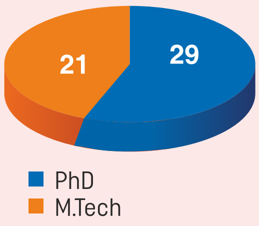
Postgraduate Programs

- M.Tech in Power Electronics & Drives (2008)
- M.Tech in Electric Vehicle Technology (2022)

PhD

> Faculty Strength

Qualification-wise



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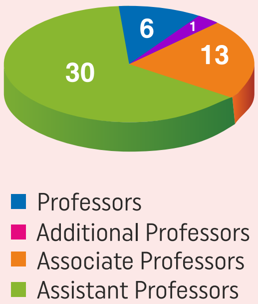


B.TECH. ELECTRICAL & ELECTRONICS ENGINEERING

Year	Sub. Code	Subject Name	L	T	P	C	Sub. Code	Subject Name	L	T	P	C
	THIRD SEMESTER						**FOURTH SEMESTER**					
II	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	MAT 2122	Engineering Mathematics - III	2	1	0	3	MAT 2227	Engineering Mathematics - IV	2	1	0	3
	ELE 2121	Electrical Circuit Analysis	3	1	0	4	ELE 2221	Analog System Design	2	1	0	3
	ELE 2122	Digital System Design	2	1	0	3	ELE 2222	Power Electronics	2	1	0	3
	ELE 2123	Electrical Machinery - I	3	1	0	4	ELE 2223	Linear Control Theory	2	1	0	3
	ELE 2124	Electromagnetic Field Theory	2	1	0	3	ELE 2224	Generation, Transmission and Distribution	3	1	0	4
	ELE 2125	Microcontrollers	2	1	0	3	ELE 2225	Electrical Machinery - II	2	1	0	3
	ELE 2141	Digital System Design Lab	0	0	3	1	ELE 2241	Analog System Design Lab	0	0	3	1
	ELE 2142	Microcontroller Lab	0	0	3	1	ELE 2242	Electrical Machinery Lab	0	0	3	1
			14	**6**	**6**	**22**			**13**	**6**	**6**	**21**
	Total Contact Hours (L + T + P)		**26**				**Total Contact Hours (L+T+P)**		**25**			
	FIFTH SEMESTER						**SIXTH SEMESTER**					
III	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	HUM 3022	Essentials of Management	2	1	0	3	HUM 3021	Engg Economics and Financial Management	2	1	0	3
	ELE 3121	Power System Analysis	3	1	0	4	ELE 3221	Measurements and Instrumentation	3	1	0	4
	ELE 3122	Digital Signal Processing	2	1	0	3	ELE ****	Flexible Core - 2 (A2/B2/C2/D2)	3	0	0	3
	ELE 3123	Switchgear and Protection	3	0	0	3	ELE ****	Program Elective - I / Minor Specialization	3	0	0	3
	ELE ****	Flexible Core - 1 (A1/B1/C1/D1)	3	0	0	3	ELE ****	Program Elective - II / Minor Specialization	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective - 2	3	0	0	3
	ELE 3141	Power Electronics Lab	0	0	3	1	ELE 3241	Measurements and Instrumentation Lab	0	0	3	1
	ELE 3142	Systems Simulation Lab	0	0	3	1	ELE 3242	Power System Lab	0	0	3	1
			17	**2**	**6**	**21**			**18**	**1**	**6**	**21**
	Total Contact Hours (L+T+P) + OE		**22+3=25**				**Total Contact Hours (L+T+P) + OE**		**22+3=25**			
	SEVENTH SEMESTER						**EIGHTH SEMESTER**					
IV	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	ELE ****	Program Elective - III / Minor Specialization	3	0	0	3	ELE 4291	Industrial Training				1
	ELE ****	Program Elective - IV / Minor Specialization	3	0	0	3	ELE 4292	Project Work				12
	ELE ****	Program Elective - V	3	0	0	3	ELE 4293	Project Work (B.Tech Honours)**				20
	ELE ****	Program Elective - VI	3	0	0	3	ELE ****	B.Tech Honours (Theory 1)** (V Semester)				4
	ELE ****	Program Elective - VII	3	0	0	3	ELE ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	*** ****	Open Elective - 3	3	0	0	3	ELE ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	ELE 4191	Mini Project (Minor Specialization)*				8						
			18	**0**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P) + OE		**15 + 3 = 18**									

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

FLEXIBLE CORE - I

ELE 3124: Modern Power Converters
ELE 3125: Distributed Generation Systems
ELE 3126: Communications Systems
ELE 3127: Foundations of EV & Hybrid Vehicles

FLEXIBLE CORE - II

ELE 3222: Solid state Drives
ELE 3223: Smart Grid Technologies
ELE 3224: Control system Design
ELE 3225: Automotive Mechanics for Electric Vehicles

MINOR SPECIALIZATIONS

I. COMPUTATIONAL INTELLIGENCE

ELE 4409: Artificial Intelligence
ECE 4409: Machine Learning
ELE 4410: Soft Computing Techniques
ECE 4410: Computer Vision

II. EMBEDDED SYSTEMS

ECE 4411: Embedded System Design
ELE 4411: FPGA Based System Design
ECE 4412: Internet of Things
ELE 4412: Real Time Systems

III. SIGNAL PROCESSING

ECE 4413: Advanced Digital Signal Processing
ELE 4413: Linear Algebra for Signal Processing
ECE 4414: Digital Speech Processing
ELE 4414: Digital Image Processing

IV. ILLUMINATION TECHNOLOGY

ELE 4401: Lighting Science: Devices and Systems
ELE 4402: Integrated Lighting Design
ELE 4403: Lighting Controls: Technology & Applications
ELE 4404: Solid State Lighting

V. E-MOBILITY

ELE 4415: EV Battery Technology and Power Train Development
ELE 4416: EV Charging Infrastructure, Vehicle Testing & Homologation
ELE 4417: EV Vehicle Design & Analysis
ELE 4418: EV Data Analytics & Cyber Security

OTHER PROGRAM ELECTIVES

ELE 4441: Building Automation Systems
ELE 4442: Computer Architecture & Organization
ELE 4443: Data Structures & Algorithms
ELE 4444: Demand Side Management
ELE 4445: Energy Analytics
ELE 4446: Energy Auditing
ELE 4447: Energy Storage Devices
ELE 4448: HVDC & FACTS
ELE 4449: Introduction to Data Science
ELE 4450: Microgrids
ELE 4451: Power System Operation & Control
ELE 4452: Power System Restructuring & Market Operations
ELE 4453: Renewable Energy
ELE XXXX: Introduction to VLSI Design
ELE XXXX: Real Time Operating System

OPEN ELECTIVES

ELE 4311: MATLAB for Engineers
ELE 4312: Essentials of Energy Auditing
ELE 4313: Solar Photovoltaics
ELE 4314: Introduction to Renewable Energy
ELE 4315: Introduction to Lighting Design
ELE 4316: Utilization of Electrical Energy

THIRD SEMESTER

MAT 2122: ENGINEERING MATHEMATICS - III [2 1 0 3]

Linear Algebra: Systems of Linear Equations, Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings, Affine Spaces. Analytic Geometry: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations. Matrix Decompositions: Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation. Fourier Series and Transforms: Periodic function, Fourier Series expansion. even and odd functions, functions with arbitrary periods, Half range expansionsFourier transform, basic properties, Parseval's identity and applications.

References:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. Grewal B.S. - Higher Engineering Mathematics, Khanna Publishers, 43rd edition, 2015
3. Stephen H. Friedberg Lawrence E Spence, Arnold J Insel, Elementary Linear Algebra: A Matrix Approach Introduction to Linear Algebra, Second Edition, 2019.
4. David Lay, Steven Lay, Judi McDonald, Linear Algebra and Its Applications, Pearson, 2019.
5. Gilbert Strang, Introduction to Linear Algebra, Fifth Edition (2016), Wellesley-Cambridge Press.
6. Mordechai Ben-Ari, Mathematical Logic for Computer Science, Third Edition, Springer.
7. Narayanan, Ramaniah and Manicavachagom Pillay, Advanced Engineering Mathematics, Vol 2 and 3, Vishwanthan Publishers Pvt Ltd. 1998
8. Erwin Kreyszig, Advanced Engineering Mathematics, 5th edn., Wiley Eastern, 1985

ELE 2121: ELECTRICAL CIRCUIT ANALYSIS [3 1 0 4]

Controlled sources, Network Theorems. Signals: Continuous time signals, classification, Elementary CT signals, Operations on signals. Systems and properties, LTI systems, convolution integral, Characterisation. Time domain analysis: Initial and final conditions, Transients analysis of RL, RC and RLC circuits. Laplace domain analysis: Laplace transforms of signals, Transformed circuits, analysis. Frequency domain analysis: Continuous Time Fourier Series, representation, Continuous time Fourier transform, properties, transfer function, frequency response. Two port networks: Z, Y, T and h parameters, Series, parallel and cascade connections. Self-study: simulation-based studies of the selected topics.

References:

1. Hayt W. H., J. E. Kemmerly & S. M. Durbin, Engineering Circuit Analysis, 9e, TMH, 2020
2. Van Valkenberg, Network Analysis, 3e, PHI, 2009
3. Nilsson J. W. & S. A. Reidel, Electric Circuits, 11e, Pearson, 2019.
4. Haykin S., Signals and Systems, 2e Wiley, 2007
5. NPTEL Course: https://nptel.ac.in/courses/117/101/117101055/

ELE 2122: DIGITAL SYSTEM DESIGN [2 1 0 3]

Combinational logic circuits: Overview of Algebraic simplification of Boolean expressions and realization using logic gates, minimization using Karnaugh map, Combinational circuit design using MSI chips: Multiplexers; demultiplexers; encoders; decoders; parity generators; parity checkers, Arithmetic circuits, Sequential logic circuits: flipflops and ripple counter, Shift registers, Analysis and design of synchronous sequential finite state machines, Digital System Implementation Options: Introduction to ASIC, Introduction to HDL, Gate level modeling, Data flow modeling, Behavioral modeling of combinational and sequential circuits, Self- Study- Simulation of combinational and sequential digital circuits, Silicon Processing

References:

1. Givone, Digital Principles & Design, TMH 2011.
2. Charles H Roth, Lizy Kurian John, Byeong Kil Lee, Digital Systems Design using Verilog, First edition, Global Engineering Publishers, 2015
3. Ronald J. Tocci, Digital Systems - Principles & Applications, Pearson, 2005.
4. Brown & Vranesic, Fundamentals of Digital Logic with Verilog HDL design, TMH,2012
5. NPTEL Courses: https://nptel.ac.in/courses/108/106/108106177/

ELE 2123: ELECTRICAL MACHINERY- I [3 1 0 4]

Single-phase transformers: Construction, working principle, equivalent circuit, performance analysis, parallel operation. Auto transformers. Three-phase transformers: Types, construction, connections, inrush current, and harmonics. Three-phase induction motors: Types, construction, working principle, winding diagram, equivalent circuit, performance analysis, testing, starting, braking, speed control, induction generators. Single-phase induction motors: Double field revolving theory, types, characteristics. DC Generators: Construction, working principle, armature winding, armature reaction, commutation. DC Motors: Types, characteristics, starting, braking, speed control, testing. Self-study: Extended exercises on analyses of electrical machines covered.

References:

1. I. J. Nagrath, D. P. Kothari, Electric Machines (5e), TMH, 2017.
2. A. Langsdorf, Theory of Alternating Current Machine (2e), TMH, 2009.
3. M. G. Say, Alternating Current Machines (5e), CBS, 2002.
4. https://nptel.ac.in/courses/108/106/108106071/
5. https://nptel.ac.in/courses/108/106/108106072/

ELE 2124: ELECTROMAGNETIC FIELD THEORY [2 1 0 3]

Vector analysis: Vector algebra, Rectangular, Cylindrical and Spherical Coordinate systems, Electrostatics: Field intensity, Flux density, Boundary conditions, Capacitance, Laplace's and Poisson's equations, Magnetostatics: Field intensity, Flux density, Boundary conditions, Magnetic forces, Inductance, Time varying fields: Maxwell's equations, Uniform Plane wave: Wave equation and its solution, Wave propagation in different media, Poynting's theorem, Wave polarization – Perpendicular and Parallel polarization, Shielding theory – Plane wave and near Field shielding theory, Applications, Self-study: extended study in selected topics

References:

1. William Hayt, Engineering Electromagnetics, TMH, 8th edition, 2011
2. Mathew Sadiku, Elements of Electromagnetics, Oxford University Press, 2014
3. Jan W. Gooch John K. Daher, Electromagnetic Shielding and Corrosion Protection for Aerospace Vehicles, Springer, 2007
4. NPTEL Courses: Electromagnetic Fields: http://nptel.ac.in /courses/108106073/
5. Markus Zahn, Electromagnetic Field Theory. (Massachusetts Institute of Technology: MIT OpenCourseWare). https://ocw.mit.edu/ resources/res-6-002-electromagnetic-field-theory-a-problem-solving-approach-spring-2008/ textbook-contents/

ELE 2125: MICROCONTROLLERS [2 1 0 3]

Introduction to microprocessors and microcontrollers, general purpose and embedded systems, CISC and RISC architectures, AT89C51 (8051) microcontroller: Architecture, pin diagram, addressing modes, instruction set, programming, stack, subroutines, GPIO, timers, serial port, interrupts. Interfacing keyboard, LCD, ADC and DAC to 8051. Embedded software development in 'C'. Programming 8051 in 'C'. ARM processors: ARM7TDMI; Processor modes, visible registers, ARM instruction set, programming, stack, subroutine, exceptions and pipelined architecture. ARM7 based NXPLPC21XX microcontroller: architecture, programming, interfacing. Self-study on Extended Embedded C programming, case studies on realisation of microcontroller based system design for practical applications.

References:

1. Muhammad Ali Mazidi and Gillispie Mazidi, The 8051 Microcontroller and embedded systems, using assembly and 'C', Pearson education, 2013.
2. Kenneth. J. Ayala, The 8051 Microcontroller and embedded systems, using assembly and 'C', Cengage Learning, 2009.
3. Steve Furber, ARM System - on – Chip Architecture, Pearson, Second Edition, 2015
4. William Hohl, Hinds Christopher, ARM Assembly Language, CRC Press, 2016
5. NPTEL Course: https://nptel.ac.in/courses/106/105/106105193/

ELE 2141: DIGITAL SYSTEM DESIGN LAB [0 0 3 1]

Design and Test Digital circuits using standard ICs: Design, Implement and test combinational circuits, asynchronous sequential circuit and synchronous sequential circuit Digital System Design using Programmable ASICs: Familiarization to HDL, modeling styles and design flow environment, Digital circuit design using Verilog HDL and implementation on FPGA, Design and develop FPGA based digital circuit for a given application

References:

1. Givone, Digital Principles & Design, TMH 2011.
2. Charles H Roth, Lizy Kurian John, Byeong Kil Lee, Digital Systems Design using Verilog, First edition, Global Engineering Publishers, 2015
3. Ronald J. Tocci, Digital Systems - Principles & Applications, Pearson, 2005.
4. Brown & Vranesic, Fundamentals of Digital Logic with Verilog HDL design, TMH,2012

ELE 2142: MICROCONTROLLER LAB [0 0 3 1]

Module I: Experiments using 8051 Microcontroller simulator.

Module II: Interfacing exercises using 8051 microcontroller

Module III: Experiments using ARM7 processor based microcontroller.

Mini-Project: Microcontroller based system design.

References:

1. Muhammad Ali Mazidi and Gillispie Mazidi, The 8051 Microcontroller and embedded systems, using assembly and 'C', Pearson education, 2013.
2. Kenneth. J. Ayala, The 8051 Microcontroller and embedded systems, using assembly and 'C', Cengage Learning, 2009.
3. ESAMCB 51 Microcontroller manual.
4. ARM 7 Based NXP LPC 2148 Manual.
5. https://nptel.ac.in/courses/106/105/106105193/

FOURTH SEMESTER

MAT 2227: ENGINEERING MATHEMATICS - IV [2 1 0 3]

Probability and Distributions: Construction of a Probability Space, Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem, Summary Statistics and Independence, Distributions: Binomial, Poisson, uniform, normal, Chi-square and exponential distributions. Multivariate Random variables and Stochastic Process: Two and higher dimensional random variables, covariance, correlation coefficient. Moment generating function, functions of one dimensional and two dimensional random variables. Static probabilities: review and prerequisites generating functions, difference equations. Dynamic probability: definition and description with examples. Markov chains, transition probabilities. Vector Calculus: Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Backpropagation and Automatic Differentiation, Higher-Order Derivatives, Linearization and Multivariate Taylor Series. Optimization: Basic solution, Convex sets and function, Simplex Method, Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers.

References:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. P L Meyer, Introductory Probability and Statistical Applications, Addison Wiley.

3. Medhi. J. Stochastic Processes, Wiley Eastern.
4. Murray R. Spiegel, Vector Analysis Theory and Problems, Schaum's Outline Series, 2019.
5. Hamdy A. Taha, “Operations Research: An Introduction”, 8thEdn., Pearson Education (2008).
6. Sheldon M. Ross, Introduction to Probability Models Eleventh Edition Elsevier.
7. E. S. Page, L. B. Wilson, An Introduction to Computational Combinatorics, Cambridge University Press.
8. Bhat U R, Elements of Applied Stochastic Processes, John Wiley.

ELE 2221: ANALOG SYSTEM DESIGN [2 1 0 3]

Review of MOSFET charecteristics, structure, biasing, current mirrors, Basic amplifier c configurations, CS, CG, CD configurations. Small signal model frequency response, high frequency MOS model. Cascaded amplifier and large signal amplifier. Basic differntial amplifier, common mode and differntial mode signals, OPAMP configuration, OPAMP in linear mode, voltage follower property and inversion property, OPAMP with positive and nagative feedback, Linear and Nonlinear applications of OPAMP, waveform generations, 555 timer based applications. Self-study: Design and SPICE simulation studies on MOSFET based amplifiers and op-amp based circuits

References:

1. Behzad Razavi., Fundamentals of Microelectronics, 2E, Wiley Publishers, 2013
2. Sergio Franco, Design with Operational Amplifiers analog Integrated Circuits, 4E, McGraw-Hill series, 2014.
3. Adel S. Sedra, Kenneth C. Smith, Arun N. Chandorkar, Microelectronic Circuits: Theory and Application (8e), Oxford, 2020.
4. NPTEL Courses: https://nptel.ac.in/courses/108/108/108108114/
5. NPTEL Courses: https://nptel.ac.in/courses/117/105/117105147/

ELE 2222: POWER ELECTRONICS [2 1 0 3]

Power Diode, SCR Family, MOSFET, IGBT: Structure, Operation, Static Characteristics, Dynamic Characteristics and Ratings. Protection of Power Electronic Devices. Comparison of Power Electronic Devices. Select devices (Part Numbers) for application. Design of High side and Low side Gate drive circuit. Analysis of Single-Phase Uncontrolled Rectifiers with filter circuit. Analysis of Single Phase Fully Controlled Full Wave Rectifiers with R, RL, RLE Load and RL Load with Freewheeling Diode. Analysis of Three Phase Fully Controlled Full Wave Rectifiers with R load. Analysis and design of Buck and Boost converter. Analysis of Single-Phase Half Bridge and Full Bridge Inverter with R and RL Load (Square Wave, Bipolar and Unipolar SPWM Technique); Analysis of Three Phase Inverters (1800 and SPWM Technique); Space Vector Pulse Width Modulation; Multi Level Inverters; Current Source Inverter. Application of Power Electronics in Power System, Renewable Energy Systems, Motor Control, SMPS and UPS, and LED Drivers. Creating Design files for customer specifications. Self-study: Verification of the driver circuit design through simulations, Analysis and simulation of Three Phase Fully Controlled Full Wave Rectifiers with RL Load, Analysis and design of Buck-Boost converter through simulations, Analysis and simulation of Three Phase Inverters (1200 mode).

References:

1. Hart D. W., Introduction to Power Electronics, PH, 2010.
2. Ned Mohan et. al., Power Electronics, Converters, Applications & Design (2e), Wiley,2001.
3. Rashid M.H., Power Electronics, Circuits, Devices and Applications, PHI, 2010.
4. Robert W. Erikson, Dragan Maksimovic, Fundamentals of Power Electronics(2e), Springer,2005
5. NPTEL Courses: https://nptel.ac.in/courses/108/102/108102145/

ELE 2223: LINEAR CONTROL THEORY [2 1 0 3]

Control systems terminologies, Mathematical modelling of Electrical circuits, Mechanical systems (translational & rotary) and Electro-Mechanical systems including geared LTI systems using transfer function approach, reduction of sub-systems, signal flow graphs, , State Space modelling approach, Time domain response of 1st order and 2nd order systems, RH criteria, Root Locus technique, Bode plots, Nyquist Plots, Design concepts of lead, lag compensators and their realization, Design concepts of P, PI, PID controllers for LTI systems and their realization. Self Study: Simulation Practice &Controller realization

References:

1. Norman S. Nise, Control Systems Engineering, John Wiley & Sons, Inc, 2010
2. Ogata K, Modern Control Engineering, Englewood Cliffs, NJ: Prentice Hall, 2010
3. Gopal M., Control Systems: Principles and Design, McGraw Hill, 2008
4. K.R. Varmah, Linear Control Theory, Tata McGraw Hill Education, 2010
5. Prof. S.D. Agashe IIT Bombay, Control systems: http://nptel.ac.in /courses/108101037/

ELE 2224: GENERATION, TRANSMISSION & DISTRIBUTION [3 1 0 4]

General layout of a power system, conventional and unconventional power generation, computation of line parameters for 1-phase and 3-phase, line compensation, need for reactive power compensation, sag and tension calculations, overhead insulators and grading of insulators, underground cables, corona, distribution schemes, reliability indices and introduction to LVDC & architecture of 48 V DC distribution. Self-study on the selected topics.

References:

1. J. Duncan Glover, Mulukutla S Sarma and Thomas J Overbye, Power System Analysis and Design, 5th ed, Cengage Learning, 2012.
2. S.N. Singh, Electric Power Generation, Transmission & Distribution, PHI, 6th printing, 2011.
3. Nag P K, Power plant engineering, Tata Mc Graw Hill, 2005.
4. Wadhwa, Electrical Power System, 3rd edition, New Age Intl, 2013.
5. NPTEL course https://nptel.ac.in/courses/108/102/108102047/

ELE 2225: ELECTRICAL MACHINERY- II [2 1 0 3]

Alternators: Constructional features, working principle, harmonics. Modeling of the non-salient pole and salient pole alternators, phasor diagrams, voltage regulation, synchronization, characteristics, alternator connected to the infinite bus, load sharing. Synchronous motors: Synchronizing power and torque, performance characteristics, power factor correction. Special electrical machines- Synchronous reluctance motors, Stepper motors, Switched reluctance Motors, Permanent magnet brushless DC Motors, Permanent magnet synchronous motors: Construction, working principle, control, and performance analysis. Self-study: Extended exercises on analyses of electrical machines covered.

References:

1. I. J. Nagrath, D. P. Kothari, Electric Machines (5e), TMH, 2017.
2. A. Langsdorf, Theory of Alternating Current Machine (2e), TMH, 2009.
3. K Venkataratnam, Special Electrical Machines, Universities Press (India), 2021.
4. https://nptel.ac.in/courses/108/106/108106072/
5. https://nptel.ac.in/courses/108/102/108102156/

ELE 2241: ANALOG SYSTEM DESIGN LAB [0 0 3 1]

Design and Test analog circuit using MOSFETs: Regulated power supply and MOSFET amplifier circuit. Analog system design using standard ICs: Design and test Op-amp based amplifiers, voltage to current converter, integrator, differentiator, biquad active filter, effect of negative feedback, Schmitt trigger, Waveform generators, 555 timer based a stable and Monostable filter. Design, develop/simulate and analysis the analog circuit for a given applications.

References:

1. Behzad Razavi., “Fundamentals of microelectronics”, 2E, Wiley Publishers
2. Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, 3E. McGraw-Hill series
3. Jim Karki, “Application Report Understanding Operational Amplifier Specifications” SLOA011B-January 2018-Revised July 2021. Texas Instruments
4. Thomas R. Brown, Jr “Hand Book of Operational Amplifier Applications” Application report SBIOA092B-October 2001-reviced September 2016. Texas Instruments
5. Colin May, “Passive Circuit Analysis with LTspice1 An Interactive Approach”,Springer Nature Switzerland AG 2020

ELE 2242: ELECTRICAL MACHINERY LAB [0 0 3 1]

Single-phase transformers: OC and SC test. Three-phase induction machine: No load & blocked rotor tests; Load test on three-phase induction motor and generator; DC machines: Speed control; Swinburne's test; Retardation test. Synchronous machines: Voltage regulation of alternator; V and inverted V curves of the alternator and synchronous motor. Dynamic modeling and simulation analysis of the starting transients, and braking of three-phase induction motors. Design and development of the winding diagrams of AC and DC machines.

References:

1. I. J. Nagrath, D. P. Kothari, Electric Machines (5e), TMH, 2017.
2. A. Langsdorf, Theory of Alternating Current Machine (2e), TMH, 2009.
3. A. E. Clayton & N. N. Hancock, The Performance and Design of Direct Current Machines, CBS, 2004.
4. A. K. Sawhney, Electrical Machine Design, Dhanpat Rai Publications, 2016.
5. https://nptel.ac.in/courses/108/106/108106071/
6. https://nptel.ac.in/courses/108/106/108106072/

FIFTH SEMESTER

HUM 3022: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Definition of management and systems approach, Nature & scope. The Functions of managers, Principles of Management. Planning: Types of plans, steps in planning, Process of MBO, how to set objectives, strategies, policies and planning premises, Strategic planning process and tools. Nature and purpose of organizing, Span of management, factors determining the span, Basic departmentation, Line and staff concepts, Functional authority, Art of delegation, Decentralization of authority. HR theories of planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership – leadership behavior & styles, Managerial grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit and Loss control, Control through ROI, Direct, Preventive control. PROFESSIONAL ETHICS - Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories about right action, Self-interest, Customs and Religion, Uses of Ethical Theories. GLOBAL ISSUES - Managerial practices in Japan and USA & application of Theory Z. The nature and purpose of international business & multinational corporations, unified global theory of management, Entrepreneurship and writing business plans. Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisers, Moral Leadership, Code of Conduct, Corporate Social Responsibility.

References:

1. Harold Koontz & Heinz Weihrich (2020), “Essentials of Management”, McGraw Hill, New Delhi.
2. Peter Drucker (2004), “The practice of management”, Harper and Row, New York.
3. Vasant Desai (2007), “Dynamics of entrepreneurial development & management”, Himalaya Publishing House.
4. Poornima M Charantimath (2006), “Entrepreneurship Development”, Pearson Education.
5. Mike W. Martin & Ronald Schinzinger (2003), “Ethics in engineering”, Tata McGraw Hill, New Delhi.
6. Govindarajan M, Natarajan S, & Senthil Kumar V S (2004),

"Engineering Ethics", Prentice Hall of India, New Delhi.

7. R. S. Nagarazan. (2004), "A text book on professional ethics and human values", New age international publishers, New Delhi.

ELE 3121: POWER SYSTEM ANALYSIS [3 1 0 4]

Single line diagram, per unit concept, selection and change of base quantities, three winding transformer in power system, symmetrical short circuit calculation, current limiting reactor, selection of circuit breakers, symmetrical components, sequence networks, unsymmetrical fault analysis in loaded and unloaded system involving transformers, admittance model of power system, load flow solution by numerical method, stability studies, equal area criterion. Write MATLAB program for Load flow solution techniques and swing equation and equal area criterion.

References:

1. Stevenson William D, Elements of Power System Analysis (4e), TMH, 2014
2. Nagrath I.J. & D.P. Kothari, Modern Power System Analysis (2e), TMH, 2013
3. Hadi Saadat, Power System Analysis, TMH, 2004
4. Elgerd Olle I., Electric Energy System Theory, TMH, 2011
5. Stagg & Elabid, Computer methods in Power System Analysis, MGH, 1986

ELE 3122: DIGITAL SIGNAL PROCESSING [2 1 0 3]

Time domain analysis of discrete-time signals & systems: linear-time invariant systems, impulse response, convolution, causality and stability, representation of LTI systems, frequency domain analysis of discrete-time signals and systems: discrete-time Fourier series, discrete-time Fourier transform, properties and applications, Z-transform representation of discrete time signals and systems, properties and applications. Sampling in time and frequency domain. Discrete Fourier transform (DFT) and properties, linear convolution using DFT. Computation of DFT using Fast Fourier transform (FFT), decimation-in-time and decimation-in-frequency FFT algorithms. Digital filter structures, digital FIR and IIR filter. FIR filter design: FIR design by Window method. IIR filter design: classical filter design using Butterworth approximations, impulse invariant and bilinear transformation methods. Applications of DSP. Self-study: simulation-based studies of the selected topics.

References:

1. Haykin Simon and Barry Van Veen, Signals and systems, (2e), John Wiley & Sons, 2007.
2. John G. Proakis, Dimitris G Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, (4e), Pearson, 2007
3. Oppenheim A. V. and R. W. Schafer, Discrete time signal processing, (3e), Pearson, 2014
4. Ingle, Vinay K., and John G. Proakis, Digital signal processing using MATLAB, 3e Cengage Learning, 2012.
5. NPTEL course: https://nptel.ac.in/courses/108/101/108101174/

ELE 3123: SWITCH GEAR & PROTECTION [3 0 0 3]

Fuses. Neutral grounding: Circuit breakers: Arc phenomenon, arc interruption theories, Special duties. CB types: Oil circuit breakers, Air circuit breakers, SF6 CB, Vacuum CB, CO2 CB, MCB, MCCB and HVDC circuit breakers. CB rating, testing, operating mechanism, Autoreclosure, metal clad switchgear, GIS. Isolators and earthing switches. Protective Relaying: Functions, characteristics, standard definition of relay terminologies, classifications & operating principles. Protection schemes for bus zone, transformer, alternator, transmission Line and Induction Motor. Static Relays, Numerical relaying: Building blocks, signal conditioning, DFT, phasor estimation, numerical relaying algorithms. Introduction to SCADA, IEDs and IEC 61850 protocol. Self-study on selected topics.

References:

1. Rao S.S., Switchgear Protection and Power systems, Khanna Publishers, 2015.
2. Badriram and Vishwakarma, Power System Protection & Switchgear, MGH, 2014.
3. Ravindranath & Chander, Power System Protection and Switchgear, New Age International, 2018.
4. Mason, The Art and Science of Protective Relaying, Wiley, 1972.
5. Ravindra P. Singh, Digital Power System Protection, PHI, 2007.

ELE 3141: POWER ELECTRONICS LAB [0 0 3 1]

Design of gate driver circuit, Study of Uncontrolled Rectifier Circuits with filter circuit, Effect of non-linear load on Single phase and Three phase supply, Controlled Rectifier with R and RL loads, Power quality analysis of AC voltage controller, Design and Realization of DC-DC Buck Converter, Design of controller for Inverter circuits, Power Electronic circuit simulation using SPICE and MATLAB, Speed Control of Motors using Power Electronics.

References:

1. Hart D. W., Power Electronics, Tata Mcgraw-Hill, 2011
2. Ned Mohan et. al., Power Electronics, Converters, Applications & Design (2e), Wiley.2010
3. Bose B.K., Modern Power Electronics and AC Drives, Pearson, 2010
4. Rashid M. H. SPICE for Power Electronics and Electrical Power, PH, 1993

ELE 3142: SYSTEMS SIMULATION LAB [0 0 3 1]

Mathematical modeling of physical systems with MATLAB scripts and SIMULINK, DC motor characteristics using Simulink, stability analysis using Bode plot, root locus, and Nyquist plot, design of controllers, analysis of discrete-time signals using discrete-time Fourier transform, discrete Fourier transform, and Z-transform, digital filter structures, digital IIR and FIR filter design, application of filtering techniques, applications of control system and DSP.

References:

1. Norman Nise, Control System Engineering, (8e), Wiley, 2019.
2. Ogata, K, Solving Control Engineering Problems with MATLAB, (1e), Prentice-Hall, 1994

3. John G. Proakis, Dimitris G Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, (4e), Pearson, 2007
4. Ingle, Vinay K., and John G. Proakis, Digital signal processing using MATLAB, (3e) Cengage Learning, 2012.
5. S. K. Mitra, Digital Signal Processing Laboratory Using MATLAB, (2e), 2001.

SIXTH SEMESTER

HUM 3021: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of Single, Uniform, and Gradient cash flow. Related problems and case studies. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, declining and double declining balance method of depreciation, Sum-of-the-Years Digits, Sinking Fund and Service Output Methods, Case Study. Balance sheet and profit & loss statement. Meaning & Contents. Ratio analysis, financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios, Drawbacks. Safety and Risk, Assessment of Risk and safety, Case study, Risk Benefit Analysis and Reducing Risk.

References:

1. Chan S. Park, "Contemporary Engineering Economics", 4th Edition, Pearson Prentice Hall, 007.
2. Thuesen G. J, “Engineering Economics”, Prentice Hall of India, New Delhi, 2005.
3. Blank Leland T. and Tarquin Anthony J., “Engineering Economy”, McGraw Hill, Delhi, 2002.
4. Prasanna Chandra, “Fundamentals of Financial Management”, Tata McGraw Hill, Delhi, 2006.
5. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.
6. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi,2004

ELE 3221: MEASUREMENTS & INSTRUMENTATION [3 1 0 4]

Electrical instrumentation, characteristics, electromagnetic interference, Moving Coil and Moving Iron Instruments, Bridge circuits for R, L and C measurements, Modern Transducers for R, L and C measurements, Signal conditioning - Signal Isolation, Charge amplifiers, Instrumentation amplifiers, Active filters, Sallen Key Topology, State Variable Filters, Successive Approximation, Flash A/D Converter, R 2R and Binary weighted D/A converter, communication using MODBUS and CANBUS, Industrial instrumentation through programmable logic controllers, Case study - ECG, Digital Frequency Meter, Digital Energy Meter. Self-study: extended study in selected topics, case studies and programming exercises.

References:

1. A. K Sawhney and Puneet Sawhney, A course in electrical & electronic measurement and instrumentation”, 19e, Dhanpat Rai & Sons, 2016.
2. Sergio Franco, Design with Operational Amplifiers and Analog Integrated Circuits, 4e, McGraw Hill, 2014.
3. W. Bolton, Programmable Logic Controllers, 4e, ELSEVIER, 2006.
4. NPTEL Courses: https://nptel.ac.in/courses/108/105/108105153/
5. Manufacturers Data sheets, Industry reference guides and modern literatures.

ELE 3241: MEASUREMENTS & INSTRUMENTATION LAB [0 0 3 1]

Module 1: Familiarization and programming exercises of LabVIEW

Module 2: Signal conditioning circuits for Realization of Instrumentation Amplifier and Analog Filter.

Module 3: Digital Instrumentation System using LabVIEW and data acquisition.

Module 4: Ladder logic programming exercises for Programmable Logic controllers.

Mini project: Measurements and Instrumentation related hardware/ simulation based projects

References:

1. Jovitha Jerome, Virtual Instrumentation Using Lab VIEW, PHI learning private limited, 2010.
2. K.R.K. Rao ,C.P. Ravikumar, Analog system lab pro kit manual', Mikro Elektronika Ltd, 2012.
3. Jeffrey Travis, Jim Kring, LabVIEW for Everyone: Graphical Programming Made Easy and Fun, 3e, Prentice Hall Professional, 2009.
4. W. Bolton, Programmable Logic Controllers, 4e, ELSEVIER, 2006.
5. NPTEL Courses: https://nptel.ac.in/courses/108/105/108105063/

ELE 3242: POWER SYSTEMS LAB [0 0 3 1]

Software Module: Transmission line performance, relay co-ordination, load flow analysis, transient stability and short circuit studies using simulation tools

Hardware Module: Numerical over current relay, solar simulator, digital energy meter, transmission line simulator.

References:

1. Stagg G W & El-Abiad A H, Computer Methods in Power System Analysis, Medtech, 2019.
2. Hadi Saadat, Power System Analysis, MGH, 2004.
3. Nagrath I.J. & D.P.Kothari, Modern Power System Analysis, (4e), TMH, 2011.
4. Badriram and Vishwakarma, Power System Protection & Switchgear, TMH, 2013.
5. MiPower and PSCAD user manuals.

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

ELE 4291: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

ELE 4293: PROJECT WORK/PRACTICE SCHOOL

The project work may be carried out in the institution/industry/ research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out, before the department committee as part of project evaluation.

FLEXIBLE CORE COURSES:

ELE 3124: MODERN POWER CONVERTERS [3 0 0 3]

Switched Mode Power converters: generalized comparison between switched mode and linear regulators, operation and steady state performance of buck, boost, buck-boost, cuk : continuous conduction mode, discontinuous conduction mode; Performance analysis of converters using DC Transformer model; DC-DC converters with isolation- Fly back converter, Forward converter, push pull converter, half bridge and full bridge DC-DC converters; Resonant Converters-series and parallel loaded converters in continuous and discontinuous mode of operation, zero current switch resonant converter (ZCS), zero voltage switch resonant converter (ZVS); Control techniques; Converter modelling- equivalent circuit modelling of converters using state space averaging technique; Closed loop converter design – PID design issues. Design of Magnetic Components, Review of magnetic circuits, Design of Inductors, Design of two winding high frequency transformers. Self-Study: SEPIC converter Simulation Using Idealized Components. Current Fed Converters. Simulation of Converter with soft switching. Simulation of DC-DC converter with closed loop control.Losses in magnetic elements, design of multilinking transformers.

References:

1. Robert W. Erickson, Dragan Maksimovic; Fundamentals of Power Electronics, (2 ed), Springer, 2005
2. Hart D. W., Introduction to Power Electronics, PH, 2010.
3. Ned Mohan et. al., Power Electronics, Converters, Applications & Design (2e), Wiley.2001
4. IssaBatarseh, Power Electronic Circuits (1e), Wiley, 2014
5. P. Krein, Elements of Power electronics, OUP, 1998
6. L Umanand, S R Bhat, Design of magnetic components for switched mode power converters (1e), New Age International, 1992.
7. NPTEL Courses: https://nptel.ac.in/courses/108/102/108102145/
8. Coursera group of courses on power electronics specialization by University of Colorado, Boulder: https://www.coursera.org/specializations/power-electronics.

ELE 3125: DISTRIBUTED GENERATION SYSTEMS [3 0 0 3]

Introduction to Distributed Generation Systems- Principle and Structure of DGS- Features of DGS, Distributed Generation Technologies-Overview, Integrating Distributed Energy Resources with the Grid, Planned/non-planned DG, Micro Grid and it's features. DG Technologies DG Technologies: Wind Energy Conversion System, Photovoltaic Systems-PV grid tied systems and different configurations. Micro turbine Generation, diesel power plant, Small Hydro Generation Systems, Fuel Cells. Energy Storage Technologies-Different Energy storage technologies-Overview, Design Issues and control of Distributed Generation Systems-General model of DGS, Technical Regulation of DG integration, DG Optimization and Energy Management..microgrid-modes of operation & isuues.

References:

1. G.B. Gharehpetian and S. Mohammad Mousavi Agah "Distributed Generation Systems. Design, Operation and Grid Integration," Butterworth-Heinemann, 2017.
2. H. Lee Willis & Walter G Scott, Distributed Power Generation planning & Evaluation", Taylor & Francis Group,2000.
3. Math Bollen & Fainan Hassan," Integration of distributed generation in the power systems'", AJohnwiley & sons , INC, Publications, 2011
4. Bo Zhao, Caisheng Wang, Xuesong Zhang "Grid integrated and standalone photovoltaic distributed generation systems analysis, design and control," Wiley, 2017.
5. Nikos Hatziargyriou, microgrid: Architecture and Control. Wiley-IEEE Press. 2014

ELE 3126: COMMUNICATION SYSTEMS [3 0 0 3]

Elements of communication systems; Analog Communication techniques: Amplitude modulation schemes and frequency modulation; Pulse modulation schemes; Shift keying techniques – frequency, phase and amplitude; Channel encoding and decoding technologies; Conceptual idea of encryption and decryption; Communication protocols and networking; Internet of Things; Wireless sensor actuator network; Applications: Spread spectrum and mobile communications Self-study: Simulation based studies of the selected topics.

References:

1. Simon Haykin, Communication Systems, John Wiley & Sons, 4e, 2009.
2. NPTEL Courses: https://nptel.ac.in/courses/106/105/106105166/
3. Stallings William, Cryptography and network security: principles and practices, Pearson Education, 2006.
4. Geng Hwaiyu, Internet of Things and Data Analytics Handbook, John Wiley & Sons, 2017.
5. Verdone Roberto et al., Wireless sensor and actuator networks: technologies, analysis and design, Academic Press, 2010.

ELE 3127: FOUNDATIONS OF EV & HYBRID VEHICLES [3 0 0 3]

Principles for Electric Vehicles: EV Industry, EV Technology and Automotive Revolution, Electrical Engineering for EV, Battery Technology

Control system for Electric Vehicles: Motor and Controller Systems, EV Numerical Calculations, EV Charging Infrastructure, Practical session - Well-to-wheel analysis of EV architecture

Essentials for Electric Vehicles: Electrical Requirement, Power Distribution Specifications, Electronic Control System, Practical session - EV connection and system analysis

Types of components in Electric Vehicles: EV Standards and Classifications, Selection for Electrical and Electronic Components, Practical session - EV hardware components

Principles for Hybrid Vehicles: Introduction to Hybrid Vehicles, Battery Chemistry, Efficiency, Definition and Parameters for Hybrid Systems, Electric Motors, Generators and Power Electronics for Hybrid Systems, Control Systems, Hybrid Electric Vehicle Operation, Practical session - Numerical study on powertrain sizing of HEV

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", Routledge, 3rd Ed, 2021, ISBN: 9780367693930
3. Muhammad Ehsani, Mehrdad Ehsani, and Ali Emadi, "Electric Vehicle Systems Architecture and Standardization Needs", Reports of the PPP European Green Vehicles Initiatives, Springer, 2015.
4. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 1st Ed, 2014, ISBN: 9781138072855.
5. Rodrigo Garcia-Valle and João A. Peças Lopes, “Electric Vehicle Integration into Modern Power Networks", Springer, 2013, ISBN: 978-1461401339.
6. Chris Mi and M. Abul Masrur, “Hybrid electric Vehicles, Principles and Applications with Practical perspectives”, WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6.
7. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

ELE 3222: SOLID STATE DRIVES [3 0 0 3]

Fundamentals of Electric Drives: components, dynamics, multi-quadrant operation, equivalent moment of inertia and torque, nature and classification of load torque, steady state stability, classes of motor duty. DC drives: Single phase and three phase controlled rectifier fed dc drives, speed torque characteristics, waveforms, expressions for voltage, current, speed, torque and power. PWM rectifiers fed DC drives. Chopper fed DC drives, quadrant of operation. Demonstration of open loop and closed loop control of drives with/without Regenerative braking. AC drives: Induction motor drives – stator voltage control, slip power recovery scheme, V/f control, principle of vector control: FOC and DTC. Comparison of scalar and vector control schemes. Overview of scalar and vector control schemes of PMSM, BLDC. Applications: Solar and battery powered drives, Traction drives. Self-study: Selection of Motor Power rating/ classes of motor duty, Effect of armature current ripples on motor performance, Analysis and simulation of Static rotor resistance control, Overview of Scalar and vector control schemes of SRM.

References:

1. Dubey G.K., Power Semiconductor Controlled Drives, PH, 1989.
2. Dubey G.K., Fundamentals of Electric Drives, Narosa, 2010.
3. Murphy J.M.D. & F.G.Turnbull, Power Electronic Control of AC motors, Pergamon 1989.
4. Bose B.K., Modern Power Electronics and AC Drives, Pearson, 2010
5. NPTEL Courses: https://nptel.ac.in/courses/108/104/108104140/

ELE 3223: SMART GRID TECHNOLOGIES [3 0 0 3]

Smart Grid and it's necessity, Advantages of building integrated and distributed power systems- concept of smart grid, Architecture of smart grid system, Standards for smart grid system, Smart grid communications technology, Switching techniques and communication channels, Wide area monitoring systems, Phasor measurement units (PMU), smart metering, Communication infrastructure and protocols for smart metering, Supervisory Control and data Acquisition (SCADA), Demand Response - Large-scale renewable energy integration, Energy storage at distribution level Smart micro grids, Electric Vehicles and Vehicle-to-Grid Systems, Computational Tools, Optimization techniques to smart grid, Hybridizing Optimization Techniques and Applications to the Smart Grid, Computational Challenges, Interoperability- Benefits and Challenges of Interoperability, Model for Interoperability in the Smart Grid Environment, Approach to Smart Grid Interoperability Standards, Smart Grid Cyber Security-Cyber Security Risks, Cyber Security Concerns Associated with AMI.

References:

1. James Momoh, “Smart Grid – fundamentals of design and analysis”, John Wiley and Sons, 2012.
2. Takuro Sato, Daniel M. Kammen, Bin Duan, Martin Macuha, Zhenyu Zhou, Jun Wu, Jun Wu, and Solomon AbebeAsfaw “Smart grid standards: specifications, requirements, and technologies”, Wiley 2015.
3. Janaka B. Ekanayake, Nick Jenkins, Kithsiri Liyanage, Jianzhong Wu, and Akihiko Yokoyama, “Smart Grid: Technology and Applications” Wiley, New Delhi, 2015.
4. Lars T. Berger, Krzysztof Iniewski, “Smart Grid Applications, Communications and Security” Wiley, New Delhi, 2015.
5. Salman K. Salman, “Introduction to the Smart Grid: Concepts, technologies and evolution” Institution of Engineering and Technology (IET), 2017.

ELE 3224: CONTROL SYSTEM DESIGN [3 0 0 3]

Control system performance objectives, Design of cascade & feedback compensation, Scalar and multivariable control systems, Industrial PID controllers, state space systems and PID control, PID tuning, Pole placement techniques for design of controllers and observers, Kalman filter, Robust control, techniques; Non-linear control system design: Linearization, compensation and design of non-linear systems, design of non-linear control system using phase plane analysis, Lyapunov stability; optimal control theory and applications; Adaptive Control ; Self tuning control; Model reference adaptive control; practical aspects: Control system design examples; Self study : MATLAB & SIMULINK for Control system Design.

References:

1. Katsuhiko Ogata, Modern Control Engineering (5e), PHI, 2010.
2. Stanley M. Shinners, Advanced modern control system theory and design, John Wiley & Sons, 1998.
3. V. I. George, C.P. Kurian, Digital Control Systems (1e), Cengage learning, 2012.
4. Norman S. Nise, Control Systems Engineering (5e), John Wiley & Sons Inc, 2010.
5. K.R. Varmah, Modern Control Theory, CBS Publishers & Distributors Pvt. Ltd.,2020

ELE 3225: AUTOMOTIVE MECHANICS FOR ELECTRIC VEHICLES [3 0 0 3]

Automotive Engineering & Vehicle Dynamics: Vehicle Dynamics Fundamentals, Tire Mechanics and Dynamics, Suspension Systems, Braking Systems, Aerodynamics, Powertrain Systems, Vehicle Stability Control, Vehicle Safety, Vehicle Dynamics Simulation, Electric and Hybrid Vehicle Dynamics, Practical session - EV Dynamics & calculations.

Sketching for Automotive EV Design [Software-based]: Introduction to Automotive Sketching Software, Overview of Vehicle Design Process and Automotive Sketching, Basic Sketching Techniques and Tools in the Software, Sketching Car Exteriors, Interiors and Details, Creating Different Views and Angles of the Vehicle, Rendering and Presenting the Final Sketches, Understanding Proportions, Perspectives and Shapes in Automotive Sketching, Creating Sketches for Different Vehicle Types (Sedans, SUVs, and Trucks), Tips and Tricks for Automotive Sketching in the Software.

Advanced EV Modelling Using Solid Works Tool [Software-based]: Introduction to EV Technology and Its Benefits, Basic Vehicle Design Principles, Design and Modelling of Chassis and Frame, Suspension Systems, Design and Modelling of Braking and Steering Systems, Design and Modelling of Electrical Components for EVs, Battery Pack Design and Modelling for 2, 3 and 4 Wheelers, Motor and Drivetrain Design and Modelling for 2, 3 and 4 Wheelers, Design and Modelling of Wheels and Tires for 2, 3 and 4 Wheelers, Testing and Simulation of Vehicle Performance Using Solid Works, Design for Manufacturability and Assembly Considerations, Sustainability and Environmental Impact Considerations in EV Design, Practical session - EV hardware components walkthrough.

Multibody Dynamics with MSC Adams [Software-based]: Introduction to MSC Adams Software and Its Capabilities, Setting Up the Modelling Environment in MSC Adams, Multi-body Dynamics Principles and Application to Vehicle Systems Modelling, Vehicle Suspension Systems Modelling, Vehicle Steering Systems Modelling, Vehicle Braking Systems Modelling, Practical session - EV Component design & modeling.

EV Analysis with MSC Adams (Software-based): Tire Force and Characteristics Modelling, Vehicle Dynamics Analysis Including Simulating Ride and Handling, Vehicle Stability and Rollover Events, Optimisation Techniques for Vehicle Designs Using MSC Adams, Integration of MSC Adams Models with Other Software Tools for System-level Simulations and Analysis, Practical session - EV body design analysis.

References:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Du, H., Cao, D., & Zhang, H. (n.d.). "Modelling, Dynamics, and Control of Electrified Vehicles", Woodhead Publishing, 2017, ISBN-13: 9780128127865
3. Zaman N., "Automotive Electronics Design Fundamentals", Springer, 2015, ISBN-13: 9783319359793
4. Gianfranco Pistoia, "Electric & Hybrid Vehicles", Elsevier, 1st ed, 2010, ISBN: 9780444638250.
5. Chau, K. T., "Electric Vehicle Machines and Drives: Design, Analysis and Application", John Wiley and Sons, Inc., 2015, ISBN-13: 9781118752524.
6. Ehsani, Mehrdad, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC, 2019, ISBN-13: 9780367137465.
7. Hughes, Austin, "Electric Motors and Drives", Newnes (an Imprint of Butterworth-Heinemann Ltd), 2019, ISBN-13: 9780081026151
8. Chris Ni and M. Abul Masrur, "Hybrid electric Vehicles, Principles and Applications", WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6
9. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

MINOR ELECTIVES:

ELE 4409: ARTIFICIAL INTELLIGENCE [3 0 0 3]

Foundations of Artificial Intelligence, Intelligent Agents and Environments, The concept of Rationality, The Nature of Environments, Problem Solving agents, Searching for Solutions, Uninformed search strategies, Informed (Heuristic) search strategies, Heuristic functions, local search algorithms, and optimization problems, Adversarial Search and Constraint satisfaction Problems, Knowledge and Reasoning, Knowledge-based agents, The wumpus world, propositional logic, first-order logic, syntax and semantics, Knowledge representation, Ontological Engineering, Uncertain knowledge and Reasoning, Acting under uncertainty, Basic probability notation, semantics of Bayesian network. Self-study: Case studies/simulation of various search techniques

References:

1. Stuart Russell & Peter Norvig, Artificial Intelligence A Modern Approach, 3e, Pearson, 2012.
2. Elaine Rich, Kevin Knight & Shivashankar B. Nair, Artificial Intelligence, 3e, Tata McGraw Hill, 2012
3. David L. Poole & Alan K. Mackworth, Artificial Intelligence: Foundations of Computational Agents, 2e, CUP, 2017
4. NPTEL Courses: http://nptel.ac.in/courses/106105077/

ECE 4409: MACHINE LEARNING [3 0 0 3]

Introduction to Machine Learning, Feature reduction techniques, Linear Discrimination, Artificial Neural Networks (ANN), Parameter estimation methods], Evaluation measures:Graphical methods, clustering methods, Reinforcement learning (RL)

References:

1. Alpaydin E, Introduction to Machine Learning, (2e), MIT Press. 2010.
2. Duda R.O, Hart P.E. and Stork D.G., Pattern Classification, (2e), Wiley, 2001
3. Bishop C. M., Pattern Recognition and Machine Learning, Springer, 2007.
4. Andrew Barto and Richard Sutton, Reinforcement learning an Introduction, MIT press, 1998.
5. Jensen R. and Shen Q. Computational Intelligence and Feature Selection: Rough and Fuzzy Approaches, Vol. 8, IEEE Press Series on Computational Intelligence, John Wiley and Sons, 2008.

ELE 4410: SOFT COMPUTING TECHNIQUES [3 0 0 3]

Introduction to soft computing techniques, Artificial Neural networks, basic models, Models of ANN, Hebb network, training algorithms, perceptron networks, perceptron training algorithms, back-propagation networks, radial basis functions, Fundamental concept of Fuzzy logic, fuzzification and defuzzification methods, methods of membership value assignments, fuzzy arithmetic, fuzzy reasoning, fuzzy inference systems, fuzzy decision making, Genetic algorithms, classification of GA, Adaptive neuro-fuzzy inference systems, Fuzzy Artificial Neural Networks, Applications of Soft computing techniques to solve real-time problems. Self-study topic: Simulation of ANN, Fuzzy logic applications using MATLAB/Python programming

References:

1. Jacek M. Zurada., Introduction to Artificial Neural Systems, JPH, 2016
2. Timothy J. Ross, Fuzzy logic with engineering applications, McGraw Hill publications, 2012
3. Sivanandam & Deepa, Principles of Soft computing, Wiley India, 2009
4. Rajasekaran & Vijayalakshmi Pai, Neural networks, Fuzzy logic and Genetic algorithms, PHI,2003
5. NPTEL Courses: https://nptel.ac.in/courses/106/105/106105173/

ECE 4410: COMPUTER VISION [3 0 0 3]

Pinhole cameras, Image formation, Sources, Image, features representation, Segmentation, Segmentation, and fitting using probabilistic methods: Expectation-maximization algorithm. The geometry of two views and Camera calibration, Pattern Classification

Reference:

1. David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003
2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010
3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, 2nd Edition, Cambridge University Press, 2004
4. Linda Shapiro and George Stockman, Computer Vision, Pearson Education, 2001

ECE 4411: EMBEDDED SYSTEM DESIGN [3 0 0 3]

Embedded systems overview, Embedded Software: Interrupts, interrupt latency, shared data problems. quescheduling, Real-time operating system architecture, Introduction to the real-time operating system; Embedded hardware: standard peripherals; Communication; protocols; Designing embedded system using FSM models. Hardware and software co-design; Embedded C programming; Embedded development life cycle(EDLC

References:

1. Frank Vahid & Tony Givargis,"Embedded system design",Wiley Publication,2002.
2. An Embedded software primer, David E Simon, Addison Wesley.
3. Shibu K.V, "Introduction to embedded systems", McGraw Hill Publication,2013.
4. RajKamal,"Embedded Systems",2nd edition,TataMcGrawHill

ELE 4411: FPGA BASED SYSTEM DESIGN [3 0 0 3]

Overview of Digital Systems – Implementation options, FPGA –Architecture, Programming technologies, Altera & Actel logic cells, I/O Blocks, Programmable interconnects, Logic implementation, Design verification- Test bench codes, Hardware testing, FPGA Architectural options; granularity of function and wiring resources, reconfigurable architectures- Fine grained, Coarse grained, Medium grained, Embedded multipliers, adders, MACs, processor cores, Configuring an FPGA; Vendor specific issues, Logic block architecture, timing models- static and dynamic timing analysis, Input and Output cell characteristics, Power dissipation, Partitioning and placement, Routing resources, Embedded system design using FPGAs, DSP using FPGAs, Multi FPGA systems, Reconfigurable systems, Application case studies. Self-study: Developing and synthesizing RTL based circuit for the given application.

References:

1. M.J.S. Smith, Application Specific Integrated Circuits, (1e), Pearson, 2002
2. Peter Ashenden, Digital Design (Verilog): An Embedded Systems Approach Using Verilog, (1e), Elsevier, 2007
3. Clive Maxfield, The Design Warriors Guide to FPGAs, (1e), Elsevier, 2004
4. Hauck, S. and DeHon, A Reconfigurable computing: the theory and practice of FPGA-based computation, (1e), Elsevier, 2010.
5. NPTEL Course: https://nptel.ac.in/courses/117/108/117108040/

ECE 4412: INTERNET OF THINGS [3 0 0 3]

Demystifying the IoT Paradigm, IoT Protocols, and Technologies, Concept of Device-to-Device/Machine-to-Machine Integration, Device-to-Cloud Integration, Realization of IoT Ecosystem Using Wireless Technologies; Infrastructure and Service Discovery Protocols for the IoT Ecosystem; Next-Generation Clouds for IoT Applications and Analytics; Cloud Computing; Emerging Field of IoT Data Analytics; Software Defined Networking (SDN)

References:

1. Raj P. and Raman A. C., The Internet of Things: Enabling Technologies, Platforms and Use Cases, CRC Press, 2017
2. Bagha A. and Medisetti V, Internet of Things: A Hands on Approach, University Press
3. Holler J., Tsiatsis V., Mulligan C., Karnouskos S., Avesand S., and Boyle D., From Machine to Machine to the Internet of Things: Introduction to a New Age of Intelligence, Academic Press, 2014
4. Vahid F, Givargis T., Embedded Systems Design: A Unified Hardware/Software Introduction, Wiley Publications, 2000
5. Axelson J, Parallel Port Complete, Penram Publications.

ELE 4412: REAL TIME SYSTEMS [3 0 0 3]

Introduction to real time systems, terminology, characteristics, real time system design issues. Types of real time systems, timing constraints, task dependencies, precedence constraints, precedence graph. Real time task scheduling: Clock driven schedulers; frame size constraints, Event driven schedulers; static and dynamic priority based schedulers. Schedulability/feasibility tests. Scheduling aperiodic and sporadic jobs. Handling task dependencies and resource constraints; priority inversion, dead-lock. Task scheduling on multiprocessor and distributed systems. Real time operating systems: kernels, queues, semaphores, benchmarking. Real time POSIX. Real time communication: Clock synchronisation, IEEE 802.5, IEEE802.4 standards.Self-study: Task scheduling, schedulability tests and real time communication

References:

1. Jane W.S. Liu, Real time systems, Pearson Education, 2013.
2. Qing Li and Caroline Yao, Real time concepts for Embedded Systems, Taylor & Francis Group, 2017.
3. C.M. Krishna, Kang.G. Shin, Real time systems, Tata McGraw-Hill Edition, 2012.
4. (Real Time Systems) http://nptel.ac.in/courses/106105036/
5. (Real Time Systems) http://nptel.ac.in/courses/106105086/

ECE 4413: ADVANCED DIGITAL SIGNAL PROCESSING [3 0 0 3]

Multi-rate signal processing, Multi-resolution analysis, Short-time Fourier transform and discrete-time wavelet transform, filter-bank for STFT and wavelet transform, Adaptive filtering, and Homomorphic signal processing.

References:

1. Vaidyanathan P. P, Multirate Systems and Filter Banks, Prentice Hall, India, 1993.
2. Gadre V M, Abhyankar A S, Multiresolution and Multirate Signal Processing: Introduction, Principles and Applications, McGraw Hill, 2017.
3. Orfanidis S. J, Optimum Signal Processing, McGraw Hill, NJ, 2007.
4. Oppenheim A.V and Schafer R.W., Digital Signal Processing, PHI Learning, 2008.

ELE 4413: LINEAR ALGEBRA FOR SIGNAL PROCESSING [3 0 0 3]

Vectors, matrices, norms, Lp-norms, Holder, Cauchy - Schwarz, and triangular inequalities, inner product spaces and their applications. System of linear equations and its solution sets, Gaussian elimination and back-substitution, echelon forms, matrix operations, LU - factorization, inverse matrices, Gauss-Jordan technique, transpose, elimination, and permutation matrices. Row space, column space, and null space of a matrix, bases and dimension, rank and nullity of a matrix, matrices as linear transformations, pseudo-inverse and applications, change of basis, affine transformations. Orthogonal subspaces, projections, Gram-Schmidt process, generalized Fourier series, QR factorization, least squares and their applications. Symmetric, Orthogonal, Hermitian, Unitary, Jacobian, and Hessian matrices, singular value decomposition and related applications. Characteristic equation, diagonalization, Jordan canonical form, special matrices, positive definite matrices and applications to signal processing. Singular value decomposition: theory and applications to signal and image processing. Self-study: implementation of topics discussed in MATLAB. Find and implement the applications in signal processing.

References:

1. Gilbert Strang, “Linear Algebra and its Applications”, 3rd edition, Thomson Learning Asia, 2003.
2. David C. Lay, “Linear Algebra and its Applications”, 3rd edition, Pearson Education (Asia) Pvt. Ltd, 2005.
3. Vittal Rao, “Advanced Matrix Theory and Linear Algebra for Engineers”, NPTEL: https://nptel.ac.in/courses /111 /108/ 111108066/#
4. Gilbert Strang, “Linear Algebra”, MITOCW: https://ocw.mit.edu/ courses/mathematics/18-06-linear-algebra-spring-2010/

ECE 4414: DIGITAL SPEECH PROCESSING [3 0 0 3]

Fundamentals of speech; Time domain analysis of speech; Short-time Fourier analysis of speech: Homomorphic processing of speech; linear predictive coding of speech; Speech Processing Applications; Speech Synthesis:

References:

1. Rabiner L.R and Schaffer R.W, “Digital Processing of Speech Signals”, Prentice Hall, NJ, 2007.
2. Thomas F. Quatieri, “Discrete.time Speech Signal Processing-Principles and Practice”, Pearson Education, Inc., 2004.
3. Douglas O' Shaughnessy, “Speech Communications. Human and Machine Reading”, Addison Wesley, 1987.
4. Dr. Shaila D. Apte, “Speech and Audio Processing”, Wiley India, 2012.
5. Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana, “Fundamentals of Speech Recognition”, Pearson, 2011 (Fifth Impression).

ELE 4414: DIGITAL IMAGE PROCESSING [3 0 0 3]

Characterization of continuous and discrete/digital image, 2D sampling and quantization, 2D continuous and discrete space signals. 2D systems and their properties. 2D convolution sum. 2D continuous and discrete space Fourier transforms and properties. 2D discrete Fourier transform (DFT), discrete cosine transform (DCT), Karhunen-Loève transform (KLT), Haar wavelet transform, Walsh and Hadamard transform. Basic gray-level transformation, histogram processing, image enhancement in the spatial domain, bilateral filters, nonlocal means filters, rotation, interpolation. Image enhancement in the frequency domain. Image degradation/restoration process, noise models. Image Compression, image compression models, image compression standards. Image pyramid. Morphological image processing. Correlation or template matching, normalized cross correlation. Basic segmentation techniques, segmentation by fitting lines, curves, shapes. Active contours. Applications to biomedical image processing. Self-study: Implementation of image processing topics discussed in MATLAB/ImageJ/Python.

References:

1. Lim J. S., Two-dimensional signal and image processing, Prentice Hall, 1990.
2. Jain A. K., Fundamentals of digital image processing, Prentice Hall, 1989.
3. Gonzalez R. C. and Woods R. E., Digital image processing, Pearson, Fourth Edition, 2018.
4. William K. Pratt, Digital image processing, Wiley, Fourth Edition, 2007.
5. W. Burger and M. J. Burge, Digital image processing – An algorithmic introduction using Java, First edition, 2007.
6. B. K. Biswas, “” Digital Image Processing”, NPTEL: https://nptel.ac.in/courses/117/105/117105079/
7. Aggelos K. Katsaggelos, “ Fundamentals of Digital Image and Video Processing”, Coursera: https://www.coursera.org/learn/digital

ELE 4401: LIGHTING SCIENCE: DEVICES AND SYSTEMS [3 0 0 3]

Electromagnetic spectrum, anatomy of eye, spectral eye sensitivity, Photometric, radiometric and quantum quantities, Relation between photometric quantities, Incandescence, Luminescence, Thermal radiators, Plank's Law, Wein's law, Stephan-Boltzmann's law, Construction & working principle of artificial light sources, Performance characteristics of conventional and solid-state lamps, Optical control of light, Screening devices, Light distribution diagrams of luminaires, Photometry measurements, Evaluation of total luminous flux. Self-study: Simulation and Case study of the selected topics

References:

1. Spiros Kitsinelis, Light Sources: Technologies & Applications, CRC press, 2010
2. Robert Karlicek, Handbook of Advanced Lighting Technology, Springer Publications, 2017
3. M.A. Cayless & A.M. Marsdon, Lamps & Lighting, 4e, Oxford & IBH publishing company, 1996.
4. Cotton H., Principles of Illumination, Chapman & Hall Ltd., London, 1960.
5. NPTEL Course: https://nptel.ac.in/courses/108/105/108105061/

ELE 4402: INTEGRATED LIGHTING DESIGN [3 0 0 3]

Interior lighting design Objectives, importance of Illuminance, uniformity and glare, factor affecting performance of lighting system, impact of Surface Reflectance's & Room proportions on Lighting, Maintenance Aspects, Types of interior lighting, Methods of Design Calculations, CU calculation Methods, Glare evaluation methods, Flood lighting design objectives, Flood lighting design method, Road Lighting Objectives, Geometrical factors affecting performance of road lighting, Basic Lightings schemes, Road lighting design method, Tunnel Lighting design considerations, Tunnel lighting design method, Sports Lighting design objectives, Sports lighting design method, Daylighting strategies, Shading devices, Glazing Area, and day light factor. Self-study:Simulation assisted case studies on both interior and exterior lighting applications, and Recent trends in daylight and artificial light integration strategies.

References:

1. Robert Karlicek, Handbook of Advanced Lighting Technology, Springer Publications, 2017.
2. N K Kishore, “Illumination Engineering”, NPTEL, [Online]. Available: https://nptel.ac.in/courses/108/105/108105061/, 2009.
3. Prafulla C. Sorcar, “Energy Saving Lighting Systems”, VNR Company, 1982.
4. Robbins Cluade L, “Day Lighting”, VNR Company,1986.
5. Mark S. Rea, "The IESNA Lighting Handbook: Reference & Application", Illuminating Engineering Society of North America, 10 Ed, 2011.

ELE 4403: LIGHTING CONTROL, TECHNOLOGY & APPLICATIONS [3 0 0 3]

Basic components of lighting control system, Sensor strategies: Occupancy sensor, Daylight harvesting, Photo sensors, Camera based lighting control: High dynamic range Imaging, Control technologies and algorithm, Artificial Intelligence in lighting comfort and daylighting, Daylight prediction methods, Human centric lighting, Zoning, LEED credits relevant to lighting, Lighting controls and Energy Conservation code, Payback period calculation, Networking and Communication strategies for lighting control : DMX 512, DALI, KNX, BacNet protocols and Li Fi technology, Power over Ethernet, ZigBee, Wireless sensor network, Internet of things – lighting control aspect. Self-study: Simulation on sensor and control strategies, communication and networking for lighting control, Case Study- KNX, BacNet protocols and Li Fi technology.

References:

1. Robert S Simpson, Lighting control technology and applications, McGraw-Hill Higher Education, Focal Press, 2003
2. LEED reference guide for building design and construction, U.S Green Building Council, 2013
3. Energy Conservation Building Code 2017, Bureau of Energy Efficiency, Govt. of India
4. Farahani, Shahin. ZigBee wireless networks and transceivers, Newnes, 2011
5. NPTEL Courses, https://nptel.ac.in/courses/108/105/108105060/

ELE 4404: SOLID STATE LIGHTING [3 0 0 3]

Introduction of LEDs, Electrical and optical characteristics of LEDs, Temperature dependence of LEDs, Light receptors of human eye, radiometric, colorimetric and photometric units, CIE chromaticity, Binning, Mac dam ellipse, Study of spectral characteristics of LEDs, white light generation using monochromatic LEDs, CRI and CQS, Color matching functions, Color Mixing Algorithm and Verification, DC and AC LED driving circuits, dimming, LED lifetime, Thermal analysis model for LEDs, Lumen maintenance and lifetime testing of solid-state lighting products, Reliability of LED products, Overview on lighting advancements- Colour tunable lighting, Human centric smart lighting, Horticulture. Self Study: Simulation and case studies of selected topics.

References:

1. E. Fred Schubert, “Light Emitting Diodes”, Cambridge University Press, 3E, 2018
2. Vinod Kumar Khanna,” Fundamentals of Solid State Lighting” CRC press,2014
3. Clemens J M Lasance and Andras Poppe, “Thermal management for LED applications”, Springer Publications, 2014
4. M Nisa Khan,”Understanding LED Illumination”,CRC Press, 2014
5. Daniel W Hart,” Power Electronics”, McGraw- Hill, 2011

ELE 4415: EV BATTERY TECHNOLOGY AND POWERTRAIN DEVELOPMENT [3 0 0 3]

Battery Fundamentals: Basics of Batteries, Battery Parameters, Lithium-Ion Characteristics, Thermal Runaway Battery Management System (BMS), Functionality, Practical session - Battery Selection and Connection Process with Vehicle Sensors.

Battery Management Systems: SOC/SOH Estimation, Cell Balancing, Protection, Thermal Management, CAN Communication, Practical session - BMS development.

Battery Pack Design & Modelling: Overview of Battery & BMS System, Electrical Design, Mechanical Design: Calculations and Mechanical Design using ANSYS, Heat Transfer, Thermal Design of Battery Pack, Battery Pack Assembly and Test, Thermal Analysis on Battery Pack, MATLAB/Simulink-based Battery Pack Modelling, Practical session - Battery life cycle testing.

Powertrain and Charging Systems of Electric Vehicles: Introduction to EV Powertrain, Overview, Architecture and Components of EV Powertrain, Thermal Management of EV Powertrain, EV Charging Systems and Types of Chargers.

Modelling, Simulation, and Analysis of EV Powertrain Components: Modelling and Simulation of EV Powertrain Components in MATLAB, Modelling and Analysis of EV Powertrain Components in SolidWorks, Analysis of EV Powertrain Components in ANSYS, Case Study on Powertrain of Existing Models.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. JIANGONG, D. H. Z., “Advances in lithium-ion batteries for electric vehicles: Degradation Mechanism, health estimation, and lifetime prediction”, Elsevier - Health Science, 2024, ISBN-13: 9780443155437.
3. R. Xiong, “Battery Management Algorithm for Electric Vehicles”, Springer, 2020, ISBN-13: 9789811502507.
4. Xiong and Weixiang Shen, “Advanced battery management technologies for electric vehicles”, John Wiley & Sons Inc, 2019, ISBN-13: 9781119481645.
5. Hick, Klaus Küpper, and HelfriedSorger, “Systems engineering for automotive powertrain development”, Springer, 2021, ISBN-13: 9783319996288.
6. Christopher D. Rahn, "Battery Systems Engineering", Wiley, 1st Ed, 2013, ISBN:9781119979500.
7. Noshin Omar, "Electric Vehicle Batteries: Moving from Research towards Innovation", Reports of the PPP European Green Vehicles Initiatives, Springer, 2015.
8. Gonzalo Abad and Joaquim Lois, “Power Electronics and Electric Drives for Traction Applications", Wiley, 2016, ISBN: 978-1-118-95442-3.
9. John G. Hayes and G. Abas Goodarzi, Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles", Wiley, 2017, ISBN: 978-1-119-06364-3

ELE 4416: EV CHARGING INFRASTRUCTURE, VEHICLE TESTING & HOMOLOGATION [3 0 0 3]

EV Business Management and Vehicle Testing: Introduction to EV (2W, 3W & 4W) Market & Opportunities, Electric Vehicle Design Procedure and ICE Model, Introduction to EV Management, EV Homologation and Testing, FAME India and Manufacturing Guidelines, EV Certification Process, EV Charging, Electric Vehicle and Retrofitting, Motor Technology and EV Motor Market Analysis, EV Categories and Proposed Changes, EV Retrofitting Business, Battery Technology in EV, EV Battery Market Analysis, Practical session - Conducting a market analysis of the EV Charging.

Fundamentals of Product Development Planning: Introduction to Product Development Plan, Segment Selection, Product Design Plan, Product Validation Plan, Vehicle Dynamics Selection, Product Design Validation, Product Specification - Competitor Analysis, Selection of Off-the-Shelf Parts.

Effective Development Methods for Product Innovation: Development Methods, Product Development Plan, Unit Economics, Design Feasibility, Design for Manufacturing, DFMEA & PFMEA, Business Plan, Product Launch, POC / MVP / Working Prototype, Practical session - Using the market analysis results to develop a business plan for an EV Charging.

Understanding EV Charging Technologies and Infrastructure: Overview of EV Charging Technologies, EV Charging Standards and Protocols, Types of EV Chargers and Charging Stations, EV Charging Infrastructure Design, Site Selection and Planning, Practical session - Case Studies of Successful EV Charging Infrastructure Projects.

Designing and Managing EV Charging Infrastructure: Electrical and Mechanical Design Considerations, Safety and Regulatory Compliance, EV Charging Infrastructure Installation and Maintenance, Charging Network Management, EV Charging Network Design and Deployment, Payment Systems and Revenue Management, Data Management and Analytics on Charging Station,

References:

1. M. S. Alam, R. K. Pillai, and N. Murugesan, “Developing Charging Infrastructure and Technologies for Electric Vehicles”, IGI Global, 2021, ISBN-13: 9781799868590, ISBN-10: 1799868591.
2. Vahidinasab and Behnam Mohammadi-Ivatloo, “Electric Vehicle Integration via Smart Charging”, Springer, 2022, ISBN-13: 9783031059087, ISBN-10: 3031059085.
3. Sivaraman Palanisamy, Sharmeela Chenniappan, and Sanjeevi kumar Padmanaban, “Fast-Charging Infrastructure for Electric and Hybrid Electric Vehicles”, John Wiley & Sons, 2023, ISBN-13: 9781119987741, ISBN-10: 1119987741.
4. Sulab Sachin, Sanjeevikumar Padmanaban, and S. Deb, “Smart Charging Solutions for Hybrid and Electric Vehicles”, John Wiley & Sons, 2022, ISBN-13: 9781119768951, ISBN-10: 1119768950.
5. R. Wang, P. Wang, and G. Xiao, “Intelligent Microgrid Management and EV Control Under Uncertainties in Smart Grid”, Springer, 2017, ISBN-13: 9789811350870, ISBN-10: 9811350876.

ELE 4417: EV VEHICLE DESIGN & ANALYSIS [3 0 0 3]

Introduction to Analog Electronics: Introduction to Basic Electronics, Diode Fundamentals, Rectifiers and Filters, Power Electronics for EVs: Voltage Regulators, Inverters and Converters, Special Purpose Diodes, Transistors and Types of Transistors, Operational Amplifier (Op-Amp).

Fundamentals of Digital Electronics: Digital Electronics, EV Control Systems, EV Communication Networks, Microcontrollers and Microprocessors, Introduction to Proteus Software, Circuit Development Using Proteus.

Essentials for Designing and Simulation Using MATLAB: Overview and Environment, Basic Syntax, Variables and Commands, Commands, M-files, and Types, Operators, Decision Making and Loops, Vectors, Matrix, and Arrays, Colon Notation and Numbers, Strings and Functions, Numbers, Plotting and Graphics, Algebra, Calculus, Differential, and Integration, Polynomials and Transforms, Programming EV Systems in MATLAB, Simulink and Fitting, Developing SIMULINK Models for Vehicle Units, Advisor and QSS Toolbox, QSS-based Vehicle Control, Practical session - Analyse and troubleshoot electronic circuits using simulation tools and lab equipment.

EV Architecture Modelling Using MATLAB [Software-based]: Motor Development and Induction Motor Characteristics, Simulink Model to Calculate Vehicle Configuration, Multi-level Inverter Design and Simulation, Solar PV-based Charger Development, DC-DC Converter, Modelling of Li-ion Battery Pack, Design of EV Using QSS Toolbox, Battery Thermal Modelling, BMS Modelling, Electric 4W Powertrain Modelling, Practical session - Data analysis and visualization using MATLAB for vehicle system.

Design of EV System Using MATLAB [Software-based]: Power Required to Overcome Resistance Forces Acting on the Vehicle, Power Converters in Electric Vehicles, Inverters in Electric Vehicles, Motor and Motor Controllers, Modelling of EV Battery and BMS, Practical session - Modelling and simulation of EV powertrain components, such as motors, controllers, and inverters, using MATLAB/Simulink.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", Routledge, 3rd Ed, 2021, ISBN: 9780367693930.
3. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 1st Ed, 2014, ISBN: 9781138072855.
4. Sandeep Dhameja, "Electric Vehicle Battery Systems", Butterworth-Heinemann, 2st Ed, 2002, ISBN: 978-0750699167.
5. Singh, Sanjeev, et al., “Electric Vehicle Components and Charging Technologies” IET, 2024, ISBN-13: 9781839536717.
6. Das, Shuvra, “Modeling for Hybrid and Electric Vehicles Using Simscape”, Springer, 2022, ISBN-13: 9783031003806.

ELE 4418: EV DATA ANALYTICS & CYBER SECURITY [3 0 0 3]

Cyber Security for Automotive Vehicle Systems: Automotive Industry, Automotive Megatrends, Automotive Development Process, Automotive Electrical and Electronics, Automotive Software Technology, The Connected Car, Automotive Cybersecurity.

Advanced Mobility Services: Mobile Apps for Connected Car, Car Hailing and Ride Sharing, Connected Parking and Automated Valet Parking, ADAS and Autonomous Driving.

Data Analytics for EV and Automotive Systems: Introduction to Data Analytics and Its Application in the Automotive Industry, Understanding of the Data Analytics Pipeline, Overview of Data Analytics, Its Tools, and Techniques, EV Data Collection and Analysis, Sensors and Data Collection in EVs, Data Acquisition and Pre-processing, Statistical Analysis of EV Data, Practical session - Conducting a vulnerability assessment on an in-vehicle network, and developing a report on the findings with recommendations for mitigations.

Automotive System Data Collection and Analysis: Automotive Systems (such as Engines, Transmissions, Brakes, etc.), Data Acquisition and Pre-processing, Statistical Analysis of Automotive System Data, Regression, Classification and Clustering, Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA), Predictive Maintenance Techniques in Automotive Systems, Fault Detection and Diagnosis, Remaining Useful Life (RUL) Prediction, Practical session - Developing predictive maintenance models for automotive systems.

Introduction to Big Data Platforms: Introduction to Big Data Platforms and Tools (such as Hadoop, Spark, and Kafka), How to Use Big Data Platforms to Process and Analyze Automotive Data, Practical session - Case studies showcasing the application of data analytics in the automotive industry.

References:

1. Mashrur Chowdhury, Amy Apon and Kakan Dey, "Data Analytics for Intelligent Transportation Systems", Elsevier, 1st Ed, 2017, ISBN: 978-0128097151.
2. Tyson Macaulay, Bryan L. Singer, and John R. Vacca, "Cybersecurity for Industrial Control Systems: SCADA, DCS, PLC, HMI, and SIS",

CRC Press, 1st Ed, 2011, ISBN: 978-1439801963.
3. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
4. David Ward and Paul Wooderson, "Automotive Cybersecurity: An Introduction to ISO/SAE 21434", SAE International, 1st Ed, 2021, ISBN: 978-1468600803.
5. Dartmann Guido, AnkeSchmeink and Houbing Song, "Big Data Analytics for Cyber-Physical Systems: Machine Learning for the Internet of Things", Elsevier, 1st Ed, 2019, ISBN: 978-0128166376.
6. Craig Smith, "The Car Hacker's Handbook: A Guide for Penetration Tester", No Starch Press US, 1st Ed, 2016, ISBN: 978-1593277031.
7. Root, Alex, “Python for Data Analytics”, Independently published, 2019, ISBN-13: 9781691418831.
8. Runkler, Thomas A., “Data Analytics”, Springer, 2020, ISBN 9783658297794.
9. Janeja, Vandana P., “Data Analytics for Cybersecurity”, Cambridge University Press, 2022, ISBN-13: 9781108415279.

PROGRAM ELECTIVES:

ELE 4441: BUILDING AUTOMATION SYSTEMS [3 0 0 3]

Concept of intelligent, green, and smart building. Overview of Digital Controllers, Network and Communication protocols, Introduction to Building Management Systems, General BMS architecture, Communication Systems and standards for BMS. Application of internet for Automation and Management. Introduction to HVAC and Optimal control methods for HVAC Systems. Lighting Control Systems and protocols. Security and Safety Control Systems such as Access Control and Fire Alarm Systems. System Integration and Convergence. Energy Management, Green Building (LEED) concept and examples. Introduction to Lon Works. Energy saving with variable speed drives.

References:

1. V. K. Jain, “Automation Systems in Smart and Green Buildings”, published by Khanna Publishers (2009), ISBN-13: 978-8174092373
2. Reinhold A. Carlson, Robert A. Di Giandomenico, “Understanding Building Automation Systems: Direct Digital Control, Energy Management, Life Safety, Security/access Control, Lighting, Building Management Programs”
3. Ronnie J. Auvil, “HVAC Control Systems”, Second Edition Hardcover January 1, 2007
4. Thomas L. Norman, “Integrated Security Systems Design: Concepts, Specifications, and Implementation (v. 1)”, CPP PSP CSC (2007)

ELE 4442: COMPUTER ARCHITECTURE & ORGANIZATION [3 0 0 3]

Introduction to Computer Architecture: Components, Instruction Set Architecture, Instruction Types and Addressing modes, CPU structures: General Register CPU; Accumulator based machine, Stack based machine, Memory Organization: Memory hierarchy, Cache memory, Virtual memory, Datapath design: General Register design, shifters, adders, ALU design, representation of numbers, Multiplication of signed and unsigned integers, Division of unsigned integers – restoring and non-restoring methods, Control path design: Hardwired and Micro-programmed, Micro-instruction formats, control unit organization, control unit optimization, Types of architecture: RISC, CISC, Architecture trends and implications for the future -dual core, multicore, superscalar architecture, Input/ Output interfacing, Pipelining and parallel processing. Self-Study: Simulation of data path unit, controller unit and microcomputer

References:

1. William Stallings, Computer Organization and Architecture, 10e, Pearson, 2016
2. David Harris and Sarah Harris, Digital Design and Computer Architecture, Elsevier, 2008
3. David Patterson and John Hennessy, Computer Organization and Design, Elsevier, 2007.
4. M. Raffiquzzman, Fundamentals of Digital logic and microcomputer design, 5e, Wiley, 2005
5. NPTEL Courses: https://nptel.ac.in/courses/106/106/106106092/

ELE 4443: DATA STRUCTURES & ALGORITHMS [3 0 0 3]

Data Structures, abstract data types, basic data structures and their representations: arrays, queues, circular queues, stacks, linked lists, singly and doubly linked lists, trees, binary trees, tree traversals, binary search trees, graphs, basic operation on data structures using pseudocode. Analysis of Algorithms, time complexity, space complexity, asymptotic notations, master theorem, iterative and recursive algorithms, Searching and Sorting, Algorithm design techniques, Greedy method, Divide and Conquer, Shortest Path Algorithms, Prim's algorithm, Kruskal's algorithm, Knapsack problem, Dynamic programming and Backtracking, Hashing. Self-study: programming practice of certain real-time applications on the topics such as searching, sorting etc.

References:

1. Cormen, Leiserson and Rivest, Introduction to Algorithms, 3e, MGH 2009
2. Aho, Hopcroft and Ulmann, Design and Analysis of Algorithms, 1e, Pearson 2002
3. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2e, Pearson 2010
4. Horowitz and Sahni, Fundamentals of computer algorithms, 2e, Universities Press. 2008
5. NPTEL Courses: https://nptel.ac.in/courses/106/102/106102064/

ELE 4444: DEMAND SIDE MANAGEMENT [3 0 0 3]

Energy conservation Act, Standard and labelling, Energy audit, Energy action planning, financial analysis, Project management, Energy conservation and efficiency, Energy monitoring and targeting. New and renewable energy sources. Distributed Generation, General tariff form, Dynamic pricing, Time-of-Day (TOD) pricing, Realtime pricing, Private and public supply. Economic load sharing. Power factor of common appliances causes and effects of low power factor, economics of power factor improvement, Lighting, Refrigerators, Air-conditioners, Distribution transformers, Electric motors. Variable Speed Drive (VFD) Applications, Fans, and pumps. Cogeneration, Trigeneration, Daylighting. ECBC code. Demand Side Management approaches – Load shifting, Load categorization, Consumer Categorization, Electric Vehicles Smart meters, Advance metering infrastructure (AMI), Smart thermostat. DSM challenges. Best practices and technologies in Electrical System. Measurement and verification of energy performance of organizations. Perform Achieve Trade (PAT). Internet of Things (IoT). Industry 4.0. Self-study: Case studies on energy audit of electrical and thermal facilities. Energy management using renewable energy sources.

References:

1. Guidebooks for National Certification Examination, 2020, [E-book] Available: http://aipnpc.org/Guidebooks.aspx.
2. Guidebook: Refresher Course for Certified Energy managers and Auditors, 2020, [E-book] Available: http://refreshercourse.in/Module/RC_Material.pdf
3. R. K. Rajput, Utilization of Electrical Power, 2006
4. Ashish Mathur, Demand Side Management, LAP Lambert Academic Publishing, 2012
5. NPTEL - Technologies for Clean and Renewable Energy Production, https://nptel.ac.in/courses/103/107/103107157/

ELE 4445: ENERGY ANALYTICS [3 0 0 3]

Energy ecosystem, Energy sources, Key steps in energy analytics, Application of energy analytics in electricity sector areas, Decarbonization, decentralization, and digitalization of electricity sector, Energy datasets, Energy dashboards (electricity, power markets, renewables, coal, oil, gas), Python programming basics, Python libraries – NumPy, Pandas, Matplotlib, Seaborn, Scikit-learn, Data visualization, Exploratory Data Analysis basics & statistical tools, Forecasting and prediction, Clustering, Monitoring & Control, Regression, Time-series analysis, Neural Networks, Support Vector Machines, Tree-based approaches, Clustering approaches, Hybrid approaches, Evaluation matrices, EVs - mobility, battery, charging type & charging station, metering, user behavior, etc. analytics, EV telematics, Analytics on Energy-efficient buildings, Roof-top solar, Residential batteries, Smart appliances, Smart metering. Self-study: Forecasting and prediction related exercises on energy datasets using machine and deep learning.

References:

1. EMC Education Services, "Data Science & Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", John Wiley & Sons, Inc., 2015.
2. G. J. Myatt, W. P. Johnson, "Making Sense of Data I: A Practical Guide to Exploratory Data Analysis and Data Mining", Second Edition, John Wiley & Sons Publication, 2014.
3. Frederik vom Scheidt, et al., "Data analytics in the electricity sector – A quantitative and qualitative literature review," Energy and AI, Elsevier, vol. 1, Aug 2020.
4. Websites of NITI Aayog, CEA, RLDCs, IEX, Nordpool, PJM, etc.
5. NPTEL Course: https://nptel.ac.in/noc/courses/ noc22/SEM1/noc22-cs32/ (Python for Data Science).

ELE 4446: ENERGY AUDITING [3 0 0 3]

Energy Scenario, Energy conservation Act 2001, Basics of energy and its forms, Energy management and audit, Energy action planning, financial management, Project management, Energy monitoring and targeting, Electrical systems, Electric motors, Fans and Pumps, Lighting systems, HVAC, and refrigeration systems. Energy conservation in buildings and Energy Conservation Building Code (ECBC) Fuels and combustion, Boilers, Cogeneration, Heat exchangers, perform achieve trade (PAT), Energy Efficiency Performance Indicators for Industries, Plant energy efficiency data analytics, EPI, AAHEPI, Power factor improvement, Demand side management. Self-study: Case studies on energy audit of electrical and thermal facilities. Energy management using renewable energy sources.

References:

1. Guidebooks for National Certification Examination, 2020, [E-book] Available: http://aipnpc.org/Guidebooks.aspx.
2. Guidebook: Refresher Course for Certified Energy managers and Auditors, 2020, [E-book] Available: http://refreshercourse.in/Module/RC_Material.pdf
3. Wayne C. Turner, Energy Management Handbook, Fifth Edition, Fairmont Press, 2004
4. NPTEL - Energy conservation and waste heat recovery - https://nptel.ac.in/courses/112/105/112105221/

ELE 4447: ENERGY STORAGE DEVICES [3 0 0 3]

Importance of energy storage and introduction to different forms of energy storage. Trends in power system development and energy storage as a structural unit of a power system, Energy and power balance in a storage unit, mathematical model of energy storage, applications of energy storage- utilities, transport, industry, house hold. Energy storage techniques: Electrochemical energy storage- Secondary batteries, electrical circuit modeling of a cell, estimation of state of charge, state of health, Energy and power estimation of battery pack, and battery charge controller design. Fuel cells: History – working principle - thermodynamics of fuel cell process –Types of fuel cells –Modeling of fuel cell-Fuel Cell System Design. Case Study on Electrical Vehicle-Architecture of Hybrid EV, Plug-in hybrid EV, Electric Vehicles, and System Design Consideration, rating and sizing of energy storage devices for EV. Thermal energy storage: General considerations-storage media- Containment- Power extraction, Flywheel storage, Superconducting magnetic energy storage:Basic principles, Superconducting coils, Cryogenic systems, Power extraction, Environmental and safety problems, Pumped hydro storage: Basic Principle-The power extraction system-The central store for pumped hydro. Compressed air energy storage, Power system considerations for energy storage: Integration of energy storage systems-Effect of energy storage on transient regimes in the power system.

References:

1. Robert Huggins, "Energy Storage: Fundamentals, Materials and Applications", Springer, 2015.
2. Gregory L Plett- "Battery Management Systems," Volume- 1, Battery Modeling, Artech House Publishers, 2015.
3. R. Boveand S.Ubertini "Modeling Solid Oxide Fuel Cells," Springer,

2008.

4. John G. Hayes and G. Abas Goodarzi, “Electric Powertrain-Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles” John Wiley&Sons Ltd. 2018.
5. F. Naseri, E. Farjah and T. Ghanbari, "An Efficient Regenerative Braking System Based on battery/Supercapacitor for Electric, Hybrid, and Plug-In Hybrid Electric Vehicles with BLDC Motor," in IEEE Transactions on Vehicular Technology, vol. 66, no. 5, pp. 3724-3738, May 2017

ELE 4448: HVDC & FACTS [3 0 0 3]

HVDC transmission system, merits & demerits, applications and schemes of HVDC, equivalent circuit diagram of two-terminal HVDC link, control characteristics, grid firing units, converter faults. Performance of uncompensated, shunt & series capacitor compensated line, Introduction to FACTS controllers-configuration and working principle of SVC, STATCOM, TCSC, SSSC, and UPFC, steady-state characteristics, performance of line with FACTS controllers, power quality issues, working principle of DVR, DSTATCOM, UPQC. Self-study on the selected topics.

References:

1. K R Padiyar, FACTS Controllers in power transmission and distribution systems, New Age International publishers, New Delhi, 2007.
2. Narendra G Hingorani & L. Gyugyi, Understanding FACTS: Concepts and Technology of flexible AC transmission systems, IEEE Press, 2000.
3. K R Padiyaar, HVDC power transmission systems, Technology and System Interactions, New Age International publishers, New Delhi, 1999.
4. Vijay K. Sood,'HVDC and FACTS Controller', Kluwer Academic Publisher, 2004.
5. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, Power Quality: Problems and Mitigation Techniques, Wiley, 2014.

ELE 4449: INTRODUCTION TO DATA SCIENCE [3 0 0 3]

Introduction to Data Science; Python libraries and visualization techniques; Statistical tools; Exploratory data analysis; Model building and analysis- Linear and Logistic Regressions, Decision Trees, Random Forests and Clustering methods, Neural Networks; Introduction to Natural Language Processing. Self-study: Simulation based studies of the selected topics.

References:

1. Joel Grus, Data Science from Scratch: First Principleswith Python, 2e, O'Reilly, 2015
2. J. Vander Plas, Python Data Science Handbook, O'Reilly, 2016
3. Steven Bird, Ewan Klein & Edward Loper, Natural Language Processing with Python, 1e, O'Reilly, 2009
4. https://nptel.ac.in/courses/106/106/106106179/
5. https://nptel.ac.in/courses/106/106/106106184/

ELE 4450: MICROGIRDS [3 0 0 3]

Microgrid Concept and Structure, Operation Modes, Control Mechanism of the Connected Distributed Generators in a Microgrid, Control Structure in Grid-connected Mode, Control Structure in Islanded Mode, Participation in the Frequency Regulation, Power Dispatching, Power Management, Mathematical Modelling, Closed-Loop State-Space Model, Microgrid Control Hierarchy, Global Control, Droop Control, Virtual Impedance Control, Hierarchical Power Management and Control, Operation Layers and Control Functions, DC Microgrid Control, Virtual Inertia-based Stability and Regulation Support, Intelligent Control Technologies, Emergency Control and Load Shedding in Microgrids, Protection Schemes. Self-study: Simulation based studies of the selected topics.

References:

1. Hatziargyriou N, “Microgrids: Architectures & Control”, John Wiley & Sons, 2014.
2. Bevrani H, Francois B, Ise T, “Microgrid Dynamics and Control”, John Wiley & Sons, 2017.
3. Blaabjerg F,” Control of Power Electronic Converters and Systems”, Academic Press, 2018.
4. Bahrami S,”Smart Microgrids: From Design to Laboratory-Scale Implementation”, Springer, 2019
5. Farhangi H, “Smart Microgrids: Lessons from campus Microgrid design and implementation”, CRC Press, 2017.
6. NPTEL: https://onlinecourses.nptel.ac.in/noc20_ee84/preview.

ELE 4451: POWER SYSTEM OPERATION AND CONTROL [3 0 0 3]

Review of Modern Power System & its characteristics: Overview of course of Power System Operation & control and methodology of teaching-learning, Modern Power system and its characteristics, Operating states, Equipment and Stability Constraints, Transmission line constraints. Optimal Economic Scheduling: Optimal scheduling of Thermal unit with Hybrid Sources. Optimal Load Flow and Unit Commitment: Optimal Power Flow Problem with and without Inequality Constraints on different variables. Unit Commitment Cost Function Formulation and Constraints, Solution method- Priority List Method, Dynamic Programming Method and Optimal Unit Commitment with Security Constraints. Power System Security and State estimation: Introduction to Power system security, Factors affecting Security, Different Contingency Analysis. Introduction to State Estimation, Different methods of State Estimation, Detection and Identification of Bad Data, The Role of State Estimation in Power System Operations. Self-study: Simulation based studies of the selected topics.

References:

1. Wood and Wollenberg, “Power Generation Operation & Control”, Wiley, 2011.
2. Jizhong Zhu, “Optimization of Power System Operation” Wiley-IEEE Press, 2009.
3. K. Uma Rao, “Power System Operation and Control” Willey, 2013.
4. NPTEL Course: https://nptel.ac.in/courses/108/101/108101040
5. NPTEL Course: https://nptel.ac.in/courses/108/104/108104052

ELE 4452: POWER SYSTEM RESTRUCTURING AND MARKET OPERATONS [3 0 0 3]

Power system restructuring: Introduction, Motivation for restructuring of Power system, Indian Power Sector-Past and Present Status, Market structure and Operation. Operations in Power Market: Power Pools, Transmission Network and Electricity Markets, Arbitrage in Electricity market, Available Transfer Capability (ATC), Methods of ATC determinations. Market Power Risk Analysis: Game Theory, Power Transactions Game, Problems, Market Competition with Incomplete Information, Market Competition for Multiple Electricity Products. Introduction of Asset Valuation, Ancillary Service Auction Market: Ancillary Services for restructuring, Forward Ancillary Service Auction-Sequential and Simultaneous approaches, Transmission Pricing: Introduction, Transmission Pricing Methods, A comprehensive transmission Pricing Scheme. Self-study: Examples and studies of the selected topics.

References:

1. Loi Lei Lai, "Power System Restructuring and Deregulation", John Wiley & Sons Ltd, England, 2001.
2. M. Shahidehpour, H. Yamin, and L. Zuyi, "Market Operations in Electric Power Systems". New York: Wiley, 2002.
3. Yong-Hua Song and Xi-Fan Wang (Eds.), "Operation of Market-oriented Power Systems", Spinger-Verlag London Limited, 2003.
4. D. S. Kirschen and G. Strbac, "Fundamentals of power system economics", John Wiley & Sons, 2004.
5. NPTEL Course: https://nptel.ac.in/courses/108/101/108101005

ELE 4453: RENEWABLE ENERGY [3 0 0 3]

Energy sources and their availability - Solar Energy - solar radiation and measurements, solar energy storage, - Solar Photo-Voltaic systems design - Wind Energy - estimation, Maximum power and power coefficient, wind energy conversion systems - design considerations and applications - Energy from Bio-Mass - Sources of bio-mass, Biomass conversion technologies - Thermo-chemical conversion and Biochemical conversions, Anaerobic digestion and Fermentation, Bio-gas generation Pyrolysis and Liquefaction, Classification of Gasifiers, Energy plantation -Energy from the Oceans - Ocean Thermal Energy Conversion, Open and Closed Cycle plants, Site selection considerations, Origin of tides, Tidal energy conversion systems, Wave energy conversion systems –Integration of Renewable energy in to grid, Hybrid Energy Systems.

References:

1. Khan B. H., Non-conventional Energy Resources, TMH, 2006.
2. Twidell J. W. & Weir A. D., Renewable Energy Resources, ELBS, 1986.
3. Mukherjee D. & Chakrabarti S., Fundamentals of Renewable Energy Systems, New Age Intl., 2004.
4. C.S. Solanki, Solar Photovoltaics Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 2016
5. D.P. Kothari, K.C.Singal and R. Ranjan, Renewable Energy Sources and Emerging Technology, PHI Learning Pvt. Ltd. , 2014

ELE 4454: INTRODUCTION TO VLSI DESIGN [3 0 0 3]

Introduction to MOSFETs, MOSFET Equivalent Circuits. MOSFET logic circuits: NMOS inverter, CMOS inverter, Power: Dynamic Power, Static Power, CMOS Fabrication Technology. Stick Diagrams, Layout design rules. CAD tools for VLSI Design. MOSFET Logic gates. CMOS combinational, sequential logic circuits, Flip flop and latch timings, Clocking. Circuit characterization and performance estimation: Resistance, capacitance estimation, Switching characteristics, Delay models. Packaging, CMOS subsystem design.

*Self-directed Learning: Data Path Blocks: Arithmetic Unit, Control unit

References:

1. Jan M. Rabaey, A. Chandrakasan, and B. Nikolic, Digital Integrated Circuits: A design Perspective, Pearson Education, 2002
2. S.M.Kang & Y. Leblebici, CMOS Digital Integrated Circuits, McGraw Hill, 2002
3. Ken Martin, Digital Integrated Circuit Design, Oxford Press, 2000.
4. Pucknell D. A. and EshraghianK.,"Basic VLSI Design", PHI publication, 2009.

   Weste. N and Eshraghian K, "Principles of CMOS VLSI Design", 2nd Edition, Addison, Wesley Publication, 1993

EEE 4455: REAL TIME OPERATING SYSTEM [3 0 0 3]

The course introduces students to QNX's microkernel architecture and principles of real-time systems. The course covers process/thread management, memory protection, scheduling, and synchronization using mutexes, semaphores, and condition variables. Students explore inter-process communication methods like message passing and shared memory, with practical exercises. Hardware programming topics include interrupt handling, IO access, DMA-safe memory, and timing mechanisms. The course also guides students in building and configuring QNX boot images, including kernel, drivers, and resource managers. Hands-on labs throughout ensure practical understanding of real-time system development and deployment using QNX RTOS.

*Self-directed Learning: (6)

1. QNX configuration and application development using QNX Momentics IDE.2. Process and thread creation, management, and synchronization.
3. Implementation of IPC methods: message passing and shared memory.
4. Interrupt handling and hardware access programming.
5. Building and deploying QNX boot/OS images.
6. Mini capstone project: Design and implement a QNX-based embedded system.

References:

1. QNX Neutrino RTOS User's Guide, QNX Software Systems.
2. Programming for Embedded Systems, Michael Barr, O'Reilly Media.
3. Hands-on RTOS with Microcontrollers, Brian Amos, Packt Publishing, 2020.
4. Operating System Concepts, Abraham Silberschatz, Peter B. Galvin, Greg Gagne, 9th Edition, Wiley, 2018.
5. Online Resource: QNX online training, QNX training material

OPEN ELECTIVES:

ELE 4311: MATLAB FOR ENGINEERS [3 0 0 3]

Introduction to MATLAB live script environment, matrices & arrays, calling functions, 2D & 3D plots, conditional statements, loop control statements, user-defined functions; evaluating an expression, solving equations, differentiation, integration, sum, limit; simple and multiple linear regression analysis, evaluating the goodness of fit using MATLAB; ordinary differential equations in Simulink, conditional blocks, subsystems, MATLAB function block, introduction to Simscape; introduction to App Designer, programming various objects like axes, botton, edit field, slider, label; interfacing Arduino, raspberry pi and smartphone sensors with MATLAB. Self-study: Simulation studies on Symbolic Math, Statistical Methods and GUI development

References:

1. https://www.mathworks.com/
2. Stephen J. Chapman, Essentials of MATLAB Programming,6e, Cengage Learning 2019,
3. Rudra Pratap, Getting Started with MATLAB, 7e, Oxford University Press, 2019
4. Self-paced online courses - https://matlabacademy.mathworks.com/

ELE 4312: ESSENTIALS OF ENERGY AUDITING [3 0 0 3]

Types of energy, Primary energy reserves, Commercial energy production, Energy needs of a growing economy, Electricity pricing, Tariffs, Energy security, Energy conservation. Energy conservation Act 2001, Electricity Act 2003, Energy policy, Objectives of Energy management and Auditing, Types of Energy audit, Benchmarking, Energy performance, Matching energy usage to requirement, maximizing system efficiencies, Fuel and energy substitution, Instruments and metering for energy audit, Bureau of Energy Efficiency regulations, Energy balance and material balance, Sankey diagram, Assessing energy profile and establishing baseline, Financial analysis techniques, Energy performance contracting and role of ESCOs, Project planning techniques, Energy monitoring and targeting, Energy management information systems, Energy and environment, Renewable energy sources, Demand side management.

References:

1. Guidebooks for National Certification Examination, 2020, [E-book] Available:http://aipnpc.org/Guidebooks.aspx.
2. Guidebook: Refresher Course for Certified Energy managers and Auditors, 2020, [E-book] Available: http://refreshercourse.in/Module/RC_Material.pdf
3. Wayne C. Turner, Energy Management Handbook, Fifth Edition, Fairmont Press, 2004
4. NPTEL - Energy conservation and waste heat recovery - https://nptel.ac.in/courses/112/105/112105221/

ELE 4313: SOLAR PHOTOVOLTAICS [3 0 0 3]

Solar Radiation: Spectrum, Terminologies, Measurement, Estimation; Sun-Earth Movement & Angles, Sun Tracking, PN Junction Diode & Characteristics, Solar Cell, Photovoltage, Light Generated Current, I-V equation & Characteristics: Short Circuit Current, Open Circuit Voltage, Maximum Power Point, Fill Factor, Efficiency, Losses, Equivalent Circuit, Effect of Series & Shunt Resistance, Solar Radiation, Temperature on Efficiency, Solar PV Modules: Series & Parallel connection, Hotspots, Bypass & Blocking Diodes, Power Output, Ratings, I-V & Power Curve, Effect of Solar Irradiation & Temperature, Balance of System (BOS): Batteries: Classification, Capacity, Voltage, Depth of Discharge, Life Cycle, Factors affecting Battery Performance; Charge Controllers, DC to DC Converters, DC to AC converters, Maximum Power Point Tracking (MPPT). Self-study: Solar Radiation data collection for India , Losses in solar cells, Applications of SPV system, Mechanical Energy storage systems

References

1. Chetan Solanki, Solar Photovoltaics: Fundamentals, Technologies and Application, PHI New Delhi, 2009.
2. G.N. Tiwari, Solar Energy: Fundamentals, Design, Modeling and Applications, Narosa Publications New Delhi, 2013.
3. Suneel Deambi, Photovoltaic System Design, CRC Press USA, 2016.
4. Frank Kreith and D. Yogi Goswami, Energy Management and Conservation Handbook (2e), CRC Press USA, Fairmont Press, USA, 2017.
5. John Balfour, Michael Shaw and Nicole B. Nash, Advanced Photovoltaic Installations, Jones & Barlett Learning USA, 2013.
6. Nptel courses: https://nptel.ac.in/courses/115/107/115107116/

ELE 4314: INTRODUCTION TORENEWABLE ENERGY [3 0 0 3]

Energy sources and their availability, current power scenario in India. - Solar Energy - solar radiation and measurements, solar energy storage, - Solar Photo-Voltaic systems and modules. Wind Energy- estimation, Maximum power and power coefficient, wind energy conversion systems - design considerations and applications. Energy from the Oceans - Ocean Thermal Energy Conversion, Open and Closed Cycle plants, Site selection considerations, Origin of tides, Tidal energy conversion systems, Wave energy conversion systems - Hybrid Energy Systems, Life Cycle Costing. Self-Study Component standalone PV system Topology. Calculate the air parameters at different conditions, wind power and average wind power, impact of installation height Life Cycle Costing. Energy from Bio-Mass - Sources of bio-mass, Bio-mass conversion technologies-Thermo-chemical conversion and Bio-chemical conversions, Anaerobic digestion and Fermentation: Estimate of Energy and Power in Single and Double Cycle Tidal System

References:

1. Mukherjee. D & S. Chakrabarti, Fundamentals of Renewable Energy Systems, New Age Intl., 2005\
2. Khan B. H, Non conventional Energy Resources, TMH, 2006
3. Twidell J. W & Weir A. D, Renewable Energy Resources, ELBS, 1986
4. Rai G. D., Non Conventional Energy Sources, Khanna Publishers, 1997
5. Rao S & B. B Parulekar, Energy Technology, Khanna Publishers, 1997
6. Bansal N K, Kleemann M & Meliss M., Renewable Energy Sources and Conversion Technology,TMH, 1990
7. Bansal N K, Kleemann M & Meliss M., Renewable Energy Sources and Conversion Technology,TMH, 1990
8. Mohamed A. EL_Sharkawi. Wind Energy An Introduction,CRC Press Taylor & Francis Group, 2016.
9. Chetan Singh Solanki. Solar Photovoltaics Fundamentals, Technologies and Applications,PHI learning Privite Limited,2011.

ELE 4315: INTRODUCTION TO LIGHTING DESIGN [3 0 0 3]

Electromagnetic spectrum, Anatomy of eye, Spectral eye sensitivity, Photometric quantities & Units, Relation between photometric quantities, Construction & working principle of artificial light sources, Performance characteristics of conventional and solid-state lamps, Optical control of light, Photometry measurements, Evaluation of total luminous flux, Generation of IES file, Light distribution diagrams of luminaires, Types of Interior lighting, Factors affecting the performance of lighting system, Lumen method of lighting design, Glare evaluation methods, Design of lighting system using simulation tool for various lighting applications, Importance of daylighting, daylighting strategies. Self-study: Comparison of photometric and radiometric quantities, Principle of operation & Performance characteristics of low-pressure gaseous discharge lamp, and Simulation assisted lighting design case studies.

References:

1. Spiros Kitsinelis, Light Sources: Technologies & Applications, CRC press, 2010
2. Robert Karlicek, Handbook of Advanced Lighting Technology, Springer Publications, 2017
3. N K Kishore, “Illumination Engineering”, NPTEL, [Online]. Available: https://nptel.ac.in/courses/108/105/108105061/, 2009.
4. National Lighting Code, Bureau of Indian Standards, SP 72, 2010.
5. Robbins Cluade L, “Day Lighting”, VNR Company,1986.

ELE 4316: UTILIZATION OF ELECTRICAL ENERGY [3 0 0 3]

Electric traction: Railway electrification – definition and analysis of traction effort – speed – time curve – traction motors - battery driven vehicles - energy efficiency drives – advanced speed control measures-tractive effort calculations - electric braking - control wire - A.C. traction - recent trend in electric traction. Illumination: Production of light - lighting calculations - high frequency, low pressure discharge tubes. Electric furnaces and welding: Resistance, inductance and Arc Furnaces - Construction and fields of application - control equipment, high frequency dielectric heating, resistance - welding equipment - characteristics of carbon and metallic arc welding - butt welding - spot welding. Electro-chemical processes: Electrolysis – Electroplating – Electro deposition – Extraction of metals Current, Efficiency - Batteries – types – Charging Methods. Overview of Electric Vehicles in India, Vehicle Dynamics, Vehicle Subsystems: EV Power-trainStorage for EVs, Fundamentals of EV. Self-study on selected topics.

References:

1. S. C. Tripathy, Electric Energy Utilisation and Conservation, Tata McGraw Hill, 1991
2. W. F. Stocker and J.W. Jones, Refrigeration & Air Conditioning Refrigeration & Air Conditioning, McGraw Hill, 1985
3. N.V. Suryanarayana, Utilisation of Electric Power, Wiley Eastern Ltd., 1993
4. J. B. Gupta –Utilization of electric power and electric traction- S K Katharia& Sons, 1994
5. NPTEL Course: https://onlinecourses.nptel.ac.in/ noc22_ee53/ preview

Department of
Electronics & Communication Engineering

Established in 1972, the Department of Electronics and Communication Engineering has established itself as a center of excellence in academics and research. The department focuses on providing world class education with basic knowledge and essential skills in the field of Electronics, communication, Signal Processing, Embedded, IoT, VLSI and Semiconductor technology.

The department offers facilities such as a MEMS design center for device simulation, fabrication, and testing; an ATMEL MCU Center; NOVOTON ARM Processor boards; Embedded & IOT System boards – Raspberry Pi, Arduino boards; a campus-wide MATLAB license for MathWorks tools; CADENCE tools, TCAD synopsis, and SEMulator 3D for VLSI design, fabrication & process technology; QualNet for network simulation. The department also features advanced communication lab facilities, including an Anechoic Chamber up to 40GHz with a vector Network Analyzer (VNA) for Antenna and Microwave measurements, and provides consultancy for Antenna characterization. It The department is equipped with a 5G Technology lab funded by the DoT, Govt. of India, to build competencies and engagement in 5G and beyond research.

To support co-curricular and extracurricular activities, we have student clubs namely Chip MIT, Bureau of Indian Standards (BIS) and professional bodies student chapters like IE(ECE), IEEE society's, and ISTE.

In addition to regular teaching and learning activities, faculty and students are involved in active research in the areas of Antenna and Microwave and wireless communication, 5G and beyond; Image, Audio, and Speech Processing, Biomedical imaging using AI/ML, Soft Computing Techniques, Source and Channel Coding, Cipher Systems, Sensor Networks, Plasmonics, Analog and Digital VLSI, Embedded Systems, MEMS and Nanotechnology, Carbon Nanotubes, and Thin Film Technology. Research and project work in these domains has resulted in journal and conference publications at national and international levels, which have brought laurels to the Department. The department's students have taken part in numerous national hackathons, earning top positions and accolades. Approximately 20% to 25% students from each graduating batch go on to pursue master's degrees at prestigious universities abroad."

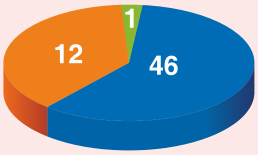
> Programs offered

Undergraduate Program
- B.Tech in Electronics and Communication Engineering (1972)
- B. Tech. in Electronics Engineering (VLSI Design and Technology) (2023)

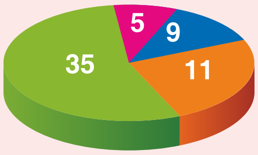
Postgraduate Programs
- M.Tech in Electronics Engineering (Digital Electronics & Communication)
- M.Tech in Electronics Engineering (Microelectronics)

> Faculty Strength

Qualification-wise



Cadre-wise



BTECH IN ELECTRONICS AND COMMUNICATION ENGINEERING

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2122	Engineering Mathematics - III	2	1	0	3	MAT 2227	Engineering Mathematics - IV	2	1	0	3
	ECE 2121	Analog Electronic Circuits	4	0	0	4	ECE 2221	VLSI Design	4	0	0	4
	ECE 2122	Network Analysis	3	0	0	3	ECE 2222	Digital Signal Processing	3	0	0	3
	ECE 2123	Signals and Systems	3	0	0	3	ECE 2223	Analog Integrated Circuits	3	0	0	3
	ECE 2124	Digital System Design	3	0	0	3	ECE 2224	Microwave Engineering	3	0	0	3
	ECE 2125	Electromagnetic Waves	3	0	0	3	ECE 2225	Modern Control Theory	3	0	0	3
	ECE 2141	Digital System Design Lab	0	0	3	1	ECE 2241	VLSI Lab	0	0	3	1
	ECE 2142	Electronic Circuits Lab	0	0	3	1	ECE 2242	Electronic System Design Lab	0	0	6	2
			18	**1**	**6**	**21**			**18**	**1**	**9**	**22**
	Total Contact Hours (L + T + P)		**25**				**Total Contact Hours (L+T+P)**		**28**			
	FIFTH SEMESTER						**SIXTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	HUM 3021	Engineering Economics and Financial Management	2	1	0	3	HUM 3022	Essentials of Management	2	1	0	3
	ECE 3121	Analog and Digital Communication	4	0	0	4	ECE 3221	Wireless Communication	3	0	0	3
	ECE 3122	Microprocessors	3	0	0	3	ECE ****	Flexible Core - 2 (A2/ B2/ C2 /D2)	3	0	0	3
	ECE 3123	Communication Networks	3	0	0	3	ECE ****	Program Elective - I / Minor Specialization	3	0	0	3
	ECE ****	Flexible Core - 1 (A1/ B1/ C1/D1)	3	0	0	3	ECE ****	Program Elective - II / Minor Specialization	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective - 2	3	0	0	3
	ECE 3141	Digital Signal Processing Lab	0	0	3	1	ECE 3241	Communication Networks Lab	0	0	3	1
	ECE 3142	Microprocessor Lab	0	0	6	2	ECE 3242	Communication Systems Lab	0	0	3	1
			19	**0**	**9**	**22**			**18**	**0**	**6**	**20**
	Total Contact Hours (L+T+P)		**28**				**Total Contact Hours (L+T+P)**		**24**			
	SEVENTH SEMESTER						**EIGHTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
IV	ECE ****	Program Elective - III / Minor Specialization	3	0	0	3	ECE 4291	Industrial Training				1
	ECE ****	Program Elective - IV/ Minor Specialization	3	0	0	3	ECE 4292	Project Work / Practice School				12
	ECE ****	Program Elective - V	3	0	0	3	ECE 4293	Project Work (B.Tech Honours)**				20
	ECE ****	Program Elective - VI	3	0	0	3	ECE ****	B.Tech Honours (Theory 1)** (V Semester)				4
	ECE ****	Program Elective - VII	3	0	0	3	ECE ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	*** ****	Open Elective - 3	3	0	0	3	ECE ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	ECE 4191	Mini Project (Minor Specialization)*				8						
			18	**0**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P)		**18**									

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

FLEXIBLE CORE-A

ECE 3124: Digital Computer Architecture (A1)
ECE 3222: System on Chip Design (A2)

FLEXIBLE CORE-B

ECE 3125: VLSI Testing and Testability (B1)
ECE 3223: RF Circuit Design (B2)

FLEXIBLE CORE-C

ECE 3126: Satellite Communication (C1)
ECE 3224: Information Theory and Coding (C2)

FLEXIBLE CORE-D

ELE 3127: Foundations of EV & Hybrid Vehicles
ELE 3225: Automotive Mechanics for Electric Vehicles

MINOR SPECIALIZATIONS

I. COMPUTATIONAL INTELLIGENCE

ELE 4409: Artificial Intelligence
ECE 4409: Machine Learning
ELE 4410: Soft Computing Techniques
ECE 4410: Computer Vision

II. EMBEDDED SYSTEM

ECE 4411: Embedded System Design
ELE 4411: FPGA Based System Design
ECE 4412: Internet of Things
ELE 4412: Real Time Systems

III. SIGNAL PROCESSING

ECE 4413: Advanced Digital Signal Processing
ELE 4413: Linear Algebra for Signal Processing
ECE 4414: Digital Speech Processing
ELE 4414: Digital Image Processing

IV. COMMUNICATION SYSTEMS

ECE 4401: Machine Learning for Communication system
ECE 4402: B5G Communication Systems
ECE 4403: Photonic communication system
ECE 4404: Satellite based Wireless Communication

V. VLSI DESIGN

ECE 4405: Low Power VLSI Design
ECE 4406: MOS Device Modelling
ECE 4407: Digital Design Verification
ECE 4408: Analog IC Design

OTHER PROGRAMME ELECTIVES

ECE 4441: 5G: Fundamentals and Architectures
ECE 4442: Antenna for 5G and beyond networks
ECE 4443: Bioinspired and Evolvable Systems
ECE 4444: BioMEMS and Micro sensors
ECE 4445: CMOS Mixed Signal VLSI Design
ECE 4446: Data Analytics and Visualization
ECE 4447: Data Structures and Algorithms
ECE 4448: Electronic Instrumentation
ECE 4449: Embedded Operating Systems and RTOS
ECE 4450: Embedded Programming
ECE 4451: Error Control Coding
ECE 4452: Flexible Electronics
ECE 4453: Hardware for Machine Learning
ECE 4454: Microwave Integrated Circuits
ECE 4455: Modern Computer Architecture and Organization
ECE 4456: Motion & Geometry based methods in Computer Vision
ECE 4457: Nano devices & Nano sensors
ECE 4458: Nature Inspired Algorithms, Tools and Applications
ECE 4459: Neuromorphic VLSI Circuits
ECE 4460: Number theory and Cryptography.
ECE 4461: Object Oriented Programming Using C++
ECE 4462: Optical Wireless Communication
ECE 4463: PCB and System Design
ECE 4464: Power Electronics
ECE 4465: Radar and Navigation Systems
ECE 4466: Semiconductor Device Modelling
ECE 4467: Spintronic VLSI
ECE 4468: Spread Spectrum Communication
ECE 4469: Switching Theory for Logic Synthesis
ECE 4470: Time Frequency and Wavelet Transforms
ECE 4471: VLSI Process Technology
ECE 4472: Wireless cellular and LTE 4G broadband
ECE 4473: Wireless Sensor Networks
ECE 4498: Real Time Operating Systems

OPEN ELECTIVES

ECE 4311: Consumer Electronics
ECE 4312: Electronic Product Design & Packaging
ECE 4313: Introduction to Communication Systems
ECE 4314: MEMS Technology
ECE 4315: Introduction to Nano science & Technology
ECE 4316: Basics of Building Automation Systems
ECE 4317: Intelligent Instrumentation System
ECE 4318: Computational Intelligence and Environmental Sustainability
ECE 4319: Applications of Signal Processing
ECE 4320: Introduction to Biosensors
ECE 4321: Machine Learning in VLSI Computer Aided Design
ECE 4322: Music and Neuroengineering
ECE 4323: Vedic Mathematics and its Applications in Modern Technologies

THIRD SEMESTER

MAT 2122: ENGINEERING MATHEMATICS-III [2 1 0 3]

Systems of Linear Equations, Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings, Affine Spaces. Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations. Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix approximation, Periodic function, Fourier Series expansion. even and odd functions, functions with arbitrary periods, Half range expansions, Fourier transform, basic properties, Parseval's identity and applications.

*Self-directed Learning: Singular Value Decomposition, Fourier cosine and sine transform application to Heat and Wave equation.

Text Books:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press, 2020.
2. Grewal B.S. – "Higher Engineering Mathematics", Khanna Publishers, 43rd edition, 2015

References:

1. Stephen H. Friedberg Lawrence E Spence, Arnold J Insel, Elementary Linear Algebra: "A Matrix Approach Introduction to Linear Algebra", Second Edition, 2019.
2. David Lay, Steven Lay, Judi McDonald, "Linear Algebra and Its Applications, Pearson", 2019.
3. Gilbert Strang, "Introduction to Linear Algebra", Fifth Edition, Wellesley- Cambridge Press, 2016
4. Mordechai Ben-Ari, "Mathematical Logic for Computer Science", Third Edition, Springer, 2012
5. Narayanan, Ramaniah and Manicavachagom Pillay, "Advanced Engineering Mathematics", Vol 2 and 3, Vishwanthan Publishers Pvt Ltd. 1998, *Erwin Kreyszig, Advanced Engineering Mathematics, 5th edn., Wiley Eastern, 1985.

ECE 2121: ANALOG ELECTRONIC CIRCUITS [4 0 0 4]

Structure, operation, I-V Characteristics of MOSFET; Large-Signal and Small-Signal Model, PMOS Transistor; MOSFET Biasing, Analysis and Design of Common-Source, Common-Gate Amplifier and Source Follower; Current mirror and active load; Differential Amplifier; Frequency Response of MOS amplifiers, High-Frequency Model of MOSFET, Frequency Response of CS, CG, CD, Cascode and differential amplifier Stage; Concepts of Feedback; Oscillators; Power Amplifiers. *Self-directed Learning: Analyse different types of Power Amplifiers.

References:

1. *Behzad Razavi, "Fundamental of Microelectronics", Wiley, 2013.
2. A. S. Sedra, K. C. Smith, "Microelectronic circuits", Oxford University Press, 2011.
3. R. L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", 2009.
4. J. Millman, C. C. Halkias, Chetan. D. Parekh, "Integrated Electronics", McGraw Hill.2010 https://youtu.be/huDZjQcEBM

ECE 2122: NETWORK ANALYSIS [3 0 0 3]

Network equations; Mesh and nodal analysis; Network theorem- Superposition, Reciprocity, Thevenin's, Norton's theorems, Maximum power transfer theorem; Initial and final conditions in RL, RC and RLC Circuits for DC Excitations. General and Particular solution of the first order and second order circuits. Applications of Laplace transform in finding solution or RC, RL, and RLC networks, Response of RC circuits for step, pulse, square, and ramp input; Two port network- Open circuit impedance parameters, short circuit admittance parameters, transmission parameters, hybrid parameters

Self-directed Learning: Two-port Interconnections

References:

1. M. E. Van Valkenberg, "Network analysis", Prentice Hall of India, 2000.
2. Ravish R Singh, "Network analysis and Synthesis", McGraw Hill, 2013.
3. William H. Hayt, Jack E. Kemmerly, Steven M Durbin, "Engineering Circuit Analysis", 8th edition, Tata McGraw Hill India,2013.
4. Millman, H. Taub, "Pulse, digital and switching waveforms", 3nd Edition, McGraw Hill, 2017.
5. Joseph Edminister, "Electric Circuits", Schaum's Series, McGraw Hill, 2018. * https://nptel.ac.in/courses/108102042 , https://nptel.ac.in/courses/108102042

ECE 2123: SIGNALS AND SYSTEMS [3 0 0 3]

Continuous time (CT) and discrete time (DT) signals, Representation and classification of Signals, Elementary signals, time domain operations on signals, correlation between signals; Continuous time and discrete time systems, system properties. LTI system, impulse response, response of LTI system, Convolution, differential/difference equation and block diagram representation; Fourier analysis of signals and systems, LTI systems in frequency domain, Parseval relation, ESD, PSD; LTI system analysis using Laplace transform, transfer function, poles/zeroes, stability; Z-transform, application in LTI system analysis; sampling and re-construction. *Self-directed Learning: Generation of signals and Fourier analysis

References:

1. Simon Haykin, Barry Van Veen, "Signals and Systems", John Wiley & Sons, NewDelhi,2008
2. A. V. Oppenheim, A. S. Willsky, A. Nawab, "Signals and Systems", PHI. Pearson Education,New Delhi, 2015.
3. H. Hsu, R. Ranjan "Signals and Systems", Schaums outline, Tata McGraw Hill, New Delhi, 2006.
4. Michael J. Roberts, "Fundamentals of Signals and Systems", First Edition, Tata McGraw Hill Publishing Company Limited, 2007.
5. Rodger E. Ziemer, William H. Tranter D. Ronald Fannin, "Signals and Systems", Fourth Edition, Pearson Education, 2004.

   *Signal Processing tool box in MATLAB

ECE 2124: DIGITAL SYSTEM DESIGN [3 0 0 3]

Logic Design Fundamentals, Review of logic minimization techniques, Design of combinational blocks and circuits, Flip-flops, counters, shift registers, analysis and design of synchronous and asynchronous sequential circuits. Digital System implementation using PROM, PLAs and PALs, FPGA, Introduction to HDL, language constructs and conventions, operators. Data flow, behavioral and structural Verilog coding, subprograms, UDP, test benches. *Self-directed Learning: Simulation of combinational and sequential circuits and their test-benches using Verilog HDL

References:

1. Donald D.Givone, "Digital Principles and Design", Tata McGraw Hill, 2002.
2. William I. Fletcher, "An Engineering approach to Digital Design", Prentice Hall of India, 2009.
3. Zvi Kohavi, Niraj K Jha, "Switching and Finite Automata Theory", Cambridge, Third edition, 2010.
4. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis," Prentice Hall PTR, 2003.
5. Charles Roth, Lizy Kurian John, ByeongKil Lee, "Digital System Design Using Verilog", 1st Edition, 2016. *https://edaplayground.com/

ECE 2125: ELECTROMAGNETIC WAVES [3 0 0 3]

Review of Electrostatics and Magneto statics: Coordinate system and vectors, Curl and Divergence, Divergence theorem and Stokes theorem in the context of electromagnetics. Uniform Plane Waves: Maxwell's equations, Electromagnetic wave propagation. Transmission Lines: parameters, Transmission line equations and solutions Standing Wave Ratio, power and impedance measurement, Stub impedance matching, Smith Chart and its applications in transmission line calculations, applications of transmission lines. Waveguides: Rectangular waveguides – TE, TM modes, power transmission. Introduction to Cylindrical waveguides. *Self-Directed Learning , Planar dielectric waveguides

References:

1. *Jr. Hayt and Buck, "Engineering Electromagnetics", 7th Edition, McGraw Hill, 2012.
2. Ryder J. D, "Networks, Lines, and Fields", 2nd Edition, PHI, 2015.
3. Shevgaonkar R. K, "Electromagnetic Waves", 2nd Edition, Tata McGraw Hill, 2019.
4. Plonus M. A, "Applied Electromagnetics", McGraw Hill, 1988
5. Edminister J. A, "Electromagnetics", 2nd Edition, Schaum's Outline Series, Tata McGraw Hill, 2006.

ECE 2141: DIGITAL SYSTEM DESIGN LAB [0 0 3 1]

TTL IC specifications & Implementation of Boolean functions; Code Conversion Circuits, Arithmetic circuits; Magnitude comparator & Parity checker/ generator. Multiplexers & De-multiplexers. Encoders & Decoders. Study of Flip-flops. Counters; Shift Registers; Sequential circuits

References:

1. Donald D.Givone, "Digital Principles and Design", Tata McGraw Hill, 2002.
2. Morris Mano, "Digital design", Prentice Hall of India, Third Edition, 2016.
3. William I. Fletcher, "An Engineering approach to Digital Design", Prentice Hall of India, 2009.
4. ZviKohavi, "Switching and Finite Automata Theory", Tata Mc Graw Hill, second edition, 2008.
5. C.H.Roth, "Fundamentals of Logic Design", Thomson, 2000.

ECE 2142: ELECTRONIC CIRCUITS LAB [0 0 3 1]

To apply various network theorems on the given circuits and analyze, to verify the diode rectifier circuits, to investigate the I/O characteristics of MOSFET and OPAMP, design and verify the OPAMP and MOSFET amplifiers and oscillators, to design and analyze OP-AMP based linear and non-linear circuits.

References:

1. Lab manual.
2. William H. Hayt, Jack E. Kemmerly, Steven M Durbin, "Engineering Circuit Analysis", 8th edition, Tata McGraw Hill India,2013.
3. Behzad Razavi, "Fundamental of Microelectronics", Wiley, 2013.
4. R. L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", 2009.

FOURTH SEMESTER

MAT 2227: ENGINEERING MATHEMATICS - IV [2 1 0 3]

Construction of a Probability Space, Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem, Summary Statistics and Independence, Distributions: Binomial, Poisson, uniform, normal, Chi-square and exponential distributions. Two and higher dimensional random variables, covariance, correlation coefficient. Moment generating function, functions of one dimensional and two dimensional random variables. Static probabilities: review and prerequisites generating functions, difference equations. Dynamic probability: definition and description with examples. Markov chains, transition probabilities. Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Backpropagation and Automatic Differentiation, Higher-Order Derivatives, Linearization and Multivariate Taylor Series. Basic solution, Convex sets and function, Simplex Method, Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers.

*Self-directed Learning: Markov chains, Transition probabilities.

References:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press, 2020.
2. P L Meyer, "Introductory Probability and Statistical Applications", Addison Wiley, 2000.
3. Medhi. J. "Stochastic Processes", Wiley Eastern, 2022.

References:

1. Murray R. Spiegel, Vector Analysis Theory and Problems, Schaum's Outline Series, 2019.
2. Hamdy A. Taha, "Operations Research: An Introduction", 8thEdn., Pearson Education (2008).
3. Sheldon M. Ross, "Introduction to Probability Models", Eleventh Edition Elsevier, 2014.
4. E. S. Page, L. B. Wilson, "An Introduction to Computational Combinatorics", Cambridge University Press, 1979.
5. Bhat U R, "Elements of Applied Stochastic Processes", John Wiley, 2022.

   *https://youtu.be/CgP-3HctGe4

ECE 2221: VLSI DESIGN [4 0 0 4]

MOS Transistor, CMOS logic, Inverter, Power: Dynamic Power, Static Power, Fabrication of MOS transistor, Latch-up in CMOS, Stick Diagrams, Layout Design Rules, Static CMOS, Ratioed Circuits, Dynamic Circuits, Pass Transistor Logic, Transmission Gates, with examples, Domino, Dual Rail Domino, CPL, Cascode Voltage Switch Logic, Bi-CMOS inverter circuits. Static latches and Registers, Dynamic latches and Registers, Sense Amplifier Based Register, clocking strategies, Subsystem design, Sheet resistance and delay models.

*Self-directed Learning: Simulation of MOSFET based logic circuits using LTSPICE

References:

1. Jan M Rabaey, "Digital Integrated Circuits", Prentice Hall India, 2003.
2. Weste. N and Eshraghian K, "Principles of CMOS VLSI Design", 2nd Edition, Addison Wesley Publication, 1993.
3. Sung Mo Kang and Yusuf leblebici, "CMOS digital Integrated circuits design and analysis", 3rd edition, Tata Mcgraw Hill, 2003.
4. Pucknell D. A. and Eshraghian K.,"Basic VLSI Design", PHI publication, 2009.
5. Amar Mukherjee, "Introduction to NMOS & CMOS VLSI systems Design", Prentice Hall, 1986.

   *https://www.analog.com/en/design-center/design-tools-and-calculators/ltspice-simulator.html

ECE 2222: DIGITAL SIGNAL PROCESSING [3 0 0 3]

Discrete Fourier transform(DFT), properties, linear filtering; efficient computation of DFT, FFT algorithm, Goertzel algorithm; Implementation of Discrete time filters, Structures for IIR and FIR filters; Classical design of IIR filters by impulse invariance, bilinear transformation and matched Z - transform, characteristics and design of commonly used filters - Butterworth, Chebyshev and elliptic filters. Spectral transformation, direct design of IIR filters; design of linear phase FIR filters using window functions, frequency sampling design; Power spectrum estimation, non-parametric methods of PSD estimation.

*Self-directed Learning: Parametric methods of PSD estimation: AR, ARMA and MA modeling

References:

1. *Proakis J. G, Manolakis D. G. Mimitris D., "Introduction to Digital Signal Processing" Prentice Hall, India, 2007.
2. Oppenheim A.V, Schafer R. W, "Discrete Time Signal Processing", Pearson Education, 2004.
3. Ifeachar, Jervis, "Digital Signal Processing - A Practical approach", Pearson Education, Asia, 2003.
4. Rabiner L. R, Gold D. J, "Theory and applications of digital signal processing", Prentice Hall, India, 1998.
5. SanjitMitra K, "Digital Signal Processing - A computer based approach", TMH, 2007

   *https://www.youtube.com/watch?v=xZ4zfE11X7U

ECE 2223: ANALOG INTEGRATED CIRCUITS [3 0 0 3]

Operational Amplifier. Linear applications of operational amplifier, instrumentation amplifier and bridge amplifier. Active filters: Design and analysis. Non-linear applications of operational amplifier: Precision half wave and full wave rectifiers, Voltage regulators, peak detector, sample and hold circuit, log and antilog amplifiers, analog multipliers and dividers, comparators, window detector, Schmitt trigger, square wave, triangular wave generators and pulse generators. Specialized ICs:555 IC, functional diagram of 555 IC, a stable multi-vibrator, positive and negative edge triggered mono-stable multi-vibrator, working of Phase looked loop IC 565 and its applications. Data Converters.

*Self-directed Learning: Working of Phase looked loop IC 565 and its applications.

References:

1. Franco S, "Design with Op amps & Analog Integrated Circuits" McGraw Hill, 4th edition, 2015.
2. *Ramakant A. Gayakwad, "Op-Amps and Linear Integrated Circuits", Prentice Hall of India, 2000.
3. Choudhury Roy D, Shail B. Jain, "Linear Integrated Circuits", Wiley Eastern, 2003.
4. Stanley William D, "Operational Amplifiers with Linear Integrated Circuits", Prentice Hall, 2004
5. Sedra A S and Smith K C, "Micoelectronics circuits- Theory and applications", Oxford publishers, 7th Edition, 2017.

   *NPTEL Link: Mod-11 Lec-31 Phase locked loop basics

ECE 2224: MICROWAVE ENGINEERING [3 0 0 3]

Waveguide tees, Magic tees, Hybrid rings, Corners, Bends, and Twists. S- Matrix. Directional couplers – Two hole directional couplers, S-matrix of a directional coupler, Circulators, and isolators Klystrons, Tunnel Diode, Gunn Diode, Read Diode, IMPATT Diode, BARITT Diode, TRAPATT Diode, Varactor Diode, Types of Antennas (Isotropic, Omnidirectional and directional antennas) radiation mechanism, current distribution. Basic antenna parameters: Radiation pattern, power density and radiation intensity, directivity, gain, efficiency, HPBW, return loss, Vector Potential A and F, Solution of vector Potential wave equations, Far-Field Radiation Infinitesimaldipole,smalldipole, and half wavedipole, two elementarray, Broad side and end-fire arrays, Design of micro-strip antenna, millimeter wave 5G antenna, Fractal antennas.

*Self-directed Learning: Introduction to Millimeter Wave Technology and Antennas , Millimeter Wave Propagation and systems

References:

1. Balanis, C. A. “Antenna theory: analysis and design” John wiley & sons,2015.
2. Liao, Samuel Y. “Microwave devices and circuits”,Pearson Education India(3rdEdition), 1989.
3. J.D Kraus “Antennas”, Second Edition, TMH Publication 1989
4. G. S. N. Raju. “Antennas and Wave Propagation” Pearson Education, 2006.
5. K.D. Prasad. “Antennas & Wave Propagation” Satya Prakashan, Tech India Publications, New Delhi, 2001.

*Link: https://onlinecourses.nptel.ac.in/noc21_ee76/preview

ECE 2225: MODERN CONTROL THEORY [3 0 0 3]

Block diagrams and signal flow graphs: Transfer function. System modeling: Modeling of electrical and mechanical systems (translational & rotational), system equations, and its electrical equivalent (analogous) networks.Time domain analysis: Stability, Routh-Hurwitz criterion, time response of continuous data systems, type and order of systems, steady state error for linear systems. Frequency domain analysis: second order prototype system, Bode diagram, gain and phase margins, Nyquist stability criterion. Compensators and Controllers: Feedback and feed forward controllers, proportional, integral, PI, PD and PID controllers, lead, lag and lead-lag compensators. State space representation, State Transition Matrix, Controllability and Observability.

*Self-directed Learning: Simulation to test the stability of a system in time domain (Root Locus), Simulation to test the stability of a system in frequency domain (Bode Plot)

References:

1. B.C.Kuo and F.Golnaraghi, “Automatic Control Systems”, 10th edition, McGraw Hill, 2018
2. Nagrath and Gopal, “Control System Engineering”, 6th edition, New Age International Publishers,2018
3. K.Ogata, “Modern control engineering”, 5th edition, Pearson 2015
4. Norman.S.Nise, “Control Systems Engineering”, 8th edition Wiley 2019
5. *Dr.Shailendra Jain, “Modeling and Simulation using MATLAB & Simulink”, 2nd Edition, Wiley, 2011.

   *LabVIEW -Control design toolbox

   Mat Lab- Control system toolbox

ECE 2241: VLSI LAB [0 0 3 1]

Introduction to VIVADO tools, logic simulation of combinational and sequential circuits, logic synthesis of circuits, Technology mapping, Implementation of circuits in FPGA Kit, drawing logical circuits using layout tool, Simulation of various MOSFET based inverter circuits using EDA Tools, Implement of MOS transistor-based switch logic and gate logic circuits.

References:

1. Lab Manual.
2. User manual for Xilinx FPGA Kit.
3. Sung Mo Kang and Yusuf leblebici, “CMOS digital Integrated circuits design and analysis”, 3rd edition, Tata Mcgraw Hill, 2003.
4. Pucknell D. A. and EshraghianK.,“Basic VLSI Design”, PHI publication, 2009.
5. edaplayground.com

ECE 2242: ELECTRONIC SYSTEM DESIGN LAB [0 0 6 2]

Design and test Mathematical operations of OPAMP, Precision rectifier using OPAMP, Non-linear applications of OPMP. Design and verify the regulation characteristics using IC regulators. Design a stable and mono-stable multi-vibrators using IC 555. Design and simulate Active filters using OPAMP. Digital filter design using Lab VIEW. Experiments based on PCB design using EDA tool.

*Self-directed Learning: Mini-project based on Software/Hardware tools.

References:

1. Lab Manual
2. https://easyeda.com/
3. Ramakant A. Gayakwad, “Op-Amps and Linear Integrated Circuits”, Prentice Hall of India, 2000
4. Lab VIEW user manual.

FIFTH SEMESTER

HUM 3021: ENGINEERING ECONOMICS & FINANCIAL MANAGEMENT [2 1 0 3]

Time Value of money: Time Value of Money, Interest Factors for Discrete Compounding, Nominal & Effective Interest Rates, Present and future worth of Single, Uniform, and Gradient cash flow. Related problems and case studies.Economic Analysis of Alternatives: Bases for Comparison of Alternatives, Present worth amount, Capitalized Equivalent Amount, Annual Equivalent Amount, Future Worth Amount, Capital Recovery with Return, Rate of Return Method, Incremental Approach for Economic Analysis of Alternatives, Replacement analysis. Break Even Analysis for Single Product and Multi Product Firms, Break Even Analysis for Evaluation of Investment Alternatives. Minimum Cost Analysis. Depreciation: Physical & Functional Depreciation, Methods of Depreciation - Straight Line, Declining Balance, Double-Declining balance method, Case Study. Financial Statement Analysis: Balance Sheet and Profit & Loss Statement, Meaning & Contents. Ratio Analysis, Financial Ratios such as Liquidity Ratios, Leverage Ratios, Turn over Ratios, and Profitability Ratios, Drawbacks of Financial Statement Analysis. Project Risk: Safety and Risk, Assessment of Risk and Safety, Case study, Risk Benefit Analysis and Reducing Risk

References:

1. Chan S. Park, Contemporary Engineering Economics, 4th Edition, Pearson Prentice Hall, 2007.
2. Thuesen G. J, Engineering Economics, Prentice Hall of India, New Delhi, 2005.
3. Blank Leland T. and Tarquin Anthony J., Engineering Economy, McGraw Hill, Delhi, 2002.
4. Prasanna Chandra, Fundamentals of Financial Management, Tata McGraw Hill, Delhi, 2006.

ECE 3121: ANALOG AND DIGITAL COMMUNICATION [4 0 0 4]

Random Process, Random Variables and Distributions used in Communication Systems. Analog Modulation Schemes: Analytical concepts and the concept of Noise. Detection and Estimation theory, practical studies and Design challenges. PCM, DPCM, DM, ADM, Baseband data transmission. Digital Modulation schemes, ASK, FSK, BPSK, QPSK, DPSK, probability of error design. Introduction to Information Theory, Entropy, Source coding: Shannon Fano Encoding and Huffman Coding. Entropy Mutual Information capacity of a DMC, Shannon's theorem on channel capacity and Binary symmetric channel. Elementary channel coding techniques. *Self-directed Learning: Fundamentals of Fourier Series, Transforms and Modulation Properties.

References:

1. * John G Proakis and Masoud-Salehi."Digital Communications" , 5th Edition 2008.
2. Herbet Taub and Schilling, "Principles of Communication systems" ,2001
3. Simon Haykin, "Analog and Digital Communication Systems" 2nd Edition, 2006
4. Simon Haykin, "Digital Communication",2nd Edition., 2008

ECE 3122: MICROPROCESSORS [3 0 0 3]

Overview of computing systems: ALU, registers, control unit, memory unit. The ARM architecture and features. The ARM7TDMI programmer's model. Assembler rules and directives. ARM instruction set and programming: Addressing modes. Instruction types and format, conditional execution, Instruction set. Endianness; Constants and literal pools. Loops and Branches, Subroutine and stacks; passing parameters to subroutine. Assembly programming. Memory mapped peripherals: The LPC2148, Architecture and features, Hardware interfacing: display devices, actuators, data converters, programming. Performance improvement techniques. ARM Thumb model, Thumb instructions, Exception handling, interrupts, and Error conditions.

*Self-directed Learning:

Embedded C program for ARM7 Microprocessor

References:

1. Andrew N Sloss, "ARM System developer's guide, designing and optimizing system software", Elsevier, 2004
2. William Hohl, "ARM assembly language fundamentals and techniques" , CRC press, 2009
3. Steve Furber," ARM System on chip Architecture", Pearson Education, 2000
4. J. R. Gibson "ARM Assembly Language-an Introduction" Dept. of Electrical Engineering and Electronics, The University of Liver-pool, 2007.
5. Raghunandan G.H, "Microcontroller (ARM) and Embedded Systems", Cengage Learning India Pvt. Ltd., 2020.

   * https://www.keil.com/download/

   *https://www.youtube.com/watch?v=j-lfh3OrXlw

ECE 3123: COMMUNICATION NETWORKS [3 0 0 3]

Types of CNs, Network Hardware, Software, ISO: OSI, TCP/IP, ATM Reference Models. Physical Layer: Media, Line coding, channel capacity, Multiplexing, Multiple Access, switching. Design issues of DLL, Error Control, Flow Control, MAC: Random Access, Controlled Access, IEEE 802.3, 802.5, FDDI. Design issues of Network Layer, Shortest Path Routing, Distance Vector, Link State, Hierarchical Routing, Congestion Control, QoS, IP Addressing, NAT, ARP, RARP, Unicast Routing Protocols. TCP, UDP. Application Layer protocols. Mobile IP and TCP.

*Self-directed Learning: Intra Domain Routing Protocols, Inter Domain Routing Protocols (BGP), Application Layer Services (HTTP, FTP, Email, DNS).

References:

1. Fourouzan B. A., "Data Communications and Networking",5th Edition Mc Graw Hill, 2013
2. Garcia A.L and Widjaja I., "Communication Networks", McGraw Hill, 2006
3. Stallings W., "Data and Computer Communication" (7e), Prentice Hall. 2004
4. Mir N.F., "Computer and Communication Networks", Pearson Education, 2007
5. Jean Walrand & Pravin Varaiya, "High Performance Communication Networks", 2nd Edition, Morgan Kauffman, 2000

   *https://nptel.ac.in/courses/106105183

ECE 3124: DIGITAL COMPUTER ARCHITECTURE [3 0 0 3]

Computer Architecture and Organization. Processor Design. Quantitative principles of computer design, Design of arithmetic and logic unit (ALU), Registers, Multiplication algorithms for signed and unsigned data, Division Algorithms. Memory and I/O Organization. Cache memory organization, Mapping techniques, Accessing I/O devices, I/O interfacing, Direct memory access, Virtual memory system. Functional Organization. Register transfer language for computer's internal operation, Micro-programmed and hardwired control unit design, Instruction pipelining and instruction-level parallelism (ILP),Data dependences and Hazards, Flynn's classification for parallelism, Thread level parallelism. DSP Architecture and addressing modes.

*Self-directed Learning: Processor Architectures: VLIW, MIMO, SIMO.

References:

1. David A. Patterson and John L. Hennessy, "Computer Organization and Design –The Hardware / Software Interface", 4th Edition, Morgan Kaufmann, Elsevier, 2009.
2. *John L. Hennessy and David A. Patterson, "Computer Architecture – A Quantitative Approach", 5th Edition, Morgan Kaufmann, Elsevier, 2011.
3. William Stallings, "Computer Organization and Architecture", Ninth edition, Pearson Education, 2013.
4. M.Raffiquzzaman & Chandra, "Modern Computer Architecture, Galgotia publications", New Delhi, 1990.
5. Kuo S. M. and Gan W. S., "Digital Signal Processors-Architectures, Implementations and Applications", Pearson Education, 2005.

ECE 3125: VLSI TESTING AND TESTABILITY [3 0 0 3]

Introduction to testing and testability: Need for testing, digital and analog testing; Physical Faults and their modeling; Fault models; Testing of combinational circuits: Various types of faults. Functional v/s structural approach to testing; Testability Techniques: scan-path testing, Boundary scan; Testing of sequential circuits: Test pattern generation for sequential circuits; Signatures and self-test: Testing with random patterns. LFSRs, random test generation and response compression, Built-in self-test (BIST), PLA Testing.

*Self-directed Learning: Testability techniques, Scan chain and Boundary scan

References:

1. *M. L. Bushnell and V. D. Agrawal, "Essentials of testing for digital, memory and mixed-signal VLSI circuits", Boston: Kluwer Academic Publishers, 2000.
2. M. Abramovici, M. A. Breuer, and A.D. Friedman, "Digital Systems Testing and Testable Design", Piscataway, New Jersey: IEEE Press, 1994.
3. Miczo, "Digital Logic Testing and simulation". New York: Harper & Row, 1986.
4. P.K. Lala, "Fault Tolerant & Fault Testable hardware Design", BS Publications, 1998
5. Stanley L. Hurst, "VLSI Testing: digital and mixed analogue digital techniques" Pub:Inspec/IEE, 1999.

ECE 3126: SATELLITE COMMUNICATION [3 0 0 3]

Overview of satellite communication systems, Satellite Orbits: Kepler's Laws, Definitions of terms for earth-orbiting satellites, Orbital effects on satellite's performance, Launching Procedures. Satellite subsystem. Earth Station: Types, Design considerations, Satellite tracking.Satellite Link Design Fundamentals: Equivalent isotropic radiated power, Transmission losses. Multiple access techniques: FDMA, TDMA, CDMA, SDMA assignment methods, compression – encryption, coding schemes. Satellite Applications: Communication satellites, Remote sensing satellites. Navigation satellites-GPS system, NAVIC, GAGAN.

*Self-directed Learning: Position determination using GNSS

References:

1. Dennis M Roddy, "Satellite communications", 4th edition, McGraw Hill, 2006.
2. Timothy Pratt and Jeremy E. Allnutt, "Satellite communications", 3rd edition, Wiley 2019
3. Tri Tha, "Digital satellite communications", 2nd edition, McGraw Hill Education, 2008
4. M.Richharia, "Satellite communication systems-Design Principles", Macmillan 2003
5. Anil K. Maini, Varsha Agrawal, "Satellite communications", Wiley India Pvt. Ltd., 2015

   *https://www.youtube.com/watch?v=50U2T6Tmr1E&list=PLLy_2iUCG87A55NPtEwWoWPiKs0-9NNT1&index=3

ELE 3127: FOUNDATIONS OF EV & HYBRID VEHICLES [3 0 0 3]

Principles for Electric Vehicles: EV Industry, EV Technology and Automotive Revolution, Electrical Engineering for EV, Battery Technology

Control system for Electric Vehicles: Motor and Controller Systems, EV Numerical Calculations, EV Charging Infrastructure, Practical session - Well-to-wheel analysis of EV architecture

Essentials for Electric Vehicles: Electrical Requirement, Power Distribution Specifications, Electronic Control System, Practical session - EV connection and system analysis

Types of components in Electric Vehicles: EV Standards and Classifications, Selection for Electrical and Electronic Components, Practical session - EV hardware components

Principles for Hybrid Vehicles: Introduction to Hybrid Vehicles, Battery Chemistry, Efficiency, Definition and Parameters for Hybrid Systems, Electric Motors, Generators and Power Electronics for Hybrid Systems, Control Systems, Hybrid Electric Vehicle Operation, Practical session - Numerical study on powertrain sizing of HEV

References:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", Routledge, 3rd Ed, 2021, ISBN: 9780367693930
3. Muhammad Ehsani, Mehrdad Ehsani, and Ali Emadi, "Electric Vehicle Systems Architecture and Standardization Needs", Reports of the PPP European Green Vehicles Initiatives, Springer, 2015.
4. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 1st Ed, 2014, ISBN: 9781138072855.
5. Rodrigo Garcia-Valle and João A. Peças Lopes, "Electric Vehicle Integration into Modern Power Networks", Springer, 2013, ISBN: 978-1461401339.
6. Chris Mi and M. Abul Masrur, "Hybrid electric Vehicles, Principles and Applications with Practical perspectives", WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6.
7. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

ECE 3141: DIGITAL SIGNAL PROCESSING LAB [0 0 3 1]

Time domain and frequency domain analysis of signals and systems. Analysis in z-domain. Filter design. Applications to speech and image signal processing. Simulation experiments using Code Composer Studio. Filter implementation using DSP Kits.

References:

1. Lab manual
2. Ifeachar, Jervis, "Digital Signal Processing - A Practical approach", Pearson Education, Asia, 2003.
3. Code Composer Studio user guides

ECE 3142: MICROPROCESSOR LAB [0 0 6 2]

Assembly Programming for arithmetic, logical and data transfer operations, Assembly as well as C Programming for interfacing I/O devices like Switches, Keypad, display devices, Data converters, and

Motor controllers. Assembly as well as C Programming for on chip features of ARM processor: hardware interrupts, timers, PWMs, ADC, DAC and serial communication protocols.

*Self directed learning: Develop and demonstrate projects using Microcontrollers.

References:

1. Lab Manual
2. William Hohl, "ARM assembly language fundamentals and techniques", CRC press, 2009
3. https://www.nxp.com/docs/en/user-guide/UM10139.pdf
4. http://arantxa.ii.uam.es/~gdrivera/sed/docs/ARMBook.pdf

SIXTH SEMESTER

HUM 3022: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Introduction to Business, Industrial Business, Classification of Industries and Job Opportunities (referring the industries visiting our campus). Functions of Managers/Management and time spent on various managerial functions by managers at various levels, two characteristics of managerial functions, Efficiency and Effectiveness. Principles of Management by Henri Fayol. Three types of managerial responsibilities. Planning: Strategic, Tactical and Operational. Nature and characteristics, Types, qualitative and quantitative objectives, Stakeholders and their interests, Fiscal and Social Responsibilities. Strategic Planning: Planning Tools – SWOT, TOWS, Business Portfolio Analysis and Porter's model; Process. Principles of Organizing; Span of Control. Departmentalization: Types of Departmentalization. Staffing HRM and HRD. Leading: Meaning, differences between – leading and managing, leader and manager. Maslow's Need Hierarchy, Herzberg's 2 – factor theory and McGregor X and Y theory. Motivational techniques. Leadership. Controlling Management Control Techniques. Entrepreneurship. International Management Practices. Professional Ethics and Global Issues.

References:

1. Harold Koontz and Heinz Weihrich, "Essentials of Management", 4th Edition, Mc Graw Hill, New Delhi, 2012.
2. Peter Drucker, "Management: Tasks, Responsibilities and Practices", Harper and Row, New York, 1993.
3. Peter Drucker, "The Practice of Management", Harper and Row, New York, 2004.
4. Vasant Desai, "Dynamics of Entrepreneurial Development and Management", Himalaya Publishing House, 2007.
5. Poornima M Charantimath, "Entrepreneurship Development", Pearson Education, 2006.
6. S S Khanka, "Entrepreneurship Development", S Chand & Co., 2007.

ECE 3221: WIRELESS COMMUNICATION [3 0 0 3]

Path Loss and Shadowing, Empirical Path Loss Models, Combined Path Loss and Shadowing, Outage Probability under Path Loss and Shadowing, Cell Coverage area. Time-Varying Channel Impulse Response, Classification of Fading models, Narrowband Fading, Wideband Fading Models, Capacity in AWGN, capacity of flat fading channel, capacity of frequency selective fading, Outage Probability, Average Probability of Error, Combined Outage and Average Error Probability; Doppler Spread, Inter symbol Interference, Adaptive equalization, Linear and Non-Linear equalization, Zero forcing and LMS Algorithms, Diversity combining techniques, Transmitter.

*Self -Directed Learning: Diversity Techniques.

References:

1. Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005
2. David Tse, Pramod Viswanath "Fundamentals of Wireless Communication", Cambridge University Press, 2005
3. Aditya Jagannatham, "Principles of Modern Wireless Communication Systems Theory and Practice", McGraw Hill, 2016
4. *Andreas F. Molisch, "Wireless Communications" IEEE Press, 2010.
5. Simon Haykin, Michael Moher "Modern Wireless Communications", Pearson, 2011.

ECE 3222: SYSTEM ON CHIP DESIGN [3 0 0 3]

Basics of SoC, Constituents of SoC - Life cycle, Design flow, Physical Design, Logic Synthesis, Floor Planning, Placement, Routing, Physical Design Constraints, Clock Tree Synthesis, Timing analysis, power routing, Interconnects, Switch Interconnects, Layered Architecture, Network Interface, IP-based design, IP evaluation on FPGA prototypes, SOC verification, testing, Standardization-SoC Test Automation, SoC packaging. Network on Chip, architectures, Reconfigurable NoC, NoC interconnects and 3D-NoC.

*Self Directed Learning Modern NoC Architectures

References:

1. Michael J.Flynn, Wayne Luk, , "Computer system Design: System-on-Chip", Wiley-India, 2012.
2. Veena S. Chakravarthi- "A Practical Approach to VLSI System on Chip (SoC) Design", Springer Nature Switzerland AG, 2020
3. Sudeep Pasricha, Nikil Dutt, "On Chip Communication Architectures: System on Chip", Morgan Kaufmann Publishers, 2008.
4. W.H.Wolf,, "Computers as Components: Principles of Embedded Computing System Design", Elsevier, 2008.

   * NPTEL-IIT Madras https://youtube.com/playlist?list=PL3p-ZpXPqK6vvxeTp1k4kDMJj74WIetyC

ECE 3223: RF CIRCUIT DESIGN [3 0 0 3]

RF systems - basic architectures, Parallel RLC tank, Quality factor, Series RLC networks, matching, Distributed Systems, Transmission lines High Frequency, Amplifier Design, Bandwidth estimation using open-circuit time constants, Bandwidth estimation using short-circuit time constants. LNA Design Multiplier based mixers, Subsampling mixers, RF Power amplifiers: Class A, AB, B, C amplifiers, Class D,E, F amplifiers Voltage controlled oscillators and Phase locked loop Radio architectures

*Self -Directed Learning: Analysis/simulation of RF modules like Low Noise amplifier or gilbert cell and its application.

References:

1. Thomas H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits" by Cambridge University Press, 2004
2. Behzad Razavi, "RF Microelectronics",.Prentice Hall, 1997.
3. Frank Ellinger, "Radio frequency integrated circuits and technologies" by. Springer Science & Business Media, 2008.
4. JörgEberspächer, Christian Bettstetter, Hans-JoergVögel, Christian Hartmann "GSM –Architecture, Protocols and Services",Wiley Telecom, 2009

   *Simulation using Cadence software/ LT simulator

ECE 3224: INFORMATION THEORY AND CODING [3 0 0 3]

Information, Entropy of discrete memoryless source and memory sources, Instantaneous and uniquely decodable codes, Kraft's inequality, compact codes, Shannon's theorem code efficiency & redundancy, Information channels, Joint Entropy and Conditional Entropy, Relative Entropy and Mutual Information and its properties, cascaded channel, channel capacity Chain Rules, Data-Processing Inequality, Fano's Inequality, Error probability and decision rules, reliable messages and unreliable channels, An example of coding to correct errors, Differential entropy Shannon's second theorem for BSC.

*Self-directed learning Channel Coding: Properties and design of Linear block codes

References:

1. Thomas M. Cover, Joy A. Thomas, "Elements of Information Theory", John Wiley and sons, INC, 1991.
2. Norman Abramson, "Information Theory and Coding", McGraw Hill, 1963.
3. Haykin S, "Digital Communications", Wiley, 2008.
4. Khalid Sayood, "Introduction to Data Compression", 3rd Edition, MK Publishers, 2012. *An Introduction to Coding Theory - Introduction - YouTube. Video lectures

ELE 3225: AUTOMOTIVE MECHANICS FOR ELECTRIC VEHICLES [3 0 0 3]

Automotive Engineering & Vehicle Dynamics: Vehicle Dynamics Fundamentals, Tire Mechanics and Dynamics, Suspension Systems, Braking Systems, Aerodynamics, Powertrain Systems, Vehicle Stability Control, Vehicle Safety, Vehicle Dynamics Simulation, Electric and Hybrid Vehicle Dynamics, Practical session - EV Dynamics & calculations.

Sketching for Automotive EV Design [Software-based]: Introduction to Automotive Sketching Software, Overview of Vehicle Design Process and Automotive Sketching, Basic Sketching Techniques and Tools in the Software, Sketching Car Exteriors, Interiors and Details, Creating Different Views and Angles of the Vehicle, Rendering and Presenting the Final Sketches, Understanding Proportions, Perspectives and Shapes in Automotive Sketching, Creating Sketches for Different Vehicle Types (Sedans, SUVs, and Trucks), Tips and Tricks for Automotive Sketching in the Software.

Advanced EV Modelling Using SolidWorks Tool [Software-based]: Introduction to EV Technology and Its Benefits, Basic Vehicle Design Principles, Design and Modelling of Chassis and Frame, Suspension Systems, Design and Modelling of Braking and Steering Systems, Design and Modelling of Electrical Components for EVs, Battery Pack Design and Modelling for 2, 3 and 4 Wheelers, Motor and Drivetrain Design and Modelling for 2, 3 and 4 Wheelers, Design and Modelling of Wheels and Tires for 2, 3 and 4 Wheelers, Testing and Simulation of Vehicle Performance Using Solid Works, Design for Manufacturability and Assembly Considerations, Sustainability and Environmental Impact Considerations in EV Design, Practical session - EV hardware components walkthrough.

Multibody Dynamics with MSC Adams [Software-based]: Introduction to MSC Adams Software and Its Capabilities, Setting Up the Modelling Environment in MSC Adams, Multi-body Dynamics Principles and Application to Vehicle Systems Modelling, Vehicle Suspension Systems Modelling, Vehicle Steering Systems Modelling, Vehicle Braking Systems Modelling, Practical session - EV Component design & modeling.

EV Analysis with MSC Adams (Software-based): Tire Force and Characteristics Modelling, Vehicle Dynamics Analysis Including Simulating Ride and Handling, Vehicle Stability and Rollover Events, Optimisation Techniques for Vehicle Designs Using MSC Adams, Integration of MSC Adams Models with Other Software Tools for System-level Simulations and Analysis, Practical session - EV body design analysis.

References:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Du, H., Cao, D., & Zhang, H. (n.d.). "Modelling, Dynamics, and Control of Electrified Vehicles", Woodhead Publishing, 2017, ISBN-13: 9780128127865
3. Zaman N., "Automotive Electronics Design Fundamentals", Springer, 2015, ISBN-13: 9783319359793
4. Gianfranco Pistoia, "Electric & Hybrid Vehicles", Elsevier, 1st ed, 2010, ISBN: 9780444638250.
5. Chau, K. T., "Electric Vehicle Machines and Drives: Design, Analysis and Application", John Wiley and Sons, Inc., 2015, ISBN-13: 9781118752524.
6. Ehsani, Mehrdad, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles", CRC, 2019, ISBN-13: 9780367137465.
7. Hughes, Austin, "Electric Motors and Drives", Newnes (an Imprint of Butterworth-Heinemann Ltd), 2019, ISBN-13: 9780081026151
8. Chris Ni and M. Abul Masrur, "Hybrid electric Vehicles, Principles and Applications", WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6
9. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

ECE 3241: COMMUNICATION NETWORKS LAB [0 0 3 1]

To simulate a three point-to-point network with duplex links between them. To simulate the transmission of ping message over a network topology and find the number of packets dropped due to congestion. To Simulate and compare the performance of network with topologies such as Star, Ring and Mesh. Wired and Wireless LANs: Mobile Ad-hoc network (MANET), Infrastructure Basic Service Set (IBSS) network with multiple traffic and analyze the performance of the network. Cluster based WSN, Wi-Max network and analyze the performance with multiple traffics. Implementation of ALOHA Protocols for packet communication between a number of nodes connected to a common bus. CSMA, CSMA/CD, Token Bus, Token Ring. To provide reliable data transfer between two nodes over an unreliable network using the stop-and-wait protocol with and without BER. Perform error control at DLL using Bit stuffing, Checksum and Character count. CRC, Hamming Coding. Routing Algorithms.

*Self-Directed Learning: Mobile Ad hoc Networks (MANETs), Wireless Sensor Networks (WSNs)

References:

1. Fourouzan B. A.,"Data Communications and Networking", 5th Edition Mc Graw Hill, 2013
2. Garcia A.L and Widjaja I., "Communication Networks", McGraw Hill, 2006
3. Stallings W.,"Data and Computer Communication" (7e), Prentice Hall. 2004
4. Mir N.F., "Computer and Communication Networks", Pearson Education, 2007
5. Jean Walrand & Pravin Varaiya, "High Performance Communication Networks", 2nd Edition, Morgan Kauffman, 2000

   * https://archive.nptel.ac.in/courses/106/105/106105160/

ECE 3242: COMMUNICATION SYSTEMS LAB [0 0 3 1]

Design and Analysis of Micro strip single band and multi band patch antenna-using HFSS. To study and Characterize the Radiation pattern for Micro strip antenna. Design and Analysis of Array and 5G MIMO antennas using HFSS. To study the performance characteristics of Microwave Components. Implementation of BPSK, QPSK and BFSK using MATLAB/LabVIEW and find the error performance using USRP 2901. Design of a simple 2×2 MIMO spatial multiplexing scheme and evaluate the performance over a Rayleigh/Rician fading channel using MATLAB. Design a Space Time Block Code (Alamouti- STBC) using MATLAB/LabVIEW. Diversity and Combining Techniques 1×1, 2×2 using MRC.

*Self-Directed Learning: Millimeter Wave components and devices

References:

1. John J Prokis and Dimitris G. Manolakis "Digital Signal Processing Principles, Algorithms, and Applications" Prentice-Hall International, Inc., 2015.
2. J Proakis and M. Salehi "Contemporary communication systems using MATLAB", 3rd Edition Cengage Learning, 2013.
3. Ed Doering -Reports on Communication Systems Projects with Lab VIEW.https://www.rose-hulman.edu/~doering/
4. KC Raveendranathan, "Communication systems modelling simulation using MATLAB and SIMULINK" by 1st edition, Taylor and Francis Group, 2015.
5. Balanis, C. A. "Antenna theory: analysis and design" John wiley & sons, 2015.
6. J.D Kraus "Antennas", Second Edition, TMH Publication 1989

   *Link: https://onlinecourses.nptel.ac.in/noc21_ee76/preview

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

ECE 4291: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester to the end of seventh semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

ECE 4292: PROJECT WORK

The project work may be carried out in the institution/industry/research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out before the department committee as part of project evaluation.

PROGRAM ELECTIVES (MINOR)

1. COMPUTATIONAL INTELLIGENCE

ECE 4409: MACHINE LEARNING [3 0 0 3]

Machine learning basics, Naïve Bayesian Model. Non-Parametric Techniques: Density Estimation, Parzen Windows, k- Nearest-Neighbor Estimation, K- nearest neighbor classification, Radial Basis Function Network, Learning Vector Quantization, Clustering, K-Means clustering, Competitive learning, , Support vector machines, , feature selection methods – Filter based techniques and wrapper methods, Principal Component Analysis, Applications of PCA, PCA ,Independent component analysis, Voting, Error correcting output codes, Bagging, Boosting *Self directed learning: Self-Organizing Maps, Recurrent Neural Network, Hopfield Neural Network, Adaptive Resonance Theory, Statistical Hypothesis testing- t-test, ANOVA.

References:

1. Alpaydin E, "Introduction to Machine Learning", (2e), MIT Press. 2010.
2. Duda R.O, Hart P.E. and Stork D.G., "Pattern Classification", (2e), Wiley, 2001
3. Harrington P., "Machine Learning in Action, Manning" Publications, 2012.
4. Bishop C. M., "Pattern Recognition and Machine Learning", Springer, 2007.

5. Jensen R. and Shen Q. "Computational Intelligence and Feature Selection": Rough and Fuzzy Approaches, Vol. 8, IEEE Press Series on Computational Intelligence, John Wiley and Sons, 2008, * https://nptel.ac.in/courses/106106139

ECE 4410: COMPUTER VISION [3 0 0 3]

Image formation, linear filters and convolution, edge detection, image features, texture analysis and synthesis, Segmentation using clustering, Segmentation and fitting using probabilistic methods, Homogenous coordinates, Epipolar geometry, least-square parameter estimation, Feature selection, Bayes Classifier, Multi-layer perceptron, Support Vector Machine. *Self directed learning: Simulation of Image Segmentation

References:

1. David A. Forsyth and Jean Ponce, "Computer Vision": A Modern Approach, Pearson Education, 2003
2. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer, 2010
3. Richard Hartley and Andrew Zisserman, "Multiple View Geometry in Computer Vision", 2nd Edition, Cambridge University Press, 2004
4. Linda Shapiro and George Stockman, "Computer Vision", Pearson Education, 2001.

*Image processing tool box in MATLAB

2. EMBEDDED SYSTEM

ECE 4411: EMBEDDED SYSTEM DESIGN [3 0 0 3]

Embedded systems overview, Embedded Software: Interrupts, interrupt latency, shared data problems. que scheduling, Realtime operating system architecture, Introduction to real time operating system; Embedded hardware: standard peripherals; Communication; protocols; Designing embedded system using FSM models. Hardware and software co-design; Embedded C programming. Embedded development life cycle(EDLC).

*Self directed learning: Design and simulate an embedded system using Circuit simulation software.

References:

1. Frank Vahid & Tony Givargis, "Embedded system design",Wiley Publication,2002.
2. David E Simon, "An Embedded software primer", Addison Wesley, 1999.
3. Shibu K.V,"Introduction to embedded systems",McGraw Hill Publication,2013.
4. Raj Kamal,"Embedded Systems", 2nd edition,Tata McGrawHill, 2003.

   *https://electrosome.com/getting-started-with-proteus-beginners-tutorial/

ECE 4412: INTERNET OF THINGS [3 0 0 3]

Demystifying the IoT Paradigm; IoT Protocols and Technologies; Concept of Device-to-Device/Machine-to-Machine Integration, Device-to-Cloud Integration, Realization of IoT Ecosystem Using Wireless Technologies; Infrastructure and Service Discovery Protocols for the IoT Ecosystem; Next-Generation Clouds for IoT Applications and Analytics; Cloud Computing; Emerging Field of IoT Data Analytics; Software Defined Networking (SDN), Self-Directed Learning: Introduction to Arduino Programming: Integration of Sensors and Actuators with Arduino Introduction to Python programming, Raspberry Pi, Implementation of IoT with Raspberry Pi.

References:

1. Raj P. and Raman A. C., The Internet of Things: Enabling Technologies, Platforms and Use Cases, CRC Press, 2017
2. Bagha A. and Medisetti V, "Internet of Things": A Hands on Approach, University Press, 2015.
3. Holler J., Tsiatsis V., Mulligan C., Karnouskos S., Avesand S., and Boyle D., From "Machine to Machine to the Internet of Things": "Introduction to a New Age of Intelligence", Academic Press, 2014
4. Vahid F, Givargis T., "Embedded Systems Design": "A Unified Hardware/Software Introduction", Wiley Publications, 2000
5. Axelson J, "Parallel Port Complete", Penram Publications, 1996. *https://onlinecourses.nptel.ac.in/noc21_cs63/unit?unit=41&lesson=48

3. SIGNAL PROCESSING

ECE 4413: ADVANCED DIGITAL SIGNAL PROCESSING [3 0 0 3]

Multi-rate systems; decimation and interpolation (integer and fractional); poly phase filter structure; quadrature mirror filter bank (QMF); short-time Fourier transform and discrete-time wavelet transform; principle of adaptive filters; least mean square (LMS) algorithm; recursive least square (RLS) algorithms; application of adaptive filters; homomorphic system; complex cepstrum; homomorphic systems for convolution and de-convolution; examples of homomorphic signal processing.

*Self directed learning , Multirate signal processing

References:

1. Vaidyanathan P. P, Multirate Systems and Filter Banks, Prentice Hall, India, 1993.
2. Gadre V M, Abhyankar A S, Multire solution and Multirate Signal Processing: Introduction, Principles and Applications, McGraw Hill, 2017.
3. Orfanidis S. J, Optimum Signal Processing, McGraw Hill , NJ, 2007.
4. Oppenheim A.V and Schafer R.W., Digital Signal Processing, PHI Learning, 2008.

   * https://www.youtube.com/playlist?list=PLyqSpQzTE6M_h5UgZWpybzBVDGmHGhQQb – NPTEL NOC - IITM

ECE 4414: DIGITAL SPEECH PROCESSING [3 0 0 3]

Fundamentals of speech: Anatomy and physiology of speech production system, phonetics, types of speech sounds. Time domain analysis of speech:Time dependent processing of speech, pitch period estimation using auto correlation function. Short-time Fourier analysis of speech:Short time Fourier transform analysis, formant evaluation using log spectrum and power spectral density estimates, spectrograms. Homomorphic processing of speech: Cepstral analysis of speech. Linear predictive coding of speech: Linear models of speech, Basic principles of LPC. Speech Processing Applications: Speech coding, Speech recognition systems. *Self-directed learning: Automatic speech recognition (ASR), Speech Synthesis.

References:

1. Rabiner L.R and Schaffer R.W, "Digital Processing of Speech Signals", Prentice Hall, NJ, 2007.
2. Thomas F. Quatieri, "Discrete. time Speech Signal Processing—Principles and Practice", Pearson Education, Inc., 2004.
3. Douglas O' Shaughnessy, "Speech Communications. Human and Machine Reading", Addison Wesley, 1987.
4. Dr. Shaila D. Apte, "Speech and Audio Processing", Wiley India, 2012.
5. *Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana, "Fundamentals of Speech Recognition", Pearson, 2011 (Fifth Impression).

4. COMMUNICATION SYSTEMS

ECE 4401: MACHINE LEARNING FOR COMMUNICATION SYSTEM [3 0 0 3]

Linking machine learning and communication systems. Overview of supervised, unsupervised and reinforcement learning. Communication Systems: use of machine learning in OSI layer. Connection between signal processing, adaptive filtering and machine learning. Self-organizing wireless networks, Cognitive radio and machine learning. Neural networks, network training, use of gradient information, gradient descent optimization; error back propagation, Bayesian neural networks, Support vector machines. ML and DL for communication system. *Self-directed Learning: Classification of learning

References:

1. Christopher Bishop, "Pattern Recognition and Machine Learning", First Edition, Springer, 2016.
2. Krishna Kant Singh, Akansha Singh, KorhanCengiz, Dac-Nhuong Le, "Machine Learning and Cognitive Computing for Mobile Communications and Wireless Networks", Wiley, 2020.
3. Yoshua Bengio, "Learning Deep Architectures for AI, Foundations and Trends in Machine Learning", First Edition, Now Publishers Inc, 2009.

   *https://www.youtube.com/watch?v=EWmCkVfPnJ8&list=PLJ5C_6qdAvBGaabKHmVbt ryZW9KpICiHC&index=2

ECE 4402: B5G COMMUNICATION SYSTEMS [3 0 0 3]

Challenges in next generation mobile technologies. High Altitude Stratospheric Platform Station Systems, Human Bond Communications, CONASENS, Introduction to propagation model for 5G. Antennas and propagation for 5G and beyond, Antennas Technology for future Generation communication system: state-of-the-art and open challenges Massive MIMO antenna technology, State-of-the-art phased arrays. 5G and beyond antenna challenges, Multiband millimetre-wave technology for 5G: Concept and topology, Megatrends toward 6G, 6G Services, Requirements, Candidate Technologies: Terahertz Technologies, Novel Antenna Technologies, Evolution of Duplex Technology, Evolution of Network Topology,Spectrum Sharing, Comprehensive AI,Split Computing, High-Precision Network. 6G Timeline. *Self-directed Learning: Topologies for 6G services

References:

1. Ramjee Prasad, "5G: 2020 and Beyond", River Publishers, 2019.
2. Qammer H. Abbasi, Syeda F. Jilani, Akram Alomainy and Muhammed A.Imran, "Antennas and propagation for 5G and beyond", IET, 2020.
3. Hai Tang, Ning Yang, Zhi Zhang, Zhongda Du, Jia Shen, "5G NR and Enhancements": From R15 to R16", Elsevier, 2021.
4. *Samsung 6G white paper "6G:The Next Hyper Connected Experience for All" Samsung Research, 2021.
5. Christopher Cox, "An Introduction to 5G: The New Radio, 5G Network and Beyond", Wiley, 2020.

ECE 4403: PHOTONIC COMMUNICATION SYSTEM [3 0 0 3]

Light propagation in multimode and single mode fibers, optical impairments, Optoelectronic Devices, Semiconductor Detectors, Photonic Devices and circuits, Light wave Systems, Optical Signal Processing, Optical Networks Photonic Communication System Design

*Self-directed Learning: Optical Networks

References:

1. B. E. A. Saleh and M. C. Teich , "Fundamentals of Photonics", Wiley-India, 2007
2. *J. M. Senior, "Optical Fiber Communication-principles and practice", Prentice hall of India, 3rd Edition, 2009.
3. Gerd Keiser, Optical Fiber Communications, TMH publication, 5th edition, 2017.
4. Govind P. Agrawal - Fiber-optic communication systems - Wiley et Sons , 4th edition,2010
5. R. Ramaswami and K. Sivarajan, Optical Networks: A Practical Perspective, Morgan Kaufmann, 2nd Edition, Elsevier, 2001.

ECE 4404: SATELLITE BASED WIRELESS COMMUNICATION [3 0 0 3]

Orbital Mechanics and Sub systems, Satellite link Design: Uplink and Downlink Design, Design of Satellite Links for Specified Carrier-to-Noise plus Interference Ratio, Noise figure and Noise temperature. Attenuation Noise, Tropospheric Multipath and Scintillation Effects. Interference Analysis, Interference to and from Adjacent Satellite Systems, Terrestrial Interference, Cross-polarization Interference, Intermodulation Interference.Diversity Combining and Handover techniques in 5G using MEO. Free Space Optical Communication for Inter Satellites: design issues. Acquisition Tracking Pointing of an optical beam. Beamforming in FSO inter satellite. *Self Directed Learning: Modulation formats for 5G wireless systems.

References:

1. Tri T. Ha ,"Digital Satellite Communications", 2/e, McGraw-Hill, 1990.
2. T. Pratt, C.W. Bostian, "Satellite Communications", John Willey and Sons, 2011.
3. *Shree Krishna Sharma, Symeon Chatzinotas and Pantelis-Daniel

Arapoglou, "Satellite Communications in the 5G Era" IET Telecommunications series- 79, 2018.

4. Terrestrial-"Satellite Communication Networks": Transceivers Design and Resource Allocation, Springer International Publishing AG 2017, LinlingKuang, Chunxiao Jiang Yi Qian, Jianhua Lu. 2017

5. VLSI DESIGN

ECE 4405: LOW POWER VLSI DESIGN [3 0 0 3]

Basics of low power VLSI design, sources of power dissipation in digital integrated circuits, Power dissipation in CMOS circuits. Dynamic and static power dissipation. Probabilistic power analysis. Equivalent Pin Ordering, Network Restructuring and Reorganization. Logic encoding, state machine encoding, reduction of power in address and data buses. Power and performance management, parallel architecture with voltage reduction, low power memory design. Low power clock distribution.

*Self-Directed Learning: Battery-Aware Systems, OS level and software level power reduction techniques.

References:

1. *Gary K. Yeap, "Practical Low Power Digital VLSI Design", KAP, 2002.
2. Christian Piguet, "Low Power CMOS Circuits – Technology, Logic Design and CAD Tools", CRC Press, 2006.
3. Jan M. Rabaey, Massoud Pedram, "Low power design methodologies", Kluwer Academic, 1997.
4. Kaushik Roy, Sharat Prasad, "Low Power CMOS VLSI Circuit Design", Wiley, 2000.
5. Kiat Seng Yeo, Samir S. Rofail, Wang-Ling Goh, "CMOS/BiCMOS ULSI: Low Voltage, Low Power", Pearson, 2002.

ECE 4406: MOS DEVICE MODELLING [3 0 0 3]

Introduction to SPICE modelling, SPICE modelling of passive elements and active devices. MOSFET model parameters; Circuit simulation techniques: DC analysis, AC analysis, Transient analysis; noise model: Noise sources in MOSFET; BSIM4 MOSFET model: BSIM3 model, issues in BSIM3, Layout-Dependent Parasitics. Data Acquisition and model parameter measurements, Other Models; Introduction to SPICE tools: Introduction to Device simulators, models supported. *Self-Directed Learning: Introduction to SPICE tools- CMOS VLSI Design

References:

1. Tar Fjeldly, Trond Ytterdal and Michael S. Shur "Introduction to Device Modeling and Circuit Simulation" Wiley-Blackwell, 1997.
2. Giuseppe Massabrio and Paolo Antognetti "Semiconductor Device Modeling with Spice" Tata McHill, 2010.
3. William Liu, "MOSFET Models for SPICE Simulation: Including BSIM3v3 and BSIM4", Wiley-IEEE Press, 2001.
4. Nandita Das Gupta and Amitava Das Gupta, "Semiconductor Devices. Modeling and Technology", PHI, New Delhi, 2004.
5. M.K.Achuthan and K.N. Bhat, "Fundamentals of Semiconductor Devices", Tata McGraw.Hill, New Delhi, 2011.

   *Introduction to SPICE tools- CMOS Digital VLSI Design By Prof. SudebDasgupta ,IITRoorkee

ECE 4407: DIGITAL DESIGN VERIFICATION [3 0 0 3]

Introduction to verification, Developing Verification strategies, Applying Verification strategies, RTL ports and interfaces, Modelling hardware interfaces with concurrency constructs, simulating test benches using Fork-join, stimulus synchronization using conventional synchronization constructs like Mailboxes, Semaphores, regions and events. Basics of UVM verification, System Verilog, Advanced Functional Verification, Basics of Formal Verification. *Self-directed Learning: Verification of combinational and sequential logic circuits using System Verilog

References:

1. Padmanabhan T.R. and Sundari B.B.T., "Design Through Verilog HDL", John Wiley &Sons, 2004.
2. Palnitkar S., Verilog® HDL. A Guide to Digital Designand Synthesis IEEE 1361-2001 Compliant (2e), Prentice Hall,2003
3. Bhaskar J., "A VerilogHDL" Primer, BS Publications, 2005.
4. Brown S..andVranesic Z., "Fundamentals of Digital Logic with VerilogDesign (5e)", Tata McGraw Hill, 2005.
5. Ciletti M.D., "Advanced Digital Design with the Verilog HDL", PHI, 2005.

   * https://edaplayground.com/

ECE 4408: ANALOG IC DESIGN [3 0 0 3]

Integrated circuit design philosophy, Recent trends and challenges in IC design, SPICE coding, Analyze and design of Basic current mirrors, Single stage amplifiers, Analysis and Design of Integrated two stage CMOS amplifier, Stability and frequency compensation, Temperature independent biasing, PTAT voltage, CTAT voltage device, beta multiplier, Band-gap reference, Linear voltage regulator specifications, performance parameters, LDOs. * Self-Directed Learning: - Examples of Current sink and sources

References:

1. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", McGraw-Hill, 2001.
2. R. Jacob Baker, "CMOS Circuit Design, Layout and Simulation", Wiley India, 2010.
3. Allen and Holberg, "CMOS Analog Circuit Design", 2nd Edition, Oxford Press, 2002
4. Sedraans Smith, "Microelectronic Circuits", Oxford Press, 2005.
5. Gabriel A. Rincon-Mora, "Analog IC Design with Low-Dropout Regulators", McGraw-Hill Education, 2009.

* http://www.satishkashyap.com/2013/06/video-lectures-and-lecture-notes-on.html

OTHER ELECTIVES

ECE 4441: 5G: FUNDAMENTALS & ARCHITECTURES [3 0 0 3]

Introduction to 4G/LTE, Introduction to 5G networks, Use Cases, Network Architecture, Understanding of Base Station Architecture & Antenna Architecture, Different types & configurations of Antennas, Various interfaces of different Network elements, 5G protocol stack for Layer 1, 2 & 3. Call Processing & Handovers, MIMO techniques, Beamforming in 5G - Types, Analog, Digital, Hybrid. 3GPP standards &

roadmap, Hands On training. *Self-directed Learning: Overview of 5G communication technology Propagation Characteristics of 5G Channel models

References:

1. Chris J, “5G New Radio in Bullets”, Paper back, 1st Edition, 2019.
2. Nokia 5G Core eBook - Innovate, execute and pivot to new opportunities
3. Nokia 5G white papers 5G white papers - 5G Massive MIMO Innovations
4. Boosting Spectral, Energy and Site Efficiency
5. 5G Indoor network strategies for small medium enterprises and residences
6. https://onestore.nokia.com /asset/200999?_ga=2.11956852. 1970943933.1650955329-1776165991.1650955328
7. 6G Flag ships https://www.oulu.fi/6gflagship/6g-white-paper-localization-sensing
   https://www.nokia.com/networks/5g/mobile/5g-resources/
8. https://onestore.nokia.com/asset/ 210692?_ga=2.255171144. 1970943933.1650955329-1776165991.1650955328
9. *Link: https://onlinecourses.nptel.ac.in/noc22_ee56/preview

ECE 4442: ANTENNA FOR 5G AND BEYOND NETWORKS [3 0 0 3]

Fundamental of Antenna: Antenna Introduction, Basic Parameters of Antenna, Impedance matching, Antenna measurements. Micro-strip Antenna Design: Introduction, Basic Characteristics, Rectangular and circular Patch antenna design. Wideband Antenna Design: UWB antenna design and applications, SWB antenna design and applications, Notching in Wideband antennas, Different notching structure design. Antennas for 5G: Key features of 5G antennas, Massive MIMO antenna technology: Antenna array topology, Single user (SU)-MIMO and multiple user (MU)-MIMO, Beamforming antennas in 5G massive MIMO, State-of-the-art phased arrays, 5G antenna challenges: Active and passive antenna systems. Millimeter Wave MIMO Antennas: Introduction, mm Wave MIMO Antennas, Compact mm Wave MIMO Antenna Design, Prototype and MIMO Antenna Performance.

*Self-directed Learning: Modeling of 5G antenna

References:

1. Balanis, Constantine A. “Antenna theory: analysis and design'. John wiley & sons, 2015.
2. James, James R., Peter S. Hall, and Colin Wood. Microstrip antenna: theory and design. Vol. 12. Iet, 1986.
3. R. ITU-R, "Characteristics of ultra-wide band technology," ITU-R, vol. SM.1755-0, 2006
4. Kumar, Sumit, et al. "Fifth generation antennas: A comprehensive review of design and performance enhancement techniques." IEEE Access 8 (2020): 163568-163593.
5. Sherine Mohamed Abd El-Kader, Hanan Hussein : “Fundamental and Supportive Technologies for 5G Mobile Networks', IGI Global,2020
   * https://www.youtube.com/watch?v=p3wU5xwyCV8

ECE 4443: BIOINSPIRED AND EVOLVABLE SYSTEMS [3 0 0 3]

Introduction to Soft, Quantum, DNA Computing, Genetic algorithms, PSO, ACO, Spiking Neural Networks, Self-Organizing Maps, Deep Learning: CNN, Immune System, Random Forest, Adleman's experiment, Universal DNA Computers. Reconfigurable Hardware: FPGAs, Evolutionary hardware Design and Application: Implementation of evolutionary clustering. Evolvable Hardware: Cartesian Genetic Programming, Redundancy and Neutrality, Fitness Landscape Analysis, Chromosome to Fitness Value, Platforms for Circuit Evolution, Evolutionary Circuit Design: Static and Dynamic Fitness Function, Communication between Evolvable Component and Environment, Applications: Filters in Image Processing, smoothing. Evolvable and Non-Uniform Cellular Automaton, General Evolvable Computational Machine, Computation of Evolvable Machines, Changing Fitness Function, The Turing Machine, Church-Turing Thesis, Site Machine.

*Self-Directed Learning Cellular Automaton

References:

1. Lukas Sekanina, “Evolvable Components: From Theory to Hardware Implementations”, Springer-Verlag Berlin Heidelberg New York, 2004,
2. David W. Corne, Peter J. Bentley, “Creative Evolutionary Systems”, Academic Publishers, 2002.
3. Albert Chun Chen Liu and Oscar Ming Kin Law, “Artificial Intelligence Hardware Design: Challenges and Solutions”, IEEE Press Wiley, 2021, First edition
4. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, Cambridge, MA, 2008.
5. Leandro Nunes de Castro, " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007 *Xuewei Li, Jinpei Wu, Xueyan Li –'Theory of Practical Cellular Automaton' Springer
   Singapore, 2018 (First edition).
   https://mathworld.wolfram.com/CellularAutomaton.html

ECE 4444: BIOMEMS AND MICRO SENSORS [3 0 0 3]

Historical Background of MEMS, MEMS Transduction and Actuation Techniques, Micro sensing for MEMS, Basic Bio-MEMS Fabrication Technologies, UV Lithography of Ultra thick SU-8 for Microfabrication of High-Aspect-Ratio Microstructures and Applications in Microfluidic and optical components, Microfluidic Devices and Components for Bio-MEMS: Micro pump Applications in Bio-MEMS, Micro mixers, Sensing Technologies for Bio-MEMS Applications, Culture-Based Biochip for Rapid Detection of Environmental Mycobacteria, MEMS for Drug Delivery, Microchip Capillary Polymerase Chain Reaction and microsystem approach for PCR.

*Self Directed Learning: Microfluidics & Bio sensing devices for real time applications.

References:

1. 1RF MEMS and Their Applications, Vijay K. Varadan, K.J. Vinoy and K.A. Jose, Wiley, 2003 Edition.

2. Bio-MEMS-Technologies and Applications, Edited by Wanjun Wang and Steven A. Soper, CRC Press, 2007.
3. 3.Richard P.Buck,WilliamE.Hatfieldc, “Biosensors Technology” Marcel dekker USA, 1990.
4. Stephen D. Senturia, "Microsystem Design" by, Kluwer Academic Publishers, 2001.
5. Marc Madou, “Fundamentals of Microfabrication” by, CRC Press, 1997.
6. Gregory Kovacs, “Micromachined Transducers Sourcebook” WCB McGraw-Hill, Boston, 1998.

*https://www.youtube.com/watch?v=BAJPvN2WBIA Lecture series 03 from ProfessorSumanChakraborthy IIT Kharagpur

ECE 4445: CMOS MIXED SIGNAL VLSI DESIGN [3 0 0 3]

Introduction to Mixed-Signal Design (MSD):Basic building blocks: data converters, continuous-time and sampled-data filters; Filters: Sample and hold (S/H) circuits, MOS switches, OTA-C approach; Switched Capacitor Circuits: Introduction to Switched Capacitor circuits- basic building blocks, Operation and Analysis; Comparators: Comparator specifications – input offset and noise, hysteresis, OPAMP as a comparator, errors and charge injections, types; Data Converters: Fundamentals, DAC and ADC specifications, DAC architectures ,ADC Architectures, Phased Lock Loop (PLL): Basic PLL topology, Dynamics of simple PLL, Mixed Signal Layout Issues: Power-supply and grounding issues, fully-differential design, ESD protection, sensor interfaces, VLSI interconnects.

* Self-Directed Learning: -Phased Lock Loop (PLL)

References:

1. R.Jacob Baker, “CMOS Mixed Signal Circuit Design, Wiley India, 2nd Edition, 2016.
2. Behzad Razavi ,Design of Analog CMOS Integrated Circuits , McGraw Hill Education; Second edition,2017.
3. Rudy van de Plassche, CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters, Springer, 2003.
4. P. V. Anand Mohan, Current-mode VLSI Analog Filters: Design and Applications, Birkhäuser; 3rd edition,2012.
5. T Deliyanis, Y Sun and J K Fidler, Continuous-Time Active Filter Design, CRC Press, 1999.

* Lecture notes by S. Aniruddhan , IIT Madras, https:// www.ee.iitm.ac.in/~ani/2013/ee5390/lectures.html

ECE 4446: DATA ANALYTICS AND VISUALIZATION [3 0 0 3]

Data analytics methods and representation, Data Gathering and Preparation: Data Formats, Parsing and Transformation, Scalability and Real-time Issues; Data Cleaning. Exploratory Analysis, Descriptive and comparative statistics, Hypothesis testing, Statistical Inference. Association rule mining, FP Growth, Partitioning, measures of pattern interestingness. Clustering: Visualization: Visual Representation of Data, Gestalt Principles, Information Overloads. Classification of Visualization Systems, Interaction and Visualization Techniques, Visualization of One, Two and Multi-Dimensional Data, Text and Text Documents; Visualization of Groups: Trees, Graphs, Clusters, Networks, Software, Metaphorical Visualization.

* Self-Directed Learning: Visualization of Volumetric Data.

References:

1. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data I: A Practical Guide to Exploratory “Data Analysis and Data Mining”, 2nd Edition, John Wiley & Sons Publication, 2014.
2. *Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data II: A Practical Guide to Data Visualization, Advanced Data Mining Methods, and Applications, John Wiley & Sons Publication, 2009.
3. E. Tufte. The Visual Display of Quantitative Information, (2e), Graphics Press, 2007.
4. Jules J., Berman D., Principles of Big Data: Preparing, Sharing, and Analyzing Complex Information, (2e), 2013.
5. Matthew Ward and Georges Grinstein, Interactive Data Visualization: Foundations, Techniques, and Applications, (2e), A K Peters/CRC Press, 2015.

ECE 4447: DATA STRUCTURES AND ALGORITHMS [3 0 0 3]

Data Structures – Introduction to Data Structures, abstract data types, Time and space complexity Linear list – singly linked, circular linked list, Double linked list, Applications of linked lists. Stacks-Operations, array and linked representations of stacks, stack applications, recursion implementation. Queues-operations, array and linked representations, applications of queues. Trees - tree representation, properties of trees, Binary tree representation, binary tree properties, binary tree traversals, binary tree implementation, applications of trees, Graph- Representation of Graph, types of graph, Matrix Representation of Graphs, Elementary Graph operations, Spanning Trees, Shortest path, Minimal spanning tree. Searching and Sorting – Sorting- selection sort, bubble sort, insertion sort, quick sort, merge sort, shell sort, radix sort, Searching- linear and binary search methods, comparison of sorting and searching methods. *Self-Directed Learning: Implementation of data structure and algorithms using compilers.

References:

1. Ellis Horowitz;Sartaj Sahni;Dinesh Mehta, “Fundamentals of Data Structures in C++”, 2nd edition, Universities Press (India) Limited, 2013.
2. Mark A. Weiss, “Data Structures and Algorithm Analysis in C++”, 3rd Edition, Pearson Education India, 2007.
3. Lipschutz, “Data Structures with C++”, Schaum outline series, 2006
4. Michael T. Goodrich, Roberto Tamassia, David Mount, “Data Structures and Algorithms in C++”, John Wiley & Sons, 2011.
5. *https://www.javatpoint.com/cpp-installation

ECE 4448: ELECTRONIC INSTRUMENTATION [3 0 0 3]

Transducers, Generalized measurement system, functional description of measuring systems. Generalized performance characteristics. Static and dynamic characteristics, Errors and their classification, statistical analysis., Temperature and pressure measurement, Level and thickness measurement, Flow measurement, applications, and Biomedical instruments for measurement of ECG, EEG, EMG, and EGG.

*Self-directed topic:Study of biomedical instruments.

References:

1. DVS Murthy, "Transducers & Instrumentation", PHI, New Delhi, 1999.
2. A.K. Sawhney, "Electrical & Electronic Measurements and Instrumentation", Dhanpat Rai & Co, New Delhi, 2002.
3. Doeblin E.O., "Measurement Systems. Application and Design", 4th edition, McGraw-Hill, New York, 1996.
3. Khandpur, "Hand book of Biomedical Instrumentation", McGraw Hill, 2003.

   *NPTEL: Electrical Measurement and Electronic Instruments

ECE 4449: EMBEDDED OPERATING SYSTEMS AND RTOS [3 0 0 3]

Embedded systems, Advanced processors and controllers; ARM cortex M-processor architecture. The Cortex Microcontroller Software Interface Standard (CMSIS). Operating systems concept, Process, Thread. Developing with RTOS, RTX – Real-time executive. Programming, UART. Scheduling options in RTX, RTX program. Uniprocessor scheduling. Inter process communication. Task synchronization, Classical synchronization problem, kernel objects. Free RTOS, Heap memory management, Task management, Queue management, Interrupt & Resource management, Event groups & Task notifications. Deadlock.

*Self Directed Learning, RTX programming on LPC 1768 (*RTX Manual). Simulation using Free RTOS

References:

1. William Stallings , "Operating systems", PHI, 2001.
2. Valvano J.W., "Embedded Systems": "Real-Time Operating Systems for ARM Cortex-M Microcontrollers", Volume3, (4e), Self Published in 2017.
3. Qing Li , "Real time concepts for Embedded Systems", CMP Books, Elsevier, 2003.
4. Wang K.C., "Embedded and Real-Time Operating Systems", Springer, 2017.
5. *Barry R., "Mastering the Free RTOS Real Time Kernel – A Hands on Tutorial Guide, Real Time Engineers LTD., 2016

ECE 4450: EMBEDDED PROGRAMMING [3 0 0 3]

Basics of Embedded Systems, Embedded Programming Concepts: Role of Infinite loop – Compiling, Linking and locating, Efficient compilation examples – downloading and debugging – Emulator and simulator processors – External peripherals – Memory testing – Flash Memory Operating System: Embedded operating systems – Real time characteristics – Selection process – Flashing the LED – serial ports – code efficiency – Code size – Reducing memory usage – Impact of object oriented programming. Hardware Fundamentals: Buses – DMA – interrupts – Built-ins on the microprocessor – Conventions used on schematics – Microprocessor Architectures – Software Architectures – RTOS Architectures. RTOS Tasks and Task states – System V IPC mechanisms – Memory management – Interrupt routines – Encapsulating semaphore and queues – Hard Real-time scheduling – Power saving. Embedded Software Development Tools– Linkers / Locators for Embedded Software – Debugging techniques – Instruction set simulators Laboratory tools – Practical example – Source code. Case study on Portable computing platforms.

*Self Directed Learning, Embedded C programming

References:

1. Michael Barr, Anthony Massa "Programming Embedded Systems with C and GNU Development Tools", O'reilly Media , Second edition, Oct, 2006.
2. David E. Simon, "An Embedded Software Primer", Pearson Education, 2003
3. *Michael Barr, "Programming Embedded Systems in C and C++", O'Reilly, 2003.
4. Wang K.C., "Embedded and Real-Time Operating Systems", Springer, 2017.

ECE 4451: ERROR CONTROL CODING [3 0 0 3]

Prime Number theory, Fields, Galois field arithmetic, vector spaces, Matrices. Linear block codes, Cyclic codes: shortened cyclic codes, burst error correcting cyclic codes, Fire codes, and interleaved codes. Multiple error correcting codes: BCH codes, Non binary BCH codes: RS codes. Convolution codes: Trellis, Tree, & state diagram, Viterbi algorithm. Recent developments: Turbo codes and LDPC codes.

*Self-Directed learning, Applications of Turbo codes and LDPC codes

References:

1. S. Lin and D. J. Costello Jr, "Error control coding Fundamentals and Applications" Prentice Hall, 1983.
2. McWilliams & Sloane, "Theory of Error Correcting Codes", North Holland Publishing Co, 2006.
3. W. W. Peterson and E. J. Weldon "Error Correcting Codes", 2nd edition, John Wiley, 1972.
4. E. R. Berlekamp, "Algebraic Coding Theory", Aegean Park Press, 1984.
5. Blahut, R. E., "Theory and Practice of Error Control Codes", Addison-Wesley Pub. Co., 1983.

   * https://archive.nptel.ac.in/courses/117/106/108106137/

ECE 4452: FLEXIBLE ELECTRONICS [3 0 0 3]

Introduction to Flexible Electronics: Background and history, trends, emerging technologies; Basic of disordered materials: Basic concepts, atomic and electronic structure, electronic properties; Materials for Flexible Electronics; Processing technology for flexible electronics: gravure printing, photolithography, low-temperature process integration; Flexible devices: Thin Film Transistors; Optoelectronic devices; Flexible Electronics Applications: Displays, memory devices, lab-on-a-chip, and flexible solar panels. Flexible devices and sensors for healthcare, environmental and agriculture applications.

*Self-Directed Learning - Gravure printing, inkjet printing, roll-to-roll processing, micro contact printing. CVD, PECVD, PVD, etching, photolithography.

References:

1. William S. Wong, Alberto Salleo, "Flexible Electronics": "Materials and Applications", 2011, 1st Edition, Springer, New York.
2. Guozhen Shen, Zhiyong Fan, "Flexible Electronics: From Materials to Devices", 2015, 1st Edition, World Scientific Publishing Co, Singapore

3. Richard Zallen, “The Physics of Amorphous Solids”, Wiley-Interscience Publication, 1983.
4. Sanjiv Sambandan, "CIRCUIT DESIGN Techniques for Non-Crystalline Semiconductors", CRC Press Taylor & Francis Group, 2013.
5. Edward Sazonov, Michael R. Newman, “Wearable Sensors: Fundamentals, Implementation and Applications”, 2014, 1st Edition, Academic Press, Cambridge * Advanced Textile Printing Technology, IIT Delhi, Prof. Kushal Sen, https://nptel.ac.in/courses/116102052.

   * VLSI Technology, IIT Madras Dr. Nandita Dasgupta, https://nptel.ac.in/courses/117106093.

ECE 4453: HARDWARE FOR MACHINE LEARNING [3 0 0 3]

Latest Machine Learning innovations and projects, Classical ML algorithms, feature extraction, Supervised, Unsupervised, Reinforcement Learning: Q-learning, Performance metrics and verification. Deep Neural networks, (CNN), Recurrent Neural Network (RNN), Generative Adversarial Networks (GAN), Model compression, Pruning, Dropout, Drop Connect, Distillation, Weight-sharing, Numerical compression, Encoding, Zero-skipping, Activation function approximation, Model and Data-flow optimization. Hardware software co-design, Optimizing Memory, Quantization Inference Engine, Fast Implementation of Deep Learning Kernels, Data flows, Sparsity. Study of Evaluation platforms like AWS Cloud, Xilinx ZYNQ, Vitis AI, Zynq FPGA, Intel OpenVINO DLDT, NVDIA Jetson Nano, TPU, Case study: Tesla- Full-Self-Driving Computer.

*Self-Directed Learning TPU: Google, Coral and Domain Specific Accelerators

References:

1. Shigeyuki Takano, “Thinking Machines: Machine Learning and Its Hardware Implementation”, Academic Press, Elsevier, 2021
2. Albert Chun Chen Liu and Oscar Ming Kin Law, “Artificial Intelligence Hardware Design: Challenges and Solutions”, IEEE Press Wiley, 2021, First edition
3. Ethem Alpaydin, "Introduction to Machine Learning", MIT press, 2004.
4. T. Mitchell, “Machine Learning”, McGraw-Hill, 1997.
5. Duda, Richard O., Hart, Peter E., Stork, David G.”Pattern Classification” John Wiley (2nd Edition), 2004

   *https://cloud.google.com/tpu/docs/tpus

   *https://viso.ai/edge-ai/google-coral/

ECE 4454: MICROWAVE INTEGRATED CIRCUITS [3 0 0 3]

Introduction to Monolithic Microwave Integrated Circuits (MMICs), planar transmission lines for MICs. Method of Conformal transformation for micro-strip analysis Coupled micro-strips. Slot Line Approximate analysis and field distribution, Fin lines & Coplanar Lines. Introduction, Analysis of Fin lines by Transverse Resonance Method, Lumped Elements for MICs: Use of Lumped Elements, Resonators and narrow band filters, Filter design, Power gain equations, Amplifier Gain Stability, Noise, DC Biasing, Oscillator Design MIC Measurement, Testing and Applications: MIC measurement system, measurement techniques, S parameter measurement, noise measurement, MIC applications.

*Self-directed Learning: Filter synthesis, Kuroda's Identity

References:

1. K. C. Gupta ,“Microwave Integrated circuit”, 1975
2. Samuel Y. Liao , “Microwave Devices & Circuits 3/e”, 2003
3. “Microstrip lines and Slot lines”, K.C. Gupta, R. Garg.,I.,Bahl, P. Bhartia, Artech House, Boston, 1996.
4. Stripline-like “Transmission lines for Microwave Integrated circuits”, B. Bhat, S. K. Koul, Wiley Eastern Ltd., New Delhi. 1990
5. Microwave Integrated Circuits, By Ivan Kneppo, J. Fabian, P. Bezousek,1994
6. SDL link: https://archive.nptel.ac.in/courses/117/105/117105138/

ECE 4455: MODERN COMPUTER ARCHITECTURE AND ORGANIZATION [3 0 0 3]

Computer architecture Interrupts, Modern computer system specifications; Network Interface, Device drivers, Input/output System (BIOS) and Unified Extensible Firmware Interface (UEFI) firmware's, Multiprocessing; Physical and virtual memory concepts, Memory management unit, Performance enhancing techniques, Multithreading; Handling interrupts and exceptions, Real-time computing systems, Digital signal processor, GPU processing; AMD x86 architecture and instruction set, RISC-V architecture and features; Processor virtualization and Cloud computing. *Self-Directed Learning Virtualization Tools

References:

1. Jim Ledin, “Modern Computer Architecture and Organization-Learn x86, ARM, and RISC-V architectures and the design of smartphones, PCs, and cloud servers”, 2020.
2. David A. Patterson and John L. Hennessy, “Computer Organization and Design –The Hardware / Software Interface”, 4th Edition, Morgan Kaufmann, Elsevier, 2009.
3. John L. Hennessy and David A. Patterson, “Computer Architecture – A Quantitative Approach”, 5th Edition, Morgan Kaufmann, Elsevier, 2011.* https://github.com/PacktPublishing/Modern-Computer-Architecture-and-Organization

ECE 4456: MOTION AND GEOMETRY BASED METHODS IN COMPUTER VISION [3 0 0 3]

Geometric primitives, 2D/3D transformations, image features, MATLAB programming, Image registration (2D/3D) of rigid and deformable objects, range image registration, Tracking by detection, tracking using optical flow and KLT, tracking linear dynamical models with Kalman filters, Epipolar geometry, binocular reconstruction, local and global methods for binocular fusion, Structure from motion: Internally calibrated perspective cameras, Uncalibrated weak perspective cameras, Uncalibrated perspective cameras.

*Self Directed Learning MATLAB programming for stereovision and structure from motion

References:

1. David A. Forsyth and Jean Ponce, “Computer Vision: A Modern Approach”, Pearson Education, 2003.
2. Richard Szeliski, “Computer Vision: Algorithms and Applications”, Springer, 2010.

3. Richard Hartley and Andrew Zisserman, “Multiple View Geometry in Computer Vision”, 2nd Edition, Cambridge University Press, 2004.
4. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, 4th edition, Pearson Education, 2018.

   * https://in.mathworks.com/discovery/stereo-vision.html

   * https://in.mathworks.com/help/vision/ug/structure-from-motion.html

ECE 4457: NANO DEVICES & NANO SENSORS [3 0 0 3]

Quantum Electronic devices – Quantum Dot array – Quantum computer-Bit and Qubit. Carbon Nanotube based logic gates; tunneling devices-Tunneling Diode – Resonant Tunneling Diode – Basics Logic Circuits – Single Electron Transistor (SET); sensor characteristics and physical effects: Active and Passive sensors – Static characteristic - Accuracy, offset and linearity – Dynamic characteristics; Nano sensors applications- Biosensors, conducting Polymer based sensor, DNA Biosensors, optical sensors. Biochips. NEMS. Nano tweezers; Nanolithography-Basics of lithography, optical, micro, ion beam lithography, lithographic tools, nanoimprint, lithography.

*Self-Directed Learning: Nanolithography- Basics of lithography, optical, micro, ion beam lithography, lithographic tools, wet chemical etching.

References:

1. K. Goser, P. Glosekotter and J. Dienstuhl, “Nanoelectronics and Nanosystems-From Transistors to Molecular Quantum Devices” , Springer, 2004.
2. .Ramon Pallas-Areny, John G. Webster, “Sensors and signal conditioning” John Wiley & Sons, 2001.
3. W.R.Fahrner, “Nanotechnology and Nanoelectronics – Materials, Devices and Measurement Techniques” Springer, 2006 13
4. H. Meixner , Sensors: Micro & Nanosensors, Sensor Market trends (Part 1&2) by
5. M Feldman, “Nanolithography:The Art of Fabricating Nanoelectronic and Nanophotonic Devices and Systems”, Woodhead Publishing Series in Electronic and Optical Materials 2014.

   * VLSI Technology, IIT Madras Dr. Nandita Dasgupta, https://nptel.ac.in/courses/117106093.

ECE 4458: NATURE INSPIRED ALGORITHMS, TOOLS AND APPLICATIONS [3 0 0 3]

Biomimetics, Individuals, Entities and agents - Parallelism and Distributivity Interactivity, Adaptation Feedback-Self-Organization-Complexity, Chaos and Fractals, Evolutionary computing, Hill Climbing and Simulated Annealing, Genetic Clustering. Swarm intelligence- PSO, ACO, Artificial Bee Colony, Grey Wolf Optimization, Colliding Bodies Optimization, Swarm Robotics, Immune system inspired computing, Random Forest, Spiking Neural Networks, Self-Organizing Maps, Perceptron, Deep Learning, DNA Computing, Adleman's experiment, Universal DNA Computers. *Self-Directed Learning DNA Computing

References:

1. Leandro Nunes de Castro, " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007
2. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, Cambridge, MA, 2008.
3. Albert Y. Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006.
4. Marco Dorrigo, Thomas Stutzle,” Ant Colony Optimization”, PHI,2005
5. *Martyn Amos- Natural Computing Series- 'Theoretical and Experimental DNA Computation' [1 ed.]- Springer 2005.

   https://computer.howstuffworks.com/dna-computer.html

ECE 4459: NEUROMORPHIC VLSI CIRCUITS [3 0 0 3]

Introduction; Signaling and operation of Biological neurons, neuron models;device physics and sub-threshold circuits; Static and dynamic circuits: current mirror, trans conductance amplifiers, multipliers, power-law circuits, resistive networks, Follower-Integrator, Differentiators; Current-Mode and Signal-Aggregation Circuits: Trans linear Principle, Floating-Gate MOS Circuits, Bump Circuit, Current Multipliers; Analog and digital neuromorphic designs: Non-volatile memristive semiconductor devices; Electronic synapse design; Architecture and performance characteristics of demonstrated chips employing Analog neuromorphic VLSI, Digital neuromorphic VLSI, Electronic synapses and other neuromorphic systems.

*Self-Directed Learning: Static and dynamic circuits: current mirror, transconductance amplifiers, multipliers, power-law circuits, resistive networks, Follower-Integrator, Differentiators, Second-Order Sections, linear and nonlinear filters, adaptive circuits -

References:

1. C. A. Mead , "Analog VLSI and Neural Systems", 1990.
2. Shih-Chii Liu, Jörg Kramer, Giacomo Indiveri, Tobias Delbrück, Rodney Douglas, “Analog VLSI: circuits and principles”, MIT press, 2002.
3. Carver Mead, “Analog VLSI and neural systems”, Addison-Wesley, 1989, ISBN0201059924
4. Eric Kandel, James Schwartz, Thomas Jessell, Steven Siegelbaum, A.J. Hudspeth, “Principles of neural science”, McGraw Hill 2012, ISBN 0071390111
5. Leslie S. Smith and Alister Hamilton, "Neuromorphic systems", World Science, 1998.

   * Analog IC Design, IIT Madras, Prof. S. Aniruddhan, NPTEL, https://nptel.ac.in/courses/108106105.

ECE 4460: NUMBER THEORY AND CRYPTOGRAPHY [3 0 0 3]

Prime Numbers theories & Algorithm, Congruence, Fields & Galois field arithmetic, Discrete Logarithms. Classical cryptosystems: Symmetric Cryptography, Substitution Cipher, Affine Cipher, Hill cipher. Stream Ciphers Vs Block ciphers, Encryption and Decryption with Stream Ciphers, SP networks. Encryption standard: DES, AES. Asymmetric key cipher: Knapsack problem, Merkle - Hellman, RSA, Rabin, Elgamal, & Diffie Hellman Key exchange. Elliptic Curve Cryptosystems and its Elgamal,& Diffie Hellman. Message integrity and message authentication: Hash function, Whirlpool algorithms, digital signatures and authentication protocols. RSA Signature Scheme, Elgamal Digital

Signature Scheme, Elliptic Curve Digital Signature Algorithm (ECDSA).

*Self DirectedLeraning

Role of digital signatures in cryptography. Recent developments in Elliptic curve cryptosystem.

References:

1. Neal Koblitz, "A course in Number Theory and Cryptography", 2nd Edition, Springer,1994
2. Behrouz A. Forouzan, D. Mukhopadhyay, "Cryptography and Network Security", 2nd edition, Tata Mc Graw Hill, 2007.
2. William Stallings, "Cryptography and Network Security", 4th edition, Pearson Education, 2005.
4. Henry Beker, Fred Piper, "Cipher systems: the protection of communications" Northwood Books, 1982.

   * https://csrc.nist.gov/Topics/Security-and-Privacy/cryptography/digital-signatures

   * P. Barreto, B. Lynn and M. Scott, "Efficient implementation of pairing-based cryptosystems", Journal of Cryptology, 17 (2004), 321–334.

ECE 4461: OBJECT ORIENTED PROGRAMMING USING C++ [3 0 0 3]

Overview of C++, Classes & Objects, defining member functions, data hiding, constructors, destructors, parameterized constructors, static data members, functions, friend functions, passing objects as arguments, Inheritance: constructors, destructors and inheritance, passing parameters to base class constructors, granting access, virtual base classes. Virtual functions, polymorphism: I/O system basics, file I/O: Exception handling.

* Self-Directed Learning: - Analytic representation of complex systems and their attributes : NPTEL course : Object-Oriented Analysis and Design, IIT Kharagpur

References:

1. Schildt H., "The Complete Reference C++", Tata McGraw Hill, 2003.
2. Lafore R., "Object-Oriented Programming in C++", Pearson Education, Reprint 2011.
3. Lippmann S.B., Lajore J., "C++ Primer", Pearson Education, 2005.
4. Deitel P.J., Deitel H.M., "C++ for Programmers", Pearson Education, 2009.
5. Sourav Sahay, "Object oriented programming with C++", Oxford University press, 2006.

   * https://nptel.ac.in/courses/106105153

ECE 4462: OPTICAL WIRELESS COMMUNICATION [3 0 0 3]

Introduction to Optical Wireless Communication, Optical Devices, Factors affecting optical signal propagation in atmosphere, Atmospheric Turbulence Models, Modulation Techniques, FSO Link Performance under the Effect of Atmospheric Turbulence, Atmospheric Turbulence Mitigation Techniques, Visible Light Communications, Hybrid Fiber and FSO Wavelength multiplexing FSO system.

*Self-Directed Learning: Atmospheric Turbulence Models (Log-Normal Turbulence Model)

References:

1. *Z. Ghassemlooy, W. Popoola, S. Rajbhandari, "Optical Wireless Communications: System and Channel Modelling with MATLAB", CRC Press, 2012
2. L. C. Andrews and R. L. Phillips, Laser Beam Propagation through Random Media, 2nd ed. Bellingham, Washington: SPIE Press- "The International Society for Optical Engineering", 2005.
3. O. J. Bandele, P. N. Desai, M. S. Woolfson, A. J. Phillips, "Saturation in Cascaded Optical Amplifier Free-Space Optical Communication Systems", IET Optoelectronics, vol. 10, no. 3 pp. 71-79, 2016
4. A. M. Mbah, J. G. Walker, A. J. Phillips, "Outage probability of WDM free-space optical systems affected by turbulence-accentuated interchannel crosstalk", IET Optoelectronics, vol. 11, no. 3 pp. 91-97, 2016

ECE 4463: PCB AND SYSTEM DESIGN [3 0 0 3]

Electronic system design, Systems approach to Engineering, electronic system design flow, design stages, reverse engineering, and redesign methodology, Signal acquisition and conditioning and assessment of electronic systems Printed circuit board and production techniques, Electronic design automation(EDA) tools for PCB designing, soldering techniques, Tin lead phase diagram, Mechanical operations, PCB technology, multilayer boards, Modern PCB Design, soldering techniques, packages for semiconductor devices ad ICs, reliability issues in ICs, SMD components, SMD family, component packaging, assembling, pad dimensions, microsystem packaging,

* Self-Directed Learning: Simulation of PCB using EDA tools

References:

1. Kevin N.Otto and Kristin L.Wood, "Product Design techniques in Reverse Engineering and New product Development", Pearson Education, 2001.
2. Walter C. Bosshart, "Printed circuit Board Design and technology", McGraw-Hill Education – Europe. 2002.
3. Neil storey,"Electronics System approach" Pearson Education, 2011
4. Rudolf Strauss, "Surface Mount Technology", Butterworth-Heinemann Ltd, Oxford, 1994.
5. Douglas Brooks, "Signal Integrity Issues and Printed Circuit Board Design", Prentice Hall, 2003.

   *F. Giudice, G. Rosa, Antonino Risitano, Product Design for the environment - A life cycle approach, Taylor & Francis 2006, ISBN: 08493272.

   * NPTEL Course on "An introduction to Electronic Systems Packaging ,IISC Bangalore by Professor G.V.Mahesh.

ECE 4464: POWER ELECTRONICS [3 0 0 3]

Power Electronics Devices, controlled rectifiers, single phase and three phase converters for different loads, dual converters and cyclo converters. DC-DC switched mode converters: Buck, Boost, Buck-Boost, Cuk, Flyback, forward. DC-AC switched mode inverters: Half bridge and full bridge single phase inverters, three phase inverters with 120o and 180o conduction.

*Self Directed Learning: Switched mode power supplies, power conditioners, UPS.

References:

1. Hart D.W., Introduction to Power Electronics, McGrawHill, 2010.
2. Rashid M.H., Power Electronics Circuits, Devices and Applications, Prentice Hall of India, New Delhi, 2004.
3. Mohan N., Power Electronics Converters, Applications and Design, John Wiley andSons.INC,1995.
4. Singh M.D.,PowerElectronics,Tata McGraw Hill,2007.

* http://www.digimat.in/nptel/courses/video/108108036/L40.html

*https://archive.nptel.ac.in/courses/108/102/108102145

ECE 4465: RADAR AND NAVIGATION SYSTEMS [3 0 0 3]

Maximum Unambiguous Range, Simple form of Radar Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications, Prediction of Range Performance, Minimum Detectable Signal, Receiver Noise, Modified Radar Range Equation. Radar Equation: SNR, Envelope Detector, Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Tracking Radar, Angular resolution, Mono pulseTechnique;CW and Frequency Modulated Radar, Bandwidth Requirements, Applications of CW radar. FM-CW Radar: FM-CW Radar, Range and Doppler Measurement, Block Diagram and Characteristics (Approaching/ Receding Targets), FM-CW, Multiple Frequency CW Radar, MTI and Pulse Doppler Radar, Navigation Approaches, Global Positioning System (GPS), GLONASS, Satellite based navigation system.* Self-Directed Learning: Tracking Radar, Angular resolution, Mono pulse Technique

References:

1. Merrill I. Skolnik, "Introduction to Radar Systems", 3rd Edition Tata McGraw-Hill, 2001.
2. Mark A. Richards, James A. Scheer, William A.Holm, "Principles of Modern Radar: Basic Principles, SciTech Publishing Inc, 2013.
3. Hofmann-Wellenhof, B., Lichtenegger, H., Verlag Wien, Collins, J "Global Positioning System Theory and Practice" Springer 2001.

   *https://onlinecourses.nptel.ac.in/noc21_ee108/preview

ECE 4466: SEMICONDUCTOR DEVICE MODELLING [3 0 0 3]

Energy Bands in Semiconductors. Device modeling basic and charge transport-Basic equations for device analysis, Mobility of carriers, Effect of electric field, temperature, doping and high electric field, Charge transport in SC, drift current, Hall effect, diffusion current, Current density equation, Einstein's relation, PN junction-PN junction under thermal equilibrium, PN junction under applied bias, Static current-voltage characteristics of PN junction, Transient analysis, Injection and transport model.MOSFET structure and operation, short channel effects on MOSFET performance parameters. Second order effects in MOSFET, Effect of Gate voltage on carrier mobility, Effect of Drain voltage on carrier mobility, Channel length modulation, Breakdown and punch through, Subthreshold current, Short channel effects. SPICE, HSPICE, PSPICE, Level 1, Level 2, Level 3, BSIM models-M MOSFET MODELING

References:

1. Nandita Das Gupta and Amitava Das Gupta, "Semiconductor Devices. Modeling and Technology", PHI, New Delhi, 2004.
2. M.K.Achuthan and K.N. Bhat, "Fundamentals of Semiconductor Devices", Tata McGraw.Hill, New Delhi, 2011.
3. B. G. Streetman and S. Banerjee, "Solid State Electronic Devices", PHI, New Delhi, 2011.
4. Tar Fjeldly, Trond Ytterdal and Michael S. Shur" Introduction to Device Modeling and Circuit Simulation" Wiley-Blackwell, 1997.
5. Giuseppe Massabrio and Paolo Antognetti "Semiconductor Device Modeling with Spice" Tata McHill, 2010.

ECE 4467: SPINTRONIC VLSI [3 0 0 3]

The advent of spintronics, Quantum Mechanics of Spin: Pauli Spin Matrices. Spin-orbit interaction, spin polarized drift/diffusion, Spin-orbit interaction in a solid: Rashba Interaction, Spin Relaxation. Spin transfer torque (STT), anomalous Hall effect, Spin Hall effect (SHE), spin orbit torque (SOT). Spin valve, Magnetic tunnel junction (MTJ). Silicon based spin electronic devices: toward a spin transistor. Spintronic computing: Hybrid spintronics, Inmemory computing using spintronic devices.

*Self Directed Learning: All spin logic, Ferroelectric tunnel junctio (FTJ), Domain wall (DW) in magnetic nanowire

References:

1. J. M. D. Coey, "Magnetism and Magnetic Materials", Cambridge University Press, 2010.
2. S. Bandyopadhyay, M. Cahay, "Introduction to Spintronics", CRC Press, 2008.
3. S. Maekawa, "Concepts in Spin Electronics", Oxford University Press, 2006.
4. D. D. Awschalom, R. A. Buhrman, J. M. Daughton, S.V. Molnar, and M.L. Roukes, "Spin Electronics", Kluwer Academic Publishers, 2004.
5. Suri Manan, "Applications of Emerging Memory Technology", Springer Series in Advanced Microelectronics, 2020.

   *https://nanohub.org/wiki/Spin

   https://nanohub.org/publications/375/1

   http://gdr-rest.polytechnique.fr/node/94

ECE 4468: SPREAD SPECTRUM COMMUNICATION [3 0 0 3]

Digital modulation and spectral efficiency, direct sequence and frequency hopping spread spectrum principles. PN sequences; Direct sequence spread spectrum system; DS/QPSK system and other advanced schemes; Frequency hopping spread spectrum system. Code acquisition and synchronization. Applications:

References

1. Peterson R. L. and Ziemer R. E., "Introduction to Spread Spectrum Communication", PHI, 1995.
2. George R. and Cooper C. D., "Modern Communications and Spread Spectrum", McGraw Hill, 2nd Ed, 1986.
3. R. C. Dixon, "Spread Spectrum Communication", IEEE press, John Wiley and Sons, 1976.
4. Sklar B, "Digital Communication Fundamentals and Applications", Pearson Education, 2001.

ECE 4469: SWITCHING THEORY FOR LOGIC SYNTHESIS [3 0 0 3]

Introduction to Boolean algebra, logic functions and their Representations; Optimization of and-or two-level logic networks: N-Dimensional Cube, Karnaugh Map, Prime Implicate, Quine-McCuskey Method; optimization of sequential networks: Sequential circuit optimization technique; Multi-valued input two-valued output function: Tautology, Equivalence, Generation of Prime Implicates, Sharp Operation. Heuristic optimization of two-level networks; Technology mapping: Decomposition, Pattern Matching; Logic design using exors: Classification of AND-EXOR Expressions, Simplification of ESOPs, Fault Detection and Boolean difference.

*Self-Directed Learning : Sequential circuit optimization – State diagram reduction using equivalence method and implicant chart table technique.

References:

1. Tsutomu Sasao, “Switching Theory for Logic Synthesis”, Springer Publication, 1999.
2. Soha Hassoun, Tsutomu Sasao, “Logic Synthesis and Verification”, Springer Publication, 2002.
3. Giovanni De Michelli , “Synthesis and Optimisation of Digital Circuits”, Tata-McGraw Hill, New Delhi,2008.
4. Gary D. Hachtel, Fabio Somenzi , “Logic Synthesis and Verification D.D. Gajski, N.D. Dutt, A.C. Wu and A.Y. Yin, “High-level synthesis: introduction to chip and system design”, Kluwer Academic Publishers.

   * Switching Theory and Logic Design-A. Anand Kumar, PHI, 2nd Edition.

ECE 4470: TIME FREQUENCY AND WAVELET TRANSFORMS [3 0 0 3]

Time frequency analysis and wavelet transforms, STFT. Continuous wavelet transforms and their properties. Discrete wavelet transforms and their properties. DWT and its relation to filter banks, Multi-rate sampling fundamentals, Haar filter bank. Designing orthogonal and bi-orthogonal wavelet systems.

*Self Directed Learning, Two-dimensional wavelet system.

References:

1. Addison P. S, The Illustrated Wavelet Transform Handbook, Institute of Physics Publishing, 2002.
2. Rao R.M., Bopardikar A.S., Wavelet Transforms- Introduction to Theory and Applications, Pearson Education, 2008.
3. *Soman K. P. and Ramachandran K. I., Insight into Wavelets from Theory to Practice, Prentice Hall of India, 2005.
4. Narasimhan S. V., Basumallick N., S. Veena, Introduction to Wavelet Transform: A Signal Processing Approach, Narosa Publishing House, 2012.
5. Vaidyanathan P. P., Multirate Systems and Filter Banks, Pearson, 2012.

ECE 4471: VLSI PROCESS TECHNOLOGY [3 0 0 3]

Material properties and Crystal Growth, Silicon Oxidation, dry and wet oxidation, Deal-Grove Model, Oxide thickness characterization. Photolithography:Optical Lithography. Etching: Wet chemical etching of Silicon and Silicon dioxide, Dry etching, Etch mechanism. Diffusion, Diffusion mechanism. Ion Implantation. Film deposition:Epitaxial growth techniques. Metallization. Fabrication processes of components and devices:resistor, capacitor, Inductor, BJT, and MOSFET.

*Self Directed Learning

Chemical Vapor Deposition (CVD) and Molecular Beam Epitaxy

References:

1. May G. S. and Sze S. M, Fundamentals of Semiconductor Fabrication, Wiley India Pvt. Ltd. 2011.
2. Gandhi S. K., VLSI Fabrication Principles, John Wiley and Sons, 2009.
3. Ruska W. S, Microelectronic Processing, McGraw Hill, 1997.
4. Zant P. V., Microchip Fabrication, McGraw Hill, 2013.
5. Campbell S., The Science and Engineering of Microelectronic Fabrication, Oxford Press, Cambridge, 2013.

https://nptel.ac.in/courses/117106093

ECE 4472: WIRELESS CELLULAR AND LTE 4G BROADBAND [3 0 0 3]

Key Enablers for LTE features, Wireless Fundamentals, Multicarrier Modulation, OFDMA and SC-FDMA, Multiple Antenna Transmission and Reception, Overview and Channel Structure of LTE, Downlink Transport Channel Processing, Uplink Channel Transport Processing, Radio Resource Management and Mobility Management, MIMO Techniques.

References:

1. Amithabha Ghosh and Rapeepat Ratausk , “Essentials of LTE and LTE-A”, Cambridge University Press.
2. Lin DU and Swamy, “Wireless Communication Systems” Cambridge University Press, 2010.
3. Chokhalingam and B. S. Rajan, “Large MIMO systems”, Cambridge University Press, 2014.
4. B. Kumbhani and R. S. Kshetrimayum, “MIMO Wireless Communications over Generalized Fading Channels”, CRC Press, 2017
5. T. L. Marzetta, E. G. Larsson, H. Yang and H. Q. Ngo, “Fundamentals of Massive MIMO”, Cambridge University Press, 2016.

ECE 4473: WIRELESS SENSOR NETWORKS [3 0 0 3]

Ad hoc Networks: Cellular vs Ad hoc Wireless Networks, Applications, Design issues: MAC schemes, Routing, Multicasting, Transport layer Protocols, Pricing schemes, QoS, Energy management. Wireless Sensor Networks: Ad hoc Networks vs Sensor Networks, Unique constraints and challenges, Advantages, Applications, Design issues, Architecture, Data Dissemination and Gathering, Enabling Technologies, Designing MAC Protocols, S-MAC, IEEE 802.15.4, Routing Protocols: Design Issues, Classification, QoS and Energy Management, Networks Layer Solutions, System Power Management Schemes, Sensor Networks Platforms and Tools: Programming, Sensor Node Hardware and Software.

Self-Directed Topics:UAV Networks, Underwater Sensor Networks.

References:

1. C Siva Ram Murthy, B.S Manoj "Ad Hoc Wireless Networks" Pearson Education 2008.
2. Holger Karl, Andreas Willig " Protocols and Architectures for Wireless Sensor Networks" John Wiley, 2005
3. Feng Zhao,Leonidas J.Guibas,"Wireless Sensor Networks-An Information Processing Approach"Elsevier 2007.
4. Kazem Sohraby, Daniel Minoli, TaiebZnati "Wireless Sensor Networks- Technology, Protocols, and Applications" John

Wiley, 2007.

5. Anna Hac "Wireless Sensor Network Designs" John Wiley 2003.

* https://archive.nptel.ac.in/courses/106/105/106105160/

OPEN ELECTIVES

ECE 4311: CONSUMER ELECTRONICS [3 0 0 3]

Microphones, headphones and hearing aids, loudspeakers, loudspeaker systems, optical recording and reproduction systems – CDs, DVDs, Blue ray technology, iPods, MP4 players and accessories, home audio systems. Elements of TV communication system, scanning, composite video signal, need for synchronizing and blanking pulses, picture tubes, construction and working of camera tubes, block diagram of TV receiver, LCD, LED and plasma TV fundamentals, block diagram and principles of working of cable TV and DTH. Basics of telephone system, caller ID telephone, intercoms, cordless telephones, cellular mobile systems. Automatic teller machines, facsimile machines, digital diaries, safety and security systems. Digital camera system, microwave ovens, washing machines, air conditioners and refrigerators.

*Self-directed Learning: Introduction to Electronics Gadgets

References:

1. S. P. Bali, "Consumer Electronics", Pearson Education, 2005.
2. R. R. Gulati, "Monochrome and Color Television", New Age International Publisher, 2001.
3. A. M. Dhake, "TV and Video Engineering", Tata McGraw-Hill Education, 2001.
4. *Introduction to Electronics Gadgets: https://nptel.ac.in/courses /117102059

ECE 4312: ELECTRONIC PRODUCT DESIGN & PACKAGING [3 0 0 3]

Industrial design, product life cycle and reliability, Thermal management, heat transfer methods, heat sink selection, cooling methods in electronic systems, packaging techniques, microelectronics, and packaging technologies, - IC packaging, printed circuit boards, Reliability prediction, and measurement, Noise in electronic systems and EMI, PCB design and layout: system assembly considerations. Sources of EMI, shielding of signal lines, ground loops, noise emission characteristic of SMPS and other power electronic equipment, reduction techniques, reflections, and cross-talk in digital circuits.

* Self-Directed Learning: - Advanced electronic packaging over multilayer PCB

References:

1. Flurshiem C. H. "Industrial design and Engineering", Springer Verilog, 2007.
2. P. Horowitz and W Hill, "The art of electronics", Cambridge, 1995.
3. H. W. Ott, "Noise Reduction Techniques in Electronic Systems", Wiley, 1989.
4. W.C. Bosshart, "Printed Circuit Boards: Design and Technology", Tata McGraw Hill, 2000.
5. G.L. Ginsberg, "Printed Circuit Design", McGraw Hill, 1991.
   https://www.digimat.in/nptel/courses/video/108108031/L01.html
6. Lecture series on electronic systems packaging

ECE 4313: INTRODUCTION TO COMMUNICATION SYSTEMS [3 0 0 3]

Model of communication systems and types of electronic communication. Telephone system, signaling tones, DTMF. Optical fibers, numerical aperture. Attenuation and dispersion, optical sources and detectors. Principles of satellite orbits and positioning, Earth station technology, multiple access techniques, Application of satellites. Free space optical communications: ATP using FSO and RF. Wireless Communications: Frequency reuse, cell splitting, sectoring, macro cell and micro cell, Architecture of GSM systems. Fundamentals of RADAR systems: Pulse radar, duplexer, MTI Radar. Wireless LAN, PAN, bluetooth, ZigBee, RFID and NFC.

*Self-directed Learning: Simulation of basic communication system using MATLAB- Simulink

References:

1. FrenzelL.E.Jr., "Principles of Electronic Communication Systems", 4th Ed. Mc Graw Hill Education, 2016.
2. Pratt T., "Satellite Communication Systems", John Wileyand Sons,2006.
3. Stallings W., "Wireless Communication and Networks", PearsonEducation,2006.
4. Keiser G., "OpticalFiberCommunication",McGrawHill,1991.
5. Kennedy G. and Davis B., "Electronic Communication Systems", Tata McGraw Hill, 1999.
   *Self-Learning part: https://www.youtube.com/watch?v= F3slBe2r8vA&list=PLq- Gm0yRYwTgX2FkPVcY6io003-tZd8Ru

ECE 4314: MEMS TECHNOLOGY [3 0 0 3]

Historical background of MEMS. Introduction to Micromachining, Bulk micromachining, surface micromachining, wafer Bonding, LIGA. Transduction and actuation techniques. Micro sensing for MEMS, MEMS Microstructures, Pressure measurement. Basic Bio-MEMS fabrication technologies. Review of RF-based Communication systems, MEMS switches, and Phase shifters. Microfluidic devices and components for Bio-MEMS, sensing technologies for Bio-MEMS, chemical and biomedical microsystems, Introduction to MEMS simulation tool, Need of simulation tool, Case studies on MEMS/Biomes microstructure and their applications.

* Self-directed learning: Simulation of various MEMS devices using COMSOL Multiphysics

References:

1. Liu C., Foundations of MEMS, Prentice Hall, 2011.
2. Bao M., Analysis and Design Principles of MEMS Devices, Elsevier Science, 2005.
3. Senturia S.D., Microsystem Design, Springer, 2001.
4. WangW., SoperS.A., Bio-MEMS-Technologies and Applications, CRC Press, 2007.
5. Rebeiz G.M., RF MEMS: Theory, Design, and Technology, John Wiley &Sons, 2003.
   *COMSOL (Installed in the Lab)

ECE 4315: INTRODUCTION TO NANO SCIENCE & TECHNOLOGY [3 0 0 3]

Crystal structure of common materials – cubic lattice systems, Surface to volume ratio, wave mechanics, Classification of Nano structures, Low dimensional structures, Quantum wells, wires and dots, Semiconductors- length scales –De-Broglie wavelength and exaction Bohr radius – Exaction Bohr radius and binding energies- confinement regimes. Quantum confinement. Carbon Nanostructures – Preparation –Properties and applications; Characterization – SEM, TEM, STM, AFM, RAMAN, XRD, FTIR. Electronic devices, sensors.

*Self-directed Learning:

References:

1. V. V. Mitin, V.A. Kochelap and M.A. Stroscio , "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering and applications", Cambridge University Press; 1st edition (6 December 2007)
2. M.Kuno, "Introduction to Nanoscience & Technology: a workbook"., CreateSpace Independent Publishing Platform, 2014.
3. Donald A Neamen, "Semiconductor physics and devices Basic principles", McGraw -Hill, 2012
4. C N R Rao, A. Muller, A.K. Cheetham, The Chemistry of Nanomaterials : Synthesis properties and applications , Wiley VCH Verlag Gmbh & Co., Weinheim 2004
5. Kenneth J Klabunde (Eds), Nanoscale Materials Science, JOHN WILEY & SONS INC, 2001
6. G. Cao, Nanostructures and Nanomaterials: Synthesis, properties and applications, Imperial College press 2004.

   * https://nptel.ac.in/courses/118104008

   Nanostructures and Nanomaterials: Characterization and Properties, IIT Kanpur, Dr. KanteshBalani, Dr. Anandh Subramaniam

ECE-4316: BASICS OF BUILDING AUTOMATION SYSTEMS [3 0 0 3]

Concept and application of Automation and Management System; Design issues related. HVAC system, Sensors & Transducers. Valves and Actuators, Various Controllers, Energy Management System, Energy Meters, Types, Meter Networking, Monitoring Energy Parameters, Analysis of Power Quality, Energy Conservation, Importance of Energy Saving. Security Systems: Introduction, Access Control – Concept, Generic Model, Components, Types, Features, Card Technologies, Protocols, Controllers, Biometrics, CCTV Cameras, CCD Camera Basics, Traditional CCTV System, Video Recording, Drawbacks, Digital Video, TCP/IP Networking Fundamentals, System Network Load Calculations, Network Design. Integration of Building Management System, Safety System, Security Systems & Video Management.

*Self-directed Learning: Energy Management system

References:

1. Shengwei "Wang, Intelligent Buildings and Building Automation", 2009.
2. Reinhold A. Carlson Robert A. Di Giandomenico, "Understanding Building Automation Systems Direct Digital Control, Energy Management, Life Safety, Security Access Control, Lighting, Building,1st edition, R.S. Means Company Ltd, 1991
3. National Joint Apprenticeship & Training Committee, "Building Automation System Integration with Open Protocols: System Integration With Open Protocols". 2009.
4. John I. Levenhagen and Donald H. Spethmann, "HVAC Controls and Systems, Mechanical Engineering", 1992.
5. James E.Brumbaugh, "HVAC fundamentals", Kindle edition, 2007.

   *Business Opportunities in the field-Research papers/conference papers

ECE 4317: INTELLIGENT INSTRUMENTATION SYSTEM [3 0 0 3]

Transducer review; Automation system; Direct Digital Control's Structure and Software. SCADA sensors, Remote terminal units, sensors and actuators; PLC; Virtual instrumentation; LabVIEW; Introduction to intelligent controllers.

*Self-directed Learning: Controller design using LabVIEW

References:

1. Krishna Kant, "Computer Based Industrial Control", PHI , 2011
2. Curtis D. Johnson, "Process Control Instrumentation", Pearson Education ,2014
3. D. Patranabis , "Principle of Industrial Instrumentation "MH publications , 2017
4. Patrick H. Garrett, "High performance Instrumentation and Automation", CRC Press, Taylor & Francis Group,2005
5. D. Patranabis , "Sensors and Transducers" -By, PHI Learning Private Limited, 2004.

   *https://www.ni.com/en-in/support/downloads/software-products/download.labview.html#460283

ECE 4318: COMPUTATIONAL INTELLIGENCE AND ENVIRONMENTAL SUSTAINABILITY [3 0 0 3]

Introduction to Computational Intelligence, Historical views of Computational Intelligence, Evolutionary Computation Concepts, Paradigms and Implementations, Environmental issues and sustainable development, Nexus between technology and sustainable development, Computational Intelligence and GIS, QGIS spatial-and temporal data analysis, Application of Computational Intelligence in Environmental sustainability.

* Self-directed learning: Simulation of various case studies on application of CI in environmental sustainability.

References:

1. A Konar, "An Introduction to Computational Intelligence. In: Computational Intelligence". Springer, Berlin, Heidelberg, 2005
2. Russell C. Eberhart and Dr. Yuhui Shi, "Computational Intelligence", Concepts to Implementation, by Morgan Kaufmann Publishers, An imprint of Elsevier by Elsevier Inc,2007.
3. F. Giudice, G. Rosa, Antonino Risitano, "Product Design for the environment - A life cycle approach", Taylor & Francis 2006, ISBN: 0849327229.
4. Allen D.T and Shonnard D.R, "Sustainable engineering, Concepts, Design and case studies", Pearson publication, 1st edition,2011.
5. Qihao Weng , "An introduction to Contemporary Remote sensing", McGraw-Hill Publication, 2012.

   *Research papers on applications of CI in environmental

sustainability and simulation using open source tools like Python/ MATLAB/Weka .

ECE 4319: APPLICATIONS OF SIGNAL PROCESSING [3 0 0 3]

Basics of multimodal signals, Types of signals in real time applications, Image perception, Image representation, Image and video processing. Basics of sound Speech and processing, time and frequency domain analysis of speech. An overview of pen computing and processing, applications of gesture recognition. Speech controlled devices for home automation, concepts of real time applications such as Surveillance video processing, face recognition, face tracking.

*Self-directed learning: Case studies with different domain such as aviation, automation like driver less vehicles, gesture controlled Robots, handwritten data analysis, recommendation systems for digital marketing.

References:

1. R.C. Gonzalez and R.E. Woods, Digital Image Processing, (4e), Pearson Education Inc., 2017.
2. A.K. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1989, Fourth Indian
3. Rabiner L.R and Schaffer R.W, Digital Processing of Speech Signals, Prentice Hall, NJ, 2007.
4. Thomas F. Quatieri, Discrete. Time Speech Signal Processing—Principles and Practice, Pearson Education, Inc., 2004.

*Introduction to Pen Point (the operating system of the Go computer). Article is from 1992, but the system is way cool

ECE 4320: INTRODUCTION TO BIOSENSORS [3 0 0 3]

Biosensor classification, Main elements in biosensors, Bio-recognition Elements in a Biosensor, Principles of Bio-recognition. Biomolecules in biosensors; Detection in biosensors – Electrochemical transducer, Enzyme-based electrochemical biosensors, Iron-Selective Field-Effect Transistor (ISFET), Immunologically Sensitive Field Effect Transistor (IMFET);Data-acquisition systems: Resistors, Diodes, Transistors, Temperature sensors, Wheatstone Bridge, Op-amp, Hardware and Software of Data Acquisition System (DAS); Fabrication: Microfabrication process, Self-assembled Monolayers, Micromachining, Micro fabricated structures for biosensors. Type of biosensors: Nanomaterial based biosensors, Conducting Polymer-based Biosensors, protein based biosensors, DNA based biosensor, Quantum Dot based sensor.

*Self-directed Learning: Basic of Sensor fabrication and characterization, electrochemical transducer, optical and Quantum dots, DNA detections.

References:

1. B. D. Malhotra and C.M. Pandey, “Biosensors: Fundamentals and Applications”, Smithers Rapra Publications, 2017.
2. Jeong-Yeol Yoon,"Introduction to Biosensors: From Electric Circuits to Immunosensors " Springer Publications, 2013.
3. Jon Cooper, “Biosensors A Practical Approach”, Oxford University press,2003.
4. Manoj Kumar Ram, Venkat R, Bhethanabolta, “Sensors for chemical and biological Applications”, CRC Press,2017.
5. C.S Kumar, “Nano materials for biosensors”, Wiley – VCH, 1st Edition, 2007.

*Optical Sensors, IIT Roorkee,Prof.Sachin Kumar Srivastava- https://nptel.ac.in/courses/115107122.

*Nanobiotechnology, IIT Roorkee,Dr. R. P. Singh , Dr. Naveen kr. Navani- https://nptel.ac.in/courses/118107015

ECE 4321: MACHINE LEARNING IN VLSI COMPUTER AIDED DESIGN [3 0 0 3]

A Preliminary Taxonomy for Machine learning in VLSI CAD, Machine learning taxonomy, VLSI CAD Design flow, Logic synthesis. Graph Theory Introduction to Graph Theory, Control, and data flow graph (CDFG). Graph optimization problems and algorithms, Reduced ordered binary decision diagram (ROBDD), IF THEN ELSE (ITE) algorithm. Machine Learning for system design and optimization- Two level combinational logic synthesis and optimization- Exact and heuristic method. Sequential circuit optimization. Machine learning for system design and optimization algorithms –A synthesis parameter autotuning system for optimizing High performance processors (SynTunSys). High level synthesis (HLS) algorithms. Machine learning from limited data in VLSI CAD, Iterative feature search, Fast Statistical analysis using machine learning. Case Study on Machine learning in VLSI.

*Self-Directed Learning: Case Study on Machine learning in VLSI Algorithms.

References:

1. Ibrahim (Abe) N Alfadel, Duane S Boning, Xin Li: Machine learning in VLSI Computer Aided design, Springer, 2019.
2. Giovanni De Michelli ,: Synthesis and Optimisation of Digital Circuits, Tata-McGraw Hill, New Delhi,2008.
3. Gary D. Hachtel, Fabio Somenzi, Logic Synthesis and Verification Algorithm, Kluwer Academic Publication, Boston,2002.
4. M.J.S.Smith , Application Specific ICs, Addison Wesley,2002.

B.TECH. IN ELECTRONICS ENGINEERING (VLSI DESIGN AND TECHNOLOGY)

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2122	Engineering Mathematics - III	2	1	0	3	MAT 2227	Engineering Mathematics - IV	2	1	0	3
	ECE 2126	Analog Circuits	4	0	0	4	ECE 2226	Physics of Semiconductor Devices	4	0	0	4
	ECE 2122	Network Analysis	3	0	0	3	ECE 2221	VLSI design	4	0	0	4
	ECE 2123	Signals and Systems	3	0	0	3	ECE 2228	Computer Organization and Architecture	3	0	0	3
	ECE 2127	Digital Circuits	3	0	0	3	ECE 2229	FPGA based System Design using Verilog	3	0	0	3
	ECE 2125	Electromagnetic Waves	3	0	0	3	ECE 2222	Digital Signal Processing	3	0	0	3
	ECE 2143	Digital Circuits lab	0	0	3	1	ECE 2243	FPGA based System Design using Verilog Lab	0	0	3	1
	ECE 2144	Analog Circuits Lab	0	0	3	1	ECE 2244	Digital VLSI Design Lab	0	0	3	1
			18	**1**	**6**	**21**			**19**	**1**	**6**	**22**
	Total Contact Hours (L + T + P)		**25**				**Total Contact Hours (L+T+P)**		**26**			
	FIFTH SEMESTER						**SIXTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	HUM 3021	Engineering Economics and Financial Management	2	1	0	3	HUM 3022	Essentials of Management	2	1	0	3
	ECE 3127	Microcontrollers and Embedded Systems	3	0	0	3	ECE 3225	Analog and Mixed Signal IC Design	4	0	0	4
	ECE 3128	VLSI Testing	3	0	0	3	ECE 3226	MEMS and NEMS	3	0	0	3
	ECE 3129	VLSI Fabrication Technology	3	0	0	3	ECE ****	Program Elective - I / (Minor Specialization)	3	0	0	3
	ECE 3130	Verification using System Verilog	3	0	0	3	ECE ****	Program Elective - II / (Minor Specialization)	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective - II	3	0	0	3
	ECE 3143	Microcontrollers and Embedded Systems lab	0	0	6	2	ECE 3243	Analog IC Design Lab	0	0	3	1
	ECE 3144	Semiconductor Device and Process Simulation Lab	0	0	3	1	ECE 3244	Semiconductor Fabrication and Characterization Lab	0	0	3	1
			18	**0**	**9**	**21**			**19**	**0**	**6**	**21**
	Total Contact Hours (L+T+P)		**27**				**Total Contact Hours (L+T+P)**		**25**			
	SEVENTH SEMESTER						**EIGHTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
IV	ECE ****	Program Elective - III / (Minor Specialization)	3	0	0	3	ECE 4291	Industrial Training				1
	ECE ****	Program Elective - IV / (Minor Specialization)	3	0	0	3	ECE 4292	Project Work / Practice School				12
	ECE ****	Program Elective - V	3	0	0	3	ECE 4293	Project Work (B.Tech Honours)**				20
	ECE ****	Program Elective - VI	3	0	0	3	ECE ****	B.Tech Honours (Theory 1)** (V Semester)				4
	ECE ****	Program Elective - VII	3	0	0	3	ECE ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	*** ****	Open Elective - III	3	0	0	3	ECE ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	ECE 4191	Mini Project (Minor Specialization)*				8						
			18	**0**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P) + OE		**18**									

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

MINOR SPECIALIZATIONS

I. Semiconductor Devices and packaging

ECE 4415: Opto-Electronic & Photovoltaics
ECE 4416: Compound Semiconductor Electronics
ECE 4406: MOS Device Modelling
ECE 4417: Fundamentals of Electronic Packaging Materials

II. Advanced Solid-State Devices

ECE 4452: Flexible Electronics
ECE 4418: III-V Novel Semiconductor Devices
ECE 4419: Photonic Material and Devices for Integrated Photonic
ECE 4420: Mesoscopic Electronic Devices

III. Computational Intelligent VLSI System

ELE 4409: Machine Learning
ELE 4410: Computer Vision
ECE 4421: Machine Learning for VLSI Design Automation
ECE 4422: Edge Artificial Intelligent Computing

IV. Advanced VLSI Architecture

ECE 4443: Bioinspired and Evolvable Systems
ECE 4459: Neuromorphic VLSI Circuits
ECE 4423: VLSI Architecture For Io T and Edge Devices
ECE 4424: Security Solutions in VLSI

OTHER PROGRAMME ELECTIVES

ECE 3222: SOC design
ECE 4405: Low Power VLSI Design
ECE 4409: Machine Learning
ECE 4444: BioMEMS and Microsensors
ECE 4447: Data Structures and Algorithms
ECE 4457: Nano devices & nano sensors
ECE 4461: Object Oriented Programming Using C++
ELE 4410: Soft Computing Techniques
ECE 4467: Spintronic VLSI
ECE 4469: Switching Theory for Logic Synthesis
ECE 4498: Real Time Operating Systems
ECE 4499: Reliability of VLSI circuits
ECE 4500: VLSI Physical Design
ECE 4501: Memory Design and Testing
ECE 4502:Fundamentals of Nanoelectronics
ECE 4503: RF microelectronics & IC DESIGN
ECE 4504: Scripting Language for VLSI
ECE 4505: Semiconductor Equipment Design and Technology
ECE 4506:Thin film and nanostructures
ECE 4507: Semiconductor Materials Characterization Techniques
ECE 4508: VLSI Digital Signal Processing

OPEN ELECTIVES

ECE 4311: Consumer Electronics
ECE 4312: Electronic Product Design & Packaging
ECE 4313: Introduction to Communication Systems
ECE 4315: Introduction to Nano science & Technology
ECE 4316: Basics of Building Automation Systems
ECE 4317: Intelligent Instrumentation System
ECE 4318: Computational Intelligence and Environmental Sustainability
ECE 4319: Applications of Signal Processing
ECE 4320: Introduction to Biosensors
ECE 4322: Music and Neuroengineering
ECE 4323: Vedic Mathematics and its Applications in Modern Technologies

THIRD SEMESTER

MAT 2122: ENGINEERING MATHEMATICS III [2 1 0 3]

Systems of Linear Equations, Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings, Affine Spaces. Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations. Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix approximation, Periodic function, Fourier Series expansion. even and odd functions, functions with arbitrary periods, Half range expansions, Fourier transform, basic properties, Parseval's identity and applications.

*Self-directed Learning: Singular Value Decomposition, Fourier cosine and sine transform application to Heat and Wave equation.

Text Books:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, "Mathematics for Machine Learning", Cambridge University Press, 2020.
2. Grewal B.S. – "Higher Engineering Mathematics", Khanna Publishers, 43rd edition, 2015

References:

1. Stephen H. Friedberg Lawrence E Spence, Arnold J Insel, Elementary Linear Algebra: "A Matrix Approach Introduction to Linear Algebra", Second Edition, 2019.
2. David Lay, Steven Lay, Judi McDonald, "Linear Algebra and Its Applications, Pearson", 2019.
3. Gilbert Strang, "Introduction to Linear Algebra", Fifth Edition, Wellesley- Cambridge Press, 2016
4. Mordechai Ben-Ari, "Mathematical Logic for Computer Science", Third Edition, Springer, 2012
5. Narayanan, Ramaniah and Manicavachagom Pillay, "Advanced Engineering Mathematics", Vol 2 and 3, Vishwanthan Publishers Pvt Ltd. 1998

ECE 2126: ANALOG CIRCUITS [4 0 0 4]

MOSFET: Structure, operation, I-V Characteristics of MOSFET; Small-Signal Model, PMOS Transistor; MOSFET Biasing, Analysis of Common-Source, Common-Gate Amplifier and Source Follower; Differential Amplifier basics, Operational Amplifier. Linear applications, instrumentation amplifier and bridge amplifier. Active filters: Design and analysis. Non-linear applications of operational amplifier: Log and antilog amplifiers, analog multipliers and dividers, comparators, Schmitt trigger, square wave, triangular wave generators and pulse generators, 555 IC, functional diagram of 555 IC, Astable multi-vibrator, Mono-stable multi-vibrator, Data Converters.

*Self Directed Learning: Concepts of Feedback; Oscillators

References:

1. Behzad Razavi, "Fundamental of Microelectronics", Wiley, 2013.
2. A. S. Sedra, K. C. Smith, "Microelectronic circuits", Oxford University Press, 2011.
3. Franco S, "Design with Op-amps & Analog Integrated Circuits" McGraw Hill, 4th edition, 2015.
4. *Ramakant A. Gayakwad, "Op-Amps and Linear Integrated Circuits", Prentice Hall of India, 2000.

ECE 2122: NETWORK ANALYSIS [3 0 0 3]

Network equations; Mesh and nodal analysis; Network theorem-Superposition, Reciprocity, Thevenin's, Norton's theorems, Maximum power transfer theorem; Initial and final conditions in RL, RC and RLC Circuits for DC Excitations. General and Particular solution of the first order and second order circuits. Applications of Laplace transform in finding solution or RC, RL, and RLC networks, Response of RC circuits for step, pulse, square, and ramp input; Two port network- Open circuit impedance parameters, short circuit admittance parameters, transmission parameters, hybrid parameters

*Self-directed Learning: Two-port Interconnections

References:

1. M. E. Van Valkenberg, "Network analysis", Prentice Hall of India, 2000.
2. Ravish R Singh, "Network analysis and Synthesis", McGraw Hill, 2013.
3. William H. Hayt, Jack E. Kemmerly, Steven M Durbin, "Engineering Circuit Analysis", 8th edition, Tata McGraw Hill India, 2013.
4. Millman, H. Taub, "Pulse, digital and switching waveforms", 3nd Edition, McGraw Hill, 2017.
5. Joseph Edminister, "Electric Circuits", Schaum's Series, McGraw Hill, 2018.

   * https://nptel.ac.in/courses/108102042

ECE 2123: SIGNALS AND SYSTEMS [3 0 0 3]

Continuous time (CT) and discrete time (DT) signals, Representation and classification of Signals, Elementary signals, time domain operations on signals, correlation between signals; Continuous time and discrete time systems, system properties. LTI system, impulse response, response of LTI system, Convolution, differential/difference equation and block diagram representation; Fourier analysis of signals and systems, LTI systems in frequency domain, Parseval relation, ESD, PSD; LTI system analysis using Laplace transform, transfer function, poles/zeroes, stability; Z-transform, application in LTI system analysis; sampling and re-construction.

*Self-directed Learning: Generation of signals and Fourier analysis

References:

1. Simon Haykin, Barry Van Veen, "Signals and Systems", John Wiley & Sons, NewDelhi,2008
2. A. V. Oppenheim, A. S. Willsky, A. Nawab, "Signals and Systems", PHI. Pearson Education,New Delhi, 2015.
3. H. Hsu, R. Ranjan "Signals and Systems", Schaums outline, Tata McGraw Hill, New Delhi, 2006.
4. Michael J. Roberts, "Fundamentals of Signals and Systems", First Edition, Tata McGraw Hill Publishing Company Limited, 2007.

5. Rodger E. Ziemer, William H. Tranter D. Ronald Fannin, "Signals and Systems", Fourth Edition, Pearson Education, 2004.

*Signal Processing tool box in MATLAB

ECE 2127: DIGITAL CIRCUITS [3 0 0 3]

Digital logic, Boolean functions, Boolean algebra, K-maps, combinational circuits, multiplexers, demultiplexer, comparators, decoders, priority encoders, synchronous sequential circuits, flip flops, clocked sequential circuits, counters, asynchronous sequential circuits, Stable and Unstable states, State reduction, race free assignments, Hazards, Pulse mode sequential circuits, Design of Hazard free circuits

*Self-Directed Learning. Asynchronous sequential circuits

References:

1. Donald D Givone, "Digital Principles and Design", Tata McGraw Hill, 2002.
2. William I. Fletcher, "An Engineering approach to Digital Design", Prentice Hall of
3. India, 2009
4. M. J. S. Smith, "Application Specific ICs" Pearson 1997.
5. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Prentice Hall PTR, 2003.
6. Stephen. Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", Tata McGraw Hill, 2013.

ECE 2125: ELECTROMAGNETIC WAVES [3 0 0 3]

Review of Electrostatics and Magneto statics: Coordinate system and vectors, Curl and Divergence, Divergence theorem and Stokes theorem in the context of electromagnetics. Uniform Plane Waves: Maxwell's equations, Electromagnetic wave propagation. Transmission Lines: parameters, Transmission line equations and solutions Standing Wave Ratio, power and impedance measurement, Stub impedance matching, Smith Chart and its applications in transmission line calculations, applications of transmission lines. Waveguides: Rectangular waveguides – TE, TM modes, power transmission. Introduction to Cylindrical waveguides.

*Self-Directed Learning: Planar dielectric waveguides

References:

1. *Jr. Hayt and Buck, "Engineering Electromagnetics", 7th Edition, McGraw Hill, 2012.
2. Ryder J. D, "Networks, Lines, and Fields", 2nd Edition, PHI, 2015.
3. Shevgaonkar R. K, "Electromagnetic Waves", 2nd Edition, Tata McGraw Hill, 2019.
4. Plonus M. A, "Applied Electromagnetics", McGraw Hill, 1988
5. Edminister J. A, "Electromagnetics", 2nd Edition, Schaum's Outline Series, Tata McGraw Hill, 2006.

ECE 2143: DIGITAL CIRCUIT DESIGN LAB [0 0 3 1]

EXPERIMENTS

Basics and universal gates, code converters and arithmetic's circuits, Logic implementation using MUX, DEMUX, Encoders and Decoders, FFs, counters and shift registers, Counters applications, Shift Registers, Design of sequential Circuits.

References:

1. Donald D Givone, "Digital Principles and Design", Tata McGraw Hill, 2002.
2. William I. Fletcher, "An Engineering approach to Digital Design", Prentice Hall of India, 2009
3. Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Prentice Hall 2003.
4. Stephen. Brown and Zvonko Vranesic, "Fundamentals of Digital Logic with Verilog Design", Tata McGraw Hill, 2013.
5. Charles Roth, Lizy K. John, Byeong Kil Lee, "Digital Systems Design Using Verilog", Cengage Learning, 2015

ECE 2144: ANALOG CIRCUITS LAB [0 0 3 1]

Course Learning Outcomes:

At the end of the course, the student will be able to:

CLO1	Demonstrate the MOSFET and Op-Amp characteristics, working of MOSFET oscillators
CLO2	Analyze the performances of MOSFET amplifiers and 555 timers.
CLO3	Build and demonstrate circuits for linear and non-linear application sing Op-Amp.

EXPERIMENTS

MOSFET basics, MOSFET as Switch, amplifier. MOSFET-based oscillator, Differential Amplifier. Linear application of op-amp: Adder, subtractor, Difference amplifier, Filter design using op-amp, Schmitt Trigger Circuits, Monostable and Astable multivibrator using 555 timer.

References:

1. Lab manual.
2. William H. Hayt, Jack E. Kemmerly, Steven M Durbin, “Engineering Circuit Analysis”, Tata McGraw Hill India, 2013.
3. Behzad Razavi, “Fundamental of Microelectronics”, Wiley, 2013.
4. R. L. Boylestad, L. Nashelsky, “Electronic Devices and Circuit Theory”, Pearson Education, 2009.
5. Sergio F, Design with Op amps and Analog Integrated Circuits, McGraw Hill, Fourth edition, 2016.

FOURTH SEMESTER

MAT 2227: ENGINEERING MATHEMATICS - IV [2 1 0 3]

Course Learning Outcomes:

Construction of a Probability Space, Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes’ Theorem, Summary Statistics and Independence, Distributions: Binomial, Poisson, uniform, normal, Chi-square and exponential distributions. Two and higher dimensional random variables, covariance, correlation coefficient. Moment generating function, functions of one dimensional and two-dimensional random variables. Static probabilities: review and prerequisites generating functions, difference equations. Dynamic probability: definition and description with examples. Markov chains, transition probabilities. Differentiation of Univariate Functions, Partial

Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Backpropagation and Automatic Differentiation, Higher-Order Derivatives, Linearization and Multivariate Taylor Series. Basic solution, Convex sets and function, Simplex Method, Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers.

*Self-directed Learning: Markov chains, Transition probabilities.

Text Books:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. P L Meyer, Introductory Probability and Statistical Applications, Addison Wiley.
3. Medhi. J. Stochastic Processes, Wiley Eastern.

References:

1. Murray R. Spiegel, Vector Analysis Theory and Problems, Schaum's Outline Series, 2019.
2. Hamdy A. Taha, "Operations Research: An Introduction", 8th Edn., Pearson Education (2008).
3. Sheldon M. Ross, Introduction to Probability Models Eleventh Edition Elsevier.
4. E. S. Page, L. B. Wilson, An Introduction to Computational Combinatorics, Cambridge University Press.
5. Bhat U R, Elements of Applied Stochastic Processes, John Wiley.
6. https://youtu.be/CgP-3HctGe4

ECE 2226: PHYSICS OF SEMICONDUCTOR DEVICES [4 0 0 4]

Electrical Conduction in Solids, Density of States Function, The Fermi–Dirac Probability Function, Charge Carriers in Semiconductors , Dopant Atoms and Energy Levels, The Extrinsic Semiconductor, Statistics of Donors and Acceptors, Charge Neutrality, Position of Fermi Energy Level, Carrier Drift, Carrier Diffusion, Graded Impurity Distribution, The Hall Effect, Carrier Generation and Recombination, Characteristics of Excess Carriers, Ambipolar Transport, Quasi-Fermi Energy Levels, Excess Carrier Lifetime, Surface Effects, Basic Structure of the pn Junction,

Reverse Applied Bias, Junction Breakdown, No uniformly Doped Junctions, pn Junction Current, Generation–Recombination Currents and High-Injection Levels, Small-Signal Model of the pn Junction, Charge Storage and Diode Transients, The Tunnel Diode, The Schottky Barrier Diode , Metal–Semiconductor Ohmic Contacts, Heterojunctions, The Two-Terminal MOS Structure, Capacitance–Voltage Characteristics, The Basic MOSFET Operation.

*Self-directed Learning: Frequency Limitations, CMOS Technology, Nonideal Effects, MOSFET Scaling.

References:

1. Donald A Neamen, "Semiconductor Physics and Devices: Basic Principles", McGraw-Hill, 2012.
2. S.M. Sze, Kwok K. Ng "Physics of Semiconductor Device," Wiley Interscience Publication, 2006.
3. Streetman, Ben G., and Sanjay Banerjee, "Solid State Electronic Devices", Upper Saddle River, N.J.: Pearson/Prentice Hall, 2006.
4. M Achuthan, K Bhat, "Fundamentals of Semiconductor Devices", McGraw Hill Education, 2017.
5. Y. Taur, & T. Ning, "Fundamentals of Modern VLSI Devices" 3rd ed., Cambridge: Cambridge University Press, 2021

ECE 2221: VLSI DESIGN [4 0 0 4]

MOS Transistor, CMOS logic, Inverter, Power: Dynamic Power, Static Power, Fabrication of MOS transistor, Latch-up in CMOS, Stick Diagrams, Layout Design Rules, Static CMOS, Ratioed Circuits, Dynamic Circuits, Pass Transistor Logic, Transmission Gates, with examples, Domino, Dual Rail Domino, CPL, Cascode Voltage Switch Logic, Bi-CMOS inverter circuits. Static latches and Registers, Dynamic latches and Registers, Sense Amplifier Based Register, clocking strategies, Subsystem design, Sheet resistance and delay models.

*Self-directed Learning: Simulation of MOSFET based logic circuits using LTSPICE

References:

1. Jan M Rabaey, "Digital Integrated Circuits", Prentice Hall India, 2003.
2. Weste. N and Eshraghian K, "Principles of CMOS VLSI Design", 2nd Edition, Addison Wesley Publication.
3. Sung Mo Kang and Yusuf leblebici, "CMOS digital Integrated circuits design and analysis", 3rd edition, Tata Mcgraw Hill.
4. Pucknell D. A. and Eshraghian K.,"Basic VLSI Design", PHI publication, 2009.
5. Amar Mukherjee, "Introduction to NMOS & CMOS VLSI systems Design", Prentice Hall, 1986.

ECE 2228: COMPUTER ORGANIZATION AND ARCHITECTURE [3 0 0 3]

Fundamentals of a computing system, Computer Instructions, Memory and Register Operations, Assembly Language, Bus Architecture. Processor Organization, Register transfer language, Control Organization, Hardwired and Micro-programmed Control, Execution of a complete instruction, Memory organization, Cache design, Virtual memory and Virtual machines, Accessing I/O devices, I/O interfacing, DMA, Pipelining, hazards, forwarding versus stalling, Control hazards, ILP, branch prediction, Pre-fetching techniques, Dynamic and static scheduling, Super scalar Processors, VLIW Processors, Limits on ILP, Thread level Parallelism, Flynn's classification for parallelism, Vector processors, Cache coherence, Hardware Multithreading, Graphical Processing Units, Multi-core Organization.

*Self-directed Learning: Graphical Processing Units

References:

1. John L. Hennessy and David A Patterson, "Computer Organization and Design, The Hardware/Software Interface", Morgan Kaufmann / Elsevier, 2007.
2. M. Morris Mano, "Computer System Architecture", Prentice Hall of India Pvt Ltd, 2002.
3. Thomas C. Bartee , "Digital Computer Fundamentals" , Tata McGraw Hill, 1985
4. Nicholas Carter, "Schaum's outline of Computer Architecture", Tata McGraw Hill, 2006,

5. A. S. Tanenbaum, T. Austin, “ Structured Computer Organization” , Prentice Hall, 2012
6. John P.Hayes , “Computer Architecture and Organization”, WCB/McGraw Hill, 19987.

*https://www.youtube.com/live/UFD8K-IprbQ?si=-0NqYUdde8FFM7Uz

*https://www.techtarget.com/searchvirtualdesktop/definition/GPU-graphics-processing-unit

ECE 2229: FPGA BASED SYSTEM DESIGN USING VERILOG [3 0 0 3]

Verilog HDL Coding Style: Lexical Conventions - Ports and Modules – Operators - Gate Level Modeling - System Tasks &Compiler Directives - Test Bench - Data Flow Modeling - Behavioral level Modeling -Tasks & Functions. Overview of FPGA Architectures and Technologies: FPGA Architectural options, coarse vs fine grained, vendor specific issues (emphasis on Xilinx FPGA), Antifuse, SRAM and EPROM based FPGAs, FPGA logic cells, interconnection network and I/O Pad. Verilog Modelling of Combinational and Sequential Circuits: Behavioral, Data Flow and Structural Realization – Adders – Multipliers- Comparators - Flip Flops - Realization of Shift Register - Realization of a Counter- Synchronous and Asynchronous FIFO –Single port and Dual port RAM – Pseudo Random LFSR – Cyclic Redundancy Check. Synchronous Sequential Circuit: State diagram-state table –state assignment-choice of flipflops – Timing diagram –One hot encoding Mealy and Moore state machines – Design of serial adder using Mealy and Moore state machines - State minimization – Sequence detection- Design examples: Sequence detector, Serial adder, Vending machine using One Hot Controller. System Design Examples using Xillinx FPGAs – Traffic light Controller, Real Time Clock

*Self-directed Learning : FIFO –Single port and Dual port RAM – Pseudo Random LFSR – Cyclic Redundancy Check.

References:

1. M.J.S. Smith, “Application Specific Integrated Circuits”, Pearson, 2000.
2. Peter Ashenden, “Digital Design using Verilog”, Elsevier, 2007. 4. W. Wolf, “FPGA based system design”, Pearson, 2004.
3. Clive Maxfield, “The Design Warriors’s Guide to FPGAs”, Elsevier, 2004
4. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis” Prentice Hall, Second Edition, 2003.
5. Wayne Wolf, “FPGA Based System Design”, Prentices Hall Modern Semiconductor Design Series.

ECE 2222: DIGITAL SIGNAL PROCESSING [3 0 0 3]

Discrete Fourier transform (DFT), properties, linear filtering; efficient computation of DFT, FFT algorithm, Goertzel algorithm; Implementation of Discrete time filters, Structures for IIR and FIR filters; Classical design of IIR filters by impulse invariance, bilinear transformation and matched Z - transform, characteristics and design of commonly used filters - Butterworth, Chebyshev and elliptic filters. Spectral transformation, direct design of IIR filters; design of linear phase FIR filters using window functions, frequency sampling design; Power spectrum estimation, non-parametric methods of PSD estimation.

*Self-directed Learning: Parametric methods of PSD estimation: AR, ARMA and MA modeling

ECE 2243: FPGA BASED SYSTEM DESIGN USING VERILOG [3 0 0 3]

Verilog HDL Coding Style: Lexical Conventions - Ports and Modules – Operators - Gate Level Modeling - System Tasks &Compiler Directives - Test Bench - Data Flow Modeling - Behavioral level Modeling -Tasks & Functions. Overview of FPGA Architectures and Technologies: FPGA Architectural options, coarse vs fine grained, vendor specific issues (emphasis on Xilinx FPGA), Antifuse, SRAM and EPROM based FPGAs, FPGA logic cells, interconnection network and I/O Pad. Verilog Modelling of Combinational and Sequential Circuits: Behavioral, Data Flow and Structural Realization – Adders – Multipliers- Comparators - Flip Flops - Realization of Shift Register - Realization of a Counter- Synchronous and Asynchronous FIFO –Single port and Dual port RAM – Pseudo Random LFSR – Cyclic Redundancy Check. Synchronous Sequential Circuit: State diagram-state table –state assignment-choice of flipflops – Timing diagram –One hot encoding Mealy and Moore state machines – Design of serial adder using Mealy and Moore state machines - State minimization – Sequence detection- Design examples: Sequence detector, Serial adder, Vending machine using One Hot Controller. System Design Examples using Xillinx FPGAs – Traffic light Controller, Real Time Clock

*Self-directed Learning : FIFO –Single port and Dual port RAM – Pseudo Random LFSR – Cyclic Redundancy Check.

References:

1. M.J.S. Smith, “Application Specific Integrated Circuits”, Pearson, 2000.
2. Peter Ashenden, “Digital Design using Verilog”, Elsevier, 2007. 4. W. Wolf, “FPGA based system design”, Pearson, 2004.
3. Clive Maxfield, “The Design Warriors’s Guide to FPGAs”, Elsevier, 2004
4. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis” Prentice Hall, Second Edition, 2003.
5. Wayne Wolf, “FPGA Based System Design”, Prentices Hall Modern Semiconductor Design Series.

ECE 2222: DIGITAL SIGNAL PROOCESSING [3 0 0 3]

Discrete Fourier transform (DFT), properties, linear filtering; efficient computation of DFT, FFT algorithm, Goertzel algorithm; Implementation of Discrete time filters, Structures for IIR and FIR filters; Classical design of IIR filters by impulse invariance, bilinear transformation and matched Z - transform, characteristics and design of commonly used filters - Butterworth, Chebyshev and elliptic filters. Spectral transformation, direct design of IIR filters; design of linear phase FIR filters using window functions, frequency sampling design; Power spectrum estimation, non-parametric methods of PSD estimation.

*Self-directed Learning: Parametric methods of PSD estimation: AR, ARMA and MA modeling

References:

1. Proakis J. G, Manolakis D. G. Mimitris D., “Introduction to Digital

Signal Processing” Prentice Hall, India, 2007.
2. Oppenheim A.V, Schafer R. W, “Discrete Time Signal Processing”, Pearson Education, 2004.
3. Ifeachar, Jervis, “Digital Signal Processing - A Practical approach”, Pearson Education, Asia, 2003.
4. Rabiner L. R, Gold D. J, “Theory and applications of digital signal processing”, Prentice Hall, India, 1998.
5. Sanjit Mitra K, “Digital Signal Processing - A computer based approach”, TMH, 2007.

ECE 2243: FPGA-BASED SYSTEM DESIGN LAB [0 0 3 1]

EXPERIMENTS

Introduction to XILINX ISE tool – simulation, synthesis and downloading, Dataflow Modeling, Sequential Modeling, Structural Modeling, Switch Level and Mixed-mode Modeling, Task and functions, user defined primitive, implementation of traffic light controller, waveform generation, stepper motor control using FPGA. Open ended design – DSP, MAC units etc.

References:

1. M.J.S. Smith, “Application Specific Integrated Circuits”, Pearson, 2000.
2. Peter Ashenden, “Digital Design using Verilog”, Elsevier, 2007. 4. W. Wolf, “FPGA based system design”, Pearson, 2004.
3. Clive Maxfield, “The Design Warriors’s Guide to FPGAs”, Elsevier, 2004
4. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis” Prentice Hall, Second Edition, 2003.
5. Wayne Wolf, “FPGA Based System Design”, Prentices Hall Modern Semiconductor Design Series.

ECE 2244: VLSI DESIGN LAB [0 0 3 1]

EXPERIMENTS

Introduction to ASIC Design flow using EDA tool. Verilog modeling of combinational and sequential digital circuits using Verilog. Synthesize digital circuits targeting suitable library and by setting area and timing constraints. Analyse the various generated reports such as Area, Power, and Delay for the Synthesized netlist. Plan the physical design of digital circuits for synthesized netlist using EDA tool and generate GDS-II file. Mini project using EDA tool.

References:

1. Charles Roth, Lizy Kurian John, Byeong Kil Lee, “Digital System Design Using Verilog”, Cengage Learning 2015.
2. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis”, Prentice Hall Professional, 2003.
3. Digital Lab Manual, Revision 2.0, University Support Team, Cadence, Bengaluru, 2017.
4. Cadence PVS User Guide, 2023.
5. Proakis J. G, Manolakis D. G. Mimitris D., “Introduction to Digital Signal Processing” Prentice Hall, India, 2007.
6. Oppenheim A.V, Schafer R. W, “Discrete Time Signal Processing”, Pearson Education, 2004.
7. Ifeachar, Jervis, “Digital Signal Processing - A Practical approach”, Pearson Education, Asia, 2003.
8. Rabiner L. R, Gold D. J, “Theory and applications of digital signal processing”, Prentice Hall, India, 1998.
9. Sanjit Mitra K, “Digital Signal Processing - A computer based approach”, TMH, 2007.

ECE 2243: FPGA-BASED SYSTEM DESIGN LAB [0 0 3 1]

EXPERIMENTS

Introduction to XILINX ISE tool – simulation, synthesis and downloading, Dataflow Modeling, Sequential Modeling, Structural Modeling, Switch Level and Mixed-mode Modeling, Task and functions, user defined primitive, implementation of traffic light controller, waveform generation, stepper motor control using FPGA. Open ended design – DSP, MAC units etc.

References:

1. M.J.S. Smith, “Application Specific Integrated Circuits”, Pearson, 2000.
2. Peter Ashenden, “Digital Design using Verilog”, Elsevier, 2007. 4. W. Wolf, “FPGA based system design”, Pearson, 2004.
3. Clive Maxfield, “The Design Warriors’s Guide to FPGAs”, Elsevier, 2004
4. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis” Prentice Hall, Second Edition, 2003.
5. Wayne Wolf, “FPGA Based System Design”, Prentices Hall Modern Semiconductor Design Series.

ECE 2244: VLSI DESIGN LAB [0 0 3 1]

EXPERIMENTS

Introduction to ASIC Design flow using EDA tool. Verilog modeling of combinational and sequential digital circuits using Verilog. Synthesize digital circuits targeting suitable library and by setting area and timing constraints. Analyse the various generated reports such as Area, Power, and Delay for the Synthesized netlist. Plan the physical design of digital circuits for synthesized netlist using EDA tool and generate GDS-II file. Mini project using EDA tool.

References:

1. Charles Roth, Lizy Kurian John, Byeong Kil Lee, “Digital System Design Using Verilog”, Cengage Learning 2015.
2. Samir Palnitkar, “Verilog HDL: A Guide to Digital Design and Synthesis”, Prentice Hall Professional, 2003.
3. Digital Lab Manual, Revision 2.0, University Support Team, Cadence, Bengaluru, 2017.
4. Cadence PVS User Guide, 2023.

FIFTH SEMESTER

ECE 3127: MICROCONTROLLERS AND EMBEDDED SYSTEMS [3 0 0 3]

Embedded vs. General Computing Systems, Classification, Applications, Core Components, ARM7TDMI Model, Register Organization. ARM Assembly Language: Directives, Macros, Instruction Set, Addressing Modes, Data Processing, Bit Manipulation, Data Transfer, Loops, Subroutines, Assembly Programming. LPC2148 Architecture, Hardware Interfacing, Display Devices, Actuators, Data Converters. Performance Techniques: Memory, Pipelines, ARM Thumb, Exception Handling, Interrupts, Error Conditions, Handlers, Priorities. Embedded System Design: Characteristics, Quality Attributes, Hardware-Software Co-Design, Firmware Development.

*Self-Directed Learning: Embedded C programming

References:

1. Andrew N Sloss, "ARM System developer's guide, designing and optimizing system software", Elsevier, 2004
2. William Hohl , "ARM assembly language fundamentals and techniques" , CRC press, 2009
3. Steve Furber," ARM System on chip Architecture", Pearson Education, 2000
4. J. R. Gibson "ARM Assembly Language-an Introduction" Dept. of Electrical Engineering and Electronics, The University of Liver-pool, 2007.

ECE 3128: VLSI TESTING [3 0 0 3]

Introduction to testing and testability, Physical Faults and their modeling, Fault collapsing, Fault Simulation, Critical Path Tracing, Testing of combinational circuits, Various types of faults. Functional v/s structural approach to testing, test vector generation for a single stuck-at-fault in combinational logic, Algebraic algorithms, Structural algorithms. Testability Techniques, controllability and observability, ad-hoc and structured approaches to DFT, scan-path testing, Testing of sequential circuits, Test pattern generation for sequential circuits, Exhaustive, Signatures and self test, Testing with random patterns. LFSRs, random test generation and response compression, Signature analysis and Online self test.

*Self-Directed Learning: Efficient Edge-AI Application Deployment for FPGAs: https://www.mdpi.com/2078-2489/13/6/279

References

1. M. L. Bushnell and V. D. Agrawal, "Essentials of testing for digital, memory and mixed-signal VLSI circuits", Boston: Kluwer Academic Publishers, 2000.
2. Abramovici, M. A. Breuer, and A.D. Friedman, "Digital Systems Testing and Testable Design", Piscataway, New Jersey: IEEE Press, 1994.
3. Miczo, "Digital Logic Testing and simulation". New York: Harper & Row, 1986.
4. P.K. Lala, "Fault Tolerant & Fault Testable hardware Design", BS Publications, 1998
5. Stanley L. Hurst, "VLSI Testing: digital and mixed analogue digital techniques" Pub:Inspec/IEE, 1999.

ECE 3129: VLSI FABRICATION TECHNOLOGY [3 0 0 3]

VLSI Environment: Cleanroom, Safety, Thin Film, Vacuum Fundamentals. Material Properties and Crystal Growth: Semiconductor Properties, Crystal Structure, Miller Indices, Defects, Silicon Growth, Dopant Distribution, Material Characterization. Silicon Oxidation: Thermal Oxidation, Deal-Grove Model, Dry/Wet Oxidation, Impurity Redistribution, Masking, Oxide Quality, Thickness Characterization. Photolithography: Optical Lithography, Exposure Tools, Masks, Photoresists, Pattern Transfer, Lift-Off, Resolution Enhancement. Etching: Wet and Dry Etching, Etch Mechanisms, Plasma Diagnostics, End-Point Control. Diffusion: Fick's Law, Pre-Deposition, Drive-In Diffusion, Diffusion Profiles. Ion Implantation: Ion Range, Distribution, Stopping, Channeling, Implant Damage, Annealing. Film Deposition: Epitaxial Growth, CVD, Molecular Beam Epitaxy, Polysilicon, Metallization (Al, Cu). Fabrication Processes: IC Resistors, Capacitors, Inductors, BJTs, MOSFETs, Packaging Fundamentals.

*Self Directed Learning: Chemical Vapour Deposition (CVD) and Molecular Beam Epitaxy

References:

1. May G. S. and Sze S. M, Fundamentals of Semiconductor Fabrication, Wiley India Pvt. Ltd. 2011.
2. Gandhi S. K., VLSI Fabrication Principles, John Wiley and Sons, 2009.
3. Ruska W. S, Microelectronic Processing, McGraw Hill, 1997.
4. Zant P. V., Microchip Fabrication, McGraw Hill, 2013.
5. Campbell S., The Science and Engineering of Microelectronic Fabrication, Oxford Press, Cambridge, 2013. https://nptel.ac.in/courses/117106093

ECE 3130: VERIFICATION USING SYSTEM VERILOG [3 0 0 3]

Introduction to verification, Developing Verification strategies, Applying Verification strategies, RTL ports and interfaces, Modelling hardware interfaces with concurrency constructs, simulating test benches using Fork-join, stimulus synchronization using conventional synchronization constructs like Mailboxes, Semaphores, regions and events. System Verilog, Advanced Functional Verification, Basics of Formal Verification.

*Self-directed Learning: Verification of combinational and sequential logic circuits using System Verilog

References:

1. Padmanabhan T.R. and Sundari B.B.T., Design Through Verilog HDL, John Wiley &Sons, 2004.
2. Palnitkar S., Verilog® HDL. A Guideto Digital Designand Synthesis IEEE 1361-2001 Compliant (2e), Prentice Hall,2003
3. Bhaskar J., A VerilogHDL Primer, BS Publications, 2005.
4. Brown S..and Vranesic Z., Fundamentals of Digital Logic with VerilogDesign (5e), Tata McGraw Hill, 2005.
5. Ciletti M.D., Advanced DigitalDesign with theVerilog HDL, PHI, 2005.

ECE 3143: MICROCONTROLLERS AND EMBEDDED SYSTEMS LAB [0 0 6 2]

Data acquisition and control using NI MyDAQ. Assembly Programming for arithmetic, logical and data transfer operations, Assembly as well as

C Programming for interfacing I/O devices like Switches, Keypad, display devices, Data converters, and Motor controllers. Assembly as well as C Programming for on chip features of ARM processor: hardware interrupts, timers, PWMs, ADC, DAC and serial communication protocols. Embedded mini project development and presentation.

*Self Directed Learning : Design and develop an embedded system application using standard Microcontrollers.

References:

1. William Hohl and Christopher Hinds, "ARM 7 Assembly language and Fundamental techniques
2. https://www.nxp.com/docs/en/user-guide/UM10139.pdf
3. http://arantxa.ii.uam.es/~gdrivera/sed/docs/ARMBook.pdf

ECE 3144: SEMICONDUCTOR DEVICE AND PROCESS SIMULATION LAB [0 0 3 1]

The primary focus of this lab is to make students understand the design aspect of processes and devices. This will explore the trade-offs in performance, power, and reliability, and optimize their final design for manufacturing. In this lab, students will be demonstrated Schottky contact, ohmic contact, PN junction diodes, Abrupt Junction diode, and MOSFET which will help them to gain insight into device simulation and process simulation.

*Self Directed Learning: Electrical, DC and Analog characteristics of Double gate MOSFET

References:

1. SM Sze, Kwok K. Ng, "Physics of Semiconductor Devices", 3/e, Wiley-Interscience, 2006.
2. Donald A. Neamen, Dhrubes Biswas "Semiconductor Physics and Devices", 4/e, McGrawHill Education, 2012.
3. Cogenda Visual TCAD tool user manual.
4. Silvaco Manual, ATLAS and ATHENA user manual from SILVACO, Silvaco , Available as Silvaco manual.

SIXTH SEMESTER

ECE 3225: ANALOG AND MIXED SIGNAL IC DESIGN [3 0 0 3]

Analog Design Flow: MOS Review, Analog Design Octagon, Second-Order Effects, Bulk Effects, MOS Models, Active Load. Amplifiers: CS, CD, CG Amplifiers, Small-Signal Analysis, Miller's Theorem, High-Frequency MOS Model, Single-Stage Amplifier Frequency Response, Differential Amplifier, CMRR, Cascode Differential Amplifier, OTA. Mirrors: Current Mirrors (Basic, Cascode, Wide Swing, Wilson, Regulated Cascode), Voltage References. Mixed-Signal Design: Design Flow, Switched-Capacitor Circuits, Continuous-Time Filters, Mixed-Signal Layout. Data Converters: DAC/ADC Specifications, R-2R, Current Steering, Charge Scaling, ADC (Flash, Successive Approximation). Phase-Locked Loops: Frequency Synthesizers, Synchronization, Basics of Analog PLLs. CMOS Layout: Design Rules, Layouts for Analog and Mixed-Signal Circuits.

*Self-Directed Learning : Layout of analog circuits

References:

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, Tata McGraw-Hill, 2002.
2. Phillip. E. Allen, and Douglas R. Holberg, CMOS Analog Circuit Design, Second edition, Oxford University Press, 2004.
3. R. Jacob Baker, Harry W. Li, David E. Boyce, CMOS circuit design, Layout, and Simulation, IEEE Press, PHI Pvt. Ltd, 2001.
4. R. Jacob Baker, CMOS: Mixed-Signal Circuit Design, volume II, Wiley, 2002
5. Deliyanis, Y Sun and J K Fidler, Continuous-Time Active Filter Design, CRC Press, 2001.
6. Layout of analog circuits: Introduction to CMOS VLSI design: https://nptel.ac.in/courses/117101105

ECE 3226: MEMS & NEMS TECHNOLOGY [3 0 0 3]

Historical background of MEMS. Introduction to Micromachining, Bulk micromachining, surface micromachining, wafer Bonding, LIGA. Transduction and actuation techniques. Micro sensing for MEMS, Beam and Cantilever, pressure measurement. Basic Bio-MEMS fabrication technologies, Review of RF based Communication System, MEMS switches, Phase shifters , Microfluidic devices and components for Bio-MEMS, sensing technologies for Bio-MEMS, chemical and biomedical microsystems, Introduction to MEMS simulation tool, Need of simulation tool, Case studies on MEMS/Biomes microstructure and their applications, Introduction to Nanotechnology and NEMS, Microfabrication Techniques for NEMS, Mechanical Behavior at Nanoscale, NEMS Device Design and Modeling

*Self-Directed Learning: Simulation of various MEMS devices using COMSOL Multiphysics

References:

1. Liu C., Foundations of MEMS, Prentice Hall, 2011.
2. Bao M., Analysis and Design Principles of MEMS Devices, Elsevier Science, 2005.
3. Senturia S.D., Microsystem Design, Springer, 2001.
4. Wang W., Soper S.A., Bio-MEMS-Technologies and Applications, CRC Press, 2007.
5. Rebeiz G.M., RF MEMS: Theory, Design, and Technology, John Wiley &Sons, 2003.
6. COMSOL (Installed in the Lab)

ECE 3243: ANALOG IC DESIGN LAB [0 0 3 1]

Familiarization of Cadence Virtuoso and Spectre tool , MOS device characterization, Inverter, Current mirror, CS,CD,CG amplifier with various loads, Differential amplifier, DAC

References:

1. Cadence Virtuoso User Manual.
2. R. Jacob Baker, Harry W. Li, David E. Boyce, CMOS circuit design, Layout, and Simulation, 3rd edition, IEEE Press, PHI Pvt. Ltd, 2010.
3. David A. Johns, Ken Martin, Analog Integrated Circuit Design, 2nd edition, Johns Wiley & Sons, 2013.

ECE 3244: SEMICONDUCTOR FABRICATION AND CHARACTERIZATION LAB [0 0 3 1]

Thermal oxidation of silicon wafer, diffusion of impurities in silicon wafer, photolithography for various mask patterns and photoresists, lift-off with thermal evaporation, wet etching of silicon wafers, resistors, MOSCAPs, MOSFETs and diodes, Electrical characterizations: I-V, C-V, sheet resistance and morphological characterizations: microscope, thickness measurement using optical (oxide layer) and step (metal layer) method.

References:

1. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).
2. Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Liss, Inc. USA, (2001).
3. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009).
4. Wachtman, J.B., Kalman, Z.H., Characterization of Materials, Butterworth Heinemann, (1993).

MINOR - I. Semiconductor Devices and Packaging

ECE 4415: Opto-Electronic & Photovoltaics

ECE 4416: Compound Semiconductor Electronics

ECE 4406: MOS Device Modelling

ECE 4417: Fundamentals of Electronic Packaging Materials

MINOR - II. Advanced Solid-State Devices

ECE 4452: Flexible Electronics

ECE 4418: III-V Novel Semiconductor Devices

ECE 4419: Photonic Material and Devices for Integrated Photonic

ECE 4420: Mesoscopic Electronic Devices

MINOR - III. Computational Intelligent VLSI System

ECE 4409: Machine Learning

ECE 4410: Computer Vision

ECE 4421: Machine Learning for VLSI Design Automation

ECE 4422: Edge Artificial Intelligent Computing

MINOR- IV. Advanced VLSI Architecture

ECE 4443: Bioinspired and Evolvable Systems

ECE 4459: Neuromorphic VLSI Circuits

ECE 4423: VLSI Architecture For Iot and Edge Devices

ECE 4424: Security Solutions In VLSI

ECE 4415: OPTO-ELECTRONIC & PHOTOVOLTAICS [3 0 0 3]

Optical emission from semiconductors, Laser, Non semiconductor lasers, Narrow-linewidth and wavelength-tunable lasers, Mid-infrared and far-infrared lasers, Light Emitting Diodes, Optical Detectors, Parameters for Optical Detectors, Phototransistors, Solar Cells, Different types of solar Cells, Parameters related to solar cells, Efficiency improvement in solar cells.

*Self Directed Learning: Characterization of Solar Cells

References:

1. Donald A. Neamen, Semiconductor Physics and Devices: Basic Principles, 4th ed., New York, NY: McGraw-Hill, 2012.
2. John M Senior, Optical Fiber Communications Principles and Practice, 3rd ed., ISBN: 978-0-13-032681-2, Pearson Education Limited, 2009.
3. Peter Wurfel and Uli Wurfel, Physics of Solar Cells from basic to advance concept, 3rd ed., ISBN: 978-3-527-41312-6, Wiley-VCH, 2016.
4. John Wilson, John Hawkes, Optoelectronics, 3rd ed. ISBN:978-9352866663, Pearson Education 2018.
5. Pallab Bhattacharya , Semiconductor Optoelectronic Devices, 2nd ed. ISBN: 978-9332587410, Pearson Education 2017.

ECE 4416: COMPOUND SEMICONDUCTOR ELECTRONICS [3 0 0 3]

Fundamentals of Semiconductors: Crystal structures, defects, electron and phonon interactions, energy bands, metal-semiconductor contacts, carrier mobility, and concentration. III-V Semiconductors: Properties of GaAs, InP, InGaAs, AlGaAs, GaN; structures, electrical characteristics, and surface states. III-V Heterojunction Devices: MODFET structure, HEMT principles (AlGaAs/GaAs, AlGaN/GaN), band structures, polarization effects, small signal analysis, and applications in high-power and high-speed scenarios. Optical Devices: III-V semiconductor-based optical devices, LED fundamentals, semiconductor laser theory. Technology: Fabrication of HEMT structures, compound semiconductor synthesis, TLM for analysis.

*Self-Directed Learning: Applications and characterization processes for III-V devices

References:

1. Keh Yung Cheng, III–V Compound Semiconductors and Devices, An Introduction to Fundamentals, Springer, 2020.
2. Donald A. Neamen, Semiconductor Physics and Devices Basic Principles Fourth Edition, McGraw-Hill, 2012.
3. Hadis Morkoç, Handbook of Nitride Semiconductors and Devices: Materials Properties, Physics and Growth, Wiley VCH Verlag GmbH & Co. KGaA, 2008.
4. S.M. Sze, Physics of Semiconductor Devices, 3rd ed. Wiley 2008.

ECE 4406: MOS DEVICE MODELLING [3 0 0 3]

This course introduces SPICE modeling for passive and active components, with a focus on MOSFET models (Level 1, 2, and 3). Topics include DC, AC, and transient analysis, process variations, Monte Carlo simulations, and noise modeling (flicker and thermal noise). Students will explore BSIM4 MOSFET models, addressing BSIM3 limitations, threshold voltage modifications, mobility models, gate resistance, and layout-dependent parasitics. The course also covers distortion analysis, nonlinearities in CMOS devices, and frequency response simulations. Practical sessions involve using SPICE tools for device simulations, supported models, and example circuit simulations, enhancing hands-on experience in SPICE-based analysis and modeling.

*Self-Directed Learning: Introduction to SPICE tools- CMOS VLSI Design

References:

1. Tar Fjeldly, Trond Ytterdal and Michael S. Shur "Introduction to Device Modeling and Circuit Simulation" Wiley-Blackwell, 1997.
2. Giuseppe Massabrio and Paolo Antognetti "Semiconductor Device Modeling with Spice" Tata McHill, 2010.
3. William Liu, "MOSFET Models for SPICE Simulation: Including BSIM3v3 and BSIM4", Wiley-IEEE Press, 2001.
4. Nandita Das Gupta and Amitava Das Gupta, "Semiconductor

Devices. Modeling and Technology", PHI, New Delhi, 2004.

5. M.K.Achuthan and K.N. Bhat, "Fundamentals of Semiconductor Devices", Tata McGraw.Hill, New Delhi, 2011.

*Introduction to SPICE tools- CMOS Digital VLSI Design By Prof. Sudeb Dasgupta , IIT Roorkee

ECE 4417: FUNDAMENTALS OF ELECTRONIC PACKAGING MATERIALS [3 0 0 3]

Introduction to packaging, Electrical Design, Modelling and Analysis, Thermal Management and Thermo-Mechanical Design, Overview of Packaging Materials, Advanced Packaging and Emerging Technologies, Packaging for Radio Frequency and mm-wave devices, Optoelectronics, MEMS and Sensors devices.

*Self-Directed Learning: Solder life span

References:

1. Rao R. Tummala, Fundamentals of Microsystems Packaging, McGraw Hill, NY, 2001.
2. William D. Brown, Advanced Electronic Packaging, IEEE Press, 1999.
3. Jamnia, Ali, Practical guide to the packaging of electronics: thermal and mechanical design and analysis. CRC Press, 2016.

ECE 4452: FLEXIBLE ELECTRONICS [3 0 0 3]

Atomic/electronic structure of various electronic material, conduction in amorphous semiconductors, Polycrystalline, amorphous semiconductors, nanowires, metal oxides, flexible substrates, Various fabrication processes, photolithography, CVD, PECVD, PVD. Thin-film transistors, solar cells, LEDs, organic TFTs, flexible CNT/graphene devices, Displays, memory devices, flexible solar panels, healthcare and environmental sensors.

*Self-Directed Learning: Gravure printing, inkjet printing, roll-to-roll processing, micro contact printing. CVD, PECVD, PVD, etching, photolithography.

References:

1. William S. Wong, Alberto Salleo, Flexible Electronics: Materials and Applications, 2011, 1st Edition, Springer, New York.
2. Guozhen Shen, Zhiyong Fan, "Flexible Electronics: From Materials to Devices", 2015, 1st Edition, World Scientific Publishing Co, Singapore
3. Richard Zallen, "The Physics of Amorphous Solids", Wiley-Interscience Publication, 1983.
4. Sanjiv Sambandan, "CIRCUIT DESIGN Techniques for Noncrystalline Semiconductors", CRC Press Taylor & Francis Group, 2013.
5. Edward Sazonov, Michael R. Newman, "Wearable Sensors: Fundamentals, Implementation and Applications", 2014, 1st Edition, Academic Press, Cambridge *Advanced Textile Printing Technology, IIT Delhi, Prof. Kushal Sen, https://nptel.ac.in/courses/116102052.

   * VLSI Technology, IIT Madras Dr. Nandita Dasgupta, https://nptel.ac.in/courses/117106093.

ECE 4418: III-V NOVEL SEMICONDUCTOR DEVICES [3 0 0 3]

Explore advanced transistors (FDSOI, DG-ETSOI, FINFETs, nanowires), focusing on their I-V characteristics, capacitances, and parasitic effects. Study circuit performance using nanoscale MOSFETs, including quantum confinement, quasi-ballistic transport, and band-to-band tunneling effects. Examine steep slope devices like Tunnel FETs and resonant TFETs, and integration challenges with Germanium and III-V compounds in MOSFETs.

*Self-Directed Learning: Strained Si technology, NEGF, Thermoelectric effects and thermoelectric devices, Quantum dot devices – quantum capacitance, IV characteristics, self-consistent method.

References:

1. Mark Lundstrom and J. Guo, "Nanoscale Transistors: Device Physics, Modeling and Simulation," Springer. 2007
2. J. P. Colinge, "FinFETs and Other Multi-Gate Transistors," Springer. 2009
3. Tak H. Ning and Yuan Taur, "Fundamentals of Modern VLSI Devices" 2015 Pearson Education India Pvt. Ltd 2015
4. S. M. Sze and Kwok K. Ng, "Physics of Semiconductor Devices," Wiley 2008
5. Donald A. Neamen, "Semiconductor Physics and Devices", McGraw Hill Higher Education 2002
6. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective," Prentice Hall 2003

ECE 4419: PHOTONIC MATERIAL AND DEVICES FOR INTEGRATED PHOTONIC [3 0 0 3]

Introduction to Photonics and integrated photonics; Propagation of electromagnetic waves; Optical waveguides and optical fibers; Coupled mode theory in optical waveguide system; Photonic devices: Mach-Zehnder interferometer, Arrayed Waveguide Grating (AWG)-based MUX/DEMUX, Add-drop multiplexer; Photonic Crystal Fiber and corresponding EM analysis; PON; FTTH; Photonic materials and fabrication technologies; Packaging of photonic devices; Recent trends.

Self-directed Learning: Photonic Bandgap and various Photonic devices design using COMSOL.

References:

1. H Nishihara, M Haruna and T Suhara, Optical Integrated Circuits, McGraw-hill, 1989.
2. Gerd Keiser, Optical Fiber Communications, 3rd Edition, McGraw-Hill International edition, 2000.
3. C. R. Pollock and M. Lip Son, Integrated Photonics, Kluwer Pub., 2003.
4. T. Tamir, (ed), Guided-wave optoelectronics, (2nd edition), Springer-Verlag, 1990.
5. Clifford Pollock, Fundamentals of Optoelectronics, Richard Irwin Inc., Chicago, 1995.
6. Journal articles i.e. IEEE, Springer, IOPscience, Elsevier and Video lectures from nanohub, NPTEL, MIT video lectures.

ECE 4420: MESOSCOPIC ELECTRONIC DEVICES [3 0 0 3]

Electrical Resistance, Conductance, Ballistic Conductance, Elastic Resistors, Transport Theories, Why Electrons Flow, The Elastic Resistor, Ballistic and Diffusive Transport, Conductance from Fluctuation, Energy Band Model, E(p) or E(k) Relation, Number of Modes, Electron Density, The Nano transistor Quantum capacitance, Current from QFL's, BTE from Newton's Laws", Quasi-Fermi Levels, Hall Effect, Smart Contacts, Thermoelectricity, Phonon Transport, Coherent transport, non-coherent transport, Quantum transport equations, Physics of Ohm's law.

*Self Directed Learning: Non-Equilibrium Green Function (NEGF)

References:

1. S. Dutta, Quantum Transport: Atom to Transistor, Revised Edition, Cambridge University Press, 2013.
2. S. Dutta, "Lessons from Nanoelectronics: A New Perspective on Transport, Basic Concepts, 2nd Edition, World Scientific Pub Co Inc, 2017
3. Jeong, Changwook; Lundstrom, Mark S., Near-equilibrium transport: fundamentals and applications, World Scientific, 2013.
4. Mark S. Lundstrom, Jing Guo, Nanoscale Transistors: Device Physics, Modeling and Simulation, Springer US , 2006.

ECE 4409: MACHINE LEARNING [3 0 0 3]

Fundamentals of machine learning, covering supervised, unsupervised, and reinforcement learning. Statistical decision theory, regression, and classification, followed by feature reduction techniques like PCA. Linear discrimination methods such as logistic regression, LDA, and SVMs are explored in depth. The course includes artificial neural networks, backpropagation, and training strategies. Parameter estimation methods, regression trees, and ensemble methods like bagging and boosting are covered. Students will learn evaluation techniques including cross-validation and ROC analysis. The course also covers graphical models (Naïve Bayes, Bayesian networks, HMMs), clustering methods (GMM, EM), and reinforcement learning with nonparametric classification approaches.

*Self-directed learning: Self-Organizing Maps, Recurrent Neural Network, Hopfield Neural Network, Adaptive Resonance Theory, Statistical Hypothesis testing- t-test, ANOVA.

References:

1. Alpaydin E, Introduction to Machine Learning, (2e), MIT Press. 2010.
2. Duda R.O, Hart P.E. and Stork D.G., Pattern Classification, (2e), Wiley, 2001
3. Bishop C. M., Pattern Recognition and Machine Learning, Springer, 2007.
4. Andrew Barto and Richard Sutton, Reinforcement learning an Introduction, MIT press, 1998.
5. Jensen R. and Shen Q. Computational Intelligence and Feature Selection: Rough and Fuzzy Approaches, Vol. 8, IEEE Press Series on Computational Intelligence, John Wiley and Sons, 2008.

   * https://nptel.ac.in/courses/106106139

ECE 4410: COMPUTER VISION [3 0 0 3]

Image formation, linear filters and convolution, edge detection, image features, texture analysis and synthesis, Segmentation using clustering, Segmentation and fitting using probabilistic methods, Homogenous coordinates, Epipolar geometry, least-square parameter estimation, Feature selection, Bayes Classifier, Multi-layer perceptron, Support Vector Machine.

*Self directed learning : Simulation of Image Segmentation

References:

1. David A. Forsyth and Jean Ponce, Computer Vision: A Modern Approach, Pearson Education, 2003
2. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer, 2010
3. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, 2nd Edition, Cambridge University Press, 2004
4. Linda Shapiro and George Stockman, Computer Vision, Pearson Education, 2001

   *Image processing tool box in MATLAB

ECE 4421: MACHINE LEARNING FOR VLSI DESIGN AUTOMATION [3 0 0 3]

This comprehensive course explores the integration of machine learning techniques into the VLSI design automation process. It begins with core concepts such as VLSI physical design, design automation tools, data structures, algorithms, graph theory, and computational complexity. The course contrasts traditional CAD algorithms with machine learning approaches to address challenges in combinatorial optimization tasks like partitioning, floor planning, placement, routing, synthesis, and testing. It also delves into the application of evolutionary algorithms (Genetic Algorithms, Particle Swarm Optimization, Simulated Annealing) for placement, and ML models such as K-Means, K-Nearest Neighbors, Decision Trees, and Random Forests for chip partitioning, congestion prediction, and routability-driven placement. The course also covers ML-based physical verification and mask synthesis methods, including layout feature extraction, hotspot detection, and optical proximity correction. Finally, it addresses ML techniques in testing, manufacturing, yield prediction, and failure modelling using statistical methods and Gaussian process-based models for high-volume production environments

Self-Directed Learning (SDL): ML for Analog design

References:

1. Elfadel, Ibrahim M., Duane S. Boning, and Xin Li, eds. Machine learning in VLSI computer-aided design. Cham: Springer, 2019.
2. Kumar, Abhishek, Suman Lata Tripathi, and K. Srinivasa Rao, eds. Machine Learning Techniques for VLSI Chip Design. John Wiley & Sons, 2023.
3. Saini, Sandeep, Kusum Lata, and G. R. Sinha, eds. VLSI and Hardware Implementations Using Modern Machine Learning Methods. CRC Press, 2021.
4. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation ", 1999.
5. *SDL: Elfadel, Ibrahim M., Duane S. Boning, and Xin Li, eds. Machine learning in VLSI computer-aided design. Cham: Springer, 2019.
6. NPTEL: CAD for VLSI Design https://archive.nptel.ac.in/courses/106/106/106106088/

ECE 4422: EDGE ARTIFICIAL INTELLIGENT COMPUTING [3 0 0 3]

AI and edge computing fundamentals, covering the relational model of AI, ML principles, and their application in IoT systems with an emphasis on Edge and Cloud AI. Python programming essentials and ML libraries with hands-on demos and case studies. IoT architectures integrating AI, and software platforms like TinyML, TensorFlow, and Keras for Edge AI development. Hardware tools, especially Arduino Nano BLE, are used for real-time models like person detection. Real-world applications in autonomous vehicles, healthcare, and education, addressing ethical, economic, and policy considerations in AI deployment.

*Self-directed learning: Python Programming

References:

1. "Edge AI – convergence of Edge Computing and Artificial Intelligence", Xiaofei Wang, Yiwen Han, Victor C.M.Leung, Dusit Niyato, Xueqiang Yan, Xu Chen, Springer, 2020. ISBN: 978-981-15-6185-6.
2. "Artificial Intelligence for Edge Computing", Mudhakar Srivatsa, Tarek Abdelzaher, Ting He, Springer,2023. ISBN:978-3-031-40786-4.
3. "Machine Learning for Edge Computing" Amitoj Singh, Vinay Kukreja, Taghi Javdani Gandomani, CRC Press - Taylor & Francis,2022. ISBN: 978-0367694326.

ECE 4443: BIOINSPIRED AND EVOLVABLE SYSTEMS [3 0 0 3]

This course covers evolutionary computing, focusing on natural, soft, and quantum computing, along with DNA and membrane computing. Topics include evolutionary algorithms like Genetic Algorithms, Genetic Programming, PSO, and ACO. It explores neural, immune, and DNA computing, covering Spiking Neural Networks, Self-Organizing Maps, and artificial immune networks. The course also examines reconfigurable hardware, including FPGA architectures and virtual devices for applications like evolutionary clustering. It delves into evolvable hardware and computational machines, studying Cartesian Genetic Programming, fitness landscape analysis, and image processing applications. Finally, it explores evolvable cellular automata and the Turing Machine in computational theory.

*Self-Directed Learning: Cellular Automaton

References:

1. Lukas Sekanina, "Evolvable Components: From Theory to Hardware Implementations", Springer-Verlag Berlin Heidelberg New York, 2004,
2. David W. Corne, Peter J. Bentley," Creative Evolutionary Systems", Academic Publishers, 2002.
3. Albert Chun Chen Liu and Oscar Ming Kin Law, "Artificial Intelligence Hardware Design: Challenges and Solutions", IEEE Press Wiley, 2021, First edition
4. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, Cambridge, MA, 2008.
5. Leandro Nunes de Castro, " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007
6. Xuewei Li, Jinpei Wu, Xueyan Li –'Theory of Practical Cellular Automaton' Springer Singapore, 2018 (First edition).

   Web: https://mathworld.wolfram.com/CellularAutomaton.html

ECE 4459: NEUROMORPHIC VLSI CIRUITS [3 0 0 3]

This course introduces the signaling and operation of biological neurons, neuron models, signal encoding, and synaptic plasticity, focusing on neuromorphic design principles. It covers FETs and MOS transistor operation, including weak and strong inversion, floating-gate circuits, electron tunneling, and hot-electron injection. Topics include static and dynamic circuits such as current mirrors, transconductance amplifiers, power-law circuits, and adaptive circuits. The course also explores current-mode circuits and signal aggregation, including translinear principles, floating-gate MOS circuits, and winner-take-all circuits. Additionally, it covers analog and digital neuromorphic designs, including memristive devices, electronic synapse design, interconnection networks, and neuromorphic VLSI architectures for large neural networks.

References:

1. C. A. Mead , "Analog VLSI and Neural Systems", 1990.
2. Shih-Chii Liu, Jörg Kramer, Giacomo Indiveri, Tobias Delbrück, Rodney Douglas, Analog VLSI: circuits and principles, MIT press, 2002.
3. Carver Mead, Analog VLSI and neural systems, Addison-Wesley, 1989, ISBN0201059924
4. Eric Kandel, James Schwartz, Thomas Jessell, Steven Siegelbaum, A.J. Hudspeth, Principles of neural science, McGraw Hill 2012, ISBN 0071390111
5. Leslie S. Smith and Alister Hamilton , "Neuromorphic systems", World Science, 1998.

ECE 4423: VLSI ARCHITECTURE FOR IoT AND EDGE DEVICES [3 0 0 3]

Concept to chip, CMOS technology basics, Scaling, Low-Power VLSI Design Techniques: Power dissipation sources in digital circuits Techniques for static and dynamic power reduction, Design for low-voltage operation, IoT Architecture, Implementation of SoC Additional interfaces using Sensors and Actuators, Edge computing hardware architectures, Communication Models - Edge, Fog and M2M, ASICs for IoT sensors and actuators, Design of low-power processors and memory architectures for Edge devices, Hardware accelerators for specific IoT functionalities, Verification and Testing: Simulation tools for functional verification of IoT, Edge computing modules, Testing methodologies for fault detection.

*Self-directed Learning: Implementation of Microcomputer RaspberryPi and device Interfacing, Edge to Cloud Protocols, MQTT

References:

1. Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, by Francis daCosta, ISBN: 978-1-4302-5740-0, 2013
2. Architecting the Internet of Things, by Dieter Uckelmann, Mark Harrison and Florian Michahelles, ISBN: 978-3-642-19157-2, 2011
3. Marco Schwartz, "Internet of Things with the Arduino Yun", Packt Publishing, 2014
4. IoT Fundamentals - Networking Technologies, Protocols and Use Cases for the Internet of Things (English, Paperback, Rowan Trollope, David Hanes, Patrick Grossetete, Jerome Henry, Rob

Barton, Gonzalo Salgueiro)

5. Arshdeep Bahga and Vijay Madisetti, "Internet of Things – A Hands on Approach",Universities Press, 2015.
6. Foundational Elements of an IoT Solutions: The Edge, The Cloud Application Development, Joe Biron and Jonathan Follett.
7. IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, by David Hanes, Gonzalo Salgueiro, Rob Barton, 2017,ISBN: 9780134307091.

ECE 4424: SECURUTY SOLUTIONS IN VLSI [3 0 0 3]

Information system review: LAN, WAN, MAN, Information flow, Security mechanisms in OSI model: Targets, Threats to Security: Physical security, Biometric systems, Monitoring controls, Data security, System security, Computer system security, Communication security, Conventional techniques: Modern techniques, DES chaining modes (Triple DES), RSA algorithm, Key management, Message authentication and Hash functions, Secure Hash functions, Digital signatures, Directory authentication service, Firewalls: Design principles, Trusted systems, IT Act and cyber laws, VPN, Future threats to networks, Recent attacks on networks- VLSI-based Case Study, Concept to chip, CMOS technology basics, Scaling, Design Methodologies: Design styles, Datapath and control path, FSM, VLSI Implementation of DES algorithm, Implementation of RSA encryption (RSA algorithm), Development of a digital signature chip using RSA algorithm.

*Self-directed Learning: Future threats to networks, Recent attacks on networks

References:

1. Cryptography and Network Security by William Stallings (Pearson Education, 2009)
2. Security in Computing by Charles P. Pfleeger (Prentice Hall, 2003)
3. Inside Internet Security by Jeff Crume (Addison-Wesley, 2000)

ECE 3222: SYSTEM ON CHIP DESIGN [3 0 0 3]

Basics of SoC, Constituents of SoC - Life cycle, Design flow, Physical Design, Logic Synthesis, Floor Planning, Placement, Routing, Physical Design Constraints, Clock Tree Synthesis, Timing analysis, power routing, Interconnects, Switch Interconnects, Layered Architecture, Network Interface, IP-based design, IP evaluation on FPGA prototypes, SOC verification, testing, Standardization-SoC Test Automation, SoC packaging. Network on Chip, architectures, Reconfigurable NoC, NoC interconnects and 3D-NoC.

*Self Directed Learning: Modern NoC Architectures

References:

1. Michael J.Flynn, Wayne Luk, , "Computer system Design: System-on-Chip", Wiley-India, 2012.
2. Veena S. Chakravarthi- "A Practical Approach to VLSI System on Chip (SoC) Design", Springer Nature Switzerland AG, 2020
3. Sudeep Pasricha, Nikil Dutt, "On Chip Communication Architectures: System on Chip", Morgan Kaufmann Publishers, 2008.
4. W.H.Wolf,, "Computers as Components: Principles of Embedded Computing System Design", Elsevier, 2008.

   * NPTEL-IIT Madras https://youtube.com/playlist?list=PL3p-ZpXPqK6vvxeTp1k4kDMJj74WIetyC

ECE 4405: LOW POWER VLSI DESIGN [3 0 0 3]

Basics of low power VLSI design, sources of power dissipation in digital integrated circuits, Power dissipation in CMOS circuits. Dynamic and static power dissipation. Probabilistic power analysis. Equivalent Pin Ordering, Network Restructuring and Reorganization. Logic encoding, state machine encoding, reduction of power in address and data buses. Power and performance management, parallel architecture with voltage reduction, low power memory design. Low power clock distribution.

*Self-Directed Learning: Battery-Aware Systems, OS level and software level power reduction techniques.

References:

1. *Gary K. Yeap, "Practical Low Power Digital VLSI Design", KAP, 2002.
2. Christian Piguet, "Low Power CMOS Circuits – Technology, Logic Design and CAD Tools", CRC Press, 2006.
3. Jan M. Rabaey, Massoud Pedram, "Low power design methodologies", Kluwer Academic, 1997.
4. Kaushik Roy, Sharat Prasad, "Low Power CMOS VLSI Circuit Design", Wiley, 2000.
5. Kiat Seng Yeo, Samir S. Rofail, Wang-Ling Goh, "CMOS/BiCMOS ULSI: Low Voltage, Low Power", Pearson, 2002.

ECE 4444: BIO-MEMS AND MICROSENSORS [3 0 0 3]

Introduction to the historical background and fundamental fabrication techniques of MEMS, bulk and surface micromachining, wafer bonding, and the LIGA process.MEMS transduction and actuation techniques, Electromechanical, piezoelectric, and electrothermal actuators. Microsensing technologies: piezoresistive, capacitive, and resonant sensing. Bio-MEMS fabrication techniques for microfluidic and optical components. Microfluidic devices: micropumps and micromixers, and sensing technologies for bio-MEMS applications, including electrochemical detection, DNA analysis, and drug delivery systems.

References:

1. RF MEMS and Their Applications, Vijay K. Varadan, K.J. Vinoy and K.A. Jose, Wiley, 2003 Edition.
2. Bio-MEMS-Technologies and Applications, Edited by Wanjun Wang and Steven A. Soper, CRC Press, 2007.
3. Richard P.Buck,William E.Hatfieldc (1990) "Biosensors Technology" Marcel dekker USA
4. Stephen D. Senturia, "Microsystem Design" by, Kluwer Academic Publishers, 2001.
5. Marc Madou, "Fundamentals of Microfabrication" by, CRC Press, 1997.
6. Gregory Kovacs, "Micromachined Transducers Sourcebook" WCB McGraw-Hill, Boston, 1998.

ECE 4447: DATA STRUCTURES AND ALGORITHMS [3 0 0 3]

Data Structures – Introduction to Data Structures, abstract data types, Time and space complexity Linear list – singly linked, circular linked list, Double linked list, Applications of linked lists. Stacks-Operations, array and linked representations of stacks, stack applications, recursion implementation. Queues-operations, array and linked representations, applications of queues.

Trees - tree representation, properties of trees, Binary tree representation, binary tree properties, binary tree traversals, binary tree implementation, applications of trees, Graph- Representation of Graph, types of graph, Matrix Representation of Graphs, Elementary Graph operations, Spanning Trees, Shortest path, Minimal spanning tree. Searching and Sorting – Sorting- selection sort, bubble sort, insertion sort, quick sort, merge sort, shell sort, radix sort, Searching-linear and binary search methods, comparison of sorting and searching methods.

*Self-Directed Learning: Implementation of data structure and algorithms using compilers

References:

1. Ellis Horowitz;Sartaj Sahni;Dinesh Mehta, "Fundamentals of Data Structures in C++", 2nd edition, Universities Press (India) Limited, 2013.
2. Mark A. Weiss, "Data Structures and Algorithm Analysis in C++", 3rd Edition, Pearson Education India, 2007.
3. Lipschutz, "Data Structures with C++", Schaum outline series, 2006
4. Michael T. Goodrich, Roberto Tamassia, David Mount, "Data Structures and Algorithms in C++", John Wiley & Sons, 2011.
5. *https://www.javatpoint.com/cpp-installation

ECE 4457: NANO DEVICES & NANO SENSORS [3 0 0 3]

Quantum devices: Electrons in mesoscopic structures – split Gate Transistor–Quantum Dot array – Quantum computer- Bit and Qubit. Carbon Nanotube based logic gates. Tunneling devices: Tunnel Effect and Tunneling Elements- Tunneling Diode – Resonant Tunneling Diode – Basics Logic Circuits – Single Electron Transistor (SET) – Principle – Coulomb Blockade- Circuit Design- Logic and Memory Circuits. Nanosensors applications: Nanosensor for Biosensors, immobilization, characteristics, applications, conducting Polymer based sensors, DNA Biosensors, Lab-on-chip. Nanolithography: Basics of lithography, optical, ion beam lithography, lithographic tools, soft lithography- nanoimprint lithography, wet chemical etching –stencil lithography and sacrificial etching– future challenges - applications.

*Self-Directed Learning: NANOLITHOGRAPHY- Basics of lithography, optical, micro, ion beam lithography, lithographic tools, wet chemical etching.

References:

1. K. Goser, P. Glosekotter and J. Dienstuhl, "Nanoelectronics and Nanosystems-From Transistors to Molecular Quantum Devices" , Springer, 2004.
2. Ramon Pallas-Areny, John G. Webster, "Sensors and signal conditioning" John Wiley & Sons, 2001.
3. W.R.Fahrner, "Nanotechnology and Nanoelectronics – Materials, Devices and Measurement Techniques" Springer, 2006 13
4. H. Meixner, Sensors: Micro & Nanosensors, Sensor Market trends (Part 1&2)
5. M Feldman, "Nanolithography:The Art of Fabricating Nanoelectronic and Nanophotonic Devices and Systems", Woodhead Publishing Series in Electronic and Optical Material 2014.
6. VLSI Technology, IIT Madras Dr. Nandita Dasgupta, https://nptel.ac.in/courses/117106093 .

ECE 4461: OBJECT ORIENTED PROGRAMMING USING C++ [3 0 0 3]

Overview of C++, Classes & Objects, defining member functions, data hiding, constructors, destructors, parameterized constructors, static data members, functions, friend functions, passing objects as arguments, Inheritance: constructors, destructors and inheritance, passing parameters to base class constructors, granting access, virtual base classes. Virtual functions, polymorphism: I/O system basics, file I/O: Exception handling.

* Self-Directed Learning: Analytic representation of complex systems and their attributes : NPTEL course : Object-Oriented Analysis and Design, IIT Kharagpur

References:

1. Schildt H., "The Complete Reference C++", Tata McGraw Hill, 2003.
2. Lafore R., "Object-Oriented Programming in C++", Pearson Education, Reprint 2011.
3. Lippmann S.B., Lajore J., "C++ Primer", Pearson Education, 2005.
4. Deitel P.J., Deitel H.M., "C++ for Programmers", Pearson Education, 2009.
5. Sourav Sahay, "Object oriented programming with C++", Oxford University press, 2006.

   * https://nptel.ac.in/courses/106105153

ECE 4467: SPINTRONIC VLSI [3 0 0 3]

The advent of spintronics, Quantum Mechanics of Spin: Pauli Spin Matrices. Spin-orbit interaction, spin polarized drift/diffusion, Spin-orbit interaction in a solid: Rashba Interaction, Spin Relaxation. Spin transfer torque (STT), anomalous Hall effect, Spin Hall effect (SHE), spin orbit torque (SOT). Spin valve, Magnetic tunnel junction (MTJ). Silicon based spin electronic devices: toward a spin transistor. Spintronic computing: Hybrid spintronics, Inmemory computing using spintronic devices.

All spin logic, Ferroelectric tunnel junction (FTJ), and Domain wall (DW) are in the magnetic nanowire. Micromagnetic simulation of spintronic devices using OOMMF/Mumax/COMSOL etc.

*Self-Directed Learning: All spin logic, Ferroelectric tunnel junction (FTJ), and Domain wall (DW) are in the magnetic nanowire. Micromagnetic simulation of spintronic devices using OOMMF/Mumax/COMSOL etc.

References:

1. J. M. D. Coey, "Magnetism and Magnetic Materials", Cambridge University Press, 2010.
2. S. Bandyopadhyay, M. Cahay, "Introduction to Spintronics", CRC Press, 2008.
3. S. Maekawa, "Concepts in Spin Electronics", Oxford University Press, 2006.
4. D. D. Awschalom, R. A. Buhrman, J. M. Daughton, S.V. Molnar, and M.L. Roukes, "Spin Electronics", Kluwer Academic Publishers, 2004.
5. Suri Manan, "Applications of Emerging Memory Technology",

Springer Series in Advanced Microelectronics, 2020.
6. *https://nanohub.org/wiki/Spin
7. *https://nanohub.org/publications/375/1
8. http://gdr-rest.polytechnique.fr/node/94
9. *https://www.comsol.com/blogs/micromagnetic-simulation-with-comsol-multiphysics

ECE 4469: SWITCHING THEORY FOR LOGIC SYNTHESIS [3 0 0 3]

Boolean algebra, two level logic networks, Exact and Heuristic techniques, Sequential circuit optimizations, Multilevel Logic synthesis, Technology mapping, logic designs using modules and exor.

Self-Directed Learning: *Sequential circuit optimization – State diagram reduction using equivalence method and implicant chart table technique.

References:

1. Tsutomu Sasao, Switching Theory for Logic Synthesis, Springer Publication, 1999.
2. Soha Hassoun , Tsutomu Sasao, Logic Synthesis and Verification, Springer Publication, 2002.
3. Giovanni De Michelli , Synthesis and Optimisation of Digital Circuits, Tata-McGraw Hill, New Delhi,2008.
4. Gary D. Hachtel, Fabio Somenzi , Logic Synthesis and Verification Algorithm, Kluwer Academic Publication, Boston,2002.
5. D.D. Gajski, N.D. Dutt, A.C. Wu and A.Y. Yin, "High-level synthesis: introduction to chip and system design", Kluwer Academic Publishers.

   * Switching Theory and Logic Design-A. Anand Kumar, PHI, 2nd Edition.

ECE 4499: RELIABILITY OF VLSI CIRCUITS [3 0 0 3]

Quasi-ballistic I-V characteristics, quantum-based terminal capacitances, and parasitic resistances. Explore delay models for nano-CMOS logic gates, timing in sequential circuits, and memories. Study power models: dynamic, short circuit, leakage, and full-chip estimation with sensitivity to process variations. Analyze analog circuit performance parameters and reliability impacts excluding VLSI design aspects.

*Self-Directed Learning: Use simulation tools to analyze and compare the impact of process variations, temperature changes, and supply voltage fluctuations on timing parameters and power consumption and gain practical insights into optimizing circuit performance.

References:

1. M Stanisavljević, A Schmid, Y Leblebici, "Reliability of Nanoscale Circuits and Systems: Methodologies and Circuit Architectures" Springer, 11th edition, 2014.
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata McGraw-Hill, 2nd edition, 2017.
3. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective," Prentice Hall 2003.

ECE 4500: VLSI PHYSICAL DESIGN [3 0 0 3]

This course covers the VLSI physical design flow, objectives, and challenges, emphasizing design rules, layout basics, and EDA tools. It explores optimization algorithms, partitioning, floorplanning, placement, routing, clock tree synthesis, timing closure, and signal integrity. Power analysis includes IR drop, EM, and low-power design techniques like power gating and UPF. Timing analysis covers static/dynamic timing, constraints, on-chip variations, and LVF. The course concludes with physical verification processes, DRC, LVS, DFM, and scripting using Tcl and Python.

*Self-Directed Learning: Writing TCL scripts to optimize design constraints during design synthesis and automate the VLSI physical design flow using EDA tool.

References:

1. Rakesh Chadha and J. Bhasker, "An ASIC Low Power Primer", Springer, 2013
2. Veena S. Chakravarthi- A Practical Approach to VLSI System on Chip (SoC) Design, Springer Nature Switzerland AG, 2020
3. Kurt Wall, "Tcl/Tk Programming for the Absolute Beginner", Cengage Learning Ptr, 1st edition, October 16, 2007.
4. Michael J.Flynn, Wayne Luk, Computer system Design: System-on-Chip, Wiley-India, 2012.
5. SDL: https://www.vlsiguru.com/tcl-scripting-training/
6. Voltus Reference Manuals, 17.12.000.
7. Tempus Reference Manual, 17.12.000.
8. Calibre Reference Manual, 2017.1_17.12

ECE 4501: MEMORY DESIGN AND TESTING [3 0 0 3]

This course explores a wide range of memory technologies, including SRAM, DRAM, and non-volatile memories like ROM, PROM, EEPROM, and Flash. It covers advanced memory architectures, reliability issues, failure mechanisms, and radiation effects with mitigation techniques. Memory testing topics include fault modeling, testability, and fault tolerance. The course also examines cutting-edge memory technologies such as FRAM, MRAM, and analog memories, along with high-density packaging approaches like 2D/3D MCMs and memory stacks, highlighting future directions in memory system design.

*Self-directed Learning: Advanced SRAM and DRAM Designs and Architectures

References:

1. Ashok K.Sharma, " Semiconductor Memories Technology, Testing and Reliability ", Prentice-Hall of India Private Limited, New Delhi, 1997.
2. Ye Zhou, "Advanced Memory Technology: Functional Materials and Devices", Royal Society of Chemistry, Published: 9 October 2023
3. Luecke Mize Care, "Semiconductor Memory design & application", Mc-Graw Hill.
4. Belty Prince, " Semiconductor Memory Design Handbook".
5. Memory Technology design and testing 1999 IEEE International Workshop on: IEEE Computer Society Sponsor (S).
6. Research Papers

ECE 4502: FUNDAMENTALS OF NANOELECTRONICS [3 0 0 3]

Introduction to Nanoelectronics, importance, applications and challenges, Quantum Mechanics for Nanoelectronics, Wave-Particle

Duality, Schrödinger Equation, Quantum Confinement, Density of States, semiconductor heterostructures: confinement models and two-dimensional electron gas, classical and ballistic transport, Nanostructures and Nanoelectronic Devices, Graphene-based Devices, Single Electron Transistors, Nanowire Transistors, Nanofabrication and Characterization, VLS growth, Nanolithography, Electrical Characterizations, Nanomaterials characterizations.

References:

1. George W Hanson "Fundamentals of Nanoelectronics", Pearson Education Inc., Prentice Hall India, 2009.
2. Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications", Cambridge University Press, 2008.
3. Supriyo Datta "Quantum Transport: Atom to Transistor", Cambridge University Press, 2005.
4. Loutfy H. Madkour "Nanoelectronic Materials: Fundamentals and Applications", Springer 2019.
5. Vladimir G. Dubrovskii "Nucleation Theory and Growth of Nanostructures", Springer-Verlag Berlin Heidelberg 2014.
6. Hassan Raza "Nanoelectronics Fundamentals: Materials, Devices and Systems", Springer, 2019.

ECE 4503: RF MICROELECTRONICS & IC DESIGN [3 0 0 3]

This course introduces RF systems, covering transmission media, matching networks, interconnects, and passive components. It explores distributed systems, transmission lines, and Smith charts. High-frequency amplifier design includes bandwidth estimation, risetime, and noise analysis. Students learn LNA design, noise matching, and mixer architectures. The course also covers RF power amplifiers (Class A-F), voltage-controlled oscillators, and PLLs with practical design examples. Finally, it concludes with an overview of GSM, CDMA, and UMTS radio architectures used in modern wireless communication systems.

*Self -Directed Learning: Analysis/Simulation of RF modules like Low Noise amplifier or gilbert cell and its applocation

References:

1. The Design of CMOS Radio-Frequency Integrated Circuits by Thomas H. Lee. Cambridge University Press, 2004
2. RF Microelectronics by Behzad Razavi.Prentice Hall, 1997.
3. Radio frequency integrated circuits and technologies by Ellinger, F. Springer Science & Business Media
4. GSM - Architecture, Protocols and Services by By Jörg Eberspächer, Christian Bettstetter, Hans-Joerg Vögel, Christian Hartmann.

*5. Simulation using Cadence software/ LT simulator installed in PG Lab.

ECE 4504: SCRIPTING LANGUAGE FOR VLSI [3 0 0 3]

Perl Scripting: Introduction to Perl Scripting, working with Simple Values, Lists and Hashes, Loops and Decisions, Regular Expressions, Files and Data in Perl Scripting, References & Subroutines, Running and Debugging Perl, Modules, Object-Oriented Perl. Tcl Scripting: Basic Syntax Commands, Data types, Variables, Operators, Decisions, Loops, Arrays, Strings, Lists, Procedures and Packages. Python Scripting: Introduction to Python, Using the Python Interpreter, More Control Flow Tools, Data Structures, Modules, Input and Output, Errors and Exceptions, Classes, Brief Tour of the Standard Library.

*Self-Directed Learning: Writing TCL scripts to optimize design constraints during design synthesis and automate the VLSI physical design flow using EDA tool.

References:

1. Randal L. Schwartz, Brian d Foy, and Tom Phoenix, "Learning PERL" O'Reilly Media, Inc. publications 6th Edn., 2011, June 2011. ISBN: 9781449303587
2. Kurt Wall, "Tcl/Tk Programming for the Absolute Beginner", Cengage Learning Ptr, 1st edition, October 16, 2007.
3. Brent Welch, Ken Jones, and Jeff Hobbs, "Practical Programming in Tcl and Tk", Prentice Hall; 4th edition (June 20, 2003)
4. Guido van Rossum, Fred L. Drake, Jr., "Python Tutorial" Python Software Foundation, June 2012.
5. https://archive.nptel.ac.in/courses/117/106/117106113/#

6*. https://www.vlsiguru.com/tcl-scripting-training/

ECE 4505: SEMICONDUCTOR EQUIPMENT DESIGN AND TECHNOLOGY [3 0 0 3]

Basic concepts of vacuum technology: Gas dynamics, pressure, conductance, gas flow regimes, Gas-surface interactions: physisorption, chemisorption, condensation, Vacuum Pumps and Instrumentation. Vacuum pumps: Mechanical, diffusion, turbo-molecular, cryopumps, ion pumps, Vacuum gauges, gas regulators, residual gas analyzers, Vacuum System Design and Troubleshooting: Materials, chambers, seals, valves, leak detection; Plasma Science and Technology: Electron/ion motion in electric and magnetic fields, DC, RF, and microwave field interactions, plasma potential, Plasma Reactors and Applications, Reactor systems, mass flow control, RF/microwave coupling. Applications of vacuum systems: etching, deposition, sputtering, vacuum coating, microelectronics.

*Self-directed Learning: Vacuum system applications for metallurgical processes, etc.,

References:

1. V.V. Rao, T.B. Ghosh, K.L. Chopra,, Vacuum Science and Technology, Allied Publishers Ltd., New Delhi, 2011.
2. Milton Ohring, Materials Science of Thin Films Deposition and Structure, Academic Press, Elsevier, 2002.
3. A.D. Tripathi A. Gupta Ac, Ultra High Vacuum Techniques, Allied Publishers Private Limited, 2002.
4. A Chambers, Modern Vacuum Physics, CRC Press, 2005.
5. Dorothy M. Hoffman, Bawa Singh, John H. Thomas Handbook of Vacuum Science and Technology, III, Academic Press.
6. M. Sugawara, Plasma Etching: Fundamentals and Applications: 7 (Series on Semiconductor Science and Technology), OUP Oxford.
7. Alexander Fridman and Lawrence Kennedy, Plasma Physics and Engineering, CRC Press.
8. Karl Jousten, Handbook of Vacuum Technology, Wiley.

ECE 4506: THIN FILMS AND NANOSTRUCTURES [3 0 0 3]

Introduction to nanomaterials: Types: 0D, 1D, 2D, 3D nanomaterials, bulk vs. nanoscale properties, top-down vs. bottom-up synthesis approaches; Nanomaterials development process: liquid and vapor phase synthesis, wet chemical methods, chemical vapor deposition, mechanical milling, laser ablation. Thin-Film and Nanostructure Growth: Electro/electroless deposition, physical vapor deposition, and chemical Vapor Deposition with materials and mechanisms; Etching techniques: Wet and dry plasma etching; crystal structures and their impact on etching processes.

Self-directed learning: Material crystal structure and etching dependency.

References:

1. R.K. Waits, Thin Film Deposition and Patterning, American Vacuum Society.
2. M. Ohring, The Materials Science of Thin Films, Academic Press, Boston.
3. Ludmila Eckertova, Physics of Thin Films, 2nd Plenum Press New York.
4. K.L. Chopra, Thin Film Phenomena, McGraw-Hill.
5. Michae J. O'Connel, Carbon Nanotubes: Properties and Applications,
6. Liz Marzan and Kamat, Nanoscale materials
7. C. N. R. Rao, A. Muller, A. K. Cheetham, Nanomaterials Chemistry, Wiley VCH , 2007.
8. C. Brechignac, P. Houdy, M. Lahmani, Nanomaterials and Nanochemistry, Springer Publication, 2007.
9. Kenneth J. Klabunde, Nanoscale materials in chemistry, Wiley Interscience Publications, 2001.
10. G. B. Sergeev, Nanochemistry, Elseiver Publications, 2006.
11. Guozhong Cao, Nanostructures and Nanomaterials, synthesis, properties and applications, Imperial College Press, 2004.
12. Yury Gogotsi, Nanomaterials – Handbook, CRC Press, Taylor & Francis group, 2006.
13. Milton Ohring, Engineering Materials Science, Academic Press, Elsevier.

ECE 4507: SEMICONDUCTOR MATERIALS CHARACTERIZATION TECHNIQUES [3 0 0 3]

Importance of material characterization, microscope its types, scanning electron microscopy, Transmission electron microscopy, Energy dispersive spectroscopy, Wavelength dispersive spectroscopy, X-ray diffraction techniques, Atomic force microscopy, scanning tunnelling microscopy, X-ray photoelectron spectroscopy, Atomic absorption spectroscopy, UV/Visible spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy, Thermo gravimetric analysis, Differential thermal analysis, Differential Scanning calorimetry, Thermo mechanical analysis and dilatometry.

References:

1. Li, Lin, Ashok Kumar Materials Characterization Techniques Sam Zhang; CRC Press, (2008).
2. Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction", Prentice-Hall, (2001).
3. Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Liss, Inc. USA, (2001).
4. Tyagi, A.K., Roy, Mainak, Kulshreshtha, S.K., and Banerjee, S., Advanced Techniques for Materials Characterization, Materials Science Foundations (monograph series), Volumes 49 – 51, (2009).
5. Wachtman, J.B., Kalman, Z.H., Characterization of Materials, ButterworthHeinemann, (1993).

ECE 4508: VLSI DIGITAL SIGNAL PROCESSING [3 0 0 3]

This course covers advanced digital signal processing architectures, focusing on pipelining, parallel processing, and retiming techniques for performance and low-power optimization. It explores folding and unfolding algorithms, register minimization, and their application in multirate systems. Systolic architecture design is introduced with emphasis on FIR filters, matrix multiplication, and delay handling. The course also includes fast convolution methods such as Cook-Toom and Winograd algorithms, cyclic and iterated convolution, highlighting efficient implementation strategies for high-performance DSP systems.

*Self-directed Learning:

References:

1. Parhi, Keshab K. VLSI digital signal processing systems: design and implementation. John Wiley & Sons, 2007.
2. Bayoumi, Magdy A., ed. VLSI design methodologies for digital signal processing architectures. Vol. 257. Springer Science & Business Media, 2012.
3. Khan, Shoab Ahmed. Digital design of signal processing systems: a practical approach. John Wiley & Sons, 2011.
4. Parhi, Keshab K., and Takao Nishitami, eds. Digital Signal processing for multimedia systems. CRC press, 2018.

*https://onlinecourses.nptel.ac.in/noc20_ee44/preview

Department of

Instrumentation & Control Engineering

The department of Instrumentation and control Engineering was established in the year 2001, with a B.E. program in Instrumentation and control Engineering with an intake of 30. At present the department offers 2 UG programs, 2 PG programs and PhD program in allied disciplines. The department has expertise in Sensor design, Process control and Automation, Computer vision and image processing, Cyber physical systems and Embedded systems. All the programs are well supported with state of the art laboratories in Electronics, Sensors & Transducers, Instrumentation, Process control, Automation, Microcontrollers, Control systems and signal processing, communication, Cyber Physical System Design, CPS Networking and Interface, Augmented and virtual reality, smart transportation etc with industry grade equipment and licensed software like MATLab, LABView, Verilog and HDL, etc. All the programs offered by the department are AICTE approved. B.Tech E&I Engineering has been accredited by NBA from Aug 2024 to Jun 2027.

Faculty and student from the department are involved in numerous research works in areas like sensors, robust control, artificial intelligence, computer aided diagnosis, MEMS, IoT, Process control and automation etc. Many faculty regularly receive research grants and fellowships from DST, SERB, ISRO, IITs, IISc and other reputed government and private organizations and laboratories. The department has active MOUs with industries and industry experts deliver special lectures to students regularly. The department organizes various research workshops and conferences. Control Instrumentation and System conference (CISCON) is an annual event of the department and being organized since 2004, which gives a platform for presentation, deliberations and networking with researchers from all across.

> Programs offered

Undergraduate Program

- B.Tech in Electronics & Instrumentation Engineering (2018)
- B.Tech in Cyber Physical Systems (2022)

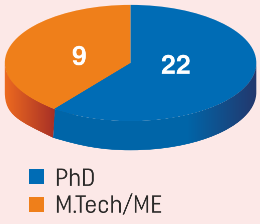
Postgraduate Programs

- M.Tech Electronics Engineering (Embedded control and Automation)
- M.Tech Electronics Engineering (Immersive Technologies)
- M.Sc Immersive Technologies

PhD

> Faculty Strength

Qualification-wise



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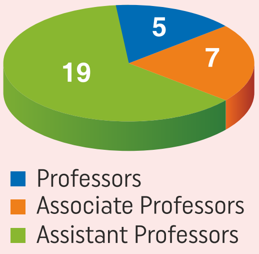


B.TECH. ELECTRONICS AND INSTRUMENTATION ENGINEERING

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2122	Engineering Mathematics - III	2	1	0	3	MAT 2228	Engineering Mathematics - IV	2	1	0	3
	ICE 2121	Analog Electronic Circuits	3	1	0	4	ICE 2221	Linear Integrated Circuits	3	0	0	3
	ICE 2122	Digital Circuits and System Design	3	0	0	3	ICE 2222	Microcontrollers	3	1	0	4
	ICE 2123	Networks and Signals	3	1	0	4	ICE 2223	Industrial Instrumentation	3	0	0	3
	ICE 2124	Sensors and Transducers	3	0	0	3	ICE 2224	Digital Signal Processing	2	1	0	3
	ICE 2125	Linear Control Theory	2	1	0	3	ICE 2229	Communication Techiques	3	0	0	3
	ICE 2141	Digital Circuits and Systems Lab	0	0	3	1	ICE 2241	Analog Systems Lab	0	0	3	1
	ICE 2142	Sensors and Circuits lab	0	0	3	1	ICE 2242	Microcontroller Lab	0	0	3	1
			16	**4**	**6**	**22**			**16**	**3**	**6**	**21**
	Total Contact Hours (L + T + P)		**26**				**Total Contact Hours (L+T+P)**		**25**			
	FIFTH SEMESTER						**SIXTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	HUM 3022	Essentials of Management	2	1	0	3	HUM 3021	Engineering Economics and Financial Management	2	1	0	3
	ICE 3121	Industrial Automation and Drives	3	1	0	4	ICE ****	Flexible Core - 2 (A2/B2/C2)	3	0	0	3
	ICE 3122	VLSI Design	3	0	0	3	ICE ****	Flexible Core - 3 (A3/B3)	3	0	0	3
	ICE 3123	Process Instrumentation and Control	3	0	0	3	ICE ****	Program Elective - I / Minor Specialization	3	0	0	3
	ICE ****	Flexible Core - 1 (A1/B1/C1)	3	0	0	3	ICE ****	Program Elective - II / Minor Specialization	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective - 2	3	0	0	3
	ICE 3141	Industrial Instrumentation Lab	0	0	3	1	ICE 3241	Control and Signal Processing Lab	0	0	3	1
	ICE 3142	Process Control Lab	0	0	3	1	ICE 3242	Industrial Automation Lab	0	0	3	1
							ICE 3243	Virtual Instrumentation Lab	0	0	3	1
			18	**1**	**6**	**21**			**18**	**0**	**9**	**21**
	Total Contact Hours (L+T+P)		**25**				**Total Contact Hours (L+T+P)**		**27**			
	SEVENTH SEMESTER						**EIGHTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
IV	ICE ****	Program Elective - III / Minor Specialization	3	0	0	3	ICE 4291	Industrial Training				1
	ICE ****	Program Elective - IV / Minor Specialization	3	0	0	3	ICE 4292	Project Work / Practice School				12
	ICE ****	Program Elective - V	3	0	0	3	ICE 4293	Project Work (B.Tech Honours)**				20
	ICE ****	Program Elective - VI	3	0	0	3	ICE ****	B.Tech Honours (Theory 1)** (V Semester)				4
	ICE ****	Program Elective - VII	3	0	0	3	ICE ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	*** ****	Open Elective - 3	3	0	0	3	ICE ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	ICE 4191	Mini Project (Minor Specialization)*				8						
						18/26						**13/33**
	Total Contact Hours (L+T+P) + OE		**18**									

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

FLEXIBLE CORE-A

INSTRUMENTATION (A)

ICE 3124: Smart sensors (A1)
ICE 3221: Micro Electro Mechanical Systems (A2)
ICE 3223: Wireless Sensor Networks (A3)

FLEXIBLE CORE-B

APPLIED ELECTRONICS (B)

ICE 3125: Embedded Systems Design(B1)
ICE 3222: Internet of Things (B2)
ICE 3224: Digital Image Processing(B3)

FLEXIBLE CORE-C

ELE 3127: Foundations of EV & Hybrid Vehicles (C1)
ELE 3225: Automotive Mechanics for Electric Vehicles (C2)

MINOR SPECIALIZATION

I. COMPUTATIONAL INTELLIGENCE

ELE 4409: Artificial Intelligence
ECE 4409: Machine Learning
ELE 4410: Soft Computing Techniques
ECE 4410: Computer Vision

II. CONTROL SYSTEMS

ICE 4401: Modern Control Theory
ICE 4402: Nonlinear control theory
ICE 4403: Digital Control Systems
ICE 4404: System Identification

III. EMBEDDED SYSTEMS

ECE 4411: Embedded System Design
ELE 4411: FPGA Based System Design
ECE 4412: Internet of Things
ELE 4412: Real Time Systems

IV. SENSOR TECHNOLOGY

ICE 4405: Sensor Design
ICE 4406: Biosensors and BioMEMS
ICE 4407: Multi Sensor Data Fusion
ICE 4408: Automotive Sensors

V. SYSTEMS ENGINEERING

ICE 4409: Introduction to Systems Engineering
ICE 4410: System architecture and Design
ICE 4411: SysML and MBSE
ICE 4412: System Verification and validation

VI. SMART TRANSPORTATION SYSTEMS

ICE 4413: Automotive Electronics
ICE 4414: In-vehicle Networking
ICE 4415: Intelligent Transportation Systems
ICE 4416: Advanced Driver Assistance Systems

VII. E-MOBILITY

ELE 4415: EV Battery Technology and Power Train Development
ELE 4416: EV Charging Infrastructure, Vehicle Testing & Homologation
ELE 4417: EV Vehicle Design & Analysis
ELE 4418: EV Data Analytics & Cyber Security

OTHER PROGRAM ELECTIVES

ICE 4441: Advanced Sensor Technology
ICE 4442: Analytical and optical Instrumentation
ICE 4443: Biomedical Instrumentation and Equipment
ICE 4444: Cyber physical systems
ICE 4445: Data Structures and algorithms
ICE 4446: DSP algorithms and Architecture
ICE 4447: Electronic Measurement Systems
ICE 4448: Industrial Internet of Things
ICE 4449: Machine learning for control systems
ICE 4450: Neural Network and Fuzzy Logic
ICE 4451: Power Electronics
ICE 4452: Real Time Operating System
ICE 4453: Reliability and safety Engineering
ICE 4454: Robotic Control Systems
ICE 4455: Robust Control

OPEN ELECTIVES

ICE 4311: Feedback Control Theory
ICE 4312: Industrial Automation
ICE 4313: Industrial Instrumentation
ICE 4314: Sensor Technology
ICE 4315: Smart Sensor
ICE 4316: Virtual Instrumentation
ICE 4317: Farm Automation
ICE 4318: Outdoor Leadership

THIRD SEMESTER

MAT 2122: ENGINEERING MATHEMATICS-III [2 1 0 3]

Linear algebra: Systems of Linear Equations, Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings, Affine Spaces, Analytic geometry: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations. Matrix decompositions: Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation. Fourier Series and transforms: Periodic function, Fourier Series expansion. even and odd functions, functions with arbitrary periods, Half range expansions Fourier transform, basic properties, Parseval's identity and applications.

References:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. Grewal B.S. - Higher Engineering Mathematics, Khanna Publishers, 43rd edition, 2015
1. Stephen H. Friedberg Lawrence E Spence, Arnold J Insel, Elementary Linear Algebra: A Matrix Approach Introduction to Linear Algebra, Second Edition, 2019.
2. David Lay, Steven Lay, Judi McDonald, Linear Algebra and Its Applications, Pearson, 2019.
3. Gilbert Strang, Introduction to Linear Algebra, Fifth Edition (2016), Wellesley-Cambridge Press.
4. Mordechai Ben-Ari, Mathematical Logic for Computer Science, Third Edition, Springer.
5. Narayanan, Ramaniah and Manicavachagom Pillay, Advanced Engineering Mathematics, Vol 2 and 3, Vishwanthan Publishers Pvt Ltd. 1998
6. Erwin Kreyszig, Advanced Engineering Mathematics, 5th edn., Wiley Eastern, 1985.

ICE 2121: ANALOG ELECTRONIC CIRCUITS [3 1 0 4]

Structure and operation of MOSFET, I-V Characteristics, Channel-Length Modulation, Transconductance, Large-Signal and Small-Signal Model, Biasing, Amplifier topologies, Common-Source Amplifier, Common-Gate Amplifier, Source Follower, Cascode, Two stage CS Amplifiers, MOS Differential amplifier, Miller's Theorem, Frequency Response of CS, CG, CD, Cascode and differential amplifier Stage, Negative Feedback Amplifiers, Feedback Topologies, Power amplifiers, Push-Pull Stage, LC Oscillators, Hartley's and Colpitt's Oscillator, RC Phase Shift Oscillator, Ring Oscillator.

References:

1. Behzad Razavi, Fundamental of Microelectronics, Wiley, (2e), 2013.
2. A. S. Sedra, K. C. Smith, Microelectronic circuits, Oxford University Press, (6e), 2011.
3. R. L. Boylestad, L. Nashelsky, Electronic Devices and Circuit Theory, PHI, (11e), 2014.

ICE 2122: DIGITAL CIRCUITS AND SYSTEM DESIGN [3 0 0 3]

Boolean Algebra – Theorems, DeMorgan's Law, Karnaugh map, Determination of Prime Implicants, Quine McCluskey method, Combinational Logic Design, Synchronous Sequential Logic Design, Introduction to Programmable circuits - Design of Read-Only Memory (ROM), Programmable Logic Arrays (PLA), Programmable Array Logic (PAL)., Programmable ASICs, Introduction to CAD Tools, Introduction to Verilog – Structural Specification; Behavioral Specification, Verilog for Combinational Circuits, Verilog for Sequential Circuits, Verilog Programming.

References:

1. Donald D. Givone, Digital Principles and Design, TMH, (1e), 2002.
2. C. H. Roth, Fundamentals of Logic Design, Thomson, (6e), 2000.
3. Anand Kumar, Switching Theory and Logic Design, PHI, (2e), 2014.
4. Samir Palnitkar, Verilog HDL: A guide to digital design and synthesis, Prentice Hall Professional, (2e), 2003.
5. J. Bhasker, A Verilog HDL Primer, BSP, (1e), 2001.
6. Stephen Brown, Fundamentals of Digital Logic with Verilog Design, TMH, (3e), 2013.
7. CemUnsalan, Bora Tar, Digital System Design with FPGA, Mc Graw Hill Education (India) Private Limited, 2017.
8. Ming-Bo Lin, Digital System Designs and practices Using Verilog HDL and FPGAs, Wiley India Pvt. Ltd., 2012.

ICE 2123: NETWORKS AND SIGNALS [3 1 0 4]

Analysis of circuits with dependent sources, Network theorems, Initial conditions and transient analysis of RL, RC and RLC circuits, Analysis of networks by Laplace transform method, Network functions, Two port network parameters. Continuous time signals and systems, LTI systems - convolution integral, Response of Continuous time LTI systems to complex exponentials, Fourier series, Fourier transform, Properties of Fourier series and Fourier transform

References:

1. Van Valkenberg, Network Analysis, 3e, PHI, 2010
2. Fundamentals of Electric Circuits, Charles K. Alexander, Matthew N. O. Sadiku, McGraw Hill(7e), 2022.
3. Allan Oppenheim, Allan Willsky with Ian S Hamid, Signals and Systems, PHI, 1999.
4. Hayt W. H., J. E. Kemmerly & S. M. Durbin, Engineering Circuit Analysis, 7e, TMH, 2010.

ICE 2124: SENSORS AND TRANSDUCERS [3 0 0 3]

Configurations and functional description, Resistive Transducers, Capacitive Transducers, Inductive Transducers, Inductive Transducers, Piezo Electric Transducers, electrochemical sensors: use and design, optical sensors: use and design, miscellaneous industrial sensors for measurement of pH, gases, humidity.

References:

1. E.O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2008.
2. DVS Murthy, Transducers & Instrumentation, PHI, (2e), 2008.
3. Skooj, Holler, Crouch, Principles of Instrumental Analysis (7e),

Cengage Learning India, 2018.

4. B.G. Liptak, Process Measurement & Analysis, Chilton Book Company, (4e), 2003.

ICE 2125: LINEAR CONTROL THEORY [2 1 0 3]

Mathematical modeling, transfer functions, Block diagram representation and reduction, signal flow graph, Masons gain formula, time domain specifications. Stability, Steady state errors, generalized error coefficients, Routh- Hurwitz criterion, Root-Locus plots, frequency domain specifications. Correlation between frequency domain and time domain specifications, Bode diagrams, Polar plots, Nyquist stability criterion, Qualitative analysis of compensator design using root-locus and frequency response approach.(Note: Theoretical concepts be demonstrated in class. Additional examples be solved using MATLAB on every topic during tutorials.)

References:

1. Norman S. Nise, Control Systems Engineering, Wiley India, (5e), 2009.
2. K. Ogata, Modern control engineering, PHI, (5e), 2011.
3. R.C Dorf and R.H Bishop, Modern Control Systems, Pearson, (11e), 2013.

ICE 2141: DIGITAL CIRCUITS AND SYSTEMS LAB [0 0 3 1]

Implementation of Boolean functions using logic gates, Code Conversion Circuits, Design and implementation of combinational circuits, Study of Flip-flops, Design and implementation of Counters, Study of Basic operators and data types in Verilog HDL, Combinational circuit design using Verilog HDL, Sequential circuit design using Verilog HDL, Keypad Interfacing, LCD Interfacing.

References:

1. Anand Kumar, Switching Theory and Logic Design, PHI, (2e), 2014.
2. M. Morris Mano, Digital Design, PHI, (5e), 2002.
3. Samir Palnitkar, Verilog HDL: A guide to digital design and synthesis, Prentice Hall Professional, (2e), 2003.
4. J. Bhasker, A Verilog HDL Primer, BSP, (1e), 2001.
5. CemUnsalan, Bora Tar, Digital System Design with FPGA, Mc Graw Hill Education (India) Private Limited, 2017.

ICE 2142: SENSORS AND CIRCUITS LAB [0 0 3 1]

AC bridges, network theorems, measurement of energy, measurement of self and mutual inductance, series and parallel resonance, characteristics of sensors and transducers – temperature, torque, force, displacement and intensity of light. Electrochemical sensor design. Optic fiber based sensor design.

References:

1. E.O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.
2. C S Rangan, G R Sharma and V S V Mani, Instrumentation Devices & Systems, TMH, (2e), 2017.

FOURTH SEMESTER

MAT 2228: ENGINEERING MATHEMATICS IV [2 1 0 3]

Probability and Distributions: Construction of a Probability Space, Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem, Summary Statistics and Independence, Distributions: Binomial, Poisson, uniform, normal, Chi-square and exponential distributions. Multivariate Random variables and Stochastic Process: Two and higher dimensional random variables, covariance, correlation coefficient. Moment generating function, functions of one dimensional and two dimensional random variables. Static probabilities: review and prerequisites generating functions, difference equations. Dynamic probability: definition and description with examples. Markov chains, transition probabilities. Vector Calculus: Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Backpropagation and Automatic Differentiation, Higher-Order Derivatives, Linearization and Multivariate Taylor Series. Optimization: Basic solution, Convex sets and function, Simplex Method, Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers.

References:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. P L Meyer, Introductory Probability and Statistical Applications, Addison Wiley.
3. Medhi. J. Stochastic Processes, Wiley Eastern.
4. Murray R. Spiegel, Vector Analysis Theory and Problems, Schaum's Outline Series, 2019.
5. Hamdy A. Taha, “Operations Research: An Introduction”, 8th Edn., Pearson Education, (2008).
6. Sheldon M. Ross, Introduction to Probability Models Eleventh Edition Elsevier.
7. E. S. Page, L. B. Wilson, An Introduction to Computational Combinatorics, Cambridge, University Press.
8. Bhat U R, Elements of Applied Stochastic Processes, John Wiley.

ICE 2221: LINEAR INTEGRATED CIRCUITS [3 0 0 3]

Op Amp fundamentals, Current to Voltage, Voltage to current Converters, Current amplifiers, Difference Amplifiers, Instrumentation Amplifiers, Active Filters, Voltage comparators, Schmitt trigger, Precision rectifiers, Peak detector, Multi vibrators, Monolithic Timers, Triangular wave generators, Sine wave generators, Voltage to frequency and Frequency to voltage converters, Digital to Analog and Analog to Digital Converters.

References:

1. Franco Sergio, Design with Op amps & Analog Integrated Circuits, McGraw Hill, (3e), 2017.
2. Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, PHI, (4e), 2015.

3. Robert F. Coughlin and Frederick S. Driscoll, Operational Amplifiers and Linear Integrated Circuits. Pearson Education Pvt Ltd., (6e), 2020.
4. Sedra and Smith, Micro Electronic Circuits, Oxford university press, (8e), 2019.

ICE 2222: MICROCONTROLLERS [3 1 0 4]

Computer Architecture, Architecture of 8051, 8051 Addressing Modes, 8051 Instruction Set, Programming 8051 using Assembly Language and C, 8051 Timer, Serial Port and Interrupt Programming using Assembly Language and C. Introduction to ARM, ARM Architecture, Introduction to LPC2148, Architecture of LPC2148 and Programming, Interfacing of I/O ports, ADC, DAC, LCD, Keyboard, Stepper motor, DC motor using 8051/LPC2148.

References:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education, (2e), 2007.
2. Kenneth J. Ayala, The 8051 Microcontroller, Cengage Learning, (3e), 2004.
3. Steve Furber, ARM System - on – Chip Architecture, Pearson, (2e), 2015
4. William Hohl, Hinds Christopher, ARM Assembly Language, CRC Press, (2e), 2014.
5. LPC21XX User Manual, 2007.

ICE 2223: INDUSTRIAL INSTRUMENTATION [3 0 0 3]

Temperature Measurement, Pressure Measurement: Manometers, Elastic types, Bell gauges, Electrical types, Differential Pressure transmitters, Dead weight Pressure gauges. Low Pressure Measurement. Flow Measurement. Multiphase flow meters, Measurement of Speed, velocity and Acceleration, Level Measurement, NEMA, ISA standards, IEI – hazard classifications and standards.

References:

1. Liptak B. G, Handbook of Process Measurement and Analysis, Chilton Book Company, (3e), 1995.
2. Gioia Falcone, Geoffrey Hewitt, C Alimonti, Multiphase Flow Metering- Principles and Applications, Elsevier Publication, 2009.
3. Patranabis D, Principles of Industrial Instrumentation, TMH, (3e), 2005.

ICE 2224: DIGITAL SIGNAL PROCESSING [2 1 0 3]

Z-transform, its properties, inverse Z-transform, solving difference equation, discrete Fourier transform, and its properties, FFT algorithms, Frequency response of analog and digital filters, FIR and IIR filter design, FIR filter design using windows, digital Butterworth and Chebyshevfilter design, realization of FIR and IIR filters, architecture of C6x processor, various addressing modes, programs.

References:

1. John G Proakis, Dimitris G Manolakis, Digital Signal Processing, Pearson Education,(4e), 2007.
2. Sanjit K Mitra, Digital Signal Processing: A Computer - Based Approach, McGrawHill Education,(4e), 2013
3. Thomas J. Cavicchi, Digital Signal Processing, Wiley, 2009
4. Steven W Smith, Digital Signal Processing: A Practical Guide for Engineers and Scientists, Elsevier, 2002
5. Rulph Chassaing, Digital Signal Processing and Applications with the C6713 andC6416 DSK. Vol. 16. John Wiley & Sons, 2004.

ICE 2229: COMMUNICATION TECHNIQUES [3 0 0 3]

Elements of communication systems; Analog Communication techniques: Amplitude modulation schemes, Power distribution, Angle modulation-frequency and phase, frequency spectrum, Sampling, Quantization, Pulse modulation schemes; Shift keying techniques – frequency, phase and amplitude, Noise in analog and digital communication systems, Detection of signal in noise, Spread spectrum and mobile communications.

References:

1. Simon Haykin, Communication Systems, John Wiley & Sons, (4e), 2009.
2. Tomasi W, Electronic communication systems, Pearson, 2012.
3. Simon Haykin and Michael Moher, Introduction to analog and digital communications, John Wiley & Sons, (2e), 2013.

ICE 2241: ANALOG SYSTEMS LABORATORY [0 0 3 1]

RC Coupled Amplifier, Applications of Op-Amp: Inverting Amplifier, Non-inverting amplifier, Integrator, Differentiator, Voltage follower, Active Filters, Instrumentation amplifier, Precision Rectifier, Schmitt trigger, Multivibrators. Astable/Monostable Multivibrators using IC 555 Timer, Data converters, IC Regulators

References:

1. Albert Malvino, Electronic Principles, McGraw Hill, (7e), 1999.
2. Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, PHI, (4e), 2015.
3. Sedra and Smith- Micro Electronic Circuits, Oxford university press, (6e), 2000.

ICE 2242: MICROCONTROLLERS LAB [0 0 3 1]

8051 programming for data transfer, arithmetic operations, code conversion, array handling, delay generation and waveform generation. Interfacing of LED, stepper motor, DC motor, seven segment displays, alphanumeric LCD panel and hex keypad to LPC 2148.

References:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education, (2e), 2007.
2. Kenneth J. Ayala, The 8051 Microcontroller, Cengage Learning, (3e), 2004.
3. Steve Furber, ARM System - on – Chip Architecture, Pearson, (2e), 2015
4. William Hohl, Hinds Christopher, ARM Assembly Language, CRC Press, (2e), 2014.
5. LPC21XX User Manual, 2007.

FIFTH SEMESTER

HUM 3022: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Definition of management and systems approach, Nature & scope. The Functions of managers, Principles of Management. Planning: Types of plans, steps in planning, Process of MBO, how to set objectives, strategies, policies and planning premises, Strategic planning process and tools. Nature and purpose of organizing, Span of management, factors determining the span, Basic departmentation, Line and staff concepts, Functional authority, Art of delegation, Decentralization of authority. HR theories of planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership – leadership behavior & styles, Managerial grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit and Loss control, Control through ROI, Direct, Preventive control. PROFESSIONAL ETHICS - Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories about right action, Self-interest, Customs and Religion, Uses of Ethical Theories. GLOBAL ISSUES - Managerial practices in Japan and USA & application of Theory Z. The nature and purpose of international business & multinational corporations, unified global theory of management, Entrepreneurship and writing business plans. Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisers, Moral Leadership, Code of Conduct, Corporate Social Responsibility.

References:

1. Harold Koontz & Heinz Weihrich (2020), “Essentials of Management”, McGraw Hill, New Delhi.
2. Peter Drucker (2004), “The practice of management”, Harper and Row, New York.
3. Vasant Desai (2007), “Dynamics of entrepreneurial development & management”, Himalaya Publishing House.
4. Poornima M Charantimath (2006), “Entrepreneurship Development”, Pearson Education.
5. Mike W. Martin & Ronald Schinzinger (2003), “Ethics in engineering”, Tata McGraw Hill, New Delhi.
6. Govindarajan M, Natarajan S, & Senthil Kumar V S (2004), “Engineering Ethics”, Prentice Hall of India, New Delhi.
7. R. S. Nagarazan. (2004), “A text book on professional ethics and human values”, New age international publishers, New Delhi.

ICE 3121: INDUSTRIAL AUTOMATION & DRIVES [3 1 0 4]

Drives, Computers in Process Control, Interface and Backplane Bus Standards for Instrumentation Systems, Programmable Logic Controller (PLC), Ladder logic Programming, Alternate Programming Languages, Distributed Control Systems (DCS), PLC Maintenance, Interface and Backplane Bus Standards, Field bus, HART protocol, Smart transmitters, Valves and Smart actuators, Communications for DCS

References:

1. John. W. Webb Ronald A Reis, Programmable Logic Controllers - Principles and Applications, PHI, (4e). 1998.
2. Lukcas M.P, Distributed Control Systems, Van Nostrand Reinhold Co., 1986.
3. Frank D. Petruzella, Programmable Logic Controllers, MGH, (2e), 1997.

ICE 3122: VLSI DESIGN [3 0 0 3]

Introduction to integrated circuit technology, CMOS logic, fabrication techniques, basic electrical properties of MOS circuits, CMOS circuit design processes and design parameters, Delay estimation, stick diagrams, VLSI Design methodologies, problems associated with VLSI Design, Design for testability.

References:

1. Douglas A. Pucknell & Kamran Eshraghian, Basic VLSI Design, Prentice-Hall of India, 1995.
2. Neil H.E.Weste, David Harris, Ayan Banerjee, CMOS VLSI Design, A Circuits and Systems Perspective, Pearson Education, 2006.
3. Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis and Design Tata Mc-Graw-Hill, 1993.
4. John P. Uyemura. Introduction to VLSI Circuits and Systems, Wiley Publishers, 2001.
5. Jab M.Rabaey, Anantha Chandrakasan, Borivoje Nikolic, Digital Integrated Circuits: A Design Perspective, Prentice-Hall of India Pvt. Limited, 2003.
6. Michal John Sebastian smith, Application-Specific Integrated Circuits, Pearson Education, 2004.

ICE 3123: PROCESS INSTRUMENTATION AND CONTROL [3 0 0 3]

Process control terminology - mathematical model, self-regulation, control actions, control modes, electronic controllers, Two Degrees of Freedom PID controllers, Anti-Reset windup, I/P converter, Control Valves, performance based controller design, tuning, advanced control strategies, multivariable control, RG Analysis, model based controller design.

References:

1. Stephanopoulis, G, Chemical Process Control, Prentice Hall of India, New Delhi, 1990.
2. Eckman. D.P., Automatic Process Control, Wiley Eastern Ltd., New Delhi, 1993.
3. Curtis D. Johnson, Process Control Instrumentation Technology, (8e) PHI, 2009.
4. Pollard A. Process Control, Heinemann educational books, London, 1971.
5. Harriott. P., Process Control, Tata McGraw-Hill Publishing Co., New Delhi, 1991.
6. Donald Coughanower, Process Systems Analysis and Control, McGraw-Hill Inc., 1991.

FLEXI CORE A1 - ICE 3124: SMART SENSORS [3 0 0 3]

Introduction: Block diagram of smart sensor, Sensor interface needs, sensor electronics, sensor models, sensor signal enhancement, Compensation schemes, sensor integration, Need for smart sensing, Sensor IQ. Sensor Communication, Standards and Implications of Smart Sensors, Smart Sensor systems: Centralised and decentralised system of the measurement chains, Process control over the Internet, intelligent transportation system- ITS user services, ADAS, Smart grid, case studies.

References:

1. Randy Frank, Understanding Smart Sensors, (2e). Artech House Publications, 2000.
2. Paul W. Chapman, Smart Sensors, ISA Press, 1996.
3. KrzystofIniewski, Smart Sensors for Industrial Applications, CRC Press, 2013.
4. Raghavendra C S, Sivalingam Krishna, Wireless Sensor Network, Springer, 2004.

FLEXI CORE B1 - ICE 3125: EMBEDDED SYSTEM DESIGN [3 0 0 3]

Introduction to embedded systems, Core of embedded systems and firmware, Architecture of ARM Cortex-M processor, Features and Instructions of ARM Cortex-M, Input/Ouput Programming, Phase-locked loop, Real-time operating systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Communication MicroC/OS II, Robotic systems, PID controller, Fuzzy logic control.

References:

1. Joseph Yiu, The Definitive Guide to the ARM Cortex-M3, 2nd Edition, Newnes, (Elsevier), 2010.
2. Shibu K V, Introduction to Embedded Systems, Tata McGraw Hill Education Private Limited, 2nd Edition.
3. J. W. Valvano, Embedded Systems: Real-Time Operating. Systems for ARM ® Cortex-M Microcontrollers, Volume 3, ISBN: 978-1466468863

FLEXI CORE C1 - ELE 3127: FOUNDATIONS OF EV & HYBRID VEHICLES [3 0 0 3]

Principles for Electric Vehicles: EV Industry, EV Technology and Automotive Revolution, Electrical Engineering for EV, Battery Technology Control system for Electric Vehicles: Motor and Controller Systems, EV Numerical Calculations, EV Charging Infrastructure, Practical session - Well-to-wheel analysis of EV architecture

Essentials for Electric Vehicles: Electrical Requirement, Power Distribution Specifications, Electronic Control System, Practical session - EV connection and system analysis

Types of components in Electric Vehicles: EV Standards and Classifications, Selection for Electrical and Electronic Components, Practical session - EV hardware components

Principles for Hybrid Vehicles: Introduction to Hybrid Vehicles, Battery Chemistry, Efficiency, Definition and Parameters for Hybrid Systems, Electric Motors, Generators and Power Electronics for Hybrid Systems, Control Systems, Hybrid Electric Vehicle Operation, Practical session - Numerical study on powertrain sizing of HEV

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", Routledge, 3rd Ed, 2021, ISBN: 9780367693930
3. Muhammad Ehsani, Mehrdad Ehsani, and Ali Emadi, "Electric Vehicle Systems Architecture and Standardization Needs", Reports of the PPP European Green Vehicles Initiatives, Springer, 2015.
4. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 1st Ed, 2014, ISBN: 9781138072855.
5. Rodrigo Garcia-Valle and João A. Peças Lopes, “Electric Vehicle Integration into Modern Power Networks", Springer, 2013, ISBN: 978-1461401339.
6. Chris Mi and M. Abul Masrur, “Hybrid electric Vehicles, Principles and Applications with Practical perspectives”, WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6.
7. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

ICE 3141: INDUSTRIAL INSTRUMENTATION LAB [0 0 3 1]

Design of measurement system for Temperature, flow, level, pressure, thickness, torque, humidity, vibration, load, distance/ speed/ volume, and object detection using optical sensor.

References:

1. C S Rangan, G R Sharma and V S V Mani, Instrumentation Devices & Systems, TMH, (2e), 2004.
2. E. O. Doeblin, Measurement Systems – Application and Design, McGraw Hill, (4e), 1992.

ICE 3142: PROCESS CONTROL LAB [0 0 3 1]

Study of control actions using temperature, flow, pressure and level Control Trainers, Study of Control valve characteristics, cascade control, Feed Forward Control, Ratio Control and gain scheduling control, Empirical model estimation PID tuning, Smith Predictor control, Study of PID control in a heat exchanger system, Study of DAQ system.

References:

1. Curtis D. Johnson, Process Control Instrumentation Technology, PHI, (8e), 2009.
2. Donald R Coughanower, Process Systems Analysis and Control, MGH, (3e), 2017.
3. Wayne Bequette, Process control, Modelling, simulation & Control, PHI, (1e), 2004.

SIXTH SEMESTER

HUM 3021: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [3 0 0 3]

Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of Single, Uniform, and Gradient cash flow. Related problems and case studies. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, declining and double declining balance method of depreciation, Case Study. Balance sheet and profit & loss statement. Meaning & Contents. Ratio analysis, financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios, Drawbacks. Safety and Risk, Assessment of Risk and safety, Case study, Risk Benefit Analysis and Reducing Risk.

References:

1. Chan S. Park, "Contemporary Engineering Economics", 4th Edition, Pearson Prentice Hall, 2007.
2. Thuesen G. J, "Engineering Economics", Prentice Hall of India, New Delhi, 2005.
3. Blank Leland T. and Tarquin Anthony J., "Engineering Economy", McGraw Hill, Delhi, 2002.
4. Prasanna Chandra, "Fundamentals of Financial Management", Tata McGraw Hill, Delhi, 2006.
5. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.
6. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, NewDelhi,2004.

FLEXI CORE A2 - ICE 3221: MICRO ELECTROMECHANICAL SYSTEMS [3 0 0 3]

Introduction to micro electromechanical systems (MEMS) Microsystem design considerations, MEMS design using COMSOL Multiphysics and finite elements. Microsystem Fabrication Processes and techniques: mask writing, lithography and advanced fabrication processes, MEMS Sensors and Actuators, case studies, Microsystem Characterization and Packaging.

References:

1. Thomas Jones and Nenad Nenadic, Electromechanics and MEMS, Cambridge University Press, (1e), 2013.
2. Tai-Ran-Hsu, MEMS & Microsystems Design and Manufacture, TMH, 2002.
3. Chang Liu, Foundations of MEMS, Pearson International Edition, 2006.
4. Sergey Edward Lyshevski, MEMS and NEMS systems, Devices and Structures, CRC Press, 2002.
5. Stephen D. Senturia, Microsystem Design, Kluwer Academic Publishers, Springer, 2000.

FLEXI CORE B2 - ICE 3222: INTERNET OF THINGS [3 0 0 3]

IOT Platform, Interfaces, API, clouds, Architectures of IOT, IOT System components, Role of sensors in IOT, sensor architecture, special requirements, Protocols, IOT cloud platforms, Business models, web security, Security model, Node.js programming for developers, JSON file format. Introduction to Arduino and Raspberry Pi, Node-Red, Interfacing sensors / actuators and accessing clouds. Python for windows, programming, control statement, string operation, list, tuple, tkinter GUI.

References:

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2014.
2. Nasreddine Bouhai, "Internet of Things: Evolutions and Innovations", Wiley, 2017.
3. Bernd Scholz-Reiter, Florian, Michahelles, "Architecting the Internet of Things", Springer, 2011.
4. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2018
5. Qusay F. Hassan, "Internet of Things A to Z: Technologies and Applications", Wiley, 2018.
6. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", Willy Publications, 2013.

FLEXI CORE C2 - ELE 3225: AUTOMOTIVE MECHANICS FOR ELECTRIC VEHICLES [3 0 0 3]

Automotive Engineering & Vehicle Dynamics: Vehicle Dynamics Fundamentals, Tire Mechanics and Dynamics, Suspension Systems, Braking Systems, Aerodynamics, Powertrain Systems, Vehicle Stability Control, Vehicle Safety, Vehicle Dynamics Simulation, Electric and Hybrid Vehicle Dynamics, Practical session - EV Dynamics & calculations.

Sketching for Automotive EV Design [Software-based]: Introduction to Automotive Sketching Software, Overview of Vehicle Design Process and Automotive Sketching, Basic Sketching Techniques and Tools in the Software, Sketching Car Exteriors, Interiors and Details, Creating Different Views and Angles of the Vehicle, Rendering and Presenting the Final Sketches, Understanding Proportions, Perspectives and Shapes in Automotive Sketching, Creating Sketches for Different Vehicle Types (Sedans, SUVs, and Trucks), Tips and Tricks for Automotive Sketching in the Software.

Advanced EV Modelling Using SolidWorks Tool [Software-based]: Introduction to EV Technology and Its Benefits, Basic Vehicle Design Principles, Design and Modelling of Chassis and Frame, Suspension Systems, Design and Modelling of Braking and Steering Systems, Design and Modelling of Electrical Components for EVs, Battery Pack Design and Modelling for 2, 3 and 4 Wheelers, Motor and Drivetrain Design and Modelling for 2, 3 and 4 Wheelers, Design and Modelling of Wheels and Tires for 2, 3 and 4 Wheelers, Testing and Simulation of Vehicle Performance Using Solid Works, Design for Manufacturability and Assembly Considerations, Sustainability and Environmental Impact Considerations in EV Design, Practical session - EV hardware components walkthrough.

Multibody Dynamics with MSC Adams [Software-based]: Introduction to MSC Adams Software and Its Capabilities, Setting Up the Modelling Environment in MSC Adams, Multi-body Dynamics Principles and Application to Vehicle Systems Modelling, Vehicle Suspension Systems Modelling, Vehicle Steering Systems Modelling, Vehicle Braking Systems Modelling, Practical session - EV Component design & modeling.

EV Analysis with MSC Adams (Software-based): Tire Force and Characteristics Modelling, Vehicle Dynamics Analysis Including Simulating Ride and Handling, Vehicle Stability and Rollover Events, Optimisation Techniques for Vehicle Designs Using MSC Adams, Integration of MSC Adams Models with Other Software Tools for System-level Simulations and Analysis, Practical session - EV body design analysis.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Du, H., Cao, D., & Zhang, H. (n.d.). “Modelling, Dynamics, and Control of Electrified Vehicles”, Woodhead Publishing, 2017, ISBN-13: 9780128127865
3. Zaman N., “Automotive Electronics Design Fundamentals”, Springer, 2015, ISBN-13: 9783319359793
4. Gianfranco Pistoia, “Electric & Hybrid Vehicles”, Elsevier, 1st ed, 2010, ISBN: 9780444638250.
5. Chau, K. T., “Electric Vehicle Machines and Drives: Design, Analysis and Application”, John Wiley and Sons, Inc., 2015, ISBN-13: 9781118752524.
6. Ehsani, Mehrdad, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles”, CRC, 2019, ISBN-13: 9780367137465.
7. Hughes, Austin, “Electric Motors and Drives”, Newnes (an Imprint of Butterworth-Heinemann Ltd), 2019, ISBN-13: 9780081026151
8. Chris Ni and M. Abul Masrur, “Hybrid electric Vehicles, Principles and Applications”, WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6
9. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

FLEXI CORE A3 - ICE 3223: WIRELESS SENSOR NETWORKS [3 0 0 3]

Overview of wireless sensor techniques, Challenges for Wireless Sensor, Enabling Technologies, Architectures, Networking sensors: Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, WSN protocols: IEEE 802.15.4 MAC – Zigbee, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing, Introduction to Time Synchronization, Localization and Positioning, Sensor Tasking and Control. Sensor network platforms and tools: Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming, Tiny OS for WSN and IOT, M2M communication, Alljoyn network, Case studies.

References:

1. Holger Karl & Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley, 2005.
2. Feng Zhao & Leonidas J. Guibas, Wireless Sensor Networks- An Information Processing Approach, Elsevier, 2007.
3. KazemSohraby, Daniel Minoli, &TaiebZnati, Wireless Sensor Networks-Technology, Protocolsand Applications, John Wiley, 2007.
4. Anna Hac, Wireless Sensor Network Designs, John Wiley, 2003.

FLEXI CORE B3 - ICE 3224: DIGITAL IMAGE PROCESSING [3 0 0 3]

Digital image fundamentals, Intensity transformations, Spatial filtering, Fuzzy techniques for intensity transformations, Filtering in frequency domain, Image restoration, Various noise models, Inverse filtering, Image Segmentation using thresholding, region growing, clustering and superpixels.

References:

1. Rafael C Gonzalez, Richard E Woods, Digital Image Processing, Pearson, (4e), 2018.
2. Anil K. Jain, Fundamentals of Digital Image Processing, Pearson, (1e), 2015.

ICE 3241: CONTROL AND SIGNAL PROCESSING LAB [0 0 3 1]

Time domain analysis and steady state errors, Compensator design, PID controller design, State - space analysis, System modeling and controller design for dynamic systems, Convolution, DFT computation and filter design.

References:

1. K. Ogata, Modern Control Engineering, PHI, (5e), 2011.
2. R.C. Dorf and R. H. Bishop, Modern Control systems, Wesley Longman, 1998.
3. John G Proakis, Dimitris G Manolakis, Digital Signal Processing, Pearson Education,(4e), 2007
4. Sanjit K Mitra, Digital Signal Processing: A Computer - Based Approach, McGraw Hill Education,(4e), 2013
5. Thomas J. Cavicchi, Digital Signal Processing, Wiley, 2009

ICE 3242: INDUSTRIAL AUTOMATION LAB [0 0 3 1]

Implementation of logic gates, flip flops, multiplexers and de multiplexers, Timers, Counter, Compare, arithmetic instructions in L&T and Siemens PLCs, study of ON/OFF control simulation using delta DIA View SCADA, Interfacing process station with HMI, Real time implementation of PLC with SCADA, Control of bottle filling station and conveyor control using PLC, Motor control with VFD and VVFD, Understanding features of CENTUM DCS, interfacing process stations with DCS.

References:

1. John. W. Webb Ronald A Reis, Programmable Logic Controllers - Principles and Applications, PHI, (4e), 1998.
2. Lukcas M.P, Distributed Control Systems, Van Nostrand Reinhold Co., New York, 1986.
3. Yokogawa Centum VP R6 Manual: https://web-material3. yokogawa.com/TI33J01A11-01EN.pdf
4. Yokogawa Centum VP R6 Manual: https://web-material3. yokogawa.com/TI33J01A10-01EN.pdf

ICE 3243: VIRTUAL INSTRUMENTATION LAB [0 0 3 1]

Introduction to Lab VIEW, Arithmetic and logical operations, Operations on arrays, Operations on Clusters, Operations using Loops, Types of structures and operations using them, Types of Graphs and use of graphs and timing pallets, Operations using strings and file I/O, Basics of Imaq vision, Measurement and automation explorer, Simulation of DAQ, acquisition and control using USB DAQ, NI c-RIO and PXI.

References:

1. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI learning, 2010.
2. Gary Johnson, LabVIEW Graphical Programming, McGraw Hill, (2e), 1997.

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

ICE 4291: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester to the end of seventh semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

ICE 4292: PROJECT WORK

The project work may be carried out in the institution/industry/research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out before the department committee as part of project evaluation.

MINOR SPECIALIZATION

MINOR: I CONTROL SYSTEMS

ICE 4401: MODERN CONTROL THEORY [3 0 0 3]

State Space Analysis, Phase variable and canonical form representation, Derivation of state models, Stability analysis, Eigen values, Eigen vectors, Solution of state equations, Cayley Hamilton theorem, Controllability and observability, Pole placement, Observer design, Non Linear Systems, Phase plane analysis, Construction of the phase trajectory, Describing function, Lyapunov's stability analysis, Sylvester's criterion, Lyapunov theorems of stability, Lyapunov function for continuous time state equations.

References:

1. K. Ogata, Modern Control Engineering, Prentice Hall India, (5e), 2011.
2. Nagrath and Gopal, Control System Engineering, New age international Limited, (2e), 1984.
3. M Gopal, Control Systems Engineering: Principles and Design, McGraw Hill, (4e), 2012.
4. Thomas Kailath, Linear Systems, Prentice-Hall, 1980

ICE 4402: NONLINEAR CONTROL THEORY [3 0 0 3]

Lyapunov stability using Krasovskii's method, Variable Gradient method,L2 stability of state models, L2 gain, small gain theorem, Passivity, Memory less functions, L2 gain and Lyapunovstability, passivity theorems, passivity based control, Review of describing function method, Absolute Stability Circle criterions, Popov Criterion, stabilization via linearization and Integral control, Gain scheduling, Graphical Linearization Methods, Analytical Linearization Method, Evaluation of Linearization Coefficients by Least-Squares Method, Local linearization, Feedback linearization, Input-state linearization, Input-output linearization, Internal dynamics, Zero dynamics, Model Reference Adaptive Control (MRAC).Slidingmode Control, sliding surfaces, continuous approximations of switching control laws, modeling performance trade off, tracking regulation via Integral control, Lyapunov redesign, non-linear damping, back stepping, and high gain observers. Back stepping algorithm.

References:

1. H.K. Khalil, Nonlinear Systems, (3e), PHI, 2002.
2. R. Marino and P. Tomei Nonlinear Control Design - Geometric, Adaptive and Robust, Prentice Hall, 1995.
3. J.J.E. Slotine and W.Li, Applied Nonlinear control, Prentice Hall, 1998.
4. Alberto Isidori, Non-linear Control Systems, Springer Verlag, 1999.
5. Zoran Vukic, Ljubomir Kuljaca, Nonlinear Control Systems, Marcel Dekker Inc., 2003.

ICE 4403: DIGITAL CONTROL SYSTEMS [3 0 0 3]

Sampling, Data acquisition, Quantization, sample and hold, zero order hold, frequency domain consideration in sampling and reconstruction, Difference equations, pulse transfer function, Block diagram analysis of sample data systems, time response of discrete time control systems, Steady State error analysis, Stability, Jury's stability test, bilinear transformation, Root locus technique, W transformation, Bode Plot. Nyquist Stability analysis, Design of Lag, Lead, Lag-lead compensator using root locus and Bode plot, Design of PID controller, Lyapunov Stability Analysis, State Space Analysis, Diagonalization, Solution of state equations, Controllability, Observability, Representation of the system in different canonical forms, Pole Placement- Ackermann's Formula, Dead beat Algorithm.

References:

1. K. Ogata, Discrete time control systems, PHI, (7e), 2011.
2. M. Gopal, Digital control and state variable methods, TMH, 2001.
3. C.H Houpis and G.B Lamont, Digital Control Systems – Theory and Hardware, MGH, 1992.
4. G.F.Franklin, J.David Powell, M. L.Workman, Digital Control of Dynamic Systems, A-Wesley Publishing Company, (2e), 1990.
5. V. I. George and C.P. Kurian, Digital Control Systems, Cengage publishers, 2012.

ICE 4404: SYSTEM IDENTIFICATION [3 0 0 3]

Introduction to system modeling, Types of system models, Importance of system models, Model development techniques – first principle based and data driven based, Introduction to System Identification, Procedure for identification, Concept of Identifiability, Signal to Noise Ratio, Overfitting, LTI System Modeling using time and frequency, Direct impulse response identification, Direct step response identification, Impulse response Identification using step response, Empirical Transfer function Identification, Correlation Methods, Linear Regression, Least Square Estimation, Equation Error Models – ARX Models, ARMAX Models, ARIMAX Models, OE Models, Box Jenkins Model,Model Validation Techniques.

References:

1. L. Ljung, System Identification: Theory for the User, Prentice Hall, 1992.
2. Arun. K. Tangirala, Principles of System Identification Theory and Practice, CRC Press, 2016.
3. Karel. J. Keesman, System Identification – An Introduction, Springer, 2011.
4. Philip D. Cha, Fundamentals of Modeling and Analyzing Engineering Systems, Cambridge, 2000.

MINOR: II SENSOR TECHNOLOGY

ICE 4405: SENSOR DESIGN [3 0 0 3]

Review of basic performance characteristics of sensors, Fractional order elements and electrochemical sensor design, Design and development of a dedicated sensor system: Requirement analysis; Definition of technical and functional requirements; Cost analysis; Development of a measurement system prototype using necessary tools, Practical realization of a sensor system; Planning and documenting. Factors Influencing Sensor-based System Design. Limited field trials and sensor calibrations. Case studies of novel sensor design. Multi-spectral sensor Concept of Operation (CONOPS) development, sensor requirements allocation and derived requirement development, Sensor Architecture development, hardware and software partitioning, functional and physical interface requirements and design, signal processing requirement definition, subcomponent performance modeling and testing, observable measurement definition, Key sensor design trade parameters, Multi-spectral sensor systems design methodology, Modern target tracking techniques. Design of sensor packaging, installation and wiring considerations based on hazard classifications. Safety considerations in sensor design and commissioning.

Reference:

1. Jacob Fraden - Handbook of Modern Sensors, Physics, Designs, and Applications, Springer, 2010.
2. T. Grandke, W. H. Ko, Sensors: Fundamentals, Volume 1, Wiley publisher, 1990.

ICE 4406: BIOSENSORS AND BIOMEMS [3 0 0 3]

Bio-recognition elements: Whole cells, Enzymes, Antibodies, Nucleic Acids, Aptamers and Molecularly Imprinted Polymers. Nanostructured substrates for biosensing and integration of the bio-recognition elements on the substrates. Transduction Platforms: Electrochemical, Optical, Mass, Thermal, Hybrid and Lateral Flow Assays. Fundamentals of microfabrication, Lab on chip for biosensing applications and case studies.

References:

1. Mohamed Gad-el-Hak ®, MEMS handbook, CRC Press, 2002.
2. Anthony P.F.Turner, Isao Karube and George S. Wilson, Biosensors: fundamentals and applications, Oxford University Press, 1987.
3. A Sadana, Engineering biosensors: kinetics and design applications, Academic Press, 2002.
4. D Voet & JGVoet, Biochemistry, J Wiley & Sons, 1990.

ICE 4407: MULTI SENSOR DATA FUSION [3 0 0 3]

Concept of fusion, Role of fusion, comparison between sensor and data fusion, fusion types, I/O types, Sensor configuration, Architecture of fusion nodes, fusion topologies, Benefits of fusion. Fusion Architectures - Centralized Fusion, Distributed Fusion, Hybrid Fusion, Introduction to process of data fusion: Need for data refinement, Spatial alignment, Temporal alignment, Semantic and radiometric alignment, Concept and need for data association and decision making, data registration, data association techniques, Decision making techniques - Biological and puzzle solving types, Command and control, Evidence combination, Information requirement for decision making. Bayesian and Dempster–Shafer Fusion Methods - Bayesian Method, Bayesian Method for Fusion of Data from Two Sensors, Dempster–Shafer Method, Comparison of the Bayesian Inference Method and the Dempster–Shafer Method. JDL framework, Revised JDL, Dasarathy's model, Boyd model, Thompolus framework, Luo-Key framework, Pau's framework, Waterfall and omnibus framework, Distributed black box, Esteban framework. Introduction to data filters, Kalman filter, Baysien filter, extended information filter, estimation, Approximate agreement, Optimization filter, Distributed dynamic fusion, Dynamic data flow analysis

References:

1. David L. Hall, Mathematical Techniques in Multisensor Data Fusion, Artech House, 2004.
2. H B Mitchell, Data Fusion: Concepts and Ideas, Springer Publishers, 2012.
3. Multi Sensor Data Fusion with MATLAB, Jitendra R. Raol, CRC Press, 2009.
4. Sensor and Data Fusion, Lawrence A. Klein, (2e), SPIE Press, 2012.

ICE 4408: AUTOMOTIVE SENSORS [3 0 0 3]

Automotive Management systems, Application areas of electronics in the automobiles, Possibilities and challenges in the automotive industry, Power train sensors, sensors for chassis management, Sensors for vehicle body management, Sensors for automotive vehicle convenience and security systems, Two wheeler and Four wheeler security systems, parking guide systems, anti-lock braking system, future safety technologies, Vehicle diagnostics and health monitoring, Safety and Reliability, Traction Control, Vehicle dynamics control, Air Bag and Seat Belt Pre tensioner Systems, Principal Sensor Functions, Passenger Convenience Systems, Electromechanical Seat, Seat Belt Height, Steering Wheel, and Mirror Adjustments, Central Locking Systems, Electromechanical Window Drives. Enabling Connectivity by

Networking:-In vehicle communication standards (CAN & LIN), Telematic solutions, Portable or embedded connectivity- Endorsing Dependability in Drive-bywire systems - Terminology and concepts, Why by-wire, FLEXRAY, Requirements on cost and dependability, Drive-by-wire case studies- prototype development-future of In vehicle communication.

References:

1. Automotive Electrics, Automotive Electronics: Systems & Components, (5e),BOSCH, 2014.
2. Automotive Sensors Handbook, (8e), BOSCH, 2011.
3. Jiri Marek, Hans-Peter Trah, Yasutoshi Suzuki, IwaoYokomori, Sensors for Automotive Technology, (4e), Wiley, New York, 2010.
4. John Turner, Automotive Sensors(1e), Momentum Press, New York, 2010.

MINOR: III SYSTEMS ENGINEERING

ICE 4409: INTRODUCTION TO SYSTEMS ENGINEERING [3 0 0 3]

Definitions and concepts of system-system science and systems engineering, life cycle stages, definitions of requirement, architecture, design. System analysis, interface management, system integration, system verification, system transition, system validation, system operation, system maintenance, system disposal. Project planning, project management and control, decision management, risk management, configuration management, quality assurance, acquisition/supply, tailoring processes and application. Introduction to system modeling and simulation, lean and agile systems engineering, specialty areas (interoperability/logistics/safety/reliability/ maintainability / security/usability)

References:

1. Kossiakof, Alexander and William N. Sweet; Systems Engineering: Principles and Practice, Wiley, 2011.
2. INCOSE Systems Engineering handbook, (4e), Wiley, 2015.
3. System Engineering Book of Knowledge, V 2.6,www.sebokwiki.org, 2022.
4. National Aeronautics and Space Administration, NASA Systems Engineering Handbook, (Rev 1), 2007.
5. Faulconbridge, R. I. and Ryan, M. J, Systems Engineering Practice, Canberra: Argos Press, Revised Edition, 2018.
6. ISO/IEC/IEEE 1528-Systems and Software engineering- System life cycle processes, https://www.iso.org/standard/63711.html
7. Blanchard, Benjamin S., Wolter J Fabrycky Systems Engineering and Analysis, Pearson (5e), 2010.

ICE 4410: SYSTEM ARCHITECTURE AND DESIGN [2 1 0 3]

Architecture definition, architecture view points, concept analysis, models and views of architecture (functional/behavioral/ data/ performance etc.) – Structure and behavior- Evaluating candidate architectures-System/subsystem analysis- tradeoff analysis-Architecture frameworks and standards-design progression-architecture domains (software/IT/ Manufacturing/social etc)-architecture heuristics- acquisition management-tailoring processes-industrial design-design for manufacturability-robustness design-patents and intellectual property.

References:

1. Rechtin, E., and M.W.Maier, The art of Systems Architecting, Boca Raton, FL: CRC Press, 2000.
2. Oliver, D. W., T. P. Kelliher, and J. G. Keegan, Jr., Engineering Complex Systems with Models and Objects, McGraw Hill, 1997.
3. Ulrich K. T and S D Eppinger Product Design and Development, 2ed, NY, McGraw Hill Inc, 2000.
4. ISO/IEC/IEEE 42010:2011-Systems and software engineering-Architecture and description, https://www.iso.org/standard/ 50508.html.
5. 1220-2005-IEEE standard for application and Management of the systems engineering process, https://standards.ieee.org /ieee/1220/3372/

ICE 4411: SYSML AND MBSE [2 0 2 3]

Introduction to MBSE-MBSE concepts- MBSE Ontology-Introduction to Object Process modelling OPM- Object process language-Overview of SysML-Block definition diagrams-Internal block diagrams-Use case diagrams-Activity diagrams-Sequence diagrams-State machine diagrams-Parametric diagrams-Requirements diagram-package diagrams-Operational analysis modeling-functional analysis modeling-logical architecture modeling-Physical architecture modeling-architecture frameworks-Case studies of MBSE-MBSE deployment-Introduction to Digital Twins.

References:

1. SysML distilled: A brief guide to the Systems modeling language. Lenny Deligatti-Addison Wesley Professional, (1e), 2013.
2. Jon Holt and Simon Perry, SysML for Systems Engineering- A model based approach. IET 2013.
3. Jean-Luc Voirin, Model based System and Architecture Engineering with the Arcadia Method(Implementation of Model Based System Engineering) ISTE Press, Elsevier, 2017.
4. DovDori, Model-Based Systems Engineering with OPM and SysML. Springer, 2016.

ICE 4412: SYSTEM VERIFICATION AND VALIDATION [3 0 0 3]

System verification-System validation-various approaches to system validation and verification-inspection/testing/analysis/ demonstration-Generation of Test cases using the Markov Chain model-Writing verification/validation plans-introduction to formal methods-formal approaches to system validation/verification-focus on specialty areas(eg..EMI/EMC)-test automation models (computation/timed automation)-simulation-model checking verification-verification validation activities prescribed in standards for safety critical systems (DO-178C/DO-254/APR4754)

References:

1. Engel, Avner, Verification, Validation and Testing of Engineered Systems, John Wiley & Sons, 2010.
2. Jean Francois Monin, Understanding Formal Methods, Springer, 2003.
3. Jean-Louis Boulanger (Editor), Industrial use of Formal Methods:

Formal Verification, Wiley, 2012.
4. Eds. Alex Gorod, Leonie Hallo Vernon Ireland, Indra Gunawan, Evolving Toolbox for Complex Project Management, CRC press, Taylor and Francis Group, Auerbach, 2019.
5. McShea, R. E. Test and Evaluation of Aircraft Avionics and Weapon Systems, (2e), IET, 2010.

MINOR: IV SMART TRANSPORTATION SYSTEM

ICE 4413: AUTOMOTIVE ELECTRONICS [3 0 0 3]

Introduction to Electronic systems in Automotives, Sensors and Actuators for body electronics, power train and chassis systems, Power train and chassis control domain, Engine management, Transmission control Battery- types and maintenance, Automotive Electronics, Sensors and Actuators, Basic sensor arrangement, Types of sensors, Electronic Fuel Injection and Ignition Systems, Digital engine control systems, Open loop and closed loop control systems.

References:

1. Bosch, Automotive Electrics and Automotive Electronics. System and components, Networking and Hybrid drive, (5e), Springer view 2014
2. Najamuz Zaman, Automotive Electronics Design Fundamental (1e), Springer 2015.
3. Hillier's, Fundamentals of Motor Vehicle Technology on Chassis and Body Electronics, (5e), Nelson Thrones, 2007.

ICE 4414: IN-VEHICLE NETWORKING [3 0 0 3]

Basics of Data Communication Networks and Automotive Communication Protocols, Need for networks, Types of networks, Need for standards, TCP/IP model, Topologies, Controller Area Network (CAN) Protocol, CAN Higher Layer Protocols and LIN, FlexRay and MOST Protocol, Process of Automotive Fault Diagnostics, Fault Codes, Vehicle Systems (open-loop and closed-loop) On- and Off- Board Diagnostics, OBD-I, OBD-II, Engine Analyzers, Steps taken to diagnose a fault, Diagnostics Protocol-KWP2000, SAE-J1587, SAE-J1708 and Case Study.

References:

1. Gilbert Held. Inter- and Intra-Vehicle Communications, CRC Press, (2007)
2. Behrouz Forouzan. Data Communications and Networking, McGraw-Hill. 2003
3. Ronald k. Jurgen. Automotive Electronics Handbook, McGraw-Hill. 1999

ICE 4415: INTELLIGENT TRANSPORTATION SYSTEMS [3 0 0 3]

Fundamentals of ITS, Definition of ITS, the historical context of ITS from both public policy and market economic perspectives, Types of ITS; Historical Background, Benefits of ITS, Sensor technologies and Data requirements of ITS, ITS User Needs and Services and Functional areas, ITS Architecture, Regional and Project ITS architecture; Concept of operations; ITS Models and Evaluation Methods, ITS applications, Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.

References:

1. Mashrur A. Chowdhury, Adel Wadid Sadek, Fundamentals of intelligent transportation systems planning, ARTECH House, 2013.
2. Lawrence A. Klein, Sensor technologies and Data requirements of ITS, Artech House, 2011.

ICE 4416: ADVANCED DRIVER ASSISTANCE SYSTEMS [3 0 0 3]

Advanced driver assistance system, human factors of automated driving systems, human factor of vehicle automation, legal issue surrounding cyber security and privacy on automated vehicle, user perspective on autonomous driving systems, ADAS technology A review on challenges, legal risk mitigation and solutions, localization and mapping for autonomous driving, open pit mine autonomous bot.

References:

1. Chapmann and Hall, Autonomous driving and advanced driver assistance system (ADAS), CRC Press, 2021
2. Dietmar P.F. Möller, Roland E. Haas, Guide to Automotive Connectivity and Cybersecurity: Trends, Technologies, 2017

MINOR: V E-MOBILITY

ELE 4415: EV BATTERY TECHNOLOGY AND POWERTRAIN DEVELOPMENT [3 0 0 3]

Battery Fundamentals: Basics of Batteries, Battery Parameters, Lithium-Ion Characteristics, Thermal Runaway Battery Management System (BMS), Functionality, Practical session - Battery Selection and Connection Process with Vehicle Sensors.

Battery Management Systems: SOC/SOH Estimation, Cell Balancing, Protection, Thermal Management, CAN Communication, Practical session - BMS development.

Battery Pack Design & Modelling: Overview of Battery & BMS System, Electrical Design, Mechanical Design: Calculations and Mechanical Design using ANSYS, Heat Transfer, Thermal Design of Battery Pack, Battery Pack Assembly and Test, Thermal Analysis on Battery Pack, MATLAB/Simulink-based Battery Pack Modelling, Practical session - Battery life cycle testing.

Powertrain and Charging Systems of Electric Vehicles: Introduction to EV Powertrain, Overview, Architecture and Components of EV Powertrain, Thermal Management of EV Powertrain, EV Charging Systems and Types of Chargers.

Modelling, Simulation, and Analysis of EV Powertrain Components: Modelling and Simulation of EV Powertrain Components in MATLAB, Modelling and Analysis of EV Powertrain Components in SolidWorks, Analysis of EV Powertrain Components in ANSYS, Case Study on Powertrain of Existing Models.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. JIANGONG, D. H. Z., “Advances in lithium-ion batteries for electric vehicles: Degradation Mechanism, health estimation, and lifetime prediction”, Elsevier – Health Science, 2024, ISBN-13: 9780443155437.

3. R. Xiong, "Battery Management Algorithm for Electric Vehicles", Springer, 2020, ISBN-13: 9789811502507.
4. Xiong and Weixiang Shen, "Advanced battery management technologies for electric vehicles", John Wiley & Sons Inc, 2019, ISBN-13: 9781119481645.
5. Hick, Klaus Ku pper, and HelfriedSorger, "Systems engineering for automotive powertrain development", Springer, 2021, ISBN-13: 9783319996288.
6. Christopher D. Rahn, "Battery Systems Engineering", Wiley, 1st Ed, 2013, ISBN:9781119979500.
7. Noshin Omar, "Electric Vehicle Batteries: Moving from Research towards Innovation", Reports of the PPP European Green Vehicles Initiatives, Springer, 2015.
8. Gonzalo Abad and Joaquim Lois, "Power Electronics and Electric Drives for Traction Applications", Wiley, 2016, ISBN: 978-1-118-95442-3.
9. John G. Hayes and G. Abas Goodarzi, Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles", Wiley, 2017, ISBN: 978-1-119-06364-3

ELE 4416: EV CHARGING INFRASTRUCTURE, VEHICLE TESTING & HOMOLOGATION [3 0 0 3]

EV Business Management and Vehicle Testing: Introduction to EV (2W, 3W & 4W) Market & Opportunities, Electric Vehicle Design Procedure and ICE Model, Introduction to EV Management, EV Homologation and Testing, FAME India and Manufacturing Guidelines, EV Certification Process, EV Charging, Electric Vehicle and Retrofitting, Motor Technology and EV Motor Market Analysis, EV Categories and Proposed Changes, EV Retrofitting Business, Battery Technology in EV, EV Battery Market Analysis, Practical session - Conducting a market analysis of the EV Charging.

Fundamentals of Product Development Planning: Introduction to Product Development Plan, Segment Selection, Product Design Plan, Product Validation Plan, Vehicle Dynamics Selection, Product Design Validation, Product Specification - Competitor Analysis, Selection of Off-the-Shelf Parts.

Effective Development Methods for Product Innovation: Development Methods, Product Development Plan, Unit Economics, Design Feasibility, Design for Manufacturing, DFMEA & PFMEA, Business Plan, Product Launch, POC / MVP / Working Prototype, Practical session - Using the market analysis results to develop a business plan for an EV Charging.

Understanding EV Charging Technologies and Infrastructure: Overview of EV Charging Technologies, EV Charging Standards and Protocols, Types of EV Chargers and Charging Stations, EV Charging Infrastructure Design, Site Selection and Planning, Practical session - Case Studies of Successful EV Charging Infrastructure Projects.

Designing and Managing EV Charging Infrastructure: Electrical and Mechanical Design Considerations, Safety and Regulatory Compliance, EV Charging Infrastructure Installation and Maintenance, Charging Network Management, EV Charging Network Design and Deployment, Payment Systems and Revenue Management, Data Management and Analytics on Charging Station,

References:

1. M. S. Alam, R. K. Pillai, and N. Murugesan, "Developing Charging Infrastructure and Technologies for Electric Vehicles", IGI Global, 2021, ISBN-13: 9781799868590, ISBN-10: 1799868591.
2. Vahidinasab and Behnam Mohammadi-Ivatloo, "Electric Vehicle Integration via Smart Charging", Springer, 2022, ISBN-13: 9783031059087, ISBN-10: 3031059085.
3. Sivaraman Palanisamy, Sharmeela Chenniappan, and Sanjeevikumar Padmanaban, "Fast-Charging Infrastructure for Electric and Hybrid Electric Vehicles", John Wiley & Sons, 2023, ISBN-13: 9781119987741, ISBN-10: 1119987741.
4. Sulab Sachin, Sanjeevikumar Padmanaban, and S. Deb, "Smart Charging Solutions for Hybrid and Electric Vehicles", John Wiley & Sons, 2022, ISBN-13: 9781119768951, ISBN-10: 1119768950.
5. R. Wang, P. Wang, and G. Xiao, "Intelligent Microgrid Management and EV Control Under Uncertainties in Smart Grid", Springer, 2017, ISBN-13: 9789811350870, ISBN-10: 9811350876.

ELE 4417: EV VEHICLE DESIGN & ANALYSIS [3 0 0 3]

Introduction to Analog Electronics: Introduction to Basic Electronics, Diode Fundamentals, Rectifiers and Filters, Power Electronics for EVs: Voltage Regulators, Inverters and Converters, Special Purpose Diodes, Transistors and Types of Transistors, Operational Amplifier (Op-Amp).

Fundamentals of Digital Electronics: Digital Electronics, EV Control Systems, EV Communication Networks, Microcontrollers and Microprocessors, Introduction to Proteus Software, Circuit Development Using Proteus.

Essentials for Designing and Simulation Using MATLAB: Overview and Environment, Basic Syntax, Variables and Commands, Commands, M-files, and Types, Operators, Decision Making and Loops, Vectors, Matrix, and Arrays, Colon Notation and Numbers, Strings and Functions, Numbers, Plotting and Graphics, Algebra, Calculus, Differential, and Integration, Polynomials and Transforms, Programming EV Systems in MATLAB, Simulink and Fitting, Developing SIMULINK Models for Vehicle Units, Advisor and QSS Toolbox, QSS-based Vehicle Control, Practical session - Analyse and troubleshoot electronic circuits using simulation tools and lab equipment.

EV Architecture Modelling Using MATLAB [Software-based]: Motor Development and Induction Motor Characteristics, Simulink Model to Calculate Vehicle Configuration, Multi-level Inverter Design and Simulation, Solar PV-based Charger Development, DC-DC Converter, Modelling of Li-ion Battery Pack, Design of EV Using QSS Toolbox, Battery Thermal Modelling, BMS Modelling, Electric 4W Powertrain Modelling, Practical session - Data analysis and visualization using MATLAB for vehicle system.

Design of EV System Using MATLAB [Software-based]: Power Required to Overcome Resistance Forces Acting on the Vehicle, Power Converters in Electric Vehicles, Inverters in Electric Vehicles, Motor and Motor Controllers, Modelling of EV Battery and BMS, Practical session -

Modelling and simulation of EV powertrain components, such as motors, controllers, and inverters, using MATLAB/Simulink.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", Routledge, 3rd Ed, 2021, ISBN: 9780367693930.
3. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 1st Ed, 2014, ISBN: 9781138072855.
4. Sandeep Dhameja, "Electric Vehicle Battery Systems", Butterworth-Heinemann, 2st Ed, 2002, ISBN: 978-0750699167.
5. Singh, Sanjeev, et al., “Electric Vehicle Components and Charging Technologies” IET, 2024, ISBN-13: 9781839536717.
6. Das, Shuvra, “Modeling for Hybrid and Electric Vehicles Using Simscape”, Springer, 2022, ISBN-13: 9783031003806.

ELE 4418: EV DATA ANALYTICS & CYBER SECURITY [3 0 0 3]

Cyber Security for Automotive Vehicle Systems: Automotive Industry, Automotive Megatrends, Automotive Development Process, Automotive Electrical and Electronics, Automotive Software Technology, The Connected Car, Automotive Cybersecurity.

Advanced Mobility Services: Mobile Apps for Connected Car, Car Hailing and Ride Sharing, Connected Parking and Automated Valet Parking, ADAS and Autonomous Driving.

Data Analytics for EV and Automotive Systems: Introduction to Data Analytics and Its Application in the Automotive Industry, Understanding of the Data Analytics Pipeline, Overview of Data Analytics, Its Tools, and Techniques, EV Data Collection and Analysis, Sensors and Data Collection in EVs, Data Acquisition and Pre-processing, Statistical Analysis of EV Data, Practical session - Conducting a vulnerability assessment on an in-vehicle network, and developing a report on the findings with recommendations for mitigations.

Automotive System Data Collection and Analysis: Automotive Systems (such as Engines, Transmissions, Brakes, etc.), Data Acquisition and Pre-processing, Statistical Analysis of Automotive System Data, Regression, Classification and Clustering, Principal Component Analysis (PCA) and Linear Discriminant Analysis (LDA), Predictive Maintenance Techniques in Automotive Systems, Fault Detection and Diagnosis, Remaining Useful Life (RUL) Prediction, Practical session - Developing predictive maintenance models for automotive systems.

Introduction to Big Data Platforms: Introduction to Big Data Platforms and Tools (such as Hadoop, Spark, and Kafka), How to Use Big Data Platforms to Process and Analyze Automotive Data, Practical session - Case studies showcasing the application of data analytics in the automotive industry.

References:

1. Mashrur Chowdhury, Amy Apon and Kakan Dey, "Data Analytics for Intelligent Transportation Systems", Elsevier, 1st Ed, 2017, ISBN: 978-0128097151.
2. Tyson Macaulay, Bryan L. Singer, and John R. Vacca, "Cybersecurity for Industrial Control Systems: SCADA, DCS, PLC, HMI, and SIS", CRC Press, 1st Ed, 2011, ISBN: 978-1439801963.
3. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
4. David Ward and Paul Wooderson, "Automotive Cybersecurity: An Introduction to ISO/SAE 21434", SAE International, 1st Ed, 2021, ISBN: 978-1468600803.
5. Dartmann Guido, AnkeSchmeink and Houbing Song, "Big Data Analytics for Cyber-Physical Systems: Machine Learning for the Internet of Things", Elsevier, 1st Ed, 2019, ISBN: 978-0128166376.
6. Craig Smith, "The Car Hacker's Handbook: A Guide for Penetration Tester", No Starch Press US, 1st Ed, 2016, ISBN: 978-1593277031.
7. Root, Alex, “Python for Data Analytics”, Independently published, 2019, ISBN-13: 9781691418831.
8. Runkler, Thomas A., “Data Analytics”, Springer, 2020, ISBN 9783658297794.
9. Janeja, Vandana P., “Data Analytics for Cybersecurity”, Cambridge University Press, 2022, ISBN-13: 9781108415279.

OTHER PROGRAM ELECTIVES

ICE 4441: ADVANCED SENSOR TECHNOLOGY [3 0 0 3]

Features of Advanced sensing techniques, Sensor classifications according to the energy domains, Introduction of advanced sensing materials, Properties (physical, electrical, chemical, and biological) of materials which make it suitable for sensing in different domain. Review of sensors for measurement of temperature, level, pressure and flow. Design and commissioning considerations of such sensors. Optical Sensors: Sources and detectors in optical systems. Aerospace Sensor: Accelerometers: Capacitive, Piezoelectric, Piezoresistive, Thermal, Chemical sensor.

References:

1. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs, and Applications, Springer, 2010.
2. P Ripka, A Tipek, Modern Sensors Handbook, Wiley Publication, 2007.
3. Sabaree Soloman, Sensors Hand Book, MGH, 1998

ICE 4442: ANALYTICAL AND OPTICAL INSTRUMENTATION [3 0 0 3]

Optical Instrumentation Systems, UV-Vis Spectroscopy, IR Spectroscopy, Chromatography and mass spectroscopy, Nuclear Magnetic Resonance, Electron Microscopy, Crystallography and elemental analysis, Case studies with sophisticated analytical instrumentation systems.

References:

1. Skooj, Holler, Crouch, Principles of Instrumental Analysis (7e), Cengage Learning India, 2018.
2. R S Kandpur, Handbook of Analytical Instruments, (2e), TMH, 2003.
3. Willard, Merritt, Dean and Settle, Instrumental Methods of Analysis, (7e), CBS Publishers, 1988.
4. J.Wilson & J F B Hawkes, Opto Electronics: An Introduction, (2e), PHI, 1993.

ICE 4443: BIO-MEDICAL INSTRUMENTATION & EQUIPMENT [3 0 0 3]

Bioelectric Potential measurement: Cell structure, basic cell functions, origin of bio-potentials, electrical activity of cells, biological control concept, electrode-electrolyte interface, half-cell potential, polarizable and non-polarizable electrode, The Cardiovascular system: Structure of heart, rhythmicity, Electrocardiograph (ECG), ECG electrodes, vector cardiograph, ECG analysis, Central Nervous System and muscular system Receptors, sensory pathways and motor systems, processing sensory information, neural, neuromuscular, sensory muscular and sensory measurements, biofeedback, evoked response, Electroencephalography (EEG), Therapeutic equipment's and life saving devices Blood flow meter, oximeter, cardiac output measurement, plethysmography, ultrasound therapy unit, nerve stimulators, Modern Imaging systems, Electrical safety.

References:

1. R.S. Khandpur, Handbook of Biomedical Instrumentation, McGraw Hill, (2e), 2008.
2. Leslie Cromwell, Fred J. Weibell and Erich A. Pfeiffer, Biomedical Instrumentations and Measurements, Prentice Hall, (2e), 2012.
3. J.G. Webster, Medical instrumentation application & design, Wiley, (4e), 2009.
2. Joseph J. Carr& John. M. Brown, Introduction to Biomedical Equipment technology, Pearson education, (4e), 2003.
3. J.G. Webster, Encyclopedia of Medical Devices and Instrumentation, John Willey and Sons, 1988.

ICE 4444: CYBER PHYSICAL SYSTEMS [3 0 0 3]

Overview of cyber physical system, key features, Applications, The Design Process. CPS - Platform components, Synchronous Model, Asynchronous Model: Asynchronous Processes, Asynchronous Design Primitives, Asynchronous Coordination Protocols, Dynamical Systems, Timed Model and Real-Time Scheduling: Timed Processes, Hybrid systems: Hybrid Dynamical Models, Designing Hybrid Systems, Linear Hybrid Automata, Secure Deployment of CPS.

References:

1. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
2. Lee, Edward Ashford, Sanjit Arunkumar Seshia, Introduction to embedded systems: A cyber-physical systems approach, MIT Press, 2016.
3. Platzer, André. Foundations of Cyber-Physical Systems, Lecture Notes CMU, Carnegie Mellon University, Pittsburgh, PA, USA, 2014.

ICE 4445: DATA STRUCTURES AND ALGORITHMS [3 0 0 3]

Structure of C++ Program: Data Types. Basic, user-defined and derived, operators: assignment, arithmetic, relational, logical, increment/decrement, conditional, precedence of operators, manipulators, decision statements, programming control statements, Functions. Main Function, Function Prototyping, Call and return by reference, Inline functions, Default and constant arguments, Pointers, Classes, Inheritance, Linked List Data structure, Linked list traversal, insert function, remove function, Linked list with tail and doubly linked lists, Recursion, Trees, Stacks, Queues, Sorting and searching algorithms: Sorting, Searching, hashing, Radix sort.

References:

1. Nell Dale, C++ Plus Data Structures, Jones and Bartlett Publishers, (4e), 2010.
2. Maria Litvin, Gary Litvin, Programming with C++ and Data Structures, Vikas Publishing House Pvt. Ltd., 2001.
3. E Balagurusamy, Object-oriented Programming with C++, TMH, (2e), 2001.
4. Yashavant P Kanetkar, Let us C++, BPB Publications, 2003.

ICE 4446: DSP ARCHITECTURE AND APPLICATION [3 0 0 3]

Architectures for Programmable Digital Signal Processing Devises, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues, Features for External Interfacing, Programmable Digital Signal Processors, Architecture of DSP processors, Data Addressing Modes, On-chip Peripherals, Interrupts, Pipeline Operation, Implementation of Basic DSP Algorithm, FIR Filters, IIR Filters, Interpolation and Decimation Filters, FFT Algorithm for DFT Computation, Bit-Reversed Index Generation, Signal Spectrum, Interfacing Peripherals to DSP Devices, External Bus Interfacing Signals. Memory Interface, Parallel I/O Interface, Programmed I/O, Interrupts and I/O, Direct Memory Access (DMA), Synchronous Serial Interface, Multichannel Buffered Serial Port. Applications of DSP Processor.

References:

1. Avatar Singh and S. Srinivasan, Digital Signal Processing Implementations: Using DSP Microprocessors with Examples from TMS320C54xx, Thomson/Brooks/Cole, 2004.
4. B. Venkataramani, M. Bhaskar, Digital Signal Processors: Architecture, Programming and Applications, Tata McGraw-Hill Education, 2002.
5. Sen-Maw Kuo, Woon-Seng Gan Digital Signal Processors: Architectures, Implementations, and Applications, Pearson Prentice Hall, 2005.

ICE 4447: ELECTRONIC MEASUREMENT SYSTEMS [3 0 0 3]

Signal Conditioning, Instrumentation and isolation amplifiers, analog filters, analog switches. Signal measurement in the presence of noise: synchronous detection, signal averaging. Noise in electronic systems, Digital Time Measurement Techniques Parallel Port Buses: PC based DAS, Data loggers; PC based industrial process measurements like flow, temperature, pressure and level development system, CRT interface and controller with monochrome and colour video display. Transmission measurements.

Reference:

1. Derek Frederick Alfred Edwards, Electronic Measurement Techniques, Butterworths, 1971.
2. T. S. Rathore, Digital Measurement Techniques, CRC Press, 2003.
3. Nihal Kularatna, Digital and Analogue Instrumentation: Testing and Measurement, IET, 2003.

ICE 4448: INDUSTRIAL INTERNET OF THINGS

IOT Vs. IIOT, Components of IIOT -Sensors, Interface, Networks, People & Process, Real life examples, IOT Platform, Interfaces, API, clouds, Data Management, Analytics, Mining & Manipulation; Challenges & Benefits in implementing IIOT.Various Architectures of IOT and IIOT, Industrial Internet - Reference Architecture; IIOT System components: Sensors, Gateways, Routers, Modem, Cloud brokers, servers and its integration, WSN, WSN network design for IOT.Roles of sensors in IIOT, sensor architecture, special requirements for IIOT sensors, types of actuators. Hardwire the sensors with different protocols such as HART, MODBUS-Serial & Parallel, Ethernet, BACNet, Current, M2M etc., Wi-Fi, Wi-Fi direct, Zigbee, Z wave, Bacnet, BLE, Modbus, SPI, I2C, IIOT protocols –COAP, MQTT,6lowpan, lwm2m, AMPQ, IIOT cloud platforms : Overview of cots cloud platforms, predix, thing works, azure. Data analytics, cloud services, Business models: Saas, Paas, Iaas. Introduction to web security, Conventional web technology and relationship with IIOT, Vulnerabilities of IoT, Privacy, Security requirements, Threat analysis, Trust, IoT security tomography and layered attacker model, Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT, Network security techniques, Management aspects of cyber security. Role of Analytics in IOT, Data visualization Techniques, Introduction to R Programming, Statistical Methods. Internet of Things Applications.

References

1. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications.
2. Bernd Scholz-Reiter, Florian, Michahelles, "Architecting the Internet of Things", ISBN 978-3- 642-19156-5 e-ISBN978-3-642-19157-2, Springer.
3. Pethuru Raj and Anupama C. Raman,"The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2018
4. Qusay F. Hassan, "Internet of Things A to Z: Technologies and Applications", Wiley, 2018

ICE 4449: MACHINE LEARNING FOR CONTROL SYSTEMS [3 0 0 3]

Machine learning fundamentals - Support Vector Machines, Kernel methods–Clustering, Principal Component Analysis, Singular Value Decomposition, Independent Component - Analysis semi supervised learning – Reinforcement Learning-Applications to Control Problems: State estimation using neuro observer- Kalman Filter and reinforcement learning - Identification of non-linear dynamical systems using neural networks - Reinforcement learning Modelling - Optimal control problems using support vector machines, regression methods, Monte-Carlo method - Model Predictive Control and Adaptive reinforcement learning - Robust control using differential neural networks - Path planning using dynamic neural networks, density based machine learning techniques - Adaptive control using self-organizing map or RBF networks -Trajectory tracking using dynamic (recurrent) neural networks.

References:

1. Frank Leroy Lewis, Suresh Jagannathan, A. Yeşildirek, Neural Network Control of Robot Manipulators and Non-Linear Systems, Taylor and Francis group, 1999.
2. Frank L. Lewis, Derong Liu, Reinforcement Learning and Approximate Dynamic Programming for Feedback Control, Wiley and IEEE press, 2013.
3. Zi-Xing Cai, Intelligent Control: Principles, Techniques and Applications World Scientific, 1997.
4. Bishop, C. M., Pattern Recognition and Machine Learning, Springer, 2006.
5. Alexander S. Poznyak, Edgar N. Sanchez, Wen Yu, Differential Neural Networks for Robust Nonlinear Control Identification, State Estimation and Trajectory tracking, World Scientific, 2001.
2. Alex Smola, S.V.N. Vishwanathan, Introduction to Machine Learning, Cambridge University Press, 2010.
3. Simon Haykins, Neural Networks and Learning Machines, Prentice Hall, 2009.

ICE 4450: NEURAL NETWORK AND FUZZY LOGIC [3 0 0 3]

Introduction, ANN, BNN and difference between ANN and BNN, McCulloch–Pitts model, Activation functions, Feedforward and feedback networks, Learning rules, Supervised Learning network, Multi-layer Feedforward Networks, Back propagation network, Unsupervised Learning network, Maxnet, Mexican Hat net, Kohonen self-organizing feature map, Vector quantization, Fuzzy sets, Membership functions, Fuzzification, Defuzzification methods, Fuzzy rule base and approximate reasoning, Fuzzy inference systems, Fuzzy logic control system, Applications.

References:

1. Laurence Fausett, Fundamentals of Neural networks, Architecture, Algorithm and Applications, Pearson Education India, (1e), 2004.
2. Timothy J. Ross, Fuzzy logic with engineering applications, John Wiley & Sons, (4e), 2016.
3. S. N. Sivanandan, S. N. Deepa, Principles of soft computing, Wiley India, 2010.
4. B. Yegnanarayana, Artificial Neural Networks, PHI, 2004.

ICE 4451: POWER ELECTRONICS [3 0 0 3]

Introduction to power electronics, SCR: device structure, characteristics and design, UJT trigger circuits, GTO, Power MOSFET, IGBT, single-phase half converters, single-phase full converters, semi-converters, three-phase half converters, three-phase full converters, dual converters, step-up choppers, step-down choppers, step up/down choppers, morgans' chopper, AC voltage converters, cyclo-converters, bridge inverters, three-phase inverters, series, and parallel inverters.

References:

1. M. H. Rashid, Power Electronics, PHI, (3e), 2005.
2. Ned Mohan, Undeland, Robbins, Power Electronics, John Wiley, (3e), 2002.
3. Bimbhra P.S, Power Electronics, Khanna Publication, (3e), 1999.
4. M. Ramamurthy, Thyristors and their Application, East-West Press, 1977.

ICE 4452: REAL TIME OPERATING SYSTEMS [3 0 0 3]

RTOS introduction, Essential features of an OS and batch processing, Process scheduling, scheduling queues, Types of schedulers, Multithreaded programming, Threading issues, scheduling criteria and algorithms, synchronization, classical problem of synchronization, deadlocks, methods for handling deadlocks, memory management strategies and virtual memory management.

References:

1. Abraham Silberschatz, Peter Galvvin, Grag Gagne, Operating System principles, John Wiley Publications, (7e), 2006.
2. Allan Burns, Andy Wellings, Real-Time Systems and Programming Languages, Addison Wesley, (3e), 2001.
3. Milan Milenkovic, Operating Stems Concepts and Design, McGraw Hill Education, (2e), 2001.
4. Maurice Bach, Design of Unix Operating System, Pearson, (1e), 1986.
5. Rajib Mall, Real Time Systems, Pearson Education, 2007.

ICE 4453: RELIABILITY AND SAFETY ENGINEERING [3 0 0 3]

Sampling distributions, Testing of hypotheses, Failure data, Failure modes, Hazard rates and failure density function, Hazard models and bath-tub curve, Reliability of systems, Redundancy, Fault Tree Analysis, Reliability improvement methods, Reliability Tests, Test -retest method, Split half method, Alternate or parallel forms Method, Rational Equivalence Method, Component reliability and MIL standards, Safety policy, Safety Organization, Measurement and prediction of human reliability and operator training, Safety margins in critical devices, Incident Recall Technique, Disaster control, Job Safety Analysis, Safety Audit.

References:

1. Govil, A.K., Reliability Engineering, TMH, 1983.
2. Sinha and Kale, Introduction to Life-Testing, Wiley Eastern, New Delhi, 1992.
3. Wisley, Human Engineering - Guide for Equipment Designers, University of California Press, 1973.
4. Hoang Pham, Handbook of Reliability Engineering, Springer, 2003. Krishnan N.V, Safety Management in Industry, Jaico Publishing House, Bombay, 1997

ICE 4454: ROBOTIC CONTROL SYSTEMS [3 0 0 3]

Robotic Systems: Components and Structures of Robots, Degrees of Freedom and Workspace, Rotation representation, Homogenous Transformations. Types of Joints, Kinematics of Manipulators, Differential transformation and Jacobian, Static force and torque, Trajectory Planning, Dynamics of Manipulators (Lagrangian and Newton-Euler methods), Feedback control of a single link manipulator, PID control of multi-link manipulator, Force control.

References:

1. Mark. W. Spong, Robotics Dynamics and Control, Wiley, (1e), 1989.
4. John. J. Craig, Introduction to robotics – Mechanics and Control, Pearson Education, (4e), 2017.
5. Ashitava Ghosal, Robotics: Fundamental Concepts and Analysis, Oxford Press, (1e), 2006.
6. S.K Saha, Introduction to Robotics, TMH, (1e), 2008.
7. D.K Pratihar, Fundamentals of Robotics, Narosa, (1e), 2017.

ICE 4455: ROBUST CONTROL [3 0 0 3]

Issues in Control System Design, need for Robust control, Norms for signals and systems, Input- Output Relationships, Computing the Norm by State-Space Methods, Eigen values and singular values, Condition for Internal stability, sensitivity and complementary sensitivity function, Asymptotic tracking, Performance, Sources of Model Uncertainties, Plant Uncertainty Model, Small Gain Theorem, Robust Stability, Robust Performance, Trade-off between robust stability and robust performance, Existence of Stabilizing Controllers, Parameterization of All Stabilizing Controllers, Coprime Factorization. Loop shaping Controllers, Shaping S, T, or Q, P-1 Stable, P-1 Unstable, The Modified Problem, Spectral Factorization, Case Studies-Robust Control for Mass Damper Spring Systems, Spacecraft and Inverted Pendulum.

References:

1. Doyle, J.C., B.A. Francis and A. Tannenbaum, Feedback Control Theory, Macmillan publishing co., 1990.
2. Kemin Zhou, Doyle J.C and Glover K., Robust and Optimal Control, Prentice Hall Inc, 1995.
3. Willian A. Wolovich, Automatic Control Systems, Saunders college publishing, 1994.
4. Kemin Zhou and Doyle J.C, Essential of Robust Control", Prentice Hall Inc, 1998.

OPEN ELECTIVES

ICE 4311: FEEDBACK CONTROL THEORY [3 0 0 3]

Feedback control systems, Mathematical modeling, Derivation of transfer functions for electrical networks, Mechanical systems, Signal flow graph, Masons gain formula, State variable representation of linear systems, Solution of state equations, Time domain specifications for second order systems, Steady state errors of unity feedback systems, Definitions of stability, Routh Hurwitz criterion, Frequency response - gain margin, phase margin.

References:

1. Nagrath and Gopal, Control Systems Engineering, New age international Limited, (2e), 1984.
2. Norman S. Nise, Control Systems Engineering, (5e), Wiley India, 2009.
3. R.C Dorf and R.H Bishop, Modern Control Systems, (11e), Addison-Wesley Longman Inc., 2013.

ICE 4312: INDUSTRIAL AUTOMATION [3 0 0 3]

Evolution of PLC, PLC Vs PC, Architecture of PLC - I/O Modules, CPU, Program Memory, Process Image Tables, Bus System and Power Supply, Sequential Flow Chart technique for programming style, Programming a PLC, Timers & Counters, Special Instructions, Levels of Industrial control, Networking, Buts Networks, Protocols., SCADA & DCS, Profibus, Modbus, SMART devices.

References:

1. John W.Webb and Ronald A.Reis, Programmable Logic Controllers –

Principles and Applications, (5e), PHI, 2003.
2. W. Bolton, Programmable Logic Controllers, 94e), Newnes Publications, 2006.
3. Frank D. Petruzella, Programmable Logic Controllers, MGH, 1989.

ICE 4313: INDUSTRIAL INSTRUMENTATION [3 0 0 3]

Measurement System, Classification of transducers, Temperature and Pressure measurement, Level and Thickness measurement, Flow measurement-Variable head type, variable area type, Mass flow meters, Measurement of Thermal conductivity, velocity, acceleration, pH and Force, Semiconductor sensors, Optical sensors.

References:

1. E.O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.
2. Patranabis D, Principles of Industrial Instrumentation, TMH, (3e), 2005.
3. A.K. Sawhney, A course in Mechanical Measurement and Instrumentation, (7e), Dhanpat Rai and Co, 2002.

ICE 4314: SENSOR TECHNOLOGY [3 0 0 3]

Basic sensor technology, characteristics, Capacitive and Inductive Sensors, Displacement Sensors, Temperature Sensors, Force/Torque Sensors, Humidity and Moisture Sensors, Acoustic Sensors, Flow Sensors, Occupancy-Motion Detectors, Acceleration and Vibration Sensors, Chemical and Biosensors, Optical and radiations Sensors, Introduction to Wireless Sensor Networks (WSN) and Applications.

References:

1. Jon S Wilson, Sensor Technology Handbook, Newnes Elsevier Publication, 2005.
2. Jacob Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, Springer, 2004.

ICE 4315: SMART SENSOR [3 0 0 3]

MCUs and DSPs, integrated signal conditioning, IEEE1451 standards, Plug and play, Sensor Communication, Wireless zone sensing, Surface acoustical wave devices, Intelligent transportation system, RF-ID, RF MEMS basics, Micro optics, Micro grippers, Microprobes, Micro mirrors, FEDs, Centralized and decentralized measurement chains, Intelligent sensors, Nano sensors, Biosensors

References:

1. Randy Frank, Understanding Smart Sensors, (2e), Artech House Publications, 2000.
2. Paul W. Chapman, Smart Sensors, ISA Press, 1996.
3. Krzystoflniewski, Smart Sensors for Industrial Applications, CRC Press, 2013.

ICE 4316: VIRTUAL INSTRUMENTATION [3 0 0 3]

Architecture of a virtual instrument, Virtual instruments V/s Traditional instruments, Advantages of VI, Graphical programming, Creating Virtual Instruments using LabVIEW-Loops, Arrays, Clusters, String and file I/O, Graphs, Data Acquisition, Common Instrument Interfaces, Current loop, System buses, Interface buses, VISA, Image acquisition and processing, Design of ON/OFF controller for a mathematically described processes using VI software

References:

1. Gary Johnson, LabVIEW Graphical Programming, (2e), MGH, 1997.
2. Lisa K. wells & Jeffrey Travis, LabVIEW for everyone, National Instruments, 1997.
3. S. Sumathi, P Surekha, LabVIEW based Advanced Instrumentation systems, Springer, 2007.
4. Rick Bitter, Taqi Mohiuddin, Matt Nawrocki, LabVIEW Advanced Programming Techniques, CRC Press, 2007.
5. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI, 2010.

ICE 4317: FARM AUTOMATION [3 0 0 3]

Farm mechanization, sources of farm power, renewable energy sources, IC engines, tillage, sowing, plant protection, intercultural operations, harvesting, threshing, biomass management techniques. Watershed concept and theory, soil erosion, measures, hydrological cycle, irrigation methods, devices, Water conveyance systems, Water harvesting, aquifer and its types, interaction of water resources with the changing environment. Engineering properties of biological materials, heat and mass transfer, devices for cleaning, grading, milling and storage of farm produce. Drying and dehydration, function and features of green house. Resource conservation management, precision farming, automated irrigation scheduling, variable rate seed and chemical applicators, robotics, Rainfall-runoff prediction models, watershed modeling, climate change impact analysis on bio-resources, drying characteristics, storage or process kinetics, simulation and modeling in tillage implements.

References:

1. Jagdshwar Sahay, Elements of Agricultural Engineering,(4e), Standard Publishers Distributors, 2006
2. A. M. Michael & T. P. Ojha, Principles of Agricultural Engineering, Vol I & II., (10e), Jain Brothers, 2018
3. K M Sahay, K. K. Singh, Unit operations of Agricultural Processing, (2e),Vikas Publishing House Pvt Ltd, 2004.
4. Qin Zhang, Francis J. Pierce, Agricultural Automation Fundamental and Practices, CRS Press, Taylor and Francis group, 2013.
5. Darwin Caldwell, Robotics & Automation in the food Industries (Current & Future Technologies), Wood Head Publishing Ltd, Oxford, 2012.
5. A. M. Chandra, S. K. Ghosh, Remote Sensing and Geographical Information System, Alpha Science, 2006

ICE 4318 OUTDOOR LEADERSHIP

Different skills of an outdoor leader, different styles of leadership, Awareness and Decision making in the field, Expedition Behaviour, Field Safety and Crisis, Trip Planning, Leave No Trace Principles, Local Ecology of the laterite pleatue, Basic bicycle problems and their solutions, Fundamentals of route planning, Nutrition and Hydration, Recovery for athletes, Group behaviour and development, How to maintain a ride log & incident report, packing for tours, Basics of Nature journaling, Basics of Photography, Creative writing,

On road bicycle maintenance and repairs, bicycle handling skills, resistance training drills, recovery rides, endurance rides, basics of camping, documenting in the field

References :

- AMC Guide to Outdoor Leadership – Alex Kosseff – Appalachian Mountain Club - 2023
- Big Blue Book of Bicycle Repair – Calvin Jones – Park Tool Co - 2019
- Manipal Bird Book – Ramit Singhal – Manipal University -2018
- The Athlete's guide to recovery – Sage Rountree - VeloPress - 2024
- Keeping a nature journal – Clarke Walker Leslie – Storey Publishing - 2021
- Langfords Starting Photography – Philip Andrew – Routeledge Press - 2015
- Naturalist on the prowl – EHA – Penguin India - 2007
- Dear Data – Giorgia Lupi – Princeton Architectural Press - 2016
  Observe, collect, draw - Giorgia Lupi - Princeton Architectural Press - 2018

B.TECH. CYBER PHYSICAL SYSTEMS

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2122	Engineering Mathematics - III	2	1	0	3	MAT 2228	Engineering Mathematics - IV	2	1	0	3
	ICE 2121	Analog Electronic Circuits	3	1	0	4	ICE 2222	Microcontroller	3	1	0	4
	ICE 2126	Digital Logic Design	3	0	0	3	ICE 2226	Digital Transmission	3	0	0	3
	ICE 2127	Computer Architecture and Organization	3	0	0	3	ICE 2227	Introduction of Cyber Physical Systems	3	0	0	3
	ICE 2128	Data Structures and Algorithms	3	1	0	4	ICE 2228	Introduction to Control Theory	2	1	0	3
	ICE 2129	Sensor Technology	3	0	0	3	ICE 2225	Communication Systems	3	0	0	3
	ICE 2142	Sensors and Circuits Lab	0	0	3	1	ICE 2243	Communication Systems Lab	0	0	3	1
	ICE 2144	Data Structures Lab	0	0	3	1	ICE 2242	Microcontroller Lab	0	0	3	1
			17	**3**	**6**	**22**			**16**	**3**	**6**	**21**
	Total Contact Hours (L + T + P)		**26**				**Total Contact Hours (L+T+P)**		**25**			
	FIFTH SEMESTER						**SIXTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	HUM 3022	Essentials of Management	2	1	0	3	HUM 3021	Engineering Economics and Financial Management	2	1	0	3
	ICE 3126	Cyber Physical System Design	3	1	0	4	ICE ****	Flexible Core - 2 (A2/B2/C2)	3	0	0	3
	ICE 3127	Data Communication and Networks	3	1	0	4	ICE ****	Flexible Core - 3 (A3/B3)	3	0	0	3
	ICE 3128	Embedded Systems Design and Programming	3	0	0	3	ICE ****	Program Elective - I / Minor Specialization	3	0	0	3
	ICE ****	Flexible Core - 1 (A1/B1/C1)	3	0	0	3	ICE ****	Program Elective - II / Minor Specialization	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective - 2	3	0	0	3
	ICE 3143	Cyber Physical Systems Design Lab	0	0	3	1	ICE 3244	CPS Interface Lab	0	0	3	1
	ICE 3144	Embedded System Programming Lab	0	0	3	1	ICE 3245	Networking lab	0	0	3	1
			18	**2**	**6**	**22**			**18**	**0**	**6**	**20**
	Total Contact Hours (L+T+P)		**26**				**Total Contact Hours (L+T+P)**		**24**			
	SEVENTH SEMESTER						**EIGHTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
IV	ICE ****	Program Elective - III / Minor Specialization	3	0	0	3	ICE 4291	Industrial Training				1
	ICE ****	Program Elective - IV / Minor Specialization	3	0	0	3	ICE 4292	Project Work				12
	ICE ****	Program Elective - V	3	0	0	3	ICE 4293	Project Work (B.Tech Honours)**				20
	ICE ****	Program Elective - VI	3	0	0	3	ICE ****	B.Tech Honours (Theory 1)** (V Semester)				4
	ICE ****	Program Elective - VII	3	0	0	3	ICE ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	XXX ****	Open Elective - 3	3	0	0	3	ICE ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	ICE 4191	Mini Project (Minor Specialization)*				8						
			18	**0**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P)		**18**									

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

FLEXIBLE CORE - A

I AUTOMATION

ICE 3129: Industry 4.0 (A1)
ICE 3227: Design of Safe systems (A2)
ICE 3225: Industrial Automation(A3)

FLEXIBLE CORE -B

II SYSTEM INTELLIGENCE

ICE 3130: Introduction to Augmented & Virtual Reality(B1)
ICE 3226: Unsupervised intelligence in CPS(B2)
ICE 3228: CPS Interface(B3)

FLEXIBLE CORE-C

ELE 3127: Foundations of EV & Hybrid Vehicles (C1)
ELE 3225: Automotive Mechanics for Electric Vehicles (C2)

MINOR SPECIALIZATION

I. CONTROL SYSTEMS

ICE 4401: Modern Control Theory
ICE 4402: Nonlinear control theory
ICE 4403: Digital Control Systems
ICE 4404: System Identification

II. SENSOR TECHNOLOGY

ICE 4405: Sensor Design
ICE 4406: Biosensors and BioMEMS
ICE 4407: Multi Sensor Data Fusion
ICE 4408: Automotive Sensors

III. SYSTEMS ENGINEERING

ICE 4409: Introduction to Systems Engineering
ICE 4410: System architecture and Design
ICE 4411: SysML and MBSE
ICE 4412: System Verification and validation

IV. SMART TRANSPORTATION SYSTEMS

ICE 4413: Automotive Electronics
ICE 4414: In-vehicle Networking
ICE 4415: Intelligent Transportation Systems
ICE 4416: Advanced Driver Assistance Systems

V. E-MOBILITY

ELE 4415: EV Battery Technology and Power Train Development
ELE 4416: EV Charging Infrastructure, Vehicle Testing & Homologation
ELE 4417: EV Vehicle Design & Analysis
ELE 4418: EV Data Analytics & Cyber Security

OTHER PROGRAM ELECTIVES

ICE 4461: Big Data Analytics
ICE 4462: Blockchain Technology
ICE 4464: CPS Assurance
ICE 4465: CPS for internal and external security
ICE 4466: Cyber Security
ICE 4467: Design of Safe Systems
ICE 4468: E-Vehicles
ICE 4469: Intelligent Manufacturing Automation
ICE 4470: Metaverse
ICE 4471: Next Generation Networks
ICE 4472: Smart Farming and Agriculture
ICE 4473: Smart Grid
ICE 4474: Smart Infrastructure
ICE 4475: Smart Sensors
ICE 4476: Wireless Sensor Technology
ICE 4477: Database Systems
ICE 4478: Operating Systems
ECE 4498: Realtime Operating Systems

OPEN ELECTIVES

ICE 4311: Feedback Control Theory
ICE 4312: Industrial Automation
ICE 4313: Industrial Instrumentation
ICE 4314: Sensor Technology
ICE 4315: Smart Sensor
ICE 4316: Virtual Instrumentation
ICE 4317: Farm Automation
ICE 4318: Outdoor Leadership

THIRD SEMESTER

MAT 2122: ENGINEERING MATHEMATICS–III [2 1 0 3]

Linear Algebra: Systems of Linear Equations, Matrices, Solving Systems of Linear Equations, Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings, Affine Spaces. Analytic Geometry: Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions, Orthogonal Projections, Rotations. Matrix Decompositions: Determinant and Trace, Eigenvalues and Eigenvectors, Cholesky Decomposition, Eigen decomposition and Diagonalization, Singular Value Decomposition, Matrix Approximation. Fourier Series and Transforms: Periodic function, Fourier Series expansion. even and odd functions, functions with arbitrary periods, Half range expansionsFourier transform, basic properties, Parseval's identity and applications.

References:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. Grewal B.S. - Higher Engineering Mathematics, Khanna Publishers, 43rd edition, 2015
3. Stephen H. Friedberg Lawrence E Spence, Arnold J Insel, Elementary Linear Algebra: A Matrix Approach Introduction to Linear Algebra, Second Edition, 2019.
4. David Lay, Steven Lay, Judi McDonald, Linear Algebra and Its Applications, Pearson, 2019.
5. Gilbert Strang, Introduction to Linear Algebra, Wellesley-Cambridge Press, Fifth Edition 2016.
6. Mordechai Ben-Ari, Mathematical Logic for Computer Science, Third Edition, Springer,2012.
7. Narayanan, Ramaniah and Manicavachagom Pillay ,Advanced Engineering Mathematics, Vol 2 and 3, Vishwanthan Publishers Pvt Ltd. 1998
8. Erwin Kreyszig, Advanced Engineering Mathematics, 5th edn., Wiley Eastern, 1985

ICE 2121: ANALOG ELECTRONIC CIRCUITS [3 1 0 4]

Structure and operation of MOSFET, I-V Characteristics, Channel-Length Modulation, Transconductance, Large-Signal and Small-Signal Model, Biasing, Amplifier topologies, Common-Source Amplifier, Common-Gate Amplifier, Source Follower, Cascode, Two stage CS Amplifiers, MOS Differential amplifier, Miller's Theorem, Frequency Response of CS, CG, CD, Cascode and differential amplifier Stage, Negative Feedback Amplifiers, Feedback Topologies, Power amplifiers, Push-Pull Stage, LC Oscillators, Hartley's and Colpitt's Oscillator, RC Phase Shift Oscillator, Ring Oscillator.

References:

1. Behzad Razavi, Fundamentals of Microelectronics, Wiley, (2e), 2013.
2. A. S. Sedra, K. C. Smith, Microelectronic circuits, Oxford University Press, (6e), 2011.
3. R. L. Boylestad, L. Nashelsky, Electronic Devices and Circuit Theory, PHI, (11e), 2014.

ICE 2126: DIGITAL LOGIC DESIGN [3 0 0 3]

Performance metrics of logic families, Binary codes, Boolean Algebra, Karnaugh map, Quine-McCluskey method, Arithmetic circuits, Code convertors, Multiplexers, De-multiplexers, Encoders, Decoders, Comparators, Parity generators and checker. Latches, flip-flops, Synchronous and Asynchronous circuits - Counters, Shift registers, Cycles, Races and Hazards, Finite State Machines, ASM Chart, Timing issues.

References:

1. Donald D. Givone, Digital Principles and Design, MGH,(1e), 2002.
2. M. Morris Mano, Digital Design,PHI, (5e), 2002.
3. C. H. Roth, Fundamentals of Logic Design, Thomson, (6e), 2000.
4. A. Anand Kumar, Switching Theory and Logic Design, PHI, (2e), 2014.

ICE 2127: COMPUTER ARCHITECTURE AND ORGANIZATION [3 0 0 3]

Number Representation and Arithmetic Operations, Character Representation, Memory locations and addresses, Memory operations, Addressing modes, CISC and RISC. Hardware for addition and subtraction, Multiplication, Hardware implementation, Booth's algorithm, Division, Floating point representation, IEEE standard floating-point representation. Bus organization, comparison of hardwired and micro-programmed approach, hardwired control design, Booths multiplier design, Micro-programmed multiplier control unit. Internal organization of memory chips, Structure of Larger Memories, Cache mapping functions, Replacement algorithms, and Virtual memories. Accessing I/O devices, Interrupts, Enabling and disabling Interrupts, DMA. Pipeline Organization, Data dependencies, Handling data dependencies, Hardware multithreading, SIMD Processing, Graphics processing units, Shared memory multiprocessors, Interconnection Networks, Cache Coherence, Write-Through Protocol, Write-Back protocol, Directory-Based Cache Coherence.

References:

1. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Computer Organization and Embedded Systems, (6e), McGraw Hill Publication, 2012.
2. William Stallings, Computer Organization and Architecture – Designing for Performance, (9e), PHI, 2015.
3. Mohammed Rafiquzzaman and Rajan Chandra, Modern Computer Architecture, Galgotia Publications Pvt. Ltd., 2010.

ICE 2128: DATA STRUCTURES AND ALGORITHM [3 1 0 4]

Structure of C++ Program: Data Types. Basic, user-defined and derived, operators: assignment, arithmetic, relational, logical, increment/decrement, conditional, precedence of operators, manipulators, decision statements, programming control statements, Functions. Main Function, Function Prototyping, Call and return by reference, Inline functions, Default and constant arguments, Pointers, Classes, Inheritance, Linked ListData structure, Linked list traversal, insert function, remove function, Linked list with tail and doubly linked lists, Recursion, Trees, Stacks, Queues, Sorting and searching algorithms: Sorting, Searching, hashing, Radix sort.

References:

1. Nell Dale, “C++ Plus Data Structures”, Jones and Bartlett Publishers, (4e), 2010.
2. Maria Litvin, Gary Litvin, Programming with C++ and Data Structures, Vikas Publishing House Pvt. Ltd., 2001.
3. E Balagurusamy, “Object-oriented Programming with C++”, TMH, (2e), 2001.

ICE 2129: SENSOR TECHNOLOGY [3 0 0 3]

Basic sensor technology, characteristics, Capacitive and Inductive Sensors, Displacement Sensors, Temperature Sensors, Force/Torque Sensors, Humidity and Moisture Sensors, Acoustic Sensors, Flow Sensors, Occupancy-Motion Detectors, Acceleration and Vibration Sensors, Chemical and Biosensors, Optical and radiations Sensors, Introduction to Wireless Sensor Networks (WSN) and Applications.

References:

1. Jon S Wilson, Sensor Technology Handbook, Newnes Elsevier Publication, 2005.
2. Jacob Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, Springer, 2004.

ICE 2142: SENSORS AND CIRCUITS LAB [0 0 3 1]

Characteristics of sensors and transducers, measurements of temperature, pressure, flow, torque, force, displacement and intensity of light.

Reference:

1. E.O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.

ICE 2144: DATA STRUCTURES LAB [0 0 3 1]

Linked list implementation, Implementation of Binary Trees, Implementation of Binary search trees, Application of Stacks, Implementation of Queues, Breadth first search, depth first search, Application of graphs, Bubble sort, insertion sort, Hashing

References:

1. Nell Dale, “C++ Plus Data Structures”, Jones and Bartlett Publishers, (4e), 2010.
2. Maria Litvin, Gary Litvin, Programming with C++ and Data Structures, Vikas Publishing House Pvt. Ltd., 2001.
3. E Balagurusamy, “Object-oriented Programming with C++”, TMH, (2e), 2001.

FOURTH SEMESTER

MAT 2228: ENGINEERING MATHEMATICS – IV [2 1 0 3]

Probability and Distributions: Construction of a Probability Space, Discrete and Continuous Probabilities, Sum Rule, Product Rule, and Bayes' Theorem, Summary Statistics and Independence, Distributions: Binomial, Poisson, uniform, normal, Chi-square and exponential distributions. Multivariate Random variables and Stochastic Process: Two and higher dimensional random variables, covariance, correlation coefficient. Moment generating function, functions of one dimensional and two dimensional random variables. Static probabilities: review and prerequisites generating functions, difference equations. Dynamic probability: definition and description with examples. Markov chains, transition probabilities. Vector Calculus: Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Backpropagation and Automatic Differentiation, Higher-Order Derivatives, Linearization and Multivariate Taylor Series. Optimization: Basic solution, Convex sets and function, Simplex Method, Optimization Using Gradient Descent, Constrained Optimization and Lagrange Multipliers.

References:

1. Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong, Mathematics for Machine Learning, Cambridge University Press, 2020.
2. P L Meyer, Introductory Probability and Statistical Applications, Addison Wiley, 2 Ed, 2017.
3. Medhi. J. Stochastic Processes, New Age International 1994.
4. Murray R. Spiegel, Vector Analysis Theory and Problems, Schaum's Outline Series, 2019.
5. Hamdy A. Taha, “Operations Research: An Introduction”, 8thEdn., Pearson Education (2008).
6. Sheldon M. Ross, Introduction to Probability Models Eleventh Edition Elsevier, 2007.
7. E. S. Page, L. B. Wilson, An Introduction to Computational Combinatorics, Cambridge University Press.
8. Bhat U R, Elements of Applied Stochastic Processes, John Wiley.

ICE 2222: MICROCONTROLLER [3 1 0 4]

Processor architecture, Architecture of 8051, 8051 Addressing Modes, 8051 Instruction Set, Programming 8051 using Assembly Language and C, 8051 Timer, Serial Port and Interrupt Programming using Assembly Language and C. Introduction to ARM, ARM Architecture, Introduction to LPC2148, Architecture of LPC2148 and Programming, Interfacing of I/O ports, ADC, DAC, LCD, Keyboard, Stepper motor, DC motor using 8051 and LPC2148.

References:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay,The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education,(2e), 2007.
2. Kenneth J. Ayala, The 8051 Microcontroller, Cengage Learning,(3e), 2004.
3. Steve Furber, ARM System-on-Chip Architecture, Addison Wesley,(2e), 2000.
4. LPC21XX User Manual, 2007.

ICE 2226: DIGITAL TRANSMISSION SYSTEMS [3 0 0 3]

Introduction to Digital Transmission, Signals and systems, Baseband Pulse Transmission, Carrier Transmission, Synchronization, Communication channels, baseband digital transmission, passband digital transmission, wideband transmission techniques, error-correcting codes, advanced topics.

References:

1. Anderson, John B. Digital transmission engineering. Vol. 12. John Wiley & Sons, 2006.
2. Guimaraes, Dayan Adionel. Digital transmission: a simulation-aided introduction with VisSim/Comm. Springer Science & Business Media, 2010.

ICE 2227: INTRODUCTION TO CYBER PHYSICAL SYSTEM [3 0 0 3]

Principles behind CPS, Concept of Synchronization in Complex Systems, Known Networks II, Graph Theory and CPS Communication Structure, Graph Theory, Eigen structure of Graph Laplacian Matrix, Single Integrator Dynamics and Average Consensus, Leader and Leaderless Cases, Motion Invariants for First-Order Consensus, Comparison of Discrete and Continuous Time Systems, Double Integrator Dynamics, Bipartite Consensus, Time Varying Graphs, Matrix Analysis of Graphs, Control Loops and Importance of Control and Actuation in CPS, Control and Estimation over Lossy and Attacked Networks, Timed Model and Real-Time Scheduling, Hybrid systems, Secure Deployment of CPS.

References:

1. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.
2. E. A. Lee, Sanjit Seshia, Introduction to Embedded Systems – A Cyber–Physical Systems Approach, MIT Press, (2e), 2017.
3. Andre Platzer, Logical Foundations of Cyber-Physical Systems,(2e), Springer Publishing, 2018.

ICE 2228: INTRODUCTION TO CONTROL THEORY [2 1 0 3]

Mathematical modeling, transfer functions, Block diagram representation and reduction, signal flow graph, Masons gain formula, time domain specifications. Stability, Steady state errors, Routh-Hurwitz criterion, Root-Locus plots, frequency domain specifications. Correlation between frequency domain and time domain specifications, Bode diagrams, Polar plots, Nyquist stability criterion, Concepts of Lag, Lead and Lag-Lead compensator in reshaping Root Locus and Bode plot (Qualitative analysis). State Space Analysis, Phase variable and canonical form representation, Derivation of state models, state transition matrix, solution of state equations. (Note: Theoretical concepts be demonstrated in class. Additional examples be solved using MATLAB on every topic during tutorials.)

References:

1. Norman S. Nise, Control Systems Engineering, Wiley India, (5e), 2009.
2. K. Ogata, Modern control engineering, PHI,(5e), 2011.
3. R.C Dorf and R.H Bishop, Modern Control Systems, Pearson, (11e),2013.

ICE 2225: COMMUNICATION SYSTEMS [3 0 0 3]

Elements of communication systems; Analog Communication techniques: Amplitude modulation Schemes, Angle (Non-Linear) Modulation; Pulse Modulation schemes ; Data transmission using analog carriers- Shift Keying techniques ; Channel Encoding & decoding technologies; Conceptual idea of encryption & decryption; Communication Protocols & Networking; Internet of Things; Wireless sensor actuator networks, Applications: Spread Spectrum & Mobile Communications - Optical fiber communication- Digital telephony , Basic principles of Digital TV Broadcasting.

References:

1. Haykin, Simon, and Michael Moher, Introduction to analog& digital communications, John Wiley & Sons. 2007.
2. Haykin, Simon, Communication systems, John Wiley & Sons, (4e), 2008.
3. Stallings, William, Cryptography and network security: principles and practices, Pearson Education India, (4e), 2006.

ICE 2242: MICROCONTROLLER LAB [0 0 3 1]

8051 Programming - Timer, Serial Port and Interrupt Programming, ARM programming, Peripherals Interfacing to 8051 and LPC2148.

References:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education, (2e), 2007.
2. Kenneth J. Ayala, The 8051 Microcontroller, Cengage Learning (3e), 2004.
3. Steve Furber, ARM System-on-Chip Architecture, Addison Wesley, (2e), 2000.
4. LPC21XX User Manual, 2007.

ICE 2243: COMMUNICATION SYSTEMS LAB [0 0 3 1]

Error detection and correction mechanisms, Flow control mechanisms, IP addressing Classless addressing, Observing Packets across the network and Performance Analysis of Routing protocols Socket programming (TCP and UDP) Multi client chatting, Simulation of unicast routing protocols Simulation of Transport layer Protocols and analysis of congestion control techniques in network Develop a DNS client server to resolve the given host name or IP address

References:

1. Computer Networks: A Systems Approach, Larry Peterson and Bruce Davie, (5e), The Morgan Kaufmann Series, Elsevier, 2011.
2. Computer Networking: A Top-Down Approach Featuring the Internet, J.F. Kurose and K. W. Ross, (6e), Pearson Education, 2012.

FIFTH SEMESTER

HUM 3022: ESSENTIALS OF MANAGEMENT [3 0 0 3]

Definition of management and systems approach, Nature & scope. The Functions of managers, Principles of Management. Planning: Types of plans, steps in planning, Process of MBO, how to set objectives, strategies, policies and planning premises, Strategic planning process and tools. Nature and purpose of organizing, Span of management, factors determining the span, Basic departmentation, Line and staff concepts, Functional authority, Art of delegation, Decentralization of authority. HR theories of planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership – leadership behavior & styles, Managerial grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit and Loss control, Control through ROI, Direct, Preventive control. PROFESSIONAL ETHICS - Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories about right action, Self-interest, Customs and Religion, Uses of Ethical Theories. GLOBAL ISSUES - Managerial practices in Japan and USA & application of Theory Z. The nature and purpose of international business & multinational corporations, unified global theory of management, Entrepreneurship and writing business plans. Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisers, Moral Leadership, Code of Conduct, Corporate Social Responsibility.

References:

1. Harold Koontz & Heinz Weihrich, "Essentials of Management", McGraw Hill, New Delhi. (2020)
2. Peter Drucker, "The practice of management", Harper and Row, New York. (2004)
3. Vasant Desai, "Dynamics of entrepreneurial development & management", Himalaya Publishing House. (2007)
4. Poornima M Charantimath (2006), "Entrepreneurship Development", Pearson Education.
5. Mike W. Martin & Ronald Schinzinger, "Ethics in engineering", Tata McGraw Hill, New Delhi. (2003)
6. Govindarajan M, Natarajan S, & Senthil Kumar V S, "Engineering Ethics", Prentice Hall of India, New Delhi. (2004)
7. R. S. Nagarazan., "A text book on professional ethics and human values", New age international publishers, New Delhi. (2004)

ICE 3126: CYBER PHYSICAL SYSTEM DESIGN [3 1 0 4]

Introduction, Understanding and complexity, information vs data, modelling, Multi-level hierarchies, Communication systems, interface and design, Wireless sensor networks: basics and fundamentals, Cyber-physical systems: basics and fundamentals, Integrating wireless sensor networks and cyber-physical systems: challenges and opportunities, Mobile sensors in wireless sensor network cyber-physical systems, Medical cyber-physical systems.

References:

1. Kopetz, H., and Simplicity Is Complex, Foundations of Cyber-physical System Design, 2019.
2. Zeadally, Sherali, and Nafaa Jabeur, Cyber-physical system design with sensor networking technologies. Institution of Engineering and Technology, 2016.

ICE 3127: DATA COMMUNICATION AND NETWORKS [3 1 0 4]

Communications Model, Circuit and Packet switching. Switched Communications Networks. Data Link Layer. Error Detection and Correction. Network Layer IPV4 Address Space. Routing Protocols. Transport Layer. TCP and UDP, Application Layer, Case Study, Recent Trends in Network Security.

References:

1. Computer Networks: A Systems Approach, Larry Peterson and Bruce Davie, (5e), The Morgan Kaufmann Series, Elsevier, 2011.
2. Computer Networking: A Top-Down Approach Featuring the Internet, J.F. Kurose and K.W.Ross, (6e), Pearson Education, 2012.

ICE 3128: EMBEDDED SYSTEMS DESIGN AND PROGRAMMING [3 0 0 3]

Typical embedded system: Core of the embedded system, memory, sensors & actuators, communication interface, Serial/Parallel Communication protocols, Hardware and software co-design: Data-path and controller design, Architecture design; Development Environment: OS and non-OS based firmware embedding techniques; Firmware Design and Development; operating system basics; Embedded development life cycle, Programming concepts, and embedded programming, Real-Time Operating systems and Task Scheduling algorithms, Hardware Software Co-simulation: Co-simulation approaches, Embedded System Development Life Cycle (EDLC).

References:

1. Vahid F and Givargis T, Embedded System Design, Wiley Publication, 2002.
2. Shibu K. V, Introduction to Embedded Systems, McGraw Hill Publication, 2013.
3. Frank Vahid and Tony Givargis, "Embedded system Design – A Unified Hardware/Software Introduction", Wiley India Pvt. Ltd, 2014.

FLEXIBLE CORE A1 ICE 3129: INDUSTRY 4.0 [3 0 0 3]

Introduction to Virtual Reality-Key elements of virtual reality experience, Virtual Reality, Bird's-Eye View, VR systems-Architecture of VR systems, VR input and output hardware, Stereoscopic Vision & Haptic rendering-Fundamentals of the human visual system, Depth cues, Stereopsis, Retinal disparity, Haptic sense, Haptic devices, Augmented Reality-AR systems and functionality, Augmented reality methods, Game development using UNITY-Introduction to unity 3D, Introduction to Monobehaviors, overview of Physics in Unity, colliders, animation, Introduction to Scripting: Accessing Components, Debugging, Lists, Loops, Applications of AR/VR in Digital Entertainment

References:

1. Jan, Bartodziej Christoph, The Concept Industry 4.0: An Empirical Analysis of Technologies and Applications in Production Logistics, 2016.
2. Gilchrist, Alasdair. Industry 4.0: the industrial internet of things. Apress, 2016.
3. Gunal, Murat M, Simulation for Industry 4.0 Past, Present, and Future, Springer 2019.

FLEXIBLE CORE B1

ICE 3130: INTRODUCTION TO AUGMENTED AND VIRTUAL REALITY [3 0 0 3]

Introduction, Signal conditioning, Separate versus integrated signal conditioning, Digital conversion, MCU control, MCUs for sensor interface, Techniques and Systems Considerations for MCUs, DSP control, Sensor integration, IEEE standards, Plug and play, Automated/ Remote sensing, Process control over the Internet, Other communication standards with case studies, Wireless zone sensing, Surface acoustical wave devices, Intelligent transportation system, RFID, RF MEMS basics, Varactors, Micro optics, Micro grippers, Microprobes, Micro mirrors, FEDs, Data processing, Pattern recognition and classification, Centralized and decentralized system of the measurement chains.

References:

1. Coiffet, P., Burdea, G. C., (2003), “Virtual Reality Technology,” Wiley-IEEE Press, ISBN: 9780471360896
2. Schmalstieg, D., Höllerer, T., (2016), “Augmented Reality: Principles & Practice,” Pearson, ISBN: 9789332578494
3. Jerald,J., (2015), The VR Book: Human-Centered Design for Virtual Reality, Morgan & Claypool.
4. Mather,G., (2009), Foundations of Sensation and Perception, 2nd Edition, Psychology Press
5. Bowman,D.A., Kruijff,E., LaViola,J.J. and Poupyrev,I., (2014), 3D User Interfaces: Theory and Practice, 2nd Edition, Addison Wesley Professional.
6. Craig, A. B. (2013). Understanding augmented reality: Concepts and applications, Elsevier Science.

FLEXI CORE C1 - ELE 3127: FOUNDATIONS OF EV & HYBRID VEHICLES [3 0 0 3]

Principles for Electric Vehicles: EV Industry, EV Technology and Automotive Revolution, Electrical Engineering for EV, Battery Technology

Control system for Electric Vehicles: Motor and Controller Systems, EV Numerical Calculations, EV Charging Infrastructure, Practical session - Well-to-wheel analysis of EV architecture

Essentials for Electric Vehicles: Electrical Requirement, Power Distribution Specifications, Electronic Control System, Practical session - EV connection and system analysis

Types of components in Electric Vehicles: EV Standards and Classifications, Selection for Electrical and Electronic Components, Practical session - EV hardware components

Principles for Hybrid Vehicles: Introduction to Hybrid Vehicles, Battery Chemistry, Efficiency, Definition and Parameters for Hybrid Systems, Electric Motors, Generators and Power Electronics for Hybrid Systems, Control Systems, Hybrid Electric Vehicle Operation, Practical session - Numerical study on powertrain sizing of HEV

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", Routledge, 3rd Ed, 2021, ISBN: 9780367693930
3. Muhammad Ehsani, Mehrdad Ehsani, and Ali Emadi, "Electric Vehicle Systems Architecture and Standardization Needs", Reports of the PPP European Green Vehicles Initiatives, Springer, 2015.
4. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 1st Ed, 2014, ISBN: 9781138072855.
5. Rodrigo Garcia-Valle and João A. Peças Lopes, “Electric Vehicle Integration into Modern Power Networks", Springer, 2013, ISBN: 978-1461401339.
6. Chris Mi and M. Abul Masrur, “Hybrid electric Vehicles, Principles and Applications with Practical perspectives”, WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6.
7. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

ICE 3143: CYBER PHYSICAL SYSTEMS DESIGN LAB [0 0 3 1]

Communication systems: interface and design, Wireless sensor networks, Cyber-physical systems, integrating wireless sensor networks and cyber-physical systems, Mobile sensors in wireless sensor network cyber-physical systems, Medical cyber-physical systems.

References:

1. Kopetz, H., and Simplicity Is Complex, Foundations of Cyber-physical System Design, 2019.
2. Zeadally, Sherali, and NafaaJabeur. Cyber-physical system design with sensor networking technologies, Institution of Engineering and Technology, 2016.

ICE 3144: EMBEDDED SYSTEM PROGRAMMING LAB [0 0 3 1]

Programming concepts, and embedded programming, Real-Time Operating systems and Task Scheduling algorithms, Hardware Software Co-simulation: Co-simulation approaches, Embedded System Development Life Cycle (EDLC).

References:

1. Frank Vahid and Tony Givargis, Embedded system Design – A Unified Hardware/Software Introduction, Wiley India Pvt. Ltd, 2014.
2. Shibu K.V, Introduction to Embedded Systems, TMH, New Delhi, 2010.

SIXTH SEMESTER

HUM 3021: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [3 0 0 3]

Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of Single, Uniform, and Gradient cash flow. Related problems and case studies. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, declining and double declining balance method of depreciation, Sum-of-the-Years Digits, Sinking Fund and Service Output Methods, Case Study. Balance sheet and profit & loss statement. Meaning & Contents. Ratio analysis, financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios, Drawbacks. Safety and Risk, Assessment of Risk and safety, Case study, Risk Benefit Analysis and Reducing Risk.

References:

1. Chan S. Park, "Contemporary Engineering Economics", 4th Edition, Pearson Prentice Hall, 2007.
2. Thuesen G. J, “Engineering Economics”, Prentice Hall of India, New Delhi, 2005.
3. Blank Leland T. and Tarquin Anthony J., “Engineering Economy”, McGraw Hill, Delhi, 2002.
4. Prasanna Chandra, “Fundamentals of Financial Management”, Tata McGraw Hill, Delhi, 2006.
5. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.
6. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004

FLEXIBLE CORE A2

ICE 3227: DESIGN OF SAFE SYSTEMS [3 0 0 3]

Composition and Compositionality in CPS, Evolving Security, Cybersecurity for Commercial Advantage, Reasoning about Safety and Security: The Logic of Assurance, From Risk Management to Risk Engineering: Challenges In Future Ict Systems, A Design Methodology for Developing Resilient Cloud Services, Cloud and Mobile Cloud Architecture, Security And Safety, Smart Grid Safety And Security, The Algebra Of Systems And System Interactions With An Application To Smart Grid.

References:

1. Griffor, Edward, ed. Handbook of system safety and security: cyber risk and risk management, cyber security, threat analysis, functional safety, software systems, and cyber physical systems. Syngress, 2016.
2. Gullo, Louis J., and Jack Dixon. Design for safety. John Wiley & Sons, 2017.

FLEXIBLE CORE B2

ICE 3226: UNSUPERVISED INTELLIGENCE IN CPS [3 0 0 3]

Overview of Reinforcement Learning, Comparison of Different Reinforcement Learning Methods, Reinforcement Learning Problems, and Model Based Reinforcement Learning Introduction, Dynamic Programming Principles & Applications, Deep Reinforcement Learning Introduction, Reinforcement Learning for Cyber Security. CASE STUDY, Unsupervised Learning Using Scikit-Learn, Dimensionality Reduction.

References:

1. Chong Li, Meikang Qiu, Reinforcement Learning for Cyber-Physical Systems and Cybersecurity Case Studies, 1st Edition, CRC Press.(2019)
2. Ankur A. Patel, Hands-On Unsupervised Learning Using Python, 1st Edition, O'Reilly Media, Inc., March 2019.

FLEXI CORE C2

ELE 3225: AUTOMOTIVE MECHANICS FOR ELECTRIC VEHICLES [3 0 0 3]

Automotive Engineering & Vehicle Dynamics: Vehicle Dynamics Fundamentals, Tire Mechanics and Dynamics, Suspension Systems, Braking Systems, Aerodynamics, Powertrain Systems, Vehicle Stability Control, Vehicle Safety, Vehicle Dynamics Simulation, Electric and Hybrid Vehicle Dynamics, Practical session - EV Dynamics & calculations.

Sketching for Automotive EV Design [Software-based]: Introduction to Automotive Sketching Software, Overview of Vehicle Design Process and Automotive Sketching, Basic Sketching Techniques and Tools in the Software, Sketching Car Exteriors, Interiors and Details, Creating Different Views and Angles of the Vehicle, Rendering and Presenting the Final Sketches, Understanding Proportions, Perspectives and Shapes in Automotive Sketching, Creating Sketches for Different Vehicle Types (Sedans, SUVs, and Trucks), Tips and Tricks for Automotive Sketching in the Software.

Advanced EV Modelling Using SolidWorks Tool [Software-based]: Introduction to EV Technology and Its Benefits, Basic Vehicle Design Principles, Design and Modelling of Chassis and Frame, Suspension Systems, Design and Modelling of Braking and Steering Systems, Design and Modelling of Electrical Components for EVs, Battery Pack Design and Modelling for 2, 3 and 4 Wheelers, Motor and Drivetrain Design and Modelling for 2, 3 and 4 Wheelers, Design and Modelling of Wheels and Tires for 2, 3 and 4 Wheelers, Testing and Simulation of Vehicle Performance Using Solid Works, Design for Manufacturability and Assembly Considerations, Sustainability and Environmental Impact Considerations in EV Design, Practical session - EV hardware components walkthrough.

Multibody Dynamics with MSC Adams [Software-based]: Introduction to MSC Adams Software and Its Capabilities, Setting Up the Modelling Environment in MSC Adams, Multi-body Dynamics Principles and Application to Vehicle Systems Modelling, Vehicle Suspension Systems Modelling, Vehicle Steering Systems Modelling, Vehicle Braking Systems Modelling, Practical session - EV Component design & modeling.

EV Analysis with MSC Adams (Software-based): Tire Force and Characteristics Modelling, Vehicle Dynamics Analysis Including Simulating Ride and Handling, Vehicle Stability and Rollover Events, Optimisation Techniques for Vehicle Designs Using MSC Adams, Integration of MSC Adams Models with Other Software Tools for System-level Simulations and Analysis, Practical session - EV body design analysis.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Du, H., Cao, D., & Zhang, H. (n.d.). “Modelling, Dynamics, and Control of Electrified Vehicles”, Woodhead Publishing, 2017, ISBN-13: 9780128127865
3. Zaman N., “Automotive Electronics Design Fundamentals”, Springer,

2015, ISBN-13: 9783319359793
4. Gianfranco Pistoia, “Electric & Hybrid Vehicles”, Elsevier, 1st ed, 2010, ISBN: 9780444638250.
5. Chau, K. T., “Electric Vehicle Machines and Drives: Design, Analysis and Application”, John Wiley and Sons, Inc., 2015, ISBN-13: 9781118752524.
6. Ehsani, Mehrdad, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles”, CRC, 2019, ISBN-13: 9780367137465.
7. Hughes, Austin, “Electric Motors and Drives”, Newnes (an Imprint of Butterworth-Heinemann Ltd), 2019, ISBN-13: 9780081026151
8. Chris Ni and M. Abul Masrur, “Hybrid electric Vehicles, Principles and Applications”, WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6
9. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

FLEXIBLE CORE A3

ICE 3225: INDUSTRIAL AUTOMATION [3 0 0 3]

Evolution of PLC, PLC Vs PC, Architecture of PLC - I/O Modules, CPU, Program Memory, Process Image Tables, Bus System and Power Supply, Sequential Flow Chart technique for programming style, Programming a PLC, Timers & Counters, Special Instructions, Levels of Industrial control, Networking, Buts Networks, Protocols., SCADA & DCS, Profibus, Modbus, SMART devices.

References:

1. John W.Webb and Ronald A.Reis, Programmable Logic Controllers – Principles and Applications, (5e), PHI, 2003.
2. W. Bolton, Programmable Logic Controllers, 94e), Newnes Publications, 2006.
3. Frank D. Petruzella, Programmable Logic Controllers, MGH, 1989.

FLEXIBLE CORE B3

ICE 3228: CPS INTERFACE [3 0 0 3]

Basic Concepts on Systems of Systems, Interfaces in Evolving Cyber-Physical Systems-of-Systems, Emergence in Cyber-Physical Systems-of-Systems (CPSoSs), AMADEOS SysML Profile for SoS Conceptual Modeling, AMADEOS Framework and Supporting Tools, Time and Resilient Master Clocks in Cyber-Physical Systems, Managing Dynamicity in SoS.

References:

1. Andrea Bondavalli, Sara Bouchenak and Hermann Kopetz. Cyber-Physical Systems of Systems, Foundations – A Conceptual Model and Some Derivations: The AMADEOS Legacy, Springer, 2016.
2. Vikram Bali, Vishal Batnagar, Cyber-Physical, IoT, and Autonomous Systems in Industry 4.0, CRC Press, 2021

ICE 3244: CPS INTERFACE LAB [0 0 3 1]

CPS Model of an Analog to Digital Converter, Digital to Analog Converter, Implementation Finite state Machine, implantation of Digital Communication Network, Cyber-Physical System Model for Estimation Over a Network, CPS implantation on process loops.

References:

1. Andrea Bondavalli, Sara Bouchenak and Hermann Kopetz. Cyber-Physical Systems of Systems, Foundations – A Conceptual Model and Some Derivations: The AMADEOS Legacy, Springer, 2016.
2. Vikram Bali, Vishal Batnagar, Cyber-Physical, IoT, and Autonomous Systems in Industry 4.0, CRC Press, 2021

ICE 3245: NETWORKING LAB [0 0 3 1]

Networking commands, Socket Program for Echo/Ping/Talk commands, File transfer, Remote Command Execution, Create a socket (UDP), Simulation of ARP, Web page downloading, TCP Module Implementation, Implementation of RMI, Implementation of Client in C Server in Java, Case study of routing algorithms.

References:

1. Computer Networks: A Systems Approach, Larry Peterson and Bruce Davie, (5e), The Morgan Kaufmann Series, Elsevier, 2011.
2. Computer Networking: A Top-Down Approach Featuring the Internet, J.F. Kurose and K.W.Ross, (6), Pearson Education, 2012.

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTTH SEMESTER

ICE 4291: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester to the end of seventh semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

ICE 4292: PROJECT WORK

The project work may be carried out in the institution/industry/research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out before the department committee as part of project evaluation.

MINOR SPECIALIZATION

MINOR: I CONTROL SYSTEMS

ICE 4401: MODERN CONTROL THEORY [3 0 0 3]

State Space Analysis, Phase variable and canonical form representation, Derivation of state models, Stability analysis, Eigen values, Eigen vectors, Solution of state equations, Cayley Hamilton theorem, Controllability and observability, Pole placement, Observer design, Non Linear Systems, Phase plane analysis, Construction of the phase trajectory, Describing function, Lyapunov's stability analysis, Sylvester's criterion, Lyapunov theorems of stability, Lyapunov function for continuous time state equations.

References:

1. K. Ogata, Modern Control Engineering, Prentice Hall India, (5e), 2011.

2. Nagrath and Gopal, Control System Engineering, New age international Limited, (2e), 1984.
3. M Gopal, Control Systems Engineering: Principles and Design, McGraw Hill, (4e), 2012.
4. Thomas Kailath, Linear Systems, Prentice-Hall, 1980

ICE 4402: NONLINEAR CONTROL THEORY [3 0 0 3]

Lyapunov stability using Krasovskii's method, Variable Gradient method, L2 stability of state models, L2 gain, small gain theorem, Passivity, Memory less functions, L2 gain and Lyapunov stability, passivity theorems, passivity based control, Review of describing function method, Absolute Stability Circle criterions, Popov Criterion, stabilization via linearization and Integral control, Gain scheduling, Graphical Linearization Methods, Analytical Linearization Method, Evaluation of Linearization Coefficients by Least-Squares Method, Local linearization, Feedback linearization, Input-state linearization, Input-output linearization, Internal dynamics, Zero dynamics, Model Reference Adaptive Control (MRAC).Slidingmode Control, sliding surfaces, continuous approximations of switching control laws, modeling performance trade off, tracking regulation via Integral control, Lyapunov redesign, non-linear damping, back stepping, and high gain observers. Back stepping algorithm.

References:

1. H.K. Khalil, Nonlinear Systems, (3e), PHI, 2002.
2. R. Marino and P. Tomei Nonlinear Control Design - Geometric, Adaptive and Robust, Prentice Hall, 1995.
3. J.J.E. Slotine and W.Li, Applied Nonlinear control, Prentice Hall, 1998.
4. Alberto Isidori, Non-linear Control Systems, Springer Verlag, 1999.
5. Zoran Vukic, LjubomirKuljaca, Nonlinear Control Systems, Marcel Dekker Inc., 2003.

ICE 4403: DIGITAL CONTROL SYSTEMS [3 0 0 3]

Sampling, Data acquisition, Quantization, sample and hold, zero order hold, frequency domain consideration in sampling and reconstruction, Difference equations, pulse transfer function, Block diagram analysis of sample data systems, time response of discrete time control systems, Steady State error analysis, Stability, Jury's stability test, bilinear transformation, Root locus technique, W transformation, Bode Plot. Nyquist Stability analysis, Design of Lag, Lead, Lag-lead compensator using root locus and Bode plot, Design of PID controller, Lyapunov Stability Analysis, State Space Analysis, Diagonalization, Solution of state equations, Controllability, Observability, Representation of the system in different canonical forms, Pole Placement- Ackermann's Formula, Dead beat Algorithm.

References:

1. K. Ogata, Discrete time control systems, PHI, (7e), 2011.
2. M. Gopal, Digital control and state variable methods, TMH, 2001.
3. C.H Houpis and G.B Lamont, Digital Control Systems – Theory and Hardware, MGH, 1992.
4. G.F.Franklin, J.David Powell, M. L.Workman, Digital Control of Dynamic Systems, A-Wesley Publishing Company, (2e), 1990.
5. V. I. George and C.P. Kurian, Digital Control Systems, Cengage publishers, 2012.

ICE 4404: SYSTEM IDENTIFICATION [3 0 0 3]

Introduction to system modeling, Types of system models, Importance of system models, Model development techniques – first principle based and data driven based, Introduction to System Identification, Procedure for identification, Concept of Identifiability, Signal to Noise Ratio, Overfitting, LTI System Modeling using time and frequency, Direct impulse response identification, Direct step response identification, Impulse response Identification using step response, Empirical Transfer function Identification, Correlation Methods, Linear Regression, Least Square Estimation, Equation Error Models – ARX Models, ARMAX Models, ARIMAX Models, OE Models, Box Jenkins Model, Model Validation Techniques.

References:

1. L. Ljung, System Identification: Theory for the User, Prentice Hall, 1992.
2. Arun. K. Tangirala, Principles of System Identification Theory and Practice, CRC Press, 2016.
3. Karel. J. Keesman, System Identification – An Introduction, Springer, 2011.
4. Philip D. Cha, Fundamentals of Modeling and Analyzing Engineering Systems, Cambridge, 2000.

MINOR: II SENSOR TECHNOLOGY

ICE 4405: SENSOR DESIGN [3 0 0 3]

Review of basic performance characteristics of sensors, Fractional order elements and electrochemical sensor design, Design and development of a dedicated sensor system: Requirement analysis; Definition of technical and functional requirements; Cost analysis; Development of a measurement system prototype using necessary tools, Practical realization of a sensor system; Planning and documenting. Factors Influencing Sensor-based System Design. Limited field trials and sensor calibrations. Case studies of novel sensor design. Multi-spectral sensor Concept of Operation (CONOPS) development, sensor requirements allocation and derived requirement development, Sensor Architecture development, hardware and software partitioning, functional and physical interface requirements and design, signal processing requirement definition, subcomponent performance modeling and testing, observable measurement definition, Key sensor design trade parameters, Multi-spectral sensor systems design methodology, Modern target tracking techniques. Design of sensor packaging, installation and wiring considerations based on hazard classifications. Safety considerations in sensor design and commissioning.

Reference:

1. Jacob Fraden - Handbook of Modern Sensors, Physics, Designs, and Applications, Springer, 2010.
2. T. Grandke, W. H. Ko, Sensors: Fundamentals, Volume 1, Wiley publisher, 1990.

ICE 4406: BIOSENSORS AND BioMEMS [3 0 0 3]

Bio-recognition elements: Whole cells, Enzymes, Antibodies, Nucleic Acids, Aptamers and Molecularly Imprinted Polymers. Nanostructured substrates for biosensing and integration of the bio-recognition elements on the substrates. Transduction Platforms: Electrochemical, Optical, Mass, Thermal, Hybrid and Lateral Flow Assays. Fundamentals of microfabrication, Lab on chip for biosensing applications and case studies.

References:

1. Mohamed Gad-el-Hak ®, MEMS handbook, CRC Press, 2002.
2. Anthony P.F.Turner, Isao Karube and George S. Wilson, Biosensors: fundamentals and applications, Oxford University Press, 1987.
3. A Sadana, Engineering biosensors: kinetics and design applications, Academic Press, 2002.
4. D Voet & JG Voet, Biochemistry, J Wiley & Sons, 1990.

ICE 4407: MULTI SENSOR DATA FUSION [3 0 0 3]

Concept of fusion, Role of fusion, comparison between sensor and data fusion, fusion types, I/O types, Sensor configuration, Architecture of fusion nodes, fusion topologies, Benefits of fusion. Fusion Architectures - Centralized Fusion, Distributed Fusion, Hybrid Fusion, Introduction to process of data fusion: Need for data refinement, Spatial alignment, Temporal alignment, Semantic and radiometric alignment, Concept and need for data association and decision making, data registration, data association techniques, Decision making techniques - Biological and puzzle solving types, Command and control, Evidence combination, Information requirement for decision making. Bayesian and Dempster–Shafer Fusion Methods - Bayesian Method, Bayesian Method for Fusion of Data from Two Sensors, Dempster–Shafer Method, Comparison of the Bayesian Inference Method and the Dempster–Shafer Method. JDL framework, Revised JDL, Dasarathy's model, Boyd model, Thompolus framework, Luo-Key framework, Pau's framework, Waterfall and omnibus framework, Distributed black box, Esteban framework. Introduction to data filters, Kalman filter, Baysien filter, extended information filter, estimation, Approximate agreement, Optimization filter, Distributed dynamic fusion, Dynamic data flow analysis

References:

1. David L. Hall, Mathematical Techniques in Multisensor Data Fusion, Artech House, 2004.
2. H B Mitchell, Data Fusion: Concepts and Ideas, Springer Publishers, 2012.
3. Multi Sensor Data Fusion with MATLAB, Jitendra R. Raol, CRC Press, 2009.
4. Sensor and Data Fusion, Lawrence A. Klein, (2e), SPIE Press, 2012.

ICE 4408: AUTOMOTIVE SENSORS [3 0 0 3]

Automotive Management systems, Application areas of electronics in the automobiles, Possibilities and challenges in the automotive industry, Power train sensors, sensors for chassis management, Sensors for vehicle body management, Sensors for automotive vehicle convenience and security systems, Two wheeler and Four wheeler security systems, parking guide systems, anti-lock braking system, future safety technologies, Vehicle diagnostics and health monitoring, Safety and Reliability, Traction Control, Vehicle dynamics control, Air Bag and Seat Belt Pre tensioner Systems, Principal Sensor Functions, Passenger Convenience Systems, Electromechanical Seat, Seat Belt Height, Steering Wheel, and Mirror Adjustments, Central Locking Systems, Electromechanical Window Drives. Enabling Connectivity by Networking:-In vehicle communication standards (CAN & LIN), Telematic solutions, Portable or embedded connectivity- Endorsing Dependability in Drive-bywire systems - Terminology and concepts, Why by-wire, FLEXRAY, Requirements on cost and dependability, Drive-by-wire case studies- prototype development-future of In vehicle communication.

References:

1. Automotive Electrics, Automotive Electronics: Systems & Components, (5e),BOSCH, 2014.
2. Automotive Sensors Handbook, (8e), BOSCH, 2011.
3. Jiri Marek, Hans-Peter Trah, Yasutoshi Suzuki, IwaoYokomori, Sensors for Automotive Technology, (4e), Wiley, New York, 2010.
4. John Turner, Automotive Sensors (1e), Momentum Press, New York, 2010.

MINOR: III SYSTEMS ENGINEERING

ICE 4409: INTRODUCTION TO SYSTEMS ENGINEERING [3 0 0 3]

Definitions and concepts of system-system science and systems engineering, life cycle stages, definitions of requirement, architecture, design. System analysis, interface management, system integration, system verification, system transition, system validation, system operation, system maintenance, system disposal. Project planning, project management and control, decision management, risk management, configuration management, quality assurance, acquisition/supply, tailoring processes and application. Introduction to system modeling and simulation, lean and agile systems engineering, specialty areas (interoperability/logistics/safety /reliability/ maintainability/ security/usability)

References:

1. Kossiakof, Alexander and William N. Sweet; Systems Engineering: Principles and Practice, Wiley, 2011.
2. INCOSE Systems Engineering handbook, (4e), Wiley, 2015.
3. System Engineering Book of Knowledge, V 2.6, 2022. www.sebokwiki.org,
4. National Aeronautics and Space Administration, NASA Systems Engineering Handbook, (Rev 1), 2007.
5. Faulconbridge, R. I. and Ryan, M. J, Systems Engineering Practice, Canberra: Argos Press, Revised Edition, 2018.
6. ISO/IEC/IEEE 1528-Systems and Software engineering- System life cycle processes, https://www.iso.org/standard/63711.html
7. Blanchard, Benjamin S., Wolter J Fabrycky Systems Engineering and Analysis, Pearson (5e), 2010.

ICE 4410: SYSTEM ARCHITECTURE AND DESIGN [2 1 0 3]

Architecture definition, architecture view points, concept analysis, models and views of architecture (functional/behavioral/ data/ performance etc.) – Structure and behavior- Evaluating candidate architectures-System/subsystem analysis- tradeoff analysis-

Architecture frameworks and standards-design progression-architecture domains (software/IT/Manufacturing/social etc)-architecture heuristics- acquisition management-tailoring processes-industrial design-design for manufacturability-robustness design-patents and intellectual property.

References:

1. Rechtin, E., and M.W.Maier, The art of Systems Architecting, Boca Raton, FL: CRC Press, 2000.
2. Oliver, D. W., T. P. Kelliher, and J. G. Keegan, Jr., Engineering Complex Systems with Models and Objects, McGraw Hill, 1997.
3. Ulrich K. T and S D Eppinger Product Design and Development, 2ed, NY, McGraw Hill Inc, 2000.
4. ISO/IEC/IEEE 42010:2011-Systems and software engineering-Architecture and description, https://www.iso.org/standard/50508.html.
5. 1220-2005-IEEE standard for application and Management of the systems engineering process, https://standards.ieee.org/ieee/1220/3372/

ICE 4411: SYSML AND MBSE [2 0 2 3]

Introduction to MBSE-MBSE concepts- MBSE Ontology-Introduction to Object Process modelling OPM- Object process language-Overview of SysML-Block definition diagrams-Internal block diagrams-Use case diagrams-Activity diagrams-Sequence diagrams-State machine diagrams-Parametric diagrams-Requirements diagram-package diagrams-Operational analysis modeling-functional analysis modeling-logical architecture modeling-Physical architecture modeling-architecture frameworks-Case studies of MBSE-MBSE deployment-Introduction to Digital Twins.

References:

1. SysML distilled: A brief guide to the Systems modeling language. Lenny Deligatti-Addison Wesley Professional, (1e), 2013.
2. Jon Holt and Simon Perry, SysML for Systems Engineering- A model based approach. IET 2013.
3. Jean-Luc Voirin, Model based System and Architecture Engineering with the Arcadia Method (Implementation of Model Based System Engineering) ISTE Press, Elsevier, 2017.
4. DovDori, Model-Based Systems Engineering with OPM and SysML. Springer, 2016.

ICE 4412: SYSTEM VERIFICATION AND VALIDATION [3 0 0 3]

System verification-System validation-various approaches to system validation and verification-inspection/testing/analysis/demonstration-Generation of Test cases using the Markov Chain model-Writing verification/validation plans-introduction to formal methods-formal approaches to system validation/verification-focus on specialty areas(eg.. EMI/EMC)-test automation models (computation/timed automation)-simulation-model checking verification-verification validation activities prescribed in standards for safety critical systems (DO-178C/DO-254/APR4754)

References:

1. Engel, Avner, Verification, Validation and Testing of Engineered Systems, John Wiley & Sons, 2010.
2. Jean Francois Monin, Understanding Formal Methods, Springer, 2003.
3. Jean-Louis Boulanger (Editor), Industrial use of Formal Methods: Formal Verification, Wiley, 2012.
4. Eds. Alex Gorod, Leonie Hallo Vernon Ireland, IndraGunawan, Evolving Toolbox for Complex Project Management, CRC press, Taylor and Francis Group, Auerbach, 2019.
5. McShea, R. E. Test and Evaluation of Aircraft Avionics and Weapon Systems, (2e), IET, 2010.

MINOR: IV SMART TRANSPORTATION SYSTEM

ICE 4413: Automotive Electronics [3 0 0 3]

Introduction to Electronic systems in Automotives, Sensors and Actuators for body electronics, power train and chassis systems, Power train and chassis control domain, Engine management, Transmission control Battery- types and maintenance, Automotive Electronics, Sensors and Actuators, Basic sensor arrangement, Types of sensors, Electronic Fuel Injection and Ignition Systems, Digital engine control systems, Open loop and closed loop control systems.

References:

1. Bosch, Automotive Electrics and Automotive Electronics. System and components, Networking and Hybrid drive, (5e), Springer view 2014
2. Najamuz Zaman, Automotive Electronics Design Fundamental (1e), Springer 2015.
3. Hillier's, Fundamentals of Motor Vehicle Technology on Chassis and Body Electronics, (5e), Nelson Thrones, 2007.

ICE 4414: IN-VEHICLE NETWORKING [3 0 0 3]

Basics of Data Communication Networks and Automotive Communication Protocols, Need for networks, Types of networks, Need for standards, TCP/IP model, Topologies, Controller Area Network (CAN) Protocol, CAN Higher Layer Protocols and LIN, FlexRay and MOST Protocol, Process of Automotive Fault Diagnostics, Fault Codes, Vehicle Systems (open-loop and closed-loop) On- and Off- Board Diagnostics, OBD-I, OBD-II, Engine Analyzers, Steps taken to diagnose a fault, Diagnostics Protocol-KWP2000, SAE-J1587, SAE-J1708 and Case Study.

References:

1. Gilbert Held. Inter- and Intra-Vehicle Communications, CRC Press, (2007)
2. Behrouz Forouzan. Data Communications and Networking, McGraw-Hill. 2003
3. Ronald k. Jurgen. Automotive Electronics Handbook, McGraw-Hill. 1999

ICE 4415: INTELLIGENT TRANSPORTATION SYSTEMS [3 0 0 3]

Fundamentals of ITS, Definition of ITS, the historical context of ITS from both public policy and market economic perspectives, Types of ITS; Historical Background, Benefits of ITS, Sensor technologies and Data requirements of ITS, ITS User Needs and Services and Functional areas, ITS Architecture, Regional and Project ITS architecture; Concept of operations; ITS Models and Evaluation Methods, ITS applications, Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.

References:

1. Mashrur A. Chowdhury, Adel Wadid Sadek, Fundamentals of intelligent transportation systems planning, ARTECH House, 2013.
2. Lawrence A. Klein, Sensor technologies and Data requirements of ITS, Artech House, 2011.

ICE 4416: ADVANCED DRIVER ASSISTANCE SYSTEMS [3 0 0 3]

Advanced driver assistance system, human factors of automated driving systems, human factor of vehicle automation, legal issue surrounding cyber security and privacy on automated vehicle, user perspective on autonomous driving systems, ADAS technology A r eview on challenges, legal risk mitigation and solutions, localization and mapping for autonomous driving, open pit mine autonomous bot.

References:

1. Chapmann and Hall, Autonomous driving and advanced driver assistance system (ADAS), CRC Press, 2021
2. Dietmar P.F. Möller, Roland E. Haas, Guide to Automotive Connectivity and Cybersecurity: Trends, Technologies, 2017

OTHER PROGRAM ELECTIVES

ICE 4461: BIG DATA ANALYTICS [3 0 0 3]

Introduction to big data-Characteristic features, Big Data Applications, web data, Modern Data Analytic Tools, Hadoop framework, Data analysis- statistical methods, classification, Mining data streams-Stream data model and architecture, Mining data streams, Real Time Analytics Platform (RTAP) Applications, Big data frameworks.

References:

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, Wiley and SAS Business Series, 2012.
3. David Loshin, Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph, 2013.

ICE 4462: BLOCKCHAIN TECHNOLOGY [3 0 0 3]

Introduction to cryptographic hash functions and cryptocurrencies, Mechanics, Storage and Use of Bitcoins, Bitcoin Mining and Anonymity, Blockchain contracts-Crowd funding, bitcoin prediction markets, smart contracts, blockchain 2.0 protocol projects, wallet development projects, Blockchain Development Platforms and APIs, Blockchain Ecosystem, Ethereum: Turing-Complete Virtual Machine, Blockchain markets and applications, Blockchain economy and variants, Blockchain Challenges, Recent Trends.

References:

1. Melanie Swan, Blockchain: Blueprint for a New Economy, O'Reilly, 2015.
2. Josh Thompsons, Blockchain: The Blockchain for Beginners-Guide to Blockchain Technology and Leveraging Blockchain Programming, 2017

ICE 4464: CPS ASSURANCE [3 0 0 3]

Cyber Physical Systems - Risk analysis, Cryptographic Components-Cryptographic components – Hash functions – Asymmetric key cryptography – Digital signatures – Security to state machines – Certified security by design for IOT applications, CPS Assurance-CPS Quality Assurance - Co-Verification Interface Design for High-Assurance CPS - High Assurance Aerospace CPS - Safety Assurance for Machine Learning in CPS, Trust Management in CPS, CPS Secured Implementation, Secure Deployment of CPS, Intelligent CPS.

References:

1. Cyber Physical Systems: Architecture, Protocol and Applications, Edited by Chi (Harold) Liu and Yan Zhang, CRC Press, 2016.
2. Cyber Physical Systems: Foundations, Principles and Applications, Edited by Houbing Song, and others, Elsevier, 2017.
3. Raj Rajkumar, Dionisio De Niz, and Mark Klein, Cyber-Physical Systems, Addison-Wesley Professional, 2016.
4. Rajeev Alur, Principles of Cyber-Physical Systems, MIT Press, 2015.

ICE 4465: CPS FOR INTERNAL AND EXTERNAL SECURITY [3 0 0 3]

Introduction to Cyber Physical Systems- Cyber Physical Systems Design Recommendations - CPS system requirements and its Applications. Security and Vulnerabilities-Cyber Security Vulnerabilities, Cyber Security Safeguards, Attacks. Physical Security, Cloud Computing Security, Interconnection- Hardware platforms for Cyber Physical Systems, Policy Issues- Policy issues in security management.

References:

1. John R.Vacca, Computer and Information Security Handbook, (2e), Elsevier 2013.
2. Richard E.Smith, Elementary Information Security, Second Edition, Jones and Bartlett Learning, 2016.

ICE 4466: CYBER SECURITY [3 0 0 3]

Digital securities-Types Of Cyber Attacks- Privacy Laws-Phishing - Definition And Working Principle, online anonymity-Anonymous Networks-VPN Design And Architecture, cryptography and secure communication-Cryptographic Functions-Disk Encryption Using Open Source Tools, cybercrime issues and investigation-Internet Hacking And Cracking-Digital Laws And Legislation, Law Enforcement Roles And Responses, digital forensics.

References:

1. Nihad Hassan and Rami Hijazi, Digital Privacy and Security Using Windows: A Practical Guide, Apress Publications, 2017
2. Digital Forensics, DSCI - Nasscom, 2012.
3. Cyber Crime Investigation, DSCI - Nasscom, 2013.

ICE 4467: DESIGN OF SAFE SYSTEMS

Composition and Compositionality in Cps, Evolving Security, Cybersecurity for Commercial Advantage, Reasoning about Safety and Security: The Logic of Assurance, From Risk Management to Risk Engineering: Challenges In Future Ict Systems, A Design Methodology for Developing Resilient Cloud Services, Cloud and Mobile Cloud Architecture, Security And Safety, Smart Grid Safety And Security, The Algebra Of Systems And System Interactions With An Application To Smart Grid.

References:

1. Griffor, Edward, ed. Handbook of system safety and security: cyber risk and risk management, cyber security, threat analysis, functional safety, software systems, and cyber physical systems. Syngress, 2016.
2. Gullo, Louis J., and Jack Dixon. Design for safety. John Wiley & Sons, 2017.

ICE 4468: E-VEHICLES [3 0 0 3]

Introduction to Electric Vehicles, Electric Drive trains, Power Converters, Electric Motor Drives, Energy storage technologies and Auxiliary systems, Automotive networking and Communication, In-vehicle networks, CAN, ADAS, V2X- Internet of things technologies, M2M communication. Cyber–Physical systems Design for Electric vehicles, Contemporary issues.

References:

1. Iqbal Hussain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, (2e), 2021.
2. Mehrdad Ehsani, Yimin Gao, and Ali Emadi, "Modern Electric, Hybrid and Fuel Cell Vehicles: Fundamentals", CRC Press, (2e), 2018.

ICE 4469: INTELLIGENT MANUFACTURING AUTOMATION [3 0 0 3]

Introduction to Automation and Digital Manufacturing-Automation principles and strategies- - Basic Elements of an Automated System, Levels of Automations, Concepts of Industry 4.0 and Connected Machines, Digital Design and Fabrication, Intelligent Manufacturing Support Systems-Online Predictive Modeling - Monitoring and Intelligent Control of production and Logistics/Supply Chain Processes, Automated Inventory and Production, Automated Inspection and Testing, Intelligent Manufacturing Systems-Artificial Intelligence based systems.

References:

1. Andrew Kusiak, Smart Manufacturing, Publisher, Taylor & Francis, 2018.
2. Mikell P. Grover, Automation, Production Systems and Computer Integrated Manufacturing (2016), Fourth Edition, Pearson Education.
3. William MacDougall, Industrie 4.0: Smart Manufacturing for the Future, Germany Trade & Invest, 2014.
4. Alasdair Gilchrist, Industry 4.0: The Industrial Internet of Things, Apress, 2016.

ICE 4470: METAVERSE [3 0 0 3]

Teaching and learning in the networked society, network learning culture and the emerging paradigm, reflections about reality, systemic thinking and complexity, epistemological conceptions, metaverse: 3D digital virtual worlds, metaverse technology and the nature of 3d digital virtual worlds, second life metaverse, open source metaverses, avatar: building a "digital virtual self", the construction of a digital virtual identity, representation/action of the "digital virtual self" through the technologicized body, immersion, tele presence, and digital virtual presence in metaverses, presence and proximity, relational presence and social presence, telepresence and digital virtual presence, interaction and interactivity in metaverse, languages and interaction/ interactivity forms in metaverse, autopoietic machines: human beings, alopoietic machines: the nature of the metaverse, structural coupling, cognition and socio-cognition in metaverse, doing, understanding, and awareness in metaverse

References:

1. Eliane Schlemmer and Luciana Backes, Learning in Metaverses: Co-Existing in Real Virtuality, IGI Global, 2014.
2. Nelson Zagalo, Leonel Morgado and Ana Boa-Ventura. Virtual Worlds and Metaverse Platforms: New Communication and Identity Paradigms, IGI Global, 2011.

ICE 4471: NEXT GENERATION NETWORKS [3 0 0 3]

Introduction to Next Generation Networks, NGN Functional Architecture, NGN Key Development Areas, Corporate Responsibility. 5G Mobile Network, Software Defined Networks, Network Function Virtualization, Recent Trends / Contemporary Issues related to 5G mobile networks / Software Defined Networks/ Network Function Virtualization.

References:

1. Next Generation Networks: Perspectives and Potentials, Dr Jingming Li Salina Pascal Salina, John Wiley & Sons, Ltd, 2007.
2. Fundamentals of 5G Mobile Networks, Jonathan Rodriguez, Wiley, (1e), 2015.
3. Foundations of Modern Networking, William Stallings, Addison-Wesley Professional, (1e), 2015.

ICE 4472: SMART FARMING AND AGRICULTURE [3 0 0 3]

Information communication technologies for Agriculture, Automation in Smart agricultural monitoring, Internet of Things practices for Agriculture, Smart Irrigation models, Wireless Sensor Networks Technologies and Applications for Smart Farming, Sustainable Smart-Farming Framework: Smart Farming, Soil monitoring, Pest and weed control.

References:

1. Ramesh C. Poonia, Xiao-Zhi Gao, Linesh Raja, Sugam Sharma, Sonali Vyas, Smart Farming Technologies for Sustainable Agricultural Development, IGI Global, 2018.
2. Internet of Things and Analytics for Agriculture, edited by Pattnaik, Prasant Kumar, Kumar, Raghvendra, Pal, Souvik (Eds), Springer, 2020.

ICE 4473: SMART GRID [3 0 0 3]

Smart Grid Basics-main features and challenges of smart grid, Energy resources - centralized vs. distributed generation- renewable energy-solar, wind, hydropower, biomass, geothermal, ocean wave; Plug-in Electric Vehicle (PEV)-history of EV- PEV challenges and potential solutions- EV and electric power grid, Demand-side management: -load profile of the power grid;-market pricing-peak shaving and valley filling-load forecasting- regulations and policies, Monitoring and Protection.

References:

1. J. Duncan Glover, Mulukutla S. Sarma, and Thomas J. Overbye, Power System Analysis and Design, 4th Ed.,Stamford, CT: Cengage Learning, 2008.
2. Jan Machowski, Janusz Bialek, and James R. Bumby, Power Systems Dynamics, Stability and Control, 2nd Ed.New York, New York: John Wiley, 2008.

3. B. Droste-Franke, et al., Balancing Renewable Electricity – energy storage, demand side management, and network extension from an interdisciplinary perspective. Heidelberg, Germany: Springer, 2012.
4. T. Ackermann, Wind Power in Power Systems. New York, New York: Wiley, 2005.

ICE 4474: SMART INFRASTRUCTURE [3 0 0 3]

CPS and IoT, Physical Infrastructures of Cyber Physical Systems, Energy and Reliability Issues in Cyber Physical Systems, Robotics and Smart Systems in Cyber Context, Ubiquitous and Cloud Computing for Monitoring Cyber Physical Systems, Security Issues in Cyber Physical Systems, Role of Cyber-Physical Systems in Big Data Analytics, Social Network Analysis, and Healthcare.

References:

1. Gaddadevara Matt Siddesh, Ganesh Chandra Deka, Krishnarajanagar Gopalalyengar Srinivasa, Lalit Mohan Patnaik, "Cyber-Physical Systems A Computational Perspective", (1e), 2016, CRC Press, Taylor and Francis.

ICE 4475: SMART SENSORS [3 0 0 3]

Introduction: Block diagram of smart sensor, Sensor interface needs, sensor electronics, sensor models, sensor signal enhancement, Compensation schemes, sensor integration, Need for smart sensing, Sensor IQ. Sensor Communication, Standards and Implications of Smart Sensors, Smart Sensor systems: Centralised and decentralised system of the measurement chains, Process control over the Internet, intelligent transportation system- ITS user services, ADAS, Smart grid, case studies.

References:

1. Randy Frank, Understanding Smart Sensors, (2e). Artech House Publications, 2000.
2. Paul W. Chapman, Smart Sensors, ISA Press, 1996.
3. Krzystof Iniewski, Smart Sensors for Industrial Applications, CRC Press, 2013.
4. Raghavendra C S, Sivalingam Krishna, Wireless Sensor Network, Springer, 2004.

ICE 4476: WIRELESS SENSOR TECHNOLOGY [3 0 0 3]

Single-Node Architecture, Energy Consumption, Operating Systems and Execution, Optimization Goals and figures of merit, Gateway Concepts, Networking sensors, WSN protocols, Wakeup Radio Concepts, Address and Name Management, Routing Protocols, Time Synchronization, Localization and Positioning, Sensor Tasking and Control, Sensor Node Hardware, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

References:

1. Holger Karl & Andreas Willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley, 2012.
2. Feng Zhao & Leonidas J. Guibas, Wireless Sensor Networks- An Information Processing Approach, Elsevier, 2007.
3. Kazem Sohraby, Daniel Minoli, & Taieb Znati, Wireless Sensor Networks - Technology, Protocols, And Applications, John Wiley, 2007.

ICE 4477: DATABASE SYSTEMS

Introduction to database system, Database users, Database architecture, Relational database, Keys, Schema, Formal relational query language, SQL basics, Constraints, Intermediate SQL, Joins, Nested queries, Advanced SQL, Functions, Procedures, Triggers, High level data modelling using entity relationship model, Relational database design, Notion of functional dependencies, Normalization, Transaction management, ACI Dproperties, Serializability, Concurrency control, Locking, Deadlock handling, Unstructured database, Introduction to NoSQL, Basics of document-oriented database, MongoDB.

References:

1. SilberschatzA.,orthH.F.,Sudarshan S.,Database system concepts(6e),McGraw-Hill,2013.
2. Elmasri, Ramez, Navathe S.,Fundamentals of database systems(7e),Pearson, 2016.
3. Molina, Hector, Ullman J.D., WidomJ., Database systems, The Complete Book (2e),Pearson Prentice Hall, 2013.
4. ChodorowK., MongoDB: The definitive guide(2e),O'Reilly, 2013.

ICE4478: OPERATING SYSTEMS

Introduction to Operating systems -Operating System Services, Operating system Structure, System calls, Process management-Process concept, Threads, Inter-process communication, CPU Scheduling, Process synchronization, Handling deadlocks - Deadlock Characterization, Deadlock Detection, Prevention, Avoidance and Recovery, Memory management-Mainmemory, Swapping, Contiguous Memory Allocation, Paging, Segmentation, Virtual memory–Demand Paging, Page Replacement, Thrashing, Allocating Kernel Memory, Storage Management-File management, Disk scheduling, Basic concepts of Real time operating systems – Classification of Real Time Systems, Microkernels, Scheduling.

References:

1. Abraham Silberschatz, Peter Baer Galvin and Greg Gagne, Operating System Concepts S(e), Wiley,2012.
2. William Stallings, Operating Systems: Internals and Design PrinciplesS(e),Pearson,2017.
3. Phillip ALaplante, SeppoJ Ovaska, Realtime systems design and analysis4(e),Wiley,2013.
4. RajibMall,Realtime systems: Theory and Practice2(e), Pearson,2009.

ECE XXXX Real Time Operating Systems

Introduction to QNX's microkernel architecture and principles of real-time systems. Process/thread management, memory protection, scheduling, and synchronization using mutexes, semaphores, and condition variables. Inter-process communication methods like message passing and shared memory, with practical exercises. Hardware programming -interrupt handling, IO access, DMA-safe memory, and timing mechanisms. Building and configuring QNX boot images, including kernel, drivers, and resource managers. Hands-on labs for practical understanding of real-time system development and deployment using QNX RTOS.

*Self-directed Learning: (6)

1. QNX configuration and application development using QNX

Momentics IDE.

2. Process and thread creation, management, and synchronization.
3. Implementation of IPC methods: message passing and shared memory.
4. Interrupt handling and hardware access programming.
5. Building and deploying QNX boot/OS images.
6. Mini capstone project: Design and implement a QNX-based embedded system.

References:

1. QNX Neutrino RTOS User's Guide, QNX Software Systems.
2. Programming for Embedded Systems, Michael Barr, O'Reilly Media.
3. Hands-on RTOS with Microcontrollers, Brian Amos, Packt Publishing, 2020.
4. Operating System Concepts, Abraham Silberschatz, Peter B. Galvin, Greg Gagne, 9th Edition, Wiley, 2018.
5. Online Resource: QNX online training, QNX training material

OPEN ELECTIVES

ICE 4311: FEEDBACK CONTROL THEORY [30 0 3]

Feedback control systems, Mathematical modeling, Derivation of transfer functions for electrical networks, Mechanical systems, Signal flow graph, Masons gain formula, State variable representation of linear systems, Solution of state equations, Time domain specifications for second order systems, Steady state errors of unity feedback systems, Definitions of stability, Routh Hurwitz criterion, Frequency response - gain margin, phase margin.

References:

1. Nagrath and Gopal, Control Systems Engineering, New age international Limited, (2e), 1984.
2. Norman S. Nise, Control Systems Engineering, (5e), Wiley India, 2009.
3. R.C Dorf and R.H Bishop, Modern Control Systems, (11e), Addison-Wesley Longman Inc., 2013.

ICE 4312: INDUSTRIAL AUTOMATION [3 0 0 3]

Evolution of PLC, PLC Vs PC, Architecture of PLC - I/O Modules, CPU, Program Memory, Process Image Tables, Bus System and Power Supply, Sequential Flow Chart technique for programming style, Programming a PLC, Timers & Counters, Special Instructions, Levels of Industrial control, Networking, Buts Networks, Protocols., SCADA & DCS, Profibus, Modbus, SMART devices.

References:

1. John W.Webb and Ronald A.Reis, Programmable Logic Controllers – Principles and Applications, (5e), PHI, 2003.
2. W. Bolton, Programmable Logic Controllers, 94e), Newnes Publications, 2006.
3. Frank D. Petruzella, Programmable Logic Controllers, MGH, 1989.

ICE 4313: INDUSTRIAL INSTRUMENTATION [3 0 0 3]

Measurement System, Classification of transducers, Temperature and Pressure measurement, Level and Thickness measurement, Flow measurement-Variable head type, variable area type, Mass flowmeters, Measurement of Thermal conductivity, velocity, acceleration, pH and Force, Semiconductor sensors, Optical sensors.

References:

1. E.O. Doeblin, Measurement Systems: Application and Design, McGraw Hill, (5e), 2004.
2. Patranabis D, Principles of Industrial Instrumentation, TMH, (3e), 2005.
3. A.K. Sawhney, A course in Mechanical Measurement and Instrumentation, (7e), Dhanpat Rai and Co, 2002.

ICE 4314: SENSOR TECHNOLOGY [3 0 0 3]

Basic sensor technology, characteristics, Capacitive and Inductive Sensors, Displacement Sensors, Temperature Sensors, Force/Torque Sensors, Humidity and Moisture Sensors, Acoustic Sensors, Flow Sensors, Occupancy-Motion Detectors, Acceleration and Vibration Sensors, Chemical and Biosensors, Optical and radiations Sensors, Introduction to Wireless Sensor Networks (WSN) and Applications.

References:

1. Jon S Wilson, Sensor Technology Handbook, Newnes Elsevier Publication, 2005.
2. Jacob Fraden, Handbook of Modern Sensors: Physical, Designs, and Applications, Springer, 2004.

ICE 4315: SMART SENSOR [3 0 0 3]

MCUs and DSPs, integrated signal conditioning, IEEE1451 standards, Plug and play, Sensor Communication, Wireless zone sensing, Surface acoustical wave devices, Intelligent transportation system, RF-ID, RF MEMS basics, Micro optics, Micro grippers, Microprobes, Micro mirrors, FEDs, Centralized and decentralized measurement chains, Intelligent sensors, Nano sensors, Biosensors

References:

1. Randy Frank, Understanding Smart Sensors, (2e), Artech House Publications, 2000.
2. Paul W. Chapman, Smart Sensors, ISA Press, 1996.
3. KrzystofIniewski, Smart Sensors for Industrial Applications, CRC Press, 2013.

ICE 4316: VIRTUAL INSTRUMENTATION [3 0 0 3]

Architecture of a virtual instrument, Virtual instruments V/s Traditional instruments, Advantages of VI, Graphical programming, Creating Virtual Instruments using LabVIEW-Loops, Arrays, Clusters, String and file I/O, Graphs, Data Acquisition, Common Instrument Interfaces, Current loop, System buses, Interface buses, VISA, Image acquisition and processing, Design of ON/OFF controller for a mathematically described processes using VI software

References:

1. Gary Johnson, LabVIEW Graphical Programming, (2e), MGH, 1997.
2. Lisa K. wells & Jeffrey Travis, LabVIEW for everyone, National Instruments, 1997.
3. S. Sumathi, P Surekha, LabVIEW based Advanced Instrumentation systems, Springer, 2007.
4. Rick Bitter, Taqi Mohiuddin, Matt Nawrocki, LabVIEW Advanced Programming Techniques, CRC Press, 2007.
5. Jovitha Jerome, Virtual Instrumentation using LabVIEW, PHI, 2010.

ICE 4317: FARM AUTOMATION [3 0 0 3]

Farm mechanization, sources of farm power, renewable energy sources, IC engines, tillage, sowing, plant protection, intercultural operations, harvesting, threshing, biomass management techniques. Watershed concept and theory, soil erosion, measures, hydrological cycle, irrigation methods, devices, Water conveyance systems, Water harvesting, aquifer and its types, interaction of water resources with the changing environment. Engineering properties of biological materials, heat and mass transfer, devices for cleaning, grading, milling and storage of farm produce. Drying and dehydration, function and features of green house. Resource conservation management, precision farming, automated irrigation scheduling, variable rate seed and chemical applicators, robotics, Rainfall-runoff prediction models, watershed modeling, climate change impact analysis on bio-resources, drying characteristics, storage or process kinetics, simulation and modeling in tillage implements.

References :

1. Jagdshwar Sahay, Elements of Agricultural Engineering, (4e), Standard Publishers Distributors, 2006
2. A. M. Michael & T. P. Ojha, Principles of Agricultural Engineering, Vol I & II., (10e), Jain Brothers, 2018
3. K M Sahay, K. K. Singh, Unit operations of Agricultural Processing, (2e),Vikas Publishing House Pvt Ltd, 2004.
4. Qin Zhang, Francis J. Pierce, Agricultural Automation Fundamental and Practices, CRS Press, Taylor and Francis group, 2013.
5. Darwin Caldwell, Robotics & Automation in the food Industries (Current & Future Technologies), Wood Head Publishing Ltd, Oxford, 2012.

5. A. M. Chandra, S. K. Ghosh, Remote Sensing and Geographical Information System, Alpha Science, 2006

ICE 4318: OUTDOOR LEADERSHIP

Different skills of an outdoor leader, different styles of leadership, Awareness and Decision making in the field, Expedition Behaviour, Field Safety and Crisis, Trip Planning, Leave No Trace Principles, Local Ecology of the laterite pleatue, Basic bicycle problems and their solutions, Fundamentals of route planning, Nutrition and Hydration, Recovery for athletes, Group behaviour and development, How to maintain a ride log & incident report, packing for tours, Basics of Nature journaling, Basics of Photography, Creative writing,

On road bicycle maintenance and repairs, bicycle handling skills, resistance training drills, recovery rides, endurance rides, basics of camping, documenting in the field

References :

- AMC Guide to Outdoor Leadership – Alex Kosseff – Appalachian Mountain Club - 2023
- Big Blue Book of Bicycle Repair – Calvin Jones – Park Tool Co - 2019
- Manipal Bird Book – Ramit Singhal – Manipal University -2018
- The Athlete’s guide to recovery – Sage Rountree - VeloPress - 2024
- Keeping a nature journal – Clarke Walker Leslie – Storey Publishing - 2021
- Langfords Starting Photography – Philip Andrew – Routeledge Press - 2015
- Naturalist on the prowl – EHA – Penguin India - 2007
- Dear Data – Giorgia Lupi – Princeton Architectural Press - 2016
- Observe, collect, draw - Giorgia Lupi - Princeton Architectural Press - 2018

**Note highlighted course code approval from academic office requested.

Department of
Mechanical & Industrial Engineering

The Department of Mechanical and Industrial Engineering, established in the year 1960, offers two Undergraduate courses, three Postgraduate courses and also PhD programmes. The department is also recognized as a QIP center for Postgraduate courses and PhD. The department consists of experienced faculty members, who are also constantly engaged in undertaking research work and subsequent publications. The department conducts workshops, seminars or conferences every year. The department has very good industry – institute interaction and has conducted several short courses for working professionals from industry. The department provides adequate laboratory facilities and hands-on training to the undergraduate students both in the conventional subject as also in the modern trends.

All the B.Tech and M.Tech programs are accredited by Institution of Engineering and Technology(IET)., UKin 2023. B.Tech(Mechanical Engineering)and B.Tech (Industrial Engineering) and M.Tech (Computer Aided Analysis and Design) are accredited by NBA.

The department has well established Computer Aided Design laboratory with state-of-the-art hardware and software. The basic laboratories such as Heat engines laboratory, Metrology laboratory, Heat transfer laboratory, Fuel testing laboratory, Machine tools laboratory, Material science laboratory, Vibration laboratory, Industrial engineering laboratory, Fluid Mechanics and Machinary laboratory, Tribology laboratory and Energy laboratory have advanced equipments so as to impart quality education. The department has sprawling workshop situated on a 30000 sq.ft are a comprising of machine shop, CNC shop, foundry, smithy, sheet metal, plumbing and welding sections. The practice school and internship opportunities provide an excellent industry exposure for students.

> Programs offered

Undergraduate Programs

- B.Tech in Mechanical Engineering (1960)
- B.Tech in Industrial Engineering (1975)
- B.Tech (Dual Degree Deakins University (2024)

Postgraduate Programs

- M.Tech in Computer Aided Analysis and Design (2003)
- M.Tech in Manufacturing Engineering (2005)
- M.Tech in Thermal Sciences and Energy Systems (2013)

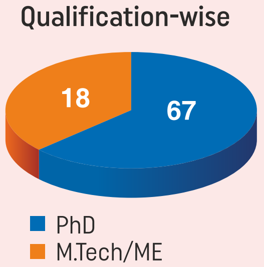
PhD

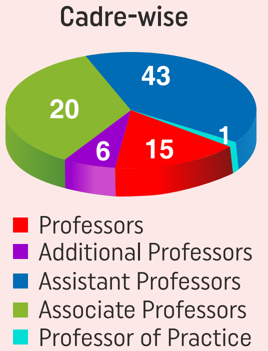
- PhD (Full time - Three years)
- PhD (Part time -Four years, for Working Professionals)
- M.Tech with PhD (Four years)





> Faculty Strength





B.TECH. MECHANICAL ENGINEERING

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2121	Engineering Mathematics - III	2	1	0	3	MAT 2230	Engineering Mathematics - IV	2	1	0	3
	MIE 2121	Theory of Machines	3	1	0	4	MIE 2221	Design of Machine Elements	3	1	0	4
	MIE 2122	Manufacturing Processes - I	3	0	0	3	MIE 2222	Materials Engineering	3	0	0	3
	MIE 2123	Fluid Mechanics	2	1	0	3	MIE 2223	Metrology and Measurements	3	0	0	3
	MIE 2124	Mechanics of Materials	2	1	0	3	MIE 2224	Turbomachines	2	1	0	3
	MIE 2125	Thermal Engineering	3	1	0	4	MIE 2225	Manufacturing Processes - II	3	0	0	3
	MIE 2141	Computer Aided Mechanical Drawing and Modelling Lab	0	0	3	1	MIE 2241	Mechanics Lab	0	0	3	1
	MIE 2142	Workshop Practice - I	0	0	3	1	MIE 2242	Workshop Practice - II	0	0	3	1
			15	**5**	**6**	**22**			**16**	**3**	**6**	**21**
	Total Contact Hours (L + T + P)		**26**				**Total Contact Hours (L+T+P)**		**25**			
III	**FIFTH SEMESTER**						**SIXTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	HUM 3021	Engineering Economics and Financial Management	2	1	0	3	HUM 3022	Essentials of Management	2	1	0	3
	MIE ****	Flexible Core - 1 (A1/B1/C1/D1)	3	0	0	3	MIE ****	Flexible Core - 2 (A2/B2/C2/D2)	3	0	0	3
	MIE 3121	Geometric Modelling	3	0	0	3	MIE ****	Flexible Core - 3 (A3/B3/C3/D3)	4	0	0	4
	MIE 3122	Finite Element Methods	3	0	0	3	MIE ****	Program Elective - I / Minor Specialization	3	0	0	3
	MIE 3123	Heat and Mass Transfer	3	1	0	4	MIE ****	Program Elective - II / Minor Specialization	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective - 2	3	0	0	3
	MIE 3141	Mechanical Lab	0	0	3	1	MIE 3241	Finite Element Methods Lab	0	0	3	1
	MIE 3142	Metrology Lab	0	0	3	1	MIE 3242	Heat Transfer and Solar Energy Lab	0	0	3	1
			17	**2**	**6**	**21**			**17**	**1**	**7**	**21**
	Total Contact Hours (L+T+P)		**25**				**Total Contact Hours (L+T+P)**		**25**			
IV	**SEVENTH SEMESTER**						**EIGHTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	MIE ****	Program Elective - III / Minor Specialization	3	0	0	3	MIE 4291	Industrial Training				1
	MIE ****	Program Elective - IV / Minor Specialization	3	0	0	3	MIE 4292	Project Work / Practice School				12
	MIE ****	Program Elective - V	3	0	0	3	MIE 4293	Project Work (B.Tech Honours)**				20
	MIE ****	Program Elective - VI	3	0	0	3	MIE ****	B.Tech Honours (Theory 1)** (V Semester)				4
	MIE ****	Program Elective - VII	3	0	0	3	MIE ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	*** ****	Open Elective - 3	3	0	0	3	MIE ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	MIE 4191	Mini Project (Minor Specialization)*				8						
			18	**0**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P) + OE		**18**									

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

FLEXIBLE CORE-A

DESIGN

MIE 3124: Design for Manufacture & Assembly (A1)
MIE 3221: Fatigue and Fracture (A2)
MIE 3224: Mechanical Vibrations (A3)

FLEXIBLE CORE-B

THERMAL

MIE 3125: Green Energy Technology (B1)
MIE 3222: Refrigeration & Air Conditioning (B2)
MIE 3225: Computational Fluid Dynamics (B3)

FLEXIBLE CORE-C

MANUFACTURING

MIE 3126: Heat Treatment of Metals and Alloys (C1)
MIE 3223: Machine Tool Technology (C2)
MIE 3226: Automation in Manufacturing (C3)

FLEXIBLE CORE-D

ELE 3127: Foundations of EV & Hybrid Vehicles (D1)
ELE 3225: Automotive Mechanics for Electric Vehicles (D2)
MIE 3231: EV Battery Technology and Thermal Management (D3)

MINOR SPECIALIZATIONS

I. MACHINE DESIGN

MIE 4401: Design of Mechanical Systems
MIE 4402: Introduction to Continuum Mechanics for Engineers
MIE 4403: Lubrication and Rotor Dynamics
MIE 4404: Modelling and Simulation of Dynamic Systems

II. MANUFACTURING TECHNOLOGY

MIE 4405: Additive Manufacturing
MIE 4406: Non-traditional Manufacturing Techniques
MIE 4407: Lean Manufacturing
MIE 4408: Micro Machining

III. THERMAL SYSTEMS

MIE 4409: Cryogenics
MIE 4410: Solar Thermal Systems
MIE 4411: Design of Heat Exchangers
MIE 4412: Jet Propulsion

IV. MATERIALS ENGINEERING

MIE 4413: Processing of Polymers and Polymer Composites
MIE 4414: Metal and Ceramic Composite Materials
MIE 4415: Materials Characterization
MIE 4416: Fibre Reinforced Composite Mechanics & Manufacturing Techniques

V. VEHICLE TECHNOLOGY

MIE 4417: Automobile Engines and Combustion
MIE 4418: Automotive Transmission
MIE 4419: Electric & Hybrid Vehicles
MIE 4420: Autotronics

VI. AUTOMATION AND ROBOTICS

MIE 4421: Robotics: Mechanics and Control
MIE 4422: Elements of Mechatronics Systems
MIE 4423: Fluid Drives and Control
MIE 4424: Mechanical Handling Systems and Equipment

VII. QUALITY ENGINEERING

MIE 4425: Statistical Quality Control
MIE 4426: Production Planning and Control
MIE 4427: Operations Research
MIE 4428: Total Quality Management

VIII. COMPUTER TECHNIQUES IN MECHANICAL ENGINEERING

MIE 4429: Programming in Mechanical Engineering
MIE 4430: Metaheuristic Optimization Techniques
MIE 4431: Machine Learning & its Applications
MIE 4432: Microcontroller Based Automation

IX. EV TECHNOLOGY

ELE 4415: EV Battery Technology and Powertrain Development
AAE 4425: EV Product Development, Homologation & Hydrogen FCEV
ELE 4417: EV Vehicle Design & Analysis
AAE 4426: EV FEA Analysis

OTHER PROGRAMME ELECTIVES

MIE 4441: Advanced Metrology
MIE 4442: Applied Numerical Methods for Mechanical Engineers
MIE 4443: Automatic Control Engineering
MIE 4444: Biomechanics
MIE 4445: Energy Audit, Conservation and Storage
MIE 4446: Friction and Wear
MIE 4447: Industrial Automation & IOT
MIE 4448: Industrial Safety Engineering
MIE 4449: MEMS and Nano Technology
MIE 4450: Non-destructive Testing of Materials
MIE 4451: Pipe Systems Engineering
MIE 4452: Product Design and Development
MIE 4453: Project Management
MIE 4454: Theory of Elasticity
MIE 4455: Wind Energy Technology
MIE 4456: Microfluidics
MIE 4457: Engineering Asset Management

OPEN ELECTIVES

MIE 4311: Introduction to Composite Materials
MIE 4312: Introduction to Biomechanics
MIE 4313: Introduction to Operations Research
MIE 4314: Energy Engineering
MIE 4315: Introduction to Finite Element Methods
MIE 4316: Bio-Fluid Dynamics
MIE 4317: Introduction to Engineering Asset Management

THIRD SEMESTER

MAT 2121: ENGINEERING MATHEMATICS - III [2 1 0 3]

Gradient, divergence and curl, Line, surface and volume integrals. Green's, divergence and Stoke's theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, Sine and cosine transforms. Partial differential equation- Basic concepts, solutions of equations involving derivatives with respect to one variable only. solutions by indicated transformations and separation of variables. One-dimensional wave equation, one dimensional heat equation and their solutions. Numerical solutions of boundary valued problems, Laplace and Poisson equations and heat and wave equations by explicit methods.

References:

1. Erwin Kreyszig: Advanced Engineering Mathematics, 5thedn. 1985 Wiley Eastern.
2. S. S. Sastry: Introductory Methods of Numerical Analysis 2nd edn.1990, Prentice Hall.
3. B. S. Grewal: Higher Engg. Mathematics, 1989 Khanna Publishers
4. Murray R. Spiegel: Vector Analysis, edn.1959, Schaum Publishing Co.

MIE 2121: THEORY OF MACHINES [3 1 0 4]

Basic concepts: Mechanism and machine, Kinematic pair, link, chain, and inversions, constrained and unconstrained motion, four-bar mechanism, single and double slider crank mechanisms with inversions. Velocity and Acceleration: velocity in mechanisms by relative velocity method, vector method, and instantaneous center method, acceleration in the mechanism by relative acceleration method. Toothed gearing: Law of gearing, Spur Gears - Terminology, cycloidal and involute teeth, the minimum number of teeth on the pinion to avoid interference, Terminology of helical and bevel gears, epicyclic gear trains. Cams: Types of Cams and followers, design of Cam profiles. Static force analysis: Conditions for static equilibrium of a member under the action of forces, analysis of slider-crank mechanism, four-bar mechanism. Balancing of machinery: Balancing of rotating masses, balancing of reciprocating masses, balancing of multi-cylinder in-line engines and V-engines. Gyroscopic forces: Gyroscopic effect on the movements of an aircraft, ship, and automobiles.

References:

1. Rattan S. S, Theory of Machines, Tata Mc-Graw Hill Publishers Pvt. Ltd, New-Delhi, 2019.
2. Uicker J. J , Pennock G. R. and Shigley, J. E., Theory of Machines and Mechanisms, Oxford University press, 2014.
3. Ballaney P. L., Theory of Machines, Khanna Publishers, New Delhi, 2015.
4. Singh, V. P., Theory of Machines, Dhanpat Rai Publishing Company Ltd., 2004.
5. Rao J. S. and Dukkipati R. V., Mechanism and Machine Theory, Wiley Eastern Ltd. Delhi, 1992.
6. Mata, Antonio Simón, Alex BatallerTorras, Juan Antonio Cabrera Carrillo, Francisco EzquerroJuanco, Antonio Jesús Guerra Fernández, Fernando Nadal Martínez, and Antonio Ortiz Fernández. Fundamentals of machine theory and mechanisms. Vol. 40. Cham: Springer, 2016.

MIE 2122: MANUFACTURING PROCESSES - I [3 0 0 3]

Types of moulding, Moulding materials, Sand Testing. Various Casting techniques. Classification of welding processes and its operational features. Sheet metal forming operations. High Energy rate forming processes. Theory of metal cutting, Machinability parameters, Tool life and wear. Merchant's analysis, Taylor's equation. Cutting force and tool life calculation. Lathe features, types, accessories and attachments, lathe operations, calculations of thread cutting and machining time. Types of Drilling machines, twist drill nomenclature and computation of drilling time. Types of milling machines, attachments, milling operations, types of milling cutters, Indexing methods. Grinding wheel – Abrasive particles, Bonding materials, Designation, Constructional features and principles of cylindrical, surface and centreless grinding machines.

References:

1. Rajput R. K., A Text book of Manufacturing Technology, Laxmi Publications Private Limited, 2011.
2. Khanna O.P., A text book of Production Technology (Vol1&2), Dhanpat Rai Publications, 2011.
3. Rao P. N., Manufacturing Technology, Tata McGraw-Hill Publishing Company Limited, 2006.
4. Serope Kalpakejian and Steven Schmid R, Manufacturing Engineering and Technology, Pearson Education, 2005.
5. Paul DeGarmo E., Black J. T. and Ronald Kohser A, Materials and Process in Manufacturing, John Wiley and Sons, 2004.
6. Lal M. and Khanna O. P., Foundry Technology, Dhanpat Rai and Sons, 1991.
7. Jain R. K., Production Technology, Khanna Publishers, 2001.
8. P. C. Sharma, A Textbook of Production Technology, S. Chand Publishing, 2007.

MIE 2123: FLUID MECHANICS [2 1 0 3]

Properties of fluids – definition of various hydrodynamic parameters, fluid continuum, different types of fluids. Fluid statics – Pressure and its measurement, hydrostatic pressure forces on flat and curved surfaces, buoyancy and its stability. Kinematics of fluid flow – methods of fluid flow description, velocity and acceleration vectors, dimensions of fluid flow; path line, stream line, streak line and stream tube; rotational and irrotational flow; velocity potential function and stream function; translation, rotation and deformation of a fluid element. Dynamics of fluid flow – continuity equation, Euler's equation, Reynold's transport theorem, energy of a flowing fluid - Euler's equation of motion along a stream line, Bernoulli's equation; Impulse momentum equation; Navier-Stokes equation. Dimensional analysis - Rayleigh's method and Buckingham's Pi-theorem, similitude, types of similarity, significance of dimensionless numbers. Internal fluid Flow - Couette flow, Hagen Poiseuille's flow, Reynolds experiment, Darcy equation, friction factor, pipe roughness, Moody's Chart, Major loss and Minor losses in pipe flow, Siphon, Venturimeter, Orifice meter and Pitot tube. External fluid flow – boundary layer theory, displacement thickness, Von-Karman momentum integral equation; flow past submerged bodies, streamlined body, Bluff body.

References:

1. Cengel Yunus A., and Cimbala John M., Fluid Mechanics-Fundamentals & Applications, 4th ed., McGraw Hill publications, 2018.
2. Frank M. White, Fluid Mechanics, 7th ed., McGraw-Hill, 2011.
3. Som S. K., Gautam Biswas, and Chakraborty S., Introduction to Fluid Mechanics and Fluid Machines, 3rd ed., Tata McGraw Hill publications, 2012.
4. Bruce R. Munson, Donald F. Young, and Teodore H. Okiishi, Fundamentals of Fluid Mechanics, Wiley, 2009.
5. Kumar K. L., Engineering Fluid Mechanics, S. Chand Publishing, New Delhi, 2016.
6. Modi P. N., and Seth S. M., Hydraulics and Fluid Mechanics Including Hydraulics Machines, 21st ed., Standard Book House, 2018.
7. Bansal R. K., Fluid mechanics and Hydraulic machines, 1oth ed., Laxmi Publications (P) Ltd. New Delhi, 2019.

MIE 2124: MECHANICS OF MATERIALS [2 1 0 3]

Shear force and bending moments in beams: Classification of beams and loads, sign convention, Shear force and bending moment. Stresses in beams: Theory of simple bending, bending and shear stresses in beams. Beam deflection: Relationship between slope, deflection and radius of curvature, double integration method and Macaulay's method. Torsion: Analysis of torsion of circular bars, shear stress distribution, bars of solid and hollow circular section, stepped shafts. Principal stresses: Stresses in a uniaxial & biaxial member, principal plane and principal stress, graphical method for evaluation of stresses. Columns and struts: Classification of columns, slenderness ratio, Euler's formula, Rankine's formula. Thin and thick cylinders: Classification of cylinders, stresses in thin cylinders, lame's theory for evaluation of stresses in thick cylinders. Materials and their properties: Stressstrain diagrams, Ductile and brittle fracture, Material specification, Theories of failure, Factor of safety.

References:

1. Popov E.P, Engineering Mechanics of Solids, Prentice-Hall of India, New Delhi, 1997.
2. Beer F. P. and Johnston R, Mechanics of Materials (3e), McGraw-Hill Book Co, 2002.
3. Nash W.A, Theory and problems in Strength of Materials, Schaum Outline Series, McGraw-Hill Book Co, New York, 1995.
4. Kazimi S.M.A, Solid Mechanics, Tata McGraw-Hill Publishing Co, New Delhi, 1981.
5. Ryder G.H, Strength of Materials (3e), Macmillan India Ltd, 2002.
6. Ray Hulse, Keith Sherwin and Jack Cain, Solid Mechanics, Palgrave ANE Books, 2004.
7. Singh D. K., Mechanics of Solids, Pearson Education, 2002.
8. Timoshenko S, Elements of Strength of Materials, Tata McGraw-Hill, New Delhi, 1997.
9. Hearn, Edwin John, Mechanics of Materials 1: The mechanics of elastic and plastic deformation of solids and structural materials, Elsevier, 1997.
10. Hearn, Edwin John, Mechanics of Materials 2: The mechanics of elastic and plastic deformation of solids and structural materials, Elsevier, 1997.

MIE 2125: THERMAL ENGINEERING [3 1 0 4]

Basic concepts: definitions, reversible and irreversible processes, Zeroth Law, path and point function. Work and heat transfer: Thermodynamic work, Displacement work, pdv work for various processes and heat transfer. First law of thermodynamics: open and closed systems, SFEE and PMM1. Second law of thermodynamics and entropy: heat engines, reversed heat engines, Kelvin-Planck and Clausius statements, PMM2, Carnot cycle, Carnot theorem, entropy, Clausius inequality, entropy change non-flow processes. Pure Substance: definitions, PVT surface, P-T diagram, dryness fraction and its measurement, Tabulated properties, different processes for pure substances. Ideal and Real gases: definition, different processes, property evaluation, adiabatic mixing of ideal gases, Vander Waal's equation, law of corresponding states, compressibility factor, generalized compressibility chart. Power cycles: Rankine cycle, effect of operating parameters, reheat cycle, Regenerative cycles and properties of working substance, air standard Otto, Diesel dual cycles, air standard efficiency and comparison, simple Brayton cycle and methods to improve its performance. Reciprocating air compressors: theory of compression, single stage compression, effect of clearance, volumetric efficiency, multi-stage compression, and inter-cooling, minimum work of compression. Refrigeration cycles: Bell-Coleman cycle, vapour compression and vapour absorption cycle, properties of refrigerants. Performance testing of IC engines: measurement of BP, IP and FP, various efficiencies, heat balance sheet, principle of combustion in S.I and C.I engines.

References:

1. Cenegel Yunus and Bole Michael, Thermodynamics: An Engineering Approach,9th ed., McGraw Hill, New York, 2019.
2. Estop and McConkey, Applied Thermodynamics for Engineering Technologies, 5thed, Pearson Education, Delhi, 2002.
3. Mayhew A. and Rogers B., Engineering Thermodynamics, 4th ed., E.L.B.S. Longman, London, 2002.
4. Van Wylen and G. J. and Sonntag R. E., Fundamentals of Classical Thermodynamics, 4th ed., John Wiley, New York, 2019.
5. Cengel, Thermodynamics and Heat Transfer, 2nd ed., McGraw Hills, New York, 2009.
6. Nag. P. K., Engineering Thermodynamics, 6th ed., Tata McGraw Hills, New Delhi, 2017.

MIE 2141: COMPUTER AIDED MECHANICAL DRAWING AND MODELLING LAB [0 0 3 1]

Introduction to Machine drawing, Conventions, Sectional views, Screw Thread Terminologies and Thread Forms; Hexagonal and Square Head Bolts, Nuts and Screws; Introduction to Sketcher Exercises using CAD tool (CATIA Software); Modelling of machine components using CAD tool (CATIA Software); Assembly of machine components; Product Drafting; Surface Modelling Exercises using CAD tool (CATIA Software).

References:

1. Gopalakrishna K. R., Machine Drawing, Subhas Publications, Bangalore, 2017.
2. Narayana K. L. and Kannaiah P, Text book on Engineering Drawing, Scitech Publications, Chennai, 2011.
3. Bhat N D ;Panchal V M., Machine drawing, AnandCharotar Publishing House, 2007.
4. Ibrahim K Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill, New Delhi, 2009.
5. Sham Tickoo, CATIA V5R20 for Engineers and Designers, Dreamtech Press New Delhi, 2019.

MIE 2142: WORKSHOP PRACTICE – I [0 0 3 1]

Arc welding practice, Lap and Butt joints, Study of Gas Welding, TIG and MIG Welding, Casting & Forging Practice, Plain turning, step turning, Taper turning & Thread cutting using lathe, Facing, Step turning, Taper turning, Stock Removal Turning, Grooving, Thread cutting, Drilling and boring using CNC Turning Center, Acceptance Test on Lathe and Drilling machine.

References:

1. Hajra Chaudhury S. K., Hajra Choudhury A. K. and Nirjhar Roy, Elements of Workshop Technology, Vol. I, Media Promoters and Publishers Pvt. Ltd., 2003.
2. Peter Smid, CNC Programming Hand book, Industrial Press, New York, 2000.

FOURTH SEMESTER

MAT 2230: ENGINEERING MATHEMATICS - IV [2 1 0 3]

Special Functions: Series solutions of Bessel and Legendre differential equations, Recurrence formulae, generating functions and Orthogonal properties for Jn(x) and Pn(x). Probability, finite sample space, conditional probability and independence, Bayes' theorem, one dimensional random variable: mean and variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least square principle of curve fitting. Distributions: binomial, Poisson, uniform, normal, gamma, chi-square and exponential. Moment generating function, Functions of one dimensional and two-dimensional random variables, Sampling theory, Central limit theorem and applications.

References:

1. Kreyzig E., Advanced Engineering Mathematics, 7th ed., Wiley Eastern.
2. Meyer P. L., Introduction to probability and Statistical applications, 2nd ed., American Publishing Co., 1965.
3. Hogg, and Craig, Introduction of Mathematical Statistics, 4th ed., MacMillan, 1975.
4. Grewal B. S., Higher Engg. Mathematics, Khanna Publishers, 1989.

MIE 2221: DESIGN OF MACHINE ELEMENTS [3 1 0 4]

Strength under combined axial, bending & torsional loads, Stress concentration. Stresses in curved beams. Fatigue: S-N diagram, Endurance limit, Variables affecting fatigue strength, Fluctuating stresses, Goodman & Soderberg equations. ASME code for design of transmission shafts, Mises Hencky theory for transmission shafting, Stress concentration, Design of shafts subjected to bending in two planes in addition to axial loads. Keys: Types of keys, Stress in keys, Design of square, rectangular & taper keys and splines. Types of welds, Strength of welds, Welded joints subjected to eccentric loading, Stresses in bolts, Effect of initial tension, Bolts subjected to various eccentric loading conditions. Types of springs, Design of helical compression springs - steady/ fluctuating loads, surge in spring, concentric springs. Design of Leaf springs: Semi elliptic carriage springs, Stress equalization. Nomenclature, Stresses in gear teeth, involute gears, Lewis equation for beam strength of tooth, Form factor, velocity factor, Static, Dynamic, Limiting load for wear. Journal bearing-Terminology, Hydrodynamic lubrication, Stribeck curve, eccentricity and minimum oil film thickness, Heat generation & dissipation. Rolling contact bearings: Types of ball and roller bearings, Life rating, Static and Dynamic load carrying capacity, Selection of bearings. Selection of V belt drive systems, Selection of rope drive systems and chain drive systems.

References:

1. Shigley J. E. and Mischke C. R., Mechanical Engineering Design, Eight Edition, McGraw Hill Inc, New York, 2008.
2. Bhandari V. B., Design of Machine Elements, Third Edition, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2012.
3. Norton R. L., Machine Design - An Integrated Approach, Second Edition, Prentice Hall Inc. New Jersey, 2007.
4. Juvenile R. C. and Marshek K. M., Fundamentals of Machine Component Design, Fifth Edition, John Wiley and Sons, Inc, New York, 2012.
5. Maleev and Hartman, Machine Design, (Revised and edited by Drop Grover), CBS Publishers, New Delhi, 2018.
6. Hamrock B. J., Jacobson B.O. and Schmid S. R., Fundamentals of Machine Elements, Second Edition, Mc Graw Hill Inc., New York, 2005.
7. Mahadevan K. and Balaveera Reddy K., Machine Design Data Hand Book, Fourth Edition, CBS Publishers and distributors' New Delhi, 2013.

MIE 2222: MATERIALS ENGINEERING [3 0 0 3]

Introduction to materials, Solidification, Homogeneous and heterogeneous nucleation, mechanism of solidification Phases in solids, Equilibrium diagrams, Lever rule and its application, Iron-Carbon systems, Allotropy and polymorphism, Fe-C equilibrium diagrams, Ferrous-alloys, Composition, properties and applications of Plain carbon steels & Alloy steels, Non-ferrous alloys, Types of Brasses, Bronzes and Al-Cu alloys Introduction to composite materials.

References:

1. Avner S. H., Introduction to Physical Metallurgy, 3rd ed., McGraw

Hill, 2004.
2. William D. Callister, Materials Science and Engineering, John Wiley & Sons, 2007.
3. Gupta K. M., Material science, Metallurgy and Engineering Materials, Umesh Publication, 2012.
4. Raghavan V., Material Science and Engineering, 4th ed., Prentice Hall of India, 2003.
5. Chawla K. K., Composite Materials Science and Engineering, Springer Verlag, 2012.
6. Jones R. M., Mechanics of Composite Materials, McGraw-Hill, 1999.

MIE 2223: METROLOGY AND MEASUREMENTS [3 0 0 3]

Measurement systems, Definition of standard terms, Measurement of pressure, temperature, strain, force, torque & shaft power. Limits, fits & tolerances, Types of fits, Gauges, Taylor's principle, Measurement of form errors, Straightness, squareness and flatness measurement, Surface texture, Screw thread measurement, Two-wire & three-wire method.

References:

1. Beckwith Thomas G., Mechanical Measurements, Pearson Education, 2003.
2. Jain R.K., Engineering Metrology, Khanna Publishers, 1997.
3. Sawhney A.K., Mechanical Measurement & Instrumentation, Dhanpat Rai and Co, 2002.
4. Nakra B.C. and Chaudry K.K., Instrumentation, Measurement and Analysis, Tata McGraw Hill, 2002.
5. Gupta I. C., Engineering Metrology, Dhanpat Rai Publications, 1997
6. Raghavendra N.V. and Krishnamurthy L., Engineering Metrology and Measurements, Oxford University Press, 2013.

MIE 2224: TURBO MACHINES [2 1 0 3]

Introduction: Types of turbo machines, dimensional analysis and similitude, specific speed, affinity laws, Moody's empirical efficiency formula. Energy transfer: Euler turbine equation, degree of reaction, concept of utilization factor, zero angle turbine, head capacity relationship, effect of exit blade angle on performance. Thermodynamics of turbomachines: Isentropic efficiency, infinitesimal polytrophic and finite stage efficiencies, preheat factor and reheat factor. Centrifugal pumps: Static pressure rise, manometric head, various efficiencies, minimum starting speed, cavitation and NPSH, slip and slip factor, main and operating characteristics, iso-efficiency graph. Centrifugal compressors, blowers and fans: h-s diagram, stage work, degree of reaction, need for limiting inlet relative velocity in high speed compressors, phenomenon of surging. Axial flow compressors and fans: h-s diagram, velocity triangles, enthalpy and stagnation pressure loss coefficients, blade loading, degree of reaction, work done factor. Hydraulic turbines: Pelton turbine, work done and hydraulic efficiency, design parameters and governing, Francis turbine, draft tube theory, Kaplan turbine, governing of reaction turbines. main and operating characteristics, iso-efficiency graph. Steam turbines: SFEE across a steam nozzle, D'laval Turbine, nozzle and blade efficiencies, need for compounding, curtis stage, Rateau turbine, Parson's reaction turbine.

References:

1. Yahya S.M., Turbines Compressors and Fans, 4th ed., Tata Mc. Hill, New Delhi, 2017.
2. Seppo A. Korpela, Principles of Turbomachinery, John Wiley & Sons Ltd, 2nd Ed, 2019.
3. Dixon S.L., Fluid Mechanics, Thermodynamics of Turbomachinery, Pergamon, 6th Ed, 2010.
4. V Kadambi, An Introduction to Energy Conversion: Turbomachinery - Vol. III, New Age International Private Limited, 2011.
5. Maneesh Dubey, BVSSS Prasad, ArchanaNema, Turbomachinery, 1st Ed, McGraw Hill Education, 2018.

MIE 2225: MANUFACTURING PROCESSES - II [3 0 0 3]

Hot and Cold Working of metals, forging processes, Rolling of metals, Principle of rod and wire drawing, Tube drawing, Principles of Extrusion. Broaching, Planing, Slotting, Shaper machines. Jigs and Fixtures, Types, Analysis of locating and clamping methods. Micro finishing Processes Chipless machining, Internal and external thread rolling, Spline rolling. Powder Metallurgy: Methods of powder production, Properties of powdered metals. Surface Coating, Powder Coating, CVD, PVD, Thermal Spray, Sputtering, Hard facing. Rapid prototyping, Fused Deposition Modeling, Stereolithography, Laminated object manufacturing, Selective Laser Sintering, Selective Powder Binding. Economics of Machining, optimization of cutting parameters and its calculations.

References:

1. Rajput R. K., A Text book of Manufacturing Technology, Laxmi Publications Private Limited, 2011.
2. Khanna O.P., A text book of Production Technology (Vol1&2), Dhanpat Rai Publications, 2011.
3. Rao P. N., Manufacturing Technology, Tata McGraw-Hill Publishing Company Limited, 2006.
4. Serope Kalpakejian and Steven Schmid R, Manufacturing Engineering and Technology, Pearson Education, 2005.
5. Paul DeGarmo E., Black J. T. and Ronald Kohser A, Materials and Process in Manufacturing, John Wiley and Sons, 2004.
6. Lal M.&Khanna O. P., Foundry Technology, Dhanpat Rai & Sons, 1991.
7. Jain R. K., Production Technology, Khanna Publishers, 2001.
8. Chua C. K, Leong K F and Lim C S, Rapid Prototyping: Principles and Applications, World Scientific, 2003.
9. Sharma P. C., A Textbook of Production Technology, S. Chand Publishing, 2007.

MIE 2241: MECHANICS LAB [0 0 3 1]

Fluid Mechanics: Coefficient of discharge for Orifice meter and Venturimeter, friction factor for pipes, Reynolds apparatus. Fluid Machines: Performance characteristics of Pelton turbine, Francis tubine, Centrifugal pump and Gear pump. Strength of materials: Uniaxial test on ductile and brittle material, Hardness tests on metals: Vicker, Brinell and Rockwell, Torsion Test on Circular Shaft, Bending test on beam of uniform cross section and beam of uniform strength, Impact tests on metals: Charpy and Izod.

References:

1. Kumar K. L., Engineering Fluid Mechanics, S. Chand Publishing, New Delhi, 2016.
2. C.P. Kothandaraman, Fluid Mechanics and Machinery, 3rd ed., New Age International Publishers, 2012.
3. R.K. Bansal, A Textbook of Strength of Materials: Mechanics of Solids, 6th ed., Laxmi publications, 2018.

MIE 2242: WORKSHOP PRACTICE - II [0 0 3 1]

Spur Gear cutting, Helical Gear cutting, Plain machining, Straight Slot machining & Taper Slot machining using shaper, Face milling, Drilling and Tapping, Contouring, slotting, Pocketing and boring using Vertical Machining Center, Surface Grinding, Cylindrical Grinding, Electro Discharge Machining, Machining using Wire EDM.

References:

1. Hajra C. S. K., Hajra C. A. K. and Nirjhar Roy, Elements of Workshop Technology, Vol. II, Media Promoters and Publishers Pvt. Ltd., 2003.
2. Peter S., CNC Programming Hand book, Industrial Press, New York, 2000.

FIFTH SEMESTER

HUM 3021: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of Single, Uniform, and Gradient cash flow. Related problems and case studies. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, declining and double declining balance method of depreciation, Sum-of-the-Years Digits, Sinking Fund and Service Output Methods, Case Study. Balance sheet and profit & loss statement. Meaning & Contents. Ratio analysis, financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios, Drawbacks. Safety and Risk, Assessment of Risk and safety, Case study, Risk Benefit Analysis and Reducing Risk.

References:

1. Chan S. Park, "Contemporary Engineering Economics", 4th Edition, Pearson Prentice Hall, 2007.
2. Thuesen G. J, “Engineering Economics”, Prentice Hall of India, New Delhi, 2005.
3. Blank Leland T. and Tarquin Anthony J., “Engineering Economy”, McGraw Hill, Delhi, 2002.
4. Prasanna Chandra, “Fundamentals of Financial Management”, Tata McGraw Hill, Delhi, 2006.

FLEXIBLE CORE 1

MIE 3124: DESIGN FOR MANUFACTURE AND ASSEMBLY [3 0 0 3]

Introduction: Essential factors of product design, morphology of design, producibility requirements in design, Design for X, selection of materials and processes. Design for casting and forging: Sand casting-design rules, Investment casting design guidelines, design guidelines for forging. Metal Extrusion: Design recommendation for metal extrusion, stamping, fine blanked parts, Rolled formed section. Design for machining: Design guidelines for turning, drilling, reaming, slotting, milling, grinding, and heat treatment. Design for die-casting and injection moulding: Design guidelines. Design for sheet metal working and powder metal processing: Design guidelines. Design for joining process: design recommendation for welding process, design for solder and brazed assembly. Design for adhesively bonded assemblies: design recommendations. Design for additive manufacturing: design rules for additive manufacturing. Design for assembly: importance of DFA, basic DFA guidelines, product design for manual assembly, design for high-speed automatic assembly and robot assembly. Process engineering: Importance of Fits, tolerance and surface finish in design, manufacturing drawings.

References:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston A. Knight, Product Design for Manufacture and Assembly, CRC Press, 2011.
2. James G. Brala, Design for Manufacturability Handbook, McGraw Hill, New York, 1999.
3. Kevin Otto and Kristin Wood, Product Design, Pearson Education, Delhi, 2001.
4. Chitale A. K. and Gupta R. C., Product Design and Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
5. George E. Dieter, Engineering Design, McGraw Hill Book Co., Singapore, 2000.
6. Karl T. Ulrich & Steven D. Eppinger, Product Design and Development, Irwin McGraw Hill, Boston, 2003.

MIE 3125: GREEN ENERGY TECHNOLOGY [3 0 0 3]

Solar energy: Introduction, principle of conversion of solar radiation into heat, types of solar collectors and their conversion, applications of solar energy conversion –thermal, photovoltaics, hydrogen production. Wind energy: Introduction, principle of wind energy conversion, classification of wind turbines, components and materials, wind farm and site selection, applications of wind energy conversion – grid connectivity, standalone, offshore, industries. Energy from Biomass: Introduction to biomass conversion – wet and dry processes, anaerobic digestion and biogas generation, gasification and pyrolysis, hydrothermal carbonization. Energy from Fuel Cells: Introduction, design and operation of fuel cells, classification of fuel cells, advantages and disadvantages, performance characteristics and efficiency, application of fuel cells. Hydrogen energy: Introduction, production of hydrogen from various methods – electrical, thermal, thermochemical, solar energy, storage and transportation of hydrogen energy, utilization of hydrogen gas.

References:

1. Duffie J. A. and Beckman W. A., Solar Energy Thermal Processes, 4th ed., John Wiley and Sons, Inc., 2013.
2. Rai G. D., Non-Conventional Energy Sources, Khanna Publishers, 2006.
3. Mittal K. M., Non-Conventional Energy Systems – Principles, Progress and Prospects, Wheeler Publications, 1997.

MIE 3126: HEAT TREATMENT OF METALS AND ALLOYS [3 0 0 3]

Iron-Carbon equilibrium diagram and fundamentals of heat treatment, Heat treatment processes viz. Annealing, Normalising, Hardening, Tempering, etc. Case and surface hardening treatments, Age hardening and thermomechanical treatments, Steel specification, classification and heat treatment of steels and cast iron, IS and AISI classification of steel, Heat treatment and application of non-ferrous metals and alloys, Aluminium alloys, Titanium alloys, Copper alloys, Defects, Causes and remedies in heat treatment.

References:

1. Rajan T. V., Sharma C.P and Alok Sharma, Heat treatment principles and techniques, PHI Publication, 1999.
2. Bolton W., Engineering materials technology, Heinmann Newness, 2001.
3. Thelning K. E., Steel and its heat treatment, Butterworth/Heinemann, 2000.
4. Romesh C. Sharma, Principles of Heat Treatment of Steels, New Age International (P) Limited, 1996.
5. Vijendra Singh, Heat Treatment of Metals, Standard Publishers Distributors, 2012.
6. Avner S. H., Introduction to Physical Metallurgy, 3rd ed., McGraw Hill, 2004.
7. William D. Callister, Materials Science and Engineering, John Wiley & Sons, 2007.

ELE 3127: FOUNDATIONS OF EV & HYBRID VEHICLES [3 0 0 3]

Principles for Electric Vehicles: EV Industry, EV Technology and Automotive Revolution, Electrical Engineering for EV, Battery Technology

Control system for Electric Vehicles: Motor and Controller Systems, EV Numerical Calculations, EV Charging Infrastructure, Practical session - Well-to-wheel analysis of EV architecture

Essentials for Electric Vehicles: Electrical Requirement, Power Distribution Specifications, Electronic Control System, Practical session - EV connection and system analysis

Types of components in Electric Vehicles: EV Standards and Classifications, Selection for Electrical and Electronic Components, Practical session - EV hardware components

Principles for Hybrid Vehicles: Introduction to Hybrid Vehicles, Battery Chemistry, Efficiency, Definition and Parameters for Hybrid Systems, Electric Motors, Generators and Power Electronics for Hybrid Systems, Control Systems, Hybrid Electric Vehicle Operation, Practical session - Numerical study on powertrain sizing of HEV

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", Routledge, 3rd Ed, 2021, ISBN: 9780367693930
3. Muhammad Ehsani, Mehrdad Ehsani, and Ali Emadi, "Electric Vehicle Systems Architecture and Standardization Needs", Reports of the PPP European Green Vehicles Initiatives, Springer, 2015.
4. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 1st Ed, 2014, ISBN: 9781138072855.
5. Rodrigo Garcia-Valle and João A. Peças Lopes, “Electric Vehicle Integration into Modern Power Networks", Springer, 2013, ISBN: 978-1461401339.
6. Chris Mi and M. Abul Masrur, “Hybrid electric Vehicles, Principles and Applications with Practical perspectives”, WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6.
7. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

MIE 3121: GEOMETRIC MODELLING [3 0 0 3]

Introduction to Computer Graphics and Coordinate systems: Introduction to computer graphics, Non-interactive versus interactive computer graphics, Graphic Standards and mode of data transfer: Neutral file formats. Geometric co-ordinate systems and Display co-ordinate systems. Geometrical Transformation techniques: 2D Translation, Rotation, Scaling and Reflection principles. Principle of concatenated transformation and homogenous coordinate system. Geometric modelling of Curves: Analytical Curve modelling and Synthetic Curve modelling. Curve manipulation techniques. Geometric modelling of Surfaces: Analytical surface modelling and Synthetic surface modelling Surface manipulation techniques. Geometric modelling of Solids: Solid modelling techniques - Boundary Representation, Constructive Solid Geometry, Analytical Solid Modelling, Sweep Representation, Pure Primitive Instancing. Solid manipulation techniques.

References:

1. Groover Mikell P. and Zimmers. Emory W., Computer Aided Design and Manufacturing, Prentice Hall of India, New Delhi, 2000.
2. Rao P.N., CAD/CAM, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2005.
3. Ibrahim K Zeid, CAD/CAM Theory and Practice, Tata McGraw Hill, New Delhi, 2009.
4. David F Rogers and J Alan Adams, Mathematical Elements for Computer Graphics, Tata McGraw Hill, New Delhi, 2002.
5. Ibrahim Zeid and R Sivasubramanian, CAD/CAM Theory and Practice, TATA Mc Graw Hill Education Private Limited, New Delhi, Special Indian Edition 2009.
6. Chougule N K, CAD/CAM/CAE, SCITECH Publications (India) Private Limited, Chennai, 2010.

MIE 3122: FINITE ELEMENT METHODS [3 0 0 3]

Introduction to Finite Element Method, steps of FEM, advantages/ disadvantages and applications of FEM, discretization and element types, matrix algebra, efficient storage of Banded matrices, matrix solution methods for system of simultaneous equations, Eigen value problem, one/two point Gauss quadrature method of numerical integration, basics of theory of elasticity, plane stress/plane stress/axisymmetric problems, minimum potential energy principle, Rayleigh-Ritz's method, Galerkin's method, Basic concepts of FEM, convergence, Pascal's triangle, higher order quadrilateral/triangular elements, shape functions for Lagrange/Serendipity elements and CST element, application of direct stiffness method for one dimensional axially loaded bar and for one dimensional fluid element, Elimination and Penalty methods of handling boundary conditions, isoparametric formulation of 1D bar element, plane/space truss element, plane/space frame element, triangular element, quadrilateral element, axisymmetric triangular element, tetrahedral and hexahedral elements. Application of the Galerkin's residual method to 1-D structural problem.

References:

1. Chandrupatla T. R. and Belegundu A. D., Introduction to Finite Elements in Engineering, Pearson Education, New York, 2001.
2. Logan Daryl L., A First course in Finite Element Method, 4th ed., Thompson Ltd, India, 2007.
3. Hutton David V., Fundamentals of Finite Element Analysis, Tata McGraw Hill, India, 2005.
4. Reddy J. N., An Introduction to Finite Element Method, 3rd ed., McGraw Hill International Edition, New York, 2006.
5. Segerlind Larry J., Applied Finite Element Analysis, 2nd ed., John Wiley, New York, 1984.
6. Desai C. S. and Abel J. F., Introduction to the Finite Element Method: a numerical method for engineering analysis, Van Nostrand Reinhold Co., 1971.
7. Krishnamoorthy C. S., Finite Element Analysis – Theory & Programming, Tata McGraw-Hill Education, 1994.

MIE 3123: HEAT AND MASS TRANSFER [3 1 0 4]

Introduction: Modes of heat transfer, governing laws and its derivatives, overall heat transfer coefficient. Steady state conduction: General heat conduction equation, heat flow through plane and composite wall, cylinder and sphere, critical thickness of insulation, temperature dependent thermal conductivity, plane, cylinder and sphere with uniform rate of internal heat generation. Heat transfer from extended surfaces, fin efficiency and effectiveness. Transient conduction: Lumped system analysis, Biot and Fourier number, time constant, transient heat conduction in large plane walls. Lumped system analysis. Convection heat transfer: Velocity and thermal boundary layer, dimensional analysis, free and forced convection heat transfer over flat plate, cylinder, sphere and in tubes. Boiling and condensation: Boiling regimes, correlations, film and drop-wise condensation, Nusselt theory. Heat exchangers: types, analysis of heat exchangers – LMTD and NTU method. Radiation: Characteristics, governing laws, radiation intensity, heat transfer between black surfaces and between gray surfaces, radiation shields. Mass transfer: Mass diffusion, Fick's law, diffusion of two species in a stationary medium, steady mass diffusion through a wall, simultaneous heat and mass transfer.

References:

1. Yunus A. Cenzel and Afshin J. Ghajar, Heat and Mass transfer, 6th ed., Tata McGraw Hill, 2020.
2. Thirumaleshwar M., Fundamentals of Heat and Mass Transfer, 1st ed., Pearson Education, 2006.
3. Rajput R. K., Heat and Mass Transfer, 7th ed., S Chand Publishing, 2019.
4. Theodore L. Bergman, Adrienne S. Lavine, Frank P. Incropera, David P. DeWitt, Fundamentals of Heat and Mass Transfer, 8th Ed, Wiley Publications, 2018.
5. R C Sachdeva, Fundamentals of Engineering Heat and Mass Transfer (SI Units), New Age International Private Limited, 6th Ed, 2022.
6. Holman J. P. and Bhattacharya Souvik, Heat Transfer, 10th ed., Tata McGraw Hill, 2017.

MIE 3141: MECHANICAL LAB [0 0 3 1]

Determination of fuel Characteristics such as viscosity, flash and fire points, carrying out the performance test in a SI and CI engines, Performance test of an air compressor and a blower, Determination of Compression ratio of an IC engine, Determination of dryness fraction of steam using Boy's Gas calorimeter, sand testing, calibration of pressure gauges and governors, balancing of revolving masses.

References:

1. Ganeshan V., Internal Combustion Engines, 4th ed., Tata McGraw Hill Education Private Limited, New Delhi, 2017.
2. Mathur M. L., and Sharma R. P., Course in Internal Combustion Engines, 8th ed., Dhanpath Raj Publishers, New Delhi, 2010.
3. Rattan S. S., Theory of Machines, 4th ed., Tata Mc-Graw Hill Publishers Pvt. Ltd, New-Delhi, 2014.
4. Cengel, Thermodynamics and Heat Transfer, 2nd ed., McGraw Hills, New York, 2008.
5. Nag. P. K., Engineering Thermodynamics, 6th ed., Tata McGraw Hills, New Delhi, 2017.

MIE 3142: METROLOGY LAB [0 0 3 1]

Measuring instruments and gauges, Screw thread measurements, Measurement of effective diameter of external screw threads, Comparators, Gear measurement, Radius and angle measurement, Calibration of Micrometer and Vernier caliper, Surface texture and straightness measurement, Use of Profile projector, Coordinate Measuring Machine and Interferometer.

References:

1. Jain R. K., Engineering Metrology, Khanna Publishers, 1997.
2. Gupta I. C., Engineering Metrology, Dhanpat Rai Publications, 1997.
3. Raghavendra N. V., Krishnamurthy L., Engineering Metrology and Measurements, Oxford University Press, 2013.

SIXTH SEMESTER

HUM 3022: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Definition of management and systems approach, Nature & scope. The Functions of managers, Principles of Management. Planning: Types of plans, steps in planning, Process of MBO, how to set objectives, strategies, policies and planning premises, Strategic planning process and tools. Nature and purpose of organizing, Span of management, factors determining the span, Basic departmentation, Line and staff concepts, Functional authority, Art of delegation, Decentralization of authority. HR theories of planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership – leadership behavior & styles, Managerial grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit and Loss control, Control through ROI, Direct, Preventive control. PROFESSIONAL ETHICS - Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories about right action, Self-interest, Customs and Religion, Uses of Ethical Theories. GLOBAL ISSUES - Managerial practices in Japan and USA & application of Theory Z. The nature and purpose of international business & multinational corporations, unified global theory of management, Entrepreneurship and writing business plans. Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisers, Moral Leadership, Code of Conduct, Corporate Social Responsibility.

References:

1. Harold Koontz & Heinz Weihrich (2020),"Essentials of Management", McGraw Hill, New Delhi.
2. Peter Drucker (2004), "The practice of management", Harper and Row, New York.
3. Vasant Desai (2007), "Dynamics of entrepreneurial development & management", Himalaya Publishing House.
4. Poornima M Charantimath (2006), "Entrepreneurship Development", Pearson Education.

FLEXIBLE CORE 2

MIE 3221: FATIGUE AND FRACTURE [3 0 0 3]

Fatigue and fracture overview, deformation and failure modes of engineering materials, fatigue types, design philosophies, mechanism; High-cycle fatigue, fatigue loads and tests, stress-life (S-N) curves, mean stress effects, constant life diagrams, influencing factors, stress concentration and notch effects, life estimation using S-N approach, cumulative damage theories; Low-cycle fatigue, monotonic and cyclic stress-strain behavior, CSSC determination, stress-plastic strain relationship, cyclic deformation and crack initiation in ductile and brittle solids, transition life, strain life equations, mean stress effects, notch strain analysis, examples of life estimation; Linear elastic fracture mechanics, fracture modes and mechanisms, Griffith's analysis, energy release rate, elastic crack tip fields, stress and displacement field, stress intensity factor, crack tip plasticity, plastic zone shape and size, Rcurves, fracture toughness; Fatigue fracture mechanics, dynamic crack growth, crack closure and fatigue threshold, effect of variable amplitude and over loading cycles, prediction of life of a structural component, generation of crack growth plots.

References:

1. Bannantine Julie A, Jess J Comer and Handrock James L, Fundamentals of Metal fatigue and Analysis, Prentice Hall, Upper Saddle River, NJ, 1990.
2. Dowling Norman E, Mechanical Behavior of Materials, Fourth Edition, Pearson Publications, USA, 2017.
3. Stephens Ralph I, Fatemi Ali, Stephens Robert R and Henry, Metal fatigue in Engineering, Second Edition, John Wiley and Sons Inc, New York, 2001.
4. Suresh S, Fatigue of Materials, Second Edition, Cambridge University Press., UK, 1998.
5. Prashant Kumar, Elements of Fracture Mechanics, McGraw Hill Education Private Limited, 2013.
6. Anderson T. L., Fracture Mechanics-Fundamentals and applications, Third Edition, CRC Press, London, 2017.

MIE 3222: REFRIGERATION AND AIR CONDITIONING [3 0 0 3]

Basic concepts and Air refrigeration cycles: Basic terminologies, uses of refrigeration and air conditioning, different refrigeration cycles, air refrigeration cycles for aircrafts. Vapour compression and absorption refrigeration systems: Thermodynamic analysis, absorption refrigeration, absorption versus compression, refrigerants for vapor compression and absorption systems. Other refrigeration cycles: Thermoelectric refrigeration, Vortex tube refrigeration, Steam jet refrigeration. Psychrometrics: Properties of air-vapour mixtures, psychrometric charts, process involving air-vapour mixtures. Air Conditioning: Air-conditioning systems and applications- Unitary and central systems. Summer and winter air conditioning systems. Cooling load calculations: Air conditioning load estimation, sensible and latent heat gain from internal and external sources, RSHF, RLHF, GTHF.

References:

1. Arora S. C. and Domkondwar S., Course in Refrigeration and Air-conditioning, Danpath Rai. New Delhi, 2018.
2. Prasad Manohar, Refrigeration and Air-conditioning, 3rd ed., New Age International Pvt. Limited. New Delhi, 2021.
3. Rex Miller, Mark Miller, Air Conditioning and Refrigeration, McGraw Hill Professional, 2006.
4. Dossat R. J., Principles of Refrigeration, 4th ed., Pearson Education India, 2002.
5. Alfred F. Bracciano, Andrew D. Althouse, Carl H. Turnquist, Daniel C. Bracciano, Gloria M. Bracciano, Modern Refrigeration and Air Conditioning, 21st Ed, G-W publishers, 2021.

MIE 3223: MACHINE TOOL TECHNOLOGY [3 0 0 3]

Introduction to Machine Tool Drives and Mechanisms: Machine tool drives-individual drive, Group drive, Regulation of Speeds and Feeds: Stepped Regulation of Speeds, Flow Diagram, Structural diagram, Ray diagram, Speed diagram, Machine tool structures: Basic

Design procedure of machine tool structures, Guide ways, Spindles, Spindle assembly of lathe, Milling & Drilling machines, Design of Spindle, Requirements of Spindle Supports, Selection of sliding and antifriction bearings, Vibration of machine tools.

References:

1. Mehta N. K., Machine Tool Design & Numerical control, Tata McGraw Hill Publishing Co. Ltd., 2012.
2. Sen G.C., Bhattacharya I., Principles of Machine Tools, New Central Book Agency, 2009.
3. C. M. T. I., Machine Tool Design Handbook, Tata McGraw Hill Publishing Co. Ltd., 2004.
4. Pal D. K., BASU S. K., Design of Machine Tools, Oxford and IBH, 2008.
5. George Schlesinger, Testing Machine Tools, Deutsche National bibliothek, 2017.

ELE 3225: AUTOMOTIVE MECHANICS FOR ELECTRIC VEHICLES [3 0 0 3]

Automotive Engineering & Vehicle Dynamics: Vehicle Dynamics Fundamentals, Tire Mechanics and Dynamics, Suspension Systems, Braking Systems, Aerodynamics, Powertrain Systems, Vehicle Stability Control, Vehicle Safety, Vehicle Dynamics Simulation, Electric and Hybrid Vehicle Dynamics, Practical session - EV Dynamics & calculations.

Sketching for Automotive EV Design [Software-based]: Introduction to Automotive Sketching Software, Overview of Vehicle Design Process and Automotive Sketching, Basic Sketching Techniques and Tools in the Software, Sketching Car Exteriors, Interiors and Details, Creating Different Views and Angles of the Vehicle, Rendering and Presenting the Final Sketches, Understanding Proportions, Perspectives and Shapes in Automotive Sketching, Creating Sketches for Different Vehicle Types (Sedans, SUVs, and Trucks), Tips and Tricks for Automotive Sketching in the Software.

Advanced EV Modelling Using SolidWorks Tool [Software-based]: Introduction to EV Technology and Its Benefits, Basic Vehicle Design Principles, Design and Modelling of Chassis and Frame, Suspension Systems, Design and Modelling of Braking and Steering Systems, Design and Modelling of Electrical Components for EVs, Battery Pack Design and Modelling for 2, 3 and 4 Wheelers, Motor and Drivetrain Design and Modelling for 2, 3 and 4 Wheelers, Design and Modelling of Wheels and Tires for 2, 3 and 4 Wheelers, Testing and Simulation of Vehicle Performance Using Solid Works, Design for Manufacturability and Assembly Considerations, Sustainability and Environmental Impact Considerations in EV Design, Practical session - EV hardware components walkthrough.

Multibody Dynamics with MSC Adams [Software-based]: Introduction to MSC Adams Software and Its Capabilities, Setting Up the Modelling Environment in MSC Adams, Multi-body Dynamics Principles and Application to Vehicle Systems Modelling, Vehicle Suspension Systems Modelling, Vehicle Steering Systems Modelling, Vehicle Braking Systems Modelling, Practical session - EV Component design & modeling.

EV Analysis with MSC Adams (Software-based): Tire Force and Characteristics Modelling, Vehicle Dynamics Analysis Including Simulating Ride and Handling, Vehicle Stability and Rollover Events, Optimisation Techniques for Vehicle Designs Using MSC Adams, Integration of MSC Adams Models with Other Software Tools for System-level Simulations and Analysis, Practical session - EV body design analysis.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Du, H., Cao, D., & Zhang, H. (n.d.). “Modelling, Dynamics, and Control of Electrified Vehicles”, Woodhead Publishing, 2017, ISBN-13: 9780128127865
3. Zaman N., “Automotive Electronics Design Fundamentals”, Springer, 2015, ISBN-13: 9783319359793
4. Gianfranco Pistoia, “Electric & Hybrid Vehicles”, Elsevier, 1st ed, 2010, ISBN: 9780444638250.
5. Chau, K. T., “Electric Vehicle Machines and Drives: Design, Analysis and Application”, John Wiley and Sons, Inc., 2015, ISBN-13: 9781118752524.
6. Ehsani, Mehrdad, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles”, CRC, 2019, ISBN-13: 9780367137465.
7. Hughes, Austin, “Electric Motors and Drives”, Newnes (an Imprint of Butterworth-Heinemann Ltd), 2019, ISBN-13: 9780081026151
8. Chris Ni and M. Abul Masrur, “Hybrid electric Vehicles, Principles and Applications”, WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6
9. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

FLEXIBLE CORE 3

MIE 3224: MECHANICAL VIBRATION [4 0 0 4]

Introduction to vibration: Importance, scope, definition, terminology, limits of vibration severity. Single degree free vibration: Natural frequency by Newton's Classical method and Energy method, Longitudinal, lateral and torsional vibration, Pendulum and pulley systems. Damped free vibration: Influence of damping on Vibration, types of Viscous damping, Coulomb damping. Forced vibration: system is subjected to harmonic excitation, rotating and reciprocating unbalance, force and displacement transmissibility, vibration isolation, whirling of shafts, critical speed of shaft. Vibration measurement: Transducers, vibrometer, accelerometer, frequency measuring instruments, exciters, machine condition monitoring using vibration signals. Two degree of freedom system: Natural frequencies and mode shapes of vibration by Classical method and Lagrange's generalized method, Dynamic vibration absorber, Centrifugal pendulum absorber. Multi degree freedom system: Natural frequency of free vibration by Influence coefficient method, Matrix iteration method, Rayleigh's method, Dunkerley's method, Stodola method and Holzer's method.

References:

1. Singirisu Rao S., Mechanical Vibration, Pearson Education, Delhi, 5th ed., 2011.

2. S. Graham Kelly, Fundamentals of Mechanical Vibrations, McGraw-Hill, Singapore, 2nd ed., 2000.
3. Rao J. S. and Gupta K., Introductory Course on Theory and Practice of Mechanical Vibrations, New Age Publishers, 2nd ed., 1999.
4. Groover G. K., Mechanical Vibrations, Nem Chand and Bros, 8th ed., 2009.
5. Seto W. W., Theory and Problems in Mechanical Vibrations, McGraw-Hill Publication, 1989.

MIE 3225: COMPUTATIONAL FLUID DYNAMICS [4 0 0 4]

Introduction: Numerical, experimental and analytical methodology, advantages, limitations, need for CFD, CFD process, equilibrium and marching problems, mathematical behavior of Parabolic, Hyperbolic and Elliptic PDE, governing equations of flow and energy, boundary condition and its types, demonstration of CFD software tool. Finite Difference Method: Finite difference representation of PDE, Taylor's series expansion, truncation, discretization and round-off errors, consistency, stability, polynomial fitting, finite difference method for steady and unsteady heat conduction. Finite Volume Method: Finite volume method for 1D and 2D steady state diffusion problems, FVM for Convection-diffusion problems: Steady 1D convection-diffusion, discretization schemes-Upwind, central, power law and hybrid, QUICK, properties of discretization schemes, Flow simulation for steady and unsteady turbulent internal flow using different discretization schemes. Pressure-Velocity Coupling: Need for Staggered grid, SIMPLE, SIMPLER, SIMPLEC, PISO algorithm, Turbulence and its modelling: Concept of turbulence, RANS, turbulence models, Flow simulation for turbulent flow over flat plate and pipes using turbulence models.

References:

1. Anderson Jr. J. D., Computational Fluid Dynamics, Tata McGrawHill, 2013.
2. Versteeg H., Malalasekera W., An Introduction to Computational Fluid Dynamics: The Finite Volume Method, 2nd ed., PHI, 2007.
3. Ghoshdastidar P. S., Computational Fluid Dynamics and Heat Transfer, 1st ed., Cengage Learning, 2017.
4. Muralidhar K., Sundarrajan T., Computational Fluid Flow and Heat Transfer, Narosa Publishing House, 2014.

MIE 3226: AUTOMATION IN MANUFACTURING [4 0 0 4]

CNC Machines: Design considerations in CNC Machines, Methods of improving machine accuracy and productivity, Machine structure, Guideways, Spindle and Feed drives, Spindle Bearings, Interpolators CNC Toolings, Distributed Numerical Control, Adaptive Control Machining System, Coordinate measuring machines, NC programming for Turning Center and Machining Center by Manual method, CNC programming with interactive graphics. Industrial Robotics Physical configurations, Manipulator Kinematics, Robot programming, End effecters, Work cell design, Work cell control and interlock, Robotic sensors, Robotic applications. Group Technology, FMS and CIM, Computer aided Process planning, Material requirement planning. Capacity planning, Shop floor control, Automated data collection systems.

References:

1. Yoram Koren and Ben Uri J., Numerical Control of Machine Tools, Khanna Publishers, New Delhi, 2005.
2. Groover Mikell P., Automation, Production Systems, and Computer Integrated manufacturing, Prentice Hall of India, New Delhi, 2003.
3. Groover Mikell P. and Zimmers Emory W., Computer Aided Design and Manufacturing, Prentice Hall of India, New Delhi, 2003.
4. Radhakrishnan P., Computer Numerical Control Machines, New Central Book Agency (P) Ltd., Kolkata, 2004.

MIE 3231: EV BATTERY TECHNOLOGY AND THERMAL MANAGEMENT [4 0 0 4]

EV Batteries: Primary Batteries; Secondary Batteries; Lithium-ion batteries; Fundamentals, Materials, Electrode preparation, Battery Assembly, Testing, Failure Analysis, Safety Issues, State of Charge and State of Health Estimation, Cell Balancing, Protection. Operational Mechanisms of Lithium-Ion Batteries Electrochemical Principles and Reactions, Factors Affecting Battery Performance, Properties of electrode material, Dendrite Formation, Battery Parameters, Lithium-Ion Characteristics, Rate of Heat Generation, Thermal Runaway Battery Management System. Battery Pack Design & Thermal Analysis. Overview of Battery & Battery Management System, Electrical Design, Mechanical Design, Heat Transfer, Thermal Design of Battery Pack, Battery Pack Assembly and Test, Thermal Analysis of Battery Pack.EV PowertrainIntroduction to EV Powertrain, Overview, Architecture, and Components of EV PowertrainThermal Management of EV Powertrain.Thermal Management Techniques for EV Selection of Cooling Technique, Cooling Rates of Different Cooling Methods, Selection Criteria; Single-Phase Gas Flow and Heat Transfer, Single-Phase Liquid Flow and Heat Transfer, Direct and Indirect Liquid Cooling, Liquid Immersion Cooling, Cooling using Phase Change Materials.

References:

1. Rahn, Christopher D., and Wang, Chao-Yang, “Battery Systems Engineering” John Wiley & Sons, Ltd, 2013.
2. Beard, Kirby W., “Linden's handbook of batteries”. McGraw-Hill Education, 2019.
3. Dhameja, Sandeep “Electric Vehicle Battery Systems” NEWNES, 2002.
4. Glaize, Christian, “Lithium batteries and other electrochemical storage systems” John Wiley & Sons, 2013.
5. Dincer, Ibrahim, Hamut, H.S., Javani, N., “Thermal management of electric vehicle battery systems” John Wiley & Sons, Ltd, 2016.
6. Hayes, John G., Goodarzi, G. Abas, “Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles” John Wiley & Sons, Ltd, 2018.

MIE 3241: FINITE ELEMENT METHODS LAB [0 0 3 1]

Analysis of Truss and Beams Using Ansys APDL; 2D Structural analysis using Ansys APDL; 3D Structure Analysis Using Ansys by importing CAD Model; 3D Structure and Thermal Analysis - Importing the CAD model to Ansys Workbench (Both steady-state and Transient Analysis) using Ansys Workbench; Shell Analysis (Composite) using Ansys Workbench; Modal and Harmonic Analysis Using Ansys Workbench;

CFD analysis using Ansys Workbench – 1 (External and Internal flow - Laminar and Turbulent); Fluid-Structure analysis using Ansys Workbench; Explicit Dynamics; Nonlinear Analysis of Structural application.

References:

1. Chandrupatla T. R. and Belegundu A. D., Introduction to Finite Elements in Engineering, Pearson Education, New York, 2002.
2. Logan Daryl L., A First course in Finite Element Method – Fourth India Edition, Thompson Ltd, India, 2007.
3. Zahavi Eliahu, The Finite Element Method in Machine Design, Prentice Hall Inc, USA, 1992.
4. Ramamurthy V., Computer Aided Mechanical Design and Analysis, Tata McGraw Hill, Delhi, 1997.
5. Tickoo Sham, ANSYS workbench 14.0 for Engineers and designers Tutorial, New Delhi Dreamtech publisher, 2014.
6. Chen Xiaolin Liu Yijun, Finite element modeling and simulation with ANSYS workbench, New York CRC Press, 2015.

MIE 3242: HEAT TRANSFER AND SOLAR ENERGY LAB [0 0 3 1]

Heat transfer: Analysis of parallel and counter flow heat exchangers, Heat transfer from a pin fin under free and forced convection, determination of thermal conductivity of a metallic bar and insulating powder, heat transfer through a composite wall, determination of emissivity, Stefan Boltzmann apparatus, calibration of temperature measuring instruments. Solar Energy: Performance evaluation of air heater, water heater, box cooker, paraboloid concentrator, performance characteristics of a Photovoltaic module.

References:

1. Holman J. P. and Bhattacharya Souvik, Heat Transfer, 10th ed., Tata McGraw Hill, 2017.
2. Cenzel Yunus A. and Ghajar Afshin J., Heat and Mass transfer, 6th ed., Tata McGraw Hill, 2020.
3. Kalogirou Soteris A., Solar Energy Engineering, 2nd ed., Academic Press, 2014.
4. Sukhatme S. P. and Nayak J. K., Solar Energy, 4th ed., Tata McGraw Hill, 2017.

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

MIE 4291: INDUSTRIAL TRAINING [0 0 0 1]

Student is undergoing industrial training for a minimum period of 4 weeks during the vacation. After successful completion of training, student is submitting a report to the department and makes a presentation on training.

MIE 4292: PROJECT WORK / PRACTICE SCHOOL [0 0 0 12]

The student is required to carry out a project work in the institution / industry / research LAB / institution of higher learning. The minimum duration of the project work/practice school is 16 weeks. As part of project work / practice school, the student is also required to prepare a project report and make a presentation on the work carried out.

PROGRAM ELECTIVES

MIE 4441: ADVANCED METROLOGY [3 0 0 3]

Introduction, End & line standards for length, Airy & Bessel points, photoelectric microscope and Moir fringe techniques, Fixed & Indicating Gauges, Taylor's principles of gauge design, Comparators, Pre-process, In-process & Post process gauging, Usage of LVDT & Capacitive type gauge heads, Automatic inspection, Measuring Machines, Floating carriage diameter measuring m/c, Universal measuring m/c, Matrix internal diameter measuring machine, Optical dividing head, Coordinate measuring machine, Design principles of measuring machines Abbe's rule, Form Errors, Evaluation of straightness, flatness & roundness, Surface Finish, stylus instrument (TALYSURF), M & E systems usage of interferograms, Screw Threads, Measurement of thread elements for internal & external threads, progressive periodic, drunkenness and irregular pitch errors, NPL pitch measuring machine, Gears, Measurement of tooth thickness, involute profile, pitch, concentricity and alignment, Rolling gear test.

References:

1. Jain R. K., Engineering Metrology, Khanna Publishers, 1997.
2. ASTME, Hand Book of Industrial Metrology, Prentice Hall of India Pvt. Ltd., 1967.
3. Gupta I. C., A Text Book of Engineering Metrology, Dhanpat Rai & Sons, 2018.
4. Bosch John A., Giddings, and Dayton Lewis, Coordinate Measuring Machines and Systems, Marcel Dekker, 1999.

MIE 4442: APPLIED NUMERICAL METHODS FOR MECHANICAL ENGINEERS [3 0 0 3]

Introduction to MATLAB Programming: MATLAB environment, Mathematical Operations, Good Programming practices. Approximations and Errors: Round-off Errors, Truncation Errors, Total Numerical Error, Model Errors. Roots Finding-Bracketing and Open methods: Roots in Engineering and Science, Newton-Raphson Method. Linear Algebraic Equations: Gauss elimination, LU factorization, Cholesky factorization, Jacobi Method, Gauss-Seidel method. Curve Fitting and Interpolation: Linear, polynomial and nonlinear Regression, Splines and piecewise interpolation. Numerical Differentiation and Integration: Richardson Extrapolation, Derivatives of unequally spaced data, Partial Derivatives, The trapezoidal rule, Simpson's Rules, Higher-Order Newton-Cotes formulas, Numerical Integration of Functions-Romberg integration, Gauss quadrature. Differential Equations: Initial and Boundary value problems, Euler's Method, Runge-Kutta Methods, Applications using relevant Case Studies.

References:

1. Chapra S. C., Applied Numerical Methods with MATLAB for Engineers and Scientists, Indian Edition, McGraw Hill, 2012.
2. Mathews J. H. and Fink K. D., Numerical methods using MATLAB. Pearson Prentice Hall, 1999.
3. Ralston A. and Rabinowitz P., A First Course in Numerical Analysis, McGraw Hill, 2001.
4. Salvadori M. G. and Baron M. L., Numerical Methods in Engineering, Prentice Hall, 1961.

5. Singiresu S. Rao, Applied Numerical Methods for Engineers and Scientists, Prentice Hall, Inc., 2002.

MIE 4443: AUTOMATIC CONTROL ENGINEERING [3 0 0 3]

Simple open and closed loop systems, concept of feedback, block diagrams, transfer functions. Representation of Control Components and Systems Representation, differential equations for mechanical systems, electrical systems, hydraulic systems and thermal systems, Integrating devices, hydraulic servo motor, temperature control system, speed control system. Block representation of system elements, Block diagram Reduction, Signal Flow Analysis. Damping ratio and natural frequency, First order and second order system response to various input, Modes of control, characteristics of various controllers. System type numbers and steady-state error, System stability criteria, stability of control system using Routh criteria. Polar and rectangular plots for the frequency response, System analysis using polar plots (Nyquist criterion). System analysis using logarithmic plots: Bode diagrams: Stability analysis using Bode diagrams, System analysis using root locus plots: System compensation: Series and feedback compensation physical devices for system compensation. Digital computer control: Concepts and control configurations. State space analysis of control systems Analysis of systems, Concept of state, state variable and state model, state model of linear systems, Eigen Values, Transfer function derivation from the state model, Solution of time invariant state equation.

References:

1. Norman S. Nise, Control Systems Engineering, Wiley India, 2015.
2. Katsuhiko Ogata, Modern Control Engineering, Prentice Hall, India, 2010.
3. Kuo B. C. and Golnarghi F., Automatic Control Systems, Wiley, India, 2009.
4. César Pérez López, MATLAB Control Systems Engineering, Springer, Apress Academic, 2014.
5. Harrison H. L. and Bollinger J. G., Automatic controls, 2nd ed., International Text Book Co. U.S.A, 1969.
6. Nagarth I. J. and Gopal M., A text book of control system engineering, New age International Publishers, 2021.

MIE 4444: BIOMECHANICS [3 0 0 3]

Introduction to Biomechanics: Brief history, Contributions of Biomechanics to health science, Contributions of Biomechanics to the field of Mechanics, Hemodynamics: Rheology of blood, Large artery hemodynamics, Small artery hemodynamic, Sports biomechanics : Movement patterns – the essence of sports biomechanics, Qualitative and quantitative analysis of sports movements, forces and torques, The anatomy of human movement, Biomechanics of respiratory system : Gross anatomy of the conducting airways and pulmonary vasculature, Anatomy of associated structures, Biomechanics of breathing, Mass transfer and particle transport in lungs, Skeletal biomechanics: Introduction to bone, Biomechanics of cortical and trabecular bone, Fracture and failure mechanics, Mechanobiology, Structure of ligament, tendon and cartilage and its biomechanics, Terrestrial locomotion : Jumping, Description of walking and running, Gait analysis, Biomechanics of Cardiovascular system: Biomechanical hierarchy in cardiovascular physiology, Structure-function relationship in cardiovascular tissues, Biomechanical feedback in the cardiovascular system, Experimental and computational methods.

References:

1. Fung Y. C., Biomechanics: motion, flow, stress, and growth, Springer Science & Business Media, 2013.
2. Oomens C., Brekelmans M., Loerakker S., and Baaijens F., Biomechanics: concepts and computation, Cambridge University Press, 2018.
3. Ethier C. R., and Simmons C. A., Introductory biomechanics: from cells to organisms, Cambridge University Press, 2007.
4. Bartlett R., Introduction to sports biomechanics: Analysing human movement patterns, Routledge, 2014.
5. Hirasawa Y., Sledge C. B., and Woo S. L., Clinical biomechanics and related research, Springer Science & Business Media, 2012.

MIE 4445: ENERGY AUDIT, CONSERVATION AND STORAGE [3 0 0 3]

Energy management and Audit: Energy management principles, action plan, audit methodologies, audit instruments. Energy conservation and performance assessment: Critical thickness and economical thickness of insulation, power factor improvement methods, electrical lighting and energy conservation methods. Waste heat recovery devices and cogeneration: Waste heat recovery devices, cogeneration principles, methods, types and performance evaluation of cogeneration system. Performance assessment of mechanical systems: Performance evaluation of different systems, energy conservation measures, case studies. Need of energy storage: Introduction and different modes of energy storage. Potential energy: Pumped hydro storage, flywheel storage, compressed air energy storage, electrical and magnetic energy storage, chemical energy storage, thermo-chemical, photo-chemical, bio-chemical, electro-chemical, hydrogen for energy storage, solar Ponds for energy storage. Sensible and Latent Heat Storage: Stratified storage systems, rock-bed storage systems, phase change materials, selection criteria, numerical heat transfer in melting and freezing process.

References:

1. Turner W. C., Energy management Handbook, 8th ed., Fairmont Press, 2012.
2. BEE (Bureau of energy efficiency) Study Material, Energy Management & Energy Audit, www.bee-india.com
3. Dinçer Ibrahim and Rosen Marc A., Thermal Energy Storage: Systems and Applications, 3rd ed., Wiley–Blackwell, 2021.

MIE 4446: FRICTION AND WEAR [3 0 0 3]

Surface interactions, influence of material properties, measurement methods of surface interactions, friction, types of friction, measurement of friction, wear & types of wear, importance of wear, different types of wear, wear testing methods as per ASTM standard, adhesive wear, types of adhesive wear, mechanism of adhesive wear, materials used in adhesive wear situations. Abrasive wear, types of abrasive wear, mechanisms of abrasive wear, erosive wear, types and mechanisms of erosive wear, corrosive wear, fatigue wear, fretting fatigue wear and respective wear mechanisms. Lubrication: Lubricants, types of lubricants, required and desired characteristics, testing methods. Hydrodynamic, hydrostatic and elasto-hydrodynamic lubrication, solid film lubrication, boundary lubrication, effectiveness of liquid lubricant and solid lubricant.

References:

1. Rabinowicz E., Friction and Wear of Materials, 2nd edition, John Wiley & Sons, Inc., 2013.
2. Bharat Bhushan, Principles and applications of Tribology, 2nd edition, John Wiley & Sons Inc., 2013.
3. Arnell R. D., Davies P. B., Halling J. & Whomes T. L., Tribology: Principles and design applications, Palgrave Macmillan, 1991.
4. Kragelsky I. V., Alisin V.V., Friction Wear Lubrication – Tribology handbook, Elsevier Science & Technology, Kent, 2016.
5. Majumdar B. C., Tribology of Bearings, S Chand, 2010.

MIE 4447: INDUSTRIAL AUTOMATION AND IOT [3 0 0 3]

Basic concepts of process automation, Architecture of industrial automation network, Basics, Design & Architecture of Programmable Logic Controller (PLC), PLC Programming Tools, Roles of computer in automation, Architecture of computer based industrial automation, Hardware and software configuration, Basic concepts of Distributed Control System (DCS), Basic concepts of Supervisory Control and Data Acquisition (SCADA), Cloud computing, Edge computing, Basics of internet of things (IoT) and industrial internet of things (IIoT).

References:

1. Dey C., Sen S.K., Industrial Automation Technologies, CRC Press, 2020.
2. Lamb F., Industrial Automation: Hands On, McGraw-Hill Education, 2013.
3. Comer D., The Cloud Computing Book: The Future of Computing Explained, CRC Press, 2021.
4. Buyya R., Srirama S. N., Fog and Edge Computing: Principles and Paradigms, Wiley, 2019.
5. Ismail Y., Internet of Things (IoT) for Automated and Smart Applications, Intech Open, 2019.

MIE 4448: INDUSTRIAL SAFETY ENGINEERING [3 0 0 3]

Introduction to Safety Engineering, Industrial Accidents, Theories of Accident Causation, Introduction to Health and Toxic Substances, Environmental Control and Noise, Ventilation and its Design Principle, Personal Protection and First Aid, Fire Protection, Machine Guarding, Safeguarding the point of operation, Power presses, Grinding machines, Saws, Belts and Pulleys, Safety consideration regarding material handling and storage. Safety Requirement for Material Handling and Storage, Electrical Hazards, Employee Participation in Promoting Safety, Safety Training, Safety Committees, Teamwork Approach to Promoting Safety.

References:

1. Asfahl C. R. and Rieske D. W., Industrial Safety and Health Management, 6th ed., Pearson Education, 2011.
2. Spellman F. R. and Whiting N. E., The Handbook of Safety Engineering: Principles and Applications, Government Institutes, 2009.
3. Gupta A., Industrial Safety and Environment, 1st ed., Laxmi Publications Pvt. Ltd., 2006
4. Goetsch D. L., Occupational Safety and Health for Technologists, Engineers and Managers, 8th ed., Pearson Education Limited, 2014.

MIE 4449: MEMS AND NANOTECHNOLOGY [3 0 0 3]

Overview of Micro Electro Mechanical Systems and Microsystems, Applications of microsystems, Working principles of microsystems micro sensor, micro actuators, micro accelerometers, microfluidics, Design of microsystems, Scaling laws in miniaturization, materials for MEMS and microsystems, fabrication process, micro manufacturing methods bulk micro manufacturing, surface micromachining, LIGA Process. General methods of preparation of nano particles, Carbon nanostructures and their Applications.Physical chemistry of Nano systems, Nanoparticles, Nanowires and Nanorods, Thin films- Self assembled monolayers, Experimental techniques- Atomic Force Microscopy, Scanning Tunnelling Microscopy, Spectroscopy and Diffractiontechniques. Nanomaterials used in energy and Environmental applications and their Properties. Device applications in hydrogen storage and Production, Fuel cells, Battery, Solar energy conversion, Waste water treatment, Pollution remedies, Nanomaterials in automobiles.

References:

1. Tai Ran Hsu, MEMS and Microsystems- Design and Manufacturing, TATA McGraw Hill, 2002.
2. James J Allen, MEMS Design, Taylor and Francis Publication, 2005. Mohamed Gad-el-Hak, The MEMS Handbook, Taylor and Francis Publication, 2005.
3. Charles P Poole, Introduction to Nanotechnology, Wiley Publication, 2003.
4. Guozhong Cao, Nanostructures & Nanomaterials, Imperial College Press, 2004.
5. C B Sobhan, Microscale and Nanoscale Heat Transfer, Taylor and Francis Publication, 2008.
6. Murthy B. S., Shankar P., Textbook of Nanoscience and Nanotechnology, Universities Press (India) Private Ltd, 2013.

MIE 4450: NON-DESTRUCTIVE TESTING OF MATERIALS [3 0 0 3]

Fundamentals of Non-Destructive Testing (NDT), Comparison of NDT vs destructive testing, Mechanical testing, Terminologies used, flaws and defects in NDT, Advantages, limitations, scope, and applications of NDT, Working principle, parameters affecting, testing methods, testing procedures adopted, sensitivity, standards applied, advantages, disadvantages and applications of Penetrant Inspection (PI) methods, Magnetic Particle Testing (MPT), Ultrasonic Testing (UT), Holography (HG), Radiographic Techniques (RGT), Eddy Current Testing (ECT),Acoustic Emission Testing (AET) and Thermography (TG) method of non-destructive testing.

References:

1. Don E. B. and Roderic K. S., Non-destructive Evaluation: A tool in design, manufacturing and service, Taylor and Francis Group, 1997.

2. Paul E. M., Introduction to Non-destructive Testing-A training Guide, 2nd ed., John Wiley and Sons, Inc, 2005.
3. NDT Hand Books Vol. 1 – 10, American Society for Non-destructive Testing (ASNT), 1999.
4. Davis J. R., ASM Handbook: Volume 17, Non-destructive Evaluation and Quality Control, 2nd ed., ASM International Materials Park, 1992.
5. ASNT (Edited), Materials and Processes for NDT Technology, ASNT, USA, 1981.
6. Ensminger D., Ultrasonics: Fundamentals, Technology, Application, 2nd ed., Marcel Dekker, New York, 1988.
7. Annual Book of ASTM Standards. Metals Test Methods and Analytical Procedures: Non-destructive Testing, section 3, v03.03, American Society for Testing and Materials, 1989.
8. Shull P. J., Non-destructive Evaluation – Theory, Applications, and Applications, Marcel Dekker, 2002.

MIE 4451: PIPE SYSTEM ENGINEERING [3 0 0 3]

Introduction: Definition and scope, Importance advantages of transport by pipeline, Piping elements. Codes and standards: ASME codes, Materials of construction, Pipe sizes. Single phase incompressible flow: Flow regimes, Development of velocity profile, Pressure drop calculations, Bernoulli's equation, Major and minor losses, Hydraulic and energy grade lines. Pipe networks: Pipe hydraulics and sizing, Pump and pipe system matching, H-Q curves, Pipes in series and parallel, Pipe network analysis. Structural design of pipe lines: Stress due to internal fluid pressure, Stress due to external fluid pressure, High/low pressure pipes. Planning and construction of pipelines: Piping drawing basics, Development of plot plan, Process piping layout, Utility piping layout, Selection of supports & expansion joints, Flexibility analysis. Protection of pipelines: Pipeline damage due to corrosion, abrasion, heating and freezing, Protection methods - Lining, coating, insulation, jacketing etc. Industrial pipelines: Non-Newtonian fluid flow, Single phase compressible flows - Flow analysis for ideal gas, flow analysis for real gas, Multi-phase flows – Slurry pipelines, Pneumotransport, Capsule pipelines.

References:

1. Henry Liu, Pipeline Engineering, Lewis Publishers, CRC Press LLC, Florida, 2003.
2. Antaki George A., Piping and Pipeline Engineering: Design, Construction, Maintenance, Integrity, and Repair, CRC Press, 2003.
3. Larock Bruce E., Jeppson Roland W., and Watters Gary Z., Hydraulics of Pipeline Systems, CRC Press LLC, Florida, 2000.
4. NayyarMohinder L., Piping Handbook, McGraw-Hill, 2000.

MIE 4452: PRODUCT DESIGN AND DEVELOPMENT [3 0 0 3]

New Product Development: Introduction to New Product Development, Evolution of design, types of design, the design process, product life cycle, generic product development process, Strategic Planning and Opportunity Identification for new products, Identifying Market Opportunities. Translation of needs into Specifications: Understanding Customer and User Needs, need gathering methods, clarification, explore systematically, establishing product specification, competitive benchmarking. Creativity and Innovation: Creative thinking, creativity and problem solving, creative thinking methods, generating design concepts, systematic methods for designing, morphological methods, TRIZ methodology, Value Analysis. Concept Development: Concept Generations, Concept Screening, Concept Scoring, Concept Testing methods. Embodiment Design: Introduction to embodiment design, product architecture, types of modular architecture, steps in developing product architecture, Industrial design, human factors design, user friendly design. Design for X: Design for serviceability, design for environment, prototyping and testing, Cost evaluation, Design for Quality, Reliability, Failure Mode and Effect Analysis, Test and Inspection, Maintenance, Warranty. Supporting Techniques: Concurrent engineering, design thinking.

References:

1. Ulrich Karl T., and Eppinger Steven D., Product Design and Development, 6th ed., McGraw-Hill, 2015.
2. Cooper Robert G., Winning at New Products: Creating Value through Innovation, Hachette Book Group, New York, 2017.
3. Starc John, Product Lifecycle Management (Decision Engineering), Springer Publications, 2015.
4. Otto Kevin and Wood Kristin, Product Design Techniques in Reverse Engineering and New Product Development, Pearson Education (LPE), 2001.
5. Chitale A. K., and Gupta R. C., Product Design and Manufacturing, 6th ed., Prentice–Hall of India, 2013.
6. NPTEL Courses: Product Design and Development, https://nptel.ac.in/courses/112107217.
7. NPTEL Courses: Design Thinking - A Primer, https://nptel.ac.in/courses/110106124.

MIE 4453: PROJECT MANAGEMENT [3 0 0 3]

Concept of project, Importance of project management, Project life cycle, Project management as an integrated approach, organizing projects within the functional organization, organizing projects as dedicated teams, Organizing projects within a matrix arrangement, Project manager and their attributes. Feasibility study: Pre-feasibility study, Technical feasibility, Managerial feasibility, Economic feasibility, Financial feasibility, Cultural feasibility, Political feasibility, Environmental feasibility, Market feasibility, Steps of feasibility study. Estimating project times and costs: Factors influencing the quality of estimates, Costs associated with projects, Estimating guidelines for times, costs and resources, Top-down approaches of estimation, Bottom-up approaches of estimation, Hybrid approach of estimation. Risk management process: Risk identification, Risk Assessment - probability analysis, mitigating risk, avoiding risk, transferring risk, sharing risk, Retaining risk, Contingency planning, Contingency funding and time buffers, Risk response control – change control management, Decision tree analysis, Numerical. Project scheduling: Bar charts and Milestone charts, Elements of network, Development of networks, Work Breakdown Structure (WBS), Critical Path Method, Program Evaluation and Review Technique, Network crashing, CPM updating, Numerical. Project audit and closure: Guidelines for conducting a project audit, Initiating and staffing, Data collection and Analysis, Audit reporting, Conditions for project closure, Evaluation of project team and members.

References:

1. Gray C., Larson E. and Desai G., Project Management – The Managerial Process, Tata McGraw Hill Pvt. Ltd., New Delhi, 2013.
2. Paneerselvam R. and Senthilkumar P., Project Management, PHI Learning Pvt. Ltd., New Delhi, 2010.
3. Meredith J. and Mantel S., Project Management – A Managerial Approach, John Wiley & Sons, USA, 2012.
4. Vohra N. D., Quantitative Techniques in Management, New Delhi, 2007.

MIE 4454: THEORY OF ELASTICITY [3 0 0 3]

Analysis of Stresses: stress transformation, stress invariants, Principal stresses, Mohr's circle for stress transformation, Octahedral stresses, Balance Laws for 3D Elasticity. Analysis of Strains: strain displacement relationship, Strain Tensor, Compatibility equations. Constitutive Laws: Generalized Hooke's law, Formulation of constitutive laws, Elastic constants for anisotropic, orthotropic and isotropic materials. 2D Elasticity and Applications: Plane stress, Plane strain and Axisymmetric problems, Airy's stress function, Applications to Thick shells, Rotating disk, Stress concentration due to circular hole. 3D Elasticity and Applications: Betti-Maxwell Reciprocal Theorem, Torsion of a uniform circular, non-circular Bars, Membrane Analogy. Introduction to Plasticity: Constitutive relations, Problems contained plastic deformation, strain rate effects, idealization, Yield criteria, plastic stress-strain relations.

References:

1. Timoshenko S. P. and Goodier J. N., Theory of Elasticity, 3rd edition, McGraw-Hill, 2010.
2. Srinath L. S., Advanced Mechanics of Solids, Tata Mc-Graw Hill Book Company, 3rd ed., 2017.
3. Sadd M. H., Elasticity, Elsevier Publishers, New Delhi, 2014.
4. Sokolnikoff I. S., Mathematical Theory of Elasticity, Krieger Publishing Company, 1983.
5. Shames I. H., Mechanics of Deformable Solids, Krieger Publishing Company, 1983.
6. Sadhu Singh, Theory of Elasticity, 1st Edition, Khanna Publishers, 1978.
7. Helena H. Jane, Theory of Elasticity and Plasticity, Paperback, PHI Learning, 2017.
8. Singh Sadhu, Theory of Plasticity and Metal Forming Process, 1st Edition, Khanna Publishers, 1980.

MIE 4455: WIND ENERGY TECHNOLOGY [3 0 0 3]

Introduction: Wind resources and modern wind turbines, classification of wind turbines and turbine components, materials and technology advancements, applications of wind turbines, grid connectivity, industries, standalone systems, offshore power. Wind resource assessment: variations of space, time, season, months, and diurnal, characteristics of steady wind and wind speed distribution. Wind measurement: parameters, types of anemometers, monitoring station, remote wind speed sensing instrumentation. Design of wind turbines: Rotor torque and power, braking, blade design and blade materials, blade section, Performance measurement. Subsystems of wind turbines: Different types of generators, wind power control systems, asynchronous load management using pumps, paddle wheels, and batteries. Wind Farms: Wind flow models, wind farm design using capacity factor, siting and layout of wind turbines, site selection, micrositing, and wake model. Economics of wind energy conversion: annual energy output, capital recovery factor, depreciation, cost of wind energy, wind generated electricity value, present value of annual costs.

References:

1. Mathew Sathyajith, Wind Energy: Fundamentals, Resource Analysis and Economics, Springer, 2006.
2. Johnson Garg L., Wind Energy Systems, Prentice Hall, Inc., 2006.
3. Ahmed Siraj, Wind Energy – Theory and Practice, 3rd ed., PHI Learning Pvt. Ltd., 2015.

MIE 4456: MICROFLUIDICS [3 0 0 3]

Introduction and Applications: Characteristics and dimensions of microfluidics, advantages, multidisciplinary and Multiphysics features, example applications.Governing Principles: Classification of forces between surfaces, scaling law and its effects, hydrodynamic equation and Reynolds number in microsystems, compressibility effects, no-slip vs slip boundary conditions, slip length, Maxwell's first order slip model.Pressure and Surface Tension driven microflows: Fundamentals, velocity profile, governing expression, low Reynolds number hydrodynamics, surface force and capillarity,Young-Laplace equation, practical examples. Microfabrication: Top-down and bottom-up approach, photolithography, soft lithography, micro-milling, paper based microfluidic devices, low-cost fabrication techniques. Bio-microfluidics: Natural and cellular microfluidics, cell-culture and analysis using TFM, confinement effects, DNA microfluidics, Lab-on-chip, 3D printing in microfluidics, biomimetics, drug delivery.

References:

1. Tabeling P., Introduction to Microfluidics, Oxford University Press, 2011.
2. Bruus H., Oxford University Press, 2008.
3. Chakraborty S., Microfluidics and Microfabrication, 1st ed., Springer, 2010.
4. Madou M.J., Fundamentals of Microfabrication, CRC Press, 2002.
5. Happel J., Brenner H., Low Reynolds Number Hydrodynamics, Springer, 1983.
6. NPTEL Course: Micro fluidics, https: https://nptel.ac.in/courses/112105187.

MIE 4457: ENGINEERING ASSET MANAGEMENT [3 0 0 3]

Engineering Asset Management: Basic concepts, Definitions, Review of Existing Frameworks for Asset Management, A framework for AM system, Requirement and Challenges, Asset Management Drivers, Benefits of Asset Management. Asset Management Standards: ISO 55000, Overview, principles, and terminology. ISO 55001 Requirements. ISO 55002 Guidelines on the application of ISO 55001.Asset Management Principles: Barriers to implement Asset

Management, Asset Life Cycle, Balancing Cost, Risk and Performance. Principles of asset integrity and management: Asset Management Tools and Elements of Asset Assessment (Performance Management), Terminology used in asset management policy and requirements. Fundamentals of Reliability Engineering: Maintenance Management; maintenance contracts and contract administration, reliability centred maintenance; total productive maintenance. Preventive component replacement and capital equipment replacement decisions.

References:

1. Campbell, J.D., Jardine, A.K.S. McGlynn, J. “Asset Management Excellence: Optimizing Equipment Life-Cycle Decisions”, 2nd Edn., CRC Press,Boca Raton, FL, 474 pp. 2011.
2. Jardine, A.K.S. and Tsang, A.H.C. “Maintenance, Replacement and Reliability: Theory and Applications”, CRC Taylor & Francis, New York, 322 pp. 2006.
3. Kelly, A. “Strategic Maintenance Planning”, Butterworth Heinemann, Oxford, 284 pp. 2006.
4. Kelly, A. “Managing Maintenance Resources”, Butterworth Heinemann, 292 pp. 2006.
5. Lawrenson, J. “Effective Spares Management”, International Journal of Physical Distribution & Materials Management, Vol 16, No. 5., 111 pp., 1986.
6. O'Conner, P.D.T. “Practical Reliability Engineering”, 5th Edn., John Wiley and Sons, 2012.
7. Moubray, J. “Reliability-Centered Maintenance”, 2nd Edition, Industrial Press Inc., NY, 414 pp., 1992.

OPEN ELECTIVES

MIE 4311: INTRODUCTION TO COMPOSITE MATERIALS [3 0 0 3]

Definition, Classification, Types of matrices & reinforcements, Characteristics & selection of Fiber, Laminated & Particulate composites, Prepregs, Micro mechanical analysis of a lamina, Rule of mixture, Processing of composites, Hand-layup, Spray-layup, Compression molding Injection molding, Reaction injection molding, Autoclaving, Resin transfer molding, Filament winding, Pultrusion, Sheet molding, Secondary processing of polymer composites: Joining, Adhesive joining, Mechanical joining, Microwave joining, Induction and resistance welding, Drilling of polymer composites, Testing of polymer composites, ASTM standards test for physical properties, mechanical properties, SEM analysis, Application developments, Aircrafts, Missiles, Space, Automobile, Electrical and electronics, Marine, Recreational, sports equipment, and Construction.

References:

1. Autar K. K., Mechanics of Composite Materials, CRC Press, 2005.
2. Krishan K. C., Composite Material Science and Engineering, 4th ed., Springer Publication, 2021.
3. Mallik P. C., Fiber Reinforced Composites, Marcel Decker Publication, 1993.
4. Rober M. J., Mechanics of Composite Materials, McGraw Hill Kogakusha Ltd, 2008.
5. Michael W..Hyer, Stress analysis of fiber Reinforced Composite Materials, McGraw Hill Publication, 1998.
6. Gupta M. C., Gupta A. P., Polymer Composites, New age international (P) Ltd, 2005.

MIE 4312: INRODUCTION TO BIOMECHANICS [3 0 0 3]

Introduction to Biomechanics: Brief history, Contributions of Biomechanics to health science, Contributions of Biomechanics to the field of Mechanics Hemodynamics: Rheology of blood, Large artery hemodynamics, Small artery hemodynamics, Ocular biomechanics: Ocular anatomy, Biomechanics of glaucoma, Ocular blood , Biomechanics of respiratory system: Gross anatomy of the conducting airways and pulmonary vasculature, Anatomy of associated structures, Biomechanics of breathing, Mass transfer and particle transport in lungs, Skeletal biomechanics: Introduction to bone, Biomechanics of cortical and trabecular bone, Structure of ligament, tendon and cartilage and its biomechanics, Biomechanics of Cardiovascular system, Biomechanical hierarchy in cardiovascular physiology, Structure-function relationship in cardiovascular tissues, Biomechanical feedback in the cardiovascular system, Experimental and computational methods.

References:

1. Fung Y. C., Biomechanics: motion, flow, stress, and growth, Springer Science & Business Media, 2013.
2. Oomens C., Brekelmans M., Loerakker S., and Baaijens F., Biomechanics: concepts and computation, Cambridge University Press, 2018.
3. Ethier C. R., and Simmons C. A., Introductory biomechanics: from cells to organisms, Cambridge University Press, 2007.
4. Hirasawa Y., Sledge C. B., and Woo S. L., Clinical biomechanics and related research, Springer Science & Business Media, 2012.
5. Brandao S., Da Roza T., Mascarenhas T., Duarte S., Ramos I., Parente M., and Natal Jr., Applied Biomechanics: Concepts and Connections Applied Biomechanics: Concepts and Connections, International journal of urology, 2013.

MIE 4313: INTRODUCTION TO OPERATIONS RESEARCH [3 0 0 3]

Introduction: Definition, Phases, Applications, Advantages and Limitations of Operations Research. Linear programming problems: Assumptions, Formulation of LPP for business and non -business applications. Graphical solutions, Special cases – Degeneracy, Infeasible Solution, Unbalanced and Multiple optimal solutions. Minimization and Maximization cases. Simplex algorithm, Concept of dual. Transportation problem: Formulation, generating initial solutions using North-West Corner (NWC) Method, Least Cost (LC) Method, Vogel's Approximation Method (VAM). MODI Method. Assignment problem, Travelling salesman problem. Game theory:Introduction to game theory, Two-person-zero sum games, Pure and Mixed Strategies, Solution methods for 2 x 2 games, Graphical method (2 x n games; m x 2 games), Queueing theory: Introduction to queueing theory, Poisson arrival rate and Exponential service times, System characteristics, Problems on the models- (M/M/1) :(/FIFO), (M/M/1): (N/FIFO). Critical Path Method (CPM). Project Evaluation and Review Technique (PERT).

References:

1. Taha H. A., Operations Research, Pearson Education, 7th ed., 2002.

2. Winston W. L., Operations Research, Thomson Asia, 2003.
3. Vohra N. D., Quantitative Techniques in Management, New Delhi, 2007.
4. Sharma S.D., Operations Research, Kedar Nath Ramnath Publications, 14th ed., 2005

MIE 4314: ENERGY ENGINEERING [3 0 0 3]

Steam power plant: Different types of fuels used for steam generation, equipment for burning coal in lump form, oil burners, advantages and disadvantages of using pulverized fuel, pulverized fuel furnaces, coal and ash handling, high and super critical pressures. Diesel engine power plant: Applications of diesel engines in power field, method of starting diesel engine, auxiliaries, layout of diesel power plant. Hydro–electric plant: hydrographs, flow duration and mass curves, unit hydrograph and numerical, different types of plants, accessories, general layout of hydel power plants. Nuclear power plant: Principles of release of nuclear energy, nuclear fuels used in the reactors, elements of nuclear reactor, reactor types, radiation hazards, shielding's, and radioactive waste disposal. Solar energy: Solar extra-terrestrial radiation and radiation at the earth surface, radiation measuring instruments, solar energy conversion systems. Biomass energy: Photosynthesis, anaerobic fermentation, classification, gasifiers. Wind energy: Properties of wind, wind velocity and power from wind, types of wind machines and their characteristics. Other energy conversion techniques: Fundamental characteristics of tidal power, harnessing tidal energy and limitations. principle of working of ocean thermal energy, Rankine cycle, limitations of OTEC. geothermal energy conversion working principle, types of geothermal stations, limitations.

References:

1. Nag P. K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2011.
2. Domkundwar, Power Plant Engineering, 8th ed., Dhanpat Rai Publications, 2016.
3. Rai G. D., Non-Conventional Energy Sources, Khanna Publishers.
4. Rao S., and Parulekar B. B., Energy Technology, Khanna Publishers, 2009.
5. Culp A. W., Principles of Energy Conversion, McGraw Hill International, 2001.

MIE 4315: INTRODUCTION TO FINITE ELEMENT ANALYSIS [3 0 0 3]

Basics Concepts of FEA: General steps involved in FEM, Convergence requirements, Pascal's triangle, Higher order quadratic elements; Local and Global coordinate systems, Shape Functions and properties. Basics of theory of Elasticity. Finite Element Formulation by DSM: FE formulation of 1D linear element by direct stiffness method, Elimination and Penalty approach. Application to bar and plane truss problems. Introduction to space truss. FE formulation of Beam element by energy approach, Application to Beam problems. Additional Methods and Applications of FEM: Structure of commercial FEM software package, Mini project on using FEA software, Mini Project on using computation approach.

References:

1. Chandrupatla T. R., and Belegundu A. D., Introduction to Finite Elements in Engineering, Pearson Education, New York, 2011.
2. Logan Daryl L., A First course in Finite Element Method, 5th ed., Cengage Publishing, India, 2012.
3. Hutton David V., Fundamentals of Finite Element Analysis, Tata McGraw Hill, India, 2005.
4. Reddy J. N., An Introduction to Finite Element Method, 4th ed., McGraw Hill International Edition, New York, 2020.
5. Bathe K. J., Finite Element Procedures, Prentice-Hall of India, New Delhi, India, 1996.
6. Rao S. S., Finite Element Analysis, 6th ed., Elsevier Butterworth-Heinemann, India, 2017.
7. Zienkiewicz O. C., and Cheung Y. K., The Finite Element Method in Structural and Solid Mechanics, 7th ed., Elsevier Butterworth-Heinemann, India, 2013.

MIE 4316: BIO-FLUID DYNAMICS [3 0 0 3]

Cardiovascular physiology: Cardiovascular system, The heart-blood vessels, Mechanical model (Winkessel model), Blood, Fundamentals of fluid mechanics: Intrinsic properties of fluid, Conservation laws-Mathematical tools, Mass Conservation, Conservation of momentum, Form of fluid motions equations, Dimensional analysis, Energy conservations & Bio-heat Equation of Mammalian Tissue, Mathematical solutions for bio-fluid problems: How to solve a problem?, Boundary conditions, Mathematical solutions for bio-fluid problems - Shear stress on arterial endothelial cells, NS in a pipe - Validity of the Hagen-Poisseuille relationship in the cardiovascular system, Pulsatile flow, Effect of pulsatility, Wormersley solution, Computational fluid dynamics (CFD) and Flow measurement in the cardiovascular: Computational fluid dynamics, Flow measurement in the cardiovascular, Flow over immersed body (incompressible): General flow characteristics, Lift and drag concepts – Definitions, Drag for different shapes, Drag coefficient, for a sphere in stokes flow, Transport of micro-particles, Characteristic flow past an object, Boundary layer characteristics - Boundary Layer Structure and Thickness on a Flat Plate, Boundary layer thickness, MomentumIntegral Boundary Layer Equation for a Flat Plate, Prandtl/Blasius Boundary Layer Solution, Turbulent boundary layer, Pressure gradient effect on flow - Separation point, Reduction of drag, Biological solution for drag reduction, Rheology of blood, Non-Newtonian fluid: Viscosimetry, Blood composition and viscosity, Cell free marginal layer, Pressure flow relationship for non-Newtonian fluid, Hemodialysis and platelet activation, Time effect viscosity, Introduction to Fluid Machinery and biomedical application: Introduction to Fluid Machinery, Fluid machinery in biomedical.

References:

1. Rittgers Stanley E., Chandran Krishnan B., and Yoganathan Ajit Prithiviraj, Biofluid mechanics: the human circulation, Taylor and Francis. 2nd ed., 2012.
2. Kundu P. K., Cohen I. M., and Dowling D. R., Fluid Mechanics, 5th ed., Academic Press, 2011.
3. Waite L., Applied Biofluid Mechanics, 1st ed., McGraw-Hill Professional, 2007.
4. Truskey George A., Yuan Fan, and Katz David F., Transport

Phenomena in Biological Systems (Pearson Prentice Hall Bioengineering), 2009.

MIE 4317: INTRODUCTION TO ENGINEERING ASSET MANAGEMENT [3 0 0 3]

Engineering Asset Management: Basic concepts, Definitions, Review of Existing Frameworks for Asset Management, A framework for AM system, Requirement and Challenges, Asset Management Drivers, Benefits of Asset Management. Asset Management Standards: ISO 55000, Overview, principles, and terminology. ISO 55001 Requirements. ISO 55002 Guidelines on the application of ISO 55001.Asset Management Principles: Barriers to implement Asset Management, Asset Life Cycle, Balancing Cost, Risk and Performance. Principles of asset integrity and management: Asset Management Tools and Elements of Asset Assessment (Performance Management), Terminology used in asset management policy and requirements. Fundamentals of Reliability Engineering: Maintenance Management; maintenance contracts and contract administration, reliability centred maintenance; total productive maintenance. Preventive component replacement and capital equipment replacement decisions.

References:

1. Campbell, J.D., Jardine, A.K.S. McGlynn, J. "Asset Management Excellence: Optimizing Equipment Life-Cycle Decisions", 2nd Edn., CRC Press,Boca Raton, FL, 474 pp. 2011.
2. Jardine, A.K.S. and Tsang, A.H.C. "Maintenance, Replacement and Reliability: Theory and Applications", CRC Taylor & Francis, New York, 322 pp. 2006.
3. Kelly, A. "Strategic Maintenance Planning", Butterworth Heinemann, Oxford, 284 pp. 2006.
4. Kelly, A. "Managing Maintenance Resources", Butterworth Heinemann, 292 pp. 2006.
5. Lawrenson, J. "Effective Spares Management", International Journal of Physical Distribution & Materials Management, Vol 16, No. 5., 111 pp., 1986.
6. O'Conner, P.D.T. "Practical Reliability Engineering", 5th Edn., John Wiley and Sons, 2012.
7. Moubray, J. "Reliability-Centered Maintenance", 2nd Edition, Industrial Press Inc., NY, 414 pp., 1992.

MINOR SPECIALIZATION: MACHINE DESIGN

MIE 4401: DESIGN OF MECHANICAL SYSTEMS [3 0 0 3]

Definition of engineering design, Steps of the design process, General consideration in machine design, Design of Piston, Design of Connecting rod, Design of Crankshaft, Design of Valve gear mechanism, Flange coupling, Screw jack, Single plate clutch, Two-speed gearbox, Passenger lift, Concrete mixer, Automobile chassis & suspension, Johnson's method of optimization.

References:

1. Bhandari V. B., Design of Machine Elements, Tata McGraw Hill Publishing Company, 5th ed., New Delhi, 2020.
2. Trikha S. N., Machine Design Exercises, Khanna Publishers, 4th ed., Delhi, 1966.
3. Patil S. P., Mechanical System Design, Jaico Publishing House, Mumbai, 2004.
4. Dieter George E., Engineering Design, McGraw Hill Book Co., Singapore, 2009.
5. Ulrich Karl T., and Eppinger Steven D., Product Design and Development, Irwin McGrawHill, Boston, 2016.
6. Ullman David G., The Mechanical Design Process, McGraw Hill Book Co., Singapore, 2010.
7. Bralla James G., Design for Manufacturability Handbook, McGraw Hill, New York, 1998.
8. Mahadevan K., and Reddy Balaveera K., Design Data Handbook, CBS Publishers and Distributors, New Delhi, 2020.

MIE 4402: INTRODUCTION TO CONTINUUM MECHANICS FOR ENGINEERS [3 0 0 3]

Introduction and Mathematical Preliminaries: Solids and fluids as continuous media, Tensors, Dummy indices, Kronecker delta, Index notation, Tensor algebra, Divergence and Curl Theorems. Kinematics of Continua: Bodies, configurations, and motions, Deformation gradient tensor, Strain measures, Strain-Rate Tensor, Spin, Infinitesimal Deformation. The Balance Laws, Stress Tensors: Transformation of stress tensors under the rotation of axes, Plane stress, Deviatoric stress, von-Mises stress. Isothermal Solid Mechanics: Elasticity equations, Initial and boundary value problems, Virtual work theorem, Uniqueness and reciprocal theorem, Constitutive relations for linearly and nonlinearly elastic solids. Isothermal Fluid Mechanics: Ideal fluids, Newtonian viscous fluids, Incompressible case, Naiver stokes equations, Applications to fluid mechanics problems.

References:

1. Batra R. C., Elements of Continuum Mechanics, American Institute of Aeronautics and Astronautics, 2006.
2. Chaves E. W. V., Notes on Continuum Mechanics, Springer Science & Business Media, 2013.
3. Gonzalez O., and Stuart A. M., A First Course in Continuum Mechanics, Cambridge University Press, 2008.
4. Holzapfel G. A., Nonlinear Solid Mechanics: A Continuum Approach for Engineering, John Wiley & Sons, 2000.
5. Nair S., Introduction to Continuum Mechanics, Cambridge University Press, 2009.
6. Reddy J., An Introduction to Continuum Mechanics, 2nd ed., Cambridge University Press, 2013.
7. Spencer A. J. M., Continuum Mechanics, Dover Publications, 2012.

MIE 4403: LUBRICATION AND ROTOR DYNAMICS [3 0 0 3]

Introduction: Rotating machinery. Lubrication: Properties and testing of lubricants. Bearing Systems: Rolling element bearings, Hydrodynamic oil-journal bearings, Gas lubricated bearings, Hydrostatic bearings and Squeeze film bearings. Rotor Dynamics: Simple rotor systems, Simple rotor-bearing foundation systems, Simple rotor systems with gyroscopic effect, Torsional vibrations of rotors, Continuous systems and FE methods: Transfer matrix method and FE method. Transverse vibration analysis of simple rotors. Instability in rotating machines, Instability of multi-degrees of freedom rotor mounted on flexible bearings.

References:

1. Bhushan Bharat, Principles and Applications of Tribology, Wiley, 2nd ed., 2013.
2. Majumdar B. C., Sarangi Mihir, and Ghosh M. K., Theory of Lubrication, Tata McGraw Hill, 2013.
3. Gwidon W. Stachowiak, Andrew W. Batchelor, Engineering Tribology, 4th ed., Butterworth Heinemann, London, 2016.
4. Rao J. S., Rotor Dynamics, 3rd ed., New Age International (P) Ltd., New Delhi, 2018.
5. Chong-Won Lee, Vibration Analysis of Rotors, Springer Science Business Media, 2012.
6. Krzysztof Czolczynski, Rotordynamics of Gas-Lubricated Journal Bearing Systems, Springer, 2012.
7. Friswell M. I., Dynamics of Rotating Machines, Cambridge, 2010.

MIE 4404: MODELING AND SIMULATION OF DYNAMIC SYSTEMS [3 0 0 3]

Introduction to Modeling and Simulation: Importance of Modeling, Models of Systems, Systems, Subsystems, and Components. Bond Graph Modeling of Dynamic Systems: Engineering Ports, Bonds, and Power, Bond Graphs, Inputs, Outputs, and Signals, Basic Bond Graph Elements, Causality considerations for the basic Elements. Basic System Models: Mechanical systems involving translation, rotation, Hydraulic systems. Acoustic systems and Electrical systems. System Models of Combined Systems: Multi Energy Domain systems, Transducers, Transformers, Gyrators, Thermo-fluid system, Mechatronic system, Multibody systems. State-Space Equations and Automated Simulation: Standard form for System equations, Basic formulation and reduction. Analysis and Control of Linear Systems: Solution techniques for ordinary differential equations, free response and Eigen values for undamped and damped oscillator.

References:

1. Karnopp Dean C., Margolis Donald L., and Rosenberg Ronald C., System Dynamics: Modeling, Simulation, and Control of Mechatronic Systems, John Wiley & Sons, Inc. 5th ed., 2012.
2. Mukherjee A., Karmakar R., and Samantaray A. K., Bond graph in modeling, simulation and fault identification, IK International, New Delhi, 2006.
3. Das Shuvra, Mechatronic Modeling and Simulation Using Bond Graphs, CRC Press, 2009.
4. Borutzky Wolfgang, Bond Graph Methodology Development and Analysis of Multidisciplinary Dynamic System Models, Springer, 2010.
5. Thoma Jean U., Simulation by Bondgraphs, Springer, 1990.

MINOR SPECIALIZATION: MANUFACTURING TECHNOLOGY

MIE 4405: ADDITIVE MANUFACTURING [3 0 0 3]

Basic principles, Advantages, limitations and applications of Additive Manufacturing (AM), Standardizations in AM, Contrast with conventional manufacturing processes, Classification, Detailed working principle, Equipment, process and techniques, Process parameters in AM, General process workflow in AM, Pre-processing for AM, Role of CAD in AM, Part placement in machine envelop and slicing, Build process, Post processing, Role of materials in AM, Properties, Specifications and development of materials for AM, Materials Issues in AM, Design for AM, Impact of AM on conventional DFM and DFA, Design guidelines for AM, Management & Implementation of AM, Case studies.

References:

1. Gibson Ian, Rosen David W., and Stucker Brent, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd ed., Springer Pub., 2015.
2. Gebhardt Andreas, Understanding Additive Manufacturing, Hanser Publishers, 2011.
3. Hopkinson N., Hague R. J. M., and Dickens P. M., Rapid Manufacturing - An Industrial Revolution for the Digital Age, John Wiley & Sons, Ltd, 2005.
4. Advanced Additive Manufacturing- Handbook, INEX-ADAM, 2020.

MIE 4406: NON-TRADITIONAL MACHINING TECHNIQUES [3 0 0 3]

Classification & selection of Non-traditional machining process, Need for NTM, Comparison with traditional machining, Process, Equipment, Working principle, Advantages, Limitations & Process parameters of Ultrasonic machining, Abrasive jet machining, water jet machining, Electrochemical machining, Electrochemical grinding, Electrochemical honing, Chemical machining, Chemical blanking, Chemical milling, Electric discharge machining, Electric discharge grinding, Wire EDM, Plasma arc machining, Laser beam machining and Electron beam machining.

References:

1. Production technology, HMT, McGraw Hill Education India Pvt. Ltd, 2001.
2. Vijay K. Jain, Advanced Machining Processes, 1st ed., Allied Publishers Pvt. Ltd., 2013.
3. Pandey P. C., and Shah H. S., Modern Machining Processes, 1st ed., Tata McGraw-Hill Educational India Pvt. Ltd., 2013.
4. Bhattacharyya Amitabha, New Technology, The Institute of Engineers (India), 2000.
5. Elanchezhian C., Vijaya Ramnath B., and Vijayan M., Unconventional Machining processes, 1st ed., Anuradha Publication, 2005.
6. Singh M. K., Unconventional Machining processes, 1st ed., New Age International Publishers, 2010.
7. Benedict. G.F., Nontraditional Manufacturing Processes, Marcel Dekker Inc., 1987.
8. Paul De Garmo, Black J. T., and Kohser Ronald. A., Material and Processes in Manufacturing, 8th ed., Prentice Hall of India Pvt. Ltd., 2001.

MIE 4407: LEAN MANUFACTURING [3 0 0 3]

Definition and basic concepts of lean manufacturing philosophy, 5S principle, Total productive maintenance, Process mapping techniques, Concept of work cell, Cause and effect diagram, Pareto chart, Spider/radar chart, Poke Yoke, Kanban, Autonomation, SMED, Standardized fixtures, DFMA, JIT concept, Visual workplace, Lean implementation and productivity improvement.

References:

1. Gopalakrishnan N., Simplified Lean Manufacture, India: Prentice-Hall

of India Pvt. Limited, 2010.
2. Socconini L., Lean Manufacturing. Step by step, Spain: ICG Marge, SL, 2021.
3. Shook J., and Rother, M., Learning to See: Value Stream Mapping to Add Value and Eliminate Muda, Germany: Taylor & Francis, 2003.

MIE 4408: MICRO MACHINING [3 0 0 3]

Introduction to micro machining, Need for miniaturization, Classification of micro machining, Applications of micro machining, MEMS vs micro machining, Machine tools for micro machining, Micro cutting tools, Sensors and actuators for monitoring and control of micro machining, Theory of micro machining, Diamond turning, Micro machining operations, Abrasive jet micro machining, Abrasive water jet micro machining, Ultrasonic micro machining, Abrasive flow finishing, Magnetic abrasive finishing, Magneto rheological finishing, Magneto rheological abrasive flow finishing, Electric discharge micro machining, Wire electric discharge micro machining, Electric discharge grinding, Electric discharge diamond grinding, Laser beam micro machining, Electron beam micro machining, Ion beam micro machining, Chemical micro machining, Electro chemical micro machining, Electro chemical micro grinding, Electro-chemical honing, Electro stream micro drilling, Electro chemical micro deburring, Shaped tube electrolytic micro machining.

References:

1. V. K. Jain, Micro Manufacturing Processes, CRC Press, Taylor & Francis Group,2012.
2. K. Cheng K., and Huo D., Micro-cutting: Fundamentals and Applications, John Wiley & Sons, 2013.
3. Jain V. K., Advanced Machining Processes, Allied Publishers Pvt. Ltd., 2007.
4. Mishra P. K.,Nonconventional Machining, Narosa Publishing House Pvt. Ltd, 2007.
5. McGeough J, A., Advanced Methods of Machining, Springer, 2011.
6. Qin Y., Micro-manufacturing Engineering and Technology, William Andrew, 2015.
7. Davim J. P., and Jackson M. J., Nano and Micromachining, John Wiley & Sons, 2013.

MINOR SPECIALIZATION: THERMAL SYSTEMS

MIE 4409: CRYOGENICS [3 0 0 3]

Introduction to cryogenics: Properties of cryogenic fluids, material properties at cryogenic temperatures mechanical properties, thermal properties, electrical properties, Carnot liquefaction cycle, F.O.M. and yield of liquefaction, cycles, inversion curve, Joule Thomson effect, areas of applications of cryogenic Engineering. Gas Liquefaction Systems: Simple Linde Hampson system, pre cooled Linde Hampson System, Claude System, Heylndt system, dual pressure, Claude system, liquefaction cycle, kapitza system and comparison, liquefaction cycle for hydrogen and helium system, critical components of liquefaction systems. Gas cycle cryogenic refrigeration systems: Classification of cryo-coolers, Stirling cycle, cryo – refrigerators, ideal cycle working principle. Schmidt's analysis of Stirling cycle, various configurations of Stirling cycle refrigerators, Gifford Mcmahoncryo- refrigerator, Pulse tube refrigerator, Cryogenic regenerators. Gas Separation and gas Purification Systems: Thermodynamic ideal separation system, properties of mixtures, principles of gas separation, Linde single column air separation. Linde double column air separation and adsorption Process. Vacuum Technology: Mechanical pumps, diffusion pumps, cryo-pumping, cryogenic insulation, evacuated porous insulation powder and fibers, gas filled powders and fibrous materials multilayer super-insulation, composite insulation.

References:

1. Barron Randal F., Cryogenic Systems, Oxford University Press, New York, 1999.
2. Flynn T. M., Cryogenic Engineering, 2nd ed., Maxwell Dekker, 2005.
3. Timmerhaus K. D. and Flynn T. M., Cryogenic Process Engineering, Plenum Press, 2013.
4. Timmerhaus Klaus D., Reed Richard Palmer, Cryogenic Engineering: 50 years of progress, Springer, 2007.

MIE 4410: SOLAR THERMAL SYSTEMS [3 0 0 3]

Introduction: World energy scenario, solar radiation geometry, radiation measurement, empirical equations, radiation on tilted surfaces, incident angle. Liquid Collectors: Construction and working of flat plate collector, thermal analysis of absorber plate, H-W-B equation, effect of various parameters, ASHRAE test standard and procedure, uncertainty analysis, working of evacuated tube collector, advantages, PV/T system analysis. Air heaters: Performance analysis of conventional air heater, absorber plate treatment, novel designs, testing procedure and performance curves, cabinet drier. Concentrating Collectors: Thermodynamic and optical limit to concentration, cylindrical parabolic system (PTC), construction, losses, thermal analysis of PTC, tracking, compound parabolic collector, performance analysis, paraboloid dish collector, thermal analysis, central receiver tower system, power cycles, fresnel lens. Other Systems: Solar cooker, desalination, solar pond, solar refrigeration, green building. energy Storage: need for energy storage, sensible and latent heat storage, liquid storage tank analysis.

References:

1. Goswami D. Yogi, Principles of solar engineering, CRC Press, 2015.
2. KalogirouSoteris A., Solar Energy Engineering, Academic Press, 2014.
3. Tiwari G. N., Solar Energy, Narosa Publications, 2014.
4. Sukhatme S. P., and Nayak J. K., Solar Energy, Tata McGraw Hill, 2012.

MIE 4411: DESIGN OF HEAT EXCHANGERS [3 0 0 3]

Introduction: Classification of heat exchanger, design methods, convection correlations, overall heat transfer coefficient, thermal network, fouling resistance, pressure drop due to fouling, general design procedure. Double pipe heat exchangers: Working, classification, applications, need for parallel-series flow, thermal and hydraulic analysis, bare and finned tube analysis. Shell and Tube Heat Exchangers: Types, basic components, layout and geometry, applications, stream allocation, design procedure, TEMA Standard, Kern and Bell-Delaware method. Compact Heat Exchangers: Different designs, design procedure, heat transfer and pressure drop calculations, plate heat exchangers, thermal performance. Evaporators and Condensers: Condensation in horizontal and vertical tubes, thermal design of shell and tube condensers, horizontal and vertical condensers with tube side and shell side condensation, flow boiling correlations, thermal design of evaporators. Furnace and Cooling towers: Types, fundamentals of combustion, heat transfer and heat balance in fired heaters, furnace heat transfer, working of cooling tower, classification, concept of psychrometry, energy balance, design and analysis. Testing of Heat Exchangers: Procedure for different heat exchangers, performance evaluation.

References:

1. Kakac Sadik, Heat exchangers: Selection, rating, and thermal design, 3rd ed., CRC Press, 2012.
2. Serth Robert W., Process Heat Transfer: Principles, Applications and Rules of Thumb, Academic Press, 2014.
3. Kern Donald Q, Process heat transfer, McGraw Hill Publication, 1997.
4. Kays W. M., and London A. L., Compact Heat Exchangers, McGraw-Hill, 1998.
5. Shah Ramesh K., Fundamentals of heat exchanger design, 1st ed., John Wiley and sons, 2003.

MIE 4412: JET PROPULSION [3 0 0 3]

Introduction to aircraft propulsion: Jet engine performance parameters; Thrust, SFC, efficiencies, single and multispool gas turbine based propulsive devices. Real cycle thermodynamic analysis: Ideal and real Brayton cycles, Jet engine cycles for aircraft propulsion. cycle components and component performance, analysis of engine real cycles. Fundamentals of rotating components: Thermodynamics of compressors and turbines, development of parameters for compressor and turbines. Compressors and turbines: Loss and blade performance estimation, single and multistage axial compressor characteristics, elements of centrifugal compressor, concept of rothalpy, centrifugal compressor characteristics, surging and choking. Combustion systems: Combustion mechanism and important combustion parameters, combustion efficiency, combustion intensity, fuels and their properties, fuel injection systems. Intakes and propelling nozzles: Requirements of an intake, aircraft intake design considerations, propelling nozzles, energy conversion in a nozzle, nozzle design considerations. Engine installed performance, sizing and matching: Installed performance of engine, dimensional analysis for engine, engine off design operations, aircraft engine component matching.

References:

1. Kroes Michael J., and Wild Thomas W., Aircraft Powerplants, 7th ed., Tata-McGraw-Hill, 2010.
2. Hill Philip, and Peterson Carl, Mechanics and Thermodynamics of Propulsion, Addison Wesley, 1992.
3. Roy Bhaskar, Aircraft Propulsion, Elsevier, 2008.
4. Mattingly J. D., Elements of Propulsion - Gas Turbines and Rockets, AIAA Education series, 2006.
5. El-Sayed Ahmed, Aircraft Propulsion and Gas Turbine Engines, Taylor and Francis (CRC Press), 2008.
6. Saravanamuttoo, H. I. H., Rogers G. F. C., and Cohen H., Gas Turbine Theory, 7th ed., Pearson, 2017.
7. Mathur M. L., and Sharma R. P., Gas Turbines and Jet Propulsion, Standard Publishers Distributors, Delhi, 2010.
8. Yahya S. M., Fundamentals of Compressible flow with Aircraft and Rocket Propulsion, 6th ed., New Age International Pvt.Ltd. New Delhi, 2018.
9. Ganesan V., Gas Turbines, Tata McGraw-Hill, New Delhi. 2005.

MINOR SPECIALIZATION: MATERIALS ENGINEERING

MIE 4413: PROCESSING OF POLYMERS AND POLYMER COMPOSITES [3 0 0 3]

Engineering materials and processing techniques, Thermoplastics and thermosets, Thermoforming process, Extrusion, Compression molding, Injection molding. Transfer molding, Rotational molding, Blow molding. Processing of polymer composites, Hand-layup, Spray-layup, Press molding, Compression molding, Injection molding. Reaction injection molding, Autoclaving, Resin transfer molding, Filament winding, Pultrusion, VARIM, RTM, Vacuum bagging, Sheet molding, Pre-pegging, Secondary processing of polymer composites, Manufacturing of Composites, Micromechanics of composites, Testing of composites, Mechanical properties, Tensile, Flexural, ILSS, impact, thermal, wear properties, standards of testing, NDT of composites.

References:

1. Chawla Krishan K. Composite materials: science and engineering, Springer Science & Business Media, 2012.
2. Mallick P. K., Fiber-reinforced composites: materials, manufacturing, and design, CRC press, 2007.
3. Mazumdar Sanjay, Composites manufacturing: materials, product, and process engineering, CRC press, 2001.
4. Kaw Autar K., Mechanics of composite materials, CRC press, 2005.

MIE 4414: METAL & CERAMIC COMPOSITE MATERIALS [3 0 0 3]

Characteristics of MMC, Various types of Metal matrix composites Alloy vs. MMC, Advantages of MMC, Limitations of MMC, Metal Matrix, Reinforcements, particles, fibres. Effect of reinforcement - Volume fraction – Rule of mixtures. Processing of MMC, Powder metallurgy process, diffusion bonding, stir casting, squeeze casting. Deformation and damage in metal matrix composites, Fatigue of discontinuous metal matrix composites Mechanical behaviour of intermetallics and intermetallic matrix composites. Engineering ceramic materials, properties, advantages, limitations, Monolithic ceramics, Need for CMC, Ceramic matrix, Various types of Ceramic Matrix composites, oxide ceramics, non-oxide ceramics, aluminium oxide, silicon nitride, reinforcements, particles, fibres, whiskers. Sintering, Hot pressing, Cold isostatic pressing (CIPing), Hot isostatic pressing (HIPing), Structure-property relationships in ceramic matrix composites.

References:

1. Nikhilesh Chawla, Krishan K. C, Metal matrix composites, Springer, 2012.
2. Nanjappan Natarajan, Vijayan Krishnaraj and Paulo Davim J., Metal Matrix Composites Synthesis, Wear Characteristics, Machinability

Study of MMC Brake Drum, Springer Briefs in Applied Sciences and technology -Manufacturing and Surface Engineering, 2014.
3. Kainer K. U., Metal Matrix Composites: Custom-made Materials for Automotive and Aerospace Engineering, Wiley, 2006.
4. Longbiao Li, Time-Dependent Mechanical Behaviour of Ceramic-Matrix Composites at Elevated Temperatures, Advanced Ceramics and Composites, Springer, 2020.

MIE 4415: MATERIALS CHARACTERIZATION [3 0 0 3]

Importance of materials characterization for Mechanical & Industrial Engineering, Hardness and instrumentation, Micro and nano indentation hardness, Sample preparation for microstructure examinations, Optical microscopy, Topography, Surface feature studies using scanning electron microscopy, Elemental chemistry identification by energy dispersive spectroscopy, Advanced materials characterizations using transmission electron microscopy, Elemental chemistry identification using electron energy loss spectroscopy. Compounds /phases, Crystal structure, Elemental composition by X-ray diffraction, X-Ray fluorescence, Scanning auger microscopy.

References:

1. Spencer Michael, Fundamentals of Light Microscopy, Cambridge University Press, 1982.
2. David B. W., and Barry Carter C., Transmission Electron Microscopy: A Textbook for Materials Science, Springer, 2009.
3. Joseph I. G., Dale E. N., Patrick Echlin, and David C. J., Scanning Electron Microscopy and X-Ray Microanalysis, 3rd ed., 2005.
4. Ray Egerton, Physical Principles of Electron Microscopy, Springer Science, 2005.
5. Brandon D., and Kaplan W., Microstructural Characterization of Materials, John Wiley and Sons, 1999.

MIE 4416: FIBER REINFORCED COMPOSITE MECHANICS & MANUFACTURING TECHNIQUES [3 0 0 3]

Importance, classification and application of composite materials, Materials – Types of fibers, Thermoset and thermoplastic polymers, Fiber surface treatments, Processing of polymer composite materials, Hand layup, Spray up, Compression, Bag molding, Pultrusion, Resin transfer molding, Injection, Filament winding, Micromechanical analysis of lamina, volume, weight, density ratios, Macro mechanical Behavior of a Lamina, Compliance and stiffness matrices, Macro mechanical Behavior of a laminate, Classical Lamination theory, Theories of failures, Maximum stress theory, Maximum strain theory, Tsai-Hill theory, Tsai Wu failure theory, Testing of composite materials, tensile, compression, flexural properties.

References:

1. Mallik P. K., Fiber Reinforced Composites: Materials, Manufacturing and Design, 3rd ed., CRC, 2007
2. Kaw Autar K., Mechanics of Composite Materials, 2nd ed., CRC Press New York, 1997.
3. Agarwal B. D., Broutman L. J., and Bert C. W., Analysis and Performance of Fiber Composites, 3rd ed., Wiley, 2012.
4. Jones Robert M., Mechanics of Composite Materials, 2nd ed., Taylor & Francis Group, 1999.

MINOR SPECIALIZATION: VEHICLE TECHNOLOGY

MIE 4417: AUTOMOBILE ENGINES AND COMBUSTION [3 0 0 3]

Introduction: SI and CI engines, main components, electric vehicles and hybrid vehicles components, vehicle kinetics, dynamics of vehicle motion. Battery: Discharge rate, state of charge and discharge, battery pack Design, properties. AC and DC machines: Motor and engine rating, DC machines, three phase A/C machines, induction machines, permanent magnet machines and switched reluctance machines. Clutch and Gearbox: Different types of clutch and gear box. Drive to wheels and tyres: Torque reaction, driving thrust, torque tube drive, universal joint, propeller shaft, differential gearbox, types of the rear axle, tyres - desirable tyre properties, tube, and tubeless tyres. Steering and suspension system: Steering geometry, steering mechanism, steering linkages for rigid axle and independent suspension systems. Brakes: Brake efficiency and stopping distance, types of brakes, balance beam compensator, antilock braking system. Combustion: Combustion in SI engines, combustion knock, SI engine combustion chamber, combustion in CI engines: DI and IDI systems, delay period and diesel knock, control of diesel knock, CI engines combustion chambers. Automotive emission control system: Controlling crankcase and evaporative emissions, exhaust gas recirculation, air-aspirator system, catalytic converter, emission standards- Euro norms, Bharat Stage norms.

References:

1. Hussain Iqbal, Electric & Hybrid Vehicles – Design Fundamentals, 2nd ed., CRC Press, 2011.
2. Larminie James, Electric Vehicle Technology Explained, John Wiley & Sons, 2003.
3. Singh Kirpal, Automobile Engineering Vol. I & II, 13th ed., Standard Publishers Distributors, New Delhi, 2017.
4. Rajput R. K., Automobile Engineering, 2nd ed., Laxmi Publication (P) Ltd, 2017.
5. Jain K. K., and R. B. Asthana, Automobile Engineering, 1st ed., Tata McGraw Hill Education, New Delhi, 2017.
6. Heywood John B, Internal Combustion Engine Fundamentals, 2nd ed., McGraw-Hill Education New York, 2018.

MIE 4418: AUTOMOTIVE TRANSMISSION [3 0 0 3]

Different Types of Clutches - Principle - Construction and Torque Capacity. Determination of Gear Ratios for Vehicles. Different Types of Gearboxes Such as Sliding Mesh Gearbox – Constant Mesh Gearbox and Synchromesh Gearbox. All Spur and internal Gear Type Planetary Gearboxes - Ford T-Model - Cotal and Wilson Gear Box - Determination of Gear Ratios - Automatic Overdrives: Principal of Torque Conversion - Single - Multistage and Polyphase Torque Converters - Performance Characteristics. Automatic Transmission: Relative Merits and Demerits When Compared to Conventional Transmission - Automatic Control of Gears. Hydrostatic Drives: Advantages and Disadvantages - Principles of Hydrostatic Drive Systems.

References:

1. Heldt P. M., Torque converters, Chilton Book Co., 1992.
2. Garrett T. K., Steeds W., and Newton K., The Motor vehicle, 13th ed.,

Butterworth-Heinemann, 2001.
3. Judge A.W., Modern Transmission systems, Chapman and Hall Ltd., 1990.
4. Crouse W. H., and Anglin D. L., Automotive Transmission and Power Trains construction, McGraw Hill, 1983.

MIE 4419: ELECTRIC AND HYBRID VEHICLES [3 0 0 3]

Hybrid vehicles – Performance characteristics of road vehicles – calculation of road load – predicting fuel economy – grid connected hybrids. Hybrid architecture – Series, Parallel and Series Parallel Configuration Locomotive Drives – Switching – Load Tracking Architecture. Hybrid Power plant specifications – Grade and Cruise Targets – Launching and Boosting – Braking and Energy Recuperation – Drive Cycle Implications. Sizing the drive system, matching electric drive and ICE, Sizing the propulsion Motor, Power Electronics. Fuel Cell characteristics – Fuel Cell Types – Alkaline Fuel Cell – Proton Exchange Membrane – Direct Methanol Fuel Cell – Phosphoric Acid Fuel Cell. Nonelectric Hybrid Propulsion Systems – Short Term Storage. Flywheel. Accumulators – Continuously Variable Transmission.

References:

1. Halderman James D., and Martin Tony, Hybrid and Alternative Fuel Vehicles, 2nd ed., 2010.
2. Arvid Linde, How your car works: Your guide to the components and systems of modern cars, Including Hybrid and Electric Vehicles, Rac Handbook, 2011.
3. Hussain Iqbal, Electric & Hybrid Vehicles – Design Fundamentals, 2nd ed., CRC Press, 2011.
4. Chris Mi, Masrur M. Abul, and David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives, 2011.

MIE 4420: AUTOTRONICS [3 0 0 3]

Principle and construction of Lead Acid and Lithium – Ion Battery, Characteristics of battery, rating capacity and efficiency of batteries. Conditions at starting, behavior of starter during starting, series motor and its characteristics, principle and construction of starter motor, Bendix type, solenoid operated and axle type of starter motor. Generation of direct current, shunt generator characteristics, armature reaction, cutout, voltage and current regulators. Inductive, Hall effect, thermistors, piezo electric, piezo resistive based sensors, Solenoids. Components for electronic engine management system, open and closed loop control strategies, PID control, look up tables. Layout and working of SI Engine Management Systems. Group and Sequential Injection Techniques. MPFI, GDI, advantages of electronic Ignition systems. Cold start and warm up phases, idle speed control, acceleration and full load enrichment, deceleration fuel cutoff.

References:

1. Bechhold, Understanding Automotive Electronics, SAE, 1998.
2. Crouse W.H., Automobile Electrical Equipment, McGraw Hill Book Co. Inc. New York, 3rd ed., 1986.
3. Judge A. W., Modern Electrical Equipment of Automobiles, Chapman & Hall, London, 1992.
4. Young A. P., and Griffiths. L., Automotive Electrical Equipment, ELBS & New Press, 1999.

MINOR SPECIALIZATION: AUTOMATION AND ROBOTICS

MIE 4421: ROBOTICS: MECHANICS AND CONTROL [3 0 0 3]

Introduction: Definition of robots, Automation and Robotics, History of Robots, Anatomy of Robot, Robot configuration, Robot Motions, Work Volume, Drive System, Control System, Precision of movement, Specification of a robot, Applications of industrial robots. Robot Motion Analysis: Coordinate frames, Mapping and Transforms. Inverting a homogeneous transform, Euler angle representation. Kinematic modelling of the manipulator, Joint Notations in kinematics, Denavit – Hartenberg Notation. Manipulator Transformation matrix. Inverse Kinematics, Position Representation, Robot arm/ manipulator, Forward and reverse transformation of 2 degree of freedom arm. Robot end effectors: Types end effectors, Mechanical grippers and their mechanisms, Force analysis of gripper, vacuum cups, magnetic grippers, hooks and scoops, tools as end effectors, Physical support of the end effectors, Power and signal transmission, Guidelines for gripper selection. Trajectory Planning: Joint-space schemes, Cartesian-space schemes, Geometric problems with Cartesian paths, path generation at run time, collision free path planning. Robot Control Systems: Control system concepts, Mathematical models, Transfer Functions, Characteristic equation for spring mass dampener system, Types of controllers.

References:

1. Mittal R. K., and Nagrath I. J., Robotics and Control, Mc Graw Hill Education (India) Pvt. Ltd.
2. Groover Mikell P., Weiss Mitchel, Nagel Roger N., OdreyNichoas G., and Dutta Ashish, Industrial Robotics, 2nd ed., McGraw Hill Education (India) Pvt. Ltd, 2012.
3. Craig John J., Introduction to Robotics: Mechanics and Control, Pearson Prentice Hall Publication.
4. Janakiraman P. A., Robotics and Image processing, Tata McGraw Hill. 1995.

MIE 4422: ELEMENTS OF MECHATRONICS SYSTEMS [3 0 0 3]

Introduction: Definition, basic concepts and elements of mechatronic systems, needs and benefits of mechatronics in manufacturing, Sensors, Transducers: Displacement. Piezoelectric actuators, Shape memory alloys. Hydraulic & Pneumatic devices – Power supplies, valves, cylinder sequencing. Data acquisition and translation: Signal conditioning – Operational amplifiers, inverting amplifier, differential amplifier, Protection, comparator, filters, Multiplexer, Pulse width Modulation Counters, decoders, ADC, DAC Signal Analysis - Linearization of data, Compensation, Signal Averaging, Fourier analysis. Data presentation system: Display - Cathode ray oscilloscope, LED, LCD, Printers, Magnetic Recording, Controllers and Algorithms: Microprocessor Applications.

References:

1. Alciatore David G., and Histand Michael B., Introduction to Mechatronics and Measurement systems, Tata McGraw Hill, 2003.
2. Boltan W., Mechatronics, Addison Wesley Longman Ltd, 1999.
3. Shetty Devdas, and Kolk Richard, Mechatronics System Design, PWS Publishing, 2001.
4. Nesculescu Dan, Mechatronics, Pearson Education Pvt. Ltd, 2002.

MIE 4423: FLUID DRIVES AND CONTROL [3 0 0 3]

Introduction to Hydraulic systems:Advantages and limitations; Pascal's law; Force transmission in hydraulics. Hydraulic actuators, accessories and valves:Actuators: linear, rotary, and telescopic; Accumulator: types, and applications; Construction, and working of direction control valves: 2/2 way, 3/2 way, 4/2 way, 4/3 way; Hydraulic circuits: Regenerative; Meter in, and meter out; Bleed off; Sequencing; Pressure reducing circuits; Electro hydraulic circuits. Introduction to pneumatic systems: Advantages, limitations, and applications; Manual pneumatics:Symbols of pneumatic valves; Traverse time diagram; Design of manually operated circuits; Control of multiple actuators. Electropneumatics: Introduction; Structure of signal flow; Advantages of electro pneumatics; Limit switches; Proximity sensors: Magnetic, Inductive, Capacitive, Optical, Ultrasonic, and Pneumatic; electrically actuated direction control valves; Relay control systems; Design of electro pneumatic circuits.

References:

1. Croser Peter, and Ebel Frank, Pneumatics Basic Level TP 101, Festo Didactic GMBH Co, Germany, 2002.
2. Prede G. and Scholz D., Electropneumatics Basic Level, Festo Didactic GMBH & Co, Germany, 2002.
3. Merkle D., Schrader B., and Thomes M., Hydraulics Basic Level TP 501, Festo Didactic GMBH & Co, Germany, 1998.
4. Rohner Peter, Industrial Hydraulic Control, John Wiley & Sons, Brisbane,1989.

MIE 4424: MECHANICAL HANDLING SYSTEMS AND EQUIPMENTS [3 0 0 3]

Elements of Material Handling System: Importance, Terminology, Principles and features, Objectives and benefits of better material handling, Selection of Material Handling Equipment: Factors affecting for selection, material handling equation, choices of material handling equipment. General analysis and procedure: Basic analytic techniques, the unit load concept. Selection of suitable types of systems for applications. Design of Mechanical Handling Equipment:Design of hoists, drives for hoisting components and hoisting mechanisms; rail travelling components and mechanisms; hoisting gear operation during transient motion. Design of load lifting attachments: Load chains and types of ropes used in material handling system; forged, standard and Ramshom Hooks; crane Grabs and Clamps; Grab Buckets. Equipment of Material Storage: Objectives of storage, Bulk material handling; gravity flow of solids through slides and chutes; Storage in bins and hoppers; Material Handling / warehouse automation and safety considerations – storage and warehouse planning and design; computerized warehouse planning; Need, Factors and Indicators for consideration in warehouse automation; which function, when and How to automate.

References:

1. Michael Rivkin, Bulk Material Handling, Partridge Publishing Singapore, 2018.
2. Charles Reese, Material Handling Systems, Taylor & Francis, 2000.
3. C.R. Woodcock & J.S. Mason, Bulk Solids Handling, Springer Netherlands, 2012.
4. Jacob Fruchtbaum, Bulk Materials Handling Handbook, Springer US, 2013.
5. Siddhartha Ray, Introduction to Materials Handling, New Age International Private Limited, 2007.

MINOR SPECIALIZATION: QUALITY ENGINEERING

MIE 4425: STATISTICAL QUALITY CONTROL [3 0 0 3]

Definitions of the term quality, Causes of variation, Patterns of variation, Frequency distribution, Measures of central tendency and dispersion, The Normal distribution curve, Inequality theorems, Shewhart's bowl drawing experiments, Control charts for variables (X , R and s charts), Type I and Type II Errors, Process capability analysis, Process capability indexes, Control charts for attributes (p ,np, c and u charts), Acceptance sampling by attributes, Single and Double sampling plans, Operating characteristic curve, Acceptable quality level, Lot tolerance percent defective, Average outgoing quality, Average total Inspection, Average fraction inspected, Producers risk, Consumers risk, Acceptance sampling tables, Conventional and Statistical tolerancing, Precision, Accuracy and Reproducibility of method of measurements, Quality costs.

References:

1. Grant E. L., and Levenworth R., Statistical Quality Control, McGraw Hill Publications, 2005.
2. Montgomery D.C., Introduction to Statistical Quality Control, John Wieley and Sons, 2005.
3. Mahajan M.S., Statistical Quality Control, Dhanpat Rai and Co. Pvt. Ltd., 2012.
4. Juran J.M., and Gryna F.M., Quality Planning and Analysis, Tata McGraw Hill Publications, 1995.

MIE 4426: PRODUCTION PLANNING AND CONTROL [3 0 0 3]

Introduction: Functions of production, planning and control. Types of production activities, Production consumption cycle. Forecasting Analysis: Importance and uses of forecasting, Type of forecasts, Qualitative methods of forecasting, Quantitative methods of forecasting, Exponential smoothing, Linear regression analysis, Correlation analysis and Seasonality, Forecast control. Aggregate planning: Need and inputs for aggregate production planning, Pure and mixed strategies of aggregate planning. Aggregate planning approach. Job shop scheduling: Factors affecting job shop scheduling, Index method, Priority sequencing rules, Determination of mean flow time, average job lateness and average number of jobs in the system, Sequencing of 'n' jobs through 'n' machines. Inventory control: Classification of inventories, Economic order quantity, Inventory control models, Effect of quantity discount, Safety stock, Reorder level, Lead time, ABC Analysis. MRP: Product structure tree, MRP inputs and outputs, MRP logic, Problems. Assembly line balancing: Meaning and determination of cycle time and theoretical minimum number of workstations, Precedence diagram, Priority rules for allocation of tasks to workstations, Longest work element time rule, Maximum following tasks rule-Calculation of efficiency and percentage delay loss.

References:

1. Monks Joseph G., Operations Management, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2004.

2. Krajewski Lee J., and Ritzman Larry P., Operations Management, Pearson Education (Singapore) Pte. Ltd., Delhi, 2005.
3. Adam Everett E. Jr., and Ebert Ronald J., Production and Operations Management, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
4. Chase Richard B., Aquilano Nicholas J., and Jacobs F. Roberts, Production and Operations Management, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 1999.

MIE 4427: OPERATIONS RESEARCH [3 0 0 3]

Introduction: Definition, Phases, Applications, Advantages and Limitations of Operations Research. Linear programming problems: Assumptions, Formulation of LPP for business and non-business applications. Graphical solutions, Special cases – Degeneracy, Infeasible Solution, Unbalanced and Multiple optimal solutions. Minimization and Maximization cases. Simplex algorithm, Concept of dual, Sensitivity analysis with respect to objective function coefficients and R.H.S. values. Transportation problem: Formulation, North-West Corner (NWC) Method, Least Cost (LC) Method, Vogel's Approximation Method (VAM). Testing the solution by Stepping stone, Modified Distribution (MODI) Method. Maximization, Multiple optimal solutions, Degeneracy and Unbalanced problems. Post optimality analysis. Assignment problem: Solution algorithm for Assignment Problems. Unbalanced, multiple optimal solutions, Maximization and Application problems. Travelling salesman / Job sequencing problem: Solution algorithm for Travelling Salesman Problem, Application to job sequencing problem Game theory: Introduction to game theory, Two-person-zero sum games, Pure and Mixed Strategies, Solution methods for 2 x 2 games, Graphical method (2 x n games; m x 2 games), Simulation of queuing system - Steps in simulation, Application and Limitations, Monte- Carlo technique-Problems involving Waiting line situations and Selection of crew members. Critical Path Method (CPM): General framework, Introduction to elements of network, conventions adapted in drawing network, analysing the network. Calculation of event and Activity times, Total Float, Free Float, Independent float, Critical path, Determination of project duration, Project Crashing. Applications and Limitations of CPM. Project Evaluation and Review Technique (PERT): Calculation of Probabilistic/Expected event and Activity times, Variance of activity duration, Determination of critical path, probability /expectation of project completion.

References:

1. Taha H. A., Operations Research, Pearson Education, 7th ed., 2002.
2. Winston W. L., Operations Research, Thomson Asia, 2003.
3. Vohra N. D., Quantitative Techniques in Management, New Delhi, 2007.
4. Sharma S. D., Operations Research, Kedar Nath Ramnath Publications, 14th ed., 2005
5. Wagnor Hervey M., Principles of Operations Research, Prentice Hall of India Private Ltd, 1999.
6. Paul Loomba, Management, A Quantitative Perspective, MacMillan, New York, 1978.

MIE 4428: TOTAL QUALITY MANAGEMENT [3 0 0 3]

Definition of quality and Total quality management (TQM), Basic concepts of TQM, Contributions of Gurus of TQM, Benefits of TQM, Characteristics of successful quality leaders, The Deming philosophy, Quality council, Quality statements, Strategic planning. Customer satisfaction, Employee involvement Continuous process improvement, Juran Trilogy, PDSA cycle, Kaizen, Six sigma, Supplier partnership, Performance measures, Quality costs, Benchmarking, Quality function deployment (QFD), QFD process, Failure Mode and Effect Analysis (FMEA), Total Productive Maintenance (TPM), The seven tools of quality control, Statistical fundamentals, Control charts for variables and attributes, Concept of six sigma quality, Taguchi's quality loss function,Quality and environmental management systems, Quality auditing, Case Studies.

References:

1. Besterfield Dale H., Besterfield-Michna Carol, Besterfield Glen, Besterfield-Sacre Mary, Urdhwarshe Hemant, and Urdwarshe Rashmi, Total Quality Management. Revised 3rd ed., Pearson Education, New Delhi, 2012
2. Evans James R., and Lindsay William M., The Management and Control of Quality, 5th ed., South-Western Thomson Learning, 2002.
3. Oakland John S., Total Quality Management text with Cases, Elsevier, New Delhi, 2006
4. Besterfield Dale H., Total Quality Management, Pearson Education, Delhi, 2006.

MINOR SPECIALIZATION: COMPUTER TECHNIQUES IN MECHANICAL ENGINEERING

MIE 4429: PROGRAMMING IN MECHANICAL ENGINEERING [3 0 0 3]

Introduction to programming, Programming the matrix algebra, Programming for plotting engineering charts, Programming applications in numerical analysis, Programming case studies in mechanical engineering - Solid geometry, Engineering mechanics, Geometric Transformations, Machine design, Mechanical vibration, Fluid mechanics, Thermal science, FEA of structural systems.

References:

1. Rao V. Dukkipati, MATLAB for Mechanical Engineers, New Age Science Limited, 2009.
2. Rao V. Dukkipati, Solving Engineering Systems Dynamics Problems with MATLAB, New Age International (P) Limited, 2007.
3. Steven T. Karris, Numerical Analysis Using MATLAB® and Spreadsheets, 3rd ed., Orchard Publications, 2007.
4. Orbaiceta, Angel Sola. Hardcore Programming for Mechanical Engineers: Build Engineering Applications from Scratch. No Starch Press, 2021.
5. Alex Kenan, Python for Mechanical and Aerospace Engineering, Licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License, 2020.
6. Amos Gilat, MATLAB®An Introduction with Applications, 4th ed., JOHN WILEY & SONS, INC., 2011.

MIE 4430: METAHEURISTIC OPTIMIZATION TECHNIQUES [3 0 0 3]

Introduction to Optimization: Optimization, mathematical structure of an optimization problem, terminologies; Evolutionary optimization techniques: Types of evolutionary optimization techniques, the Genetic Algorithm (GA), structure and working principle of the GA; Swarm intelligence optimization techniques: Types of swarm intelligence optimization techniques, the Particle Swarm Optimization (PSO) technique, structure and working principle of the PSO; Algorithmic-specific-parameter-less optimization techniques: Limitations of the advanced metaheuristic optimization techniques, the Teaching Learning Based Optimization (TLBO) technique, the JAYA optimization technique, structure and working principle of the TLBO and JAYA; Multi-objective optimization problems: Singleobjective versus the multi-objective optimization, Approaches of solving multi-objective optimization problems; Application of optimization techniques to Mechanical Engineering problems.

References:

1. Bozorg-Haddad Omid, Solgi Mohammad, and Loáiciga Hugo A., MetaHeuristic and Evolutionary Algorithms for Engineering Optimization, John Wiley & Sons, Inc., 2017.
2. Deb Kalyanmoy, Multi-objective optimisation using evolutionary algorithms, Wiley, 2001.
3. Goldberg David E., Genetic Algorithms in Search, Optimization, and Machine Learning, Addison-Wesley Professional, 1989.
4. Sun Jun, Lai Choi-Hong, and Wu Xiao-Jun, Particle Swarm Optimisation Classical and Quantum Perspectives, CRC Press, Taylor & Francis Group, 2019.
5. Rao RavipudiVenkata, Jaya: An advanced Optimization Algorithm and its Engineering Applications, Springer International Publishing, 2019.

MIE 4431: MACHINE LEARNING AND ITS APPLICATIONS [3 0 0 3]

Machine Learning Definition and Basics; Learning Models - Supervised Learning (Classification Problem, Regression Problem), Unsupervised Learning, Semi supervised Learning, Reinforcement Learning; Regressions - Linear Regression, Normal Equation Method vs Gradient Descent Method, Logistic Regression; Model improvement - Nonlinear Contribution, Feature Scaling, Gradient Descent Algorithm Variations, Regularization, Multi-class Classifications; Classification - Nonlinear Decision Boundary, Skewed Class, Naïve Bayes' Algorithm, Support Vector Machines - Kernel Selection; Random Forests - Decision Tree, Disadvantages of Decision Trees, Data Bagging, Feature Bagging, Cross Validation, Prediction in Random Forests, Disadvantages of Random Forests; Testing the Algorithm and the Network; Artificial Neural Networks - Neural Network Representation, Training the Network, Backpropagation, Updating weights, Controlling computations; ML case studies in Mechanical Engineering - Implementation of machine learning models to solve problems in Design Engineering, Thermal sciences, Vibration analysis, Materials engineering, Manufacturing engineering.

References:

1. Jo T., Machine Learning Foundations Supervised, Unsupervised, and Advanced Learning, In Machine Learning Foundations, Springer International Publishing, 2021.
2. Kramer O., Machine learning for evolution strategies, Springer International Publishing, 2016.
3. Rebala G., Ravi A. and Churuwala S., Introduction to Machine Learning, In Studies in Computational Intelligence, Vol. 975, 2021.
4. Manohar Swamynathan, Mastering Machine Learning with Python in Six Steps, A Practical Implementation Guide to Predictive Data Analytics Using Python, Second Edition, APress, 2019.
5. Rodrigo Fernandes De Mello and MoacirAntonelliPonti, Machine Learning, A Practical Approach on the Statistical Learning Theory, Springer International Publishing AG, 2018.
6. Oliver Theobald, Machine Learning For Absolute Beginners: A Plain English Introduction, 3rd ed., 2021.

MIE 4432: MICROCONTROLLER BASED AUTOMATION [3 0 0 3]

Introduction to microcontrollers, embedded system and automation, Instruction set architecture of ARM microcontroller, Embedded C programming, sensors, actuators and their interfacing, Microcontroller development boards and embedded programming platforms, D/A and A/D converter, Timers, Delay generation, PWM, Inter Integrated Circuit communication, Universal Asynchronous Receiver/Transmitter, Serial Peripheral Interface communication protocols, Temperature sensing unit, Light sensing unit, Sound sensing unit, Feedback control system, relay control unit, driving electrical appliances like motors, bulb, pump, etc. motion sensing using accelerometer, control of appliances, case study based on automation sectors.

References:

1. CemÜnsalan, Hüseyin Deniz Gürhan, Mehmet ErkinYücel, Embedded System Design with Arm Cortex-M Microcontrollers, Springer Cham, 2022.
2. Mazidi, and Naimi, STM32 Arm Programming for Embedded Systems, Microdigitaled, 2018.
3. Carmine Noviello, Mastering STM32, A step-by-step guide to the most complete ARM Cortex-M platform, LeanPub.com, 2022.
4. Donald Norris, Programming with STM32: Getting Started with the Nucleo Board and C/C++, McGraw-Hill Education, 2018.
5. Dogan Ibrahim, Nucleo Boards Programming with the STM32CubeIDE, ElektorVerlag, 2022.
6. Yury Magda, ARM Assembly Language Programming With STM32 Microcontrollers: Learning By Example, 2020.
7. https://www.st.com/en/development-tools/stm32cubeide.html

MINOR SPECIALIZATION – EV TECHNOLOGY

ELE 4415: EV BATTERY TECHNOLOGY AND POWERTRAIN DEVELOPMENT [3 0 0 3]

Battery Fundamentals: Basics of Batteries, Battery Parameters, Lithium-Ion Characteristics, Thermal Runaway Battery Management System (BMS), Functionality, Practical session - Battery Selection and Connection Process with Vehicle Sensors.Battery Management Systems: SOC/SOH Estimation, Cell Balancing, Protection, Thermal Management, CAN Communication. Practical session - BMS development.Battery Pack Design & Modelling: Overview of Battery & BMS System, Electrical Design, Mechanical Design: Calculations and Mechanical Design using ANSYS, Heat Transfer, Thermal Design of Battery Pack, Battery Pack Assembly and Test, Thermal Analysis on Battery Pack, MATLAB/Simulink-based Battery Pack Modelling. Practical session - Battery life cycle testing.Powertrain and Charging Systems of Electric Vehicles: Introduction to EV Powertrain, Overview, Architecture and Components of EV Powertrain, Thermal Management of EV Powertrain, EV Charging Systems and Types of Chargers.

Modelling, Simulation, and Analysis of EV Powertrain Components:

Modelling and Simulation of EV Powertrain Components in MATLAB, Modelling and Analysis of EV Powertrain Components in SolidWorks, Analysis of EV Powertrain Components in ANSYS, Case Study on Powertrain of Existing Models.

References:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. JIANGONG, D. H. Z., "Advances in lithium-ion batteries for electric vehicles: Degradation Mechanism, health estimation, and lifetime prediction", Elsevier – Health Science, 2024, ISBN-13: 9780443155437.
3. R. Xiong, "Battery Management Algorithm for Electric Vehicles", Springer, 2020, ISBN-13: 9789811502507.
4. Rui Xiong and Weixiang Shen, "Advanced battery management technologies for electric vehicles", John Wiley & Sons Inc, 2019, ISBN-13: 9781119481645.
5. Hannes Hick, Klaus Kupper, and Helfried Sorger, "Systems engineering for automotive powertrain development", Springer, 2021, ISBN-13: 9783319996288.
6. Christopher D. Rahn, "Battery Systems Engineering", Wiley, 1st Ed, 2013, ISBN:9781119979500.
7. Noshin Omar, "Electric Vehicle Batteries: Moving from Research towards Innovation", Reports of the PPP European Green Vehicles Initiatives, Springer, 2015.
8. Gonzalo Abad and Joaquim Lois, "Power Electronics and Electric Drives for Traction Applications", Wiley, 2016, ISBN: 978-1-118-95442-3.
9. John G. Hayes and G. Abas Goodarzi, Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles", Wiley, 2017, ISBN: 978-1-119-06364-3.

AAE 4425: EV PRODUCT DEVELOPMENT, HOMOLOGATION & HYDROGEN FCEV [3 0 0 3]

EV Design, Manufacturing & Management: Introduction to EV (2W, 3W & 4W) Market and Opportunities, Electric Vehicle Design Procedure and ICE Model, Introduction to EV Management (Categories, Regulations and Standards), EV Homologation and Testing, FAME India and Manufacturing Guidelines. EV Testing, Certification & Market analysis: EV Certification Process, EV Charging, Electric Vehicles and Retrofitting, Motor Technology and EV Motor Market Analysis, EV Categories and Proposed Changes, EV Retrofitting Business, Battery Technology in EV, EV Battery Market Analysis, Practical session - Conducting a market analysis of the EV industry.EV R&D Product Development: Introduction to Product Development Plan, Segment Selection, Product Design Plan, Product Validation Plan, Vehicle Dynamics Selection, Product Design Validation, Product Specification - Competitor Analysis, Selection of Off-the-Shelf Parts, Development Methods, Product Development Plan, Unit Economics, Design Feasibility, Design for Manufacturing, DFMEA and PFMEA, Business Plan, Product Launch, POC/MVP/Working Prototype, Practical session – Using the market research to develop a business plan for an EV manufacturer.Hydrogen Fuel Cells: Introduction to Future Mobility, Why Hydrogen-based Technology, Essentials of Hydrogen, How Does Hydrogen Compare to Hydrocarbon Fuels in Terms of Energy, Flammability and Safety, Hydrogen Fuel Cells, Use of Hydrogen in IC Engines, Hydrogen Fuel Cell Techniques and Systems, Fuel Cell Engine Safety and Maintenance.Hybrid Vehicles & Fuel Cells: Fuel Cell Hybrid Electric Vehicle Acts, Codes, Regulations and Guidelines, Maintenance and Fuelling Facility Requirements, Fuel Cells in Hybrid Electric Vehicles and Pure Electric Vehicles, Auxiliary Power Generation Using Hydrogen, Types of Fuel Cells and Techniques Used, Fuel Stack Module Construction, Fuel Cell Performance, Characteristics, Polarisation, Stoichiometry Effects, Temperature and Pressure Effects, Practical session – Study on Hydrogen fuel cell with MATLAB/SIMULINK.

References:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Tom Denton, "Electric and Hybrid Vehicles", Routledge 2nd Ed, 2020, ISBN: 978-0367273231.
3. Chris Ni and M. Abul Masrur, "Hybrid electric Vehicles, Principles and Applications", WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6.
4. Beate Müller, and Gereon Meyer, "Electric Vehicle Systems Architecture and Standardization Needs", Springer, 2016, ISBN-13: 9783319360966.
5. O chsner Andreas, and Springerlink, "Engineering Applications for New Materials and Technologies", Cham, Springer International Publishing, 2018, ISBN-13: 9783319891972.
6. "Electric Cars" - offered by Delft University of Technology on edX Link: https://www.edx.org/professional-certificate/electric-vehicles-and-mobility.
7. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

ELE 4417: EV VEHICLE DESIGN & ANALYSIS [3 0 0 3]

Introduction to Analog Electronics: Introduction to Basic Electronics, Diode Fundamentals, Rectifiers and Filters, Power Electronics for EVs: Voltage Regulators, Inverters and Converters, Special Purpose Diodes, Transistors and Types of Transistors, Operational Amplifier (Op-Amp).Fundamentals of Digital Electronics: Digital Electronics, EV Control Systems, EV Communication Networks, Microcontrollers and Microprocessors, Introduction to Proteus Software, Circuit Development Using Proteus.Essentials for Designing and Simulation Using MATLAB: Overview and Environment, Basic Syntax, Variables and Commands, Commands, M-files, and Types, Operators, Decision Making and Loops, Vectors, Matrix, and Arrays, Colon Notation and Numbers, Strings and Functions, Numbers, Plotting and Graphics, Algebra, Calculus, Differential, and Integration, Polynomials and Transforms, Programming EV Systems in MATLAB, Simulink and Fitting, Developing SIMULINK Models for Vehicle Units, Advisor and QSS Toolbox, QSS-based Vehicle Control. Practical session - Analyze and troubleshoot electronic circuits using simulation tools and lab equipment.EV Architecture Modelling Using MATLAB [Software-based]: Motor Development and Induction Motor, Characteristics, Simulink Model to Calculate Vehicle Configuration, Multi-level Inverter Design and Simulation, Solar PV-based Charger Development, Dc-DC Converter, Modelling of Li-ion Battery Pack, Design of EV Using QSS Toolbox, Battery Thermal Modelling, BMS Modelling, Electric 4W Powertrain

Modelling. Practical session - Data analysis and visualization using MATLAB for vehicle system.Design of EV System Using MATLAB [Software-based]: Power Required to Overcome Resistance Forces Acting on the Vehicle, Power Converters in Electric Vehicles, Inverters in Electric Vehicles, Motor and Motor Controllers, Modelling of EV Battery and BMS. Practical session - Modeling and simulation of EV powertrain components, such as motors, controllers, and inverters, using MATLAB/Simulink.

References:

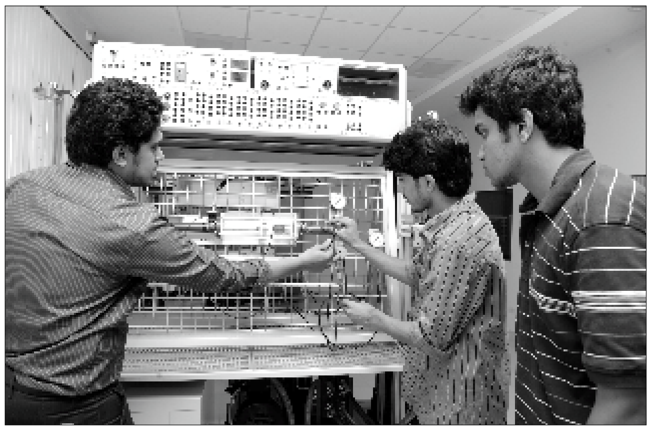
1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", Routledge, 3rd Ed, 2021, ISBN: 9780367693930.
3. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 1st Ed, 2014, ISBN: 9781138072855.
4. Sandeep Dhameja, "Electric Vehicle Battery Systems", Butterworth-Heinemann, 2st Ed, 2002, ISBN: 978-0750699167.
5. Singh, Sanjeev, et al., “Electric Vehicle Components and Charging Technologies” IET, 2024, ISBN-13: 9781839536717.
6. Das, Shuvra, “Modeling for Hybrid and Electric Vehicles Using Simscape”, Springer, 2022, ISBN-13: 9783031003806.

AAE 4426: EV FEA Analysis [3 0 0 3]

EV Design and Structural Analysis with Altair Hyper Mesh: Theory of FEA/CAE, Introduction to Hyper Mesh, Creating and Modifying Geometry, Geometry Clean-up and Defeature, Introduction to 2D Meshing, Introduction to 3D Meshing, Element Quality, Mesh Edit, Introduction to Plastic Meshing, Introduction to 1D Meshing, Modal Analysis, Linear Static Analysis, Buckling Analysis, Connectors. Practical session - Optimization techniques using Hyper Mesh. ABAQUS in EV Engineering [Software-based]: Introduction to Abaqus Software, Fundamentals of FEA-Stress, About Abaqus Software-Features, Applications of Abaqus Software in Different Industries, Simple Modelling in Abaqus Software, Create Material and Create Assembly, Create Steps, Loads, Boundary Conditions, Generate Mesh, Result Visualization, Practical session - Multi physics analysis using Abaqus. Finite element Analysis of EV structural components [Software-based]: One Dimensional Analysis, Linear Static Analysis and Linear Buckling Analysis, Heat Transfer Analysis, Non-linear Analysis, Dynamic Simulation-Modal Analysis, Impact Analysis, Time-Dependent Load Analysis. ANSYS in EV Engineering [Software-based]: Basics of Finite-Element Analysis (FEA) along with ANSYS Tool and Software Interface, Essential Mechanical and Electrical Properties of Materials, Various Case Studies on ANSYS Mechanical, Basics of Computational Fluid Dynamics (CFD), Various Case Studies on ANSYS Fluent. Practical session – FEA analysis using ANSYS. Dynamic Simulation and Transient Analysis [Software-based]: Simulation of Battery Thermal Management in Electric Vehicle, Vibration and Fatigue Analysis of Battery Pack, Simulation of Structural Integrity for Motor Mount, Thermal Analysis of Liquid-Cooled Radiator, CFD Study of External Cooling Mechanism for Battery Pack. Practical session - Vulnerability analysis.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.Eric Miller and Jeff Strain, “Introduction to the ANSYS Parametric Design Language (APDL), Phoenix, 2nd Ed, 2016, ISBN: 978-1537133997.
2. Narayana, Lakshmi, et al., “Advances in Automation, Signal Processing, Instrumentation, and Control”, Springer, 2021, ISBN 9789811582202.
3. P Seshu., “Textbook of Finite Element Analysis”, Prentice-Hall of India, 2010, ISBN-13: 9788120323155.
4. Turner, John., “Progress in Modelling and Simulation of Batteries”, SAE International, 2016, ISBN-13: 9780768082821.
5. Y Nakasone, et al., “Engineering Analysis with ANSYS Software”, Butterworth-Heinemann, 2018, ISBN-13: 9780081021644
6. Mohamed Amine Fakhfakh, “Modeling and Simulation for Electric Vehicle Applications”, BoD – Books on Demand, 2016, ISBN-13: 9789535126362.
7. Atul Sharma, "Introduction to Computational Fluid Dynamics: Development, Application and Analysis", Wiley, 1st Ed, 2017, ISBN: 9781119002994.
8. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/



B.TECH. INDUSTRIAL ENGINEERING

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2121	Engineering Mathematics - III	2	1	0	3	MAT 2229	Engineering Mathematics - IV	2	1	0	3
	MIE 2126	Industrial Internet of Things	3	0	0	3	MIE 2226	Operations Research	3	1	0	4
	MIE 2127	Data Analytics and Visualisation	3	0	0	3	MIE 2227	Work System Engineering and Ergonomics	3	0	0	3
	MIE 2128	Control Systems Engineering	2	1	0	3	MIE 2228	Supply and Logistics Management	2	1	0	3
	MIE 2129	3D Printing and Design	3	0	0	3	MIE 2229	Design of Experiments	2	1	0	3
	MIE 2130	Industrial Automation and Robotics	3	1	0	4	MIE 2230	Lean Manufacturing and Six Sigma	3	1	0	4
	MIE 2143	Data Analytics and Visualisation Lab	0	0	3	1	MIE 2243	Work System Engineering and Ergonomics Lab	0	0	3	1
	MIE 2144	Automation and Robotics Lab	0	0	3	1	MIE 2244	Computer Aided Operations Research Lab	0	0	3	1
			15	**3**	**7**	**21**			**15**	**5**	**6**	**22**
	Total Contact Hours (L + T + P)		**25**				**Total Contact Hours (L+T+P)**		**26**			
III	FIFTH SEMESTER						SIXTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	HUM 3021	Engineering Economics and Financial Management	2	1	0	3	HUM 3022	Essentials of Management	2	1	0	3
	MIE ****	Flexible Core - 1 (A1 / B1 / C1)	3	0	0	3	MIE ****	Flexible Core - 2 (A2 / B2 /C2)	3	0	0	3
	MIE 3127	Simulation Modeling and Analysis	3	0	0	3	MIE 3227	Operations Management	3	1	0	4
	MIE 3128	Total Quality Management	3	0	0	3	MIE ****	Program Elective - I / Minor Specialization	3	0	0	3
	MIE 3129	Engineering System Design	3	1	0	4	MIE ****	Program Elective - II / Minor Specialization	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective - 2	3	0	0	3
	MIE 3143	Computer Aided Quality Engineering Lab	0	0	3	1	MIE 3243	Computer Aided Experimental Design Lab	0	0	3	1
	MIE 3144	Simulation Modeling and Analysis Lab	0	0	3	1	MIE 3244	Computer Aided Operations Management Lab	0	0	3	1
			17	**2**	**6**	**21**			**17**	**2**	**6**	**21**
	Total Contact Hours (L+T+P)		**25**				**Total Contact Hours (L+T+P)**		**25**			
IV	SEVENTH SEMESTER						EIGHTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	MIE ****	Program Elective - III / Minor Specialization	3	0	0	3	MIE 4291	Industrial Training				1
	MIE ****	Program Elective - IV / Minor Specialization	3	0	0	3	MIE 4292	Project Work / Practice School				12
	MIE ****	Program Elective - V	3	0	0	3	MIE 4293	Project Work (B.Tech Honours)**				20
	MIE ****	Program Elective - VI	3	0	0	3	MIE ****	B.Tech Honours (Theory 1)** (V Semester)				4
	MIE ****	Program Elective - VII	3	0	0	3	MIE ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	*** ****	Open Elective - 3	3	0	0	3	MIE ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	MIE 4191	Mini Project (Minor Specialization)*				8						
			18	**0**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P)		**18**									

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

FLEXIBLE CORE-A

FINANCIAL MANAGEMENT

MIE 3130: Accountancy for Managers (A1)
MIE 3228: Statistics for Managers (A2)

FLEXIBLE CORE-B

INDUSTRIAL MANAGEMENT

MIE 3131: Technology Management (B1)
MIE 3229: Project Management (B2)

FLEXIBLE CORE-C

HUMAN RESOURCE MANAGEMENT

MIE3132: Personnel Management and Industrial Relations (C1)
MIE 3230: Organizational Behavior(C2)

MINOR SPECIALIZATIONS

I. INDUSTRIAL INTERNET OF THINGS

MIE 4433: Industry 4.0
MIE 4434: Block Chain Technology
MIE 4435: Artificial Intelligence for Industrial Engineering.
MIE 4436: Cyber Security

II. COMPUTER ORGANIZATION AND PROGRAMMING

MIE 4437: Basics of Computer Organization
MIE 4438: Basics of Operating System
MIE 4439: Programming Using Python
MIE 4440: Machine Learning

III. EV TECHNOLOGY

ELE 4415: EV Battery Technology and Powertrain Development
AAE 4420: EV Product Development, Homologation & Hydrogen FCEV
ELE 4417: EV Vehicle Design & Analysis
AAE 4421: EV FEA Analysis

OTHER PROGRAMME ELECTIVES

MIE 4457: Engineering Asset Management
MIE 4461: Artificial Neural Network
MIE 4462: Business Process Re-engineering
MIE 4463: Data Management and Analysis with Excel
MIE 4464: Database Management System
MIE 4465: Design for Manufacture & Assembly
MIE 4466: Enterprise Resource Planning
MIE 4467: Facilities Planning and Design
MIE 4468: Financial Analysis and Reporting
MIE 4469: Financial Markets, Treasury & Risk Management
MIE 4470: Industrial Safety and Risk Management
MIE 4471: International Financial Management
MIE 4472: Management Information Systems
MIE 4473: Materials Management
MIE 4474: Metaheuristic Techniques
MIE 4475: Plant Engineering and Maintenance
MIE 4476: Production Economics
MIE 4477: Security Analysis and Portfolio Management
MIE 4478: Strategic Management
MIE 4479: Tool Engineering
MIE 4480: Waste Management

OPEN ELECTIVES

MIE 4311: Introduction to Composite Materials
MIE 4312: Introduction to Biomechanics
MIE 4313: Introduction to Operations Research
MIE 4314: Energy Engineering
MIE 4315: Introduction to Finite Element Methods
MIE 4316: Bio-Fluid Dynamics
MIE 4317: Introduction to Engineering Asset Management

THIRD SEMESTER

MAT 2121: ENGINEERING MATHEMATICS III [2 1 0 3]

Gradient, divergence and curl, Line, surface and volume integrals. Green's, divergence and Stoke's theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, Sine and cosine transforms. Partial differential equation- Basic concepts, solutions of equations involving derivatives with respect to one variable only. Solutions by indicated transformations and separation of variables. One-dimensional wave equation, one dimensional heat equation and their solutions. Numerical solutions of boundary valued problems, Laplace and Poisson equations and heat and wave equations by explicit methods.

References:

1. Erwin Kreyszig: Advanced Engineering Mathematics, 5thedn. 1985 Wiley Eastern.
2. S. S. Sastry: Introductory Methods of Numerical Analysis 2nd edn.1990, Prentice Hall.
3. B. S. Grewal: Higher Engg.Mathematics, edn., 1989 Khanna Publishers
4. Murray R.Spiegel: Vector Analysis, edn.1959, Schaum Publishing Co.

MIE 2126: INDUSTRIAL INTERNET OF THINGS [3 0 0 3]

Basic concepts of IoT, IoT architecture, Application-based IoT protocols, Cloud computing, Introduction to Big data, Design requirements of industry 4.0, Drivers of industry 4.0, Cybersecurity – threats and requirements, Impacts of industry 4.0 – economic, business, and global perspective, IIOT and industry 4.0, Industrial internet consortium (IIC), Industrial internet systems, Industrial sensing, Digital enterprise, Introduction and definitions of business model and reference architecture, Reference architecture of IoT, Reference architecture of IIoT, Industrial internet reference architecture (IIRA), Basics of offsite key technologies, Fog computing, Augmented reality (AR), Virtual reality (VR), Smart factories–characteristics and technologies,Lean manufacturing system, Data transmission, Data acquisition, Distributed control system, Power line communication (PLC), Supervisory control and data acquisition (SCADA), Introduction to analytics, ML, DL and data science.

References:

1. Roy, C., Introduction to Industrial Internet of Things and Industry 4.0. United States, CRC Press, 2021.
2. Veneri, G. and Capasso, A., Hands-On Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure Using Industry 4.0. United Kingdom, Packt Publishing, 2018.
3. Gilchrist, A., Industry 4.0: The Industrial Internet of Things. United States, Apress, 2016.
4. Bhattacharjee, S., Practical Industrial Internet of Things Security: A Practitioner's Guide to Securing Connected Industries. United Kingdom, Packt Publishing, 2018.

MIE 2127: DATA ANALYTICS AND VISUALISATION [3 0 0 3]

Introduction: Functions-logical, summarizing, text, lookup and reference, statistical and financial. Analysis of quantitative data: Tools, analysis for time series data and cross-sectional data using visual analysis and descriptive statistics, data relationship tools. Analysis of qualitative data: dealing with data errors, pivot chart or pivot table reports. Inferential statistical analysis of data: statistical techniques to fit the data-chi square test, z-test and ttest, test of hypothesis, Analysis of variance. Presentation of quantitative data: data classification, data context and data orientation, charts and graphs, macros. Presentation of qualitative data.

References:

1. Dick Kusleika, Data Visualization with Excel Dashboards and Reports, Wiley, 2021.
2. Hector Guerrero, Excel Data Analysis: Modeling and Simulation, Springer, 2019.
3. Manisha Nigam, Advanced Analytics with Excel 2019, BPB publications, 2020.
4. Paul Mcfedries, Excel data analysis for dummies, Wiley, 2022.

MIE 2128: CONTROL SYSTEMS ENGINEERING [2 1 0 3]

Control system terminologies and basic structures, Feedforward-feedback control structure, Multivariable control systems, Block diagram of a feedback system, Signal flow graphs and the Mason's gain rule, Models of industrial control devices and systems, Feedback and non-feedback systems, Control over system dynamics, Time response analysis, Frequency response analysis, Nyquist stability criterion.

References:

1. Gopal, M. and Nagrath, I. J., Control Systems, New Age International (P) Limited, 2009.
2. Gopal, M. Control Systems: Principles and Design. United Kingdom, McGraw-Hill, 2008.
3. Kumar, A. A., Control Systems. India, PHI Learning, 2014.
4. Ogata, K., Modern Control Engineering. United Kingdom, Prentice Hall, 2010.

MIE 2129: 3D PRINTING & DESIGN [3 0 0 3]

3D Printing: Introduction, Process, Classifications, Advantages, comparison of 3D printing with Conventional Manufacturing processes, Applications. CAD for 3D Printing: CAD Data formats, Data translation, Data loss, STL format. 3D Printing Techniques: Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology, Process, Process parameter, Process Selection for various applications. 3D Printing Application in various domains. Materials for 3D Printing: Polymers, Metals, Non-Metals, Ceramics Process, Process parameter, Process Selection for various applications. Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties, Support Materials. 3D Printing Equipment: Process Equipment- Design and process parameters, Governing Bonding Mechanism, Common faults and troubleshooting, Process Design. Post Processing: Requirement and Techniques, Support Removal, Sanding, Acetone treatment, polishing. Product Quality: Inspection and testing, Defects and their causes.

References:

1. Lan Gibson, David W. Rosen and Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
2. Andreas Gebhardt, Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing, Hanser Publisher, 2011.
3. Sabrie Soloman, 3D Printing and Design, Khanna Publishing House, Delhi, 2020
4. Chee Kai Chua; Kah Fai Leong, 3D Printing and Rapid Prototyping- Principles and Applications, World Scientific, 5th Edition, 2017.

MIE 2130: INDUSTRIAL AUTOMATION AND ROBOTICS [3 1 0 4]

Structure and signal flow of pneumatic systems, Constructional details and working of Filter, Lubricator and Pressure regulator. Pneumatic actuators, Control valves for direction and flow, Symbols of pneumatic valves, Traverse time diagram, Design of manually operated circuits, Control of multiple actuators. Structure and signal flow of electro pneumatic systems, Limit switches, magnetic, Inductive, Capacitive, Optical, Ultrasonic, Pneumatic proximity sensors, Electrically actuated direction control valves, Relay control systems. Design of electro pneumatic circuits. Pascal's law, Force transmission in hydraulics, Hydraulic power pack and accessories. Hydraulic fluids, Filters, Types of hydraulic pumps, Calculation of force, Speed, Power developed. Construction and working of Direction control valves, Pressure control valves, Flow control valves. Hydraulic circuits, Pressure reducing circuits, Electro hydraulic circuits.

Anatomy of Robot, Robot configuration, Robot Motions, Work Volume, Drive System, Control System, Specification of a robot. Joint Notations in kinematics, Position Representation, Robot arm/manipulator, Forward and reverse transformation of 2 degree of freedom arm, Arm manipulation for 3 degree of freedom arm, Homogeneous transformations and robot kinematics, Mechanical grippers and their mechanisms, Force analysis of gripper, vacuum cups, magnetic grippers etc. Different types of sensors and their working principle. Requirements for drives, Classification of actuators, Robot transmission systems.

References:

1. Espositio A., Fluid Power with Applications, Pearson, 2002.
2. Majumdar S. R.,Oil Hydraulic Systems, Tata McGraw Hill 2000
3. Majumdar S. R., Pneumatic systems-principles and Maintenance, Tata McGraw Hill, 2000.
4. Janakiraman P.A., Robotics and image processing, Tata McGraw Hill, 1995.

MIE 2143: DATA ANALYTICS AND VISUALIZATION LAB [0 0 3 1]

Introduction to spreadsheets, basics of formula and functions, Data cleaning and wrangling, Data sorting, filtering and Lookup using spreadsheets, Data visualizing using spreadsheet, descriptive statistics, 2-sample and paired t-test, Correlation test, Covariance test, Analysis of variance (ANOVA) tests, Regression analysis.

References:

1. Montgomery, D. C., Design and Analysis of Experiments. United

Kingdom, John Wiley & Sons, Limited, 2021.

2. Ragsdale, C., Spreadsheet Modelling & Decision Analysis: A Practical Introduction to Business Analytics. United States, Cengage Learning, 2021.
3. Jones, B. and Goos, P., Optimal Design of Experiments: A Case Study Approach. United Kingdom, Wiley, 2011.

MIE 2144: AUTOMATION AND ROBOTICS LABORATORY [0 0 3 1]

Understanding the working principle of single and double acting hydraulic and pneumatic cylinders. Working of pressure control valves and direction control valves. Use of sensors. Working of simulation and offline programming software - Robot studio. Working with Collaborative robot to perform task such as pick and place etc.

References:

1. Waller D, and Werner H, Pneumatics - Workbook Basic Level, Festo Didactic GMBH & Co. Germany, 1983.
2. Rouff C, Waller D, and Werner H, Electropneumatic - Workbook Basic Level, Festo Didactic GMBH & Co.
3. Germany, 1983.
4. Bosch Rexroth A G, Project Manual Industrial Hydraulics, RE 00845/04.07.
5. Bosch Rexroth A G, Trainer's Manual Electro Hydraulics, R900071655.

FOURTH SEMESTER

MAT 2229: ENGINEERING MATHEMATICS IV [2 1 0 3]

Measures of central tendency, measures of dispersion, mean, median, mode, standard deviation. correlation coefficient Introduction to probability, finite sample space, conditional probability and independence, Bayes' theorem, one dimensional random variable: mean and variance, Chebyshev's inequality. Two and higher dimensional random variables, covariance, correlation coefficient, regression, least square principle of curve fitting. Distributions: binomial, Poisson, uniform, normal, gamma, chi-square and exponential. Moment generating function, Functions of one dimensional and two-dimensional random variables, Sampling theory, Central limit theorem and applications.

References:

1. Kreyzig E-Advanced Engineering Mathematics, 7thedn. Wiley Eastern.
2. Meyer P.L. - Introduction to probability and Statistical applications, 2ndedn. American Publishing Co.
3. Hogg & Craig - Introduction of Mathematical Statistics, 4th edn.1975 MacMillan.
4. B.S.Grewal:Higher Engg.Mathematics, edn., 1989 Khanna Publishers

MIE 2226: OPERATIONS RESEARCH [3 1 0 4]

Linear programming: Formulation of L.P.P. for different applications, graphical solution, simplex algorithm, the concept of dual, sensitivity analysis. Transportation algorithm: solution algorithm using North-West corner, Least Cost, Vogel's Approximation method, testing solution using Modified Distribution method. Assignment algorithm: Hungarian assignment method, traveling salesman problems. Dynamic programming: the concept of stages, Applications in deterministic situations. Game theory: Two-person zero-sum games; solution methods for 2 x 2 games; 2 x n games; m x 2 games. Network analysis: Critical path method, Project evaluation and review technique, project crashing. Queuing theory: System characteristics, Poisson arrival rate and Exponential service times, Simulation of queuing models, Monte-Carlo Technique.

References:

1. Taha H. A., Operations Research, (7e), Pearson Education, 2002.
2. W.L. Winston, Operations Research, Thomson Asia, 2003.
3. Vohra N. D., Quantitative Techniques in Management, New Delhi, 2007.
4. Sharma S. D., Operations Research, (14e), KedarNathRamnath Publications, 2005.

MIE 2227: WORK SYSTEMS ENGINEERING AND ERGONOMICS [3 0 0 3]

Productivity in the individual enterprise, Total time of a job, Factors tending to reduce productivity, Techniques for reducing excess work content and ineffective time, Basic procedure of Work study and Method study, Construction of Outline Process Chart, Flow process chart, Flow diagram, Two handed process chart, Multiple activity chart, Travel chart, String diagram, The questioning technique, The principles of motion economy, Two handed process chart, Micromotion study, SIMO chart, Work measurement, Time study, Types of elements, Methods of timing the elements, Methods of rating, Standard time determination, Work sampling, Predetermined time standards, Standard Data, Restricted work, Definition and objectives of Ergonomics/Human factors, Types and characteristics of systems, Stages of information processing, Types of Visual displays and Auditory displays, Biomechanics of motion, NIOSH lifting guidelines, Types of controls, Anthropometry, Principles of arranging components, Principles of seat design, Working environment.

References:

1. International Labour Office (ILO), Introduction to Work study, 3rd Edition, Oxford & IBH Publishers, Geneva, 2008.
2. Niebel B.W. and Frievalds, A., Methods, Standards, and Work design, 12th Edition, McGraw-Hill, New York, 2009.
3. Sanders M.S. and McCormic E.J., Human Factors in Engineering Design, 7th Edition, Mc Graw Hill, 1992.
4. Lakhwinder Pal Singh, Work Study and Ergonomics, Cambridge University Press, New Delhi, 2016

MIE 2228: SUPPLY CHAIN AND LOGISTICS MANAGEMENT [2 1 0 3]

Introduction to supply chain management, Enablers of supply chain performance, Supply chain performance in India, Customer service and cost trade-offs, Supply chain performance measures , Enhancing SC performance , Nature, concepts, and importance of procurement, Strategic procurement models, Make-or-buy decision making, Sourcing and vendor management strategy, Vendor selection, Vendor rating, Vendor development, Elements of transportation cost, Modes of Transport, Multimodal transportation system, Containerization, Factors for selection, Devising a strategy for transportation – distribution network design options, cross-docking, Vehicle scheduling, Transportation cost in E-retailing, Nature and concepts of outsourcing, Third-party logistics (3PL), Fourth party logistics (4PL), Concepts of warehousing, Elements of warehousing costs, Operational mechanisms of warehousing, Automated warehousing system, Green supply chain management, Reverse logistics.

References:

1. Agarwal, D., Supply Chain Management: Strategy, Cases and Best Practices. India, Macmillan Publishers India Limited, 2010.
2. Shah, J., Supply Chain Management: Text and Cases. India, Pearson Education India, 2016.
3. Sople, V., Supply Chain Management: Text and Cases. India, Dorling Kindersley (India), 2012.
4. Meindl, P. and Chopra, S., Supply Chain Management: Strategy, Planning, and Operation. India, Pearson, 2016.

MIE 2229: DESIGN OF EXPERIMENTS [2 1 0 3]

Introduction to experimental design: Strategy of experimentation, Typical applications of experimental design, Basic principles, Guidelines. Screening Design: Two level fractional factorial designs, Plackett-Burman designs and definitive screening designs. Two-level factorial design: Two-level experiments design for two factors and three factors. Higher-level factorial design: Three level experimental design for two factors and three factors, fractional factorial design, saturated designs. Mixture design: simplex design. Quality by experimental design: Quality, western and Taguchi's quality philosophy, Quadratic loss function, Robust design, Reliability improvement through experiments. Experimental design using Taguchi: selection of standard orthogonal array, linear graphs and interaction assignment, compound factor method, Signal to Noise ratio. Response Surface design: Central composite design, Box- Behnken design.

References:

1. Douglas C. Montgomery, Design and Analysis of Experiments, Wiley India Pvt. Ltd. 2021.
2. Madhav S Phadke, Quality Engineering using Robust design, Pearson education,2008.
3. Thomas Barker and Marcel Dekker, Quality by experimental design, Inc ASQC quality press, 2000.
4. C.F. Jeff Wu and Michel Hamada, Experiments planning, analysis and parameter design optimisation, John Wiley 2nd Ed., 2011

MIE 2230: LEAN MANUFACTURING AND SIX SIGMA [3 1 0 4]

Basic elements of lean manufacturing, Continuous improvement, 5S implementation process, Total productive maintenance, Process mapping, Value stream mapping concept, Work cell concept, Manpower – calculation and selection, Employee training, Preventive maintenance schedule, Quality standard formulation, Production control system and automated testing, Cause and effect diagram, Pareto chart, Spider/radar chart, Poke Yoke, Kanban, Automation, SMED, Standardized fixtures, DFMA, JIT concept, Visual workplace, Hoshin planning, Tree diagram, Operator productivity improvement, Process improvement, Improving machinery and Equipment utilization, Workplace organization, Avoidance of excess production and inventory, Evolution of six sigma, Six sigma definition, DPMO and sigma level, Six sigma and quality certification, Voice of customer, Guidelines for selecting and defining six sigma projects, Project prioritization matrix.

References:

1. Gopalakrishnan, N., Simplified Lean Manufacture. India, Prentice-Hall of India Pvt. Limited, 2010.
2. Socconini, L., Lean Manufacturing. Step by Step. Spain, Marge Books, 2021.
3. Rother, M., and Shook, J., Learning to See: Value Stream Mapping to Add Value and Eliminate Muda. Germany, Taylor & Francis, 2003.
4. Urdhwareshe, H., Six Sigma for Business Excellence: Approach, Tools and Applications. India, Pearson India, 2011.

MIE 2243: WORK SYSTEM ENGINEERING AND ERGONOMICS LAB [0 0 3 1]

Outline process charting, Two-handed process charting, Performance rating, Time study, Synthetic time study, Bicycle ergometer, Tread mill ergometer, Anthropometric experiment, Work-related musculoskeletal disorder gauging, Information Processing.

References:

1. Gilbreth, F.B., Motion Study: A Method for Increasing the Efficiency of the Workman (1911). United States, Literary Licensing, LLC, 2014.
2. Barnes, R.M., Motion And Time Study Design And Measurement of Work, 7Th Ed. India, Wiley India Pvt.
3. Limited, 2009.
4. Singh, L.P., Work Study and Ergonomics. India, Cambridge University Press, 2018.

MIE 2244: COMPUTER AIDED OPERATIONS RESEARCH LAB [0 0 3 1]

Formulating and solving real-world problems into a linear problem with suitable assumption, objective functions and constraints using graphical, Simplex method, transportation and assignment method and conducting sensitivity analysis. Solving problems related to game theory, waiting line models, network analysis, dynamic programming and simulation model using the Monte Carlo Simulation Technique.

References:

1. Taha H. A., Operations Research (7e), Pearson Education, 2002.
2. Winston W.L., Operations Research, Thomson Asia, 2003.
3. Vohra N. D., Quantitative Techniques in Management, Tata McGraw-Hill Education, 2007.
4. Sharma S. D., Operations Research (14e), Kedar Nath Ramnath Publications, 2005.

FIFTH SEMESTER

HUM 3021: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of Single, Uniform, and Gradient cash flow. Related problems and case studies. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, declining and double declining balance method of depreciation, Sum-of-the-Years Digits, Sinking Fund and Service Output Methods, Case Study. Balance sheet and profit & loss statement. Meaning & Contents. Ratio analysis, financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios, Drawbacks. Safety and Risk, Assessment of Risk and safety, Case study, Risk Benefit Analysis and Reducing Risk.

References:

1. Chan S. Park, "Contemporary Engineering Economics", 4th Edition, Pearson Prentice Hall, 007.
2. Thuesen G. J, “Engineering Economics”, Prentice Hall of India, New Delhi, 2005.
3. Blank Leland T. and Tarquin Anthony J., “Engineering Economy”, McGraw Hill, Delhi, 2002.
4. Prasanna Chandra, “Fundamentals of Financial Management”, Tata McGraw Hill, Delhi, 2006.

FLEXIBLE CORE 1

MIE 3130: ACCOUNTING FOR MANAGERS [3 0 0 3]

Concepts of accounting, types of accounting-financial accounting, cost accounting. cost accounting, expenses, elements of cost, transactions, classification of ledgers, preparation of financial statements-trial balance, profit loss accounts, balance sheet, Concepts of overhead, significance of overhead costs, apportionment of overhead costs, absorption overhead costs. Direct and indirect labour costs, incentive wage plans, work study, job evaluation and merit rating, elements of labour cost, problems. Nature of costing-job, contract and batch, cost sheet, recording costs on jobs/contract, value and profit of contract, economic batch quantity, problems. Nature of process costing, costing procedure, preparation of process cost accounts, joint and b product, problems. Budgeting concepts, differential costing, standard costing, variable costing, problems.

References:

1. Jawaharlal,Cost Accounting;McGraw-Hill Education(India) Ltd, 2008.
2. S.P. Jain & K.L. Narang, Cost and Management Accounting; Kalyani Publishers, New Delhi, 2007.
3. V.K. Saxena& C.D. Vashist Cost and Management Accounting; Sultan Chand & Sons, New Delhi, 2006.
4. M.N. Arora, Cost and Management Accounting (Theory and Problems); Himalaya Publishing House, Mumbai. 2009.

MIE 3131: TECHNOLOGY MANAGEMENT [3 0 0 3]

Introduction to technology management, Concept of environment and technological environment, Globalization, Time compression and Technology integration, Definition and components of innovation, Innovation dynamics, Definition of diffusion, Dynamics of diffusion, Competitive domains, Competitive consequences of technology change, Framework for analysis of technological emergence, Concept and definition of technology intelligence, Signals of new technology, Significance of technology intelligence, Levels of technology intelligence, External versus internal technology intelligence, Key principles of technology strategy, Types of technology strategy, Intellectual property strategy.

References:

1. Narayanan, V.K., Managing Technology and Innovation for Competitive Advantage. India, Pearson Education, 2001.
2. Phaal, R. et al. Technology Management: Activities and Tools. United Kingdom, Palgrave Macmillan.
3. Rastogi, P N. Management of Technology and Innovation: Competing Through Technological
4. Excellence. India, SAGE Publications, 2009.
5. Daim, T. U., Managing Technological Innovation: Tools And Methods. Singapore, World Scientific Publishing Company, 2017.

MIE 3132: PERSONNEL MANAGEMENT AND INDUSTRIAL RELATIONS [3 0 0 3]

Human Resource Planning: Importance of Human Resource, Manpower Planning Defined, Promotions, Demotions, Transfers, Separation. Absenteeism and turn over: Promotions. Job Evaluation and Wage and Salary administration: Introduction. Definition of Job Evaluation Objectives of Job Evaluation. Principles of Wage and Salary Administration, Wages, Theory of Wages. Grievances and Discipline and Disciplinary Action: Definition of Grievance. Causes/Sources of Grievances Need for a Grievance Procedure, Basic Elements of a Grievance Procedure. Meaning and Features of Discipline, Aims and Objectives of Discipline, Forms and Types of Discipline. Employee Safety and Industrial Health: Employee Safety and Industrial Health, Employee Safety. Industrial Accident and Industrial Injury, Safety Organisation. Industrial Relations: Introduction, Definition of Industrial Relations, Objectives of Industrial Relations, Aspects of Industrial Relations, Industrial Relations Program. Trade Unions: Definition and Characteristics, Principles of Trade Unionism.

References

1. Mamoria, C.B. Personnel management, Himalaya Publishing House.
2. Megginson, Leon C., Personnel and Human Resource Administration.
3. Beach, D.S., Personnel: The Management of People at Work,1977.
4. Yoder, Dale, Personnel Management, and Industrial Relations,1972.

MIE 3127: SIMULATION MODELING AND ANALYSIS [3 0 0 3]

Introduction to Simulation: Concepts, nature of simulation, model classification, types of simulation, steps in a simulation study, discrete event simulation, time keeping mechanisms, software, simulation examples. Statistical models in simulation: random variable, discrete and continuous distributions, queuing systems, Markovian models, generation of random numbers and testing its randomness. Analysis of input data: Input modeling, sample independence, parameter estimation, goodness of fitness of tests. Output data analysis: Model building, verification, calibration and validation of models, design of simulation experiment, statistical independence, variance reduction techniques, regression analysis, analysis of variance.

References:

1. Banks, J., J.S. Carson, B.L. Nelson, and D.M. Nicol, Discrete-Event

System Simulation, 5th Edition, Prentice Hall, 2010.
2. Law, A.M., Simulation Modeling and Analysis, 5th Edition, McGraw-Hill, New York, 2015.
3. Frank L. Severance, System Modeling and Simulation, Wiley, 2001.
4. D. S. Hira, System simulation, S. Chand Publications, 2001.

MIE 3128: TOTAL QUALITY MANAGEMENT [3 0 0 3]

Definition Total quality management (TQM), Basic concepts of TQM, Contributions of Gurus of TQM, Characteristics of successful quality leaders, The Deming philosophy, Quality statements, Strategic planning, Customer satisfaction, Juran Trilogy, PDSA cycle, Kaizen, Supplier partnership, Performance measures, Quality costs, General quality control engineering fundamentals, Frequency distribution, Inequality theorems, The seven tools of quality control, Control charts for variables (*X, R* and *s* charts) and attributes (*p*, *np*, *c andu* charts), Process capability indexes, Concept of six sigma quality, Acceptance sampling by attributes, Operating characteristic curve, Some aspects of specifications and tolerances, Equipment failure pattern, System reliability, Benchmarking, Quality function deployment (QFD), Failure Mode and Effect Analysis (FMEA), Total Productive Maintenance (TPM), Management tools, Taguchi's quality loss function, Quality and Environmental management systems, Case Studies.

References:

1. Dale H. Besterfield, Carol Besterfield-Michna, Glen Besterfield, Mary Besterfield-Sacre, Hemant Urdhwarshe, RashmiUrdwarshe, Total Quality Management, Revised 3rd Edition, Pearson Education, New Delhi, 2012.
2. Mukherjee P.N., Total Quality Management, PHI Learning, New Delhi, 2010.
3. Grant E. L and Levenworth R., Statistical Quality Control, McGraw Hill Publications, New York, 2005.
4. Mahajan M. S., Statistical Quality Control, Dhanpat Rai and Co. Pvt. Ltd., Delhi, 2012.

MIE 3129: ENGINEERING SYSTEM DESIGN [3 1 0 4]

Introduction Morphology of Design: Design by evolution, System approach of engineering problems. Morphology of Design: Structure of design process, decision making and iteration. Identification and Analysis of Need: Preliminary need statement, analysis of need, specifications and standards of performance and constraints. Origination of Design Concept: Process of idealization, mental fixity, and various design methods. Preliminary Design: Mathematical modeling for functional design, concept of sensitivity, compatibility and stability analysis. Evaluation of Alternatives and Design Decisions: Physical reliability, DESIGN TREE: Quality of design, Concept of utility. Reliability Considerations in Design: Bath tub curve, exponential reliability function, system reliability concept. Economics and Optimization in Engineering design Optimization: Economics and Optimization in Engineering design: Economics in Engineering Design, Man Machine Interaction: Designing for use and maintenance, Man-Machine Cycle, Design of displays and controls.

References:

1. V. Gupta and P. Murthy, An Introduction to Engineering Design Method, Tata McGraw Hill, 2000.
2. T. Woodson, Introduction of Engineering Design, McGraw Hill, 2001.
3. D. D. Meredith, K.W. Wong, R.W. Wood head and K. K. Worthman, Design & Planning of Engineering systems, 2000.
4. M. A. Asimov, Introduction to Design, Prentice Hall, 1996.

MIE 3143: COMPUTER AIDED QUALITY ENGINEERING LAB [0 0 3 1]

Distribution Identification, Evaluation of Measurement Process Capability, Evaluation of Variations in Measurement System, Process Stability Monitoring, Test for Over-dispersion or Under-dispersion, Process Variability Monitoring, Normal capability Sixpack Analysis, Acceptance Sampling.

References:

1. Besterfield D. H., Total Quality Management, (Revised Edition). India, Pearson, 2011.
2. Qiu, P., Introduction to Statistical Process Control. United Kingdom, CRC Press, 2013.
3. Neubauer, D. V., and Schilling, E. G., Acceptance Sampling in Quality Control. United States, CRC Press, 2009.

MIE 3144: SYSTEM MODELING AND ANALYSIS LAB [0 0 3 1]

Introduction to Simulation Packages, identifying probability distributions for given data, Monte-Carlo simulation, Simulation model of banking service, Simulation model of Production line, Simulation model of job shop production, Simulation model of airport operations, Simulation model of government office, Simulation model of movie theatre and restaurant, Simulation model of transportation system, Simulation model of material handling system, Simulation model of educational service.

References:

1. Jerry Banks, John S Carson, II, Berry L Nelson, David M Nicol – Discrete - Event System Simulation, 4th Edition, Pearson Education,2005.
2. Geoffrey Gordon, System Simulation, Pearson India Education Services Pvt Ltd, 2015.
3. Averill M. Law, Simulation Modelling and Analysis, 4th Edition, Tata McGraw-Hill, New Delhi, 2008.
4. Narsingh Deo, Systems Simulation with Digital Computer, PHI Publication (EEE), 3rd Edition, 2004.

SIXTH SEMESTER

HUM 3022: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Definition of management and systems approach, Nature & scope. The Functions of managers, Principles of Management. Planning: Types of plans, steps in planning, Process of MBO, how to set objectives, strategies, policies and planning premises, Strategic planning process and tools. Nature and purpose of organizing, Span of management, factors determining the span, Basic departmentation, Line and staff concepts, Functional authority, Art of delegation, Decentralization of authority. HR theories of planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques.

Leadership – leadership behavior & styles, Managerial grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit and Loss control, Control through ROI, Direct, Preventive control. PROFESSIONAL ETHICS - Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories about right action, Self-interest, Customs and Religion, Uses of Ethical Theories. GLOBAL ISSUES - Managerial practices in Japan and USA & application of Theory Z. The nature and purpose of international business & multinational corporations, unified global theory of management, Entrepreneurship and writing business plans. Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisers, Moral Leadership, Code of Conduct, Corporate Social Responsibility.

References:

1. Harold Koontz & Heinz Weihrich (2020), "Essentials of Management", McGraw Hill, New Delhi.
2. Peter Drucker (2004), "The practice of management", Harper and Row, New York.
3. Vasant Desai (2007), "Dynamics of entrepreneurial development & management", Himalaya Publishing House.
4. Poornima M Charantimath (2006), "Entrepreneurship Development", Pearson Education.

FLEXIBLE CORE 2

MIE 3228: STATISTICS FOR MANAGERS [3 0 0 3]

Introduction to Statistics, functions, scope and limitations, Collection and presentation of data, frequency distribution, measures of central tendency, Measures of dispersion: Range – Quartile Deviation – Mean Deviation Standard Deviation – Variance-Coefficient of Variance - Comparison of various measures of Dispersion, Moments. Correlation and Regression: Scatter Diagram, Karl Pearson correlation, Spearman's Rank correlation, simple and multiple regressions. Probability Distribution, Rules of probability –Random variables – Concept of probability distribution – Theoretical probability distributions: Binomial, Poisson, Normal and Exponential. Time Series Analysis, Methods of estimating seasonal index: method of simple averages - ratio to trend method - ratio to moving average method. Hypothesis Types and characteristics, formulation of hypotheses, errors in hypotheses. Parametric and Non Parametric Tests- t-test, z-test, f-test, (problems on all tests). Normality and reliability of hypothesis. ANOVA-oneway, two-way classification.

References:

1. S C Gupta,Fundamentals of Statistics, Himalaya Publications, 2012
2. Ranjit Kumar,Research Methodology, Sage Publications, 2018
3. VimalaVeeraraghavan and Suhas,Parametric and Non-Parametric Statistics, Sage Publication, 2017
4. S P Gupta Sultan,Statistical Methods, Chand Publications, 2014

MIE 3229: PROJECT MANAGEMENT [3 0 0 3]

In the modern-day world working on large project with constraints for cost and time requires understanding of people in industry. It is imperative for persons to have a general and advance concept of Project Management. This course is designed to meet the demand of UG and PG students. At the end of this course., students are introduced to Project management using the structure of organizations, Feasibility studies, Estimating project times and costs, Risk management process, Project scheduling, Project audit and closure.

References:

1. Gray C., Larson E. and Desai G., Project Management – The Managerial Process, Tata McGraw Hill Pvt. Ltd., 2013.
2. Paneer Selvam R. and Senthil Kumar P., Project Management, PHI Learning Pvt. Ltd., 2010.
3. Chandra P., Projects – Planning, Analysis, Selection, Financing, Implementation and Review, Tata McGraw Hill Pvt. Ltd., 2009.
4. Choudhry S., Project Management, Tata McGraw Hill Publishing Co. Ltd., 1997.

MIE 3230: ORGANIZATIONAL BEHAVIOR [3 0 0 3]

Introduction: Definition, Contributing disciplines, Basic Model. Learning: Definition, Theories of learning: Classical & Operant Conditioning, Methods of shaping behaviour: Positive and Negative reinforcement, Schedule, Values, attitudes, job satisfaction: Values: Definition, Types, Values across cultures. Attitudes: Definition, Components, Sources, Types of attitudes: Job Satisfaction, involvement and Organisational commitment, Determinants of Job satisfaction. Personality: Determinants of Personality, MBTI and Big Five Model theories, personality attributes: Locus of Control, Machiavellianism, Self- Esteem, Monitoring and Risk Taking. Perception:Definition, Factors influencing perception, Attribution Theory, Selective perception, Halo effect, Contrast effect, Stereotyping. Basic motivation concepts:Definition, Maslow's hierarchy of needs, Theory X and Theory Y, Frederick Herzberg's Motivation Hygiene Theory, Contemporary Theories: ERG, DavisMcClelland theory of needs, Vroom's Expectancy theory, The Job Characteristic Model, Rotation, Enlargement and Enrichment. Group dynamics:Group: Definition, Classification, Stages, Behaviour Model. Leadership:Definition, Quality of good leader, types, theories of leadership. Conflict:Definition, Functional Vs Dysfunctional, Process, Dimensions of Conflict Handling Intentions. Organisational change, development: Organisational Change: Forces for change, Resistance to Change, Lewin's Model, Action research, Organisational Development.

References:

1. Robbins Stephen P., Organisational Behaviour, Pearson Education, 2013
2. Luthans Fred, Organisational Behaviour McGraw Hill, New York, 1989.
3. Gupta Rakesh, Organisational Behaviour, Kitab Mahal, Allahabad, 1998.
4. Davis Keith and Newstrom J.W., Organisational Behaviour at Work, Tata-McGraw Hill, New Delhi, 1997.

MIE 3227: OPERATIONS MANAGEMENT [3 0 1 4]

Operations Management Concepts: Introduction, Operations Functions in Organizations, Operations Decision Making: Introduction, Management as a science, Characteristics of decisions, Decision Tree Problems, Economic Models Break-even analysis in operations, P/V ratio. System Design and Capacity. Forecasting Demand: Opinion and Judgmental methods, Delphi technique, Time series methods, Moving Average methods, Exponential smoothing, Trend adjusted Exponential Smoothing, Regression, and correlation methods. Aggregate Planning and Master Scheduling: Introduction- planning and scheduling, Objectives of aggregate plan, Three Pure Strategies of Aggregate planning, Master scheduling methods with numerical, Numerical on Level production and chase demand, Material Requirements Planning. Scheduling and Controlling Production Activities: priority sequencing. Single and multiMachine Scheduling.

References

1. Lee J Karjewski and Larry P Ritzman, Manoj Malhotra, Operations Management – Processes and Supply Chain, Pearson Education Asia, 12th Edition, 2010.
2. B. Mahadevan, Operations Management – Theory and Practice, 2nd Edition, PHI, 2010.
3. Buffa, Modern Production/Operations Management, Wiley India Ltd. - 4th edition.2009.
4. Chary S.N, Production and Operations Management, Tata-McGraw Hill. - 3rd edition 2015.

MIE 3243: COMPUTER AIDED EXPERIMENTAL DESIGN LAB [0 0 3 1]

Definitive screening design, Plackett-Burman screening design, 2-Level factorial design, General full factorial design, Static Taguchi design, Dynamic Taguchi design, Mixture Design,Central composite response surface design, BoxBehnken response surface design with all Continuous Factors, Response surface design with at least one categorical factor.

References:

1. Montgomery, D. C., Design and Analysis of Experiments. United Kingdom, John Wiley & Sons, Limited, 2021.
2. Jones, B. and Goos, P., Optimal Design of Experiments: A Case Study Approach. United Kingdom, Wiley, 2011.
3. Sleeper, A., Minitab Demystified. United States, McGraw-Hill Education, 2011.

MIE 3244: COMPUTER AIDED OPERATIONS MANAGEMENT LAB [0 0 3 1]

Aggregate planning problem-Pure strategy and Mixed strategy, Forecasting using quantitative models-Comparison and Evaluation, Materials requirement planning, Scheduling- One machine with multiple products, Scheduling-2 machines and 3 machines with multiple products, Inventory analysis-EOQ, Quantity discount, ABC Analysis cases, Line balancing Problems-Case study, Financial a nalysis-Financial report preparation, Stock analysis-Purchase order, invoice generation, Stock analysis- Sales order, stock summary, profit sheet.

References:

1. Monks J.G -Operations Management, McGraw-Hill International, Editions, 1987.
2. Pannerselvam. R -Production and Operations Management, PHI, 2nd edition.
3. Yasuhiro Monden -An introductory book on lean systems, TPS.
4. Prasanna Chandra: Financial Management 2011-Tata McGraw-Hill publishing company.

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

MIE 4291: INDUSTRIAL TRAINING [0 0 0 1]

Student is undergoing industrial training for a minimum period of 4 weeks during the vacation. After successful completion of training, student is submitting a report to the department and also makes a presentation on training.

MIE 4292: PROJECT WORK / PRACTICE SCHOOL [0 0 0 12]

The student is required to carry out a project work in the institution / industry / research laboratory / institution of higher learning. The minimum duration of the project work/practice school is 16 weeks. As part of project work / practice school, the student is also required to prepare a project report and make a presentation on the work carried out.

PROGRAM ELECTIVES

MIE 4457: ENGINEERING ASSET MANAGEMENT [3 0 0 3]

Engineering Asset Management: Basic concepts, Definitions, Review of Existing Frameworks for Asset Management, A framework for AM system, Requirement and Challenges, Asset Management Drivers, Benefits of Asset Management. Asset Management Standards: ISO 55000, Overview, principles, and terminology. ISO 55001 Requirements. ISO 55002 Guidelines on the application of ISO 55001.Asset Management Principles: Barriers to implement Asset Management, Asset Life Cycle, Balancing Cost, Risk and Performance. Principles of asset integrity and management: Asset Management Tools and Elements of Asset Assessment (Performance Management), Terminology used in asset management policy and requirements. Fundamentals of Reliability Engineering: Maintenance Management; maintenance contracts and contract administration, reliability centred maintenance; total productive maintenance. Preventive component replacement and capital equipment replacement decisions.

References:

1. Campbell, J.D., Jardine, A.K.S. McGlynn, J. "Asset Management Excellence: Optimizing Equipment Life-Cycle Decisions", 2nd Edn., CRC Press,Boca Raton, FL, 474 pp. 2011.
2. Jardine, A.K.S. and Tsang, A.H.C. "Maintenance, Replacement and Reliability: Theory and Applications", CRC Taylor & Francis, New York, 322 pp. 2006.
3. Kelly, A. "Strategic Maintenance Planning", Butterworth Heinemann, Oxford, 284 pp. 2006.

4. Kelly, A. “Managing Maintenance Resources”, Butterworth Heinemann, 292 pp. 2006.
5. Lawrenson, J. “Effective Spares Management”, International Journal of Physical Distribution & Materials Management, Vol 16, No. 5., 111 pp., 1986.
6. O'Conner, P.D.T. “Practical Reliability Engineering”, 5th Edn., John Wiley and Sons, 2012.
7. Moubray, J. “Reliability-Centered Maintenance”, 2nd Edition, Industrial Press Inc., NY, 414 pp., 1992.

MIE 4461: ARTIFICIAL NEURAL NETWORK [3 0 0 3]

Introduction, Neurons and neural networks, Basic models of artificial neural networks, Training of neural network, Applications, Fuzzy sets, Fuzzy reasoning and clustering, Fuzzy control methods, Fuzzy decision making, Adaptive networks based Fuzzy systems, Classification and Regression Trees, Neuro-Fuzzy controls, Simulated annealing, Evolutionary computation, Genetic algorithms.

References:

1. D. K. Pratihar, Soft Computing, Narosa Publishing House, 2008.
2. S. Haykin, Neural Networks: A Comprehensive Foundation, 2nd Ed, Pearson Education, 1999.
3. G. Chen and T. T. Pham, Introduction to Fuzzy Sets, Fuzzy Logic, and Fuzzy Control Systems, CRC Press, 2001.
4. P. M. Dixit, U. S. Dixit, Modeling of metal forming and machining processes: by finite element and soft computing methods, 1st Ed, Springer-Verlag, 2008.

MIE 4462: BUSINESS PROCESS RE-ENGINEERING [3 0 0 3]

Dimensions of business process, common business processes in an organization, definition of business process redesign, business process improvement. basics of BPR, definition of business process reengineering, emergence of BPR, need for reengineering, benefits of BPR, role of leader and manager. Enablers of BPR in manufacturing-Agile Manufacturing, lean manufacturing, Just-in-time, collaborative manufacturing, intelligence manufacturing, product planning, product design and development, supply chain management. Relationship between BPR and IT, Role of IT in Reengineering, BPR tools and techniques. Necessary attributes of BPR methodology, BPR team characteristics, key concepts of BPR, BPR methodology, different phases of BPR, BPR model, Steps in BPR implementations. Reengineering success factors, critical success factors of BPR, reasons for BPR project failure and success. Risks associated with BPR projects, BPR implementation barriers, areas generating barriers to BPR, root causes to IT barriers, frame work for barrier management. Differences between BPR and process simplification, differences between BPR and continuous improvement, difference between BPR and TQM.

References:

1. Radhakrishnan R. and Balasubramanian S., Business Process Re-Engineering- text and cases, PHI Learning Private Limited, 2003.
2. Jayaraman M. S., Natarajan Ganesh, Ranagaramanujan A. V., Business Process Reengineering, Tata McGraw Hill, 2007.
3. Sethi Vikram; King William R., Organizational transformation through business process reengineering, Prentice Hall, 2003.
4. Grover Varun, M. Lynne Markus, Business Process Transformation, PHI Learning Pvt. Ltd, 2010.

MIE 4463: DATA MANAGEMENT & ANALYSIS WITH EXCEL [3 0 0 3]

Logical Functions, Text Functions, Date and Time Functions, Basic Statistical Functions, Mathematical Functions, Financial and Database Functions, Lookup and Reference Functions used in Excel with practical examples.

References:

1. Held, Bernd. Microsoft Excel Functions & Formulas. United States, Jones & Bartlett Learning, 2006.
2. McFedries, Paul. Microsoft Excel 2019 Formulas and Functions. United States, Pearson Education, 2019.
3. Adam, Ramirez. Excel Formulas and Functions: Step-By-Step Guide with Examples, Caprioru, 2019.
4. Manohar, Hansa Lysander. Data Analysis and Business Modelling Using Microsoft Excel. India, Prentice Hall India Pvt., Limited, 2017.

MIE 4464: DATABASE MANAGEMENT SYSTEM [3 0 0 3]

Introduction: Definition, characteristics, users, advantages and implications of database approach. DBMS system architecture: Data models, schemas, instances, architecture and data independence, database languages, interfaces, database system environment, classification. Data modeling: Benefits, Types, Phases. The entity relationship model, Entity types, entity sets, attributes, and keys. Relationships, relationship types, roles, structural constraints. Weak entity types, ER diagrams, design issues. Relational data model and relational algebra: Relational model concepts, constraints, schemas. Update operation on relations, basic, additional relational algebra operations, queries Structured Query Language (SQL): Definition, Basic and complex queries Insert, delete, update statements, views, embedded SQL. Physical storage, primary file organizations: Secondary storage devices, buffering of blocks, placing file records on disk, operations on files, heap files, sorted files, hashing techniques. Indexing of files: Primary, secondary, multilevel ordered indices, dynamic multi-level indices using B-trees and B+ trees. Relational database design: Design guidelines for relational schemas, functional dependencies normalization–1st- 5th normal forms, importance.

References:

1. Elmasri Ramez and Navathe Shamkanth B., Fundamentals of database Systems, (3e), Addison Wesley Publishing Company, 2011.
2. Raghu Ramakrishnan and Johannes Gehrke, Database Management System, (3e), Tata McGraw Hill, 2010.
3. McFadden, Hoffer J, Prescott, by Modem Data base management, 2007.
4. Hansen Gary W. and Hansen James V., Database Management and Design, (2e), PHI Pvt. Ltd, 2002.

MIE 4465: DESIGN FOR MANUFACTURE AND ASSEMBLY [3 0 0 3]

Essential factors of product design, morphology of design, producibility requirements in design, Design for X, DFMA-History, advantages of DFMA in product design, selection of materials and processes. Sand casting-design rules for sand castings, Investment casting design guidelines. Metal Extrusion: Design recommendation for metal extrusion, stamping, fine blanked parts, Rolled formed section. Characteristics of the forging process and design guidelines. Design for machining, Introduction, Design guidelines for turning, drilling, reaming, slotting, milling, grinding, and design guidelines for heat treatment. Design for die-casting and injection moulding: Introduction, Design guidelines for manufacture of parts. Design for sheet metal working and powder metal processing: Introduction, Design guidelines for manufacture of parts. Design for joining process: Welding-different types of welding processes, design recommendation for welding process. Design for solder and brazed assembly: Process, typical characteristics, suitable materials, detail design recommendations. Design for adhesively bonded assemblies: Introduction, typical characteristics, suitable materials, design recommendations for adhesive joint.

References:

1. Geoffrey Boothroyd, Peter Dewhurst and Winston A. Knight, Product Design for Manufacture and Assembly, CRC Press, 2011.
2. James G. Brala, Design for Manufacturability Handbook, McGraw Hill, New York, 1999.
3. Kevin Otto and Kristin Wood, Product Design, Pearson Education, Delhi, 2001.
4. Chitale A. K. and Gupta R. C., Product Design and Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
5. George E. Dieter, Engineering Design, McGraw Hill Book Co., Singapore, 2000.
6. Karl T. Ulrich & Steven D. Eppinger, Product Design and Development, Irwin McGraw Hill, Boston, 2003.

MIE 4466: ENTERPRISE RESOURCE PLANNING [3 0 0 3]

Introduction to ERP: Introduction, evolution, reasons for growth of ERP market, advantages, Integrated management information, business modelling, integrated data model. ERP and related technologies: Introduction, business process reengineering, management information systems, decision support system, executive information system, data warehousing, data mining, online analytical processing, supply chain management. ERP-A manufacturing perspective: Introduction, ERP, CAD/CAM, Materials requirement planning, bill of materials, closed loop MRP, distribution requirements planning, JIT, Kanban, product data management, benefits Make-to-order, make-to-stock, assemble-to-order, engineer-to-order, configure-to-order. ERP modules: Introduction, finance, plant maintenance, quality management, materials management. Benefits of ERP:Introduction, Reduction of lead time, on-time shipment, reduction in cycle time, improved resource utilization, customer satisfaction, supplier performance, flexibility, quality costs, information accuracy, decision making flexibility. ERP implementation lifecycle: Introduction, pre-evaluation screening, package evaluation, project planning phase, gap analysis, reengineering, configuration, implementation team training, testing, end user training, post-implementation, In-house implementation pros, cons, vendors, consultants, end users. Future directions in ERP:New markets, channels, faster implementation methodologies, business models.

References:

1. Ellen Monk and Bret Wagner, Concepts in Enterprise Resource Planning, (4e), Cengage Learning Custom Publishing, 2011.
2. Alexis Leon, Enterprise Resource Planning, Tata McGraw Hill, 1999.
3. Joseph A. Brady, Ellen F. Monk, Bret J. Wangner, Concepts in Enterprise Resource Planning, Thomson Learning, 2001.
4. Garg Vinod Kumar and Venkata Krishnan N. K, Enterprise Resource Planning – Concepts and Planning, Prentice Hall, 1998.

MIE 4467: FACILITIES PLANNING AND DESIGN [3 0 0 3]

Introduction: Facilities planning defined, significance of facilities planning, Plant Location and Layout: Factors influencing plant location, Theories of plant location.Materials Handling: Introduction, scope and definition of material handling, material handling principle, types of material handling equipment.Space determination in a plant layout & area allocation: Factors for consideration in space planning, receiving, storage, production, shipping, tool room and tool crib.Design of plant layouts: Apple's Plant Layout Procedure and Reed 's procedure. Flow Analysis, Quantitative and Qualitative Flow Measurement. Quantitative facilities planning models: Introduction, Facility location models- Single and Multi-facility, Location allocation Models, Special facility layout models, Machine layout models. Computer Aided Layout: Introduction. Constructing the layout: Methods of constructing the layout, Evaluation of layout, efficiency indices, presenting layout to management.

References:

1. Facilities Planning, James A Tompkins, John A White, Yavuz A Bozer, 4th Edition, 2010, Wiley India, ISBN: 978-0-470-44404-7.
2. Facility layout and Location, Francies, R.L. and White, J.A., 2nd Edition, 1998, Prentice Hall of India, ISBN: 8120314603.
3. Plant Layout and Material handling - James M Apple, John, Wiley and Sons,2nd Edition
4. Practical layout - Muther Richard, McGraw Hill-1955.

MIE 4468: FINANCIAL ANALYSIS AND REPORTING [3 0 0 3]

Financial Reporting Overview, balance Sheet Equation, Assets, Liabilities, and Stockholders Equity, Debit and Credit Bookkeeping, Accrual Accounting and the Income Statement: Revenues and Expenses, Adjusting Entries. Operating, Investing, and Financing Cash Flows, Statement of Cash Flows, Overview of Ratio Analysis. Time Value of Money, Interest Rates, Inflation, Discounted Cash Flow, Decision Making, Discounted Cash Flow Analysis, Free Cash Flow, Forecast Drivers, Return on Investment, Decision Criteria, Sensitivity Analysis, Return on Investment. NPV Rule, Simple vs. Compound Interest, Introduction to Fixed Income Valuation, Prices and Returns on Coupon Bonds, Semi Annual Bonds, The Yield Curve. probabilistic models, regression models. Spread sheet in financing, Using functions, conditional expressions and errors, cash flow modes, random variables, simulations. Assets, Disposal of Fixed Assets, Short-Term Liabilities, Long-Term Liabilities, Shareholders' Equity, Overview, Shareholders Equity, Equity Issuance and Profitability.

References

1. Prasanna Chandra: Financial Management 2011-Tata McGraw-Hill publishing company.

2. M.Y. Khan & P.K Jain: Financial Management 2012-Tata McGraw-Hill publishing company.
3. James C.Van Horne: Fundamentals of Financial Management2001, Prentice- Hall India.
4. Ravi. M.Kishore: Financial Management2011-Taxman Publications.

MIE 4469: FINANCIAL MARKETS, TREASURY AND RISK MANAGEMENT [3 0 0 3]

Financial System: An overview of Indian Financial System, Types of Markets, Repo and Reverse Repo. Treasury management in Banking Industry: Concept and Functions of Treasury Management in Commercial Banks, Funding and Regulatory aspects. Risk Management Process in Banking: Risks in Banking Activities, Types of Risks, Management in Banking. Commercial Banks and their Roles in Indian Economy: Role of RBI in ensuring economic growth, Recent Trends in Banking system. Profit planning activities of Banks through Subsidiary activities: Merchant Banking, IPO and Equity issue, Increasing liquidity and profitability through the process of Securitization.

References:

1. Avadhani. V.A, Treasury Management in India, Himalaya Publishing House, 2002
2. Khan M.Y., Financial Services, Tata McGraw Hill, 2004
3. Khan M.Y., Indian Financial System, Tata McGraw Hill, 2007
4. Varshney and Mittal, Indian Financial System, Sultan Chand Publications, 2003

MIE 4470: INDUSTRIAL SAFETY AND RISK MANAGEMENT [3 0 0 3]

Industrial safety – history, evolution and introduction, Safety at plants, Industrial accidents, Accident prevention measures,: Theories of accident causation, Accident investigation and reporting, Ergonomic risk prevention and control, Cumulative Trauma Disorders, Common mechanical injuries and definition of safeguarding, Risk assessment in machine operation, Robot safeguards, Lockout/tagout systems, General precautions, Slip and fall prevention programs, OSHA fall protection standards, Ladder safety, Impact and acceleration risks, Lifting risks, Standing risks, Hand protection, Forklift safety, Personal protective equipment, Noise control strategies, Vibration hazards, Humanrobot interaction, Minimizing the problems of automation.

References:

1. Industrial Safety and Maintenance Management. India, Khanna Publishing House.
2. Goetsch, D.L., Occupational Safety and Health for Technologists, Engineers, and Managers, Global Edition. United Kingdom, Pearson Higher Education & Professional Group, 2014.
3. Spellman, F.R., Safety Engineering: Principles and Practices. United States, Bernan Press, 2018.
4. Handbook of Safety Principles. United Kingdom, Wiley, 2018.

MIE 4471: INTERNATIONAL FINANCIAL MANAGEMENT [3 0 0 3]

Financial Management in a Global Context, Recent Changes in Global Financial Markets, International Monetary System, Foreign exchange reserves, Balance of payments, Balance of Trade, Bilateral and multilateral agreements relating to financial transactions, Integration of global developments with the changing business environment in India. Foreign Exchange Market Structure of the Foreign Exchange Market, Types of Transactions and Settlements, The Concept of Hedging and Speculation, Currency Forwards, Currency Futures, Currency Options, Currency swaps, devaluation of Rupee, Theories of Exchange Rate Determination, Fundamental International Parity Conditions, Purchasing Power and Interest Rate Parity, Fisher Effect and International Fischer Effect. The Risk Management Process, Exposure Management, Transactions Exposure, Operations Exposure, International working capital management.

References

1. Shapiro, Allen C., Multinational Financial Management, New Delhi, Prentice Hall India Pvt. Ltd.
2. Apte P.G., Multinational Financial Management, New Delhi, Tata McGraw Hill
3. Seth A.K., International Financial Management, New Delhi, Galgotia Publishing Company
4. Brian Hock, Tenth Edition CPA Preparatory Program, Hock International, 2016.

MIE 4472: MANAGEMENT INFORMATION SYSTEMS [3 0 0 3]

Introduction: Importance of MIS, Evolution of MIS, Computers and MIS, Typical Management Information Systems. Information systems and organizations: Organizational and Information System Structure, Management and Decision making, Classification of Information systems, Information Support for functional areas of management, Impact of Business on information Systems, Key ingredients of success, Organizing Information Systems, Absorption of MIS in Organizations. Information system technology: Computer hardware and Software, Telecommunications, Database management, Modern communication, Video conferencing, Internet, Superhighway system configuration and selection. Information system in management: Transaction, processing and Reporting, Decision making and decision support system, Artificial Intelligence and Expert system, Office information system, MIS as technique for programmed decision. Planning, designing, and implementing MIS: Strategic and project planning, Conceptual design, Detailed design, Implementation, Evaluation and Maintenance, Controlling of IS System concept-control Modelling case study in Hostel, Hospital, Hotel, Stores, Production Industries.

References:

1. Davis Gordon B., Olson Margrethe H., *Management Information Systems*, McGraw-Hill, New York, 2005.
2. Laudon Kenneth, Laudon Jane Prince, *Management Information Systems*, Prentice Hall of India, Delhi, 2006.
3. Sadagopan S., *Management Information Systems*, Prentice Hall of India, New Delhi, 2002.
4. Mudrick Ross, *Information Systems for Modern Management*, Prentice Hall of India, Delhi,1997.

MIE 4473: MATERIALS MANAGEMENT [3 0 0 3]

Introduction: Dynamics of materials management - Materials management at levels, inventories of materials, total concept-definition. Systems approach to materials management: Systems approach - The process of management and the materials function, Forecasting: Objectives and the materials organization: Systems design, forecasting and planning, forecasting methods, objectives of materials management - organization of materials management, Materials planning: Making the materials plan work, the materials cycle and flow control system, purchasing: Purchasing principles, Purchasing in materials management system concept: Price determination, vendor-vendee relations, Purchasing and procurement: Activities under materials management, Incoming material quality control: Significance of inspection, SQC in operation: A work-site problem study. Purchasing capital: Equipment, plant and machinery - Responsibility and decision, governmental purchasing: policy and procedures, tenders. Registration of Firms: Procedure for registration, terms of registration, Inventory models: Deterministic inventory models with numerical examples, materials planning system (MPS)/Materials Requirement Planning (MRP), basic tool. Stores management and operation: Storage system, standardization and variety reduction, Materials management information system and computer: MIS - computer system for MIS and MM, In-process materials and management control.

References:

1. Dutta A.K, Materials management: Procedures, text and cases, Prentice Hall of India Pvt. Ltd, New Delhi, 2001.
2. Gopala Krishnan P, Handbook of materials management, Prentice Hall of India Pvt. Ltd, New Delhi, 2002.
3. Sharma S.D, Operations research, Kedarnath-Ramnath & Co, 1996.
4. Philips, Ravindran and Soleberg, Principles of operations research theory and practice, Wiley India Pvt. Ltd.

MIE 4474: METAHEURISTIC TECHNIQUES [3 0 0 3]

Optimization: Definition and Classification of an Optimization Problem, Heuristic Algorithms vs. Metaheuristics, Swarm Intelligence, Population-Based Optimization. Classical Optimization Techniques: Linear programming, Nonlinear Programming. Heuristic Optimization Algorithms: Different types of algorithms - Neighbourhood Search, Hill Climbing Methods, Simulated Annealing, Evolutionary Algorithms, Tabu Search, Ant Colony Optimization, Particle Swarm Optimization. Simulated Annealing: Real Annealing and Simulated Annealing, One-loop Simulated Annealing.

Evolutionary Algorithms: Encoding, Operators and models of Evolution, Genetic Algorithms and Programming, Memetic Algorithms, Differential Evolution. Tabu Search: Basic and Continuous Tabu Search, Short-term and Longterm Memory, Diversification and Intensification. Ant Colony Optimization: Basic ACO Algorithms, Ant Algorithms for TSP. Particle Swarm Optimization: Canonical PSO Algorithm, Neighbourhood Topologies. Heuristic Algorithms: Multiobjective Algorithms, Handling Dynamic Optimization Problems, Noisy Problems, Expensive Cost Functions.

References:

1. Z. Michalewicz and D. B. Fogel, How to Solve it: Modern Heuristics, Springer, 2004.
2. Sean Luke, Essentials of Metaheuristics, Lulu, 2013.
3. Stefan Edelkamp, Peter Norvig, Heuristic Search: Theory and Applications, Elsevier, 2011.
4. Fred Glover, Gary A. Kochenberger, Handbook of Metaheuristics, Springer, 2010.

MIE 4475: PLANT ENGINEERING AND MAINTENANCE [3 0 0 3]

Introduction: Plant engineering-its role, need for maintenance. Industrial Lubrication: lubricants used in industries, methods of application. Fire prevention and protection. Paintings and protective coatings and Pollution control: Types of corrosion prevention methods, surface preparation. Industrial Pollution and Dust control: fibre dust collector, mechanical dust collector, wet type collectors and electrostatic precipitator. Gaseous and Noise Pollution control: waste and noxious gases control. Illumination and Effluent treatment: Fundamentals of lighting calculations, illumination needed, different types of light sources. Industrial effluent treatment: types of contaminants, process of effluent treatment- physical, chemical, combined biological treatments. Industrial safety: Economic impact of accidents, analysis of accident records, accident investigation and analysis of accidents, organization for safety. Maintenance: functions and types of maintenance. Work execution: repair order control, man power requirements and Preventive maintenance.

References:

1. Higgins & Marrow (1977), Maintenance engineering handbook, Mc Grew Hill.
2. Miller and Blood (1971), Modern maintenance management, Taraporevala.
3. Sushil Kumar, Srivasthava (2002), Industrial Maintenance and Management, Chand.
4. P. Gopalakrishnan, A. K. Banergy, (1997), Maintenance and Spare Management –Prentice Hall of India (PHI).

MIE 4476: PRODUCTION ECONOMICS [3 0 0 3]

The concept of a production function, assumptions. Law of diminishing returns and the three stages of production, Production costs. Economic efficiency, Profit maximization, Farm income and costs. The production function for two variable inputs, Relationships between inputs, the least cost criterion, Expansion paths and profit maximization. Substitution and expansion effects, Alternative production function. Related problems. Production possibility curve, Relationship among products, Maximum revenue combination of outputs, Intermediate and final products. Production and Equilibrium in the long run. Time within the production period, time over a period of years. Analyzing risky production processes, Utility in risky situations, Comparison of traditional and modern analysis.

References:

1. Doll, J. P., & Orazem, F. 1984, Production economics: Theory with Applications.
2. Koutsoyiannis, Anna. 1979. Modern microeconomics. Springer.
3. Petersen, H. C., & Lewis, W. C. 1999, Managerial Economics.

MIE 4477: SECURITY ANALYSIS AND PORTFOLIO MANAGEMENT [3 0 0 3]

Introduction to Investment: Objectives and Process of Investment, Securities Trading, Recent Developments in Stock Market. Fundamental and Technical Analysis: Economy analysis, Theories of Technical

Analysis, Dow and Elliot Wave theory, Efficient Market Hypothesis (EMH). Portfolio Management and Portfolio Analysis: Steps in Portfolio Management, Types of portfolio analysis, Risk and Return of Portfolio. Portfolio selection, Portfolio Revision and Evaluation: Optimal Portfolio, Pricing of securities with CAPM2, Portfolio Revision strategies, Portfolio Evaluation, Risk Adjusted Returns, Sharpe's, Treynor's and Jensen's Measure for Portfolios Performance, FAMA's Decomposition.

References:

1. S. Kevin, Security analysis and Portfolio Management, PHI, 2010, 2nd Edition, New Delhi.
2. G.J, Sharpe. W.F and Bailey. J.V, Fundamentals of Investments, Pearson, 2001.
3. Reilly, Brown, Analysis of Investments and Management of Portfolios, Cengage Learning, New Delhi, 2013.
4. Prasanna Chandra, Investment Analysis and Portfolio Management, TMH, New Delhi, 2013.
5. Charles. P.J, Investments: Analysis and Management, John Wiley & Sons, Inc. 9th Ed.

MIE 4478: STRATEGIC MANAGEMENT [3 0 0 3]

Introduction to Strategic Management: Introduction to competition, Strategy & Strategist and Process of Strategy, Formulation, The role of strategy, Strategic decisions, Aligning strategy and organization. Analyzing the External Environment: Strategic context of the firm, Industry Analysis: Porter's framework, complements, strategic groups and key success factors, PESTLE Analysis. Analyzing the Internal Environment: The Resource based view of the firm, VRIO framework, Sustenance of competitive advantage. Competitive Positioning: Competitive positioning, Business level strategies: Cost leadership, differentiation, focus and dual advantage, Value chain analysis. Managing the Multibusiness Firm: Strategies for the multi-business firm, The need of corporate strategy, Corporate level strategies, Strategy portfolio frameworks, Strategy implementation.

References:

1. Hill, C. W. L. & Jones, G. R. 2008. Strategic Management: An integrated approach, 8th Edition, Houghton Mifflin.
2. Dess, G. G., Lumpkin, G. T., Eisner, A. B., McNamara, G. 2013. Strategic Management: Creating Competitive Advantages, 7th Edition, McGraw-Hill International Edition, McGraw-Hill/Irwin.
3. Michael A. Hitt, R. Duane Ireland, Robert E. Hoskisson (2008), Management of Strategy- Concepts and Cases, 4/e, Cengage Learning, New Delhi.
4. Charles. W.L Hill, Gareth R Jones (2005), Strategic Management-An Integrated Approach,6/e, Biztantra, New Delhi.

MIE 4479: TOOL ENGINEERING [3 0 0 3]

Nomenclature systems of Single point cutting tools. Geometry of cutting tools - Twist drills and Milling cutters. Theory of metal cutting: Orthogonal and Oblique cutting, cutting parameters - speed, feed, depth of cut and their selection criteria; Machinability parameters, Tool life and wear. Merchant's analysis, Taylor's equation and factors affecting tool life. Numerical on shear plane angle, Cutting force and tool life calculation. Design of single point cutting tools Classification of Single point cutting tools, Design of tool shank for strength and rigidity, Design of tool tips, sizing of the inserts, Optimization of tool shape. Design of jigs and fixtures: Functions of Jigs and fixtures, Elements of jig and fixtures, Design procedure, Principle of location, different types of locators, Principle of work holding devices, Press tool design: Theory of press tool action, Methods of reducing cutting forces, Design principles, Design of different types of dies and punch, Die materials, Method of punch support, Design of elements of press tools, Strip layout, Centre of pressure, Design of Forming and Drawing dies.

References:

1. ASME handbook, Fundamentals of tool design, Society of Manufacturing Engineers, New York, 1991.
2. Juneja B. L. and Sekhon G. S., Fundamentals of Metal cutting and Machine Tools, New Age International (P) Ltd. Delhi, 1995.
3. Shaw M. C., Metal cutting principles, Clarendon Press, Oxford, 1996.
4. Nagpal G R, Tool Engineering & Design, Khanna Publishers, Delhi, 2008.
5. Joshi P H, Jigs and Fixture, Wheeler Publishing, Mumbai, 1996.

MIE 4480: WASTE MANAGEMENT [3 0 0 3]

Definition and process of solid waste management, functional elements of a solid waste management system, hierarchy of waste management, the principles of life cycle Importance of municipal solid waste management, Materials recovery and recycling: segregation, reuse and recycle, market issues, recycling of different materials Meaning of hazardous waste, significance, precautions to be taken in storage and transportation of hazardous waste, hazardous waste from rural and urban Area. Storage of hazardous waste, incineration of hazardous wastes Special Categories of Waste-universal wastes, Management of used oil Medical and Infectious Wastes-definitions and sources, advantages and disadvantages of incineration Construction and demolition debris-characteristics, management, hazardous materials Management of electronic wastes-major types of electronic equipment, barriers to recycling ewaste.

References:

1. George Tchobanoglous, Frank kreith, Hand book of solid waste management (second edition), McGraw-Hill, 2002
2. John T. Pfeffer, Solid waste management engineering, Prentice-Hall of India Private Limited, New Delhi
3. Rameshachandrappa, Digantabhusan das, Solid waste management-principles and practice, Springer, 2012
4. A.K.Haghi, Waste management- research advances to convert waste to wealth, Nova Science Publishers, Inc., 2010.

MINOR SPECIALIZATION: INDUSTRIAL INTERNET OF THINGS

MIE 4433: INDUSTRY 4.0 [3 0 0 3]

Introducing Industry 4.0: Components and design principles of Industry 4.0. Cyber Physical Systems: Characteristics, basic functions, architecture and applications of Cyber Physical Systems. Cloud computing, Data sources and Data centres: Features, benefits, limitations of cloud services and data repositories. Internet of Things (IoT): Key technologies, essentials, enablers, applications, impacts and dangers of IoT in industries. Smart Factories: Digital supply network, key features, requirements and benefits of smart factories, concepts of Manufacturing 4.0, digital lean manufacturing, logistics 4.0 and augmented reality. Cybersecurity and Risk: Concepts of cybersecurity in IT & OT, layered security, survivability under attack, Taxonomy of security threats and blockchains in Cybersecurity.

References:

1. Diego Galar Pascual, Pasquale Daponte and Uday Kumar, Handbook of Industry 4.0 and Smart Systems, CRC Press Taylor & Francis group, 2020.
2. Alasdair Gilchrist, *Industry 4.0:* The Industrial Internet of Things, APress Springer Science+Business Media Finance, 2016.
3. Christoph Jan Bartodziej, The Concept Industry 4.0, Springer Fachmedien Wiesbaden GmbH, 2017.
4. Ana Landeta Echeberria, A Digital Framework for Industry 4.0, Palgrave Macmillan, Springer Nature, 2020.
5. Dominik T. Matt, Vladimír Modrák, Helmut Zsifkovits, Implementing Industry 4.0 in SMEs – Concepts, Examples and Applications, Palgrave Macmillan, Springer Nature, 2021.

MIE 4434: BLOCKCHAIN [3 0 0 3]

Introduction to Blockchain Technology and distributed system, Decentralization concepts, Concepts of cryptography, Data encryption standard, RSA, Discrete logarithmic problem in ECC, Hash functions, RSA digital signature algorithm, Elliptic curve digital signature algorithm, financial market concepts, Introduction to Bitcoin, Alternate cryptocurrencies, Smart Contracts and Ethereum, Alternative Blockchains, Blockchain Non-currency Applications.

References:

1. Bashir, I. Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained, 2nd Edition. United Kingdom, Packt Publishing, 2018.
2. Laurence, Tiana. Introduction to Blockchain Technology: The many faces of blockchain technology in the 21st century. Netherlands, Van Haren, 2019.
3. Blockchain Technology: Applications and Challenges. Germany, Springer International Publishing, 2021.
4. Essentials of Blockchain Technology. United States, CRC Press, 2019.
5. Cryptocurrencies and Blockchain Technology Applications. United Kingdom, Wiley, 2020.

MIE 4435: ARTIFICIAL INTELLIGENCE FOR INDUSTRIAL ENGINEERING [3 0 0 3]

Introduction to Artificial Intelligence: Introduction to AI, Conceptual introduction to Machine Learning: Introduction to Neural Networks, Supervised, Unsupervised, and Semi-Supervised Learning, Deep Learning, Reinforcement Learning, Linear Regression. Conceptual introduction to Natural Language Processing, BOT Technologies and Virtual Assistants: Chabot, Image Processing & Computer Vision: Image, Smart Applications.

References:

1. Tom Markiewicz & Josh Zheng, Getting started with Artificial Intelligence, O'Reilly Media, 2017.
2. Stuart J. Russell and Peter Norvig, Artificial Intelligence A Modern Approach., Prentice-Hall
3. Kevin Night and Elaine Rich, Nair B., 2008, Artificial Intelligence (SIE), McGraw Hill.
4. Kumar, Ela. Artificial Intelligence. India, I.K. International Publishing House Pvt. Limited, 2013.
5. Sabouret, Nicolas. Understanding Artificial Intelligence. United States, CRC Press, 2020.

MIE 4436: CYBER SECURITY [3 0 0 3]

Introduction: What Is Computer Security, Integrity, Availability, Type of Threats. Toolbox: Authentication, Access Control, Access Policies, Implementing Access Control, Procedure-Oriented Access Control, Role-Based Access Control and Cryptography. Programs and Programming: Buffer Overflow, Incomplete Mediation, Undocumented Access Point, Off-by-One Error, Integer Overflow, Malicious Code - Malware, Countermeasures. Web User Side: Browser Attacks, Web Attacks Targeting Users, Malicious Web Content, Email Attacks, Phishing. Operating Systems: Security in Operating Systems, Simplicity of Design, Layered Design, Kernelized Design, Reference Monitor, Trusted Systems. Networks: Network concepts, War on Networks: Threats to Network Communications, Wireless Network Security.

References:

1. Charles P. Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, Security in Computing, 5th Ed, Pearson Education, 2015
2. SumitBelapure, Nina Godbole, Cyber Security: Understanding cybercrimes, Computer Forensics and Legal perspectives, Wiley India,2011
3. Sammons, John, and Michael Cross. The basics of cyber safety: computer and mobile device safety made easy. Elsevier, 2016.
4. Brooks, Charles J., Christopher Grow, Philip Craig, and Donald Short. Cybersecurity essentials. John Wiley & Sons,2018.

MINOR SPECIALIZATION: COMPUTER ORGANIZATION AND PROGRAMMING

MIE 4437: BASICS OF COMPUTER ORGANIZATION [3 0 0 3]

Basic Structure of Computers: Functional Units, Basic Operational Concepts, Number Representation and Arithmetic Operations, Character Representation, Memory locations and addresses. Input/Output Organization: Accessing I/O Devices, Interrupts, Controlling I/O Device Behaviour, Direct Memory Access. Basic Processing Unit: Fundamental Concepts, Hardwired Control, Microprogrammed Control. Memory System: Internal organization of memory chips, Structure of Larger Memories, Virtual memories. Arithmetic: Hardware for addition and subtraction, Multiplication, Division, Floating point representation. Pipelining: Pipeline Organization and pipelining Issues, Data Dependencies, Parallel Processing and Performance: Hardware Multithreading, SIMD Processing, Graphics Processing Units.

References:

1. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Computer Organization and Embedded Systems, (6e), McGraw Hill Publication, 2012

2. William Stallings, Computer Organization and Architecture – Designing for Performance, (9e), PHI, 2015
3. Mohammed Rafiquzzaman and Rajan Chandra, Modern Computer Architecture, Galgotia Publications Pvt. Ltd., 2010
4. D.A. Patterson and J.L.Hennessy, Computer Organization and Design-The Hardware/Software Interface, (5e), Morgan Kaufmann, 2014
5. J.P.Hayes, Computer Architecture and Organization, McGraw Hill Publication, 1998

MIE 4438: BASICS OF OPERATING SYSTEMS [3 0 0 3]

Introduction to Operating systems: Operating System structure and operations; Process management; Memory management; Storage management; Operating System structure. Process Management: Process concept; Process scheduling; Multithreading models; Process Synchronization: Petersons solution; Synchronization hardware. CPU Scheduling: Basic concepts; Scheduling Criteria; Scheduling Algorithms; Thread scheduling. Deadlocks: System model; Deadlock characterization. Memory management strategies; Contiguous memory allocation; Virtual Memory Management: Demand paging; Copy-on-write; Page replacement. Secondary Storage Structures: Disk structure; Disk scheduling; Disk management. File System Interface: File concept; Access methods; Directory structure;. Protection: Goals of protection, Principles of protection.

References:

1. Silberschatz, P. B. Galvin and G. Gagne, Operating System Concepts, (9e), Wiley and Sons (Asia) Pvt Ltd, 2013.
2. Milan Milenkovic, Operating systems: Concepts and Design, McGraw Hill, New York, 1987
3. H. M. Dietel, An Introduction to Operating Systems, Addison Wesley, 1990.
4. Andrew S.Tannebaum, Operating System: Design and Implementation, (3e), Prentice Hall of India, 2008
5. Maurice J Bach, Design of UNIX Operating System, Prentice Hall of India, 1988.

MIE 4439: PROGRAMMING USING PYTHON [3 0 0 3]

Elements of Python, understanding variables, basic Operators, blocks, Python Data Types, Loops in python, Programming using Python conditional and loops block, Python arrays, Calling Functions, Passing Arguments, Scope of the Variables in a Function - Global and Local Variables, Powerful Lamda function, Slicing, Methods; Tuples, Sets, Dictionaries, Sequences. Comprehensions, Dictionary manipulation, list and dictionary in build functions. Syntax Errors, Exceptions, Handling Exceptions, Raising Exceptions, Defining Clean-up Actions, Types of testing, Handling Exceptions.

References:

1. Allen B. Downey, Think Python: How to Think Like a Computer Scientist, 2nd edition, Shroff/O'Reilly Publishers, 2016.
2. Kenneth. A. Lambert, Fundamentals of Python First Programs, 2nd edition, Cengage, 2017
3. Guido van Rossum and Fred L. Drake Jr, An Introduction to Python, Network Theory Ltd., 2011.
4. John V. Guttag, Introduction to Computation and Programming Using Python, The MIT Press, 2013
5. Timothy A. Budd, Exploring Python, Mc-Graw Hill Education (India) Private Ltd., 2015.

MIE 4440: MACHINE LEARNING [3 0 0 3]

Introduction: Statistical Decision Theory - Regression, Classification, Bias Variance. Linear regression, multivariate regression, principle component regression, logistic regression, perceptron, support vector machines. Neural Networks: perceptron learning, backpropagation, training and validation, parameter estimation. Decision trees, regression trees, boot strapping and cross validation, class evaluation measures, ensemble methods. Random forest, multiclass classification, Bayesian networks. Partitional clustering, Hierarchical clustering, reinforcement learning.

References:

1. The Elements of Statistical Learning, by Trevor Hastie, Robert Tibshirani, Jerome H. Friedman (freely available online)
2. Pattern Recognition and Machine Learning, by Christopher Bishop
3. Harrington, Peter. Machine Learning in Action. United States, Manning, 2012.
4. Alpaydin, Ethem. Introduction to Machine Learning. United Kingdom, MIT Press, 2014.
5. Mehrotra, Dheeraj. Basics of Artificial Intelligence & Machine Learning, Notion Press, 2019.

MINOR SPECIALIZATION – EV TECHNOLOGY

ELE 4415: EV BATTERY TECHNOLOGY AND POWERTRAIN DEVELOPMENT [3 0 0 3]

Battery Fundamentals: Basics of Batteries, Battery Parameters, Lithium-Ion Characteristics, Thermal Runaway Battery Management System (BMS), Functionality, Practical session - Battery Selection and Connection Process with Vehicle Sensors.Battery Management Systems: SOC/SOH Estimation, Cell Balancing, Protection, Thermal Management, CAN Communication. Practical session - BMS development.Battery Pack Design & Modelling: Overview of Battery & BMS System, Electrical Design, Mechanical Design: Calculations and Mechanical Design using ANSYS, Heat Transfer, Thermal Design of Battery Pack, Battery Pack Assembly and Test, Thermal Analysis on Battery Pack, MATLAB/Simulink-based Battery Pack Modelling. Practical session - Battery life cycle testing.Powertrain and Charging Systems of Electric Vehicles: Introduction to EV Powertrain, Overview, Architecture and Components of EV Powertrain, Thermal Management of EV Powertrain, EV Charging Systems and Types of Chargers.

Modelling, Simulation, and Analysis of EV Powertrain Components: Modelling and Simulation of EV Powertrain Components in MATLAB, Modelling and Analysis of EV Powertrain Components in SolidWorks, Analysis of EV Powertrain Components in ANSYS, Case Study on Powertrain of Existing Models.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. JIANGONG, D. H. Z., “Advances in lithium-ion batteries for electric

vehicles: Degradation Mechanism, health estimation, and lifetime prediction", Elsevier – Health Science, 2024, ISBN-13: 9780443155437.

3. R. Xiong, "Battery Management Algorithm for Electric Vehicles", Springer, 2020, ISBN-13: 9789811502507.
4. Rui Xiong and Weixiang Shen, "Advanced battery management technologies for electric vehicles", John Wiley & Sons Inc, 2019, ISBN-13: 9781119481645.
5. Hannes Hick, Klaus Ku pper, and Helfried Sorger, "Systems engineering for automotive powertrain development", Springer, 2021, ISBN-13: 9783319996288.
6. Christopher D. Rahn, "Battery Systems Engineering", Wiley, 1st Ed, 2013, ISBN:9781119979500.
7. Noshin Omar, "Electric Vehicle Batteries: Moving from Research towards Innovation", Reports of the PPP European Green Vehicles Initiatives, Springer, 2015.
8. Gonzalo Abad and Joaquim Lois, "Power Electronics and Electric Drives for Traction Applications", Wiley, 2016, ISBN: 978-1-118-95442-3.
9. John G. Hayes and G. Abas Goodarzi, Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles", Wiley, 2017, ISBN: 978-1-119-06364-3.

AAE 4420: EV PRODUCT DEVELOPMENT, HOMOLOGATION & HYDROGEN FCEV [3 0 0 3]

EV Design, Manufacturing & Management: Introduction to EV (2W, 3W & 4W) Market and Opportunities, Electric Vehicle Design Procedure and ICE Model, Introduction to EV Management (Categories, Regulations and Standards), EV Homologation and Testing, FAME India and Manufacturing Guidelines. EV Testing, Certification & Market analysis: EV Certification Process, EV Charging, Electric Vehicles and Retrofitting, Motor Technology and EV Motor Market Analysis, EV Categories and Proposed Changes, EV Retrofitting Business, Battery Technology in EV, EV Battery Market Analysis, Practical session - Conducting a market analysis of the EV industry.EV R&D Product Development: Introduction to Product Development Plan, Segment Selection, Product Design Plan, Product Validation Plan, Vehicle Dynamics Selection, Product Design Validation, Product Specification - Competitor Analysis, Selection of Off-the-Shelf Parts, Development Methods, Product Development Plan, Unit Economics, Design Feasibility, Design for Manufacturing, DFMEA and PFMEA, Business Plan, Product Launch, POC/MVP/Working Prototype, Practical session – Using the market research to develop a business plan for an EV manufacturer.Hydrogen Fuel Cells: Introduction to Future Mobility, Why Hydrogen-based Technology, Essentials of Hydrogen, How Does Hydrogen Compare to Hydrocarbon Fuels in Terms of Energy, Flammability and Safety, Hydrogen Fuel Cells, Use of Hydrogen in IC Engines, Hydrogen Fuel Cell Techniques and Systems, Fuel Cell Engine Safety and Maintenance.Hybrid Vehicles & Fuel Cells: Fuel Cell Hybrid Electric Vehicle Acts, Codes, Regulations and Guidelines, Maintenance and Fuelling Facility Requirements, Fuel Cells in Hybrid Electric Vehicles and Pure Electric Vehicles, Auxiliary Power Generation Using Hydrogen, Types of Fuel Cells and Techniques Used, Fuel Stack Module Construction, Fuel Cell Performance, Characteristics, Polarisation, Stoichiometry Effects, Temperature and Pressure Effects, Practical session – Study on Hydrogen fuel cell with MATLAB/SIMULINK.

References:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Tom Denton, "Electric and Hybrid Vehicles", Routledge 2nd Ed, 2020, ISBN: 978-0367273231.
3. Chris Ni and M. Abul Masrur, "Hybrid electric Vehicles, Principles and Applications", WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6.
4. Beate Müller, and Gereon Meyer, "Electric Vehicle Systems Architecture and Standardization Needs", Springer, 2016, ISBN-13: 9783319360966.
5. O chsner Andreas, and Springerlink, "Engineering Applications for New Materials and Technologies", Cham, Springer International Publishing, 2018, ISBN-13: 9783319891972.
6. "Electric Cars" - offered by Delft University of Technology on edX Link: https://www.edx.org/professional-certificate/electric-vehicles-and-mobility.
7. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

ELE 4417: EV VEHICLE DESIGN & ANALYSIS [3 0 0 3]

Introduction to Analog Electronics: Introduction to Basic Electronics, Diode Fundamentals, Rectifiers and Filters, Power Electronics for EVs: Voltage Regulators, Inverters and Converters, Special Purpose Diodes, Transistors and Types of Transistors, Operational Amplifier (Op-Amp).Fundamentals of Digital Electronics: Digital Electronics, EV Control Systems, EV Communication Networks, Microcontrollers and Microprocessors, Introduction to Proteus Software, Circuit Development Using Proteus.Essentials for Designing and Simulation Using MATLAB: Overview and Environment, Basic Syntax, Variables and Commands, Commands, M-files, and Types, Operators, Decision Making and Loops, Vectors, Matrix, and Arrays, Colon Notation and Numbers, Strings and Functions, Numbers, Plotting and Graphics, Algebra, Calculus, Differential, and Integration, Polynomials and Transforms, Programming EV Systems in MATLAB, Simulink and Fitting, Developing SIMULINK Models for Vehicle Units, Advisor and QSS Toolbox, QSS-based Vehicle Control. Practical session - Analyze and troubleshoot electronic circuits using simulation tools and lab equipment.EV Architecture Modelling Using MATLAB [Software-based]: Motor Development and Induction Motor, Characteristics, Simulink Model to Calculate Vehicle Configuration, Multi-level Inverter Design and Simulation, Solar PV-based Charger Development, Dc-DC Converter, Modelling of Li-ion Battery Pack, Design of EV Using QSS Toolbox, Battery Thermal Modelling, BMS Modelling, Electric 4W Powertrain Modelling. Practical session - Data analysis and visualization using MATLAB for vehicle system.Design of EV System Using MATLAB [Software-based]: Power Required to Overcome Resistance Forces Acting on the Vehicle, Power Converters in Electric Vehicles, Inverters in Electric Vehicles, Motor and Motor Controllers, Modelling of EV Battery and BMS. Practical session - Modeling and simulation of EV powertrain components, such as motors, controllers, and inverters, using MATLAB/Simulink.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", Routledge, 3rd Ed, 2021, ISBN: 9780367693930.
3. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 1st Ed, 2014, ISBN: 9781138072855.
4. Sandeep Dhameja, "Electric Vehicle Battery Systems", Butterworth-Heinemann, 2st Ed, 2002, ISBN: 978-0750699167.
5. Singh, Sanjeev, et al., “Electric Vehicle Components and Charging Technologies” IET, 2024, ISBN-13: 9781839536717.
6. Das, Shuvra, “Modeling for Hybrid and Electric Vehicles Using Simscape”, Springer, 2022, ISBN-13: 9783031003806.

AAE 4421: EV FEA Analysis [3 0 0 3]

EV Design and Structural Analysis with Altair Hyper Mesh: Theory of FEA/CAE, Introduction to Hyper Mesh, Creating and Modifying Geometry, Geometry Clean-up and Defeature, Introduction to 2D Meshing, Introduction to 3D Meshing, Element Quality, Mesh Edit, Introduction to Plastic Meshing, Introduction to 1D Meshing, Modal Analysis, Linear Static Analysis, Buckling Analysis, Connectors. Practical session - Optimization techniques using Hyper Mesh. ABAQUS in EV Engineering [Software-based]: Introduction to Abaqus Software, Fundamentals of FEA-Stress, About Abaqus Software-Features, Applications of Abaqus Software in Different Industries, Simple Modelling in Abaqus Software, Create Material and Create Assembly, Create Steps, Loads, Boundary Conditions, Generate Mesh, Result Visualization, Practical session - Multi physics analysis using Abaqus. Finite element Analysis of EV structural components [Software-based]: One Dimensional Analysis, Linear Static Analysis and Linear Buckling Analysis, Heat Transfer Analysis, Non-linear Analysis, Dynamic Simulation-Modal Analysis, Impact Analysis, Time-Dependent Load Analysis. ANSYS in EV Engineering [Software-based]: Basics of Finite-Element Analysis (FEA) along with ANSYS Tool and Software Interface, Essential Mechanical and Electrical Properties of Materials, Various Case Studies on ANSYS Mechanical, Basics of Computational Fluid Dynamics (CFD), Various Case Studies on ANSYS Fluent. Practical session – FEA analysis using ANSYS. Dynamic Simulation and Transient Analysis [Software-based]: Simulation of Battery Thermal Management in Electric Vehicle, Vibration and Fatigue Analysis of Battery Pack, Simulation of Structural Integrity for Motor Mount, Thermal Analysis of Liquid-Cooled Radiator, CFD Study of External Cooling Mechanism for Battery Pack. Practical session - Vulnerability analysis.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.Eric Miller and Jeff Strain, “Introduction to the ANSYS Parametric Design Language (APDL), Phoenix, 2nd Ed, 2016, ISBN: 978-1537133997.
2. Narayana, Lakshmi, et al., “Advances in Automation, Signal Processing, Instrumentation, and Control”, Springer, 2021, ISBN 9789811582202.
3. P Seshu., “Textbook of Finite Element Analysis”, Prentice-Hall of India, 2010, ISBN-13: 9788120323155.
4. Turner, John., “Progress in Modelling and Simulation of Batteries”, SAE International, 2016, ISBN-13: 9780768082821.
5. Y Nakasone, et al., “Engineering Analysis with ANSYS Software”, Butterworth-Heinemann, 2018, ISBN-13: 9780081021644
6. Mohamed Amine Fakhfakh, “Modeling and Simulation for Electric Vehicle Applications”, BoD – Books on Demand, 2016, ISBN-13: 9789535126362.
7. Atul Sharma, "Introduction to Computational Fluid Dynamics: Development, Application and Analysis", Wiley, 1st Ed, 2017, ISBN: 9781119002994.
8. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

OPEN ELECTIVES

MIE 4311: INTRODUCTION TO COMPOSITE MATERIALS [3 0 0 3]

Definition, Classification, Types of matrices & reinforcements, Characteristics & selection of Fiber, Laminated & Particulate composites, Prepregs, Micro mechanical analysis of a lamina, Rule of mixture, Processing of composites, Hand-layup, Spray-layup, Compression molding Injection molding, Reaction injection molding, Autoclaving, Resin transfer molding, Filament winding, Pultrusion, Sheet molding, Secondary processing of polymer composites: Joining, Adhesive joining, Mechanical joining, Microwave joining, Induction and resistance welding, Drilling of polymer composites, Testing of polymer composites, ASTM standards test for physical properties, mechanical properties, SEM analysis, Application developments, Aircrafts, Missiles, Space, Automobile, Electrical and electronics, Marine, Recreational, sports equipment, and Construction.

References:

1. Mein Schwartz, Composite Materials Handbook, McGraw Hill Publication, 1984.
2. Autar K. Kaw, Mechanics of Composite Materials, CRC Press New York.
3. Krishan K. Chawla, Composite Material Science and Engineering, Springer Publication, 1987.
4. Mallik P. C., Fiber Reinforced Composites, Marcel Decker Publication, 1993.

MIE 4312: INRODUCTION TO BIOMECHANICS [3 0 0 3]

Introduction to Biomechanics: Brief history, Contributions of Biomechanics to health science, Contributions of Biomechanics to the field of Mechanics Hemodynamics: Rheology of blood, Large artery hemodynamics, Small artery hemodynamics, Ocular biomechanics: Ocular anatomy, Biomechanics of glaucoma, Ocular blood, Biomechanics of respiratory system: Gross anatomy of the conducting airways and pulmonary vasculature, Anatomy of associated structures, Biomechanics of breathing, Mass transfer and particle transport in lungs, Skeletal biomechanics: Introduction to bone, Biomechanics of cortical and trabecular bone, Structure of ligament, tendon and cartilage and its biomechanics, Biomechanics of Cardiovascular system, Biomechanical hierarchy in cardiovascular physiology, Structure-function relationship in cardiovascular tissues, Biomechanical feedback in the cardiovascular system, Experimental and computational methods.

References:

1. Fung Y C. Biomechanics: motion, flow, stress, and growth. Springer Science & Business Media.
2. Oomens C, Brekelmans M, Loerakker S, Baaijens F. Biomechanics: concepts and computation. Cambridge University Press.
3. Ethier C R, Simmons CA. Introductory biomechanics: from cells to organisms. Cambridge University Press.
4. Hirasawa Y, Sledge CB, Woo SL. Clinical biomechanics and related research. Springer Science & Business Media.

MIE 4313: INTRODUCTION TO OPERATIONS RESEARCH [3 0 0 3]

Introduction: Definition, Phases, Applications, Advantages and Limitations of Operations Research. Linear programming problems*:* Assumptions, Formulation of LPP for business and non -business applications. Graphical solutions, Special cases – Degeneracy, Infeasible Solution, Unbalanced and Multiple optimal solutions. Minimization and Maximization cases. Simplex algorithm, Concept of dual. Transportation problem: Formulation, generating initial solutions using North-West Corner (NWC) Method, Least Cost (LC) Method, Vogel's Approximation Method (VAM). MODI Method. Assignment problem, Travelling salesman problem. Game theory: Introduction to game theory, Two-person-zero sum games, Pure and Mixed Strategies, Solution methods for 2 x 2 games, Graphical method (2 x n games; m x 2 games), Queueing theory*:* Introduction to queueing theory, Poisson arrival rate and Exponential service times, System characteristics, Problems on the models- (M/M/1) :(/FIFO), (M/M/1): (N/FIFO). Critical Path Method (CPM). Project Evaluation and Review Technique (PERT).

References:

1. Taha H. A., Operations Research, Pearson Education, (7e), 2002.
2. W.L. Winston, Operations Research, Thomson Asia, 2003.
3. Vohra N. D., Quantitative Techniques in Management, New Delhi., 2007.
4. Sharma S. D., Operations Research, Kedar Nath Ramnath Publications, (14e), 2005.

MIE 4314: ENERGY ENGINEERING [3 0 0 3]

Steam power plant: Different types of fuels used for steam generation, equipment for burning coal in lump form, oil burners, advantages and disadvantages of using pulverized fuel, pulverized fuel furnaces, coal and ash handling, high and super critical pressures. Diesel engine power plant: Applications of diesel engines in power field, method of starting diesel engine, auxiliaries, layout of diesel power plant. Hydro–electric plant: hydrographs, flow duration and mass curves, unit hydrograph and numerical, different types of plants, accessories, general layout of hydel power plants. Nuclear power plant: Principles of release of nuclear energy, nuclear fuels used in the reactors, elements of nuclear reactor, reactor types, radiation hazards, shielding's, and radioactive waste disposal. Solar energy: Solar extra-terrestrial radiation and radiation at the earth surface, radiation measuring instruments, solar energy conversion systems. Biomass energy: Photosynthesis, anaerobic fermentation, classification, gasifiers. Wind energy: Properties of wind, wind velocity and power from wind, types of wind machines and their characteristics. Other energy conversion techniques: Fundamental characteristics of tidal power, harnessing tidal energy and limitations. principle of working of ocean thermal energy, Rankine cycle, limitations of OTEC. geothermal energy conversion working principle, types of geothermal stations, limitations.

References:

1. Nag P. K., Power Plant Engineering, Tata McGraw Hill, 2002.
2. Domkundwar, Power Plant Engineering, Dhanpat Rai Publications, 2003.
3. Rai G. D., Non-Conventional Energy Sources, Khanna Publishers.
4. Rao S. and Parulekar B. B., Energy Technology, Khanna Publishers, 2004.

MIE 4315: INTRODUCTION TO FINITE ELEMENT ANALYSIS [3 0 0 3]

Basics Concepts of FEA: General steps involved in FEM, Convergence requirements, Pascal's triangle, Higher order quadratic elements; Local and Global coordinate systems, Shape Functions and properties. Basics of theory of Elasticity. Finite Element Formulation by DSM: FE formulation of 1D linear element by direct stiffness method, Elimination and Penalty approach. Application to bar and plane truss problems. Introduction to space truss. FE formulation of Beam element by energy approach, Application to Beam problems. Additional Methods and Applications of FEM: Structure of commercial FEM software package, Mini project on using FEA software, Mini Project on using computation approach.

References:

1. Chandrupatla T. R. and Belegundu A. D., "Introduction to Finite Elements in Engineering", Pearson Education, New York.
2. Daryl L. Logan, "A First course in Finite Element Method", Fifth Edition, Cengage Publishing,India
3. David V. Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw Hill, India.
4. J. N. Reddy, "An Introduction to Finite Element Method", Fourth Edition, McGraw Hill International Edition, New York.

MIE 4316: BIO-FLUID DYNAMICS [3 0 0 3]

Cardiovascular physiology: Cardiovascular system, The heart-blood vessels, Mechanical model (Winkessel model), Blood, Fundamentals of fluid mechanics: Intrinsic properties of fluid, Conservation laws-Mathematical tools, Mass Conservation, Conservation of momentum, Form of fluid motions equations, Dimensional analysis, Energy conservations & Bio-heat Equation of Mammalian Tissue, Mathematical solutions for bio-fluid problems: How to solve a problem?, Boundary conditions, Mathematical solutions for bio-fluid problems - Shear stress on arterial endothelial cells, NS in a pipe - Validity of the Hagen-Poisseuille relationship in the cardiovascular system, Pulsatile flow, Effect of pulsatility, Wormersley solution, Computational fluid dynamics (CFD) and Flow measurement in the cardiovascular: Computational fluid dynamics, Flow measurement in the cardiovascular, Flow over immersed body (incompressible): General flow characteristics, Lift and drag concepts – Definitions, Drag for different shapes, Drag coefficient, for a sphere in stokes flow, Transport of micro-particles, Characteristic flow past an object, Boundary layer characteristics - Boundary Layer Structure and Thickness on a Flat Plate, Boundary layer thickness, MomentumIntegral Boundary Layer Equation for a Flat Plate, Prandtl/Blasius Boundary Layer Solution, Turbulent boundary layer, Pressure gradient effect on flow - Separation point, Reduction of drag, Biological solution for drag reduction, Rheology of blood, Non-Newtonian fluid: Viscosimetry, Blood composition and viscosity, Cell free marginal layer, Pressure flow relationship for non-Newtonian fluid, Hemodialysis and platelet activation, Time effect viscosity, Introduction to Fluid Machinery and biomedical application: Introduction to Fluid Machinery, Fluid machinery in biomedical.

References:

1. K. B. Chandran, Biofluid mechanics: the human circulation. Taylor and Francis. 2nd edition.
2. Kundu P K, Cohen I M and Dowling D R, Fluid Mechanics", 5th Edition, Academic Press.
3. Mazumdar J, Biofluid Mechanics, World Scientific, Singapore.
4. L. Waite. Applied Biofluid Mechanics. 1st edition, McGraw-Hill Professional.

MIE 4317: INTRODUCTION TO ENGINEERING ASSET MANAGEMENT [3 0 0 3]

Engineering Asset Management: Basic concepts, Definitions, Review of Existing Frameworks for Asset Management, A framework for AM system, Requirement and Challenges, Asset Management Drivers, Benefits of Asset Management. Asset Management Standards: ISO 55000, Overview, principles, and terminology. ISO 55001 Requirements. ISO 55002 Guidelines on the application of ISO 55001.Asset Management Principles: Barriers to implement Asset Management, Asset Life Cycle, Balancing Cost, Risk and Performance. Principles of asset integrity and management: Asset Management Tools and Elements of Asset Assessment (Performance Management), Terminology used in asset management policy and requirements. Fundamentals of Reliability Engineering: Maintenance Management; maintenance contracts and contract administration, reliability centred maintenance; total productive maintenance.Preventive component replacement and capital equipment replacement decisions.

References:

1. Campbell, J.D., Jardine, A.K.S. McGlynn, J. "Asset Management Excellence: Optimizing Equipment Life-Cycle Decisions", 2nd Edn., CRC Press,Boca Raton, FL, 474 pp. 2011.
2. Jardine, A.K.S. and Tsang, A.H.C. "Maintenance, Replacement and Reliability: Theory and Applications", CRC Taylor & Francis, New York, 322 pp. 2006.
3. Kelly, A. "Strategic Maintenance Planning", Butterworth Heinemann, Oxford, 284 pp. 2006.
4. Kelly, A. "Managing Maintenance Resources", Butterworth Heinemann, 292 pp. 2006.
5. Lawrenson, J. "Effective Spares Management", International Journal of Physical Distribution & Materials Management, Vol 16, No. 5., 111 pp., 1986.
6. O'Conner, P.D.T. "Practical Reliability Engineering", 5th Edn., John Wiley and Sons, 2012.
7. Moubray, J. "Reliability-Centered Maintenance",2nd Edition, Industrial Press Inc., NY, 414 pp., 1992.

Department of
Mechatronics

Mechatronics is an interdisciplinary domain that integrates Electronics, Mechanical, Electrical, and Computer Science Engineering. As automation becomes increasingly vital across sectors such as manufacturing, healthcare, space, defense, civil infrastructure, and agriculture, there is a growing demand for skilled Mechatronics engineers equipped with knowledge of artificial intelligence and data science. The primary objective of the department is to prepare students to address future technological challenges by laying a strong foundation in multidisciplinary engineering principles. The department offers a continuously evolving curriculum that blends traditional teaching with a research-oriented approach. Emphasis is placed on developing hands-on skills using modern software tools and state-of-the-art hardware. The department has established industry-supported laboratories that include the Sensorics Lab by Bosch Rexroth, Robotics Lab by ABB Bengaluru, the Industrial Internet of Things Lab by Beckhoff Automation India Pvt. Ltd. and Texas Instruments, and the Collaborative Robot (COBOT) platform by Universal Robots Pvt. Ltd.

A dedicated Research Lab in collaboration with Altair Engineering Inc., Bengaluru, supports simulation-driven design and innovation. In addition, a Centre of Excellence (CoE) in Industrial Internet of Things (IIoT) has been set up in partnership with the Centre for Development of Advanced Computing (CDAC) to drive cutting-edge research and training initiatives.

The department fosters interdisciplinary learning through a team of young, dynamic, and motivated faculty members specializing in Robotics, Control Systems, Kinematics and Dynamics, Electric Drives, Machine Learning, Artificial Intelligence, Manufacturing, Data Science, Software Applications, Computer Vision, and Embedded Systems. Facilities such as the Maker's Space in the Innovation Centre and the MAHE-JanyuTech Centre for Robotics enable students and researchers to explore and develop innovative solutions in areas like mobile and aerial robotics, robotic vision, and multi-robotic systems. With consistent achievements by its faculty and students, the department has grown rapidly and earned significant recognition, including a prestigious six-year NBA accreditation granted in 2019 - a testament to its academic excellence and industry relevance.

> Programs offered

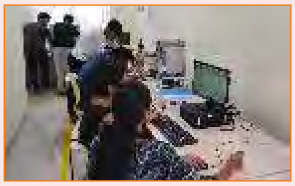
Undergraduate Program

- B.Tech in Mechatronics (2006)

Postgraduate Program

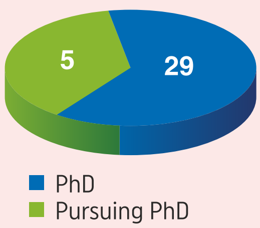
- M.Tech in Industrial Automation & Robotics (2015)

PhD



> Fayculty Strength

Qualification-wise



Cadre-wise

B.TECH. MECHATRONICS

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2121	Engineering Mathematics - III	2	1	0	3	MAT 2231	Engineering Mathematics - IV	2	1	0	3
	MTE 2121	Data Structures and Algorithms	2	1	0	3	MTE 2221	Theory of Machines	2	1	0	3
	MTE 2122	Digital Design and Verilog Programming	2	1	0	3	MTE 2222	Design of Machine Elements	3	1	0	4
	MTE 2123	Digital and Analog CMOS Design	3	0	0	3	MTE 2223	Industrial Automation	3	0	0	3
	MTE 2124	Mechanics of Robotics Systems	2	1	0	3	MTE 2224	Linear Control Theory	2	1	0	3
	MTE 2125	Sensors and Transducers	3	0	0	3	MTE 2225	Microcontroller based System Design	2	1	0	3
	MTE 2141	Industrial Robotics Lab	0	0	3	1	MTE 2241	CAD and Kinematics Simulation Lab	0	0	3	1
	MTE 2142	Integrated Electronics Lab	0	0	3	1	MTE 2242	Microcontroller Lab	0	0	3	1
	MTE 2143	Manufacturing Processes Lab	0	0	3	1	MTE 2243	Sensors and PLC Lab	0	0	3	1
			14	**4**	**9**	**21**			**14**	**5**	**9**	**22**
	Total Contact Hours (L + T + P)		**27**				**Total Contact Hours (L+T+P)**		**28**			
III	**FIFTH SEMESTER**						**SIXTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	HUM 3021	Engineering Economics and Financial Management	2	1	0	3	HUM 3022	Essentials of Management	2	1	0	3
	MTE 3121	Digital Signal Processing	2	1	0	3	MTE 3221	Energy and Heat Transfer	3	0	0	3
	MTE 3122	Electric Drives	3	1	0	4	MTE ****	Flexible Core-2 (A2/B2)	3	0	0	3
	MTE ****	Flexible Core-1 (A1/B1)	2	1	0	3	MTE ****	Program Elective - I / Minor Specialization	3	0	0	3
	MTE 3124	Hydraulics and Pneumatics Systems	3	0	0	3	MTE ****	Program Elective - II / Minor Specialization	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation				3	*** ****	Open Elective - 2				3
	MTE 3141	Drives, Controls and Modelling Lab	0	0	3	1	MTE 3241	Hydraulics Lab	0	0	3	1
	MTE 3142	Robot Operating System Lab	0	0	3	1	MTE 3242	IIoT Lab	0	0	3	1
							MTE 3243	Pneumatics Lab	0	0	3	1
			12	**4**	**6**	**21**			**14**	**1**	**9**	**21**
	Total Contact Hours (L+T+P) + OE		**22 + 3 = 25**				**Total Contact Hours (L+T+P) + OE**		**24 + 3 = 27**			
IV	**SEVENTH SEMESTER**						**EIGHTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	MTE ****	Program Elective - III / Minor Specialization	3	0	0	3	MTE 4291	Industrial Training				1
	MTE ****	Program Elective - IV / Minor Specialization	3	0	0	3	MTE 4292	Project Work/Practice School				12
	MTE ****	Program Elective - V	3	0	0	3	MTE 4293	Project Work (B.Tech Honours)**				20
	MTE ****	Program Elective - VI	3	0	0	3	MTE ****	B.Tech Honours (Theory 1)** (V Semester)				4
	MTE ****	Program Elective - VII	3	0	0	3	MTE ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	*** ****	Open Elective - 3				3	MTE ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	MTE 4191	Mini Project (Minor Specialization)*										
			15	**0**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P) + OE		**15 + 3 = 18**									

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

MINOR SPECIALIZATIONS

I. Electric Vehicle Technology

ELE 4415: EV Battery Technology and Power Train Development
AAE 4420: EV Product Development, Homologation and Hydrogen FCEV
ELE 4417: EV Vehicle Design and Analysis
AAE 4421: EV FEA Analysis

II. Industrial IoT Systems

MTE 4405: Database Management Systems
MTE 4406: Cyber Security for Industrial Automation
MTE 4407: Internetworking for Industries
MTE 4408: Principles of Cryptography

III. Robotics and Automation

MTE 4409: Artificial Intelligence for Robotic Vision
MTE 4410: Robot Dynamics and Control
MTE 4411: Robot Path Planning and Mobile Robots
MTE 4412: Soft Robotics

IV. Micro and Nano Systems

MTE 4413: Semiconductor and VLSI systems
MTE 4414: Smart Materials for Micro and Nano Systems
MTE 4415: Design of Micro and Nano Devices
MTE 4416: Fabrication and Testing of Micro Systems

V. Precision Agriculture Technology

MTE 4417: Smart Farming Machinery
MTE 4418: Robotics and Automation in Agriculture
MTE 4419: Food Process Automation
MTE 4420: Digital Agriculture

VI. Computational Mathematics

MAT 4401: Applied Statistics and Time Series Analysis
MAT 4402: Computational Linear Algebra
MAT 4403: Computational Probability and Design of Experiments
MAT 4404: Graphs and Matrices

VII. Business Management

HUM 4401: Human Resource Management
HUM 4402: Marketing Management
HUM 4403: Financial Management
HUM 4404: Operations Management

Other Program Electives

MTE 4441: Antennas, Radar and Navigation
MTE 4442: Augmented Reality and Virtual Reality
MTE 4443: Autonomous Mobile Robotics
MTE 4444: Biomechatronics
MTE 4445: Building Automation
MTE 4446: Cloud Computing
MTE 4447: Data Analytics and Machine Intelligence
MTE 4448: Data Mining and Visualization
MTE 4449: Digital Manufacturing
MTE 4450: Deep Learning for Computer Vision
MTE 4451: Design of Mechanical Drives
MTE 4452: Electric Vehicles
MTE 4453: Embedded Systems and RTOS
MTE 4454: Engineering Materials
MTE 4455: Fractional Order Modelling and Control
MTE 4456: Human Robot Interaction
MTE 4457: Machine Learning
MTE 4458: Machine Tool Technology
MTE 4459: Machine Vision
MTE 4460: Mechanical Vibrations
MTE 4461: Micro and Nano Fabrication of Electronic Devices
MTE 4462: Micro Electro Mechanical Systems
MTE 4463: Micro-manufacturing Systems
MTE 4464: Nanotechnology
MTE 4465: Object Oriented Programming using Python
MTE 4466: Production and Operations Management
MTE 4467: Reinforcement Learning for Robotics
MTE 4468: Renewable Energy Technology
MTE 4469: Sustainable Manufacturing
MTE 4470: Systems Modelling and Simulation
MTE 4471: Wireless Sensor Networks
MTE 4076: Heavy Vehicle Technology
MTE ****: Digital Twins for Mechatronics

Open Electives

MTE 4311: Autonomous Mobile Robots
MTE 4312: Farm Automation
MTE 4313: Hydraulics and Pneumatics Systems
MTE 4314: Industrial IoT
MTE 4315: Introduction to Industrial Robotics

THIRD SEMESTER

MAT 2121: ENGINEERING MATHEMATICS - III [2103]

Gradient, divergence and curl,. Line, surface and volume integrals. Green's, divergence and Stoke's theorems. Fourier series of periodic functions. Half range expansions. Harmonic analysis. Fourier integrals. Sine and cosine integrals, Fourier transform, Sine and cosine transforms. Partial differential equation- Basic concepts, solutions of equations involving derivatives with respect to one variable only. solutions by indicated transformations and separation of variables. One-dimensional wave equation, one dimensional heat equation and their solutions. Numerical solutions of boundary valued problems, Laplace and Poisson equations and heat and wave equations by explicit methods

References:

1. Erwin Kreyszig: Advanced Engineering Mathematics, (5e) 1985 Wiley Eastern.
2. S.S.Sastry : Introductory Methods of Numerical Analysis (2e)1990, Prentice Hall.
3. B.S.Grewal : Higher Engg.Mathematics, 1989 Khanna Publishers
4. Murray R.Spiegel : Vector Analysis, Schaum Publishing Co.

MTE 2121: DATA STRUCTURES AND ALGORITHMS [2 1 0 3]

Introduction to Python Programming: Data types. I/o statements, Conditional and Looping statements, Functions. Stacks, Queues, Evaluation of expressions, Linked lists-singly, doubly, header node, circular along with application. Trees- Binary trees, In-order, Preorder and Post order traversal of Trees. Creation, Insertion and Deletion operations on Binary search tree. Sorting - Bubble sort, Selection sort, Merge sort, Quick sort, Heap sort. Searching - Linear search, Binary search. Horspool algorithm, Open Hash table, Floyd's algorithm, Warshall's algorithm, Prim's algorithm, Kruskal's algorithm, Dijkstra's algorithm.

Self-study: Courseera course entitled Python programming for all

References:

1. Bradley N. Miller, David L. Raum, Problem Solving with Algorithms and Data Structures using Python, (3e), FBA Publishers, 2018.
2. Agarwal Basant, Baka Benhamin, Hands-On Data Structures and Algorithms with Python, (2e), Packt Publishing, 2018.
3. Dinesh P. Mehta, SartajSahni, Handbook ofData Structures and Applications, (2e), CRC Press, 2018.

MTE 2122: DIGITAL DESIGN AND VERILOG PROGRAMMING [2 1 0 3]

Logic Families, Review of logic minimization techniques, Weighted and unweighted codes, Binary Adder/ Subtractor, BCD Adder,code converters, Binary comparators, Parity generator/ checker. Combinational circuit design usinglogic blocks: multiplexers, demultiplexers, encoders,priority encoder, decoder; Shannon's decomposition, Sequential Logic Design: Latches, Flip-flops: Design of synchronous andasynchronous counters, Shift registers, Synchronous Sequential machines: classification, finite state machine (FSM), analysis and design, Introduction to Verilog HDL: VHDL versus Verilog, Structural modeling, Data-flow Modeling, Behavioral Modeling, Switch Level Modeling, Tasks and Functions, Test Bench, Digital Implementation Options and FPGA Architectures: Full-custom and semi-custom, PLD, ASICs: CPLDs, MPGAs and FPGAs, Architecture of ACTEL and XILINX logic family.

Self-Study: Shannon's decomposition, E-waste Management, Risks and Hazards involved in circuit design, Safety and Hazards in semiconductor industry, semiconductor industries for sustainable future.

Prereequisite: K map reduction, Boolean algebraic expression minimization

References:

1. ZviKohavi, Niraj K Jha, Switching and Finite Automata Theory, (3e), Cambridge, 2010.
2. Morris Mano, Digital design, (3e), Prentice Hall of India, 2002.
3. Floyd and Jain, Digital Fundamentals, (11e), Pearson Education, 2015.
4. A. Anand Kumar, Switching Theory and Logic Design, (2e), Prentice Hall of India, 2009
5. Bhasker. J, A Verilog HDL Primer, (3e), Star Galaxy, 2016.
6. Stephen. Brown and ZvonkoVranesic, Fundamentals of Digital Logic with Verilog Design, (3e), Tata McGraw Hill, 2014.
7. M. J. S. Smith, Application Specific ICs, Pearson Education, 2004.

MTE 2123:DIGITAL AND ANALOG CMOS DESIGN [3 0 0 3]

Moore's law, VLSI technology trends, BJT versus MOS, MOSFET: types, VI characteristics and regions of operation, second-order effects, NMOS and CMOS inverter, pass transistors and transmission gates, CMOS circuit realisation of combinational circuits using switch logic and gate logic, CMOS fabrication process, Stick diagrams, Layouts, delay unit, CMOS inverter delay, Analog versus digital, Analog building blocks: Current Mirror, VFOA, CFOA, CCII, OTA. Operational Amplifier: block diagram representation, ideal and practical characteristics, Linear and non-linear applications of Op-amp, Active-RC filters, Data converters.

References:

1. Pucknell D. A and Eshraghian K, Basic VLSI Design, (3e), PHI Publication, 2015.
2. R. Jacob Baker, Harry W. Li, David E. Boyce, CMOS: Circuit design, Layout, and SimulationWiley-IEEE Press, 2019.
3. Ramakant A. Gaikwad, Op-Amps and Linear Integrated Circuits, Prentice Hall of India, (4e), 2015.
4. Stanley William D., Operational Amplifiers with Linear Integrated Circuits, Prentice Hall, 2004.
5. Franco Sergio, Design with Op-amps and Analog Integrated Circuits, McGraw Hill, (3e), 2017.
6. Choudhury Roy D and Shail B. Jain, Linear Integrated Circuits, Wiley Eastern, (4e), 2018.

MTE 2124: MECHANICS OF ROBOTICS SYSTEMS [2 1 0 3]

Introduction to robotics- types and specification of robots, DoF, configurations, control resolution, spatial resolution, accuracy and repeatability, actuators and sensors, drives and transmission systems used in robotics. Kinematic analysis & coordinate transformation-Direct kinematic problem in robotics, homogeneous transformation matrices, joint space, and cartesian space, Denavit-Hartenberg method, Inverse manipulator kinematics solvability, robot kinematics constraints, robot workspace, holonomic robots, Jacobian matrix, Jacobian singularity. Trajectory generation- general considerations in path description and generation, joint-space schemes, cartesian-space schemes. Manipulator dynamics-Newton's equation, Euler'sdynamic formulation, iterative vs. closed form. Lagrangian Formulation of Dynamics, Introduction to 3D rigid body dynamics: The Inertia Tensor. Kinematic modeling of planar and spatial parallel manipulators, Closed-loop equation, four-bar and slider-crank mechanism, Stewart platform. Feedback and closed-loop control (SISO & MIMO), second-order linear systems, Case studies.

Self-study: Kinematic configurations of the industrial robot, case studies on different industrial manipulator working principles and applications or mini project.

References:

1. John J. Craig, Introduction to Robotics: Mechanics and Control, (3e), PHI, 2005.
2. C. Peter., Robotics, Vision and Control: Fundamental Algorithms in MATLAB. Vol. 73. Springer, 2011.
3. G. Ashitava, Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2006.
4. Murray, Richard M., Zexiang Li, S. Shankar Sastry, and S. ShankaraSastry, A Mathematical Introduction to Robotic Manipulation, CRC press, 1994.
5. S. Bruno and O. Khatib, EDS: Springer handbook of Robotics, Springer, 2016.
6. Mittal, R. K., and I. J. Nagrath. Robotics and control. Tata McGraw-Hill, 2003.
7. Niku, Saeed B. Introduction to robotics: analysis, control, applications. John Wiley & Sons, 2020.

MTE 2125: SENSORS AND TRANSDUCERS [3 0 0 3]

Units and standards, calibration, static and dynamic characteristics of an instrument, error analysis, electromechanical measuring instruments. Material science concepts: materials used for manufacturing sensors and transducers. analog and digital voltmeters, ammeters, LCR-Q meters, DC bridges, AC bridges, cable fault detection, shielding and grounding, introduction to sensors and transducers. Types of sensors, Physics behind sensors, Selection and calibration of sensors. Measurement of physical quantities- position, velocity, acceleration, proximity, strain, force, temperature, pressure, flow, level, humidity, light, gas sensors, LiDAR, Radar sensors, oxygen sensors, breathanalyzers, heart rate sensor. Sensor applications, transmitters, Digital Storage Oscilloscope, Data acquisition system, Signal conditioning. IEC, ISO, IP standards, Electrical safety, Engineering ethics, Case study.

Prerequisite: Understanding of physics, solving basic electrical circuits

Self-Study: Risk assessment and mitigation

References:

1. Sawhney A.K., A Course in Electrical and Electronic Measurements and Instrumentation, (28e), Dhanpat Rai & Co., 2020
2. Boyes W., Instrumentation Reference Book, Butterworth-Heinemann, (4e), 2009
3. Murty D.V.S., Transducers and Instrumentation, (2e), Prentice Hall India Learning Private Limited, 2012.
4. Charles B. Fleddermann, Engineering ethics, (4e), Pearson, 2012.
5. Bela G. Liptak, Process Measurement and Analysis, (4e), CRC press, 2003.

Online Courses:

1. Ethics, Technology and Engineering -Coursera
   https://www.coursera.org/learn/ethics-technology-engineering
2. Responsible Innovation: Ethics, Safety and Technology-edX https://www.edx.org/course/responsible-innovation-ethics-safety-and-technology
3. Sensor Manufacturing and Process Control (Coursera)
4. Sensors and Sensor Circuit Design (Coursera)

MTE 2141: INDUSTRIAL ROBOTICS LAB [0 0 3 1]

Introduction to Robot Studio an offline Programming Tool, Defining Targets and Trajectory Generation, Creating a Custom Tool and Defining a Work object, Conveyor Tracking using Robot Studio. Manual programming using Teach pendant for IRB2600, Control of Digital Inputs and Outputs through IRB2600 Robot, automation applications with industrial robot IRB2600 and collaborative robot Universal Robot UR5. Control of Stepper Motor and servo motor actuators using Raspberry PI. PID Control of Lego Line Following Robot. Robot Vision- with image processing software or Open CV.

Self study topics: Kinematic modeling of the industrial robot, knowledge of Sensors and actuators for case study or mini project.

References:

1. S. Bruno and O. Khatib, EDS: Springer handbook of Robotics, Springer, 2016.
2. Niku, Saeed B. Introduction to robotics: analysis, control, applications. John Wiley & Sons, 2020.
3. C. Peter., Robotics, Vision and Control: Fundamental Algorithms in MATLAB. Vol. 73, Springer, 2011.
4. Operating manual RobotStudio, ABB Robotics, 2021
5. Sherlock Machine Vision Software User's Reference Manual, for Software versions 7.1.x and 7.2.x.

MTE 2142: INTEGRATED ELECTRONICS LAB [0 0 3 1]

Introduction to op-amp using 741IC, linear applications of Op-amp, Operational amplifier and block diagram representation, characteristics of operational amplifier, Analyze and design linear and non-linear applications of Op-Amp using 741 IC. Design Timer circuits using 555 IC and voltage regulator using 78xx, and LM317 ICs. Design combinational and sequential logic circuits using digital Ics.

References:

1. Stanley William D., Operational Amplifiers with Linear Integrated Circuits, 4(e), Prentice Hall, 2004.

MTE 2143: MANUFACTURING PROCESSES LAB [0 0 3 1]

Introduction to machine shop, foundry and smithy shop. Preparation of the models by lathe involving turning, thread cutting, knurling operations, preparation of models using milling, shaping and surface grinding machines; operation of CNC milling and turning center, preparation of arc welding models. Demonstration of Wire-EDM, TIG and MIG welding process.

Self-Study: Case studies on various manufacturing processes for designing a component .

References:

1. Chaudhury S. K. Hajara & Others, Elements of Workshop Technology Vol 1 & 2, (5e), Media Promoters & publishers Pvt.Ltd ., Mumbai, 2004.
2. R.K. Jain, Production Technology, (2e), Khanna Publishers, New Delhi, 2002.
3. Raghuwanshi, B.S., A course in Workshop technology, Vol 1 & II,Dhanpat Rai & Sons, New Delhi.

FOURTH SEMESTER

MAT 2231: ENGINEERING MATHEMATICS IV [2 1 0 3]

The z transforms, properties of z transforms, initial and final value theorems, solution of difference equations by the method of z transforms, convolution theorem. Special functions: Series solutions of ordinary differential equations ,Series solutions of Bessel's and Legendre's differential equations, Recurrence relations and generating functions. Orthogonal properties, Probability: Finite sample space, conditional probability and independence, Bayes' theorem, one dimensional random variable: mean and variance, Chebyshev's inequality. Binomial, Poisson, uniform, normal, gamma, chi-square and exponential distributions. Two and higher dimensional random variables ,Covariance, correlation coefficient, regression lines, least square principles of curve fitting. Moment generating function, Functions of random variables, Sampling theory, Central limit theorem and applications.

References:

1. Kreyzig E-.Advanced Engineering Mathematics, (7e)., Wiley Eastern.
2. Meyer P.L. - Introduction to Probability and Statistical applications, (2e). American Publishing Co.
3. Ross S.M. - Introduction to Probability and Statistics for Engineers and Scientists, (2e). Wiley International.
4. Grewal B.S - Higher Engineering Mathematics, Khanna Publishers.
5. Hogg & Craig - Introduction of Mathematical Statistics, (7e).2013. MacMillan

MTE 2221: THEORY OF MACHINES [2 1 0 3]

Introduction to mechanisms and machines: Kinematics and Dynamics, Mechanisms and Machines, Plane and Space Mechanisms, Mechanisms and their Inversions. Kutzbach and Grubler's criterion, Grashof's criterion. Other mechanisms: Straight line Mechanism, Toggle mechanism, Pantograph, Hooke's joint, Ackermann and Davis steering gear, Geneva mechanism and Ratchet mechanism. Analysis and synthesis of planar mechanisms: Velocity and acceleration analysis, Corioli's component of acceleration. Balancing and Dynamic force analysis: Power Smoothening by Flywheels. Gears and Gear trains.Cams and followers.

Self-study: Mechanisms used in robotic applications and analysis of velocity and acceleration of varoius links used in industrial robots.

References:

1. John J. Uicker Jr., Gordon R. Pennock, Joseph E. Shigley, Theory of Machines and Mechanisms, (5e) OUP USA, 2017.
2. Rattan. S. S, Theory of Machines, (4e), Tata Mc Graw Hill, New Delhi, 2017.
3. Bevan. T, Theory of Machines, (4e), Laxmi Publications, New Delhi, 2016.
4. Ghosh and Mallick. A. K, Theory of Machines and Mechanisms, (3e), Affiliated East West Private Limited New Delhi, 2008.
5. Ballaney P. L, Theory of Machines and Mechanisms, Khanna Publishers, New Delhi, 2005.

MTE 2222: DESIGN OF MACHINE ELEMENTS [3 1 0 4]

Stresses and Strains: Shear force and bending moments. Types of loads and stresses. Bending and Torsional Stresses: Types of beams and supports, theory of simple bending, stress variation in beams, analysis of torsion in shafts, shear stress in shafts and stress distribution, Deflection of Beams: Deflection of beams by double integration method and Macaulay's method. Static and Dynamic Loading: Stress concentration, fatigue strength, stress-life (S-N) diagram, Design of Transmission Shafts: Materials, permissible stresses, permissible deflection and permissible angular twist, power transmitting elements, design for static and fatigue load (bending and torsion), ASME code for shaft design. Design of Helical Springs: Helical coil spring: Power Screws: Power Screws: Types of power screws, terminology, torque for power screws, collar friction, efficiency, Design of Spur Gears: Spur gears, terminology, tooth profile, pressure angle, Lewis equation for beam strength, form factor, velocity factor, Selection of Bearings: Definition, objective, viscosity and types of lubrication. Construction, application, merits and demerits of journal bearing. Rolling Contact Bearings: Types, capacity of bearings, bearing life, loading ratio, equivalent bearing load and bearing selection.

Self-study: Mechanical components used in robotic applications and design of these components used in industrial robots

References:

1. Timoshenko and Young, Elements of Strength of Materials, Tata McGraw Hill, New Delhi, 2003.
2. Popov E.P., Engineering Mechanics of Solids, Prentice Hall India, New Delhi, 2001.
3. Beer F. P. and Jonhston R, Mechanics of Materials, (3e), MacGraw Hill Book Company, 2002
4. Shigley J. E. and Mischke C. R., Mechanical Engineering Design, (5e), McGraw Hill Inc, New York. 2004.
5. Bhandari V B., Design of Machine Elements, (2e), Tata McGraw-Hill Publishing Company Limited, Newh Delhi, 2007

MTE 2223: INDUSTRIAL AUTOMATION [3 0 0 3]

Introduction to industrial automation, types of automation; architecture of industrial automation, Industrial revolutions, advantages and limitations of Automation, and trends in industrial automation. Sensors and actuators used in industry: Sensors, Transmitters, Actuators and Signal Conditioning: Measurements with Industrial Field Instruments, Data Acquisition Systems. Drives and motors: Types of motors and

Drives. Industrial Controllers and drives: PLC, PID, DCS, Industrial monitoring: HMI and SCADA. Industrial Communication and networking: Device network: CAN, PROFIBUS-PA, HART, Control network: ControlNet, PROFIBUS-DP, Ethernet, Interfaces: RFID, Barcode. Safety instrument used in automation technology. Overview of Industrial robots. Advancement industrial automation: Industry 4.0 and Industrial IoT.

Self-study: NPTEL, Coursers, Swayam and Edx Case study from industry journal (Electronics for you and Automation-ISA)

References:

1. Stamatios Manesis, George Nikolakopoulos, Introduction to Industrial Automation, CRC Press, 2018 .
2. Chanchal Dey, Sunit Kumar Sen, Industrial Automation Technologies, CRC Press, 2020.
3. Frank Lamb, Industrial Automation: Hands On, McGraw-Hill Professional, 2013.
4. A.K. Gupta, S.K. Arora, Jean Riescher Westcot, Industrial Automation and Robotics: An Introduction, Mercury Learning & Information, 2016.
5. Zongwei Luo, Zongwei Luo, Robotics, Automation, and Control in Industrial and Service Settings, IGI Global; Engineering Science Reference, 2015.

MTE 2224: LINEAR CONTROL THEORY [2 1 0 3]

Feedback control systems terminologies, control system design process. differential equation of physical systems, linear approximation, frequency domain representation, Time domain analysis and design, first and second order system response analysis, time domain and Steady State Error (SSE), stability, RH criteria, root locus technique. Introduction to compensator design, design of lag, lead, and lag-lead compensating network. Frequency domain analysis- frequency response, Bode plot construction and interpretation of system behaviour, gain margin & phase margin, relation between time domain & frequency domain specification, SSE characteristics from frequency response, P, PI and PID Controllers and their tuning.

Self-study: Topics related to safety and risk measures for industrial control system from

- Dave Macdonald, Practical Industrial Safety, Risk Assessment and Shutdown Systems for Industry, 2004.
- Yasushi Nakagawa, Functional Safety in Industrial Automation, 2022.

References:

1. Norman S. Nise, Control Systems Engineering, (6e), Wiley India, 2010
2. R.C Dorf, R. H. Bishop, Modern Control Systems, (12e), PEARSON, India, 2011.
3. B.C. Kuo, F. Golnaraghi, Automatic Control Systems, (10e), TMH, India, 2017.
4. K. Ogata, Modern Control Engineering, (5e), PEARSON, India, 2010.
5. M. Gopal, Control System: Principles and Practices, (4e), TMH, India, 2016.

MTE 2225: MICROCONTROLLER BASED SYSTEM DESIGN [2 1 0 3]

Microcomputer: Significance of Microcomputer Technology, Digital Vs Analog Computing and Types of Instruction set Computing. ARM Cortex M series: Introduction to ARM Cortex A series, Cortex R series & Cortex M series. Introduction to Cortex M4: Architecture, Memory Mapping, Types of registers. Instruction sets in assembly: Data Movement, Arithmetic, Logical, Memory addressing, Bitwise, Branching, and Subroutine. Calculation of delay. Introduction to Embedded C: C programming Vs Embedded C, GPIO, System Timer, NVIC, Watchdog Timer, Clock Select, Timer-32, Timer-A, PWM Generation, UART Communication. Case studies.

References:

1. Bai, Ying. Microcontroller Engineering with MSP432: Fundamentals and Applications. Crc Press, 2016.
2. Unsalan, Cem, H. DenizGurhan, and M. ErkinYucel. Programmable Microcontrollers: Applications on the MSP432 LaunchPad. McGraw Hill Professional, 2017.
3. MSP432 Manual by Texas Instrumentation.

MTE 2241: CAD AND KINEMATICS' SIMULATION LAB [0 0 3 1]

2D sketcher exercises of simple machine components, solid modeling and assembly exercise of machine components like 6 axis robot, CPU fan, bench vice, screw jack. Kinematic analysis of simple mechanisms like slider crank mechanism, 4 bar mechanism, cam and follower mechanism.

Self-study: Udemy course entitled Complete CATIA V5 express training.

References:

1. Gopalkrishna K. R., Machine Drawing, Subhas Publications, Bangalore, 2002.
2. Bhat N.D., Machine Drawing, Charotar Publishing House, Anand, 2002.
3. Venugopal K., Engineering drawing and graphics + Auto CAD, Newage International ublishers, Delhi 2002.
4. Narayana K.L. and Kannaiah P, Text Book on Engineering drawing, Scitech Publications, Chennai 2002.

MTE 2242: MICROCONTROLLER LAB [0 0 3 1]

Introduction to Keil software, Assembly programming: Familiarization of assembly instructions, Data Movement, Arithmetic, Logical instructions, Memory addressing, Bitwise, Branching instructions, and Subroutines. Introduction to Embedded C programming, GPIO programming, hardware interfacing, delay generation using SysTick Timer, Timer-32, PWM Generation using Timer-A, serial communication using UART, ARM controller based system design.

Self-study: Risk and safety assessment for microcontroller-based system.

References:

1. Bai, Ying. Microcontroller Engineering with MSP432: Fundamentals and Applications. CRC Press, 2016.
2. Unsalan, Cem, H. DenizGurhan, and M. ErkinYucel. Programmable Microcontrollers: Applications on the MSP432 LaunchPad. McGraw Hill Professional, 2017.
3. MSP432 Manual by Texas Instrumentation.

https://www2.keil.com/mdk5/uvision/.

MTE 2243: SENSORS AND PLC LAB [0 0 3 1]

Behavior of inductive, magnetic, reflection light scanner, and one way barriers, reflection light barrier OBS and an ultrasonic sensor. Path power characteristic curve of inductive analog encoder, reduction factor of reflection light scanner OJ, fitted with an optical waveguide. Response curve of inductive sensor, capacitive sensor, magnetic field sensors. Switching frequency and switching distance and hysteresis of NBN, CJ, MB, OJ. Calculation of maximum admissible velocity of an object using ultrasonic sensor. Introduction of PLC, study basic components, networking and different programming technique. Of PLC. Study NO, NC and holding circuit programs, Implement of Simple Ladder program, to study basic functions of timers, counters, math, logical and program control instructions. Study different applications using ladder logic.

Self-study: Siemen and Allen Bradely manual

https://instrumentationtools.com

References:

1. Siemens PLC manual, Siemens.
2. PLC training practice module, BOSCH REXROTH manual Germany 2011.
3. John W. Webb and Ronald A. Reiss, Programmable logic controllers-Principle and applications, (5e), PHI, 2005.
4. Sensorics training system practice module, BOSCH REXROTH manual, Germany 2011.
5. Sensors in theory and practice, BOSCH REXROTH AG Germany 2007.

FIFTH SEMESTER

HUM 3021: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [2 1 0 3]

Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of Single, Uniform, and Gradient cash flow. Related problems and case studies. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with return, Rate of return method, Incremental approach for economic analysis of alternatives, Replacement analysis. Break even analysis for single product and multi product firms, Break even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight line depreciation, declining and double declining balance method of depreciation, Sum-of-the-Years Digits, Sinking Fund and Service Output Methods, Case Study. Balance sheet and profit & loss statement. Meaning & Contents. Ratio analysis, financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios, Drawbacks. Safety and Risk, Assessment of Risk and safety, Case study, Risk Benefit Analysis and Reducing Risk.

References:

1. Chan S. Park, "Contemporary Engineering Economics", 4th Edition, Pearson Prentice Hall, 007.
2. Thuesen G. J, “Engineering Economics”, Prentice Hall of India, New Delhi, 2005.
3. Blank Leland T. and Tarquin Anthony J., “Engineering Economy”, McGraw Hill, Delhi, 2002.
4. Prasanna Chandra, “Fundamentals of Financial Management”, Tata McGraw Hill, Delhi, 2006.
5. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.
6. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.

MTE 3121: DIGITAL SIGNAL PROCESSING [2 1 0 3]

Introduction to Signal Processing, operations on signals, Properties of signals and systems, Impulse Response and convolution, Sampling, Aliasing, Transform domain analysis of discrete-time systems: Z Transform and application of Z transforms, Discrete Fourier Transform, Fast Fourier Transform. Digital Filter Characteristics and structures, IIR Filter Design using Butterworth approximations. Bilinear transformation methods. FIR Filter Design using Window method. Applications of digital signal processing- speech, image, video, communication, acoustics and vibration.

References:

1. Oppenheim A.V, Willsky A.S, *Signals and Systems*, (2e), PHI,2011.
2. Oppenheim A.V. and R.W. Schafer, *Discrete time signal processing*, (2e), Prentice-Hall, 2001.
3. Proakis J.G. and D.G. Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, (3e), PHI, 2007.
4. SanjitK.Mitra, Digital Signal Processing – A computer-based approach(4e), McGrawHill Education, 2013.

MTE 3122: ELECTRIC DRIVES [3 1 0 4]

Fundamentals of electric drives, basic components, advantages, closed loop control, speed, torque conventions, steady state equilibrium, and determination of motor power rating. Introduction to power electronics, Power Diode, SCR, BJT, MOSFET and IGBT, Uncontrolled and controlled rectifiers, loads, freewheeling diodes. Choppers, Inverters and AC-AC converters. DC motors, operating principles, torque speed characteristics, speed control concepts, Control of DC motor using choppers and controlled rectifiers. AC motors, three phase induction motors, operating principles, torque speed characteristics, speed control, single phase induction motors, synchronous motors, linear induction motors, PM synchronous motors, BLDC motors, switched reluctance motors and synchronous reluctance motors. Servo motors, stepper motors and universal motors.

Self-study:

1. Advanced Power Semiconductor devices: SiC and GaN and their advantages and applications.
2. Advanced Motors: Axial motors, Hub Motors

References:

1. Gopal K. Dubbey, *Fundamentals of Electric Drives*, (2e), Narosa Publishers, 2010.
2. Bimbra P.S., *Power electronics*, (3e), Khanna Publishers, 2010.
3. P. C. Sen, *Principles of Electrical Machines,* (3e), Wiley, 2020.
4. R. Krishnan, *Electric Motor Drives Modeling, Analysis, and Control*, (2e), Prentice Hall, 2012.
5. L. Umanand, *Power Electronics: Essentials & Applications,* Wiley 2009.

MTE 3124: HYDRAULICS AND PNEUMATICS SYSTEMS [3 0 0 3]

Introduction to pneumatic systems: Structure and signal flow, Applications of pneumatic systems, Pneumatic power pack, Air reservoir, Air generation and Distribution, different types of compressor, Constructional details and working of filter, lubricator and pressure regulator. Actuators and Control valves: Single acting and double acting cylinders, Air motor and types, comparison between Air and electric motor, Various types of poppet valve, spool and rotary direction control valves, Check valves, Dual pressure valve, shuttle valves, Time delay valves, Pressure sequence valves. Manual pneumatics: Traverse time diagram, Design of pneumatic circuits using classic, Cascade and Step counter approaches. Electro-pneumatics components and sensors: Electrically actuated direction control valves, Relay control systems, Application circuits using electronic sensors. Logic circuit design using K-V mapping. Introduction to Hydraulic systems: Physical principles of oil hydraulics, Hydraulic power pack, Types of hydraulic pumps: Hydraulic actuators, valves and accessories. Pressure control valves. Hydraulic circuits: Regenerative, meter in, meter out, bleed off, Sequencing, pressure reducing circuits, electrohydraulic circuits.

References:

1. Anthony Esposito, Fluid power with applications, Pearson Education, 2003.
2. Andrew A. Parr, Hydraulics and Pneumatics, Elsevier Science & Technology Books, (3e), 2011.
3. Scholz D., Proportional Hydraulics, Festo Didactic GMBH & Co, Germany, 2002.
4. Majumdar S.R., Pneumatic Systems - Principles and Maintenance, Tata McGraw Hill, 2000.
5. Merkle D., Rupp K. and Scholz D., Electrohydraulics Basic Level TP 601, Festo Didactic GMBH & Co, Germany, 1994.

FLEXIBLE CORE-1

MTE 3123: MANUFACTURING TECHNOLOGY [3 0 0 3]

Over View of Manufacturing process: Types of manufacturing processes and their operating principles, tooling, quality issues in manufacturing processes. Computer Numerical Controlled Machines tools: Components of CNC Machines, Construction details of CNC machines, Machine structure, Guide ways, Spindle, Measuring systems, Drives and Controls. Configuration of CNC system, Interfacing, Monitoring, Diagnostics, Compensations for machine accuracy, Adaptive control CNC systems. Testing of CNC machines. Advanced Manufacturing techniques: Abrasive Jet Machining, Ultrasonic Machining, Electro Chemical Machining, Laser and electron beam machining, Electro Discharge Machining. Additive Manufacturing: Process Chain for Additive Manufacturing Processes, Benefits of Additive Manufacturing. Rapid Prototyping Data Formats Non – Manifold Conditions. Liquid Based Process. Application in design, engineering, analysis and planning, Application in manufacturing and tooling, automotive, biomedical industry, Application in jewellery, coin industry.

Self-study: Different applications based on manufacturing processes and case studies on methodologies involving various techniques for prototyping.

References:

1. C.K. Chua, K.F. Leong, C.S. Lim, Rapid Prototyping: Principles and Applications, (3e), 2010.
2. Gibson, I, Rosen, D W., and Stucker, B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2014.
3. Kalpakajain, Manufacturing Engineering and Technology, (4e), Addison Wesley, New York, 2014.
4. Hans B. Kief, Helmut A. Roschiwal, CNC Handbook, (1e), McGraw-Hill Education, 2012.

   Jagadeesha T, Non-Traditional Machining Processes, I K International Publishing House Pvt. Ltd, 2016.

ELE 3127: FOUNDATIONS OF EV & HYBRID VEHICLES [3 0 0 3]

Principles for Electric Vehicles: EV Industry, EV Technology and Automotive Revolution, Electrical Engineering for EV, Battery Technology

Control system for Electric Vehicles: Motor and Controller Systems, EV Numerical Calculations, EV Charging Infrastructure, Practical session - Well-to-wheel analysis of EV architecture

Essentials for Electric Vehicles: Electrical Requirement, Power Distribution Specifications, Electronic Control System, Practical session - EV connection and system analysis

Types of components in Electric Vehicles: EV Standards and Classifications, Selection for Electrical and Electronic Components, Practical session - EV hardware components

Principles for Hybrid Vehicles: Introduction to Hybrid Vehicles, Battery Chemistry, Efficiency, Definition and Parameters for Hybrid Systems, Electric Motors, Generators and Power Electronics for Hybrid Systems, Control Systems, Hybrid Electric Vehicle Operation, Practical session - Numerical study on powertrain sizing of HEV

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals", Routledge, 3rd Ed, 2021, ISBN: 9780367693930
3. Muhammad Ehsani, Mehrdad Ehsani, and Ali Emadi, "Electric Vehicle Systems Architecture and Standardization Needs", Reports of the PPP European Green Vehicles Initiatives, Springer, 2015.
4. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, 1st Ed, 2014, ISBN: 9781138072855.
5. Rodrigo Garcia-Valle and João A. Peças Lopes, “Electric Vehicle Integration into Modern Power Networks", Springer, 2013, ISBN: 978-1461401339.
6. Chris Mi and M. Abul Masrur, “Hybrid electric Vehicles, Principles and Applications with Practical perspectives”, WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6.
7. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

MTE 3141: DRIVES, CONTROLS AND MODELLING LAB [0 0 3 1]

Modeling of RL and RLC circuits, Power Electronics. Closed loop PID control. DC Motor Modelling and Control. AC Induction Motor Control. Industrial PLC Based PMSM motor control. V/f Control of Induction

Motor. PWM Based DC Motor Control. Advanced drives: BLDC, Switched Reluctance Motor, Stepper, Servo and Linear Motor Drives, AC Servo drives.

Self-study: Selection of power semiconductor devices as per applications. Impact of PID gains on control systems, Applications of closed loop controls.

References:

1. Drives and Control training system- Practice module, BOSCH REXROTH manual, Germany 2011.
2. Matlab Documentation, Mathworks.
3. PLC training practice module, BOSCH REXROTH manual Germany 2011.
4. John W. Webb and Ronald A. Reiss, Programmable logic controllers-Principle and applications, (5e), PHI.
5. Hackworth and Hackworth F.D, Programmable logic controllers-Programming Method and applications, Pearson, 2004.

MTE 3142: ROBOT OPERATING SYSTEM LAB [0 0 3 1]

Introduction to ROS2, Installation, Create ROS2 Workspace: Python and C++ Package, Object-Oriented Programming, ROS2 Nodes, Publisher/Subscriber, Custom, Experiments with Turtle Sim Package, Topics, Services, Actions, Parameters, Debug Tools in ROS2, Introduction to URDF, 3 axis manipulator design, Control of manipulator, 3 wheeled robot Design, Gazebo and RViz, Sensor Integration, Introduction to Moveit2, ROS2 Industrial Robots, Working with TurtleBot and UR5 using ROS2.

Self-study:

1. Basic knowledge of object-oriented programming in python or C++
2. Basic knowledge of robotics
3. Path planning algorithms, Coursera Course on Collaborative Robot Safety: Design & Deployment.

References:

1. AnisKoubâa, Robot Operating System (ROS), the complete reference, volume 1, Springer International Publishing, 2016.
2. AnisKoubâa, Robot Operating System (ROS), the complete reference, volume 2, Springer International Publishing, 2017.
3. Lentin Joseph, Robot Operating System for absolute beginners, Apress Media LLC, 2018.
4. Wyatt Newman, A systematic approach to learning robot programming with ROS, Chapman and Hall, 2017.
5. Joseph Howse, Prateek Joshi, Michael Beyeler, OpenCV_Computer Vision projects with Python, Packt Publishing, 2016.
6. Alvaro Morena, Artificial Vision and Language Processing for Robotics, Packt Publishing, 2019. https://wiki.ros.org/.

SIXTH SEMESTER

HUM 3022: ESSENTIALS OF MANAGEMENT [2 1 0 3]

Definition of management and systems approach, Nature & scope. The Functions of managers, Principles of Management. Planning: Types of plans, steps in planning, Process of MBO, how to set objectives, strategies, policies and planning premises, Strategic planning process and tools. Nature and purpose of organizing, Span of management, factors determining the span, Basic departmentation, Line and staff concepts, Functional authority, Art of delegation, Decentralization of authority. HR theories of planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership – leadership behavior & styles, Managerial grid. Basic Control Process, Critical Control Points & Standards, Budgets, Non-budgetary control devices. Profit and Loss control, Control through ROI, Direct, Preventive control. PROFESSIONAL ETHICS - Senses of Engineering Ethics, Variety of moral issues, Types of inquiry, Moral dilemmas, Moral Autonomy, Kohlberg's theory, Gilligan's theory, Consensus and Controversy, Models of professional roles, Theories about right action, Self-interest, Customs and Religion, Uses of Ethical Theories. GLOBAL ISSUES - Managerial practices in Japan and USA & application of Theory Z. The nature and purpose of international business & multinational corporations, unified global theory of management, Entrepreneurship and writing business plans. Multinational Corporations, Environmental Ethics, Computer Ethics, Weapons Development, Engineers as Managers, Consulting Engineers, Engineers as Expert Witnesses and Advisers, Moral Leadership, Code of Conduct, Corporate Social Responsibility.

References:

1. Harold Koontz & Heinz Weihrich (2020), "Essentials of Management", McGraw Hill, New Delhi.
2. Peter Drucker (2004), "The practice of management", Harper and Row, New York.
3. Vasant Desai (2007), "Dynamics of entrepreneurial development & management", Himalaya Publishing House.
4. Poornima M Charantimath (2006), "Entrepreneurship Development", Pearson Education.
5. Mike W. Martin & Ronald Schinzinger (2003), "Ethics in engineering", Tata McGraw Hill, New Delhi.
6. Govindarajan M, Natarajan S, & Senthil Kumar V S (2004), "Engineering Ethics", Prentice Hall of India, New Delhi.
7. R. S. Nagarazan. (2004), "A text book on professional ethics and human values", New age international publishers, New Delhi.

MTE 3221: ENERGY AND HEAT TRANSFER [3 0 0 3]

Properties of pure substances and ideal gases, First and second laws of thermodynamics, Energy conversion by cycles, Power-absorbing and power producing cycles. Fluids and Their Properties, Fluid Pressure and Its Measurement, Hydrostatics, Buoyancy and Floatation, Kinematics of Fluid Flow, Venturiemeter and Pitot Tube, Small and Large Orifices, Applications of the Momentum equation, Flow Through pipes, Heat Transfer: Introduction to heat transfer, General Law of Heat Conduction, Steady state one dimensional heat conduction with and without heat generation, Heat Transfer from Extended Surfaces, Heat Transfer by Forced convection and Free convection, Radiation, Heat Exchangers, Cooling of Electronic equipment.

Self-study: Risk mitigation, and safety for Vapor compression cycle and heat exchangers for refrigeration and thermal power plants and industry.

References:

1. Cengel Y Al and Boles M A, Thermodynamics, An Engineering

Approach, Tata Mc Graw Hill, 2003.
2. Michael J Moran, Fundamentals of Engineering Thermodynamics, Wiley India Pvt. Ltd., 2010.
3. Munson B R, Young D F and Okiishi T H, Fundamentals of Fluid Mechanics, John Wiley & Sons., Singapore, 2006
4. Kumar D. S, Fluid Mechanics and Fluid Power Engineering, Kataria S K and Sons, New Delhi, 2010.
5. Yunus A. Cengel, Heat Transfer: A Practical Approach, Tata McGraw Hill Inc., New Delhi, 2005.

FLEXIBLE CORE -2

ELE 3225: AUTOMOTIVE MECHANICS FOR ELECTRIC VEHICLES [3 0 0 3]

Automotive Engineering & Vehicle Dynamics: Vehicle Dynamics Fundamentals, Tire Mechanics and Dynamics, Suspension Systems, Braking Systems, Aerodynamics, Powertrain Systems, Vehicle Stability Control, Vehicle Safety, Vehicle Dynamics Simulation, Electric and Hybrid Vehicle Dynamics, Practical session - EV Dynamics & calculations.

Sketching for Automotive EV Design [Software-based]: Introduction to Automotive Sketching Software, Overview of Vehicle Design Process and Automotive Sketching, Basic Sketching Techniques and Tools in the Software, Sketching Car Exteriors, Interiors and Details, Creating Different Views and Angles of the Vehicle, Rendering and Presenting the Final Sketches, Understanding Proportions, Perspectives and Shapes in Automotive Sketching, Creating Sketches for Different Vehicle Types (Sedans, SUVs, and Trucks), Tips and Tricks for Automotive Sketching in the Software.

Advanced EV Modelling Using Solid Works Tool [Software-based]: Introduction to EV Technology and Its Benefits, Basic Vehicle Design Principles, Design and Modelling of Chassis and Frame, Suspension Systems, Design and Modelling of Braking and Steering Systems, Design and Modelling of Electrical Components for EVs, Battery Pack Design and Modelling for 2, 3 and 4 Wheelers, Motor and Drivetrain Design and Modelling for 2, 3 and 4 Wheelers, Design and Modelling of Wheels and Tires for 2, 3 and 4 Wheelers, Testing and Simulation of Vehicle Performance Using Solid Works, Design for Manufacturability and Assembly Considerations, Sustainability and Environmental Impact Considerations in EV Design, Practical session - EV hardware components walkthrough.

Multibody Dynamics with MSC Adams [Software-based]: Introduction to MSC Adams Software and Its Capabilities, Setting Up the Modelling Environment in MSC Adams, Multi-body Dynamics Principles and Application to Vehicle Systems Modelling, Vehicle Suspension Systems Modelling, Vehicle Steering Systems Modelling, Vehicle Braking Systems Modelling, Practical session - EV Component design & modeling.

EV Analysis with MSC Adams (Software-based): Tire Force and Characteristics Modelling, Vehicle Dynamics Analysis Including Simulating Ride and Handling, Vehicle Stability and Rollover Events, Optimisation Techniques for Vehicle Designs Using MSC Adams, Integration of MSC Adams Models with Other Software Tools for System-level Simulations and Analysis, Practical session - EV body design analysis.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", Wiley, 2nd ed, 2012, ISBN: 978-1-119-94273-3.
2. Du, H., Cao, D., & Zhang, H. (n.d.). “Modelling, Dynamics, and Control of Electrified Vehicles”, Woodhead Publishing, 2017, ISBN-13: 9780128127865
3. Zaman N., “Automotive Electronics Design Fundamentals”, Springer, 2015, ISBN-13: 9783319359793
4. Gianfranco Pistoia, “Electric & Hybrid Vehicles”, Elsevier, 1st ed, 2010, ISBN: 9780444638250.
5. Chau, K. T., “Electric Vehicle Machines and Drives: Design, Analysis and Application”, John Wiley and Sons, Inc., 2015, ISBN-13: 9781118752524.
6. Ehsani, Mehrdad, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles”, CRC, 2019, ISBN-13: 9780367137465.
7. Hughes, Austin, “Electric Motors and Drives”, Newnes (an Imprint of Butterworth-Heinemann Ltd), 2019, ISBN-13: 9780081026151
8. Chris Ni and M. Abul Masrur, “Hybrid electric Vehicles, Principles and Applications”, WILEY, 2nd Ed, 2017, ISBN: 978-1-118-97054-6
9. "Introduction to Electric Vehicles" - offered by IIT Delhi on NPTEL Link: https://archive.nptel.ac.in/courses/108/106/108106170/

MTE 3222: AUTOMOBILE ENGINEERING [3 0 0 3]

Introduction to automobile engineering: vehicle construction and layouts, chassis, frame and body. Vehicle power supply systems. Transmission systems, clutch types & construction, gear boxes-Hydrodynamic Clutches, Torque Converter. Heating and air conditioning systems. Steering geometry and types of steering gear box, power steering, types of front axle, types of suspension systems, pneumatic and hydraulic braking systems. Desirable tyre properties, conventional tubed & tubeless tyre. Noise vibration and harshness in automobiles, Fundamentals of regenerative braking. Bearing and lubrication systems, environmental management and service information systems. Electrical and lighting systems, Industrial Fabric, ergonomics and safety standards in automotive industry.

References:

1. Jack Erjavec, Rob Thompson, Automotive Technology - A Systems Approach, Cengage (7 e), 2018.
2. Richard Stone, Jeffrey K. Ball, Automotive Engineering Fundamentals, SAE International (1e), 2004.
3. Trelle Borg, Automotive Vibration Control Technology: Fundamentals, Materials, Construction, Simulation, and Applications (1e), Vogel Business Media GmbH & Co. KG, 2015.
4. Kripal Singh, Automobile Engineering (4e), Vol-1 and 2, Standard Publishers, Delhi, 2011.
5. Robert Fischer, FeritKüçükay, Gunter Jürgens, Rolf Najork, BurkhardPollak, Automotive transmission book (4e), Springer International Publishing Switzerland 2015.

MTE 3241: HYDRAULICS LAB [0 0 3 1]

Working principles of hydraulic pumps, hydraulic motors, pressure switch, pressure reducing valve, accumulator, proximity switch, throttle valves, pressure compensated flow control valves and direction control valves. Rigging of manual and electro hydraulic circuits using above components. Working principle of Proportional direction control valve, Proportional pressure relief valve, command value module, proximity switches. Rigging of proportional hydraulic circuits using above components.

References:

1. Industrial Hydraulics Trainee's manual, BOSCH REXROTH manual, Germany 2011.
2. Proportional valve technology Trainee's Manual BOSCH REXROTH manual, Germany 2014

MTE 3242: IIOT LAB [0 0 3 1]

Computer Networking fundamentals. Simulation of network devices viz., hub, switch and router using Cisco packet Tracer. Simulation of IIoT environment using Cisco Packet tracer. Operation of MSP432 microcontroller from TI. Interfacing of communication booster packs for Wi-Fi and Radio communication. Sensor data logger using STM32 microcontroller.

Self-study: CourseEra course entitled: The Bits and Bytes of Computer Networking

References:

1. MSP432 Manual by Texas Instrumentation.
2. STM32 Manual by STMicroelectronics

MTE 3243: PNEUMATICS LAB [0 0 3 1]

Operations of various valves like directional control valves, flow control valves, pressure control valves and switches like pressure switches, proximity switches. Operations of timers and counters. Rigging of manual pneumatic and electro-pneumatic circuits using above valves and switches. Closed loop Pneumatics: Constant pressure control, Force control, Basics of PID control, Electro-pneumatic control with spring, Properties of electro-pneumatic control with spring.

Self-study: Working of PID controllerand its application in closed loop pneumatic circuits

References:

1. Practice for Professional Pneumatics Trainee's manual, BOSCH REXROTH manual, Germany 2011.
2. Practice for Professional Electro-Pneumatics Trainee's manual, BOSCH REXROTH manual, Germany 2011.
3. Training system for pneumatics, Bosch Rexroth manual, Germany 2014

SEVENTH SEMESTER

There are five program electives and one open elective with total of 18 credits to be taught in this semester.

EIGHTH SEMESTER

MTE 4291: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

MTE 4292: PROJECT WORK/PRACTICE SCHOOL

The project work may be carried out in the institution/industry/ research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out, before the department committee as part of project evaluation.

MINOR SPECIALIZATIONS

ELECTRIC VEHICLE TECHNOLOGY

ELE 4415: EV BATTERY TECHNOLOGY AND POWERTRAIN DEVELOPMENT [3 0 0 3]

Basics of Batteries, Battery Parameters, Lithium-Ion Characteristics, Thermal Runaway Battery Management System (BMS), Functionality, Practical session - Battery Selection and Connection Process with Vehicle Sensors. SOC/SOH Estimation, Cell Balancing, Protection, Thermal Management, CAN Communication. Practical session - BMS development. Overview of Battery & BMS System, Electrical Design, Mechanical Design: Calculations and Mechanical Design using ANSYS, Heat Transfer, Thermal Design of Battery Pack, Battery Pack Assembly and Test, Thermal Analysis on Battery Pack, MATLAB/Simulink-based Battery Pack Modelling. Practical session - Battery life cycle testing. Introduction to EV Powertrain, Overview, Architecture and Components of EV Powertrain, Thermal Management of EV Powertrain , EV Charging Systems and Types of Chargers. Modelling and Simulation of EV Powertrain Components in MATLAB, Modelling and Analysis of EV Powertrain Components in SolidWorks, Analysis of EV Powertrain Components in ANSYS, Case Study on Powertrain of Existing Models.

References:

1. James Larminie and John Lowry, “Electric Vehicle Technology Explained", 2nd Edition, Wiley-Blackwell, 2012.
2. Sandeep Dhameja, “Electric Vehicle Battery Systems”, Newnes Publisher, 1st Edition, 2001.
3. Christopher D. Rahn, “Battery Systems Engineering” 1st edition, Wiley, 2013.
4. Bruno Scrosati , K. M. Abraham , Walter A. van Schalkwijk , Jusef Hassoun, “Lithium-Ion Batteries: Advanced Materials, Technologies, and Applications” 2nd Edition, Wiley-Blackwell, 2013.
5. Emma Briec, Beate Müller, “Electric Vehicle Batteries: Moving from Research towards Innovation” 1st Edition, Springer International Publishing AG, 2016.

AEE 4420: EV PRODUCT DEVELOPMENT, HOMOLOGATION & HYDROGEN FCEV [3 0 0 3]

Introduction to EV (2W, 3W & 4W) Market and Opportunities, Electric Vehicle Design Procedure and ICE Model, Introduction to EV Management (Categories, Regulations and Standards), EV Homologation and Testing, FAME India and Manufacturing Guidelines, EV Certification Process, EV Charging, Electric Vehicles and Retrofitting, Motor Technology and EV Motor Market Analysis, EV Categories and Proposed Changes, EV Retrofitting Business, Battery Technology in EV, EV Battery Market Analysis, Practical session - Conducting a market analysis of the EV industry, Introduction to Product Development Plan, Segment Selection, Product Design Plan, Product Validation Plan, Vehicle Dynamics Selection, Product Design Validation, Product Specification - Competitor Analysis, Selection of Off-the-Shelf Parts, Development Methods, Product Development Plan, Unit Economics, Design Feasibility, Design for Manufacturing, DFMEA and PFMEA, Business Plan, Product Launch, POC/MVP/Working Prototype, Practical session – Using the market research to develop a business plan for an EV manufacturer, Introduction to Future Mobility, Why Hydrogen-based Technology, Essentials of Hydrogen, How Does Hydrogen Compare to Hydrocarbon Fuels in Terms of Energy, Flammability and Safety, Hydrogen Fuel Cells, Use of Hydrogen in IC Engines, Hydrogen Fuel Cell Techniques and Systems, Fuel Cell Engine Safety and Maintenance, Fuel Cell Hybrid Electric Vehicle Acts, Codes, Regulations and Guidelines, Maintenance and Fuelling Facility Requirements, Fuel Cells in Hybrid Electric Vehicles and Pure Electric Vehicles, Auxiliary Power Generation Using Hydrogen, Types of Fuel Cells and Techniques Used, Fuel Stack Module Construction, Fuel Cell Performance, Characteristics, Polarisation, Stoichiometry Effects, Temperature and Pressure Effects, Practical session – Study on Hydrogen fuel cell with MATLAB/SIMULINK.

References:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained", 2nd Edition,Wiley-Blackwell, 2012.
2. Tom Denton, "Electric and Hybrid Vehicles"2nd Edition, CBS Publisher, 1905.
3. Chris Mi, M. Abul Masrur & David Wenzhong Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives" 2nd Edition, Wiley Publications, 2017.

ELE 4417: EV VEHICLE DESIGN & ANALYSIS [3 0 0 3]

Introduction to Basic Electronics, Diode Fundamentals, Rectifiers and Filters, Power Electronics for EVs: Voltage Regulators, Inverters and Converters, Special Purpose Diodes, Transistors and Types of Transistors, Operational Amplifier (Op-Amp). Digital Electronics, EV Control Systems, EV Communication Networks, Microcontrollers and Microprocessors, Introduction to Proteus Software, Circuit Development Using Proteus. Overview and Environment, Basic Syntax, Variables and Commands, Commands, M-files, and Types, Operators, Decision Making and Loops, Vectors, Matrix, and Arrays, Colon Notation and Numbers, Strings and Functions, Numbers, Plotting and Graphics, Algebra, Calculus, Differential, and Integration, Polynomials and Transforms, Programming EV Systems in MATLAB Simulink and Fitting, Developing SIMULINK Models for Vehicle Units, Advisor and QSS Toolbox, QSS-based Vehicle Control, Practical session - Analyze and troubleshoot electronic circuits using simulation tools and lab equipment.,Motor Development and Induction Motor Characteristics, Simulink Model to Calculate Vehicle Configuration, Multi-level Inverter Design and Simulation, Solar PV-based Charger Development, Dc-DC Converter, Modelling of Li-ion Battery Pack, Design of EV Using QSS Toolbox, Battery Thermal Modelling, BMS Modelling, Electric 4W Powertrain Modelling. Practical session- Data analysis and visualization using MATLAB for vehicle system. Power Required to Overcome Resistance Forces Acting on the Vehicle, Power Converters in Electric Vehicles, Inverters in Electric Vehicles, Motor and Motor Controllers, Modelling of EV Battery and BMS, Practical session - Modeling and simulation of EV powertrain components, such as motors, controllers, and inverters, using MATLAB/Simulink.

References:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained", 2nd Edition, Wiley-Blackwell, 2012.
2. Iqbal Husain, "Electric and Hybrid Vehicles: Design Fundamentals"2nd Edition,CRC Press, 2010.
3. Ali Emadi, "Advanced Electric Drive Vehicles","1stEdition,CRC Press, 2014.
4. Sandeep Dhameja, "Electric Vehicle Battery Systems", Newnes Publisher, 1st Edition, 2001.
5. Haitham Abu-Rub, Mariusz Malinowski, Kamal Al-Haddad, "Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications"1stEdition, Wiley-IEEE Press, 2014.
6. J Larminie"Electric Vehicle Technology"2nd Edition, Wiley-Blackwell, 2012.

AAE 4421: EV FEA ANALYSIS [3 0 0 3]

Theory of FEA/CAE, Introduction to HyperMesh, Creating and Modifying Geometry, Geometry Clean-up and Defeature, Introduction to 2D Meshing, Introduction to 3D Meshing, Element Quality, Mesh Edit, Introduction to Plastic Meshing, Introduction to 1D Meshing, Modal Analysis, Linear Static Analysis, Buckling Analysis, Connectors, Practical session-Optimization techniques using HyperMesh, Introduction to Abaqus Software, Fundamentals of FEA-Stress, About Abaqus Software-Features, Applications of Abaqus Software in Different Industries, Simple Modelling in Abaqus Software, Create Material and Create Assembly, Create Steps, Loads,, Boundary Conditions, Generate Mesh, Result Visualization, Practical session - Multiphysics analysis using Abaqus, One Dimensional Analysis, Linear Static Analysis and Linear Buckling, Analysis, Heat Transfer Analysis, Non-linear Analysis, Dynamic Simulation-Modal Analysis, Impact Analysis, Time-Dependent Load Analysis, Basics of Finite-Element Analysis (FEA) along with ANSYS Tool and Software Interface, Essential Mechanical and Electrical Properties of Materials, Various Case Studies on ANSYS Mechanical, Basics of Computational Fluid Dynamics (CFD), Various Case Studies on ANSYS Fluent, Practical session - FEA analysis using ANSYS, Simulation of Battery Thermal Management in Electric Vehicle, Vibration and Fatigue Analysis of Battery Pack, Simulation of Structural Integrity for Motor Mount, Thermal Analysis of Liquid-Cooled Radiator, CFD Study of External Cooling Mechanism for Battery Pack, Practical session - Vulnerability analysis.

References:

1. James Larminie and John Lowry, "Electric Vehicle Technology Explained", 2nd Edition,Wiley-Blackwell, 2012.
2. ErikSchaltz, "Electrical Vehicle Design and Modeling" 1st Edition, InTech Publisher, 2011.
3. J Larminie, "Electric Vehicle Technology", 2nd EditionWiley-Blackwell, 2012.
4. Jeff Strain, Ted Harris, Eric Miller, "Introduction to the ANSYS Parametric Design Language (APDL)", 2nd Edition PADT, Inc., 2019.
5. Abaqus Analysis User's Guide by Dassault Systems Publisher: Dassault Systems ISBN: N/A (Available as part of the Abaqus

documentation).

6. Patrick J. Roache, “Fundamentals of Computational Fluid Dynamics”Hermosa Pub., Revised Edition, Roache Publisher, Revised Edition, 2003.

MTE 4076: HEAVY VEHICLE TECHNOLOGY [3 0 0 3]

Fundamentals of Heavy Vehicle Technology, Trends and challenges in heavy vehicle engineering. Vehicle Propulsion Systems, Powertrain, Engine Management, Layout, Components of engine systems. Power Management, Power Components. Vehicle Transmission Systems, Gearboxes, Clutch Units, Retarders, Axles, Propeller shafts, etc. Vehicle Braking System, Pneumatics brakes, Hydraulics brakes, Braking circuits, Service Braking vs Auxiliary Braking, and Environmental Impact. Vehicle Axles & Steering system. Vehicle Suspension & Chassis. Vehicle Cabin Overview; Regulation; Crash Safety, Vehicle transport management; Heavy Vehicle Electrical and Electronics. Vehicle Auxiliary Equipment & Functions. Fuel cell technology for Heavy Vehicles, Diagnostic Fault Tracing, Troubleshooting common issues in heavy vehicles, Case studies.

References:

1. Light and Heavy Vehicle Technology, M.J. Nunney, Elsevier, Fourth Edition 2006.
2. Automotive Technology, Jack Erjavec, Cengage Learning, Fifth Edition, 2009
3. Motor Automotive technology, Anthony E. Schwaller, Delmar, Third Edition, 1998.
4. Automotive suspension and steering systems, Thomas W. Birch, Delmar Cengage Learning, Third Edition, 1998.

MTE ****: DIGITAL TWINS FOR MECHATRONICS [3 0 0 3]

Overview of Digital Twins, Types, Architecture and workflow, applications; Data base management and acquisition systems, DAQ - Interfacing with microcontroller using EMBED, IOT protocols, Edge deployment of vision algorithms, image processing and video analytics; Physics based Twins - System Dynamic Theory/ State Space equations, basic system modelling, hybrid modelling approach, mathematical scripting; Surrogate modelling approach to Digital Twins - Engineering data science approach, Deep learning methods for fast physics predictions for 2D/3D models, Reduced order modelling (ROM) and fast optimization, Twin deployment for physical dynamic systems. System identification and parameter estimation techniques; Data based twins : Linear and Logistic Regression, Gradient Descent Algorithm, Decision Tree, K-Means Clustering, Neural Network & Deep Learning Techniques for training models. Industrial use cases; Overall integration and deployment - Sensor related challenges, Detection and diagnosis of faults, Overall hybrid integration of physics and AI models & anomaly detection, applications of integration in different industries, Machinery failures, basic maintenance strategies.

References

1. Digital Twin: A Complete Guide for the Complete Beginner, by Vijay Raghunathan, Santanu Deb Barma, November 2019.
2. Digital Twins: Internet of Things, Machine Learning, and Smart Manufacturing by Yogini Borole, PradnyaBorkar, Roshani Raut, Vijaya Parag Balpande, Prasenjit Chatterjee, Walter de Gruyter GmbH & Co KG, Sept 2023.

Reference from Altair:

- https://altair.com/one-total-twin
- https://altair.com/blog/articles/overview-what-is-digital-twin-technology?_gl=1*1a0wy0f*_gcl_aw*R0NMLjE3MzQzNTA2NTEuQ2owS0NRaUF2UC02QmhEeUFSSXNBSjN1djdidEw3Q25vOEVRdVRNdHJ0Y2JBT1EybkFzRnVZR1NpTkpKNW0zY1BITlJzVlJQWGx3dm9HY2FBcG9PRUFMd193Y0I.*_gcl_au*Njc4NzA5MDEuMTczMzgwOTYwOA..
- https://altair.com/digital-twin
- https://altair.com/resourcelibrary?trend=Digital%20Twin
- https://altair.com/resource/transform-development-with-altair-digital-twins?lang=en

MTE 4401: AUTOTRONICS [3 0 0 3]

Fundamentals of automotive electronics, components for electronic engine management, sensors & actuators, digital engine control system, fuel control maps, SI engine management - injection system controls layout and working of monojetronic, l-jetronic and lh-jetronic, three way catalytic converter, CI engine management- fuel injection system, parameters affecting combustion, noise and emissions in CI engines, vehicle motion control and stabilization systems, vehicle motion control - adaptive cruise control, electronic transmission control, vehicle stabilization system - antilock braking system, traction control system, electronic stability program, onboard diagnosis system, future automotive electronic systems.

References:

1. Young, Griffitns, Automobile electrical & electronic equipments, Butterworths, London, 2010.
2. Wiliam B. Ribbens, Understanding automotive electronics, (5e), Newnes, Butterworth– Heinemann, 2009.
3. Robert Bosch, Diesel engine management, (3e), SAE Publications, 2004.
4. Robert Bosch, Gasoline engine management, (2e), SAE Publications, 2004.
5. Robert Bosch GmbH, Automotive electrics and automotive electronics, John Wiley and Sons 2008.

MTE 4402: HYBRID AND ELECTRIC VEHICLES [3 0 0 3]

History of Hybrid and Electric Vehicles technology, Economics and Environmental aspects of vehicle technologies. Vehicle dynamics-vehicle resistance, dynamic equation, tire ground adhesion, maximum tractive effort, vehicle speed, transmission characteristics, vehicle performance. Hybrid and electric drive trains-configurations of electric vehicles, traction motor characteristics, basic concept of hybrid traction, hybrid drive train architecture – series, parallel torque and speed coupling. Electric propulsion unit: different motors, configuration and control of dc and induction motor drives, introduction to power modulators, control, advanced motor drives for EV: PMSM, BLDC, SRM and SyncRel Motor drives. Energy storage, regenerative breaking, classification of different energy management strategies, fundamentals of regenerative braking. Sizing the drive system- propulsion motor, sizing the power electronics, selecting the energy storage technology, communications, supporting subsystems. Hybridness, PHEV, Range extension vehicles, Control of Hybrid and Electric vehicles: ECU, CAN-bus, Vehicle Dynamics Control. Charging stations. Design of series hybrid drive train.

Self-study:

1. Case studies on types of Hybrid vehicles available in Market.
2. Case studies on Solar Powered vehicles.
3. New Sodium Ion Battery technology using SiC and GaN devices.

References:

1. MehrdadEhsani, Modern Electric, Hybrid Electric and Fuel Cell Vehicles- Fundamentals, Theory and Design, (3e), CRC Press, 2018.
2. Iqbal Hussein, Electric and Hybrid Vehicles-Design Fundamentals, (2e), CRC Press, 2010.
3. Gianfranco Pistoia, Electric and Hybrid Vehicles - Power Sources, Models, Sustainability, (2e), CRC Press, 2010.

MTE 4403: VEHICLE DYNAMICS [3 0 0 3]

Introduction to Vehicle System Dynamics: Theoretical background on Vehicle Dynamics and control, Fundamental approach to Vehicle modelling. Longitudinal dynamics: Vehicle Load Distribution – Acceleration, Brake Force Distribution, Braking Efficiency and Braking Distance, Braking, Semi-Trailer. Tire Mechanics: Introduction, Mechanical Properties of Rubber, Slip, Grip and Rolling Resistance, Tire Construction and Force Development, Contact Patch and Contact Pressure Distribution, Tire Brush Model, Lateral Force Generation – Ply Steer and Conicity, Tire Models – Magic Formula, Classification of Tyre Models, and Combined Slip. Lateral Dynamics: Introduction, Bicycle Model, Stability, and Steering Conditions, Effect of road loads on Dynamics of Vehicle – Aerodynamics, rolling resistance, Total road load, Under-steer Gradient and State Space Approach, Parameters affecting vehicle handling characteristics, Subjective and Objective Evaluation of Vehicle Handling and Rollover Prevention. Vertical Dynamics: Introduction, Quarter Car Model, Half Car Model. Introduction to Automotive Safety: Basic concepts, risk evaluation, basic models, accident avoidance, occupant injury prevention, human simulation applications, crash testing, special design models, future vehicle safety.

Self-study: Industrial standard related to automotive safety. Advancement in human comfort and safety in automobile.

References:

1. Thomas D. Gillespie, Fundamentals of Vehicle Dynamics, SAE International 1997.
2. Reza N. Jazar, Vehicle dynamics: theory and application. Springer, 2017.
3. Hans B. Pacejka, Tire and Vehicle Dynamics, Elsevier, 2012.
4. George Peters, Barbara Peters, Automotive Vehicle Safety, CRC Press, 2002.
5. J Y Wong, Theory of Ground Vehicles, John Wiley & Sons Inc., 2001.

MTE 4404: MODELLING OF HYBRID AND ELECTRIC VEHICLES [3 0 0 3]

Introduction to Vehicle Propulsion and Powertrain Technologies: Objectives of vehicle propulsion control. Powertrain architecture and technologies. Importance of Powertrain Modelling and Models – Drivetrain. Motor design, modelling and simulation of drives for Electric Propulsion. Vehicle dynamics control. Modelling and Control of Battery Management Systems. Braking. Design and Control of Hybrid Electric Vehicles. Modelling and control of Fuel cell based EV.

Self-study: Case study on vehicle body drag coefficient modeling using FEM tools.Case study on Modeling of Hybrid and Electric Vehicle designs available in Market.

References:

1. Shuvra Das, Modeling for Hybrid and Electric Vehicles Using Simscape, Morgan & Claypool Publishers, 2021.
2. Tom Denton, Electric and Hybrid Vehicles, Taylor and Francis, 2020.
3. Mehrdad Ehsani, Modern Electric, Hybrid Electric and Fuel Cell Vehicles- Fundamentals, Theory and Design, (3e), CRC Press, 2018.
4. Gianfranco Pistoia, Behaviour of Lithium ion batteries in Electric Vehicles: Battery Health, Performance, Safety, Cost, (1e), Springer, 2018.
5. Amir Khajepour, Saber Fallah and Avesta Goodarzi, Electric And Hybrid Vehicles Technologies, Modeling And Control: A Mechatronic Approach, Wiley 2014.

INDUSTRIAL IoT SYSTEMS

MTE 4405: DATABASE MANAGEMENT SYSTEMS [3 0 0 3]

Introduction: Database-System Applications, Relational Databases, Data Storage and Querying, Transaction Management, Database Architecture, Database Users and Administrators. Relational Model: Structure of Relational Databases, Database Schemas, Keys, Relational Query Languages, Relational Operations. Database Design and The E-R Model: SQL: SQL Data Definition, SQL Data Types and Schemas, Integrity Constraints, Basic Structure of SQL Queries, Set Operations, Aggregate Functions, Nested Subqueries, Additional Basic Operations Null Values, Atomic Domains and First Normal Form, Decomposition Using Functional Dependencies, Functional Dependency Theory, Algorithms for Decomposition, Decomposition Using Multivalued Dependencies. Transaction Management: Transaction Concept. Data mining: Introduction, Association rules mining, market based analysis, Apriori Algorithm, Partition Algorithm, Pincer –Search Algorithm, Dynamic item set counting algorithm, FP-tree growth Algorithm, PC Tree, Multilevel association rules, Clustering Techniques: Introduction, Clustering paradigms, Partitioning Algorithms, k – Medoid & k- means Algorithms, CLARA, CLARANS, Hierarchical Clustering, DBSCAN.

Self-study: Topics related to Ethics in Database management from O'Keefe, O Brien, Ethical Data and Information Management: Concepts, Tools and Methods, (1e), Kogan Page, 2018.

References:

1. Silberschatz, Korth, Sudarshan, Database System Concepts, (7e), McGrawHill, New York, 2019.
2. Ramez Elmasri and Shamkant Navathe, Durvasula V L N Somayajulu, Shyam K Gupta, Fundamentals of Database Systems, (6e), Pearson Education, United States of America,2011.
3. Thomas Connolly, Carolyn Begg, Database Systems – A Practical Approach to Design, Implementation and Management, (4e), Pearson Education, England, 2005.
4. Peter Rob, Carlos Coronel, Database Systems–Design,

Implementation and Management, (10e), Course Technology, Boston , 2013.

5. Jiawei Han and Micheline Kamber, Data Mining Concepts and Techniques, Morgan Kauffmann Publishers, (2e), 2008.

MTE 4406: CYBER SECURITY FOR INDUSTRIAL AUTOMATION [3 0 0 3]

Introduction to Security; Characteristics of Information; Components of an Information system; Systems Development Life Cycle; Security Systems Development Life Cycle; The Need for Security-Business Needs First; Threats; Attacks; Intruders; Intrusion Detection; Malicious Software – Types, Viruses, Viruses Countermeasures, Worms; Introduction to Database security; SQL Injection, Reliability and Integrity; Sensitive Data; Inference; Multilevel Databases; Proposals for Multilevel Security; Designs of Multilevel Secure Databases; Transport-level Security – Web Security Issues, SSL, TLS, PGP, S/MIME; IP Security – IP Security Policy, Encapsulating Security Payload, Internet Key Exchange; The Need for Firewalls; Firewall Characteristics; Types of Firewalls; Cyber Crimes and Hackers – Cyber Crimes, Hackers, Types of Attacks, Dealing with the Rising Tide of Cyber Crimes, Indian Cyber Law Offences, IEC 62243 Compliance.

References:

1. William Stallings, *Cryptography and Network Security: Principles and Practice*, (7e), Pearson, 2017.
2. Michael E. Whitman and Herber J. Mattord, *Principles of Information Security*, (6e), Centage Learning India Publication, 2017.
3. Charles P Pfleeger and Shari Lawrence Pfleeger, *Security in Computing*, (5e), PHI, 2015.
4. Joseph Migga Kizza, *A Guide to Computer Network Security*, (3e), Springer International Edition, 2015.
5. Global Cyber Security Alliance, *Quick Start Guide: An Overview of ISA/IEC 62443 standards; Security of Industrial Automation and Control Systems*. ISA. 2022.

MTE 4407: INTERNETWORKING FOR INDUSTRIES [3 0 0 3]

Introduction to Computer Networks: Types of networks, Types of transmission media, Concept and types of Multiplexing, Concept and types of Multiple Access techniques, Principles and types of Analog and Digital Modulation. ISO/OSI model: Physical layer: Types of cables, Types of connectors, Communication standards, Data-Link layer, Network Layer: IPv4, IPv6, Routing and Subnetting, Transport Layer: TCP, UDP. Networks in Industrial Process Automation: Introduction to networks in Industrial Process Automation, Networks and Protocols: AS-i, CAN, DeviceNet, Interbus, LON, Foundation Fieldbus, HART, PROFIBUS-PA, BACnet, ControlNet, Industrial Ethernet, Ethernet/IP, MODBUS, PROFIBUS-DP. Fiber Optic Communication: Principles of Fiber-Optic networks, Types of Fiber-Optic cables, Fiber-Optic Network design, Fiber cable installation and setup, Splices and Connectors, Inspection and testing. Radio, Satellite and Infrared Communication: Radio systems, Spread Spectrum techniques, Satellite LANs, Communication bands in satellite communication, Infrared Systems, Very fast Infrared.

References:

1. Liptak, B.G. (Ed.), *Instrument engineers' handbook, Vol. 3: Process software and digital networks*, (4e) CRC Press, Boca Raton, London, 2012.
2. Andrew S. Tanenbaum, *Computer Networks*, (5e), Prentice Hall of India Pvt. Ltd., 2011.
3. William Stallings, *Data and Computer Communications*,(8e), Prentice Hall of India Pvt. Ltd., 2014.
4. James F. Kurose, Keith W. Ross, *Computer Networking (A Top-Down Approach Featuring the Internet)*, (3e), Pearson Education, 2005.
5. Todd Lammle, *Cisco Certified Network Associate-Study Guide*, (2e), Sybex Inc. Publishing. 2000.

MTE 4408: PRINCIPLES OF CRYPTOGRAPHY [3 0 0 3]

Introduction – Security Goals, Attacks, Services and Mechanisms, Mathematics of Cryptography – Euclidean Algorithm, Modular Arithmetic, Fermat's and Euler's Theorems, Testing for Primality, The Chinese Remainder Theorem, Classical Encryption Techniques – Symmetric Cipher Model, Substitution and Transposition Techniques, S-DES, DES, 2DES, 3DES, Modes of Operation, AES - Structure, Round Functions, Key Expansion, Stream Ciphers, RC4, Public-Key Cryptosystems, RSA Algorithm, Diffie-Hellman Key Exchange, ElGamal Cryptographic System, Cryptographic Hash Functions – Applications, Hash Functions based on Cipher Block Chaining, Secure Hash Algorithm, SHA-3, Message Authentication Requirements, Message Authentication Functions, Digital Signatures.

References:

1. William Stallings, Cryptography and Network Security: Principles and Practice, (7e), Pearson, 2017.
2. Behrouz A. Forouzan and Debdeep Mukhopadhyay, Cryptography and Network Security, (3e), McGraw Hill, 2015.
3. AtulKahate, Cryptography and Network Security, (3e), McGraw Hill, 2017.
4. Bruce Schneier, Applied Cryptography, (2e), John Wiley and Sons, Inc., 1996.

ROBOTICS AND AUTOMATION

MTE 4409: ARTIFICIAL INTELLIGENCE FOR ROBOTIC VISION [3 0 0 3]

Image Formation, Linear Filtering, Correlation, and Convolution, Visual Features: Edge, Blobs, Corner Detection Algorithms, SIFT, SURF, HOG, Geometric transformation, Perceptron, Delta Learning Rule, Multi-layer Perceptron, Backpropagation, optimizers and Regularizers, data augmentation, Introduction to CNN, Evolution of CNN Architectures: AlexNet, ZFNet, VGG, Inception Nets, ResNets, DenseNets, Background of Object Detection, CNN for Recognition and Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO, SSD, RetinaNet; CNNs for Segmentation: FCN, SegNet, U-Net, Mask-RCNN Review of RNNs; CNN + RNN Modls for Video Understanding,Deep Generative Models: GAN, Cycle-GANs, Progressive GANs, StackGANs, Pix2Pix Applications: Image Editing, Inpainting, Super-Resolution, Image Restoration, 3D Object Generation.

Prerequisite:

1. Probability, linear algebra, and calculus

2. Experience of programming in Python

References:

1. Good fellow, Ian, Yoshua Bengio, and Aaron Courville. Deep learning. MIT press, 2016.
2. Nielsen, Michael A. Neural networks and deep learning. San Francisco, CA, USA: Determination press, 2015.
3. Adrian Rosebrock, Deep Learning for Computer vision with Python-Starter Bundle, Pyimagesearch, 2017.
4. Adrian Rosebrock, Deep Learning for Computer vision with Python-Practitioner Bundle, Pyimagesearch, 2017.
5. Szeliski, Richard. Computer vision: algorithms and applications. Springer Science & Business Media, 2010.
6. David, A., and Ponce Jean. Computer vision: a modern approach. Prentice Hall ,2002.
7. Richard Hartley, Andrew Zisserman, Multiple View Geometry in Computer Vision, 2004.

MTE 4410: ROBOT DYNAMICS AND CONTROL [3 0 0 3]

Review of Robot Kinematics-Transformations:Joint/Task space, Forward Kinematics, Inverse Kinematics, Jacobians, Trajectory Generation, Serial and Parallel Kinematics. Robot Dynamics-Lagrange-Euler Dynamics, Force, Inertia, and Energy, Lagrange's Equations of Motion, Newton's equations of motion, Formulation of robot dynamics, State-Variable Representations, Dynamics of robots with actuators. Robot control problems – Regulator problem, tracking problem, controllers. Set point Tracking, Actuator Saturation, Integrator Anti-windup Compensation, Quadratic Optimal control problem. Nonlinear dynamics and control – Lyapunov stability theorem, Robust control, Feedback-Linearization Controllers, Lyapunov Designs, Variable-Structure Controllers , Saturation-Type Controllers.

Self-study: RoboAnalyzer software model-based software to learn the Robotics concepts. http://www.roboanalyzer.com/

References:

1. Mark W. Spong, Seth Hutchinson, M. Vidyasagar, *Robot Modeling and Control*, (2e), John Wiley and sons, 2009.
2. Frank L. Lewis, *Robot Manipulator Control- Theory and Practice*, (2e), CRC Press, 2003.
3. Mark W. Spong, *Robot Dynamics and Control*, (2e), John Wiley and sons, 2009.
4. Yoshikawa, *Foundations of Robotics: Analysis & Control*, (1e), Prentice Hall India, 2009.

MTE 4411: ROBOT PATH PLANNING AND MOBILE ROBOTS [3 0 0 3]

Autonomous mobile robots - Locomotion - Wheeled locomotion- Robot kinematics models & constraints, Mobile robot workspace. Configuration Space – Obstacles space, dimensions of configuration space, topology of configuration space, parameterization, transformations, Potential Functions, Gradient descent. Implementation in plane- computation, local minima problem. Algorithms – Analysis and complexity, running time, complexity, completeness. Visibility graph, Graph Search A*, Weighted A*, Anytime & Incremental Search D*, Road Maps - Generalized Voronoi Graph (GVG), GVG – transversality, connectivity, opportunist path planning.Cell Decomposition – Trapezoidal decomposition, Morse cell decomposition, Visibility based decomposition. Sampling Based Algorithms, Rapidly Exploring Random Trees (ERT), Control based planning, Manipulation planning, Optimal motion planning, Feedback motion planning. Motion Planning – Motion planning under kinematics and dynamic constraints, Trajectory planning, Non-holonomic constraints, Path planning, Combined path planning and control.

List of Experiments:

1. Implement Dijikstra's algorithm for a mobile robot
2. Implement A* algorithm for a mobile robot
3. Extend A* algorithm to a C-space for 2 degree planar manipulator
4. Implement Probabilistic Road Maps for more than 3 degree of freedom manipulator
5. Implement Artificial Potential Functions for path planning.
6. Executing any one of the above mentioned algorithms for planning a path and then control a Lego robot to follow the path generated.

Self-study: Classification of different robots and their case studies with applications

References:

1. Fahimi, Farbod, Autonomous robots: modeling, path planning, and control. Vol. 107. Springer Science & Business Media, 2008.
2. H. Choset, K. M. Lynch, S. Hutchinson, G. A. Kantor, W. Burgard, L. E. Kavraki, S. ThrunPrinciples of Robot Motion: Theory, Algorithms, and Implementations, MIT Press, Cambridge, MA, 2005.
3. S. M. LaValle, Planning Algorithms, Cambridge University Press, Cambridge, UK, 2006.

MTE 4412: SOFT ROBOTICS [3 0 0 3]

Bio robotics, biomimetics, nature-inspired designs, materials for soft robot, biological analogy, Soft Actuators, Soft Sensors, Electroactive Polymer, Ionic Polymer Metal Composites, Shape Memory Alloy, Artificial Muscles based on Electric/Pneumatics, Thermal/Chemical Actuation , Introduction to 3D Printing, 3D printing of Soft Materials, Hyper-elasticity, Finite Element Analysis, Stretchable Electronics, Soft Electrical Materials, Soft Mechanical Composite Materials, Gradient of Material Stiffness, Mechanical Soft Materials, Pneumatic Artificial Muscles, Mathematical Modelling of Flexible Manipulator, Introduction to Euler Cautchy Elasticity Problem Hyper-redundant kinematic structures, Resolution of inverse kinematics, Mathematical formulation for animating flexible structure, Bio-mimetics (modelling of snake/earthworm, caterpillar etc), Continuum Mechanics, Eigenvalues and Eigenvectors, Geometric interpretation of eigenvectors, Cayley-Hamilton theorem, Principal Component Analysis, Singular Value Decomposition, ISO-Map Dimensional Reduction technique, Case Studies on wearable Robotics, Space Robotics, Deep-Sea Robotics, Healthcare Systems, Under-actuated Robots.

Self-study: Continuum mechanics, SOFA software: https://www.sofa-framework.org/

References:

1. Matthew Borgatti, Kari Love, Christopher G. Atkeson, MAKE: Soft Robotics – A DIY Introduction to Squishy, Stretchy, and Flexible

Robots, 2018.
2. Jog, C.S., Foundations and applications of mechanics: Volume I: Continuum mechanics, Narosa Publishing House, 2007.
3. Alexander Verl, Alin Albu-Schaffer, Oliver Brock, Annika Raatz, Soft Robotics Transferring Theory to Application, Springer, 2015.
4. Jaeyoun (Jay) Kim, Microscale Soft Robotics: Motivations, Progress, and Outlook, Springer International Publishing, 2017.
5. Cecilia Laschi, Jonathan Rossiter, Fumiya Iida, Matteo Cianchetti, Laura Margheri, Soft Robotics: Trends, Applications and Challenges, Springer International Publishing, 2016.

MICRO AND NANO SYSTEMS

MTE 4413: SEMICONDUCTOR AND VLSI SYSTEMS [3 0 0 3]

Introduction to Semiconductor devices, Device Basic Structure and Characteristics, High current effects in diodes, Breakdown considerations for various devices, Schottky rectifiers.- P-i-N rectifiers Power BJTs, Parasitics in Power Transistors, Power MOSFETs, Thyristors , Power Insulated Gate Transistors, Heat transfer in power devices, device packaging. Basic MOS device. Overview of non-ideal behaviour of deep sub-micron MOS transistors. Current mirrors and current sources. Single stage amplifiers, differential amplifiers – small signal analysis, frequency response, noise. OTA circuits – differential pair, cascodes, folded-cascodes, two-stage OTAs. Stability, frequency compensation, CMRR, PSRR. Feedback. Fully differential op-amps, CMFB. Bandgap references. Output stages. Overview of CMOS device fundamentals (DC Characteristics, AC Characteristics, Processing overview).

Self-study:

1. Case study on VLSI technology and its appliction- MIT Lib,USA
2. NPTEL,EdX contents on semiconductor and VLSI

References:

1. Baliga,G.J., Fundamentals of Power Semiconductor Devices, Springer.
2. S.M. Sze, Physics of Semiconductor Devices, (2e), Wiley, 1981.
3. Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGrawHill.
4. Willy M. C, Analog Design Essentials,Sansen, Springer
5. Gray, Hurst, Lewis and Meyer, Analysis and Design of Analog Integrated Circuits, Wiley.
6. Neil H.E. Weste, David Money Harris, Addison-Wesley, CMOS VLSI design: A circuits and systems perspective, Pearson.

MTE 4414: SMART MATERIALS FOR MICRO AND NANO SYSTEMS [3 0 0 3]

Material Science: introduction, structure, defects, bonds and bands, thermodynamics of material, kinetics, nucleation. Thin film nucleation: Atomic view of substrate surfaces, thermodynamic aspects of Nucleation, Kinetic processes in Nucleation and growth. Epitaxy: Lattice mismatch and defects in epitaxial film, epitaxy of compound semiconductors, High and low temp. methods of deposition. Structural and chemical characterization of films and surfaces. XRD, TEM, AFM, SEM. Inter diffusion: compound formation, phase transformation in thin film, metal, semiconductor reaction, mass transport in thin film. Mechanical properties of thin films: Mechanical testing and strength of thin films, analysis of internal stress.

Self-study:

1. NPTEL, IISC courses on smart materials
2. Case study on material characteristics

References:

1. Ephrahim Suhir, Y.C Lee, C. P Wong, Micro- and Opto- Electronic Materials and Structures.
2. Kasturi L. Chopra, Thin Film Phenomena.
3. Kasturi L. Chopra, Indrajeet Kaur, Thin Film Device Applications.
4. Milton Ohring, The Materials Science of Thin Films.
5. Klaus K. Schuegraf, Hand book of thin films deposition processes and techniques; Principles, methods, equipment, and application.
6. O. S. Heaven, Thin Film Physics.

MTE 4415: DESIGN OF MICRO AND NANO DEVICES [3 0 0 3]

Introduction and historical background, Microsensors : Sensors and characteristics, Integrated Smart sensors, Sensor Principles/ classification-Physical sensors (Thermal sensors, Electrical Sensors, tactile sensors, accelerometers, gyroscopes, Proximity sensors, Angular displacement sensors, Rotational measurement sensors, pressure sensors, Flow sensors, MEMS microphones etc.), Chemical and Biological sensors (chemical sensors, molecule-based biosensors, cell-based biosensors), transduction methods(Optical, Electrostatic, Electromagnetic, Capacitive, Piezoelectric, piezoresistive etc.), Microactuators: Electromagnetic and Thermal microactuation, Mechanical design of microactuators, Microactuator examples,- microvalves, micropumps, micromotors Microactuator systems : eg. Ink-Jet printer heads, Micro-mirror TV Projector. Introduction to interfacing methods: bridge circuits, Programmable gain instrumentation amplifiers, A/D and D/A converters, microcontrollers Applications and case studies: Microsensors and actuators in environmental sensing, RF/Electronics devices, Optical/Photonic devices, microsensors for space applications, MEMS sensors in navigation systems, radiation sensors, Medical devices, Bio-MEMS

References:

1. M.-H. Bao, Micromechanical Transducers: Pressure sensors, accelrometers, and gyroscopes, Elsevier, New York, 2000
2. Richard S. Muller, Roger T. Howe, Stephen D. Senturia, Rosemary L. Smith, and Richard M. White, Microsensors, IEEE Press, IEEE Number PC 0257-6, ISBN 0-87942-254-9, New York, 1991.
3. William Trimmer, Micromechanics and MEMS: Classic and Seminal Papers to 1990, IEEE Press, IEEE Number PC4390, ISBN 0-7803-1085-3, New York.
4. Beckwith T. G., Margoni R. D., Lienhard J. H.,Mechanical Measurements, New York: Addison-Wesley Pub. Co, 1995
5. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalakrishnan, K. N. Bhat, and V. K. Aatre, Micro and Smart Systems, Wiley-India, 2010.

MTE 4416: FABRICATION AND TESTING OF MICRO SYSTEMS [3 0 0 3]

Classical scaling in CMOS, Moore's Law, Clean room concept, Material properties, crystal structure, lattice, Growth of single crystal Si, Cleaning and etching, Thermal oxidation, Dopant diffusion in silicon, Deposition & Growth (PVD, CVD, ALD, epitaxy, MBE, ALCVD etc.),Ion-implantation, Lithography (Photolithography, EUV lithography, X-ray lithography, e-beam lithography etc.), Etch and Cleaning, CMOS Process integration, Back end of line processes (Copper damascene process, Metal interconnects; Multi-level metallization schemes), Advanced technologies(SOI MOSFETs, Strained Si, Silicon-Germanium MOS, metal semiconductor source / drain junctions, High K, metal gate electrodes and work function engineering, Double gate MOSFETs, FinFETs, TunnelFETsetc..) , emerging research devices and architectures (Nanowire FETs, CNT FETs, Graphene transistors, Organic FETs)

References:

1. James Plummer, M. Deal and P.Griffin, *Silicon VLSI Technology*, Prentice Hall Electronics
2. Stephen Campbell, *The Science and Engineering of Microelectronics*, Oxford University Press, 1996
3. S.M. Sze (Ed), *VLSI Technology*, (2e), McGraw Hill, 1988.
4. C.Y. Chang and S.M.Sze (Ed), *ULSI Technology*, McGraw Hill Companies Inc, 1996.

PRECISION AGRICULTURE TECHNOLOGY

MTE 4417: SMART FARMING MACHINERY [3 0 0 3]

Importance of agriculture as an industry in the context of shortage of quality food and resources, soil properties and their importance, soil fertility and essential plants nutrients. Soil-water-plant relationship, types of horticultural crops and its life cycle; Working principles of tools and machinery associated with soil preparation for variety of crops, principles of sowing and cultivation equipment, mechanically and electronically controlled fertilizer supply and pesticide spraying machines, machinery for horticultural crops protection and weed control; Introduction to climate controlled agriculture, Plant response to greenhouse environment, materials, planning and design of greenhouses, Instrument for measurement: pH, Electrical conductivity, gas analysis, humidity, leaf area, chlorophyll content and soil moisture & temperature, automatic control of temperature, moisture, air, smart irrigation systems, hydroponics technology. Working principles of harvesting machinery for various crops, Material handling equipment, conveyer and elevators, their working principle and selection; Grain drying equipment: deep bed dryer, flat bed dryer, tray dryer, fluidized bed dryer, re-circulatory dryer and solar dryer.

Self-study: Agriculture robots, IoT and cloud computing in agriculture, integration of smart farm machinery and internet of things for precision agriculture.

References:

1. R.K. Sharma, A.K.Soni, R. Bhagat, N. Pandey and V.K. Pandey, Basics of Agriculture for Engineers, Daya Publishing House, New Delhi, 2014.
2. Farm Power and Machinery ICAR e-Course.
3. Sanjay Kumar, Farm Power \and Machinery, Kalyani Publications, 978-9327287257, 2018.
4. Cecilia Stanghellini; Bert Van 't Ooster; Ep Heuvelink, Greenhouse Horticulture Technology for Optimal Crop Production, ISBN: 978-90-8686-329-7, Wageningen Academic Publishers, 2019.
5. Basavaraj; Srigiri, D.; P.R., Jayan, Textbook Of Farm Machinery And Power Engineering, New India Publishing Agency, 2019.
6. Amalendu Chakraverty, Arun S. Mujumdar, Hosahalli S. Ramaswamy, Handbook of Postharvest Technology: Cereals, Fruits, Vegetables, Tea, and Spices, CRC Press, 2003.
7. Prabhat K. Nema, Barjinder Pal Kaur, Arun S. Mujumdar, Drying Technologies for Foods, Fundamentals & Applications, CRC press, 2019.

MTE 4418: ROBOTICS AND AUTOMATION IN AGRICULTURE [3 0 0 3]

General robotic architecture, sensors, drive systems, kinematics, task and trajectory planning, robot controller and operating system; Classification and working of the electric and pneumatic drive used in robots, different types of pneumatic control valves and design of pneumatic control circuits; working principles of different types of end-effectors, Design and development of robotic end-effector for harvesting different crops; Working principals of thermal, depth, real-sense and multi-spectral cameras, capturing, processing and analysis of different images, integration of vision system with the end effector and drive system; Working Principles of drone, classification of agriculture drones, components of drones, application of drones in agriculture for surveillance and pesticide application.

Self-study: Mobile robots, servo motors, actuators, robotic manipulators, machine vision.

References:

1. R Mittle, I Nagrath, Robotics and Control, McGraw Hill Education.
2. Joji P, Pneumatic Controls, John Wiley & Sons, 2018.
3. S.K. Pillai, A First Course on Electrical Drives, New Age Publishers.
4. Gareth J. Monkman, Stefan Hesse, Ralf Steinmann, Henrik Schunk, Robot Grippers, Wiley VCH Verlag GmbH & Co. KGaA, 2006.
5. Inamuddin, RajenderBoddula, Abdullah M. Asiri, Actuators: Fundamentals, Principles, Materials and Applications, Scrivener Publishing LLC, 2020.
6. Berthold K.P. Horn, Robot Vision, MIT Press
7. K. R. Krishna, Agricultural Drones A Peaceful Pursuit, 2018.

MTE 4419: FOOD PROCESS AUTOMATION [3 0 0 3]

Introduction to Food quality, automated evaluation of food quality, food quality quantization and process control, typical problems in food quality evaluation, food odor measurement, continuous snack food frying quality; Sampling elaboration with examples, concepts and systems for data acquisition such as: ultrasonic signal acquisition, electronic nose data acquisition for food odor measurement, snack food frying data acquisition for quality process control, Image acquisition: elaboration with examples. Data analysis: Data pre-processing, Static data analysis, Dynamic data analysis, Image processing: Image segmentation, Image feature extraction etc.; Modeling strategies: Theoretical and empirical modeling, Static and dynamic modeling, Linear statistical modeling, ANN modeling etc. Prediction: Prediction and classification, Sample classification for grading, examples such as, based on linear statistical and ANN models, Electronic nose data classification for food odor pattern recognition, Snack food classification for eating quality evaluation based on linear statistical and ANN models, One-step-ahead prediction; Process control, Internal model control, Predictive control, Neuro-fuzzy PDC for product, Systems integration: Product quality quantization systems integration, product quality and process control systems integration, product quality quantization and process control systems development; Vacuum, Controlled and Modified atmosphere packaging systems, bottling machines, Cartooning systems, Seal and Shrink-packaging machine, Form, Fill and Sealing machine, Aseptic packaging systems, Retort packaging, Active and Intelligent packaging systems.Future trends in food industry: 3D food printing technology using: Extrusion based, inkjet based, Binder jetting, Selective laser sintering.

Self-study: Food safety, Quality control system, data analysis, image processing, predictive modelling.

References:

1. Robberts Theunis C., Food Plant Engineering Systems, CRC Press, Washington, 2013.
2. Krammer, A. and Twigg, B.A. Quality Control for the Food Industry, Volume 2, Applications. The AVI Publishing Company, Westport, Connecticut.
3. Ranganna, S., Hand book of Analysis and Quality Control for Fruits and Vegetable Products, Tata McGraw Hill, New Delhi.
4. N. P. Padhy, S. P. Simon, Soft Computing: With MATLAB Programming, Oxford University Press, 2015.
5. Sudheer, K P. and Indira, V. Post Harvest Engineering of Horticultural crops. New India Publishing House.
6. Lal Giridhari, Siddappa and Tondon, Preservation of Fruits and Vegetables. ICAR, New Delhi, 2001.
7. Srivastava and Sanjeev Kumar. Fruit and Vegetable Preservation: Principles and Practices. Kalyani Publishers, 2008.

MTE 4420: DIGITAL AGRICULTURE [3 0 0 3]

Use of electrical energy in agriculture, electro-mechanical energy conversion, Electrical motors, pumps, Selection of motors for different farming applications, remote controlled intelligent irrigation systems, machine learning approach for efficient water usage, renewable energy sources. ; An Introduction to precision farming, GIS/GPS positioning system for precision farming, Yield monitoring and mapping, soil sampling and analysis, Computers and Geographic information systems, Precision Farming-Issues and conditions, Role of electronics in farm machinery for precision farming. ; Design and development of IoT system for fully automatic farm. Vertical forming, monitoring of climate conditions, green house automation, crop management, IOT for allied agriculture practices. ; Data acquisition systems, Test sites, Common measurements, Geologic investigations, Agriculture and Forestry investigations, Atmospheric investigation, visual image interpretation, digital image processing, Earth resource satellite, Ground water level monitoring.; The digital agriculture revolution, challenges of digital transformation, key drivers of digital agriculture transformation, Information and Communication Technology (ICT), Mobile Technology and its impact on agriculture and rural development, Artificial Intelligence (AI) based farming, adoption of ICTs and digital technologies in agriculture, Online Marketing of agro-based products, Strengthening Agricultural Market Access with ICT and Digital Tools.

Self-study: Soil sensors calibration, irrigation scheduling, crop water estimation. Water quality management in irrigation etc.

References:

1. Singh Brahma and Balraj Singh, Advances in Protected Cultivation, New India Publishing Company, 2014.
2. Sharma P. Precision Farming,Daya Publishing House New Delhi, 2007.
3. Qin Zhang, Precision Agriculture Technology for Crop Farming, (1e), 2016.
4. Narendra Singh Rathore, Sunil Joshi, Naveen Choudhary, Digital Technologies for Agriculture, ISBN: 9789390591916, 2022.
5. Annamaria Castrignano, Gabriele Buttafuoco, Raj Khosla, Abdul Mouazen, Dimitrios Moshou, Olivier Naud, Agricultural Internet of Things and Decision Support for Precision Smart Farming, (1e), 2020.
6. Pradeep Tomar, Gurjit Kaur, Artificial Intelligence and IoT-Based Technologies for Sustainable Farming and Smart Agriculture, 2021.

PROGRAM ELECTIVES

MTE 4441: ANTENNAS, RADAR AND NAVIGATION [3 0 0 3]

Antenna Fundamentals: Radiation mechanism and current distribution in thin wire antennas. Antenna fundamental parameters. Radiation Integrals and Auxilliary Potential Functions: Vector potential A and F and their solutions. Electric and magnetic fields of J and M sources. Far field pattern. Duality and reciprocity theorem. Types of Antennas. Introduction to RADAR and Navigation systems: Radar range equation. Minimum detectable signal, receiver noise, radar clutter, pulse repetition frequency. Doppler effect. Introduction to navigation systems and its types. Types of RADARs and SONAR: CW radar, FMCW radar. Moving target indicator (MTI) and pulse Doppler radar, Synthetic aperture radar. Radio altimeter, LORAN, DECCA, OMEGA, inland shipping aids, SONAR.

References:

1. Balanis C. A., *Antenna Theory*, *Analysis and Design* (4e), John Wiley and Sons, New Delhi, 2016.
2. Kraus J.D., *Antennas for all Applications* (4e), McGraw-Hill, 2001.
3. Balanis C. A., *Introduction to Smart Antennas* (1e), Morgan and Claypool Publishers, 2007.
4. Skolnic M., *Introduction to RADAR Systems* (2e), McGraw-Hill, 2010.
5. PeytonZ. and Peebles Jr., *Radar Principles* (2e), Wiley India, 2009.

MTE 4442: AUGMENTED REALITY AND VIRTUAL REALITY [3 0 0 3]

Introduction - The three I's of Virtual reality, History of Virtual Reality, Early Commercial VR Technology, Classic Components of VR System. Multiple Models of Input and Output Interface in Virtual Reality: Gesture Interfaces, Three-Dimensional position trackers, Navigation and Manipulation Interfaces. Gesture Interfaces, Graphics, Three-dimensional Sound and Haptic Display, Graphic Displays, Sound Displays, Haptic Feedback, Marker Tracking, Multiple Camera Infrared Tracking, Natural Feature Tracking by Detection, Incremental Tracking, Simultaneous Localization and Mapping, Outdoor Tracking, Computer Architectures for VRs: The Rendering Pipeline, PC Graphics Architecture, Workstation Based Architectures, Distributed VR architectures, Geometric Modelling, Kinematic Modelling, Physical Modelling, Behavioral Modelling, Model management

References:

1. Burdea, Grigore C., and Philippe Coiffet. "Virtual reality technology."International Journal of e-Collaboration 2, no. 1 (2006): 61-64.
2. Schmalstieg, Dieter, and Tobias Hollerer. Augmented reality: principles and practice.
   Addison-Wesley Professional, 2016.
3. Parisi, Tony. Learning virtual reality: developing immersive experiences and applications for desktop, web, and mobile. " O'Reilly Media, Inc.", 2015.
4. Aukstakalnis, Steve. Practical augmented reality: A guide to the technologies, applications, and human factors for AR and VR. Addison-Wesley Professional, 2016.
5. Linowes, Jonathan. Unity virtual reality projects. Packet Publishing Ltd, 2015.

MTE 4443: AUTONOMOUS MOBILE ROBOTICS [3 0 0 3]

Locomotion: Introduction, Legged Mobile Robots, Wheeled Mobile Robots. Mobile Robot Kinematics and Motion in Global Coordinates: Kinematic Models and Constraints, Mobile Robot Maneuverability, Mobile Robot Workspace, Dynamics of Quadrotor-Type Mobile Robots. Perception: Sensors for Mobile Robots, Feature Extraction. GNSS and Mobile Robot Localization: The Challenge of Localization: Localization-Based Navigation versus Programmed Solutions, Map Representation. Probabilistic Map-Based Localization. Global Navigation Satellite System. Planning, Navigation and Energy Considerations: Competences for Navigation, Navigation Architectures, Energy Limitations and Energetic Efficiency of Mobile Robots.

Self-study: Different types of robots and their classification with case studies. Implementing various algorithms, in Mini projects

References:

1. Siegwart, Roland, Illah Reza Nourbakhsh, and DavideScaramuzza. *Introduction to autonomous mobile robots*. MIT press, 2011.
2. Howie Choset, Kevin M Lynch, *Principles of Robot Motion*, MIT Press, 2005.
3. King Sun Fu, Gonzalez ,*Robotics- control, sensing, vision, and intelligence*, McGraw-Hill, 1987.
4. Kagan, Eugene, NirShvalb, and Irad Ben-Gal, eds. *Autonomous mobile robots and multi-robot systems: Motion-planning, communication, and swarming*. John Wiley & Sons, 2019.

MTE 4444: BIOMECHATRONICS [3 0 0 3]

Introduction to biomechatronics, physiological systems- biochemical, nervous, cardiovascular, respiratory, musculoskeletal systems, fusion of bio and mechatronics, components of a biomechatronic system-sensors, actuators, controller, signal processor, few application areas; Sensors for capture of biological signals- surface electromyographic sensors, types of electrodes, intramuscular electromyography, electroencephalography, electrocardiography, electrooculography, nerve cuff, brain array, oxygen light sensors, oxygen consumption sensors; Chemical sensors to capture to stimuli produced by various chemical compounds, electric sensors, optical sensors, mechanical sensors, thermal sensors; Purpose of biomechatronic actuators-biological function replacement, augmentation or improvement, design goals of biomechatronic actuators, types of biomechatronic actuators-Motors, electromagnetic actuators, fluidic actuators, shape memory alloys, electroactive polymers, transmissions- linear, rotary, differential gear transmissions; Biomechatronic system model- Model based open loop control, model based closed loop control, case study-model based control of a biomechatronic system; Biomechatronic applications of brain-computer interface, upper limb prosthetic device, upper and lower extremity exoskeletons.

Self-study: Neuro muscular physiology, Human gait

References:

1. Jacob Segil, *Handbook of Biomechatronics*, Academic Press, 2019.
2. Marko B. Popovic, *Biomechatronics*, Academic Press, 2019.
3. Graham m. Brooker, *Introduction to Biomechatronics*, Scitech Publishing, 2012.
4. Shane Xie, Wei Meng, *Biomechatronics in Medical Rehabilitation*, Springer, 2017.

MTE 4445: BUILDING AUTOMATION [3 0 0 3]

Overview of Digital Controller: Data Form used in computers, Microcomputer, Input / Output Unit, Processor Operation and Software, Sensors, Actuator, I/O devices, Field Controllers. Network and Communication protocols: Networking basics, Types of Networks-Serial and Parallel Communication, RS232 and RS 485 Interfaces, MODBUS protocol overview, BACnet protocol overview. Introduction to Building Management Systems: Buildings and Energy Management, Different systems in a building. Introduction to HVAC, Struxure Ware for Building Operation. General BMS architecture: Introduction to HVAC and Optimal control methods for HVAC Systems: Important components of HVAC, HVAC Control systems and Direct Digital Control, AHU, Chillers, Zones, Air Distribution Systems, Field Devices, Schneider Controllers (PLC's). Lighting control systems: Strategies for energy management and lighting. Security and Safety Control Systems: Access Control-Introduction, Basic Components, Controller / Panel, Credentials, Reader, Locking Device, How it works / Operations, Type of Card/Readers, Anti-Pass back, Power Requirements, Videos (Digital Video Recorder), Types of Camera, Fire Alarm Systems - Sprinklers. System integration and convergence: Need for integration, interoperability and protocols, BMS integration case studies, iBMS, Compatibility of different internet technologies and its application in BMS. Application of internet for Automation and Management: Web Based Automation, General Architecture, Web Enablement, Data Communication Energy Management: Overview on EMS, Energy Analysis/Audit. Green Buildings (LEED): Green Buildings Approach, Benefits of Green Buildings, Elements of Green Building Design, Leadership in Energy and Environmental Design (LEED), LEED Case Study.

References:

1. V. K. Jain ,Automation Systems in Smart and Green Buildings,

published by Khanna Publishers, 2009.
2. Reinhold A, Understanding Building Automation Systems: Direct Digital Control, Energy Management, Life Safety, Security/access Control, Lighting, Building Management Programs, 2009.
3. Ronnie J. Auvil ,HVAC Control Systems , (2e), 2007.
4. Thomas L. Norman, Integrated Security Systems Design: Concepts, Specifications, and Implementation (1e) by CPP PSP CSC 2007.
5. Benantar, Messaoud, Access Control Systems: Security, Identity Management and Trust Models, Springer publication, 2005.

MTE 4446: CLOUD COMPUTING [3 0 0 3]

Introduction, Cloud infrastructure, Cloud computing delivery models and services, Cloud computing at Amazon, The Google perspective, Microsoft Windows Azure, Application paradigms, Architectural styles of cloud computing, Cloud resource management and scheduling, Cloud resource virtualization, Types of virtualization, Understanding hypervisors, Virtual machine and its components, Resource management, Memory ballooning, Thin virtual provisioning, Storage tiering, Virtual LAN, VLAN trunking, VLAN tagging, Business continuity and cloud management, Virtual machine fault tolerance, Virtual machine replication methods, Cloud security, Virtual machine security, Access control and identity management, Cloud tools: Eucalyptus, OpenNebula/OpenStack, CloudSim.

References:

1. Dan C Marinescu, Cloud Computing Theory and Practice, Elsevier, 2013.
2. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Mastering Cloud Computing, McGraw Hill, 2017.
3. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, Cloud Computing: A Practical Approach, McGraw Hill, 2017.

MTE 4447: DATA ANALYTICS AND MACHINE INTELLIGENCE [3 0 0 3]

Statistical topics for Data science, Data- sources, privacy and confidentiality, samples vs. population. Data Pre-processing. Data Analysis and Visualization – descriptive, inferential statistics, data mining techniques. Grouping – Cluster Analysis. Market Basket Analysis, Association Analysis, Market Basket Analysis. Evaluation of Classification and Predictive performance, Forecasting models as application. Big-analytics software architectures. Introduction to Machine Learning, Mathematical Preliminaries, Supervised Learning, Model Selection, learning theory-bias/variance trade-off, Unsupervised learning-clustering, Dimensionality reduction techniques, Ensemble Models, Reinforcement learning. Deep Feed forward Networks: architecture design, Back propagation algorithm, Regularization for Deep Learning, Dataset Augmentation techniques, Adversarial Training, Optimization for Training Deep Models, Convolutional Networks using Baseline models, Recurrent and Recursive Networks, Time Series Applications.

References:

1. Kevin P Murphy, Machine Learning: A Probabilistic Perspective, MITcPress, 2012.
2. Mehryar Mohri, Afshin Rostamizadeh, and Ameet Talwalkar, Foundations of Machine Learning, MIT Press, 2012.
3. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, MIT Press 2016.
4. Glenn J. Myatt, Wayne P. Johnson, Making Sense of Data I: A Practical, Guide to Exploratory Data Analysis and Data Mining, (2e), John Wiley & Sons Publication, 2014.

Self-Study: Course Era course entitled Python programming for All.

MTE 4448: DATA MINING AND VISUALIZATION [3 0 0 3]

The Statistical Data Mining Process: The Data Pre-processing Phase and Analytical Phase. The Basic Data Types: Non-dependency Oriented Data, Dependency Oriented Data, Association Pattern Mining, Data Clustering, Outlier Detection, Data Classification, Application Scenarios. Data Classification: Feature Selection for Classification, Filter, Wrapper and Embedded Models, Decision Trees, Rules based classifiers, SVM, Probabilistic Classifiers and Neural Nets. Mining Data Streams: Data Structures for Streams, Clustering Data Streams, Streaming Classification. Mining Text Data: Document Preparation and Similarity Computation, Specialized Classification Methods for Text. Mining Time-Series Data: Time-Series Preparation and Similarity, Time-Series Forecasting, Clustering, Classification and Outlier detection. Mining Discrete Sequences: Sequential Pattern, Sequence Clustering, Hidden Markov Models and Sequence Classification. Mining Web Data: Web Crawling and Resource Discovery, Search Engine Indexing and Query Processing, Ranking Algorithms, Recommender Systems, Web Usage Mining. Data Visualization, principles, tools and techniques.

References:

1. Charu Aggarwal, Data Mining, 2(e), 2015.
2. CR Rao, Data Mining and Data Visualization, 2(e), 2010
3. Claus O. Wilke, Fundamentals of Data Visualization, 2020, 2(e), O'Reilly.

MTE 4449: DIGITAL MANUFACTURING [3 0 0 3]

Introduction to Digital manufacturing: Types of production systems. Needs of digital manufacturing, effective & efficient use of digital manufacturing (DM) tools. Scope of digital manufacturing in future. Flexible manufacturing systems, Computers in manufacturing industries, Key challenges, techniques, requirements, product life cycle management, Integration of CAD/CAM systems, Industrial control systems. Digital twin, architecture of digital twins, case studies on the application of digital twins in different domains.

References:

1. M.P.Groover, E.W.Zimmers Jr., “CAD/CAM: Computer aided design and manufacturing”, Prentice-Hall of India Pvt. Ltd. 2001
2. P.N.Rao, “CAD/CAM: Principles & Application”, Tata McGraw Hill 2005.
3. Tai Ran Hsu, MEMS and Microsystems- Design and manufacturing, Tata McGraw Hill, 2001
4. Marc J. Madou, Fundamentals of microfabrication,2002
5. https://www.coursera.org/learn/ethics-technology-engineering/

MTE 4450: DEEP LEARNING FOR COMPUTER VISION [3 0 0 3]

Image Formation, Linear Filtering, Correlation, and Convolution, Visual Features: Edge, Blobs, Corner Detection Algorithms, SIFT, SURF, HOG, Multi-layer Perceptron, Backpropagation, Introduction to CNN, Evolution of CNN Architectures: AlexNet, ZFNet, VGG, Inception Nets, ResNets, DenseNets, Visualization of Kernels; Backprop-to-image/Deconvolution Methods. Background of Object Detection, CNN for Recognition and Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO, SSD, RetinaNet; CNNs for Segmentation: FCN, SegNet, U-Net, Mask-RCNN Review of RNNs; CNN + RNN Models for Video Understanding.Implementation using Deep Learning Libraries.Deep Generative Models: GAN, Cycle-GANs, Progressive GANs, StackGANs, Pix2Pix Applications: Image Editing, Inpainting, Super-Resolution, Image Restoration, 3D Object Generation.

Prerequisite

1. Basic course in Machine Learning
2. Deep Learning, or exposure to topics in neural networks
3. Probability, linear algebra, and calculus
4. Experience of programming in Python

References:

1. Goodfellow, Ian, YoshuaBengio, and Aaron Courville. Deep learning. MIT press, 2016.
2. Nielsen, Michael A. Neural networks and deep learning. San Francisco, CA, USA: Determination press, 2015.
3. Szeliski, Richard. Computer vision: algorithms and applications. Springer Science & Business Media, 2010.
4. David, A., and Ponce Jean. Computer vision: a modern approach. Prentice Hall ,2002.
5. Bishop, Christopher. Neural Networks for Pattern Recognition, New York, NY: Oxford University Press, 1995.
6. Richard Hartley, Andrew Zisserman, Multiple View Geometry in Computer Vision, 2004
7. Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997

MTE 4451: DESIGN OF MECHANICAL DRIVES [3 0 0 3]

Introduction, bevel gear and worm gear, beam strength, dynamic load and wear load, heat dissipation and efficiency of worm gear, sliding contact bearings, lubricants, viscosity, bearing modulus, Sommerfield number, coefficient of friction, mechanism of film lubrication, eccentricity and minimum oil film thickness. Belt drives, power transmission, flat and V belts, power rating, V-flat drives, selection of belts and pulleys. Wire and rope drives - types & construction of wire ropes, loads & stresses in ropes, selection of wire ropes. Chain drives, chordal action, sprocket size and teeth, chain speed, selection of roller chains. Mechanical brakes - block brakes, band brakes, pivoted Shoe brakes, disc brake, torque capacity, heat dissipation, clutches, friction clutches, disc clutch, cone clutch, design projects.

Self-study: Mechanical components used in robotic applications and design of these components used in industrial robots.

References:

1. Shigley J. E. and Mischke C. R., Mechanical Engineering Design, (5e), McGraw Hill Inc, New York, 2004.
2. Bhandari V. B., Design of Machine Elements, (2e), Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.
3. Norton R. L., Machine Design - An Integrated Approach, (2e), Prentice Hall Inc. New Jersy, 2004.
4. Juvenile R. C. and Marshek K. M., Fundamentals of Machine Component Design, (3e), John Wiley and Sons, Inc, New York, 2000.
5. Mahadevan K. and Balaveera Reddy K., Machine Design Data Hand Book, (4e), CBS Publishers and Distributors, New Delhi, 2014.

MTE 4452: ELECTRIC VEHICLES [3 0 0 3]

History of Vehicle technology. Case studies on vehicles. Economics and Environmental aspects of vehicle technologies – IC, Hybrid and EV. Overview of vehicle dynamics. Power Plants in vehicle technologies. IC Engine based vehicles – Fundamentals and types. IC Engine speed torque characteristics. EV Power plant characteristics. Electric Vehicle components: Battery, Motors and Auxiliary units. Types of Electric Vehicle configurations. Concept of regenerative braking and its significance in Electric Vehicles. Control of Electric Vehicles. Challenges in Electric Vehicles. Hybrid Vehicles – Series, Parallel, Series Parallel and Complex configurations. Fuel Cell based vehicles – Fundamentals and Future Potential of FCEV. Solar Powered EV. Case studies on types of Electric and Hybrid Vehicles.

Self-study: Case studies on types of Electric and Hybrid Vehicles.

References:

1. MehrdadEhsani, Modern Electric, Hybrid Electric and Fuel Cell Vehicles- Fundamentals, Theory and Design, (3e), CRC Press, 2018.
2. Iqbal Hussein, Electric and Hybrid Vehicles-Design Fundamentals, (2e), CRC Press, 2010.
3. Gianfranco Pistoia, Electric and Hybrid Vehicles - Power Sources, Models, Sustainability, (2e), CRC Press, 2010.

MTE 4453: EMBEDDED SYSTEMS AND RTOS [3 0 0 3]

Introduction to embedded system, attributes and major application areas of ES, Processor and memory organization, Communication networks, ARM processor introduction, architectural inheritance, Architectural features of ARM Processor, instruction set, Pipelined architecture in ARM, THUMB instruction format, memory mapped peripherals, architectural features of ARM Cortex M3 and programming examples. Introduction To Real-Time Operating Systems, Tasks and Task states, Semaphores, Message queues, Mail boxes and pipes, Hard and Soft real time systems, scheduling considerations, Multicore real time systems. Case studies.

Self-study: Risk and safety assessment for embedded systems.

References:

1. Wolf, Wayne, Computers as Components- Principles of Embedded Computing System Design, Morgan-Kaufmann, 2000.
2. Steve Furber, ARM System-on-chip Architecture, Pearson Education, 2000.
3. Andrew Sloss, Domnic Symes, Chris Wright, ARM system Developer's Guide, 1st edition.

MTE 4454: ENGINEERING MATERIALS [3 0 0 3]

Crystal structures, Miller indices, crystal imperfections, mechanism of solidification, nucleation and crystal growth, phases in solids, equilibrium diagrams, iron-Carbon systems, principle and objectives of heat treatment, TTT diagrams, electronic materials, deposition of thin films, insulators and dielectric properties, polarization in dielectrics, electrostriction, piezoelectricity, ferroelectricity, magnetic materials, magnetic dipole and moments, magnetization, super paramagnetic materials, applications of magnetic materials, photonic materials, refraction, reflection, absorption, emission phenomena.

References:

1. Donald R. Askeland and Pradeep P. Fulay, The Science and Engineering of Materials, Cengage learning publishers, (6e),2011.
2. Lakhtin Yu., Engineering Physical metallurgy and heat treatment, MIR Publishers, Moscow, 1985.
3. Higgins R.A., Engineering Metallurgy, (5e), ELBS, London,1983.

MTE 4452: ELECTRIC VEHICLES [3 0 0 3]

History of Vehicle technology. Case studies on vehicles. Economics and Environmental aspects of vehicle technologies – IC, Hybrid and EV. Overview of vehicle dynamics. Power Plants in vehicle technologies. IC Engine based vehicles – Fundamentals and types. IC Engine speed torque characteristics. EV Power plant characteristics. Electric Vehicle components: Battery, Motors and Auxiliary units. Types of Electric Vehicle configurations. Concept of regenerative braking and its significance in Electric Vehicles. Control of Electric Vehicles. Challenges in Electric Vehicles. Hybrid Vehicles – Series, Parallel, Series Parallel and Complex configurations. Fuel Cell based vehicles – Fundamentals and Future Potential of FCEV. Solar Powered EV. Case studies on types of Electric and Hybrid Vehicles.

Self-study: Case studies on types of Electric and Hybrid Vehicles.

References:

1. MehrdadEhsani, Modern Electric, Hybrid Electric and Fuel Cell Vehicles- Fundamentals, Theory and Design, (3e), CRC Press, 2018.
2. Iqbal Hussein, Electric and Hybrid Vehicles-Design Fundamentals, (2e), CRC Press, 2010.
3. Gianfranco Pistoia, Electric and Hybrid Vehicles - Power Sources, Models, Sustainability, (2e), CRC Press, 2010.

MTE 4453: EMBEDDED SYSTEMS AND RTOS [3 0 0 3]

Introduction to embedded system, attributes and major application areas of ES, Processor and memory organization, Communication networks, ARM processor introduction, architectural inheritance, Architectural features of ARM Processor, instruction set, Pipelined architecture in ARM, THUMB instruction format, memory mapped peripherals, architectural features of ARM Cortex M3 and programming examples. Introduction To Real-Time Operating Systems, Tasks and Task states, Semaphores, Message queues, Mail boxes and pipes, Hard and Soft real time systems, scheduling considerations, Multicore real time systems. Case studies.

Self-study: Risk and safety assessment for embedded systems.

References:

1. Wolf, Wayne, Computers as Components- Principles of Embedded Computing System Design, Morgan-Kaufmann, 2000.
2. Steve Furber, ARM System-on-chip Architecture, Pearson Education, 2000.
3. Andrew Sloss, Domnic Symes, Chris Wright, ARM system Developer's Guide, 1st edition.

MTE 4454: ENGINEERING MATERIALS [3 0 0 3]

Crystal structures, Miller indices, crystal imperfections, mechanism of solidification, nucleation and crystal growth, phases in solids, equilibrium diagrams, iron-Carbon systems, principle and objectives of heat treatment, TTT diagrams, electronic materials, deposition of thin films, insulators and dielectric properties, polarization in dielectrics, electrostriction, piezoelectricity, ferroelectricity, magnetic materials, magnetic dipole and moments, magnetization, super paramagnetic materials, applications of magnetic materials, photonic materials, refraction, reflection, absorption, emission phenomena.

References:

1. Donald R. Askeland and Pradeep P. Fulay, The Science and Engineering of Materials, Cengage learning publishers, (6e),2011.
2. Lakhtin Yu., Engineering Physical metallurgy and heat treatment, MIR Publishers, Moscow, 1985.
3. Higgins R.A., Engineering Metallurgy, (5e), ELBS, London,1983.
4. Avner S.H., Introduction to Physical Metallurgy, (3e), McGraw Hill. Delhi, 2004.
5. Arzamasov, Material Science, MIR Publishers, Moscow. 1989.

MTE 4455: FRACTIONAL ORDER MODELLING AND CONTROL [3 0 0 3]

Fractional order calculus: Review of basic definitions of integer-order (IO) derivatives and integrals and their geometric and physical interpretations, Definition of Riemann-Liouville (RL) integration, Definitions of RL, Caputo and Grunwald-Letnikov (GL) fractional derivatives (FDs), Various geometrical and physical interpretations of these FDs, Computation of these FDs for some basic functions like constant, ramp, exponential, sine, cosine, etc., Laplace transforms of FDs. Fractional-order modeling : Review of basic concepts of complex analysis, Concepts of multivalued functions, branch points, branch cuts, Riemann surface and sheets, Fractionalorder transfer function (FOTF) representation, Concepts like commensurate and noncommensurate TFs. fractional-order (FO) modelling of electrical circuit elements like inductor, capacitor, electrical. Models of basic circuits and mechanical systems using FO elements, FO models of heat transfer, A brief overview of FO models of biological systems. Fractional-order Control: Detailed discussion and analysis of the superiority of FO control over the conventional IO control in terms of closed-loop performance, robustness, stability, etc., FO PID control, design of FO state-feedback, Realization and implementation issues for FO controllers, survey of various realization methods and the comparative study, Case study.

Self-study: Risk management in the industrial control system.

References:

1. K. B. Oldham and J. Spanier. The Fractional Calculus. Dover Publications, USA, 2006.
2. Kilbas, H. M. Srivastava, and J. J. Trujillo. Theory and Applications of Fractional Differential Equations, Elsevier, Netherlands, 2006.
3. Podlubny. Fractional Differential Equations. Academic Press, USA, 1999.
4. C. A. Monje, Y. Q. Chen, B. M. Vinagre, D. Xue, and V. Feliu. Fractional-order Systems and Control: Fundamentals and Applications.

Springer-Verlag London Limited, UK, 2010.
5. R. L. Magin. Fractional Calculus in Bioengineering. Begell House Publishers, USA, 2006.
6. R. Caponetto, G. Dongola, L. Fortuna, and I. Petras. Fractional Order Systems: Modeling and Control Applications. World Scientific, Singapore, 2010.
7. K. S. Miller and B. Ross. An Introduction to the Fractional Calculus and Fractional Differential Equations. John Wiley & Sons, USA, 1993.
8. S. Das. Functional Fractional Calculus for System Identification and Controls, Springer, Germany, 2011.
9. M. D. Ortigueira. Fractional Calculus for Scientists and Engineers. Springer, Germany, 2011.
10. Petras. Fractional-Order Nonlinear Systems: Modeling, Analysis and Simulation. Springer, USA, 2011.

MTE 4456: HUMAN ROBOT INTERACTION [3 0 0 3]

IO channels, Framework and design flow, Ergonomics, prototyping and lifecycle, usability engineering, HCI models, Cognitive and scoio organizational issues, Evalution techniques and .design rules. Collaborative models – HCI, application framework, mobile HCI design and case study, virtual layouts and process flow in web interfacing design.

Self-Study: Case studies on different human robot interactions.

References:

1. Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale,Human Computer Interaction, (3e), Pearson Education, 2004.
2. Brian Fling, Mobile Design and Development, (1e), O'Reilly Media Inc., 2009.
3. Bill Scott and Theresa Neil, Designing Web Interfaces, (1e), O'Reilly, 2009.

MTE 4457: MACHINE LEARNING [3 0 0 3]

Introduction to Machine Learning, Review of Linear Algebra, Review of Probability theory, Overview of Convex optimization, Hidden Markov models, Bayesian decision theory, Maximum likelihood ratio, Parametric classification, Regression, Multivariate methods, K-nearest neighbor classification, Supervised learning: Logistic regression, Perceptron, Generative learning algorithms, Naïve Bayes, Support vector machines, Model selection and feature selection, Evaluation and debugging learning algorithms. Unsupervised learning: Clustering, K-means, Hierarchical clustering, Competitive learning, Dimensionality reduction techniques, Hidden Markov model, Linear Regression, Generating diverse learners, Ensemble techniques. Applications of Machine Learning in diverse fields

References:

1. Shai Shalev-Shwartz and Shai Ben-David, Understanding Machine Learning, Cambridge University Press. 2017.
2. Ethem Alpaydin, Introduction to Machine Learning, (2e), MIT Press, 2010.
3. Mehryar Mohri, Afshin Rostamizadeh and Amet Talwalkar, Foundation of Machine Learning, (1e), MIT Press 2012.
4. Dive into Deep Learning Aston Zhang and Zachary C. Lipton and Mu Li and Alexander J. Smola, 2019
5. Christopher M. Bishop, Pattern Recognition and Machine Learning, (1e), Springer, 2007.

MTE 4458: MACHINE TOOL TECHNOLOGY [3 0 0 3]

Types of motion in cutting, cutting speed, feed, depths of cut in machining, cutting tools classification, nomenclature of single point cutting tool, difference between orthogonal and oblique cutting, mechanism of metal cutting, types of chips, chip breakers, forces acting on a tool, merchant circle diagram, velocity relations, specific energy in cutting, tool wear, tool life factors, Taylor's tool life equation, tool wear mechanisms, heat distribution in metal cutting, measurement of temperature in metal cutting, lathe tool dynamometer, cutting fluids selection and applications, cutting tool materials, specifications for inserts and tool holders. CNC tooling, tool presetting, automated tool & pallet changing, work holding, cutting process parameter selection, jigs and fixtures, types of clamping devices, principles of clamping. Self-Study: Industrial ethics and technological risks.

References:

1. Milton C.Shaw, Metal Cutting Principles, (2e), Oxford University Press, 2000.
2. Kempster, Jigs and Fixtures, (3e), Mark Howard Publications, 2004. Steve Krar, Arthur Gill
3. and Peter Smid, Machine Tool Technology Basics, (2e), Industrial Press Inc., U.S, 2012.
4. Sharma. P. C, A Text Book of Production Engineering, (7e), SChand Publishers, New Delhi, 2008.

MTE 4459: MACHINE VISION [3 0 0 3]

Vision System Components, Pinhole Camera Model, Image Acquisition, Sampling & Quantization, Fundamentals of Color Image Processing and Color Space Conversion, Basic Operations on Images, Geometrical Transformations, Image Enhancement, Spatial Domain, and Frequency Domain Processing, Image Noise, Image Restoration, Morphological Operations, Region Segmentation, Feature Extraction, Background Subtraction, Lucas Kanade Optical Flow Estimation, Object Tracking using Kalman Filter, Localization using Passive Markers. Linear Camera Model, RGB+D camera, Time of Flight (ToF) cameras, Camera Calibration, Intrinsic and Extrinsic Camera Parameters, Stereo, Epipolar Geometry, Estimation of Fundamental Matrix, Computing Depth, Motion Field and Optical Flow, Structure from Motion, Observation Matrix, Computer Vision Software Tools for Color and Shape Detection, Human Detection, Object Tracking, Camera Calibration, Depth Estimation, Stereo Correspondence Algorithms.

References:

1. Rafael C. Gonzalez, Richard E. Woods, Digital Image Processing, (3e), Pearson Education, 2008.
2. Szeliski, Computer Vision: Algorithms & Applications, Springer, 2012
3. Milan Sonka, Vaclav Hlavac, Roger Boyle, Image Processing, Analysis and Machine Vision, (2e), 1998.
4. Boguslaw Cyganek & J. Paul Siebert, An Introduction to 3D Computer Vision Techniques and Algorithms, (1e), Wiley, 2009

5. David A. Forsyth, Jean Ponce, Computer vision: A modern approach, Pearson Education Limited.
6. E.R. Davies, Royal Holloway, Machine Vision: Theory, Algorithms and Practicalities, (3e), University of London, 2004.

MTE 4460: MECHANICAL VIBRATIONS [3 0 0 3]

Introduction to mechanical vibration, vibration system and types, vibration analysis - degrees of freedom, mathematical modelling, equations of motion, SHM, natural frequency of single degree of freedom system – mathematical modelling, derivation of governing differential equation of motion for free undamped and damped systems, forced vibration – single degree of freedom system under harmonic excitation, steady state, reciprocating and rotating unbalance, transmissibility and isolation, base excitation with harmonic input. Two degree of freedom systems - natural frequencies and mode shapes, forced vibration. Natural frequency of multi-degree of freedom systems, vibration control, vibration testing and measurement.

Self-study: Case studies on vibrational experiments using different examples

References:

1. Groover G.K., Mechanical Vibrations, Nemchand and Bros, Roorkee, 2012.
2. Singirisu Rao S, Mechanical Vibration, Pearson Education, Delhi, 2004.
3. Dukkapatti Rao V., Text Book of Mechanical Vibration. Prentice Hall of India Ltd, 2004.
4. Daniel Imnan J. Engineering Vibration, Prentice Hall, New Delhi, 2001.
5. Thomson W.T., Theory of Vibrations with Applications, Chapman and Hall, 4^{th} Edition, 1993.

MTE 4461: MICRO AND NANO FABRICATION OF ELECTRONIC DEVICES [3 0 0 3]

Intrinsic and extrinsic semiconductors, Zener diodes, Schottky diode, BJTs, MOSFETs, optoelectronic devices- LEDs, photodetectors, solar cells. Moore's Law, Scaling in CMOS, clean room concept, crystal structure of silicon, material properties, silicon wafer types, basic wafer fabrication operations: layering, patterning, doping, heat treatment. Lithography- photolithography, X-ray lithography, e-beam lithography, scanning probe, photoresists, masks; Etching- wet and dry; Deposition and growth- CVD, PVD, ALD, MBE; metallization-sputtering, CVD, electroplating; Polishing. Process and device evaluation, process yield; CMOS and SOI Technology, SOI MOSFET, strained SiGe MOSFET, Characterization: two-point, four-point probes, capacitance voltage profiling, scanning electron microscopy, transmission electron microscopy, X-ray diffraction; Packaging methods.

References:

1. Stephen A. Campbell, Fabrication Engineering at the Micro- and Nanoscale, Oxford University Press, 2013
2. Gary S. May, Simon M. Sze, Fundamentals of semiconductor fabrication, Wiley, 2003.
3. James D. Plummer, Michael D. Deal, Peter B. Griffin, Silicon VLSI Technology: Fundamentals, Practice and Modeling, Prentice Hall, 2009
4. D. Chattyopadhyay, P.C. Rakshit, Electronics Fundamentals and Applications, New Age International, 2020

MTE 4462: MICRO ELECTRO MECHANICAL SYSTEMS [3 0 0 3]

MEMS and Microsystems applications, Review of Mechanical concepts, Actuation and Sensing techniques, Scaling laws in miniaturization, Materials for MEMS, Micro System fabrication techniques, Micro manufacturing, Micro system Packaging, Bonding techniques for MEMS, Overview of MEMS areas.

References:

1. Chang Liu, Foundations of MEMS, Pearson 2012
2. Tai-Ran Hsu, MEMS and Microsystems Design and Manufacture, TMH, 2002
3. Chang C Y and Sze S. M., VLSI Technology, McGraw-Hill, New York, 2000
4. Julian W Gardner, Microsensors: Principles and Applications, John Wiley & Sons, 1994
5. Mark Madou, Fundamentals of Micro fabrication, CRC Press, New York, 1997
6. Stephen D. Senturia, Microsystem design, Springer (India), 2006.
7. Thomas B. Jones, Electromechanics and MEMS, Cambridge University Press, 2001
8. James J Allen, MEMS Design, Taylor and Francis, 2005.

MTE 4463: MICRO MANUFACTURING SYSTEMS [3 0 0 3]

Introduction, working principles and process parameters, machine tools, applications of the micro manufacturing processes, challenges in meso, micro, and nanomanufacturing, industrial applications and future scope of micro-manufacturing processes. Different instruments related to micro manufacturing such as microsensors, microactuators, microsystems. Working principles, machine construction, and applications of micromachining, nanofinishing, microjoining, microforming, microcasting, micromolding, LIGA for micro/nano products and features, the diversified industrial applications of the micro-manufactured processes, and recent research trends in this area.

References:

1. Jain V. K., Introduction to Micromachining, Narosa Publishing house Pvt. Ltd., 2010.
2. Jain V. K., Micromanufacturing, CRC Press, 2012.
3. Jain V. K., Advanced Machining Processes, Allied Publishers Pvt. Ltd., 2014.
4. Mahalik N. P., Micromanufacturing & Nanotechnology, Springer Berlin Heidelberg, 2006.
5. Jackson J. M., Microfacbrication & Nanomanufacturing, CRC Press, 2005.

MTE 4464: NANO TECHNOLOGY [3 0 0 3]

Introduction to nanotechnology, bottom-up and top-down approaches, physical and chemical properties, methods of preparation of nanoparticles, carbon nanostructures and their applications, physical chemistry of nanosystems, micro electro mechanical devices and technologies-microsensors, MEMS fabrication processes and applications, microscale and nanoscale heat conduction, nanofluids preparation and characterization, nanomaterials used in energy and environmental applications and their properties, future development of micro actuators, nanolithograghy, photoresist patterning, photolithography, electron beam lithography, production of polygon mirrors, optic fibers, future trends in nanotechnology.

References:

1. Charles P. Poole, *Introduction to Nanotechnology*, Wiley-Interscience, 2003.
2. Guozhong Cao, *Nanostructures & Nanomaterials*, Imperial College Press, 2004. 532
3. C B Sobhan, *Microscale and Nanoscale Heat Transfer*, Taylor and Francis, 2008.
4. Norio Taniguchi, *Nanotechnology*, Oxford University Press, 2008.
5. James J Allen, *MEMS Design*, Taylor and Francis, 2005.

MTE 4465: OBJECT ORIENTED PROGRAMMING USING PYTHON [3 0 0 3]

Introduction to the Object-oriented programming using Python language, Data types, Variable and arrays, Type conversion and casting, Generators, Iterators, Operators, control statements, functions and Modules. Classes and inheritance, Abstraction, Encapsulation, Polymorphism, Packages and interfaces, Working with In-built data-structures, List, Tuples, Dictionaries and set and application involving abstract DS. Exception handling, Thread concepts – synchronization, inter thread communication, Input/output – File: file input stream, File output stream, Random access files, Reader, Writer, Decorators, Map, Reduce and Collections. Serialization, Serializable, Object input stream, Object output stream, Swings - swing fundamentals, Introduction to event handling. Application: GUI, Accessing a database, Django, Flask.

References:

1. John Zelle. Python Programming: An Introduction to Computer Science (3e). CRC Press.
2. Muller and Guido. Introduction to Machine Learning with Python: A Guide for Data Scientists. (2e). Prentice Hall of India.
3. Mark Lutz. Programming Python: Powerful Object-Oriented Programming. (2e). Prentice Hall of India.

Self-Study: Courseera course entitled Python Programming for All.

MTE 4466: PRODUCTION AND OPERATIONS MANAGEMENT [3 0 0 3]

Introduction, production consumption cycle, forecasting- quantitative and qualitative methods, Forecast control, measures of forecast accuracy product development and design, product life cycle, process design, process charts, flow diagrams and man machine charts capacity planning, breakeven analysis, single and multi-product P-V charts, aggregate planning, trial and error approach, use of transportation algorithm, job shop scheduling, Sequencing of “n” jobs through 2 machines, “n” jobs through 3 machines and 2 jobs through “n” machines inventory management and line balancing, resource conversion and concepts, planning models and behavioural applications, case studies.

Self-study: Coursera course - Ethics, technology and engineering.

References:

1. Adam Everett E. Jr. and Ebert Ronald J., Production and Operations Management, Prentice Hall of India Pvt. Ltd., 2002.
2. Chase Richard B., Aquilano Nicholas J. and Jacobs F. Roberts, Production and Operations Management, Tata McGraw-Hill publishing Co. Ltd., 1999.
3. Eilon Samuel, Elements of Production Planning and Control, Universal Publishing Corporation, 1991.
4. Monks Joseph G., Operations Management, Tata McGraw-Hill Publishing Co. Ltd., 2004.
5. Krajewski Lee J. and Ritzman Larry P., Operations Management, Pearson Education Pvt. Ltd., 2005.
6. https://www.coursera.org/learn/ethics-technology-engineering

MTE 4467: REINFORCEMENT LEARNING FOR ROBOTICS [3 0 0 3]

Probability basic concepts: Probability, Random variables discrete and continuous, Conditional probability, Probability distributions, Bayes theorem, Maximum Likelihood and MAP. Sequential Decision Making with Evaluative Feedback. Learning Action Values, Estimating Action Values Incrementally, Optimistic Initial Values Upper-Confidence Bound (UCB) Action Selection, Jonathan Langford: Contextual Bandits for Real World Reinforcement Learning. Markov Decision Processes. Examples of MDPs, The Goal of Reinforcement Learning, Michael Littman: The Reward Hypothesis. Continuing Tasks, Examples of Episodic and Continuing Tasks. Value Functions & Bellman Equations: Value Functions, Rich Sutton and Andy Barto: A brief History of RL, Bellman Equation Derivation Why Bellman Equations? Optimal Policies, Optimal Value Functions, Using Optimal Value Functions to Get Optimal Policies. Dynamic Programming: Iterative Policy Evaluation, Policy Improvement, Policy Iteration, Flexibility of the Policy Iteration Framework, Efficiency of Dynamic Programming. Monte Carlo Methods for Prediction & Control: Using Monte Carlo for Prediction, Using Monte Carlo for Action Values, Using Monte Carlo methods for generalized policy iteration, Solving the Blackjack, Example: Epsilon-soft policies off-policy learning matter, Importance Sampling, Off-Policy Monte Carlo Prediction. Temporal Difference Learning Methods for Prediction: Rich Sutton: The Importance of TD Learning, The advantages of temporal difference learning Comparing TD and Monte Carlo, Andy Barto and Rich Sutton: More on the History of RL. Temporal Difference Learning Methods for Control: Sarsa: GPI with TD, Sarsa in the Windy Grid World, What is Q-learning?, Q-learning in the Windy Grid World, How is Q-learning off-policy?, Expected Sarsa, Expected Sarsa in the Cliff World, Generality of Expected Sarsa. Planning, Learning & Acting: What is a Model, Comparing Sample and Distribution Models, Random Tabular Q-planning, The Dyna Architecture, The Dyna Algorithm, Dyna & Q-learning in a Simple Maze, what if the model is inaccurate? In-depth with changing environments, Drew Bagnell: self-driving, robotics, and Model Based RL.

Self-study: Case studies on applications and implementation of different reinforcement learning algorithms

References:

1. Richard S. Sutton and Andrew G. Barto. Introduction to Reinforcement Learning, (2e), MIT Press. 2017. [Draft copies available now]
2. Dimitri Bertsikas and John G. Tsitsiklis. Neuro Dynamic Programming. Athena Scientific. 1996.
3. EnesBilgin, Mastering Reinforcement Learning with Python: Build next-generation, self-learning models using reinforcement learning techniques and best practices. Packt, (2e). 2020.

MTE 4468: RENEWABLE ENERGY TECHNOLOGY [3 0 0 3]

Energy resources – Electrical energy generation. Indian Power Generation. Environmental aspects of Electrical Energy generation. Solar Energy – fundamentals of solar energy, Solar thermal and Photovoltaics. Solar cells, solar modules and sizing, solar photovoltaics systems, solar photovoltaic applications. Grid connected PV systems. Wind Energy Systems – Fundamentals of wind energy systems. Grid connected and standalone wind power generation. Small hydropower, Geo-thermal power generation. Tidal energy, wave energy and conversion systems. Biomass Energy. Fuel cells and Hydrogen Energy Systems.

Self-study:

1. High efficient solar panels with multi crystalline.
2. New wind turbines: Bladeless turbines

References:

1. D.P. Kothari, K.C. Singal, and Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, (3e), PHI, 2022.
2. G.D. Rai, Non-conventional Energy Sources, Khanna Publishers, 2004.
3. Solanki C.S, Solar Photovoltaics - Fundamentals, Technologies and Applications, (3e), PHI, 2015.
4. S.M. Muyeen, Wind Energy Conversion Systems: Technology and Trends (Green Energy and Technology), Springer, 2012.

MTE 4469: SUSTAINABLE MANUFACTURING [3 0 0 3]

Concept of sustainability, environmental, economic and social dimensions of sustainability. Relation between green, lean and sustainable manufacturing. Environmental conscious- quality function deployment, Environmental impact assessment methods, Sustainability assessment-concept models and various approaches, Sustainable manufacturing processes - Abrasive Jet Machining, Laser beam machining, Ultrasonic Machining, Electro Chemical Machining,Electro Discharge Machining. Product Life cycle management and analysis - Tools for LCA, optimization for achieving sustainability in manufacturing, value analysis, analysis for carbon footprint-software packages for sustainability analysis. Case studies on Evaluation on Machining Processes for Sustainable Manufacturing, SDL on Introduction to Sustainability using coursera course.

References:

1. Subramanian S. M., Monica M.S., *Handbook of Sustainability in Additive Manufacturing*, Vol. 2, Springer Publication, 2018.
2. Atkinson G, Dietz S, Neumayer E, *Handbook of sustainable manufacturing*, Edward Elgar Publishing limited, Ed. 2, 2014.
3. Paul C. P., Jinoop A. N., *Additive Manufacturing*, McGraw Hill,2021.
4. https://www.coursera.org/learn/sustainability

MTE 4470: SYSTEMS MODELLING AND SIMULATION [3 0 0 3]

Principles of modeling and simulation, modeling and simulation of mixed systems, transfer function, block diagram, state space representation of SISO, MIMO, modeling of dynamic systems, construction, analysis, practical applications, linear systems, methods of model order determination, impulse and frequency response methods, system identification, algorithms for parameter estimation, gradient algorithm, least square algorithm, ARX, ARMAX applications of LS and ARMA methods, regression methods, introduction to nonlinear modeling, identification NARMAX model, case studies UAV quad-rotor, hard discs, maglev systems, ball and beam systems.

References:

1. George Pelz, Mechatronic Systems Modeling and Simulation with HDLs, Wiley, 2003.
2. Devdas Shetty, Richard Kolk, Mechatronics System Design, (2e), Cengage Learning, 2010.
3. Benjamin C. Kuo, FaridGolnarghi, Automatic Control Systems, (8e), Wiley, 2009.
4. Jack W. Lewis, Modeling of Engineering Systems PC-Based Techniques and Design Tools, High Text Publications, 2000.
5. Ioan D. Landau, Gianluca Zito, Digital Control Systems Design, Identification and Implementation, Springer, 2006.
6. System Identification: Theory for the User (2nd Edition), Lennart Ljung, Pearson: Prentice Hall.

MTE 4471: WIRELESS SENSOR NETWORKS [3 0 0 3]

Challenges for wireless sensor networks, Single node architecture – Hardware components, Energy consumption of sensor nodes, Network architecture – Types of sources and sinks, Single hop versus multi-hop networks, Multiple sinks and sources, Wireless channel and communication fundamentals – Frequency allocation, Modulation and demodulation, MAC protocols – Fundamentals of (wireless) MAC protocols, contention-based protocols, SMAC – BMAC, TRAMA, IEEE 802.15.4 MAC protocol, Q-MAC (Querry MAC), Q-MAC (QoS MAC). Routing challenges and design, SPIN COUGAR, ACQUIRE, LEACH, PEGASIS, GF, GAF, GEAR, Aggregation techniques – TAG, Tiny DB traditional transport control protocols. Wireless protocols – LANs: 802.11, 802.11a/b/g, 802.16-WiMAX, UWB communications, wireless personal area networks, Blue Tooth. Healthcare monitoring system using wireless sensor networks, remote home lighting and appliance control system, automatic speed control and vehicle tracking using GSM and GPS technologies.

References:

1. KazemSohraby, Daniel Minoli and TaiebZnati, Wireless Sensor Networks Technology-

   Protocols and Applications, John Wiley & Sons, 2010.
2. Holger Karl and Andreas Willig, Protocols and Architectures for Wireless Sensor Networks,

   John Wiley & Sons, Ltd Paperback edition, 2007.
3. Ananthram Swami, Qing Zhao, Yao-Win Hong, Lang Tong Pub,

Wireless SensorNetworksSignal Processing and Communications, First Edition, John Wiley & Sons, 2007.

4. Murthy, Ad Hoc Wireless Networks: Architectures and Protocols, Pearson Education, 2006.
5. Sridhar S. Iyengar, NandanParameshwaran, Vir V. Phoha, N. Balakrishnan, Chuka D. Okoye,

   Fundamentals of Sensor Network Programming: Applications and Technology, First Edition, John Wiley & Sons, 2010.

OPEN ELECTIVES

MTE 4311: AUTONOMOUS MOBILE ROBOTS [3 0 0 3]

Locomotion: Introduction, Legged Mobile Robots, Wheeled Mobile Robots. Mobile Robot Kinematics and Motion in Global Coordinates: Kinematic Models and Constraints, Mobile Robot Maneuverability, Mobile Robot Workspace, Dynamics of Quadrotor-Type Mobile Robots. Perception: Sensors for Mobile Robots, Feature Extraction. GNSS and Mobile Robot Localization: The Challenge of Localization: Localization-Based Navigation versus Programmed Solutions, Map Representation. Probabilistic Map-Based Localization. Global Navigation Satellite System. Planning, Navigation and Energy Considerations: Competences for Navigation, Navigation Architectures, Energy Limitations and Energetic Efficiency of Mobile Robots.

References:

1. Siegwart, Roland, Illah Reza Nourbakhsh, and DavideScaramuzza. *Introduction to autonomous mobile robots*. MIT press, 2011.
2. Howie Choset, Kevin M Lynch, *Principles of Robot Motion*, MIT Press, 2005.
3. King Sun Fu, Gonzalez ,*Robotics- control, sensing, vision, and intelligence*, McGraw-Hill, 1987.
4. Kagan, Eugene, NirShvalb, and Irad Ben-Gal, eds. *Autonomous mobile robots and multi-robot systems: Motion-planning, communication, and swarming*. John Wiley & Sons, 2019.

MTE 4312: FARM AUTOMATION [3 0 0 3]

Farm automation system, sensors, controller, actuators, regulators and servos; Agriculture robotic vehicles: Wheel-type robot tractor, Crawler type robotic tractor, rice transplanting robot, robot combined harvester; Automation in irrigation: Automated Irrigation, Portable timer system, Timer/Sensor Hybrid/SCADA, Methods of automating Irrigation layout, Machine Learning in Tank Monitoring System. IoT in Irrigation: IoT based Automated Irrigation System, Solar based Automatic Irrigation System, components, operation, Automation by sensing soil moisture, Automation using ANN based controller operation, Crop water estimate, Remote Monitoring design of Automatic Irrigation system, Cost and Benefits of Automation; Automation in Protected Cultivation: Automation in seed, seedling and nursery, automation in seed processing, automation in polyhouse: Heading and Pruning Automation in Polyhouse Production, Mechanical Mass Harvesting of Fruits, Nuts and Vegetables; Automation through robots: Harvesting and picking, weed control, Autonomous mowing, pruning, seeding, spraying and thinning, Phenotyping, Sorting and packing, Utility platforms robots, Soil moisture, nutrient status analysis by robots, Smart cameras for weed-crop segmentation; Automation in food processing: Introduction, Post-Harvest and Food Processing Unit Operations, Material Handling, Packaging and Transportation, Novel Food processing techniques.

References:

1. Brian Wahlin and DarellZimbelman, Canal Automation for Irrigation Systems, American Society of Civil Engineers, 2014
2. Qin Zhang and Francis J Pierce, Agricultural Automation: Fundamentals and Practices, CRC Press
3. Darwin G. Caldwell, Robotics and Automation in the Food Industry. Current and Future Technologies, Woodhead Publishing Series in Food Science, Technology and Nutrition, (2013).
4. P. J. Fellows, Food Processing Technology, Principles and Practice, (4e).

MTE 4313: HYDRAULICS AND PNEUMATICS SYTEMS [3 0 0 3]

Pneumatic systems, structure and signal flow, compressors, actuators and control valves, single acting and double acting cylinders, manual pneumatics, single and multiple actuators, limit switches, proximity sensors, electro pneumatics and design of electro pneumatic circuits, direction control valves, relay control systems, timers, counters, pressure control valves, closed loop pneumatics and Flow control valves. Hydraulic systems, physical principles of oil hydraulics, hydraulic actuators, valves and accessories, hydraulic power pack, types of hydraulic pumps, accumulator, Filters, hydraulic circuits, regenerative, meter in, meter out, bleed off, sequencing, pressure reducing circuits, electro hydraulic circuits, proportional hydraulics and servo hydraulics.

References:

1. Anthony Esposito, *Fluid power with applications*, Pearson Education, 2003.
2. Andrew A. Parr, *Hydraulics and Pneumatics*, Elsevier Science & Technology Books, 1999.
3. Scholz D., *Proportional Hydraulics*, Festo Didactic GMBH & Co, Germany, 2002.
4. Majumdar S.R., *Pneumatic Systems - Principles and Maintenance*, Tata McGraw Hill, 2000.

   Merkle D., Rupp K. and Scholz D., *Electrohydraulics Basic Level TP 601*, Festo Didactic GMBH & Co, Germany, 1994.

MTE 4314: INDUSTRIAL IOT [3 0 0 3]

Introduction to Industrial IoT, Components of IIoT. Sensors, Acceleration: Accelerometers (Piezoelectric, Capacitive); Proximity & Range: Proximity Switches, Ultrasonic Sensor, Hall Effect Sensor, Eddy Current Sensor, Temperature: Bimetallic, RTD, Thermocouple, Thermistor, Optical Pyrometer; Pressure: Electric Transducers, Pressure Transmitters, Pressure Gauges – McLeod, Knudsen, Pirani, Vacuum; Flow: Ultrasonic, V Cone, Laser Doppler, Mass flowmeters. Introduction to PLC: Advantage of PLC, and Chronological Evolution of a PLC, Type of PLC, Parts of PLC and Block diagram PLC, I/O modules and interfacing, networking of PLC ,Input-Output System Sinking and Sourcing, power supply module, Programming Equipments. Programming formats using contacts and coils, latching etc. Converting simple relay logic diagram to PLC ladder diagram, Digital logic implementation in ladder programming, Timer and counter functions, Arithmetic functions, R-trig / F- trig pulses, shift registers, sequence functions, PID principles and functional block, position indicator with PID control. Industrial Process Automation, Networks and Protocols: AS-i, CAN, DeviceNet, Interbus, LON, Foundation Fieldbus, HART, PROFIBUS-PA, BACnet, ControlNet, Industrial Ethernet, Ethernet/IP, MODBUS, PROFIBUS-DP. Database-System Applications, Purpose of Database Systems, View of Data, Database Languages, Relational Databases. Introduction to security, Characteristics of Information, Components of an Information system, Security System Development Lifecycle, The Need for Security- Business Needs first, Threats, Attacks, Intruders, Intrusion detection.

References:

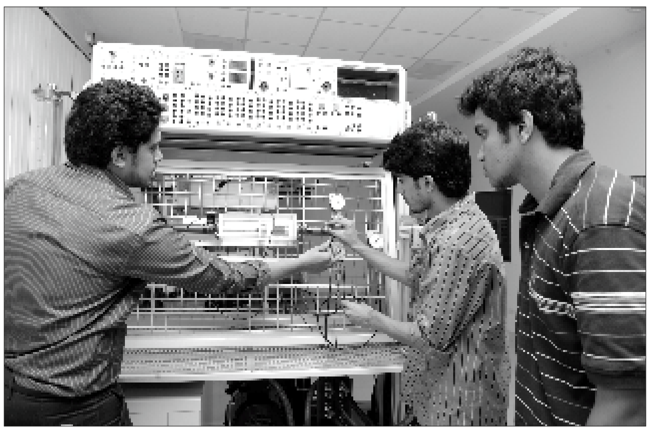
1. Liptak, B.G. (Ed.), Instrument engineers' handbook, Vol. 3: Process software and digital networks, (4e) CRC Press, Boca Raton, London, 2012.
2. Andrew S. Tanenbaum, Computer Networks, (5e), Prentice Hall of India Pvt. Ltd., 2011.
3. William Stallings, Data and Computer Communications, (8e), Prentice Hall of India Pvt. Ltd., 2014.

MTE 4315: INTRODUCTION TO INDUSTRIAL ROBOTICS [3 0 0 3]

Introduction: definition of robots, anatomy, degrees of freedom, Robot configuration, control parameters, actuators and sensors. Spatial Descriptions and Transformations: Frame representation and mapping, operators. Industrial Manipulator Kinematics:link description, forward kinematics of industrial robots, Inverse kinematics of standard industrial manipulators. Industrial Manipulator Dynamics: Jacobian and force vector.Forward dynamics and inverse dynamic simulations in Robo Analyzer software, Robotics Application: Image processing: colour detection through Open CV programming. Arduino programming for servo and DC motor control. Socio-economic and Safety Aspect of Industrial Robots: Social and labor issues impact. Economic analysis. Safety, training, maintenance and quality improvement, Robotics technology of the future.

References:

1. John J. Craig, Introduction to Robotics: Mechanics and Control, (3e), PHI, 2005.
2. C. Peter. Robotics, Vision and Control: Fundamental Algorithms in MATLAB. Vol. 73. Springer, 2011.
3. G. Ashitava, Robotics: Fundamental Concepts and Analysis, Oxford University Press, 2006.
4. Murray, Richard M., Zexiang Li, S. Shankar Sastry, and S. Shankara Sastry, A Mathematical Introduction to Robotic Manipulation, CRC press, 1994.
5. Siciliano, Bruno, and Oussama Khatib. "Robotics and the Handbook." Springer Handbook of Robotics. Springer, Cham, 2016.
6. Groover, Mikell P., Mitchell Weiss, and Roger N. Nagel. Industrial robotics: technology, programming and application. McGraw-Hill Higher Education, 1986.



Department of Mathematics

The Department of Mathematics at Manipal Institute of Technology was started in 1957. It provides the mathematical foundation required to formulate, analyse and solve the problems of engineering and management. Currently the department has grown and developed into a status of eminence both in terms of number and quality of its academic output. The faculty members, along with the regular teaching, also guide the students in acquiring higher-level knowledge of pure and applied mathematics. The primary responsibility of the department is to teach mathematics to undergraduate students. It also takes up teaching specialized subjects to M.Tech. and MCA programs. The department also offers M.Sc. (Applied Mathematics and Computing) and Integrated M.Sc. (Mathematics and Computing) programs. There are 46 faculty members of which 6 Professors, 5 Additional Professors, 15 Associate Professors and 20 Assistant Professors with diversified specializations. The core competencies include Linear Algebra, Numerical Analysis, Fluid Dynamics, Applied Graph Theory, Number Theory, Complex Analysis, Algebra and Applications, Functional Analysis, Topology, Statistical Inferences, Deep Learning, Reliability Theory, Control & Optimization. Further, a substantial number of faculty members are pursuing their Ph.D. degree. A few faculty members have also obtained Post-Doctoral fellowship in specialized areas of Mathematics. The department offers Ph.D. programs in various specializations for students admitted through national level entrance exams. The department is associated with the Centre for Advanced Research in Applied Mathematics & Statistics (CARAMS), MAHE. The department offers B.Tech. Mathematics and Computing, jointly with the department of Data Science and Computer Applications from the academic year 2023-2024.

> Programs offered

Undergraduate Program

- B.Tech in Mathematics and Computing (2023)

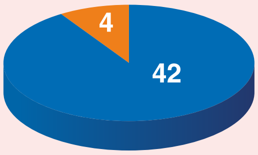
Postgraduate Program

- M.Sc in Applied Mathematics and Computing (2009)

PhD

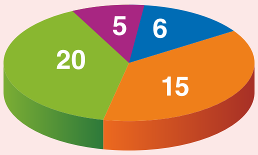
> Faculty Strength

Qualification-wise



- PhD
- M.Sc

Cadre-wise



- Professors
- Additional Professors
- Associate Professors
- Assistant Professors

B.TECH. MATHEMATICS AND COMPUTING

Program offered by the Department of Mathematics jointly with the Department of Data Science and Computer Applications

Year	THIRD SEMESTER						FOURTH SEMESTER					
II	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	MAT 2135	Computational Linear Algebra	3	1	0	4	MAT 2235	Algebraic Structures	2	1	0	3
	MAT 2136	Probability and Stochastic Process	3	1	0	4	DSE 2223	Design and Analysis of Algorithms	2	1	0	3
	DSE 2122	Data Structures	3	0	0	3	MAT 2236	Real Analysis	3	1	0	4
	MAT 2137	Elementary Number Theory	2	1	0	3	MAT 2237	Mathematical Logic	3	0	0	3
	DSE 2125	Advanced Programming	3	0	0	3	MAT 2238	Vector Analysis and Complex Variables	2	1	0	3
	MAT 2138	Discrete Mathematics	2	1	0	3	DSE 2222	Fundamentals of Machine Learning	3	0	0	3
	DSE 2144	Advanced Programming Lab	0	0	3	1	DSE 2243	Design and Analysis of Algorithms Lab	0	0	3	1
	DSE 2142	Data Structures Lab	0	0	3	1	DSE 2244	Machine Learning Lab	0	0	3	1
			16	**4**	**6**	**22**			**18**	**3**	**6**	**21**
	Total Contact Hours (L + T + P)		**26**				**Total Contact Hours (L+T+P)**		**27**			
III	**FIFTH SEMESTER**						**SIXTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	HUM 3021	Engineering Economics and Financial Management	2	1	0	3	HUM 3022	Essentials of Management	2	1	0	3
	DSE 3123	Database Management Systems	3	0	0	3	MAT 3231	Advanced Numerical Methods	3	0	0	3
	MAT 3131	Multivariate Analysis	3	0	0	3	MAT 3232	Time Series Analysis	3	1	0	4
	MAT 3132	Artificial Intelligence	3	0	0	3	MAT ****	Program Elective - I / Minor Specialization	3	0	0	3
	DSE 3124	Principles of Software Engineering	3	1	0	4	MAT ****	Program Elective - II / Minor Specialization	3	0	0	3
	IPE 4302	Open Elective - 1 Creativity, Problem Solving and Innovation	3	0	0	3	*** ****	Open Elective - 2	2	1	0	3
	DSE 3143	Principles of Software Engineering Lab	0	0	3	1	MAT 3241	Scientific Computing Lab	0	0	6	2
	DSE 3144	Database Management Systems Lab	0	0	3	1						
			17	**2**	**6**	**21**			**18**	**1**	**6**	**21**
	Total Contact Hours (L+T+P) + OE		**22+3=25**				**Total Contact Hours (L+T+P) + OE**		**22+3=25**			
IV	**SEVENTH SEMESTER**						**EIGHTH SEMESTER**					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
	MAT ****	Program Elective - III / Minor Specialization	3	0	0	3	MAT 4291	Industrial Training				1
	MAT ****	Program Elective - IV / Minor Specialization	3	0	0	3	MAT 4292	Project Work				12
	MAT ****	Program Elective - V	3	0	0	3	MAT 4293	Project Work (B.Tech Honours)**				20
	MAT ****	Program Elective - VI	3	0	0	3	MAT ****	B.Tech Honours (Theory 1)** (V Semester)				4
	MAT ****	Program Elective - VII	3	0	0	3	MAT ****	B.Tech Honours (Theory 2)** (VI Semester)				4
	*** ****	Open Elective - 3	3	0	0	3	MAT ****	B.Tech Honours (Theory 3)** (VII Semester)				4
	MAT 4191	Mini Project (Minor Specialization)*				8						
			18	**0**	**0**	**18/26**						**13/33**
	Total Contact Hours (L+T+P) + OE		**15 + 3 = 18**									

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

MINOR SPECIALIZATIONS

I APPLIED MATHEMATICS

MAT 4405: Linear Optimization
MAT 4406: Non-Linear Optimization
MAT 4407: Combinatorics and Design of Experiments
MAT 4408: Game Theory and Statistical Decisions

II ADVANCED MATHEMATICS

MAT 4409: Applied Graph Theory
MAT 4410: Matrix Theory
MAT 4411: Advanced Algorithms and Deep Learning
MAT 4412: Algebraic Coding Theory

III MULTIMODAL INTELLIGENT SYSTEM

DSE 4401: Information Retrieval
DSE 4402: Natural Language Processing
DSE 4403: Social Network Analysis
DSE 4404: Computer Vision

IV NETWORK ANALYTICS

DSE 4405: Cloud Computing
DSE 4406: Internet of Things
DSE 4407: Enterprise Data Architecture
DSE 4408: Blockchain Technology

OTHER PROGRAM ELECTIVES

MAT 4444: Big Data Analytics
MAT 4446: Computational Fluid Dynamics
MAT 4447: Functional Programming
MAT 4448: Fuzzy Logic and Neural Networks
MAT 4450: Geometric Topology
MAT 4453: Mathematics for Finance
MAT 4455: Reliability Theory
MAT 4456: Theory of Computation
MAT 4457: Topology of Metric Spaces

THIRD SEMESTER

MAT 2135: COMPUTATIONAL LINEAR ALGEBRA [3 1 0 4]

Introductory Example: Linear Models in Economics and Engineering; Systems of Linear Equations; Row Reduction and Echelon Forms; Vector Equations; The Matrix Equation Ax = b; Solution Sets of Linear Systems; Applications of Linear Systems; Linear Independence; Introduction to Linear Transformations; The Matrix of a Linear Transformation; Linear Models in Business, Science, and Engineering; Matrix Algebra; Partitioned Matrices; Matrix Factorizations; Subspaces of Rn; Dimension and Rank; Vector Spaces; Vector Spaces and Subspaces; Null Spaces, Column Spaces, and Linear Transformations; Linearly Independent Sets; Bases; The Dimension of a Vector Space; Applications to Difference Equations; Eigenvectors and Eigenvalues; The Characteristic Equation; Diagonalization; Inner Product Spaces; Orthogonal Projections; The Gram-Schmidt Process; Least-Squares Problems. Determinants, Diagonalization of Symmetric Matrices; Quadratic Forms; Constrained Optimization; The Singular Value Decomposition.

Reference Books:

1. S. Kumarasen, Linear Algebra, Geometric approach, PHI, 2017
2. R. Rao and P. Bhimsankaram: Linear algebra, Hindustan book agency, 2000.
3. S. H. Friedberg, A. J. Insel and L. E. Spence: Linear algebra, Pearson, 2015.
4. D. C Lay: Linear algebra and its applications, Pearson, 2014.

MAT 2136: PROBABILITY AND STOCHASTIC PROCESS [3 1 0 4]

Probability: Basic concepts -Random Experiments, Sample space, Elementary and compound events, Algebra of events, Classical definition of probability and its limitations, relative frequency approach, Conditional Probability and Independence, Multiplication theorem, Bayes' Theorem (with proof) and its applications. Random Variables, one and two dimensional, with marginal and conditional probability distributions. Expectation of r.v. s, functions of random variables, M.G.F. Discrete distributions, Limiting Distributions. Continuous univariate distributions. Sampling: Population and Sample, Complete enumeration v/s sample surveys - merits and demerits. Need for sampling, random and non-random sampling, limitations of non-random sampling and judgment sampling, Errors in sampling. Parameter and statistic, Unbiasedness, variance and precision of estimators, pilot survey, determination of sample size, Sampling variances, standard errors, Sampling Distributions-Definition and derivation of students' t, Chi-squared and F- distributions using transformation of random variables – their properties. Estimation & Inference: Limit theorems - Markov's inequality, statement and proof of Chebychev's inequality, sequence of random variables, convergence in probability: basic results (without proof), Weak law of large numbers, central limit theorem for i. i. d. random variables and its application. Methods of estimations and characteristics of an ideal estimator, testing of hypothesis – basic concepts-type I & II errors, size & power of the test, testing for equality of mean/ two means, independence of attributes, proportions, testing for goodness of fit. Confidence intervals also to be covered.

References:

1. Gupta, S. C., & Kapoor, V. K. (2002). Fundamental of Mathematical Statistics. Sultan Chand & sons.
2. Rohatgi, V. K. (2002). An Introduction to Probability theory and Mathematical Statistics. Wiley Eastern Limited.
3. Ross, S. M. (2003). Introduction to Probability Models. 10e, Academic Press, UK.
4. Mukhopadhyay P. (1998): Theory and Methods of Survey Sampling, Prentice-Hall of India
5. Medhi, J. (2006). Statistical Methods: An Introductory Text. New Age International(P) Limited, New Delhi.
6. P L Meyer: Introductory Probability and Statistical Applications 2Ed (2017), Wiley.

DSE 2122: DATA STRUCTURES [3 0 0 3]

Introduction - Pointers and Pointer Application, Accessing variables through pointers, pointers to pointers, pointer arithmetic and arrays, pointers and functions, Recursion- definition, recursive programs, efficiency of recursion, Stacks, queues, evaluation of expressions, multiple stacks and queues and its application, Linked lists representations- Singly, doubly, header node, circular along with the applications, Trees-Binary trees, representation, recursive/ non recursive inorder, preorder and post order tree traversal, level order traversal, Binary search tree, creation, insertion deletion operations on binary search tree, Additional Binary Tree Operations, Threaded Binary Tree and applications and Introduction to the concepts of Optimal Binary Search Trees, Tree variations, Searching and Sorting Techniques, Graphs- Storage representations, BFS,DFS, Spanning tree, Minimum spanning tree.

SDL: Graphs- Storage representations, BFS, DFS, Spanning tree, Minimum spanning tree.

References:

1. Behrouz A. Forouzan, Richard F. Gilberg, A Structured Programming Approach Using C, (3e), Cengage Learning India Pvt. Ltd, India, 2007
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson and Freed, Fundamentals of Data Structures in C, (2e), Silicon Press, 2007
3. Richard F. Gilberg, Behrouz A. Forouzan, Data structures, A Pseudocode Approach with C, (2e), Cengage Learning India Pvt. Ltd, India , 2009
4. Tenenbaum Aaron M., Langsam Yedidyah, Augenstein Moshe J., Data structures using C, Pearson Prentice Hall of India Ltd., 2007
5. Debasis Samanta, Classic Data Structures, (2e), PHI Learning Pvt. Ltd., India, 2010

MAT 2137: ELEMENTARY NUMBER THEORY [2 1 0 3]

Linear diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues. Chinese remainder theorem, Fermat's little theorem, Wilson's theorem. Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function. Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli. Public key encryption, RSA encryption and decryption, the equation Fermat's Last theorem.

References:

1. David M. Burton, Elementary Number Theory, 6th Ed., Tata McGraw-Hill, Indian reprint, 2007.
2. Neville Robinns, Beginning Number Theory, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.

DSE 2125: ADVANCED PROGRAMMING [3 0 0 3]

Getting started with python scripting, Using the file system, Reading and writing files, Numerical Computing In Python, SciPy package, Classes and object-oriented programming, Data types as objects, Graphical user interfaces, Regular expressions, Network, web, and database programming: Accessing databases in Python, Network programming in Python, Creating a Python web application, Sample project—creating a message wall, Web frameworks creating a model to add database service – using SQLite; Cloud computing: google app engine and web services: What is cloud computing, levels of cloud computing service, what is Aapp Engine, The sandbox and the App Engine SDK, Choosing an App Engine framework.

References:

1. Hans Peter Langtangen, Python Scripting for Computational Science, (3e), Springer Publishers, 2014
2. Naomi R. Ceder, The Quick Python Book, (2e), Manning Publications Co., 2010
3. Wesley J. Chun, Core Python Applications Programming, (3e), Prentice Hall Publishers, 2012
4. Bill Lubanovic, Introducing Python - Modern Computing in Simple Packages, O'Reilly Publication, 2015
5. Allen B. Downey, Think Python-How to think like a computer scientist, (2e) O'Reilly Publication, 2015

DSE 2144: ADVANCED PROGRAMMING LAB [0 0 3 1]

Class and Objects: Class Definition, Creating Objects; Array and Strings: Programs Based Upon 1-D, 2-D and Dynamic Arrays, String Comparison and Manipulation; Inheritance: Inheritance and Its Types, Abstract Class, Inner and Outer Class, Super, Final, Static Keywords; Collection Framework & Generics: Using Collection Classes such as Array Lists and Linked Lists Writing Generic Classes; Exception Handling: Errors and Exceptions, Types of Exceptions; Multithreading: Thread Class, Runnable, Synchronization, Thread Priority; Event Handling and GUI Programming

References:

1. Schildt H, Java: The Complete Reference, (10e), Tata McGraw-Hill Education Group, 2017.
2. Balagurusamy E, Programming with Java, (5e), Tata McGraw Hill

Education Group, 2017.

3. Daniel Liang Y, Introduction to Java Programming, (10e), Pearson Education India, 2018.
4. Horstmann CS, Big Java: Early Objects, (5e), Wiley's Interactive Edition, 2015.

MAT 2138: DISCRETE MATHEMATICS [2 1 0 3]

Sets and Sequences: Finite Sets, Power Set, Cardinality of finite sets, Cartesian Product, Properties of Sets, Vector Implementations of Sets. Introduction to Logic. Propositional Logic, Truth tables, Deduction, Resolution, Predicates and Quantifiers. Relational Structures on Sets: Relations & Graphs. Relations, Equivalence Relations. Functions, Bijections. Binary relations and Graphs. Introduction to Graph Theory: Trees, Spanning trees – algorithms, Enumeration of trees Graph Decomposition and labelling shortest paths, Eulerian graphs. Boolean Algebras, Representation Theorem, Boolean Functions, Minimization, and Applications. Sizes of Sets: Counting & Combinatorics. Counting, Sum and product rule, Principle of Inclusion Exclusion. Pigeon Hole Principle, Counting by Bijections. Double Counting. Linear Recurrence relations - methods of solutions. Generating Functions. Permutations and counting.

Reference Books:

1. An Introduction to Computational Combinatorics, E. S. Page, L. B. Wilson, Cambridge Press, 1979.
2. Discrete Mathematics and its Applications - Kenneth H. Rosen 7th Edn.Tata McGraw Hill, 1988.
3. Elements of Discrete Mathematics, C. L Liu, McGraw-Hill Inc., 1985. Applied Combinatorics, Alan Tucker, 2007.
4. Concrete Mathematics, Ronald Graham, Donald Knuth, and Oren Patashnik, 2nd Edition - Pearson Education Publishers - 1996.
5. Combinatorics: Topics, Techniques, Algorithms by Peter J. Cameron, Cambridge University Press, 1994 (reprinted 1996).

DSE 2142: DATA STRUCTURES LAB [0 0 3 1]

Reviewing the concepts of pointers, structures and recursion, Studying the operation of stacks and queues and the associated application programs, Creating dynamic allocation of memory for linked list and applying it to examples using singly, doubly and circular linked list and their applications, Creation of binary trees and the application associated with the trees.

References:

1. Behrouz A. Forouzan, Richard F. Gilberg, A Structured Programming Approach Using C, (3e), Cengage Learning India Pvt. Ltd, India, 2007
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson and Freed, Fundamentals of Data Structures in C, (2e), Silicon Press, 2007
3. Richard F. Gilberg, Behrouz A. Forouzan, Data structures, A Pseudocode Approach with C, (2e), Cengage Learning India Pvt. Ltd, India, 2009
4. Tenenbaum Aaron M., LangsamYedidyah, Augenstein Moshe J., Data structures using C, Pearson Prentice Hall of India Ltd., 2007
5. Debasis Samanta, Classic Data Structures, (2e), PHI Learning Pvt. Ltd., India, 2010

FOURTH SEMESTER

MAT 2235: ALGEBRAIC STRUCTURES [2 1 0 3]

Groups: Symmetries of the plane. Groups. The symmetric group Sn. Homomorphisms of groups. Cyclic Groups, Subgroups. Lagrange's theorem. Conjugacy. Normal subgroups, Quotient groups. Homomorphism theorems. Permutation groups, Group actions. Semigroups: Basic theory and properties. Rings: Rings. Subrings. Ideals. Polynomials. Integral domains and fields. Roots of polynomials. Symmetric polynomials. Factorization in integral domains. Field extensions and Geometric Constructions.

References:

1. Michael Artin: Algebra, Second Edition, Pearson Prentice-Hall of India, New Delhi, 2011.
2. David S. Dummit and Richard M. Foote: Abstract Algebra, Third Edition, Wiley, 2005.
3. Joseph A. Gallian: Contemporary Abstract Algebra, Eighth Edition, BROOKS/COLE Cengage Learning, 2013
4. Topics in Algebra, I.N. Herstein, Wiley, 1975.
5. Thomas W. Judson, Abstract Algebra - Theory and Applications, 1994.

DSE 2223: DESIGN AND ANALYSIS OF ALGORITHMS [2 1 0 3]

Fundamentals of Algorithms, Important Problem Types, Analysis of algorithm efficiency. Analysis Framework: Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non recursive and Recursive Algorithms. Brute force Techniques, Divide and Conquer, Decrease and Conquer: Insertion Sort, Depth First Search, Breadth First Search, Topological Sorting. Transform and Conquer: Pre-sorting, BST, Heapsort. Space and Time trade-offs: Input Enhancement in String Matching. Dynamic Programming: Warshall's and Floyd's Algorithms, The Knapsack Problem. Greedy Techniques: Prim's, Kruskal's and Dijkstra's Algorithm, Huffman Trees. Coping with limitations of algorithmic power, P, NP, and NP-complete Problems, Backtracking: n–Queens problem, Hamiltonian Circuit Problem, Subset–Sum Problem. Branch and Bound: Assignment Problem, Knapsack Problem, TSP.

SDL: Branch and Bound: Assignment Problem, Knapsack Problem, TSP.

References:

1. Anany Levitin, Introduction to the Design and Analysis of Algorithms, (3e), Pearson Education, 2011
2. Ellis Horowitz and Sartaj Sahni, Computer Algorithms/C++, (2e), University Press, 2008.
3. Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, Introduction to Algorithms, (3e), PHI, 2009

MAT 2236: REAL ANALYSIS [3 1 0 4]

Real Number System: Algebra of Real Numbers, Upper and Lower Bounds, LUB and GLB property and its applications, Absolute Value and Triangle Inequality. Sequences and Their Convergence: Cauchy Sequences, Monotone Sequences, Sandwich Lemma, Some important Limits, Sequences Diverging to +, -, Subsequences, Sequences Defined Recursively. Continuity: Continuous Functions, - definition of continuity, Intermediate Value Theorem, Extreme Value Theorem, Monotone Functions, Limits, Uniform Continuity. Differentiation: Differentiability of functions, Mean Value Theorems, L'Hospital Rules, Higher Order Derivatives, Taylor's Theorem, Convex functions. Functions of Two variables. Infinite Series: Convergence, Abel's Summation by parts, Cauchy product of two infinite Series. Reimann Integration: Darboux Integrability, Properties of the integral, Fundamental Theorem of Calculus. Introduction to Metric spaces, examples, open sets, closed sets, limit point, continuity.

References:

1. Ajit Kumar and Kumaresan, A Basic Course in Real Analysis, CRC Press. 2014.
2. Tom M. Apostol: Mathematical Analysis, Second Edition, Addison Wesley Publishing Company, 1974.
3. W. Rudin, Principles of Mathematical Analysis, 3rd Edition (2017).
4. Sudhir R. Ghorpade and B. V. Limaye, A Course in Calculus and Real Analysis (Undergraduate Texts in Mathematics) Hardcover – 2006 (Springer).
5. Sudhir R. Ghorpade and B. V. Limaye, A Course in Multivariable Calculus and Analysis, 2010 (Springer)

MAT 2237: MATHEMATICAL LOGIC [3 0 0 3]

Formal proofs, resolution, Axiom systems, strong completeness and compactness of propositional logic. First order with equality: First order structures in mathematics, Propositional reduction, completeness and compactness. Variants of Lowenheim - Skolem theorem. Some complete axiom systems. Isomorphism and equivalence of structures. Expressive and distinguishing power of First order logics. EF games and 0-1 law. Proof sketch of Incompleteness theorems. Undecidability.

References:

1. Singh A., Logics for Computer Science, PHI Learning. 2003
2. A Friendly Introduction to Mathematical Logic - Christopher C. Leary, Lars Kristiansen - Milne Library 2nd edition 2015.
3. A course in mathematical logic - Yu I Manin – Springer. 1977
4. Leonid Libkin, Elements of Finite Model Theory, Springer, 2004.

MAT 2238: VECTOR ANALYSIS AND COMPLEX VARIABLES [2 1 0 3]

Vectors Analysis: Gradient, Curl, Divergence, Geometric meaning, Differentiation of Univariate Functions, Partial Differentiation and Gradients, Gradients of Vector-Valued Functions, Gradients of Matrices, Useful Identities for Computing Gradients, Backpropagation and Automatic Differentiation, Higher-Order Derivatives, Linearization and Multivariate Taylor Series. Complex Numbers and elementary properties: Argand plane and Properties, Polar and Exponential Forms, Powers and roots, Functions of a Complex variable, Limits, Continuity, Differentiability, Cauchy Riemann Equations, Analytic functions, Entire functions. Harmonic functions, Elementary functions: Exponential function, Trigonometric functions, Hyperbolic functions and Logarithmic functions. Definite integrals of functions. Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals. Cauchy-Goursat theorem, Cauchy integral formula.

References:

1. James Ward Brown, Ruel V. Churchil, Complex Variables and Applications, 8th Ed., Mc Graw Hill Publications, 2009.
2. H.S. Kasana, Complex variables theory and applications, 2nd Ed., PHI Learning Pvt Ltd., New Delhi, 2005.
3. Murray Spiegel, Seymour Lipschutz, Dennis Spellman, VECTOR ANALYSIS: Schaum's Outlines Series |2nd Edition Paperback –2017.

DSE 2222: FUNDAMENTALS OF MACHINE LEARNING [3 0 0 3]

Machine Learning Basics: Types of Machine Learning, Supervised vs. Unsupervised Learning, Parametricvs.non-parametricmodels., Instance Based learning–k-nearest neighbors, Simple Regression Models: Linear, Logistic, Cost functions, Gradient Descent, Batch Gradient Descent, Over fitting, Model Selection, No free lunch theorem, bias/variance trade-off, union and Chernoff bounds, VC dimensions. Bayesian Models: Bayesian concept learning, Bayesian Decision Theory, Naïve Bayesian, Laplacian Correction, Bayesian Belief Networks. Tree Models: information theory, decision tree induction, tuning tree size, ID3,C4.5,CHAID, Decision Stump. Support Vector Machines: kernel functions, Regression Models: Ridge and Lasso Regression, GLM and the exponential Family. Bagging algorithm, Random Forests, Grid search and randomized grid search, Partial dependence plots. Ensembling and Boosting Algorithms: Concept of weak learners, Adaptive Boosting, Extreme Gradient Boosting (XGBoost). Artificial Neural Networks: Perceptron, Backpropagation, Hopfield Network. Curse of Dimensionality: Factor Analysis, Principal Component Analysis(PCA), Difference between PCAs and Latent Factors

References:

1. K.Murphy, Machine Learning: A Probabilistic Perspective, MIT Press,2012.
2. G. James, D. Witten, T Hastie, R Tibshirani, An introduction to statistical learning with applications in R, Springer, 2013.
3. J. Han, M. Kamber, J. Pei, Data Mining concepts and techniques, (2e), Morgan Kaufmann-Elsevier,2011.
4. T.Hastie, R.Tibshirani, J.Friedman, The Elements of Statistical Learning, (2e),Springer,2009.
5. T.M.Mitchell, Machine Learning,(Indian Edition),MacGrawHill,2017.
6. C.Bishop,Neural Networks for Pattern Recognition, Oxford University Press,2019

DSE 2243: DESIGN & ANALYSIS OF ALGORITHMS LAB

Exercises to implement doubly linked list & Binary Search Tree, GCD Techniques. Sorting algorithms. String Matching, DFS, BFS, Topological sorting, AVL tree, 2-3 tree, Horspool algorithm, Open hash table, Floyd's algorithm, Warshall's algorithm, Greedy Techniques, Dijkstra's algorithm, Backtracking.

References:

1. Anany Levitin, Introduction to the Design and Analysis of Algorithms, (3e), Pearson Education, India, 2011.
2. Ellis Horowitz and Sartaj Sahni, Computer Algorithms/C++, (2e),

University Press, 2007

3. Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, Introduction to Algorithms, (2e), PHI, 2006

DSE 2244: MACHINE LEARNING LAB [0 0 3 2]

Tutorial on tools for Machine Learning. Python suggested. Experiments with datasets to be defined in lab manual to perform preprocessing and deploy classifiers such as Bayesian, Decision Trees, Support Vector Machines, k-nearest neighbor, Regression Models. Classification accuracy measures, improving classifier performance through ensembling, boosting etc.

References:

1. Hans Peter Langtangen, Python Scripting for Computational Science, (3e), Springer Publishers, 2014
2. Naomi R. Ceder, The Quick Python Book, (2e), Manning Publications Co., 2010
3. Wesley J. Chun, Core Python Applications Programming, (3e), Prentice Hall Publishers, 2012
4. G. James, D. Witten, T Hastie, R Tibshirani, An introduction to statistical learning with applications in R, Springer, 2013.

FIFTH SEMESTER

MAT 3131: MULTIVARIATE ANALYSIS [3 0 0 3]

Multivariate distributions: multivariate normal distribution and its properties, distributions of linear and quadratic forms, tests for partial and multiple correlation coefficients and regression coefficients and their associated confidence regions. Data analytic illustrations. Wishart distribution (definition, properties), construction of tests, union-intersection and likelihood ratio principles, inference on mean vector, Hotelling's T2. MANOVA- Inference on covariance matrices. Classification methods: Discriminant analysis, principal component analysis and factor analysis, Canonical Correlation analysis, Correspondence Analysis, Multidimensional Scaling, Cluster analysis. Nonparametric and robust methods of multivariate analysis. Graphical representation of multivariate data.

Reference Books:

1. T. W. Anderson (2009), An Introduction to Multivariate Statistical Analysis. (third edition). John Wiley & sons.
2. Richard Arnold Johnson and Dean W. Wichern (2007) Applied Multivariate Statistical Analysis, Prentice Hall.
3. Alvin C. Rencher, William F. Christensen (2012), “Methods of Multivariate Analysis” John Wiely.
4. Rao, C. R. (2002). Linear Statistical Inference and its Applications. (second edition) (Wiley Series in Probability and Statistics)
5. Mathematical Statistics, Basic Ideas and Selected Topics, Volumes I-II Package By Peter .J. Bickel, Kjell A. Doksum· 2015. (CRC Press) (second edition)
6. C. Casella and R. L. Berger: Statistical Inference, 2nd Edition (2007) Cengage Learning.

DSE 3123: DATABASE MANAGEMENT SYSTEMS [3 0 0 3]

Introduction to Database Management Systems - Applications, View of data, Database languages, Database users and Administrator. Introduction to Relational Model: database schema, keys, schema diagrams, Relational Query Languages, Relational algebra: introduction, Selection and projection, set operations, renaming, Joins, Division, syntax, semantics. Operators, grouping and ungrouping, relational comparison. Tuple relational calculus, Domain relational Calculus, calculus vs algebra, computational capabilities, Introduction to SQL: Data Definition, Basic structure of SQL queries, Basic operations, Set operations, Null values, Aggregate Functions, Nested subqueries, Modification of the database. Intermediate SQL: Join expressions, Views, Transactions, Integrity Constraints, SQL Data types and schemas, Authorization, Advanced SQL-PL/SQL, Cursors, Functions, Procedures, Triggers, recursive queries, advanced aggregation features. Database Design and Entity-Relationship Model: Design Process, ER Model, Reduction to Relational schema. Relational Database design: Functional dependencies, Normal forms, Closure, Canonical cover, Lossless joins, dependency preserving decomposition, Storage and File structure, Indexing & Hashing. Query Processing, Overview, Measure of query cost, selection, Join operation, sorting, Evaluation of expressions. Query Optimization: Overview, Estimating statistics of expression results, Materialized Views. Transactions: Concepts, Simple transaction model, Transaction atomicity and durability, Transaction Isolation, Serializability, Transaction Isolation Levels. Concurrency Control- Lock based protocols, Deadlock Handling, Multiple granularity, Timestamp-based Protocols, Validation-based Protocols. Recovery System: Failure classification, Storage, Recovery algorithm, Buffer Management. Unstructured database: Introduction to NoSQL, Basics of document-oriented database, MongoDB.

References:

1. Abraham Silberschatz, Henry Korth, S. Sudarshan, Database System Concepts, 6th Edition, McGraw Hill, 2010.
2. Ramez Elmasri, Shamkant Navathe, Fundamentals of Database System, 6th Edition, Addison Wesley Publications Co., 2010.
3. Raghu Ramakrishnan, Johannes Gehrke, Database Management System, 3rd Edition, WCB/McGraw Hill Publisher, 2014.
4. Ivan Bayross, SQL, PL/SQL-The Programming Language of Oracle, 4th Edition, BPB Publications, 2010.
5. Shashank Tiwari, Professional NoSQL, Wiley, 2015.

DSE 3144: DATABASE MANAGEMENT SYSTEMS LAB [0 0 3 1]

MS Access, Introduction to SQL, Intermediate SQL, Integrity Constraints in SQL, Additional Exercises on SQL, PL/SQL Basics, Exception Handling and Cursors, Additional Cursors constructs and Transactions, Procedures, Functions and Packages, Triggers, Mini Project

References:

1. Silberschatz, Korth, Sudarshan, Database System Concepts, (6e), McGraw-Hill, 2011
2. Ivan Bayross, SQL, PL/SQL, (2e/3e), BPB Publications, 2009.
3. G. Reese, Database Programming with JDBS and Java, (2e), O'Reilly, 2000

HUM 3021: ENGINEERING ECONOMICS AND FINANCIAL MANAGEMENT [3 0 0 3]

Nature and significance, Micro & macro differences, Law of demand and supply, Elasticity & equilibrium of demand & supply. Time value of money, Interest factors for discrete compounding, Nominal & effective interest rates, Present and future worth of single, Uniform gradient cash flow. Bases for comparison of alternatives, Present worth amount, Capitalized equivalent amount, Annual equivalent amount, Future worth amount, Capital recovery with the return, Rate of return method, an Incremental approach for the economic analysis of alternatives, Replacement analysis. Break-even analysis for single product and multiproduct firms, Break-even analysis for evaluation of investment alternatives. Physical & functional depreciation, Straight-line depreciation, Declining balance method of depreciation, Sum-of-the years digits method of depreciation, Sinking fund and service output methods, Costing and its types – Job costing and Process costing, Introduction to balance sheet and profit & loss statement. Ratio analysis - Financial ratios such as liquidity ratios, Leverage ratios, Turn over ratios, and profitability ratios

Reference s:

1. Prasanna Chandra., Fundamentals of Financial Management, Tata Mc-Graw Hill Companies, New Delhi, 2005.
2. James L Riggs, David D Bedworth and Sabah U Randhawa., Engineering Economics, Tata McGraw – Hill Publishing Company Ltd, New Delhi, 2004.
3. T. Ramachandran., Accounting and Financial Management, Scitech Publications Pvt. Ltd. India, 2001. Eugene F. B. & Joel F. H., Fundamentals of Financial Management, 12 (e), Cengage Learning publisher, 2009.
4. M. Y. Khan & P. K. Jain., Financial Management, 5 edition Tata McGraw Hill Publication, New Delhi, 2008.
5. Thuesen G.J., Engineering Economics Prentice Hall of India, New Delhi, 2005.
6. Blank Leland T. Tarquin Anthony J. Engineering Economy, McGraw Hill, Delhi, 2002.
7. Chan S. Park, Fundamentals of Engineering Economics, 3rd edition, Pearson Publication, 2013.

MAT 3132: Artificial Intelligence [3 0 0 3]

Introduction to Artificial Intelligence: Brief history of AI. Agents and rationality, task environments, agent architecture types. Search and Knowledge representation. Search spaces Uninformed and informed search. Learning – knowledge in learning, logical formulation; statistical learning, complete data, hidden variables; reinforcement learning, passive and active. Unsupervised Learning: Clustering, Dimension reduction, Expectation Maximization, Mixture of Gaussians, Hidden Markov Models, Anomaly detection. Techniques of Artificial Intelligence: Hill climbing, simulated annealing, genetic algorithms. Logic based representations (PL,FoL) and inference, Prolog. Rule based representations, forward and backward chaining, matching algorithms. Probabilistic reasoning and uncertainty. Bayes nets and reasoning with them. Learning of Artificial Intelligence: Uncertainty and methods to handle it. Forms of learning. Statistical methods: Naive-Bayes, nearest neighbour, kernel, neural network models, noise and over fitting. Decision trees, inductive learning. Clustering - basic agglomerative, divisive algorithms based on similarity/dissimilarity measures. Applications to Natural Language Processing, vision, robotics, etc.

References:

1. Tom Mitchell. Machine Learning. McGraw Hill, 1997.
2. Machine Learning: A Probabilistic Perspective, Kevin P Murphy, MIT Press, 2012.
3. Christopher M. Bishop. Pattern Recognition and Machine Learning. Springer 2006.
4. Richard O. Duda, Peter E. Hart, David G. Stork. Pattern Classification. John Wiley & Sons, 2006.
5. Trevor Hastie, Robert Tibshirani, Jerome Friedman. The Elements of Statistical Learning: Data Mining, Inference, and Prediction. Springer 2009.
6. MacKay, David. Information Theory, Inference, and Learning Algorithms. Cambridge, UK: Cambridge University Press, 2003.
7. Russel, S., and Norvig, P., (2015), Artificial Intelligence: A Modern Approach, 3rd Edition, Prentice Hall
8. Lang, Q. (1997), Intelligent Planning: A decomposition and abstraction-based approach, Springer Verlag, Berlin Heidelberg.

DSE 3124: PRINCIPLES OF SOFTWARE ENGINEERING [3 1 0 4]

Evolution of engineering discipline, Software development Projects, Exploratory style of software development, Waterfall model and its extensions, Rapid Application Development, Agile development models, Spiral Model, Requirement Analysis and Specification, Software Design, Overview of the design Process, Cohesion and coupling, Layered arrangement of modules, Approaches to software design, Function-Oriented Software Design, Structured analysis, Developing the DFD Model of a system, Structured design, Detailed design, Design review, Object Modelling Using UML: UML, UML diagrams, Use case model, Class diagrams, Interaction diagrams, Activity Diagram, State chart diagram, Postscript, Design Patterns, An Object-Oriented Analysis and Design (OOAD) Methodology, Code review.

References:

1. Rajib Mall, Fundamentals of Software Engineering, (4e), PHI Learning, 2014
2. Hans Van Vliet, Software Engineering: Principles and Practice, (3e), Wiley India, 2012
3. Roger S. Pressman, Software Engineering - A Practitioner's Approach, (7e), McGraw-Hill International Edition, 2010
4. Bernd Bruegge, Allen H. Dutoit, Object-Oriented Software Engineering using UML Patterns and Java, (2e), Pearson Publication, 2011
5. Ian Sommerville, Software Engineering, (9e), Addison-Wesley, 2011
6. Nooper Davis, Secure Software Development Life Cycle Processes, Software Engineering Institute, Carnegie Mellon University, 2013.
7. Julie Cohen, Dan Plakosh, Kristi Keeler, Robustness Testing of Software-Intensive Systems: Explanation and Guide, Carnegie Mellon University, 2005.

DSE 3143: PRINCIPLES OF SOFTWARE ENGINEERING LAB [0 0 3 1]

Identifying the Requirements from Problem Statements, Estimation of Project Metrics, Modeling UML Use Case Diagrams and Capturing Use Case Scenarios, E-R Modeling from the Problem Statements, Identifying Domain Classes from the Problem Statements, Statechart and Activity Modeling, Modeling UML Class Diagrams and Sequence diagrams, Modeling Data Flow Diagrams, Estimation of Test Coverage Metrics and Structural Complexity, Designing Test Suites

References:

1. Software Engineering, A practitioner's Approach- Roger S. Pressman, 6th edition, Mc Graw Hill International Edition, 2004.
2. Software Engineering- Sommerville, 7th edition, Pearson Education, 2004.
3. The unified modeling language user guide Grady Booch, James Rambaugh, Ivar Jacobson, Pearson Education, 1999.

SIXTH SEMESTER

MAT 3232: TIME SERIES ANALYSIS [3 1 0 4]

Introduction to Time series - Trend, Seasonality, Cyclic and Irregular variations, Time series plots, Method of semi averages, Method of Curve fitting by the principles of least squares, Conversion of Trend equation, Ratio to trend method, Ratio to moving average method, Method of link relatives. Measurement of cyclical variations, Measurement of irregular variation. Introduction to Univariate time series modelling and forecasting: Time series as a discrete parameter stochastic process (A strictly stationary process, A weakly stationary process, A white noise process),Moving average processes, Autoregressive processes, the partial autocorrelation function, ARMA & ARIMA processes, Box––Jenkins approach, Exponential smoothing, in-sample and out-of-sample forecasts, Forecasting with time series versus structural models, Determining whether a forecast is accurate or not. Introduction to Multivariate time series modelling and forecasting:Vector autoregressive models - VAR with contemporaneous terms- Block significance and causality tests - VARs with exogenous variables - Impulse responses and variance decompositions - Forecasting with VARs. Modelling long-run relationships: Stationarity and unit root testing – Cointegration - Equilibrium correction or error correction models (Engle and Granger, 1987) - Testing for and estimating cointegrating systems using the Johansen technique based on VARs. Introduction to Financial Time Series: Basic concepts of financial markets and financial systems, Financial time series and their characteristics: Assets and Markets, Asset Returns, Distribution of returns, Basic difference between Time Series and Financial Time Series, Modelling with Financial Time Series Data (stationarity checking, cointegration, error correction model, causality etc.). Modelling volatility and correlation: Volatility modelling, Introduction to Conditional Heteroscedastic models: ARCH and GARCH Models, Properties of ARCH and GARCH models, Limitations, Order determination and model building.

References:

1. Spyros Makridakis, Steven C Wheelwright, Rob J Hyndman, Forecasting Methods and Applications, 3rd Edition, John Wiley & Sons Publication, 2005, ISBN: 978-81-265-1852-
2. Walter Enders, Applied Econometric Time Series, 3rd Edition, John Wiley & Sons Publication, 2015 ISBN: 978-81-265-4391-5.
3. Gujarati, N.D., Basic Econometrics, Fifth Edition, McGraw Hill, 2012 ISBN: 978-0-07-133345-0
4. G.S. Maddala, Introduction to Econometrics, Third Edition, John Wiley & Sons Publication, 2005, ISBN: 978-81-265-1095-5
5. Montgomery D C, Jennings C L, Kulahci M. Introduction to time series analysis and forecasting. John Wiley & Sons; 2015.
6. Brockwell P J, Davis R A. Introduction to time series and forecasting. Springer; 2016.
7. Box G E, Jenkins G M, Reinsel G C, Ljung G M. Time series analysis: forecasting and control. John Wiley & Sons; 2015.

HUM 3022: ESSENTIALS OF MANAGEMENT [3 0 0 3]

Definition of management and systems approach, Nature & scope. The functions of managers. Corporate social responsibility. Planning: Types of plans, Steps in planning, Process of MBO, How to set objectives, Strategies, policies & planning premises. Strategic planning process and tools. Nature & purpose of organising, Span of management, Factors determining the span, Basic departmentation, Line & Staff concepts, Functional authority, Art of delegation, Decentralisation of authority. HR planning, Recruitment, Development and training. Theories of motivation, Special motivational techniques. Leadership- leadership behaviour & styles, Managerial grid. Basic control process, Critical control points & standards, Budgets, Non-budgetary control devices. Profit & loss control, Control through ROI, Direct, Preventive control. Managerial practices in Japan & USA, Application of Theory Z, The nature & purpose of international business & multinational corporations, Unified global theory of management. Entrepreneurial traits, Creativity, Innovation management, Market analysis, Business plan concepts, Development of financial projections.

References:

1. Harold Koontz & Heinz Weihrich, Essentials of Management, McGraw Hill, New Delhi, 2012.
2. Peter Drucker., Management: Tasks, Responsibilities and Practices, Harper and Row, New York, 1993.
3. Peter Drucker., The Practice of Management, Harper and Row, New York 2004.

MAT 3231: ADVANCED NUMERICAL METHODS [3 0 0 3]

Introduction to Partial differential equations. First order equations: classification, construction and geometrical interpretation, Lagrange's and Charpit's method for solving PDE. Method of characteristics for obtaining general solution of quasi linear equations. Canonical forms of first-order linear equations. Introduction to calculus of variations, Approximate methods, Finite elements, Nodes classifications, Approximate functions, Solution of boundary value problems of second order differential equation, Finite element equations for the heat conduction equation, Vibration equation, Elliptic problems using Galerkine and Ritz methods.

References:

1. M. K. Jain, Numerical Solution of Differential Equations, PHI Ltd., 1984.
2. R. Mitchell and R. Wait, Finite element methods in partial differential equations., 1977, John Wiley.
3. T. Amarnath, Partial Differential Equations, 2(e), 2003, Narosa Publ.
4. S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
5. Martha L Abell, James P Braselton, Differential equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.

MAT 3241: SCIENTIFIC COMPUTING LAB [0 0 6 2]

MATLAB, MATHEMATICA, MAPLE, SaGE Lab, GAP, etc.

Basic of the MATLAB/Simulink programming, Live script, array, loop, function, plotting, Approximations and Error, Linear Algebraic Systems, Solution of linear systems – built-in methods; implementation of Gaussian elimination. Bases of column space and null space using RREF, Eigenvalues and Eigenvectors-Matrices, Curve fitting and Optimization and transportation planning, Linear and Nonlinear Equation, Regression and Interpolation, Multistep, Boundary Value Problems- of PDE, Finite Element Method. Introduction to SageMath using Jupyter Notebook. Linear algebra in SageMath. Matrix operations, eigenvalues, eigenspaces, characteristic and minimal polynomials, diagonalization. Matrices over different fields and rings; precision. Vector spaces, subspaces, bases. Matrix factorisations. Statistical computing (R software), data accessing, and indexing, packages, Graphics in R, built in functions, saving, storing and retrieving work Multivariate normal distributions, Principal component analysis, Factor analysis - 2 sessions, Multivariate regression, Discriminant analysis & Cluster analysis.

References:

1. Robert J. Schilling and Sandra L. Harries, Applied Numerical Methods for Engineers using MATLAB and C, Thomson Learning Inc., 2000.
2. Brian R Hunt, et al, Guide To Matlab: For Beginners and Experienced Users, (2e), Cambridge University Press, 2011.
3. Fausett L.V., Applied Numerical Analysis Using MATLAB, (2e)., Pearson Education, 2007.
4. MATLAB Programming Fundamentals. The MathWorks Inc. 2019.
5. B.R. Hunt, R.L. Lipsman, J.M. Rosenburg. A Guide to MATLAB. Cambridge University Press. 2001.
6. Sage Reference Manual (Release 8.9). SageMath. 2019.

SEVENTH SEMESTER

There are five program electives and one open elective with a total of 18 credits to be taught in this semester.

EIGHTTH SEMESTER

MAT 4291: INDUSTRIAL TRAINING

Each student has to undergo industrial training for a minimum period of 4 weeks. This may be taken in a phased manner during the vacation starting from the end of third semester to the end of seventh semester. Student has to submit to the department a training report in the prescribed format and also make a presentation of the same. The report should include the certificates issued by the industry.

MAT 4292: PROJECT WORK

The project work may be carried out in the institution/industry/research laboratory or any other competent institutions. The duration of the project work shall be a minimum of 16 weeks which may be extended up to 24 weeks. A mid-semester evaluation of the project work shall be done after about 8 weeks. An interim project report on the progress of the work shall be submitted to the department during the mid-semester evaluation. The final evaluation and viva-voice will be conducted after submission of the final project report in the prescribed form. Student has to make a presentation on the work carried out before the department committee as part of project evaluation.

MINOR SPECIALIZATION:

MAT 4405: LINEAR OPTIMIZATION [3 0 0 3]

Introduction to Linear Programming: Basic Solution, Hyperplane, Convex Polyhedron, Simplex Method: Duality Theorem. Complementary Slackness. Farkes' Lemma. Revised Simplex Method. General LP Problems: Infeasibility. Sensitivity Analysis. Primal-Dual Algorithm: Applications to Network Flow and Matching. Efficient Algorithm: Linear Programming in fixed dimensions. Randomized Linear Programming. Integer Linear Programming: Total Unimodularity. Semidefinite Programming: Application to MAXSAT problems. Dynamic programming - Deterministic Dynamic programming, and probabilistic Dynamic programming. Queuing systems, different types of queuing models, simulation models. Finite Markov process and Markovian birth – death processes.

References:

1. Bronson Richard - theory and Problems of Operations Research - Schaum series- MGH, 1983.
2. Hamdy A. Taha - operations Research (Ed.5) PHI, 1995
3. Hiller and Liberman, Introduction to Operation Research, PHI, 1995.
4. V. Chavtal, Linear Programming, W. H. Freeman and Company, New York, 1983.
5. C. H. Papadimitriou and K. steiglitz, Combinatorial optimization: Algorithms and Complexity, Dover Publications, Inc., New York, 1998.
6. M. Grotschel, L. Lovasz and A. Schrijver, Geometric Algorithms and Combinatorial Optimization, John Wiley & Sons, Inc., New York, 1998.
7. W. Cook, W. H. Cunningham, W. R. Pulleyblank and A. Schrijver, Combinatorial Optimization, John Wiley & Sons, Inc., New York, 1998.
8. R. Motwani and P. Raghavan, Randomized Algorithms, Cambridge University Press, 1995.
9. David G. Luenberger, and Yinyu Ye Linear and Nonlinear Programming, Springer 2016.

MAT 4406: NON- LINEAR OPTIMIZATION [3 0 0 3]

Introduction to Non-Linear Optimization - Connections with Geometry. Local vs. Global optimum. Problem Classification, Convex and Concave Functions, Properties of Convex Functions, Convex Hulls, Convex Programming, Optimality conditions. Optimality conditions for unconstrained problems. Optimality conditions for constrained problems with equality and Quadratic Programming Problems. Frank–Wolfe Algorithm, Separable Programming, Geometric Programming, Dynamic programming approach to find shortest path in any network. Search Techniques Basic optimization methods and their convergence analysis. Unconstrained problems: Basic descent methods, conjugate direction and Quasi Newton methods. Constrained problems: Reduced gradient and Gradient projection methods, penalty and barrier methods, cutting plane methods, and Lagrange methods. Method of Approximation Programming.

References:

1. Nonlinear Programming: Theory and Algorithms, Hanif D. Sherali& C. M. Shetty Mokhtar S. Bazaraa Wiley Publications
2. Mokhtar S. Bazaraa, Hanif D. Sherali, and C. M. Shetty, Nonlinear Programming: Theory and Algorithms, Second Edition, John Wiley & Sons, New York 1993.
3. Solutions Manual to Accompany Nonlinear Programming: Theory and Algorithms C. M. Shetty, Hanif D. Sherali, and M. S. Bazaraa Wiley publications.
4. David G. Luenberger, and Yinyu Ye Linear and Nonlinear Programming, Springer 2016.

MAT 4407: COMBINATORICS AND DESIGN OF EXPERIMENTS [3 0 0 3]

Design of Experiments: Meaning and terminology - experiment, 'treatment, experimental unit, experimental error and precision. Basic Principles of experimental design- Randomisation, Replication, Local Control. Incomplete and complete block designs, BIBD, PBIBD - concepts & analysis. CRD, RBD and LSD: Layout, model, splitting of Total variation into different components. least square estimates of effects, ANOVA tables, Multiple comparisons: Tuckey's method, critical difference, advantages and limitations of each design. Missing plot technique: Estimation of one or two missing observations in RBD and LSD (least square estimates). ANOVA in case of missing observations. Factorial experiments: Meaning and advantages. and factorial experiments in RBD and LSD, main and interaction effects. Yates' method of computing factorial effect totals, ANOVA table and inferences. Contrasts and orthogonal contrasts.

References:

1. Cochran, W. G., & Cox, G. M. (1959). Experimental Designs. Wiley Eastern.
2. Federer, W. T. (1963). Experimental Designs. Oxford & IBH Publishing Co.
3. Gupta, S. C., & Kapoor, V. K. (2001). Fundamentals of Applied Statistics. Sulthan Chand & Co.
4. Robert Kabacoff, I. (2015). R in Action - Data Analysis and Graphics with R, second edition. Dreamtech Press
5. Sudha Purohit, G., Sharad Gore, D., & Shailaja Deshmukh, R. (2008). Statistics Using R. Narosa Publishing House.

MAT 4408: GAME THEORY AND STATISTICAL DECISIONS [3 0 0 3]

Games and statistical games, statistical decision problem, decision function, risk function, prior and posterior distribution, Bayes risk and Bayes rules, least favourable prior, minimaxity, admissibility and complete classes, admissibility of Bayes rules, existence of minimal complete class and Bayes rules, the supporting and separating hyperplane theorems, essential completeness of the class of nonrandomized rules Two-person zero-sum games and non-zero-sum games, N-person games, strategies, mixed strategies, fair game, Two-person zero-sum games, N-person games, minimax and complete class theorems, solving for minimax rules, essential completeness of class of rules based on sufficient statistics, continuity of risk functions, invariant decision problems, admissible and minimax invariant decision rules. Applications

References:

1. Ferguson, T.S. Mathematical Statistics: A Decision Theoretic Approach. Academic Press (10 July 2014).
2. David A. Blackwell and M. A. Girshick. (1979). Theory of Games and Statistical Decisions. Dover Publications.
3. Thomas, L.C. (1993). Games, Theory and Applications. Dover Publications.
4. Straffin, P.D. (2017). Game Theory and Strategy. MAA Press.

MAT 4409: APPLIED GRAPH THEORY [3 0 0 3]

Graphs and simple graphs. Graph isomorphism. Incidence and adjacency matrices. Subgraphs, vertex degrees, walks, paths, cycles. Connectedness. Shortest path problem. Sperner's Lemma. Trees. Cut edges and cut vertices. Cayley's formula. Connector problem, minimum spanning tree, Kruskal's algorithm. Edge colourings. Edge chromatic number. Vizing's theorem. The timetabling problem. Directed graphs, directed paths, directed cycles. Job sequencing problem. Ranking participants in a tournament. Networks and flows. Max-Flow Min-Cut Theorem. Menger's theorems. Feasible flows.

References:

1. J. A. Bondy and U. S. R. Murty. Graph Theory With Applications, 5th printing. Elsevier Science Publishing Co., Inc., New York. 1982.
2. D. B. West. Introduction to Graph Theory, 2nd edition. Prentice Hall, New Delhi. 2001

MAT 4410: MATRIX THEORY [3 0 0 3]

Basics of Linear Algebra: Matrix in the row reduced Echelon Form, solving Linear System, finding Null Space of a Matrix, finding Rank of Matrix, finding Inverse of Matrix, in finding Rank Factorization and LU decomposition of a Matrix Vector Space over an Arbitrary Field, Subspaces, Dimension. Linear Transformation and its Matrix Representation, Rank-Nullity Theorem. Linear Functionals, Dual Space, Transpose of a linear transformation. Inner Product Space and Linear Operators: Real or Complex Inner Product, Norm, and basic properties, Orthogonality, Gram-Schmidt's Orthogonalization Process.

Determinant, Invariant Subspaces and Matrix Decompositions:Basics of Determinants: Determinant Function and its properties, Adjoint and Inverse, Eigenvalues, Eigen space, Caley-Hamilton Theorem, Diagonalization, Systems of Differential Equations, Matrix Exponential, Invariant Subspaces, Simultaneous Triangulation, Simultaneous Diagonalization, Direct Sum Decomposition, Invariant Direct Sums, The Primary Decomposition Theorem, Spectral Decomposition, Singular Value Decomposition, and Jordan Decomposition. Quadratic Forms: Introduction, classification of Quadratic Forms, Rank and Signature, Positive Definite and Nonnegative Definite Matrices, Extrema of Quadratic Form, Square root Method, Hermitian Form. Generalized Inverses: Definition and Characterizations of Generalized inverse, General Solution of System of Linear Equations, Minimum Norm Solutions and Least Square Solution, Penrose Conditions, Moore-Penrose Inverse, its Properties and Computation Generalized Inverses in the Linear Model, Miscellaneous Applications of Moore-Penrose Inverse.

References:

1. R. B. Bapat: Linear Algebra and Linear Models, Third Edition, Hindustan Book Agency, 2012.
2. S. H. Friedberg, A. J. Insel and L. E. Spence: Linear algebra, Pearson, 2015.
3. Kenneth Hoffman and Ray Kunze: Linear Algebra, Second Edition, Prentice-Hall, Inc, 1971.
4. Leslie Hogben: Handbook of Linear Algebra, Second Edition, Chapman and Hall/CRC, 2007.
5. S. Kumarasen, Linear Algebra, Geometric approach, PHI
6. D. C Lay: Linear algebra and its applications, Pearson, 2014.
7. Carl D. Meyer: Matrix Analysis and Applied Linear Algebra, Siam, 2000.
8. Gilbert Strang: Linear Algebra and its Applications, Fourth Edition, Academic Press, 1980.
9. A. Ramachandra Rao and P. Bhimasankaram, Second Edition, Hindustan Book Agency, 2000

MAT 4411: ADVANCED ALGORITHMS AND DEEP LEARNING [3 0 0 3]

Introduction, Mathematical Preliminaries, Machine Learning Basics, Advanced Algorithms, Deep Feedforward Networks, Regularization for Deep Learning, Optimization for Training Deep Models, Convolutional Networks, Recurrent and Recursive Networks, Practical Methodology.

References:

1. Goodfellow I., Bengio Y., and Courville A., Deep Learning, MIT Press 2017.
2. Haykin S., Neural Networks and Learning Machines, PHI, 2016.
3. Patterson J., and Gibson A., Deep Learning: A Practitioner's Approach, O'Reilly, 2017.
4. Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, Introduction to Algorithms, (2e), PHI, 2006

MAT 4412: ALGEBRAIC CODING THEORY [3 0 0 3]

Basic notions: Noisy channels, binary symmetric channel, error detection and error correction. Block codes. Hamming distance, minimal distance. Algebraic tools: finite fields (basic properties, existence and uniqueness, constructions, polynomials over finite fields). Linear codes, generator and parity check matrices, Hamming codes. Cyclic codes, described by means of ideals. Codes and polynomials: generating and parity check polynomials, BCH codes, Reed-Solomon codes, quadratic residue codes, Reed-Muller codes, Golay codes, perfect codes. Bounds on linear codes: Singleton, Hamming, Gilbert-Varshamov, Plotkin. Decoding methods: syndromes, decoding BCH codes. Error correction in digital media processing (compact disc).

References:

1. E. R. Berlekamp: Algebraic Coding Theory. Aegean Park Pr; 1984.

MULTIMODAL INTELLIGENT SYSTEMS

DSE 4401: INFORMATION RETRIEVAL [3 0 0 3]

Introduction to Information Retrieval: Mathematical Basics, Vector spaces and Similarity, Probabilities and Statistics, Text Analysis; Pre-processing: Document processing, Stemming, String Matching, Basic NLP tasks–POS Tagging Shallow Parsing; Overview of Text Retrieval Systems: System Architecture, Boolean Models, Inverted Indexes, Document Ranking, IR Evaluation; Retrieval Models and Implementation: Vector Space Models, TF-IDF Weighting, Retrieval Axioms, Implementation Issues, Probabilistic Models;Statistical Language Models: Okapi/BM25, Language Models, KL-divergence, Smoothing; Query Expansion and Feedback: Query Reformulation, Relevance feedback, Pseudo-Relevance Feedback, Language Model Based, Feedback; Web Search Engines: Models of the Web, Web Crawling; Static Ranking: Page Rank HITS, Query Log Analysis, Adversarial IR, Information Filtering: Adaptive Filtering, Collaborative Filtering, User Interfaces, Text Classification, NaïveBayes, K-nearestneighbors,Feature selection, Semi-supervised Learning; Text Clustering:Vector-space Clustering; K-means, EM algorithm, Text shingling; Graph-Based Methods: WordNet, Document and Word Graphs, Network Analysis, Random Walks, Harmonic Functions.

References:

1. Christopher D. Manning, Prabhakar Raghavan and Hinrich Schütze, Introduction to Information Retrieval",(2e), Cambridge University Press, 2015.
2. B.Croft, D.Metzler, T.Strohman, Search Engines:Information Retrievalin Practice,(3e),MITPress, 2016.
3. Chengxiang Zhai, Statistical Language Models for Information Retrieval (Synthesis Lecture Serieson Human Language Technologies), (2e),Morgan & Claypool Publishers,2017.

DSE 4402: NATURAL LANGUAGE PROCESSING [3 0 0 3]

Knowledge in Speech and Language Processing, Ambiguity, Models and Algorithm, Regular Expressions, Finite State Automata, Words And Transducers: Survey of English Morphology, Finite-State Morphological Parsing, Building a Finite-State Lexicon, FSTs for Morphological Parsing, Lexicon-Free FSTs. Words and Sentence to kenization: Normalizing Text, Segmentation, Probablistic Models of Pronunciation and Spelling :Detecting and Correcting Spelling Errors, Noisy Channel Model, Minimum Edit Distance, N-Grams:Unsmoothed N-Grams, Smoothing, Interpolation and Backoff, English Word Classes: Tag-sets for English, Part-of-Speech Tagging, Formal Grammars of English: Context Free Grammars ,Grammar Rules,TreeBank, Dependency Grammar, Parsing with Context Free Grammars, Dynamic Programming Parsing, CKY algorithm, Statistical Parsing,NLP using NLTK SDL: NLP using NLTK

References:

1. Daniel Jurafsky & James H. Martin, Speech and Language Processing, (2e), Pearson, 2009.
2. Steven Bird, Ewan Klein and Edward Loper, Natural Language Processing with Python ,First Edition,O'Reilly Media,2009.
3. J.E.Hopcroft, R.Motwani & J.D.Ullman, Introduction to Automata Theory Languages, and Computation, (3rd Edition) , 2006,Pearson Education.

DSE 4403: SOCIAL NETWORK ANALYSIS [3 0 0 3]

Introduction to Social Web, Nodes, Edges and Network Measures, Describing Nodes and Edges, Describing Networks, Layouts, Visualizing network features, The role of Tie strength, Measuring Tie strength and its network structures, network propagation, Link prediction, entity resolution, Case study, Introduction to community discovery, communities in context, quality functions, The Kernighan-Linalgorithm, Agglomerative algorithms, spectral algorithms, multi-level graph partitioning, Markov clustering, Other approaches, Introduction to social influence, Influence related statistics, social similarity and influence, Homophily, Existential Test for social influence, Influence and actions, Influence and interactions, influence maximization in viral marketing.

References:

1. Jennifer Golbeck., Analysing the Social Web, Morgan Kaufmann publications,2013
2. Charu C. Aggarwal, Social Network Data Analytics, Springer publications,2011
3. John Scott, Social Network A nalysis,(3e), Sagep ublications limited,2013
4. Jay Goldman, Facebook Cookbook,O'Reilly,2009
5. Shamanth Kumar,Fred Morstatter, HuanLiu, Twitter Data Analytics, Springe r publications,2013

DSE 4404: COMPUTER VISION [3 0 0 3]

Introduction: Image Processing, Components of Image processing system, Image formation and digitization concepts, Neighbours of pixel adjacency connectivity, regions and boundaries, Distance measures, Image processing operations, Arithmetic, Logical, Geometrical, Convolution and Correlation Operations, Applications: Document Image Analysis, Biometrics, Object Recognition, Tracking, Medical Image Analysis, Content-Based Image Retrieval, Video Data Processing, Multimedia, Virtual Reality and Augmented Reality, Image Formation, Image representations (continuous and discrete) ,Image pre-processing Techniques, Feature Extraction-Point, Line and Edge Detection, Color, Texture, Shape and structure Features in spatial and frequency domains, Corner Detection, Hough Transform ,Image Segmentation: Boundary detection based techniques, Point, line detection, Edge detection, Edge linking, local processing, regional processing, Hough transform, Thresholding, Iterative thresholding, Otsu's method, Moving averages, Multivariable thresholding, Region-based segmentation, Water shedalgorithm, Use of motion in segmentation, Computer Vision: Computer Vision, What is Computer Vision-Low-level,Mid-level,High-level,Overview of Diverse Computer Vision Applications, Fundamentals of object recognition, Low-level computer vision-Edges, contours, textures, shapes, and colors, Motion, optical flow, and tracking Local features, invariance, bag-of-words models, Fisher vector,Middle-level representations of objects: parts, attributes, embedding.

References:

1. David Aforsyth & Jeanponce Computervision–Amodern Approach, Prentice Hall, Pearson Education India;Edition:Second.
2. R.C.Gonzalez, R.E.Woods. Digital Image Processing. Pearson, Inc.,Edition-Fourth.
3. A.K.Jain,Fundamentals of Digital Image Processing. Prentice-Hall,Pearson;Edition:First.
4. Bernd Jahne and Horst Hau Becker, Computer vision and Applications, Academicpress,2000.

NETWORK ANALYTICS

DSE 4405: CLOUD COMPUTING [3 0 0 3]

Cloud Computing Overview: Definition and evolution of Cloud Computing Enabling Technologies, Service and Deployment Models, Popular Cloud Stacks and Use Cases Benefits, Risks, and Challenges of Cloud Computing, Virtualization: Introduction, Characteristics of Virtualized Environment, Types of Virtualization, Implementation Levels of Virtualization, Taxonomy of Virtualization Techniques, Tools and Mechanisms, Pros and Cons of Virtualization. Programming Model: Parallel and Distributed Programming Paradigms, Cloud Platforms in Industry: Amazon Web Services, Google App Engine, Microsoft Azure, Service level agreements; Data in the cloud, MapReduce and extensions, Security In The Cloud: Security Overview, Cloud Security Challenges and Risks, Software-as-a-Service Security, Security Governance, Risk Management, Security Monitoring, Security Architecture Design, Data Security, Application Security , Virtual Machine Security, Identity Management and Access Control, Autonomic Security. SDL: Cloud Platforms in Industry: Amazon Web Services, Google App Engine, Microsoft Azure, Virtualization Tools and Mechanisms.

References:

1. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, Mastering cloud computing: foundations and applications programming, Elsevier Inc, 2013.
2. Gautam Shroff, ENTERPRISE CLOUD COMPUTING: Technology, Architecture, Applications, Cambridge University Press, 2010
3. Barrie Sosinsky, “Cloud Computing Bible”, Wiley India Edition, 2013.
4. Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr.Deven Shah, “Cloud computing black Book”, Dream Tech Press, 2014.
5. Velte Anthony T, Toby J. Velte and Robert E., “Cloud Computing: A Practical Approach”, Tata McGraw Hill, 2013

DSE 4406: INTERNET OF THINGS [3 0 0 3]

Internet of Things, Physical Design, Logical Design, IoT Enabling Technologies, IoT Levels & Deployment Templates, Domain Specific IoT Applications. IoT Network Architecture and Design: Drivers Behind New Network Architectures, Comparing IoT Architectures, A Simplified IoT Architecture, The Core IoT Functional Stack, IoT Data Management and Compute Stack. Smart Objects: The "Things" in IoT, Sensors, Actuators, and Smart Objects, Sensor Networks, Connecting Smart Objects, Communications Criteria, IoT Access Technologies. IP as the IoT Network Layer, Optimizing IP for IoT, Profiles and Compliances, Application Protocols for IoT, The Transport Layer, IoT Application Transport Methods. Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics. Securing IoT, A Brief History of OT Security, Common Challenges in OT Security, Formal Risk Analysis Structures. Prototyping Endpoints - Embedded Computing Basics, Arduino, Raspberry Pi, Beagle Bone Black, IoT Use Cases - Industrial Automation, Smart Home, Smart City, Commercial Building Automation.

SDL: Data and Analytics for IoT, An Introduction to Data Analytics for IoT, Machine Learning, Big Data Analytics Tools and Technology, Edge Streaming Analytics, Network Analytics

References:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet Of Things, 1stEdition, Pearson Education (Cisco Press Indian Reprint).
2. Arshdeep Bahga, Vijay Madisetti, Internet of Things – A hands-on approach, Universities Press, 2015.
3. Adrian McEwen, Hakim Cassimally, Designing the Internet of Things, Wiley, 2014.
4. Holler J., From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence, Academic Press, 2014.
5. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things – Key applications and Protocols, Wiley, 2012.

DSE 4407: ENTERPRISE DATA ARCHITECTURE [3 0 0 3]

Introduction to Enterprise Architecture:- Overview, core elements, Structure of enterprises, Introduction to Enterprise Data Architecture (EDA), Evolution of architecture, Monolithic systems – Mainframes. N-tier Architecture:- Introduction to N-tier architecture, Application Layer, Data Layer – Structured and Unstructured Data, Communication Layer. Service oriented architecture and Micro services:-Service oriented architecture, Web Services, Introduction to Microservices, Components of Microservices, Containers, Orchestration, Mesh, API Design, Data Handling, Architectural principles, Effectiveness of SoA. Data Models and Data governance: - Introduction to Data Models, Performance considerations, rendering, performance testing and monitoring, Disaster Recovery strategies, Fault Tolerance and Recovery, data-sharding, de-duplication in-memory computing, Scaling, Data governance, Security, privacy, value and risk, Repository and Support Tool. Architecture for Modern Technologies: - Hardware, Polycloud, Modern communication, Architecture for AI systems, Architecture for Distributed Financial systems and Architecture for Web 3.0. Enterprise Architectural frameworks: - Open-Source Frameworks, MEGAF, India Enterprise Architecture (IndEA), National Institute of Standards and Technology (NIST), Zachman Framework, Introduction to Enterprise Architectural frameworks- TOGAF, Enterprise Architectural frameworks- TOGAF framework modular structure, TOGAF content framework, architecture styles.

References:

1. Andy Graham, The Enterprise Data Model: A framework for enterprise data architecture, Koios Associates Ltd, 2nd edition, 2012.
2. Charles D. Tupper, Data Architecture: From Zen to Reality, Morgan Kaufmann, 1 edition, 2011.
3. Scott A. Bernard, An Introduction to Enterprise Architecture, AuthorHouse, 3rd edition.

DSE 4408: BLOCK CHAIN TECHNOLOGY [3 0 0 3]

Introduction, Structure of a Block, The Genesis Block, Linking Blocks in the Blockchain, Merkle Trees, Simplified Payment Verification, Using hash functions to chain blocks, for Proof-of-Work, Digital Signatures to sign transactions, Distributed Ledger, Byzantine Agreement, Eventual Consistency & Bitcoin Consistency-Availability and Partitions, Bitcoin, Smart Contracts, Weak Consistency, Distributed Storage, Consistent Hashing, Hyper cubic Networks, Mining and Consensus: Decentralized Consensus, Independent Verification of Transactions Mining Nodes, Aggregating Transactions into Blocks, Constructing the Block Header, Successfully Mining the Block, Validating a New Block, Assembling and Selecting Chains of Blocks, Consensus Attacks, Changing the Consensus Rules,Soft Fork Signaling with Block Version, Consensus Software Development, Ethereum and Bitcoin, block format, mining algorithm, proof-of-stake (PoS) algorithm, account management, contracts and transactions, Solidity language, account management, contracts and transactions, Applications of Blockchain : Case studies

References:

1. Andreas M.Antonopoulos, Mastering Bitcoin: unlocking digital cryptocurrencies, O'Reilly Media, (1e) 2014
2. Roger Wattenhofer, Distributed Ledger Technology,The science of the Block chain,Inverted Forest Publishing, (2e), 2017.
3. Antonopoulos, Andreas M. and Wood, Gavin, Mastering Ethereum, O'ReillyMedia,2018.
4. GeorgeIcahn, Blockchain: the complete guide to understanding block chain technology, Amazon publishers, 2017.

OTHER PROGRAM ELECTIVES

MAT 4444: BIG DATA ANALYTICS [3 0 0 3]

Introduction to NoSQL, Types and Advantages of NoSQL, Comparison of SQL, NoSQL and New SQL, MongoDB: Features, Data types, Query Language; Cassandra: Features, Data types, Query Language. Core Hadoop components, Hadoop Ecosystem, YARN and MapReduce, Understanding I/O in Map Reduce, Processing common serialization formats, Big data serialization formats, Organizing and optimizing data in HDFS, MapReduce with NOSQL as a data source, Applying MapReduce patterns to Big Data, Introduction to Data Analysis with Spark, Recommendation algorithm, predicting with Decision Trees, Anomaly Detection with K-means Clustering, Latent Semantic Analysis, Analyzing Co-occurrence Networks.

References:

1. Acharya S., Big Data and Analytics, Wiley India Pvt. Ltd., 2015
2. Holmes A., Hadoop in Practice, (2e), Manning Publications, 2015
3. Ryza S., Advanced Analytics with Spark: Patterns for Learning from Data at Scale, (2e), O'Reilly, 2017
4. White T., Hadoop: The definitve guide, (4e), O'Reilly, 2015
5. Sadalage P., NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence, (1e), Addison-Wesley, 2012

MAT 4446: COMPUTATIONAL FLUID DYNAMICS [3 0 0 3]

Introduction to CFD and Governing Equations: Need of CFD as tool, role in R&D, continuum, material or substantial derivative or total derivative, gradient, divergence and curl operators, Linearity, Principle of Superposition. Derivation of Navier-Stokes equations in control volume (integral form) and partial differential form, Euler equations (governing inviscid equations). One-dimensional Euler's equation: Conservative, Non-conservative form and primitive variable forms of Governing equations. Flux Jacobian Is there a systematic way to diagonalise Eigenvalues and Eigenvectors of Flux Jacobian. Decoupling of Governing equations, introduction of characteristic variables. Relation between the two non-conservative forms. Conditions for genuinely nonlinear characteristics of the flux Jacobian. Introduction to Turbulence Modeling: Derivation of RANS equations and k-epsilon model. Mathematical classification of PDE (Hyperbolic, Parabolic, Elliptic). Method of characteristics, Introduction to Riemann Problem and Solution Techniques. Representation of Functions on Computer : Need for representation of functions, Box Function, Hat Function, Representation of sinx using hat functions: Aliasing, high frequency, low frequency. Representation error as a global error. Derivatives of hat functions, Haar functions, Machine Epsilon. Using Taylor series for representation of Derivatives. Finite difference method – Applied to Linear Convection equation, Laplace Equations, Convection Diffusion equations, Burgers equations, modified equations Explicit methods and Implicit methods – as applied to applied to linear convection equation, Laplace equations, convection diffusion equation FTCS, FTFS,FTBS,CTCS Jacobi Method, Gauss-Siedel, Successive Over Relaxation Method, TDMA. Von Naumann stability (linear stability) analysis. Upwind Method in Finite Difference method. Finite volume method. Finding the flux at interface. Central schemes - Lax-Friedrichs Method, Lax-Wendroff Method, Two-Step Lax-Wendroff Method and Mac Cormack Method. Upwind Method in Finite Volume methods - Flux Splitting Method Steger and Warming, vanLeer, Roe's Method and finding Roe's Averages.

References:

1. T. J . Chung, Computational Fluid Dynamics, Cambridge University Press, 2002
1. Ghoshdastidar, Computational fluid dynamics and heat transfer, Cengage learning, 2017.

MAT 4447: FUNCTIONAL PROGRAMMING [3 0 0 3]

Principles of functional programming: expressions, evaluations, functions, and types. Type definitions and built-in types: numbers, characters, strings and lists. Basic operations on lists, including map, fold and filter, together with their algebraic properties. Recursive definitions and structural induction. Simple program calculation. Infinite lists and their uses. Further data structures: binary trees, general trees. Use of trees for representing sets and symbolic data. Normal order reduction and lazy evaluation. Simple cost models for functional programs; time and space complexity.

References:

1. Richard Bird, Introduction to Functional Programming using Haskell, second edition, Prentice-Hall International, 1998.
2. Graham Hutton, Programming in Haskell (2nd edition), Cambridge University Press, 2016.

MAT 4448: FUZZY LOGIC AND NEURAL NETWORKS [3 0 0 3]

Basic concepts: fuzzy set theory - basic concept of crisp sets and fuzzy sets- complements- union intersection- combination of operation-general aggregation operations- fuzzy relations-compatibility relations-orderings- morphisms- fuzzy relational equations-fuzzy set and systems. Architectures: motivation for the development of natural networks-artificial neural networks-biological neural networks-area of applications-typical Architecture-setting weights-common activations functions Basic learning rules- Mcculloch-Pitts neuron- Architecture, algorithm, applications-single layer net for Page 1 of 7 pattern classification- Biases and thresholds, linear separability - Hebb'srule-algorithm -perceptron - Convergence theorem-Delta rule. Back propagation neural net:standard back propagation-architecture algorithm- derivation of learning rules number of hidden layers--associative and other neural networks- hetro associative memory neural net, auto associative net- Bidirectional associative memory-applications-Hopfield nets-Boltzman Neural network based on competition: fixed weight competitive nets- Kohonenself organizing maps and applications-learning vector quantization-counter propagation nets and applications adaptive resonance theory: basic architecture and operation-architecture, algorithm, application and analysis of ART1 & ART2 Cognitron and Neocognitron - Architecture, training algorithm and application-fuzzy associate memories, fuzzy system architecture- comparison of fuzzy and neural systems.

References:

1. T Kliryvan- Fuzzy System & Fuzzy logic Prentice Hall of India, First Edition.
2. Lawrence Fussett- fundamental of Neural Network Prentice Hall, First Edition.
3. Bart Kosko, Neural network and Fuzzy System - Prentice Hall-1994.
4. J. Klin and T. A. Folger, Fuzzy sets University and information-Prentice Hall -1996.
5. J. M. Zurada, Introduction to artificial neural systems-Jaico Publication house, Delhi 1994.

MAT 4450: GEOMETRIC TOPOLOGY [3 0 0 3]

Metric spaces, examples, topological spaces, examples, open balls, open sets, closed sets, interior and boundary; examples, sequences, functions, convergence and continuity in metric spaces; examples, continuity in terms of preimages; examples and applications, pointwise convergence of sequences of functions, bounded sets, dense sets, basis, product topology and subbases, boundary of a set, connected spaces, path connected spaces, Hausdorff spaces, continuity, homeomorphisms, 2-dimensional manifolds, classification of surfaces.

References:

1. W. S. Massey, A Basic Course in Algebraic Topology, Springer, 1991.
2. Hatcher, Algebraic Topology, Cambridge, 2002.
3. J. R. Munkres, Elements of Algebraic Topology, Perseus Publishing, 1984.
4. J. M. Lee, Introduction to Smooth Manifolds, Springer, 2002.
5. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill, 1963.

MAT 4453: MATHEMATICS FOR FINANCE [3 0 0 3]

Introduction to Stochastic Processes, Poisson Process, Brownian Motion, Martingales Present Value Analysis, Interest rate analysis, Market Model Specification problems. Arbitrage Theorem, Multi-period binomial Model, Block - Scholes formula. Valuing investments by expected utility, Portfolio selection problem, Capital Assets Pricing model, Rates of return, Single period and geometric Brownian motion, Mean-variance analysis of risk - neutra-lpriced call options, Autoregressive models and mean regression, Other pricing options and applications.

References:

1. S. M. Ross, "An Introduction to Mathematiacl Finance", Cambridge University Press, 1999
2. Prakash A J, R.M.Bear, K.Dandapani, G.L.G.T.E.Pactwa and A.M.Parchigari, "The return Generating Models in Global Finance", Pergamon Press, 1998
3. S. M. Ross, "Applied Probability models with Optimization Applications", Holdenday, 1980.

MAT 4455: RELIABILITY THEORY [3 0 0 3]

Static probabilities: review and prerequisites generating functions, difference equations. Dynamic probability: definition and description with examples. Markov chains, transition probabilities, Chapmen Kolmogrov equations. Classification of states, chains of Markov process. Stability of Markov systems, limiting behaviour, random walk. Poisson Processes: assumptions and derivations, related distributions, birth and death processes. Queueing System, general concepts, Model M/M/1 and M/M/S, steady state behvaour, transient behaviour. Wiener processes and Gaussian processes. Differential equations of a wiener process, Kolmogrov equations, Ornstein – Unlenbick Process. White note. Reliability Theory: Definition of Reliability, types of failure, Hazard rate, Laws of failure - normal, exponential & Weibull failure laws - System reliability - in series, in parallel series - parallel system, Paralled - series system & related problems.

References:

1. Medhi. J. Stochastic Processes, Wiley Eastern.
2. Bhat U R , Elements of Applied Stochastic Processes , John Wiley.
3. Srinivasan and Mehata, Stochastic Processes, Tata McGraw Hill.
4. A Papoulis, Probability, Random Variables and Stochastic Procesess, McGraw Hill.
5. Shane and Hoel, "Fundamentals of Systems Engineering"

MAT 4456: THEORY OF COMPUTATION [3 0 0 3]

Finite automata, Moore and Melay machines, Regular Expressions, Pumping lemma, Minimizing the automata, Formal Languages, Regular languages, Context free languages (CFL), Chomsky and Greibach Normal forms, Pushdown automata (PDA), Equivalence of PDA and CFL, Turing machines, Theory of recursive functions, Complexity theory, NP – Completeness.

References:

1. Aho, Hopcraft & Ullman, Automata, Languages and Computation, Narosa, 1986.
2. Mishra and Chandrashekar, Theory of Computer Science, Prentice Hall of India, 1998.
3. Peter Linz, Introduction to Formal Languages and Automata Theory, Jones & Bartlett Learning, 1997.

MAT 4457: TOPOLOGY OF METRIC SPACES [3 0 0 3]

Basic Notions: Definition of Metric space and Examples, Open Balls and Open Sets, Convergence, Convergent Sequences, Limit and Cluster Points, Cauchy Sequences and Completeness, Bounded Sets, Dense Sets, Basis, Boundary of a Set, Continuity, Continuous Functions, Equivalent Definitions of Continuity, Topological Property, Uniform Continuity, Limit of a Function, Open and closed maps, Compactness, Compact Spaces and their Properties, Continuous Functions on Compact Spaces, Characterization of Compact Metric Spaces, Arzela-Ascoli Theorem, Connectedness, Connected Spaces, Path Connected spaces.

References:

1. S. Kumaresan, Topology and Metric Spaces, Narosa Publ. (2011)
2. J. Munkres Topology, Pearson Publ. (2014)

Department of Humanities & Management

The Department of Humanities & Management, MIT was established in May 2009. The department has two disciplines: Management and English. The department has expertise in System Dynamics Modeling and Simulation, Organizational Behavior, Econometrics and Marketing, Research Methodology, Linguistics, English Literature, German Language, Cultural Studies, and English Communication.

The modules delivered at the undergraduate and post-graduate courses aim at making the engineering students develop an awareness of social, cultural, economic, ethical and human values. The department offers one undergraduate program and two postgraduate programs. It also offers minor programs in Business Management, Entrepreneurship, Fintech Services, People Management, Finance & Investments, Modern Literature and Professional Communication. It also offers wide variety of open electives in Management and Humanities. The Department of Humanities & Management plays a distinctive role in moulding the careers of engineers, as it provides an opportunity for students to learn managerial skills, communication skills and group dynamics so as to make them fit into the multi-cultural environment of the industry.

> Programs offered

Undergraduate Program

- B.Tech. in Computer Science and Financial Technology (2023)

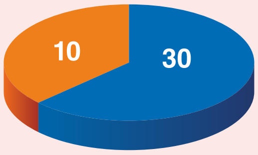
Postgraduate Program

- M.Tech in Engineering Management (1989)
- Integrated M.Tech in Entrepreneurship (2024)

PhD

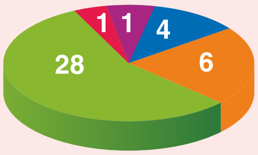
> Faculty Strength

Qualification-wise



- PhD
- M.Tech/ME/M.Sc

Cadre-wise



- Professors
- Professor of Practice
- Additional Professors
- Associate Professors
- Assistant Professors

B.TECH. IN COMPUTER SCIENCE & FINANCIAL TECHNOLOGY
(2024 SCHEME)

Year	THIRD SEMESTER						FOURTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
II	MAT 2132	Mathematics for Finance	4	0	0	4	MAT 2232	Probability, Stochastic Process and Operations Research	4	0	0	4
	CSS 2180	Programming Paradigm	4	0	0	4	HUM 2221	Accounting & Financial Management	4	0	0	4
	CSS 2106	Algorithms & Data Structures - Java	4	0	0	4	CSS 2205	Cyber Security	3	0	0	3
	CSS 2109	Introduction to Banking, Payments and Capital Markets	4	0	0	4	CSS 2206	Introduction to Fintech	3	0	0	3
	CSS 2107	Database Management Systems	3	0	0	3	CSS 2207	Software Systems	3	0	0	3
	CSS 2181	Programming Paradigm Lab	0	0	3	1	HUM 2222	Design Thinking	1	0	2	2
	CSS 2108	Database Management Systems Lab	0	0	3	1	CSS 2280	Fintech Lab	0	0	6	2
	CSS 2105	Algorithms & Data Structure - Lab - Java										
			19	**0**	**9**	**22**			**20**	**0**	**8**	**21**
		Total Contact Hours (L+T+P)		**28**				**Total Contact Hours (L+T+P)**		**28**		

Year	FIFTH SEMESTER						SIXTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	CSS 3106	Software Application Design	3	0	0	3	CSS 3201	Machine Learning & Deep learning	4	0	0	4
	CSS 3105	InsureTech	3	0	0	3	HUM 3022	Essentials of Management	3	0	0	3
	CSS 3103	Banking Technology	4	0	0	4	CSS 3202	Capital Markets Technology	3	0	0	3
	CSS 3108	Statistics for Finance	3	0	0	3	CSP ****	PE – 1 / Minor Specialisation	3	0	0	3
	CSS 3102	AI in Finance	3	0	0	3	CSP ****	PE – 2 / Minor Specialisation	3	0	0	3
	IPE 4302	Open Elective-1 Creativity, Problem Solving and Innovation	3	0	0	3	****	Open Elective - 2	0	0	3	1
	CSS 3107	Software Application Design-Lab	0	0	3	1	CSS 3203	Capital Markets Lab	0	0	3	1
	CSS 3104	Banking Technology lab	0	0	3	1	CSs 3204	Machine Learning Lab				
			19	**0**	**6**	**21**			**19**	**0**	**6**	**21**
		Total Contact Hours (L+T+P)		**24**				**Total Contact Hours (L+T+P)**		**25**		

Year	SEVENTH SEMESTER						EIGHTTH SEMESTER					
	Sub. Code	**Subject Name**	**L**	**T**	**P**	**C**	**Sub. Code**	**Subject Name**	**L**	**T**	**P**	**C**
III	CSP ****	PE – 3 / Minor Specialisation	3	0	0	3	CSS 4291	Industrial Training (MLC)				1
	CSP ****	PE – 4 / Minor Specialisation	3	0	0	3	CSS 4292	Project Work				12
	CSP ****	PE – 5	3	0	0	3	CSS 4293	Project Work (B Tech – Honours) **				20
	CSP ****	PE – 6	3	0	0	3	CSS ****	B Tech – Honours Theory – 1**(V semester)				4
	CSP ****	PE – 7	3	0	0	3	CS ****	B Tech – Honours Theory – 2** (VI semester)				4
	*** ***	Open Elective – 3	3	0	0	3	CSF ****	B Tech – Honours Theory – 3** (VII semester)				4
	CSS 4191	Mini Project (Minor specialisation)				8						
			18	**0**	**0**	**18/26***						**13/33***
		Total Contact Hours (L+T+P)		**18**				**Total Contact Hours (L+T+P)**				

*Applicable to students who opted for minor specialization **Applicable to eligible students who opted for and successfully completed the B Tech – Honours requirements

MINOR SPECIALIZATIONS

I. BFSI TRACK

CSP 4434: Dev Sec Ops
CSP 4435: Software Reliability
CSP 4436: Reporting & Analytics using AI for Fintech
CSP 4437: Software Quality Assurance and Project Management

II. INVESTMENT MANAGEMENT

CSP 4438: Economics
CSP 4439: Financial Statement Analysis
CSP 4440: Derivatives and Alternative Investments
CSP 4441: Security Analysis and Portfolio Management

OTHER PROGRAMME ELECTIVES

CSS 4441: SOC design
CSS 4443: Low Power VLSI Design
CSS 4404: Machine Learning

OPEN ELECTIVES

CSS 4121: Management Research Methods

THIRD SEMESTER

MAT 2132: MATHEMATICS FOR FINANCE [4 0 0 4]

The geometry of linear equations, elimination with matrices, multiplication and inverse matrices, factorisation into A=LU, Transpose, permutation of matrices, vector space, Column Space and Null Space, Solving Ax=0: Pivot variables, special solutions; Solving Ax=b: Row reduced form, independence, basis and dimension, independence, basis and dimension, Projection matrices and least squares, orthogonal matrices and Gram- Schmidt orthogonalization, Eigen Values and Eigen vectors, Diagonalisation and powers of matrix A, Markov matrices, Symmetric matrices and positive definite matrices, similar matrices and Jordan form, Singular value decomposition, Linear transformation, and their matrices.

Introduction to systems of first-order linear differential equations, Solution techniques: Matrix methods, eigenvalues, eigenvectors, Applications in finance and technology: modeling interconnected systems, Markov chains, etc. Modeling financial derivatives using differential equations (Black-Scholes equation, etc.). Differential equations in risk management and portfolio optimization.

Introduction to PDEs: Classification (elliptic, parabolic, hyperbolic). Boundary value problems and initial value problems. Applications in option pricing, stochastic calculus, and quantitative finance. Solution Methods: Laplace transform/ Fourier transform.

Numerical Methods for Differential Equations: Finite difference methods for solving partial differential equations. Monte Carlo simulations in financial modeling.

Stochastic differential equations in financial mathematics. Control theory applications in financial technology.

References Books:

1. D. C Lay, Linear algebra and its applications, Pearson, 2014.
2. Gilbert Strang, Introduction to Linear Algebra, Wellesley-Cambridge Press, 2000
3. William E. Boyce and Richard C. DiPrima, Elementary Differential Equations and Boundary Value Problems, John Wiley & Sons, Inc., 2009.
4. Stanley J. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications Inc., 2003.
5. Bernt Oksendal, Stochastic Differential Equations- An Introduction with Applications, Springer Berlin Heidelberg, 2013.

CSS 2180: PROGRAMMING PARADIGMS [4 0 0 4]

Imperative Programming :Assignments, side effects, memory models, control structures, branching, procedures, parameter passing. Discussions using C and Go. Object-Oriented Programming: Concepts of objects, classes, inheritance, specialization of methods, covariance and contravariance, type parametrization, reflective and meta programming. Discussions using Java and Go. Functional Programming: Pure functions, lists, recursive functions, higher order functions, closures, curry functions, lambdas, evaluation as computation, folds. Discussions using JavaScript, Haskell, ML, or Clojure. Parallel and Concurrent Programming: Concurrent programming model, parallelism, message passing, thread models, synchronization, deadlocks, live locks, GPU programming principles. Discussing using Scala, Java, C and Go. Integrated View of Applications of Paradigms : Problem analysis and choosing appropriate paradigm for different components of applications. Interoperability between different programming languages - JVM languages, Foreign Function Interface, and services.

References:

1. B.W. Kernighan and D. Ritchie, "The C Programming Language," PHI, 1988
2. A.A. Donovan and B.W. Kernighan, "The Go Programming Language, "PHI, 2016
3. C. Horstmann, "Core Java, Vol I", 12th Edition, Pearson, 2023
4. C. Horstmann ,"Core Java, Vol II", 12th Edition, Pearson, 2023
5. D. Flanagan, "JavaScript: The Definitive Guide," 7th Edition, O'Reily 2020
6. M. Odersky et.al. "Programming in Scala," 5th Edition, Goel's Computer Hut, 2022
7. Class notes and handouts

CSS 2106: ALGORITHMS & DATA STRUCTURES [4 0 0 4]

Introduction - Pointers and Pointer Application, Accessing variables through pointers, pointers to pointers, pointer arithmetic and arrays, pointers and functions, Recursion- definition, recursive programs, efficiency of recursion, Stacks, queues, evaluation of expressions, multiple stacks and queues and its application, Linked lists representations- Singly, doubly, header node, circular along with the applications, Trees-Binary trees, representation, recursive/ non recursive inorder, preorder and post order tree traversal, level order traversal, Binary search tree, creation, insertion deletion operations on binary search tree, Additional Binary Tree Operations, Threaded Binary Tree and applications and Introduction to the concepts of Optimal Binary Search Trees.

Fundamentals of Algorithms, Important Problem Types, Analysis of algorithm efficiency. Analysis Framework: Asymptotic Notations and Basic Efficiency Classes, Mathematical Analysis of Non-recursive and Recursive Algorithms. Brute force Techniques, Divide and Conquer, Decrease and Conquer: Insertion Sort, Depth First Search, Breadth First Search, Topological Sorting. Transform and Conquer: Presorting, BST, Heapsort. Space and Time tradeoffs: Input Enhancement in String Matching. Dynamic Programming: Warshall's and Floyd's Algorithms, The Knapsack Problem. Greedy Techniques: Prim's, Kruskal's and Dijkstra's Algorithm, Huffman Trees. Coping with limitations of algorithmic power, P, NP,and NP-complete Problems, Backtracking: n-Queens problem, Hamiltonian Circuit Problem, Subset-Sum Problem. Branch and Bound: Assignment Problem, Knapsack Problem, TSP.

References:

1. Behrouz A. Forouzan, Richard F. Gilberg, A Structured Programming Approach Using C, (3e), Cengage Learning India Pvt. Ltd, India, 2007
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson and Freed, Fundamentals of Data Structures in C, (2e), Silicon Press, 2007

3. Richard F. Gilberg, Behrouz A. Forouzan, Data structures, A Pseudocode Approach with C, (2e), Cengage Learning India Pvt. Ltd, India, 2009
4. Tenenbaum Aaron M., Langsam Yedidyah, Augenstein Moshe J., Data structures using C, Pearson Prentice Hall of India Ltd., 2007
5. Debasis Samanta, Classic Data Structures, (2e), PHI Learning Pvt. Ltd., India, 2010
6. Anany Levitin, Introduction to the Design and Analysis of Algorithms, (3e), Pearson Education, 2011
7. Ellis Horowitz and Sartaj Sahni, Computer Algorithms/C++, (2e), University Press, 2007.
8. Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, Introduction to Algorithms, (2e), PHI, 2006

CSS 2107: DATABASE MANAGEMENT SYSTEM [3 0 0 3]

Database-System Applications, Database Languages, Relational Databases, Database Design, Data Storage and Querying, Database Architecture, Database Schemas, Keys, Relational Query Languages, Relational Operations, Overview of the Design Process, The Entity-Relationship Model, Extended E-R Features, Reduction to Relational Schemas, Features of Good Relational Design, Atomic Domains and Normalization, File concepts, Indices Concept, Static Hashing, Dynamic Hashing, Comparison of Ordered Indexing and Hashing, Bitmap Indices, Transaction Concept, Failure Classification, Storage, Recovery and Atomicity, Recovery algorithm, Overview, Measuring of Query Cost, Selection Operation, Sorting, Join Operation, Evaluation of Expressions.

References:

1. Ramez Elmasri and Shamkant Navathe, Durvasula V L N Somayajulu, Shyam K Gupta, Fundamentals of Database Systems, (6e), Pearson Education, United States of America, 2011.
2. Thomas Connolly, Carolyn Begg, Database Systems - A Practical Approach to Design, Implementation and Management, (4e), Pearson Education, England, 2005.
3. Peter Rob, Carlos Corone I, Database Systems-Design, Implementation and Management, (10e), Course Technology, Boston, 2013.

CSS 2109: INTRODUCTION TO BANKING, PAYMENTS AND CAPITAL MARKETS [4 0 0 4]

Introduction to Banking and Financial Services, Evolution of Banking, Categories of Banks, Product Lines and Product Types, Customer Servicing and Revenue Model, Embedded Finance, Banking Regulations and Compliance, Introduction to Payments, Payment Instruments and Payment Systems, Clearing and Settlement Mechanisms, Payments Messages Standards, Domestic and International Payments, Payment Processing Value Chain, Digital Payments, Payment Gateways & E Commerce Payments, Security in Payments, Regulations and Risks, Introduction to Capital Market, Structure and Functions of Capital Market, Participants of Capital markets, Importance of Capital market in the economy, Capital Market Instruments, Regulations and Risks, Introduction to Insurance

References

1. MacDonald Scott S., Koch Timothy W, Management of Banking. (7 E), Indian: Cengage learning, 2009.
2. Khan, M.Y, Financial services (5 E). Tata McGraw Hill Publications, 2011.
3. Bhole, L.M, Financial institution and markets (3rd ed.). Tata McGraw Hill Publications, 2008
4. Suresh, P. and Justin Paul, Management of Banking and Financial Services, (4th Edition), Pearson Publications, 2017.
5. Indian Institute of Banking and Finance. Bank Financial Management, Macmillan Education, 2011, New Delhi.
6. Bindseil, U., & Pantelopoulos, G. Introduction to Payments and Financial Market Infrastructures. Springer Nature, 2023.
7. Raste, D. R. Capital Market in India: Reforms and Regulations. New Century Publications, 2011.
8. Fabozzi, F. J , Capital markets: institutions, instruments, and risk management. MIT Press, 2015.

CSS 2181: PROGRAMMING PARADIGMS LAB [0 0 3 1]

Suggested Lab Exercises

Parameter passing and safety. Memory models and pointers. Inheritance, overriding, covariance, contravariance, Reflective Programming, Parametrized types and inheritance, List manipulations with recursion, Higher Order functions, Monads, Closures and currying, Multi-threaded program and synchronization, Thread Pool, Message passing, Programming language interoperability

References:

1. B.W. Kernighan and D. Ritchie. "The C Programming Language," PHI, 1988.
2. A.A. Donovan and B.W. Kernighan. "The Go Programming Language," PHI, 2016
3. C. Horstmann. "Core Java, Vol I", 12th Edition, Pearson, 2023
4. C. Horstmann. "Core Java, Vol II", 12th Edition, Pearson, 2023
5. D. Flanagan. "JavaScript: The Definitive Guide," 7th Edition, O'Reily 2020
6. M. Odersky et.al. "Programming in Scala," 5th Edition, Goel's Computer Hut, 2022

CSS 2108: DATA BASE MANAGEMENT SYSTEMS LAB [0 0 3 1]

Data Definition Language, Data manipulation language, Basic database query operations, Integrity Constraints in SQL, Nested subqueries, Join Operations, Views, PL/SQL Basics, Exception Handling, Cursors, Stored procedures, Functions, Packages, Trigger, and project on design and development of application based on database concepts.

References

1. Silberschatz, Korth, Sudarshan, Database System Concepts, (6e) McGraw-Hill, 2011.
2. Ivan Bayross, SQL, PL/SQL - The Programming Language of Oracle, (3e) , BPB Publications, 2010.
3. G, Reese, Database Programming with JDBC and Java, (2e), O'REILLY, 2000.

CSS 2105: ALGORITHMS & DATA STRUCTURE - LAB [0 0 3 1]

Reviewing the concepts of pointers, structures and recursion, Studying the operation of stacks and queues and the associated application programs, Creating dynamic allocation of memory for linked list and applying it to examples using singly, doubly and circular linked list and their applications, Creation of binary trees and the application associated with the trees. Implement a doubly linked list & BST, GCD Techniques, Bubble sort, Selection sort, Linear search, String Matching, sorting algorithms, DFS, BFS, Topological sorting, AVL tree, 2-3 tree, Horspool algorithm, Open hash table, Floyd's algorithm, Warshall's algorithm, Greedy Techniques, Dijkstra's algorithm, Backtracking.

References:

1. Behrouz A. Forouzan, Richard F. Gilberg, A Structured Programming Approach Using C, (3e), Cengage Learning India Pvt. Ltd, India, 2007
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson and Freed, Fundamentals of Data Structures in C, (2e), Silicon Press, 2007
3. Anany Levitin, Introduction to the Design and Analysis of Algorithms, (3e), Pearson Education, India, 2011.
3. Ellis Horowitz and Sartaj Sahni, Computer Algorithms/C++, (2e), University Press, 2007
4. Thomas H. Cormen, Charles E. Leiserson, Ronal L, Rivest, Clifford Stein, Introduction to Algorithms, (2e), PHI, 2006

FOURTH SEMESTER

MAT 2232: PROBABILITY, STOCHASTIC PROCESS AND OPERATION RESEARCH [4 0 0 4]

Basic Probability theory & applications: Basic concepts: Sample space, events, probability axioms, Counting principles: Permutations and combinations, Conditional probability and independence, Bayes' theorem and applications. Random variables and probability distributions, Expected values and moments.

Applications of Probability in Finance: Introduction to financial markets and instruments, Probabilistic models in finance, Probability distributions in finance (Normal distribution, Binomial distribution, etc.), Risk measurement and management using probability Advanced Probability Theory: Joint and marginal distributions, Functions of random variables and their distributions, Central Limit Theorem and its implications in finance, Limit theorems and convergence concepts Stochastic Processes in Finance: Markov chains and applications in finance, Continuous-time stochastic processes (Brownian motion, Poisson processes), Introduction to stochastic calculus and Ito's lemma, Applications of stochastic processes in option pricing and modeling Monte Carlo Simulation in Finance: Basics of Monte Carlo methods, Simulation techniques for pricing derivatives, Applications of Monte Carlo methods in risk management, Time Series Analysis and Forecasting, Introduction to time series data: Autoregressive (AR), Moving Average (MA), and ARMA models, forecasting techniques using time series models, Volatility modeling and ARCH/GARCH models Applications of Probability in Financial Technology: Machine learning and probabilistic models in Financial Technology, Blockchain and distributed ledger technologies: Probability aspects, Quantitative trading strategies using probability and statistics, Risk analytics and predictive modeling in Financial Technology

Linear Programming: Formulation of linear programming problems, Graphical method for solving LP problems, Simplex method and its variations, Duality and sensitivity analysis in LP.

Network Models: Introduction to network models in Financial Technology, Shortest path problems, Minimum spanning trees, Maximum flow problems and applications in financial networks Integer Programming: Introduction to integer programming, Branch and bound method, Applications of integer programming in Financial Technology: portfolio optimization, resource allocation.

Reference Books:

1. Rao, B. L. S. P., A First Course in Probability and Statistics, World Scientific, 2009.
2. Gupta, S. C., & Kapoor, V. K., Fundamental of Mathematical Statistics. Sultan Chand & sons, 2002.
3. Steven E. Shreve, Stochastic Calculus for Finance I: The Binomial Asset Pricing Model, Springer, 2004
4. J.K. Sharma, Operational Research Theory and Application, Trinity Press, 2016
5. Frederick S. Hillier and Gerald J. Lieberman , Introduction to Operations Research, McGraw Hill Education, 2017
6. Hamdy A. Taha, Operations Research: An Introduction, Pearson Education, 2019

HUM 2221: ACCOUNTING AND FINANCE FOR ENGINEERS [4 0 0 4]

Accounting concepts & conventions, accounting cycle, Accounting Information System (AIS), Introduction to other Areas of Accounting like Cost accounting, Management accounting, Tax accounting, Auditing, Forensic accounting, Human Resource Accounting, CSR Accounting, ESG Reporting. Functions of financial management, Time value of money, Capital budgeting techniques, cost of capital, EBIT-EPS-MPS Analysis, Security valuation, working capital estimation, Technology enabled financial transformation.

Reference Books

1. Prasanna Chandra, Financial Management-Theory and Practice, 9th Edition, Tata McGraw Hill Education, 2016.
2. I M Pandey. Financial Management. Vikas Publishing House, 2015.
3. Eugene F Brigham and Michael C E. Financial Management: Theory and Practice, 16th Edition, Cengage Learning, 2019.
4. N Ramachandran and Ram Kumar Kakani. Financial Accounting for Management, 3rd Edition, Tata McGraw Hill Education, 2011.
5. R. Narayanaswamy. Financial Accounting: A Managerial Perspective, 6th Edition, PHI Learning, 2017.

CSS 2205: CYBER SECURITY [3 0 0 3]

OWL Ontologies in Cybersecurity: Conceptual Modeling of Cyber-Knowledge: Introduction to Knowledge Engineering in Cybersecurity, Cybersecurity Taxonomies, Upper Ontologies for Cybersecurity, Formal Knowledge Representation for Cyber-Situational Awareness-Representing Network Knowledge Using Ontology Definition, Representing Network Data Provenance, Vulnerability and Exploit Analysis- Likelihood of Exploitation, Time-Based Analysis, Vendor-/Platform-Based Analysis, Experimental Setup-Performance Evaluation, Training the Binary Classifier for Detecting Network Attacks-Calculating and Preprocessing Network Parameters, Genetic Optimization of the Weights of the Binary Classifier, An Algorithm for Network Attack Detection. Schemes for Combining the Binary Classifiers -Low-Level Schemes for Combining Detectors, Machine Learning in Network Intrusion Detection, Detecting Malware Using SVM - SVM: A Brief Overview, Feature Settings, Hyperparameter Tuning, Evaluation Metrics.

References:

1. Russell, S. and Norvig P, Artificial Intelligence: A Modern Approach, (3e), Prentice-Hall, 2010.
2. Clarence Chio, David Freeman, Machine Learning & Security: Protecting Systems with Data And Algorithms, (1e), Oreilly. 2018
3. Elaine Rich, Kevin Knight, Shivasankar B. Nair, Artificial Intelligence, (3e), The McGraw Hill publications, 2009.

CSS 2206: INTRODUCTION TO FINTECH [3 0 0 3]

Introduction to FinTech, History of FinTech and Stages, Fintech Application Categories & Technology, Cloud Computing in Fintech, Distributed Ledger Technology, Digital and Crypto currency, Machine Learning in Fintech, FinTech challenges, Evolving Innovations in Fintech, Case Studies

References:

1. Bernardo Nicoletti, The Future of FinTech: Integrating Finance and Technology in Financial Services. Palgrave Macmillan, August 2018.
2. Lynn, Theo, Rosati, & Cummins, Disrupting finance: FinTech and strategy in the 21st century. Springer Nature, 2019.
3. Rubini, Agustin, Fintech in a flash: financial technology made easy. Walter de Gruyter GmbH & Co KG, 2018.
4. Susanne Chishti & Janos Barberis, The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, (1e). John Wiley, New York, 2016.

CSS 2207: SOFTWARE SYSTEMS [3 0 0 3]

Operating Systems: Operating system fundamentals and its components. Introduction to process management, memory management, resource management, virtualization, security, embeded and mobile operating system. Case studies - Unix, MS Windows, MacOS, Androd and iOS. Computer Networks: Fundamentals of computer networks, network layers and protocols, transmission and error control, network applications, software defined networks, wireless protocols. Internet of Things: Smart devices, physical devices, sensors and actuators, connection of smart devices, applications, power considerations, network protocols for IoT, security. Cloud Computing: Cloud as a compute resource, cloud OS, cloud as infrastructure, cloud storage, cloud platform as a service, cloud applications as a service, serverless computing, cloud security. Case Studies, AWS, GCP and Azure. Modern Application Development: Modern application architectures and design, standards and protocols web application architecture, mobile application architecture, design for scale, security considerations.

References:

1. R. Arpaci-Dusseau and A. Arpac-Dusseau. "Operating Systems Three Easy Pieces" 2018. Online Book https://pages.cs.wisc.edu/ ∼remzi/OSTEP/
2. L. Peterson and B. Davie."Computer Networks - A Systems Approach,", 5th Edition, Elsevier, 2011 or online version https://book.systemsapproach.org/
3. C. Pfister, Shroff "Getting Started With The Internet Of Things,", O'Reilly. 2011
4. T. Erl and E. Monroy. "Cloud Computing: Concepts, Technology and Architecture", Pearson, 2024

HUM 2222: DESIGN THINKING [1 0 2 2]

Fundamentals of Design Thinking - Need, Importance, History, Human centric approach & Customer centric approach, Traditional Thinking & Design thinking, the importance of innovation in finance, Design Thinking Models, Understanding Customers, Delivering Value to Customers, Understanding the problem - Search Field Determination, Problem Clarification, Problem Analysis, Reformulation of the problem, Identifying pain points in financial services. Empathetic phase and methods for observing, Defining the problem - Point of view phase, The role of problem framing in financial innovation, Ideation phase - Creativity techniques and idea evaluation , Idea generation in finance: balancing creativity and feasibility, Importance of Prototyping in Design Thinking, Low-fidelity vs. High-fidelity Prototypes Story boarding, Advanced Prototyping Techniques: Interactive Prototypes, Usability Testing Preparation, User Testing and Feedback: Conducting Usability Tests , Gathering and Analysing Feedback, Applying Design Thinking to Financial Services : Case studies and Group Project: Successful financial innovations using design thinking, Challenges and opportunities in applying design thinking in finance, Ethical considerations in financial design.

Reference Books

1. Agarwal, A. Design Thinking: A Framework for Applying Design Thinking in Problem Solving (1st ed.). Cengage. 2023.
2. Soni, P. Design Your Thinking. Penguin Random House India Private Limited. 2020
3. Mueller-Roterberg, C. Handbook of design thinking: Tips and tools for how to design thinking. Independently Published. 2018.
4. Van der Pijl, P., Lokitz, J., & Solomon, L. K. Design a better business: New tools, skills, and mindset for strategy and innovation. John Wiley & Sons. 2016.
5. Brown, T. Change by design. HarperCollins Publishers Inc. 2009.

CSS 2280 FINTECH LAB [0 0 6 2]

Introduction to Fintech Application, Aspects of development, demonstrate a sample of Schema, LDM, API's, UI Screens, Cloud deployment etc, Use cases, Standards of coding, Reusability, Audit, History, Regulation, Error Handling, Logging, Customer Creation retrieval /KYC.

Reference books:

Material developed by MIT-FIS

V SEMESTER

CSS 3106: SOFTWARE APPLICATION DESIGN [3 0 0 3]

Evolution from an art form to an engineering discipline, Software development Projects, Exploratory style of software development, Emergence of software Engineering, Notable changes in software development practices. Computer Systems Engineering. A few basic concepts, Waterfall model and its extensions, Rapid Application Development, Agile development models, Spiral Model, A Comparison of different Life Cycle models, Case Studies. Requirement Gathering and Analysis, Software Requirement Specifications, Case Studies Formal Specification Techniques, Case Studies. Overview of the design Process, How to characterize a good software design? Cohesion and coupling, Layered arrangement of modules, Approaches to software design. Overview of SA/SD methodology, Structured analysis, Developing the DFD Model of a system, Case Studies Structured Design, Case Studies Detailed design, Design review, Case Studies. Basic object-orientation concepts, UML, UML diagrams, Use case model, Class diagrams, Interaction diagrams, Activity Diagram, State chart diagram, Case Studies Postscript, Design Patterns, An Object-Oriented Analysis and Design (OOAD) Methodology, Case Studies. Coding, Code review, Software Documentation, Testing, Unit Testing, Black-Box testing, White-Box Testing, Debugging, Program Analysis tools, Regression testing, Security testing, Robustness testing, Fuzzy testing, Integration testing, Testing OOP, System testing, Some general issues associated with testing.

References Books:

1. Rajib Mall, Fundamentals of Software Engineering (5e), PHI Learning, 2019.
2. Hans Van Vliet, Software Engineering: Principles and Practice (3e), Wiley India, 2012.
3. Roger S. Pressman, Software Engineering - A Practitioner's Approach (7e), McGraw-Hill International Edition, 2010.
4. Bernd Bruegge, Allen H. Dutoit, Object-Oriented Software Engineering using UML Patterns and Java (2e), Pearson Publication, 2011.
5. Ian Sommerville, Software Engineering (9e), Addison-Wesley, 2011.
6. Nooper Davis, Secure Software Development Life Cycle Processes, Software Engineering Institute, Carnegie Mellon University, 2013.
7. Julie Cohen, Dan Plakosh, Kristi Keeler, Robustness Testing of Software-Intensive Systems: Explanation and Guide, Carnegie Mellon University, 2005.

CSS 3105: INSURTECH [3 0 0 3]

InsurTech Definition, Digital Transformation in Insurance, Problem or Solution for Agents and Brokers, InsurTech Startups-Role, InsurTech Now and Next A Cartographer's Dream - Exploring, and Mapping, the New Unknown, Internationalizing InsurTech, Collaborative Innovation: Observe - Partner - Invest The Corporate Collaboration Opportunity in InsurTech, The Value Chain, Behavioural Design and Price Optimization in InsurTech, Cyber Risk, Innovating within the Business to-Business Insurance Claims Handling Ecosystem, Business Model Innovation - From Incremental to Disruptive, The Future of Insurance - From Managing Policies to Managing Risks, From Claim Settlement to Claim Prevention, Digital Transformation and Corporate Innovation Management, Social Media in Insurance, The Future of Microinsurance

Reference Books:

1. Sabine L.B VanderLinden, Shân M. Millie, Nicole Anderson, Susanne Chishti.The INSURTECH Book: The Insurance Technology Handbook for Investors, Entrepreneurs and FinTech Visionaries. John Wiley,2018
2. Cruz Rambaud, S., & López Pascual J. Insurtech, Proptech, and Fintech Environment: Sustainability, Global Trends and Opportunities. Sustainability, 15(12), 9574.2023

CSS 3103: BANKING TECHNOLOGY [4 0 0 4]

Banking Core Product Lines (Deposits, Lending etc), Key Geography Variations (currency, language, taxation, regulatory etc.), Bank Segmentation (Large/Mega/Mid/Digital), Banking Applications (Digital/Channel Apps), Core Banking Platform, Enterprise Components, Risk and Fraud components, Data Analytics/Data Warehouse, Payment Apps, Four Dimensions of Core Banking, High Engineering Complexity, Evolving Trends to be supported by Banking Technology, Evolution of Core banking Platforms, Processing Models, Scalability, Elasticity, Observability, 24*7 Availability, Security Architecture, Data Architecture, Integration Architecture, Extensibility Architecture, CI-CD/DevOps Architecture, Deployment Models, Key Industry Standards Support, Programming Languages, Persistence Technologies (Databases), Container Technologies and Services, Cloud Service

Reference Books:

1. Shroff, F. T. Modern banking technology. Northern Book Centre.2007
2. Keyes, J. (Ed.). Banking technology handbook. CRC Press. 1998
3. Ravi, V. (Ed.). Advances in Banking Technology and Management: Impacts of ICT and CRM: Impacts of ICT and CRM. IGI Global. 2007

CSS 3108: STATISTICS FOR FINANCE [3 0 0 3]

Introduction statistics, data, data Types, Measures of central tendency and dispersion, Classical linear regression model, Analysis of the classical linear regression model, Classical linear regression model assumptions and diagnostic tests, Introduction to logistic Regression Univariate time series modelling and forecasting, Multivariate models, Modelling long-run relationships in finance, Modelling volatility and correlation, Switching models, Panel data, Limited dependent variable models, Simulation methods, High frequency data

References Books:

1. Chris Brooks. Introductory Econometrics for Finance, 2e. Cambridge University Press, New York, 2008.
2. Damodar N. Gujarati, Dawn C. Porter, & Sangeetha Gunasekar. Basic of Econometrics, 5e. McGraw Hill Education Pvt. Ltd., New Delhi, India, 2012.

CSS 3102: AI FOR FINANCE [3 0 0 3]

Artificial Intelligence, Superintelligence, Normative Finance, Data-Driven Finance, Machine Learning, Deep Neural Network, Recurrent Neural Networks, Reinforcement Learning

References:

1. Yves Hilpisch, Artificial Intelligence in Finance, O'Reilly Media, 2020.
2. Marcos López de Prado, Advances in Financial Machine Learning, Wiley, 2018.
3. Marcos López de Prado, Machine Learning for Asset Managers, Cambridge University Press, 2020.
4. Ernest P. Chan, Quantitative Trading: How to Build Your Own Algorithmic Trading Business (2nd Edition), Wiley, 2017.
5. Yves Hilpisch, Python for Finance: Mastering Data-Driven Finance (2nd Edition), O'Reilly Media, 2018.
6. Stefan Jansen, Hands-On Machine Learning for Algorithmic Trading (2nd Edition), Packt Publishing, 2020.
7. Ali N. Akansu, Sanjeev R. Kulkarni, Dmitry M. Malioutov, Financial Signal Processing and Machine Learning, Wiley, 2016.

IPE 4302: CREATIVITY, PROBLEM-SOLVING AND INNOVATION [3-0-0-3]

CSS 3107: SOFTWARE APPLICATION DESIGN-LAB [0 0 21]

Rational Rose, Star UML, SRS, SRS of Case Study, Code Generation, Project Implementation, Use Cases, SOLID Principles, Class Diagrams, Interaction Diagrams, Package Diagrams, Component Diagrams, Deployment Diagrams, NUnit, Junit.

Reference Books:

1. Rajib Mall, Fundamentals of Software Engineering (5e), PHI Learning, 2019

CSS 3104: BANKING TECHNOLOGY LAB [0 0 2 1]

Banking Applications - Categories, Core Banking Platform, Enterprise Processing Components, Data Analytics / Data Warehouses, Payments Apps, Enterprise / Cloud Native Services

VI SEMESTER

CSS 3201: MACHINE LEARNING & DEEP LEARNING [4 0 0 4]

Introduction: Background Big Data-Big Compute in Finance, Fintech , Machine Learning and Prediction, Entropy, Neural Networks, Statistical Modeling vs. Machine Learning, Modeling Paradigms, Financial Econometrics and Machine Learning, Over-fitting, Reinforcement Learning, Examples of Supervised Machine Learning in Practice, Algorithmic Trading, High-Frequency Trade Execution, Mortgage Modeling. Data Preprocessing for Finance- Financial Data Types: Stock prices, time series, high-frequency data, sentiment analysis data; Data Cleaning and Transformation: Handling missing data, Outlier detection, Feature scaling; Feature Engineering for Finance, Feature selection techniques, Domain-specific feature engineering for financial datasets. Supervised Learning Algorithms in Finance- Regression Models: Linear and Logistic Regression for financial prediction; Decision Trees and Random Forests: Risk modeling and credit scoring, Support Vector Machines: Fraud detection and classification, Evaluation Metrics for Finance: AUC, ROC, Precision, Recall, Sharpe ratio. Unsupervised Learning in Finance-Clustering Techniques: K-means, Hierarchical Clustering, DBSCAN for market segmentation; Dimensionality Reduction: PCA, LDA for portfolio optimization and risk management, Anomaly Detection: Fraud detection and outlier identification in finance. Risk Modeling and Credit Scoring- Risk Models: VaR, Expected Shortfall for risk assessment; Credit Scoring Techniques: Logistic Regression, Decision Trees, and Random Forests for risk modelling. Anomaly Detection and Fraud Detection- Anomaly Detection in Financial Transactions: Identifying suspicious transactions using ML. Evaluation Metrics: Confusion matrix, precision, recall, F1-score. Time Series Forecasting- Time Series Analysis: AR, MA, ARMA, and ARIMA models for stock price prediction; Deep Learning in Financial Applications- Deep Learning Fundamentals: Neural networks, CNNs, RNNs, and LSTMs; Application of Deep Learning in Finance: Sentiment analysis using CNN, Fraud detection using autoencoders, Portfolio optimization using deep reinforcement learning.

Sentiment Analysis in Finance-Natural Language Processing (NLP) in Finance: Text mining and sentiment analysis from financial news and social media. RNNs for Sentiment Analysis: Building sentiment analysis models using RNNs or LSTMs to predict market movements. LSTM and RNN in Financial Time Series: Predicting stock prices using deep learning; Volatility Modeling: GARCH models for financial volatility estimation.

Reference Books

1. Bryan T. Kelly, Dacheng Xiu, FINANCIAL MACHINE LEARNING ,SSRN,July 2023
2. Matthew F. Dixon, Igor Halperin, Paul Bilokon, MACHINE LEARNING IN FINANCE FROM THEORY TO PRACTICE, Springer Nature Switzerland AG .2020
3. M. Narasimha Murty & V. Susheela Devi, INTRODUCTION TO PATTERN RECOGNITION AND MACHINE LEARNING, World Scientific Publishing Co. Pvt. Ltd. 2015
4. Marcos Lopez De Prado, ADVANCES IN FINANCIAL MACHINE LEARNING, John Wiley & Sons, Inc., Hoboken, New Jersey publication, 2018.
5. Yves Hilpisch, PYTHON FOR FINANCE MASTERING DATA-DRIVEN FINANCE, O'Reilly Media Publication, Second Edition, 2020
6. Luigi Troiano, Arjun Bhandari, Elena Mejuto Villa, HANDS-ON DEEP LEARNING FOR FINANCE, Packt Publishing Ltd. Publication, 2020
7. Pradeep Singh, FUNDAMENTALS AND METHODS OF MACHINE AND DEEP LEARNING ALGORITHMS, Tools and Applications, Scrivener Publishing LLC, 2022
8. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, THE ELEMENTS OF STATISTICAL LEARNING, Springer Series in Statistics, 2009
9. Ian Goodfellow, Yoshua Bengio, Aaron Courville, DEEP LEARNING, The MIT Press, 2016.

HUM 3022: ESSENTIALS OF MANAGEMENT [3 0 0 3]

Introduction to Business, Classification of Industries, Importance of management for an engineer, Manager Roles External Environment, Social Responsibility of managers, Ethics in managing, International Business, Strategies and Policies, Strategic Planning Process & tool, Span of Management, Departmentation, Recruitment, Selection, Induction, Orientation. Leadership and Motivational tools and

Techniques, Group Decision, Communication, Management Control Techniques

Reference Books:

1. Harold Koontz, Heinz Weihrich, & Mark V. Cannice, "Essentials of MANAGEMENT: An International, Innovation, and Leadership Perspective", 11th Edition, McGraw Hill Education (India) Private Limited. 2020

CSS 3202:CAPITAL MARKETS TECHNOLOGY [3 0 0 3]

Overview of Capital Market: Indian Capital Market, Authorities Governing Capital Markets in India, Market Regulation, Securities Market Reforms and Regulatory Measures to Promote Investor Confidence, Features of Developed Capital Market: IOSCO, Overview of Depository System in India, Intermediaries in the Capital Market: Merchant Bankers, Registrar to an issue & Share transfer agents, Underwriters, Bankers to an issue, Debenture trustees, Portfolio Managers, Stockbrokers and sub-brokers, Institutional investors, Foreign Portfolio Investors (FPIs), Custodians, Clearing House, Deeper look of capital markets, Industry landscape - Roles of banks, Hierarchy, Asset classes - Transaction processing (Equity, Mutual Funds, ETFs, Derivatives, Government Bonds, Corporate Bonds, OTC Derivates), Retail Brokerage, Wealth Management, Institutional Brokerage, Asset Management, Custodian, Prime Brokerage, Market Infrastructure - Stock exchanges, Central counter party, Central securities Depository, Share Registrars

References Books:

1. Bodie Kane, Marcus, Investments. Tata McGraw Hill, Eleventh Edition, 2019.
2. Dr. Prasanna Chandra, Investment Analysis and Portfolio Management, Sixth Edition, McGraw Hill, 2021.
3. Donald Fischer, J Jordan, Securities Analysis & Portfolio Management ,Seventh Edition, Pearson Education, 2018.
4. Keith Brown & Frank Reily. Investment Analysis and Portfolio Management, Eleventh Edition, Cengage, 2022.
5. R. P. Rustagi. Investment Analysis and Portfolio Management Latest edition, S. C and Sons, 2022.

CSP 4434: CLOUD COMPUTING & DEV SEC OPS [3 0 0 3]

Azure DevOps Fundamentals, Infrastructure as Code (IaC) with Azure Resource Manager (ARM), Continuous Integration and Delivery (CI/CD) with Azure Pipelines, Containerization with Docker and Azure Kubernetes Service (AKS), Security and Compliance with Azure Security Center and Azure Policy. Monitoring and Logging with Azure Monitor and Azure Log Analytics

Reference Books:

1. David Okeyode, and Joylynn Kirui, DevSecOps for Azure: End-to-end supply chain security for GitHub, Azure DevOps, and the Azure cloud. Packt Publishing.2024
2. Krief, M.Learning DevOps: The Complete Guide to Accelerate Collaboration with Jenkins, Kubernetes, Terraform and Azure DevOps. Packt Publishing Ltd. . 2019

CSP 4435: SOFTWARE RELIABILITY [3 0 0 3]

Introduction to Software Reliability, Reliability Engineering for Financial Software, Risk Management in Financial Systems, Reliability Prediction and Models, Reliability and Security in Financial Software, Financial Software Failure Modes and Disaster Recovery, Case Studies.

References Books:

1. Michael R. Lyu."Software Reliability Engineering: A Practitioner's Approach". McGraw Hill.1996
2. Carlo Ghezzi, Mehdi Jazayeri, and Dino Mandrioli. "Fundamentals of Software Engineering". Pearson.2002
3. Elsayed A. Elsayed. "Reliability Engineering". Wiley .2012
4. Heather Adkins, Betsy Beyer, Paul Blankinship, and Piotr Lewandowski. "Building Secure and Reliable Systems". O'Reilly Media.2020
5. Niall Richard Murphy, Betsy Beyer, Chris Jones, and Jennifer Petoff."Site Reliability Engineering: How Google Runs Production Systems". O'Reilly Media .2016

CSS 3203: CAPITAL MARKETS LAB [0 0 2 1]

FIS will share the contents of the Lab at a later date

CSS 3204: MACHINE LEARNING LAB [0 0 2 1]

Data Preprocessing for Financial Data, Feature Selection for Financial Data, Linear and Logistic Regression in Financial Trees and Random Forests for Risk Modeling and Credit Scoring, Clustering Techniques for Market Segmentation, Principal Component Analysis (PCA) for Portfolio Optimization, Anomaly Detection in Financial Data Time Series Analysis for Stock Price Prediction, LSTM and RNN for Financial Time Series Prediction, Deep Learning for Fraud Detection, Sentiment Analysis Using NLP for Market Prediction, Portfolio Optimization using Deep Reinforcement Learning.

Reference Books:

1. Marcos Lopez De Prado, ADVANCES IN FINANCIAL MACHINE LEARNING, John Wiley & Sons, Inc., Hoboken, New Jersey publication, 2018.
2. Yves Hilpisch, PYTHON FOR FINANCE MASTERING DATA-DRIVEN FINANCE, O'Reilly Media Publication, Second Edition, 2020
3. Luigi Troiano, Arjun Bhandari, Elena Mejuto Villa, HANDS-ON DEEP LEARNING FOR FINANCE, Packt Publishing Ltd. Publication, 2020
4. Pradeep Singh, FUNDAMENTALS AND METHODS OF MACHINE AND DEEP LEARNING ALGORITHMS, Tools and Applications, Scrivener Publishing LLC, 2022

VII SEMESTER

SP 4436: REPORTING & ANALYTICS USING AI FOR FINTECH [3 0 0 3]

Data warehouse and online analytical processing basic concepts, Data warehouse modelling, Data warehouse design, usage and implementation, Data generalization, Data cube preliminary concepts and computation methods, Prediction mining in cube space, Multifeature cubes: complex aggregation at multiple granularities, Mining frequent patterns basic concepts, Frequent Itemset Mining Methods, Pattern Evaluation Methods, Pattern mining in Multilevel, Multidimensional space, Constraint based frequent pattern mining, Mining high-dimensional data and colossal patterns, Classification basic concepts, Decision tree induction, Rule based classification, Model evaluation and selection, Techniques to improve classification accuracy, Requirements for Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid-Based Methods, Evaluation of Clustering, Mining Data Streams, Mining Sequence Patterns.

References Books:

1. Jiawei Han and Micheline Kamber, Data Mining- Concepts and Techniques, (3e), Morgan Kaufmann Publishers, 2012.
2. Jiawei Han and Micheline Kamber, Data Mining- Concepts and Techniques, (2e), Morgan Kaufmann Publishers, 2010.
3. G. K. Gupta, Introduction to Data Mining with Case Studies, (3e), PHI Learning Pvt. Ltd., 2014.
4. Mohammed J. Zaki, Wagner Meira, Data Mining and Analysis: Fundamental Concepts and Algorithms, Cambridge University Press, 2017.
5. Pang-Ning Tan, Vipin Kumar, Michael Steinbanch, Introduction to Data Mining, (2e), Pearson Addison Wesley, 2020.

CSX XXXX: COMPLIANCE AND REGULATION FOR FINTECH [3 0 0 3]

Regulatory strategy for Fintech Companies, Overview of financial services regulation, Regulation in practice, Financial service industry, retail financial services products, Wholesale financial service products, alternative investment fund managers directive, anti-money laundering directives, bank recovery and resolution directives, cross-border payments in regulation, consumer contracts directives.

References Books:

1. Stefan Loesch .A Guide to Financial Regulation for Fintech Entrepreneurs, Wiley.2018

CSX XXXX: FINANCIAL RISK MANAGEMENT [3 0 0 3]

Risk Management, Nature of risk and Uncertainty, The meaning of risk, kinds of risk, process of risk management, risk management tools - forwards, futures, options. Basics of derivatives, Basics of derivatives, Derivatives Market - History and Evolution, Importance of Derivatives, risks faced by the participants in derivatives, Basics of Forwards Contracts and Futures Contracts, Differences between the two, Futures contracts Payoff Graphs, Pricing of Futures contracts, Basics of options, Distinction between futures and options contracts, Analysis of options from the perspectives of buyer and seller - Payoff Charts for Options - Long and Short Call, Long and Short Put, Strategies - Straddle, Strangle, Covered Call, Protective Put, Butterfly Spread, Pricing and Sensitivity of Options, Black, Scholes and Merton Model for pricing Options, Introduction to Greeks of Options - Delta, Gamma, Theta, Vega, Rho.

References Books:

1. John. C. Hull, and Sankarshan. Basu Options, Futures and Other Derivatives, Eleventh Edition, Pearson Education Asia 2022.
2. National Institute of Securities Markets (NISM) Workbook for NISM Series VIII - Equity Derivatives Certification Examination, 2018 Edition, Taxman Publications Private Ltd, 2018.
3. arashuraman, Fundamentals of Financial Derivatives, 2nd Edition, Wiley Publication, 2014.
4. Rene M. Stulz, Risk Management and Derivatives. Thompson Publications, New Delhi, 2007.
5. S. L. Gupta, Financial Derivatives: Theory, Concepts and Problems, Second Edition Prentice Hall of India Private Limited, New Delhi, 2017.
6. Babu V Daniel Jose, Financial Derivatives: Concepts, Components and Functions, New Century Publications, 2012.
7. S.S. Kumar, Financial Derivatives, PHI Publications, New Delhi, 2012.

CSP 4437: SOFTWARE QUALITY ASSURANCE AND PROJECT MANAGEMENT [3 0 0 3]

Introduction to Software Quality Assurance, Software quality assurance system - overview and Assuring the Quality of Software Maintenance Components, Software Testing - Strategies and Implementation, Project Management- An Overview, Project Management Growth: Concepts and Definitions

References Books:

1. Daniel Galin. "Software Quality Assurance: Principles and Practice". Alpha Science Int., Ltd. 2006
2. Harold Kerzner "Project Management: A Systems Approach to Planning, Scheduling, and Controlling". JOHN WILEY.2017
3. Ken Schwaber. "Agile Project Management with Scrum". Microsoft Press US.2004.

CSX XXXX: ALGORITHMIC TRADING [3 0 0 3]

Market Structure and Participants, Market Efficiency and Algorithmic Trading, Moving Averages: SMA and EMA ,Price Action and Trend-following Strategies, Statistical Methods for Time-series Analysis, Regression Models for Market Prediction, Risk Management Metrics, Trading Algorithms, Handling Market Data and APIs, Backtesting Trading Strategies , Limit Order Books and Liquidity, Transaction Costs and Slippage, Algorithm Optimization , Introduction to High-frequency Trading (HFT), Introduction to Machine Learning in Trading.

References Books:

1. B. Johnson, Algorithmic Trading and DMA: An Introduction to Direct Access Trading Strategies. London, UK: 4Myeloma Press, 2010.
2. M. López de Prado, Advances in Financial Machine Learning. Hoboken, NJ, USA: Wiley, 2018.
3. E. P. Chan, Quantitative Trading: How to Build Your Own Algorithmic Trading Business, 2nd ed. Hoboken, NJ, USA: Wiley, 2017.
4. L. Harris, Trading and Exchanges: Market Microstructure for Practitioners. Oxford, UK: Oxford Univ. Press, 2003.
5. I. Aldridge, High-Frequency Trading: A Practical Guide to Algorithmic Strategies and Trading Systems, 2nd ed. Hoboken, NJ, USA: Wiley, 2013.
6. D. Ruppert, Statistics and Data Analysis for Financial Engineering, 2nd ed. New York, NY, USA: Springer, 2015.
7. Michell L Halls Moore, Successful Algorithmic Trading, GitHub 2014

MINOR IN BUSINESS MANAGEMENT

HUM 4401: HUMAN RESOURCE MANAGEMENT [3 0 0 3]

Introduction, Scope of HRM, Objectives of HRM, Functions, Activities, Roles, HRD organization and responsibilities. Evolution of HRM, global trends shaping HR practices. Influence of various factors on HRM. Human resource planning: Introduction, Strategic considerations, Nature and scope, Human Resources Inventory, Job analysis, Job design, Job description, Job specification and Job evaluation. Employee Recruitment & Selection: Policy, Process, Tests, modern methods, Interview, Provisional selection, Medical/Physical examinations, Placement, Induction programs and socialization. Training and development: Basic concepts, Employees training Process, Planning, Preparation of trainees, Implementation, Performance evaluation and Follow-up training. Competency Mapping and Career development programmes. Performance appraisal and Merit rating, Promotion, transfers and separations, Wages and salaries administration, Discipline and grievances. Industrial and labour relations and Trade Unionism Overview: Collective bargaining and maintaining Industrial health, Practising Inclusivity, Role of HR in Mergers & Acquisitions, HR in Entrepreneurial firms.

References

1. Michael Armstrong., A Handbook of Human Resource Management Practice: 10th Edition, New Delhi, Kogan Page India,2006
2. Gary Dessler & Biju Varkey .,Human Resource Management:12th
3. Edition Dorling Kindersley(India),Noida,2011
4. T. V. Rao and Pereira D F., Recent experiences in Human Resources Development, Oxford and IBH Publishing, 1986.
5. Subbrao A., Essentials of Human Resource Management and industrial Relations, Himalaya Publishing House, 1999
6. Aswathappa K, Human Resource Management,Text & Cases McGraw Hill 7th Edition, 2006
7. N G Nair and Latha Nair., Personnel Management and Industrial
8. Relations, S. Chand Company, 1995.

HUM 4402: MARKETING MANAGEMENT [3 0 0 3]

Marketing definition, scope and concepts, Adapting marketing to the New Economy, Marketing strategic planning. Market Demand, Marketing Environment, Marketing Information System, Marketing Research. Segmentation, Targeting and Positioning, Buying Behaviour: Consumer Markets and Business Markets, Competition: Identifying competitors, analysing competitors. Product Life Cycle: Product life-cycle marketing strategies. New Market Offerings: New product development and challenges, Branding. Designing and Managing Services, Price Strategies, Retailing, Wholesaling, Integrated Marketing Communications, Digital Marketing and Trends, International Marketing.

References

1. Philip Kotler, Kevil Keller, SweeAng, Chi Tan, Siew Leong, Marketing Management- An Asian Perspective, Pearson Education, Singapore, 2021.
2. Philip Kotler, Kevil Keller, Abraham Koshy &MithileshwarJha, Marketing Management: A South Asian Perspective, Pearson Education Inc, New Delhi, 2012.
3. Deepak &Jeyakumar, Marketing Management. Educreation Publishing, 2019.

HUM 4403: FINANCIAL MANAGEMENT [3 0 0 3]

Introduction and objectives of financial management, Evolution of corporate finance. Types of accounts, Golden rules of accounting, Preparation of journal, ledger, trial balance and final accounts. Sources of long-term finance, Characteristics of equity capital, preference capital, debenture capital & term loans. Valuation of securities, Bond valuation and related models, Bond value theorems, Yield to maturity, Equity valuation, Dividend capitalization approach. Leverage, Operating leverage, financial leverage, Total leverage, Indifference point analysis. Working capital management. Capital budgeting, Appraisal criteria, Payback period, Average rate of return, Net present value, Benefit cost ratio, Internal rate of return. Risk analysis in capital budgeting. Cost of capital, Cost of debt capital, preference capital and equity capital, Weighted average cost of capital, Determination of proportions, Cash management, Dividend decisions.

References:

1. Prasanna Chandra. Financial Management-Theory and Practice, 9/e. Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2016.
2. I M Pandey. Financial Management. Vikas Publishing House Pvt. Ltd., New Delhi,2015.
3. N Ramachandran & Ram Kumar Kakani. Financial Accounting for Management, 3e. Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2011.
4. Eugene F Brigham & Michael C E. Financial Management: Theory and Practice, 12e. Cengage Learning, India, 2008.
5. R. Narayanaswamy. Financial Accounting: A Managerial Perspective, 6e. PHI Learning Pvt. Ltd., New Delhi, 2017.

HUM 4404: OPERATIONS MANAGEMENT [2 1 0 3]

Introductions to operations management, Forecasting – qualitative and quantitative methods of forecasting, and forecast errors. Capacity Planning- long-term capacity and capacity cushions. Aggregate planning – Strategies and developing an aggregate plan. Scheduling - machine scheduling and workforce scheduling. Theory of constraints - identifying and reliving bottlenecks in a line process. Supply Chain Management- design, organization, and performance measures. Quality Management – concepts of TQM, lean and continuous improvement.

References:

1. Krajewski L. J., Ritzman L. P., Malhotra M., and Srivastava S. K., Operations Management, 11th edition, Pearson Education (Singapore) Pvt. Ltd., Delhi, 2016.
2. Heizer J. and Render B. and Munsen C., Operations Management, 12th edition. Pearson Education India, 2017.
3. Khanna R. B., Production and Operations Management, 2nd edition, PHI Learning Private Limited, 2015.
4. Stevenson, W. J., Operations management. McGraw Hill, 2020.

MINOR IN FINANCE & INVESTMENTS

HUM 4403: FINANCIAL MANAGEMENT [3 0 0 3]

Introduction and objectives of financial management, Evolution of corporate finance. Types of accounts, Golden rules of accounting, Preparation of journal, ledger, trial balance and final accounts. Sources of long-term finance, Characteristics of equity capital, preference capital, debenture capital & term loans. Valuation of securities, Bond valuation and related models, Bond value theorems, Yield to maturity, Equity valuation, Dividend capitalization approach. Leverage, Operating leverage, Financial leverage, Total leverage, Indifference point analysis. Working capital management. Capital budgeting, Appraisal criteria, Pay-back period, Average rate of return, Net present value, Benefit cost ratio, Internal rate of return. Risk analysis in capital budgeting. Cost of capital, Cost of debt capital, preference capital and equity capital, Weighted average cost of capital, Determination of proportions, Cash management, Dividend decisions.

References:

1. Prasanna Chandra. Financial Management-Theory and Practice, 9/e. Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2016.
2. I M Pandey. Financial Management. Vikas Publishing House Pvt. Ltd., New Delhi,2015.
3. N Ramachandran & Ram Kumar Kakani. Financial Accounting for Management, 3e. Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2011.
4. Eugene F Brigham & Michael C E. Financial Management: Theory and Practice, 12e. Cengage Learning, India, 2008.
5. R. Narayanaswamy. Financial Accounting: A Managerial Perspective, 6e. PHI Learning Pvt. Ltd., New Delhi, 2017.

HUM 4405: FINANCIAL SYSTEM [3 0 0 3]

Introduction to financial market, Stock markets trading mechanism, Major stock exchanges, Stock market indices. Factors affecting stock market, analysis of market indices- SENSEX and NIFTY components, calculation and revision, International stock exchange and its operation for NYSE, NASDAQ, and LSE. Role of IT in capital market, Provident funds, Pension funds, Chit funds. Objective and functions debt market. Primary and secondary mortgage market, Participants in mortgage markets, International trends in securitization. Derivative securities markets- forward, futures, options and financial swaps market, trading mechanism, regulatory framework and pricing of the instruments. Financial intermediaries, Commercial banks, Credit system for short-term developments in credit information system. Development banks-structure, philosophy and operations. Non-Banking Financial Cos- the types, role and function. Regulatory framework for NBFCs, provident funds. Pension fund's objectives and functions. Real Assets- Land and house property, bullion, art and precious stones. Mutual Fund- concept, types and functioning, Limitations of mutual funds. Overall comparative analysis of financial market in India & UK / China / Euro Zone / Japan / Brazil / Russia and South Africa.

Reference:

1 Bhole, L. M. Financial Institutions and Markets: Structure, Growth & Innovation, 6e. McGraw Hill Education, New Delhi, 2017.

2 Saunders, A. & Cornett, M. Financial Markets and Institutions, 6e. McGraw-Hill Education, New Delhi, 2014

3 Machiraju, H. R. Indian Financial System, 5e. Vikas Publishing House, New Delhi, India, 2019.

4 Varshney, P. N. Banking Law & Practice, Sultan Chand & Sons, 2017.

5 Harris, Larry. Trading and exchanges: Market microstructure for practitioners. OUP USA, 2003.

HUM 4406: SECURITY ANALYSIS & PORTFOLIO MANAGEMENT [3 0 0 3]

Introduction, Accounting information and regression analysis, Common stock- return, growth, and risk, Introduction to valuation theories, Bond valuation and analysis, The uses and calculation of market indexes, Risk-Aversion, Capital asset allocation, and Markowitz portfolio-selection model, Capital asset pricing model and beta forecasting, Index models for portfolio selection, Performance measure approaches for selecting optimum portfolios, The efficient-market hypothesis & security valuation, Arbitrage pricing theory, Intertemporal capital asset pricing model.

Reference:

1. Finnerty, Joseph, et al. Security Analysis, Portfolio Management, and Financial Derivatives. World Scientific Publishing Company, 2012.
2. Fischer, D. E., Jordan, R. J. & Ashwini, K. P. Security Analysis Portfolio Management, 7e. Pearson Education, New Delhi, India, 2018.
3. Chandra, P. Investment Analysis and Portfolio Management, 5e. McGraw Hill Education, New Delhi, India, 2017.
4. Kevin, S. Security Analysis Portfolio Management, 2e. PHI Learning Pvt. Ltd., New Delhi, India, 2015.
5. Ranganatham, M. &Madhumathi, R. Security Analysis Portfolio Management, 2e. Pearson Education India, 2011.
6. Damodaran, Aswath. Investment valuation: Tools and techniques for determining the value of any asset. Vol. 666. John Wiley & Sons, 2012.

HUM 4407: PROJECT FINANCE [3 0 0 3]

Project finance and its importance, Development of project finance, elements of project finance structures and examples. Project development and management, Sponsors and other investors, Role of advisors, Joint-ventures issues, The project company, Public procurement. Market for project finance- applications and sectors, Working with lenders. Project characteristics, Risk analysis and risk management, Types of project agreement, Common aspects of project agreement, Sub-contracts and other related agreements. Valuing the project, Project cash flow analysis. Financing the deal, Funding options-equity, funding options, Legal aspects of project finance. Risk in project finance, Commercial risks, Macro-economic risks, Regulatory and political risks evaluation and allocation, Financial structuring, The financial model, Recent market developments and prospects for project finance.

Reference:

1 Yescombe, E. R. Principles of Project Finance, 2e. Academic Press, Waltham, USA, 2014.

2 Gatti, S. Project Finance in Theory and Practice: Designing, Structuring, and Financing Private and Public Projects, Academic Press, Waltham, USA, 2013.

3 Prasanna Chandra. Projects- Planning Analysis, Selection, Financing, Implementation and Review, 8e. McGraw Hill Education, 2017.

4 Machiraju, H. R., Introduction to Project Finance, 1e. Vikas Publication House Pvt. Ltd., New Delhi, India, 2001.

MINOR IN FINANCIAL TECHNOLOGY

HUM 4408: FINTECH SERVICES [3 0 0 3]

Introduction, FinTech history, initiatives ecosystem, and challenges, Technology Enablers for Fintech, Digital Transformation and Disruption, Digital signatures and Cryptography, Distributed ledger technology FinTech model and classifications, Business model for FinTech. Innovations and FinTech, Critical success factors for FinTech. Regulations importance, the role of regulators. Application of fintech in Banking, lending and Borrowing, Wealth Management, and Capital Markets. Digital technologies and their role in FinTech, payment gateway.

References:

1 Chavan, Chandrahauns., Patankar, Atul., Introduction to Fintech, Pearson, 2024

2. Bernardo Nicoletti. The Future of FinTech: Integrating Finance and Technology in Financial Services. Palgrave Macmillan, August 2018.

3. Rubini, Agustin. Fintech in a flash: financial technology made easy. Walter de Gruyter GmbH & Co KG, 2018.

4. Susanne Chishti & Janos Barberis. The FINTECH Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries, 1e. John Wiley, New York. 2016.

HUM 4409: INTRODUCTION TO BANKING AND PAYMENT SYSTEMS [3 0 0 3]

Introduction to Banking and Financial Services, Evolution of Banking, Categories of Banks, Product Lines and Product Types, Customer Servicing and Revenue Model, Embedded Finance, Banking Regulations and Compliance, Introduction to Payments, Payment Instruments and Payment Systems, Clearing and Settlement Mechanisms, Payments Messages Standards, Domestic and International Payments, Payment Processing Value Chain, Digital Payments, Payment Gateways & E-Commerce Payments, Security in Payments, Regulations and Risks

References:

1. Khan, M.Y. Financial services, 5e. Tata McGraw Hill Publications, 2011.

2. Bhole, L.M. Financial Institution, and Markets, 3e. Tata McGraw Hill Publications, 2008.

3. Suresh, P. and Justin Paul. Management of Banking and Financial Services, 4e. Pearson Publications. 2017.

4. Indian Institute of Banking and Finance. Principles & Practices of Banking, New Delhi, Macmillan Education. 2011.

5. Bindseil, U., & Pantelopoulos, G. Introduction to Payments and Financial Market Infrastructures. Springer Nature. 2023.

HUM 4410: FINANCIAL ECONOMETRICS [3 0 0 3]

Econometrics, Structure of economic data, Classical linear regression model, Analysis of the classical linear regression model, Classical linear regression model assumptions and diagnostic tests, Univariate time series modelling and forecasting, Multivariate models, Modelling long-run relationships in finance, Modelling volatility and correlation, Switching models, Panel data, Limited dependent variable models, Simulation methods, High frequency data.

References:

1. Chris Brooks. Introductory Econometrics for Finance, 2e. Cambridge University Press, New York, 2008.

2. Damodar N. Gujarati, Dawn C. Porter, & Sangeetha Gunasekar. Basic of Econometrics, 5e. McGraw Hill Education Pvt. Ltd., New Delhi, India, 2012.

3. Jeffrey M. Wooldridge. Introductory Econometrics: A Modern Approach, 5e. Cengage Learning, New Delhi, India, 2020.

MINOR IN ENTREPRENEURSHIP DEVELOPMENT

HUM 4403: FINANCIAL MANAGEMENT [3 0 0 3]

Introduction and objectives of financial management, Evolution of corporate finance. Types of accounts, Golden rules of accounting, Preparation of journal, ledger, trial balance and final accounts. Sources of long-term finance, Characteristics of equity capital, preference capital, debenture capital & term loans. Valuation of securities, Bond valuation and related models, Bond value theorems, Yield to maturity, Equity valuation, Dividend capitalization approach. Leverage, Operating leverage, financial leverage, Total leverage, Indifference point analysis. Working capital management. Capital budgeting, Appraisal criteria, Payback period, Average rate of return, Net present value, Benefit cost ratio, Internal rate of return. Risk analysis in capital budgeting. Cost of capital, Cost of debt capital, preference capital and equity capital, Weighted average cost of capital, Determination of proportions, Cash management, Dividend decisions.

References:

1. Prasanna Chandra. Financial Management-Theory and Practice, 9/e. Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2016.

2. I M Pandey. Financial Management. Vikas Publishing House Pvt. Ltd., New Delhi,2015.

3. N Ramachandran & Ram Kumar Kakani. Financial Accounting for Management, 3e. Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2011.

4. Eugene F Brigham & Michael C E. Financial Management: Theory and Practice, 12e. Cengage Learning, India, 2008.

5. R. Narayanaswamy. Financial Accounting: A Managerial Perspective, 6e. PHI Learning Pvt. Ltd., New Delhi, 2017.

HUM 4411: ENTREPRENEURSHIP [3 0 0 3]

The Entrepreneurial mind-set, Startup eco-system, Corporate entrepreneurship, Generating and exploiting new entries, Creativity and the business idea, Identifying and analysing opportunities (domestic and international), Protecting the idea and other legal issues for the entrepreneur, Business plan, Marketing plan, Organizational plan, Financial plan, Sources of capital, Informal risk capital, Venture capital, Going public, Strategies for growth , Managing the implications of growth, Accessing resources for growth from external sources, Succession planning.

Reference book

1. Hisrich, R D., Peters, M P, Shepard D A, and Sinha. S. Entreprenuership, 11e.McGraw-Hill Special Indian Edition, New Delhi, India, 2020.
2. Neck, Heidi M., Christopher P. Neck, and Emma L. Murray. Entrepreneurship: the practice and mindset, 2e. Sage Publications, New Delhi, India, 2019.
3. Norman Scarborough &Jeffrey Cornwall. Essentials of Entrepreneurship and Small Business Management, 9e. Pearson, Noida, India, 2019.

HUM 4412: DESIGN THINKING [3 0 0 3]

History of design thinking, Value of design thinking, Design thinking as solution, Design thinking for strategy, Revisiting the business model canvas as a common language, Strategy project set-up, Target industry, Guiding principles, Process overview, The business model layer, The competition layer, Shaping the strategy by designing business model prototypes, Designing objectives, The designing process, Documenting the current detailed business model, Generating innovative ideas, Transforming ideas into business model prototypes, Design thinking is a tool box.

References

1. Den-Dekker, T. Design Thinking, Routledge, UK, 2020.
   Diderich, Claude. Design
2. Thinking for Strategy. Springer International Publishing,Switzerland, 2020.
3. Nixon, Natalie W., ed. Strategic Design Thinking: Innovation in Products, Services, Experiences and Beyond. Fairchild Books, United States, 2015.

HUM 4413: INTELLECTUAL PROPERTY MANAGEMENT [3 0 0 3]

Fundamentals of intellectual property rights- creating value by generating innovation, capturing value by protecting innovation, types of intellectual property rights. Protection strategies-patent strategies in general, offensive, and defensive patent strategies, core dimensions of patent strategies, cost of patents, complementary strategies to patenting. Evaluating and valuing patents-evaluating patents, valuing patents, managing the patent portfolio. Successful practices in commercializing patents-licensing, cross-licensing, sale, strategic alliance, spin-off and call-back, joint venture, patenting for access to finance, litigation for value, complex strategies, commercialisation concepts and conclusion. organizing patent management-governance vs service patent department, costs and benefits of patent department, core processes of patent management, preventing product piracy. Patent management by industry, Patent management in new technology environments, Practical Considerations in Patenting-structure of patent, Patent document codes, Patent classification, IP tax regimes, Indian IPR laws, Brief comparison of patent legislation

References

1. Gassmann, Oliver, Martin A. Bader, and Mark James Thompson. Patent management: protecting intellectual property and innovation. Springer, Cham, 2021.
2. Saunders, K. Intellectual Property and the Law of Ideas. Routledge, London and New York, 2021.
3. Liu, K., & Racherla, U. Innovation, Economic Development, and Intellectual Property in India and China. Springer Nature, Singapore, 2019.
4. Karhad, Prasad. How to patent an idea in India: From idea to granted patent in quickest time, saving costs and making money with your patented invention. India, 2018.

MINOR IN PEOPLE MANAGEMENT

HUM 4401: HUMAN RESOURCE MANAGEMENT [3 0 0 3]

Evolution, Significance, Strategic HRM, HR practices-planning, recruitment, selection, placement and induction, Training & Development, Performance evaluation, Compensation management. HR for Entrepreneurs, inclusive practices, International HRM, strategic HRM, Discipline & Grievances, HR in digital world.

References

1. Pareek, U., & Rao, T. V. (2015). Designing and managing human resource systems. Oxford and IBH publishing.
2. Dessler, G., (2017), "Human Resource Management", Pearson publications
3. Aswathappa, K. E. M. A. L. (2013). Human resource management: Text and cases. Tata McGraw-Hill Education.

HUM 4414: ORGANIZATIONAL BEHAVIOUR [3 0 0 3]

Perception, Attributes, Attitude, Individual- traits, value system, motivation theories, behaviour, Group dynamics – nature, types, theories & decision making. Conflict management, Change Management, Organization culture, Organization development, organization life cycle, learning organization

References

1. Luthans F., (2002),"Organisational Behaviour", Tata McGraw Hill: New Delhi.
2. Robbins S.,(2002),"Organisational Behaviour Concepts, Controversies & Applications", Peacock Publications.
3. Pareek, U., (2012), "Understanding organizational Behaviour", Oxford University Press
4. Luhman, J., & Cunliffe, A. (2013). Key concepts in organization theory. SAGE Publications Ltd.

HUM 4415: PROFESSIONALISM & ETHICS [3 0 0 3]

Theoretical underpinnings-psycho social theories of moral development, characteristics of a professional – who is a professional, demonstration of characteristics in various circumstances, types of Ethics – utilitarianism, absolutism, universalism, ethics as understood by different nations & culture. understanding self– emotional intelligence, self-awareness, inter-personal relationship, understanding Professionalism, Practising ethics, individual development plan.

References:

1. Daniel Albuquerque. Business Ethics: principles and practices. Oxford.
2. Subroto Bagchi. The Professional: defining the new standards of excellence at work. Penguin India.
3. Subrato Bagchi. The Professional companion: how to make the best of your workplace skils. Penguin India.
4. Satya Sundar Shetty. Contemporary Ethical issues in Engineering. IGI Global publications.
5. Paul Hersy & Ken Blanchard. Management of Organizational Behaviour: utilizing human resources. 4th ed. PHI.

HUM 4416: LEADERSHIP & DECISION MAKING [3 0 0 3]

Understanding leadership – trait theories, behavioural theories, contingency theories, leader-membership exchange theory, self-assessment, traits, leadership styles – charismatic, transformational, transactional, authentic leadership, interpersonal relationship, developing leadership skills, ethics in leadership.

References:

1. DuBrin, A. J. (2015). Leadership: Research findings, practice, and skills. Cengage Learning.
2. Northouse, P. G. (2021). Leadership: Theory and practice. Sage publications.
3. Nohria, N., & Khurana, R. (Eds.). (2010). Handbook of leadership theory and practice. Harvard Business Press.

MINOR IN PROFESSIONAL COMMUNICATION

HUM 4417: PUBLIC SPEAKING [3 0 0 3]

Public Speaking -Introduction to Public speaking- Voice modulation, Sounds/accent (basics), Articulation, Anxiety management, Logical arguments, Concept of purpose, Audience, Smart use of Body language. Types of speech-Informative speeches - designing and delivery- Persuasive speeches – designing and delivery- Impromptu speeches – designing and delivery -Special occasion speeches- designing and delivery, Presentations - planning and execution -Types of presentation - Informative-Planning and delivery - Persuasive - Planning and delivery - Motivational - Planning and delivery, Other forms of speaking – Debates, Seminars, Panel Discussion, Group Discussion, Tall Tales, Turn Coat, Art of Evaluation-Providing feedback- planning, designing and delivering constructive feedback - Receiving feedback – making use of relevant feedback -Techniques of providing feedback- Speech analysis –Role of the Evaluator.

References:

1. Duarte Nancy., Resonate: Present Visual Stories that Transform Audiences, John
2. John Wiley and Sons, 2010.
3. Minto Barbara., The Pyramid Principle: Logic in writing, thinking and Problem Solving, Financial Times Prentice Hall, 2002.
4. Berkun Scott., Confessions of a Public Speaker, O'Reily Media, 2009.
5. Goodale Malcolm., Professional Presentations, Cambridge University Press, 2005, Carnegie Dale., The Art of Public Speaking, 1905.

HUM 4418: INTERCULTURAL COMMUNICATION [3 0 0 3]

The challenges of intercultural communication - interacting in a diverse world, understanding cultures, alternative views of reality. Intercultural Communication concepts, assumptions and norms. Understanding cultural Dimensions and Cultural Stereotyping- case studies. Intercultural Business Communication Competence - The Role of Language in Intercultural Business Communication, Nonverbal Language in Intercultural Communication, Cultural influence on interpersonal communication, Intercultural Dynamics in the multicultural organizations.Intercultural Encounters and Self-Awareness, Managing Diversity, Managing Intercultural Teams

References:

1. Gannon M J and Pillai R.Understanding Global Cultures, Sage Publications, California. 2010.
2. Steers, Richard M., LuciaraNardon, and Carlos J. Sanchez-Runde. Management across cultures: Developing global competencies. Cambridge University Press, 2013.
3. Bowe, Heather, Kylie Martin, and Howard Manns. Communication across cultures: Mutual
4. understanding in a global world. Cambridge University Press, 2014.
5. Samovar, Larry A., et al. Communication between cultures. Cengage Learning, 2016.
6. Ting-Toomey, Stella, and Tenzin Dorjee. Communicating across cultures. Guilford Publications, 2018.

HUM 4419: CORPORATE COMMUNICATION [3 0 0 3]

Background: Within a broader context on communication management, media, and advertising, this course introduces a basic understanding on the allied fields of mass media like public relations, and its relevance in a corporation. Focus on effective ways of communication, PR and Corporate communication – concepts and principles, tools, definition, nature and scope, structure and management, media management, convergence, corporate communication in industry and in the digital age. Comparison with Public Relations, advertising, publicity and propaganda. Organisational communication, social environment affecting organizational communication - internal and external, brand management and communication strategies, advertising and creative communication, global communication and diplomacy, health and science communication, communication during crisis etc.

References:

1. Stohl, Cynthia, Organisational Communication, Sage, 1995,
2. L.Putnam, Linda and K.Mumby, Dennis, ed. The SAGE Handbook of Organisational Communication, 3rd Edition, 2013.
3. J V Vilanilam, Science Communication and Development, Sage Publications, 1993
4. H. Bell, Arthur and M.Smith, Dayle, Management Communciation, 3rd Edition, 2009

HUM 4420: TECHNICAL AND BUSINESS WRITING [3 0 0 3]

Technical and Business Writing: Principles, techniques, and skills required to prepare scientific, technical, or business writing. Instruction related to writing of reports, letters; preparation and presentation of oral reports, Emphasis on clarity, conciseness, and accuracy of expression. Mechanics of writing: use of appropriate structures, punctuation and style; copy editing and content proof; practice writing: letters, resume', proposals, recommendations, portfolio. Technical writing process: Document development process, Documentation Planning, Selection of Tools, Templates, Audience Profiling, Task Analysis, Content Development, Elements of Style, Technical Reviews, Content Cleaning and Publishing.

References:

1. Gerson, Sharon J., and Steven M. Gerson. Technical writing: Process and product. Prentice-Hall
2. Gould, Jay R. Directions in Technical Writing and Communication. Routledge, 2020.
3. Huckin, Thomas N., and Leslie A. Olsen. Technical writing and professional communication. McGraw-Hill, 1996.
4. Strunk, William. The elements of style. Penguin, 2007.

MINOR IN MODERN LITERATURE

HUM 4421: UNDERSTANDING LITERATURE[3 0 0 3]

Evolution and Development of literary forms: Poetry, Drama, Fiction. Major themes; allegory, satire, romanticism, realism, modernism and post modernism. Major writers and their contribution. Genre and canon; Socio-political conditions of the society; Literary Transactions; Literary Movements; Contemporary concerns and representations in Poetry, Drama and fiction; Reception and Literary Criticism: major contributions and relevance

References:

1. Jahn, Manfred. Poems, Plays, and Prose: A Guide to the Theory of Literary Genres, 2002
2. Frye, Northrop. Anatomy of criticism: Four essays. Princeton University Press, 2020
3. Jenkinson, Edward B.(eds.) On Teaching Literature London: Indiana University Press, 2010.
4. Mayhead, R. Understanding Literature Cambridge: CUP, 2016
5. Styan, J.L. The Elements of Drama Cambridge: CUP, 2016
6. Auerbach, Erich, and Edward W. Said. Mimesis: The Representation of Reality in Western Literature - New and Expanded Edition. Vol. 78. Princeton University Press, 2013.

HUM 4422: TWENTIETH CENTURY LITERATURE [3 0 0 3]

Background: social context, political context and literary movements; World Wars and its influence on Literature. Twentieth century literature: transformation and transition in poetry, drama, and fiction. Major movements: aesthetic, formal, and thematic diversity among twentieth century writers; artistic, cultural, and critical contours Modernism; World War I and II and impact on twentieth century literature: reflections in poetry, drama and fiction. Post-modernism: features and representation: Feminism and Post colonialism; Questions concerning “the nation,” race, welfare state, and language. Literary Criticism and theory, and application.

References:

1. Aaron, Jane, Ann L. Ardis, and Timothy David Armstrong. The Cambridge history of twentieth-century English literature. Vol. 1. Cambridge University Press, 2004.
2. Blamires, Harry. A guide to twentieth century literature in English. Routledge, 2021.
3. Greenblatt, Stephen, ed. The Norton Anthology of English Literature: (Volume A, B, C). Vol. 1. WW Norton & Company, 2018.
4. Stringer, Jenny, & John Sutherland, eds. The Oxford companion to twentieth-century literature in English. Oxford University Press, USA, 1996.
5. Thody, Philip. Twentieth-century literature: critical issues and themes. Macmillan International Higher Education, 1995.

HUM 4423: COMPARATIVE LITERATURE [3 0 0 3]

Comparative Literature: Aims, features and theory. Themes: fate and chance, individual and society, freedom and enslavement, boundaries and borders, sexuality and gender roles, and identity in literature. Religious Poetry: Select Poems from English literature and select Poems from Indian literary traditions; Drama: Gender roles and identity in Drama- European Drama and Indian Writing in English. Short Stories: realism and social value: Russian, African, European and Indian short stories. Fiction: Post-Colonial themes and concerns in modern fiction.

References:

1. Apter, Emily S. Comparative literature in an age of globalization. JHU Press, 2006.
2. Domínguez, César, Haun Saussy, and Darío Villanueva. Introducing comparative literature: New trends and applications. Routledge, 2014.
3. Damrosch, David, ed. World literature in theory. John Wiley & Sons, 2014.
4. Mukherjee, Tutun. "Comparative Literature and Ex-centricity." Companion to Comparative Literature, World Literatures, and Comparative Cultural Studies. Eds. Steven Tötösy de Zepetnek and Tutun Mukherjee. New Delhi: Cambridge University Press India Pvt. Ltd (2013): 36-58.

HUM 4424: MODERN INDIAN LITERATURE [3 0 0 3]

Beginning of Indian Writing in English. The Gandhian Influence; Partition and Independence; early Indian Novel in English; The Growth of Indian Theatre in English: Indainaisation and Western influence in Drama. Poetry: Early Poetry-Toru Dutt, Sarojini Naidu, Kamala Das, Amrita Pritam, Jayanta Mahapatra,; Development in poetic trends: A K Ramanujam, Gauri Deshpande, R Partha Sarathi Nissim Ezekeil, Keki Daruwalla, Arvind Kolatkar. Fiction in Indian writing: R K Narayan, Amitav Ghosh, Arundati Roy; Rohinton Mistry, Salman Rushdhi, and JumpaLahri.

References:

1. Appudurai, Arjun, Appadurai, Arjun. Modernity at Large: Cultural Dimensions of Globalization. University of Minnesota Press, Minneapolis, 2005.
2. Deshmane, Chetan, ed. Muses India: Essays on English-Language Writers from Mahomet to Rushdie. Jefferson, NC, and London: McFarland & Co., 2013.
3. Mukherjee, Meenakshi. The Twice Born Fiction. Pencraft, New Delhi,

2001.

4. Iyengar, Srinivasa K.R.: Indian Writing in English. Sterling Publishers Private Limited. Reprint 1994.
5. Naik, M.K. A History of Indian English Literature. Sahitya Academy, 1982, reprint.

OPEN ELECTIVES

HUM 4321: COMMUNICATIVE ENGLISH [3 0 0 3]

(Offered for Lateral Entry Students only)

Phonetics: Transcription; Word Accent; Common Errors in English: Subject Verb Agreement; Uses of Tenses / Sequence of Tense; Prepositions; Punctuation; Articles; Special Usages; Creative Writing Essay: Types of Essays, Argumentative Essay, Descriptive/Expository / Narrative Essays; Reading Comprehension; Non- detailed Text - Critical Evaluation; Vocabulary; Confused pair of words; Idiomatic Expressions; Antonyms and Synonyms; Tutorials : Group Discussions; Presentation Skills; Essay writing

References:

1. Green David Contemporary English Grammar, Structures and Composition Chennai: Macmillan Publications.
2. Thompson AJ & Martinet AB A Practical English Grammar, OUP
3. Turton N D , Heaton J B Longman Dictionary of Common Errors, 1998
4. McCarthy Michael English Idioms in Use 2002, London Cambridge University Press
5. Jones Daniel, An Outline of English Phonetics New York: Cambridge University Press
6. English Today- A Course in Reading and Writing, Foundation Books Pvt. Ltd., Cambridge House, New Delhi, 2005. (For 2009 - 2011)

HUM 4322: FILM STUDIES [3 0 0 3]

History of invention of motion pictures - Daguerre, Muybridge, Edison, Skaldanowsky Brothers, Lumieres; Evolution of film – Lumieres, Melies, Porter, Griffith, Basic techniques – Mise-en-scene, Mise-en-shot, Deepfocus Photography, Longtake, Continuity, Editing, Montage, German Expressionism; French Impressionism; Soviet Montage cinema; Hollywood cinema, Italian Neo-realism; French Nouvelle Vague, Documentary, Directors – Eisenstein, Kurosawa, Godard, Chaplin, Bergman; Mohsen Makmalbakf, Majid Majidi, Keislowski, Zhang Yimou, Kim Ki Duk, “New Wave” Cinema in India - Bengali; Malayalam; Kannada; Hindi, To be screened- Bicycle Thieves, The 400 blows, Rashomon, Wild strawberries, Battleship Potemkin, Cabinet of Dr. Caligari, The kid, Children of heaven, Hero, Ghatashraddha, Pather Panchali, Mathilukal.

References:

1. 100 Years of American Films ·, Ref PN1993.5.U6A59 2000.
2. Bowker's Complete Video Directory·, Ref PN1992.95B69.
3. Cinema Studies: The Key Concepts·, Ref PN1993.45.H36 2000.
4. Dictionary of Film Studies: The Aesthetic Companion to Film and Art ·, Ref PN1993.45 .B33 2006.
5. Filmakers Dictionary·, Ref PN1993.45.S56 1990.
6. Halliwell's Film and Video Guide·, Ref PN1998.H433.

HUM 4323: GERMAN FOR BEGINNERS [3 0 0 3]

Text selections, dialogue and exercises which have been designed to give the absolute beginner grounding in the rudiments of the German language, as well as providing background information about the history, life and culture in Germany.

Introduction to the German alphabet and the German language – dialogues & conversations – pronunciation - basic vocabulary lists - key points of grammar - background information about the history and culture of Germany - exercises on vocabulary, grammar and German culture - reading & listening comprehension.

References:

1. Sally Johnson, Natalie Braber, 2008 Exploring the German Language, Second Edition, Cambridge University Press.
2. Charles Russ, 1994 The German Language Today: A Linguistic Introduction, Routledge.

HUM 4324: Indo- European Intercultural Dynamics [3 0 0 3]

The challenges of Intercultural communication - interacting in a diverse world, understanding cultures, alternative views of reality, cultural stereotyping. Foundational Theories in Intercultural Communication - Edward Hall, Samovar, G Hofstede, Understanding cultural Dimensions and Cultural Stereotyping- collectivism/ individualism, power distance, masculine/feminine, cultural metaphors, Intercultural Business Communication Competence. Cultural influence on interpersonal communication.

References:

1. Dodd, Carley H. 1998, Dynamics of Intercultural Communication, McGraw-Hill, Boston.
2. Gannon M J and Pillai R. 2010, Understanding Global Cultures, Sage Publications, California.
3. Hofstede, Geert 2001, Cultures' Consequences, Comparing Values, Behaviors, Institutions, and Organizations across Nations, Sage Publications, Thousand Oaks, CA.
4. Martin, J.N. & Nakayama, T.K. 2007, Intercultural communication in contexts. 4th Edition. Mountain View, CA: Mayfield.
5. Samovar, L A and Porter, R. 2007, Communication between Cultures, Cengage Learning, Wadsworth, CA.

HUM 4325: INTERPRETATION OF LITERARY TEXTS

Texts-static, dynamic, cryptic and delphic ; Language of literature; Form and structure; Literature verses popular fiction; Text and discourse; Authors and critics; Theories and approaches to literary texts; Formalism, Structuralism, Marxism, Feminism, Deconstruction; Ideational functions and textual Functions; Class, gender and texuality; Race and nationality; Genre, phonological deviations –sound patterns and figures of speech; Pragmatic approach to literature; Understanding syntax, Lexical and syntactic analysis of literary texts; Point of view in literary texts and foregrounding; Prediction and making sense of a text; Stylistic analysis of a novel; Kinds of meaning, Rhetorical structure; Pragmatics and discourse analysis; Interpreting cohesive devices and complex functional values; Stylistic approach to literature ; Elements of literary style; Stylistic analysis of selected short stories, Poems, Novels and Plays; Genre, the plot setting, characterization, tone and themes; Stylistics and its implications on narrative techniques; Intertextuality and conceptual blending; Identifying patterns in the texts; Meaning making process in literature; Imagery, metaphor as a mode of thought; Coherence and Cohesion; Context, turn taking and Adjacency Pair; Pro-forms, Discourse markers, Lexical cohesion and presupposition; Recognizing text organization; Critical texts, Shared assumptions on critical texts; The role of schema and the concept of speech acts in literary texts.

References:

1. Austin, J.L. (1992). How to do Things with Words, Longman, London.
2. Barthes, R.(1977). Introduction to the Structural Analysis of Narratives, Fontana,London.
3. Blake, N.F.(1990). An Introduction to the Language of Literature, Macmillan, London.
4. Carter, R. (ed.) (1982).Language and Literature: An introductory Reader in Stylistics, Allen and Unwin, London.
5. Cook, G. (1994). Discourse and Literature, Oxford University Press, London.

HUM 4326: PUBLIC SPEAKING [3 0 0 3]

Public Speaking -Introduction to Public speaking- Voice modulation, Sounds/accent (basics), Articulation, Anxiety management, Logical arguments, Concept of purpose, Audience, Smart use of Body language. Types of speech-Informative speeches - designing and delivery- Persuasive speeches – designing and delivery- Impromptu speeches – designing and delivery -Special occasion speeches- designing and delivery, Presentations - planning and execution -Types of presentation - Informative-Planning and delivery - Persuasive - Planning and delivery - Motivational - Planning and delivery, Other forms of speaking – Debates, Seminars, Panel Discussion, Group Discussion, Tall Tales, Turn Coat, Art of Evaluation-Providing feedback- planning, designing and delivering constructive feedback - Receiving feedback – making use of relevant feedback -Techniques of providing feedback- Speech analysis –Role of the Evaluator.

References:

1. Duarte Nancy, Resonate: Present Visual Stories that Transform Audiences, John Wiley and Sons, 2010
2. Minto Barbara, The Pyramid Principle: Logic in writing, thinking and Problem Solving, Financial Times Prentice Hall,2002
3. Berkun Scott, Confessions of a Public Speaker, O'Reily Media, 2009
4. Goodale Malcolm, Professional Presentations, Cambridge University Press, 2005
5. Carnegie Dale, The Art of Public Speaking, 1905.

HUM 4327: ANALYTICAL WRITING [3 0 0 3]

Essay Writing: Narrative---Instructional and Process narratives, Descriptive, Expository, Argumentative—Different components of Argumentation, Critical Writing Strategies: Summarizing, Paraphrasing, Synthesizing, Brainstorming Strategies: Clustering, Mapping, Outlining, Cubing, Looping, Logical Reasoning: Inductive Reasoning, Deductive Reasoning, Logical Fallacies, Mechanics of Writing: Punctuation Marks, Rules related to the use of quotation marks, Rules related to Acknowledging Sources, Analyzing texts – tone, style, vocabulary and structure Use of graphics in the text. Mechanics of Thesis writing and Journal writing.

References:

1. Rise B. Alexrod, Charles R. Cooper (2002), St. Martin's Guide to Writing, Sixth Edition, Bedford St. Martin's, NY.
2. Dorothy Seyler, (2009), Read, Reason and Write, Sixth Edition, McGraw-Hill Higher Education, NY.
3. Thomas S. Kane, (1994),The Oxford Essential Guide To Writing, Oxford University.

HUM 4328: COMMONWEALTH LITERATURE [3 0 0 3]

Definition, terminology; Emergence; Beginning; Versatility and importance; Central ideas; characteristics; Themes, styles and patterns; Authors and critics; Theories; Critical text; Approaches to literary text; Issues common to writers; Interpretation of the text; critical approaches; Culture and imperialism; Cross-cultural understanding; Ethnicity, human identity; Nationalism; Diaspora, transnationality, multiculturalism; analysis of selected Novels, Poems and Short-stories,

References:

1. Narasimhaiah, C. D. (2014). An Anthology of Commonwealth Poetry, Trinity. India.
2. Sinha, P.K., J. K. Sinha. (2011). History of Commonwealth Literature. Commonwealth Publishers. New Delhi.
3. Ray, Mohit K. (2003). Studies in Commonwealth Literature. Atlantic. New Delhi.
4. Bill, Ashcroft. (2002). The Empire Writes Back. Routledge. London.
5. Dhawan. R. K. (2006). Contemporary Commonwealth Literature. Prestige Books. India.

HUM 4329: CREATIVE COMMUNICATION: ART, MEDIA, CULTURE AND IDEAS [3 0 0 3]

Background: Within a broader context of art and ideas, this course situates itself in the area of art, history and cultural studies; with a core on 'culture and creativity' across the historical 'time and space' engagements. Art as a reaction, reflection and revolution within the socio-cultural and political timeline. 'Isms' from renaissance to romanticism, realism to expressionism and postmodern, along with concepts such as defamiliarization, Indian and Western aesthetics. Theories on 'beauty', 'taste', 'original' and the 'sublime'. Not just limiting to the established art movements and experiments but also the 'subaltern' deprived parallels such as folklore, tribal and the endangered. Art critics, curators and their role. Festivals and activism. Environmental art movements, animation, advertising, installation art, art films, experimental art.

References:

1. Berger, John, Ways of Seeing. New York: Viking Press, 2018.
2. Shaw, Philip, The Sublime – The New Critical Idiom. London & New York: Routledge. 2019.
3. Berger, John, About Looking. New York: Pantheon, 1980.

4. Coomaraswamy K Ananda, The Transformation of Nature in Art, Harvard University Press, 1934.
5. Mitter, Partha, Much Maligned Monsters: A history of European reactions to Indian Art, the university of Chicago Press, 1992.
6. Appadurai, Arjun, and Mack, Arien ed. India's World: The politics of Creativity in a globalized society, Rain tree, 2012.

HUM 4331: WOMEN'S WRITING [3 0 0 3]

The course is a survey of writing by women from various time periods, geographic regions, and social classes of India and the world. It seeks to impart to students the history and development of women's rights and issues from the classical period to the present; to familiarize and sensitize the students to critical debates and discussions surrounding women's rights and issues at the intersections of gender, race, nation, caste, and ethnicity; to enable them to understand the unique forms of language, style, genre, and theories that impact women's writing. White Feminism: Mary Wollstencraft, Vindication of the Rights of Women; Elaine Showalter; Virginia Woolf, A Room of One's Own; Simone de Beauvoir, The Second Sex; Helene Cixous; Ali Smith, Girl Meets Boy. Black Feminism: Maya Angelou, I Know Why the Caged Bird Sings; Toni Morrison; ChimamandaAdichi, Half of a Yellow Sun. South-Asian Feminism: Anita Desai; IsmatChugtai, The Crooked Line; Sashi Deshpande; Kamani, Ginu. Junglee Girl, Kamala Das; Nisha Susan, Women Who Forgot to Invent the Facebook and Other Stories.Subaltern Women's Writing: Urmila Pawar; Sujatha Gidla, Ants Among Elephants. Transgender and Queer Writing: A. Revathi, The Truth About Me; Jeanette Winterson, Oranges Are Not The Only Fruit.

References:

1. Bhasin, Kam la and Nighat Said Khan. Some Questions on Feminism and its Relevance in South Asia. Kali for Women, 1996.
2. Jung, Anees. Unveiling India: A Woman's Journey. Penguin, 1987
3. Kumar, Radha. The History of Doing: An Illustrated Account of Movements for Women's Rights and Feminism in India, 1800-1990. Kali for Women, 1997
4. Butalia, Urvashi and Ritu Menon, eds. In Other Words: New Writing by Indian Women. Kali for Women, 1992.
5. Hameed, Syeda S. and Sughra Mehdi, trans. Parwaaz: Urdu Short Stories by Women. Kali for Women, 1996

HUM 4332: CULTURE AND SOCIETY IN LITERATURE [3 0 0 3]

The course explores the themes of religion, individual and collective identity, morality and society, boundaries and borders, sexuality and gender roles in literatures of different nations. Cultural constructions of identities and values are examined through analysis of representations. Examination of the idea of 'faith' in Religious Poetry: Selected Poems of John Donne, George Herbert, C Rosetti, G M Hopkins; Selected Poems from Vachanas; Selected poems of Tagore; Selected Poems of Aurobindo; Exploration of the notion of 'woman' in Drama: The Doll's House - H Ibsen, Phèdre - Jean Racine, Nagamandala - G Karnad; investigation of 'values' in society in Short Stories: Selected stories of Maupassant, A. Chekov , V M Basheer and ChimamandaNgoziAdichie; Notion of boundaries in Fiction: Things Fall Apart- Chinua Achebe, Heart of Darkness - J Conrad, The White Tiger - Aravinda Adiga.

Reference:

1. Bremond, Claude. “Concept and Theme.” The Return of Thematic Criticism. Ed. Werner Sollors. Cambridge: Harvard UP, 1993. 46 – 59.
2. Ghosh, Paramita. "Desires from the World beyond and the Women in Naga Mandala." Indian Drama in English. 2011
3. Hirschberg, Stuart, and Terry Hirschberg. One world, many cultures. Pearson/Longman, 2004.
4. Milner, Andrew. Literature, culture and society. Psychology Press, 2005.
5. Sharp, Joanne. Geographies of postcolonialism. Sage, 2008.
6. Shiva Prakash (Ed.), I keep vigil of Rudra: The Vachanas. Penguin UK, 2010.

HUM 4333: INTRODUCTION TO PSYCHOLOGY [3 0 0 3]

Psychology - Meaning, Nature and Scope, Defining Psychology, Meaning of the term Behavior, Nature of Psychology, Scope of Psychology: Branches and fields of Psychology. Development of Psychology - Historic Sketch of Psychology, Modern Age of Psychology, Gestalt Psychology, Psycho Analysis, Contemporary Psychology. Systems of Psychology- The Nervous System, Nature V/s Nurture, Sensation and perception, States of Consciousness. Methods of Psychology - Classical Conditioning, Introspection Method, Naturalistic Method, Experimental Method, Differential Method, Clinical Method, Psycho Physical Method. Personality- Personality types, Personality Disorders, Abnormal psychology, Treatment of personality disorders. Thinking - Nature of Thinking, Types of Thinking, Language and Intelligence. Discussion, Presentation and Assignments

References:

1. Boring, E.G., Langfield, H.S.&Weld, H.P, “Foundations of Psychology”, Asia Publishing House, Calcutta, 1963.
2. Carson, R.C., Butcher, J.N. & Coleman, J.C, “Abnormal Psychology & Modern Life”, (8th ed.) Scoff, Foresman& Co. 1988.
3. Lahey, B.B. “Psychology: An Introduction”, 6th Ed., Tata McGraw Hill, New York, 1965
4. Olson, M.; Hergenhahn, B.R “Introduction to the Theories of Learning”, Prentice-Hall India, 200

HUM 4334: INTRODUCTION TO PHILOSOPHY, RELIGION AND CULTURE [3 0 0 3]

Notions of Philosophy; The Origin and Development of Philosophy; Ancient Philosophy; Medieval Philosophy; Modern Philosophy; Contemporary Philosophy; Indian Philosophy; Comparative Religion; Western Philosophy; The Relevance of Philosophy; Branches of Philosophy; Methods of Philosophy; Philosophy and other Branches of Study; Some Problems of Philosophy; Themes of Philosophy; Mind and Body, and the Problem of Universal; Change/Movement time and place; Existence of God and Evolution; Indian Culture; Social Ethics; Logic and Scientific Methods; Philosophy of Language.

References:

1. Aquinas, Thomas. (1968). On Being and Essence. Trans. Armand Maurer. Canada: Pontifical Institute of Mediaeval Studies.
2. John-Terry, Chris. (1994).For the Love of Wisdom: An Explanation of

the meaning & Purpose of Philosophy. New York: Alba House.

3. Maritain, Jacques. (1979). An Introduction to Philosophy. London: Sheed and Ward.
4. Radhakrishnan, S. (Ed). History of Philosophy Eastern and Western Vol.II George Allen and Unwin Ltd., London, 1953.
5. Wallace, William. (1990). The Elements of Philosophy. New York: Alba House

HUM 4335: CREATIVE WRITING [3 0 0 3]

Various literary/prose forms and their characteristics: Longform Journalism, Travelogue, Short Fiction, Memoir, Autobiography, Novel; Critical Concepts and Terms in Literary Writing: Narrator, Tone, Voice, Style; Literary Movements: Realism, Modernism, Surrealism, Expressionism, Post-Modernism, Magic Realism, Regional writing, Time & Space, Imagery: Metaphor, Simile, Personification, Narrative Space, Point of View. Introduction/Orientation to the course; Various literary/prose forms and their characteristics: Longform Journalism, Travelogue, Short Fiction, Memoir, Autobiography, Novel; Critical Concepts and Terms in Literary Writing: Narrator, Tone, Voice, Style Literary Movements: Realism, Modernism, Surrealism, Expressionism, Post-Modernism, Magic Realism, Regional writing.

References:

1. David Lodge,The Art of Fiction, Penguin Books, 1992.
2. Milan Kundera, The Art of the Novel, Faber and Faber, 1988.
3. Paul Eschholz and Alfred Rosa, Eds.,University of Vermont, Outlooks and Insights: A Reader for Writers, St. Martin's Press/New York, 1983.
4. James Moffet, Ed., Points of View, University of Chicago Press, 2000.
5. M.H. Abrams, A Glossary of Literary Terms, Seventh Edition, Macmillan, 2005.

HUM 4336: GRAPHIC NOVELS: HISTORY, FORM AND CULTURE [3 0 0 3]

Part I:The History of Comic Books, Part 1: Developing a Medium Defining comic books as a medium-Relationships between comic books and other forms of sequential art-The (continental) roots of comics as an art form -The ways in which comic strips and pulps contributed to the emergence of the comic book. The History of Comic Books, Part 2: The Maturation of the Medium-Influence of underground movement, ways in which mainstream publishers began to address more relevant topics, proliferation of independent comics, the increase in the profile and prominence of the medium due to ambitious projects. Part II: Creating the Story: Graphic Storytelling and Visual Narrative-Some narrative structures commonly found in comic books -The types and techniques of encapsulation-The nature of the relationship between the pictorial and linguistic elements of comic books Experiencing the Story: The Power of Comics- About diegetic images that show the world of the story- About interpretive images that comment on the story-The impact art style has on the emotional reactions of the reader; and how the meaning of each image is affected by the relationship to other images in that particular book, in other texts, and in the reader's personal experience-Part III: Comic Book Genres-the definition of genre and the role it plays in shaping the creation of comics products- the characteristics of genres, including character types, narrative patterns, themes, and other conventions-how the example genres of teen humor, romance, funny animals, horror, and memoir developed in comics, and what characterizes each-how the hybridization of genres helps experimentation and expansion of narrative possibilities

References:

1. Comics, Comix and Graphic Novels, Roger Sabin
2. Comics, Manga and Graphic Novels: A History of Graphic Narrative, Robert Petersen
3. Comics as Performance, Fiction as Scalpel; Allan Moore
4. Arguing Comics: Studies in Popular culture; JeetHeer, Kent Worcester
5. Comics and the City, JornArhens
6. Graphic Women: Life Narrative and Contemporary Comics, Hillary Chute
7. The Classic Popular, NandiniChandran
8. Comics and Sequential Art, Will Eisner
9. Understanding Comics, the Invisible Art, Scott Mccloud
10. Making Comics, Scott Mccloud
11. The Language of Comics, Mario Saraceni
12. Graphic Storytelling and Visual Narrative, Will Eisner

HUM 4337 INTRODUCTION TO ENTERPRISE RISK MANAGEMENT [3 0 0 3]

Introduction, Risk Maturity, Global Risks, The Present State of Global Corporations, Businesses & Processes. Risk Culture - A Practical Approach to Risk Management, The Individual Level, Personal Predisposition to Risk, Personal Ethics. Risk & Risk Management - Other Concepts, Definition of Risk Management. COSO Framework - Structure and Approach of COSO Guidance. Designing a Risk Appetite - "The Building Blocks", Risk Capacity. Implementing a Risk Appetite. Resources and Implementation. Extended Enterprise - An Overview-Operating in the Extended Enterprise, Preliminary Steps. Risk Communication in the 21st Century Extended Enterprise. Importance of Risk Communication. Factors Affecting Risk Communication. Public Perceptions and Priorities. Components of a Risk Communication Plan. Incident Response Specific Communication. Desired Outcomes from Assurance. Mending the Assurance Model.

Reference:

Hersh Shah, Enterprise Risk Management, 2e. Handbook for working professionals, IRM India Affiliate. 2024.

HUM 4338: RESEARCH METHODS IN MANAGEMENT [3 0 0 3]

Introduction, Problem Definition, Qualitative Research Tools, Secondary Data Research in a Digital Age, Survey Research, Observation Methods, Experimental Research, Measurement and Scaling Concepts, Attitude Measurement, Questionnaire Design, Sampling Designs and Sampling Procedures, Determination of Sample Size, Fieldwork, Basic Data Analysis, Univariate Statistical Analysis, Bivariate Statistical Analysis, Multivariate Statistical Analysis, Communicating Research Results.

References:

1. Zikmund, W. G., Babin, B. J., Carr, J. C., & Griffin, M. (2013). Business Research Methods, Ninth Edition. Cengage Learning.
2. Saunders, M., Lewis, P., & Thornhill, A. (2015). Research Methods for Business Students, Seventh Edition. Pearson Education.
3. Cooper, D. R., Schindler, P. S., & Sun, J. (2017). Business Research Methods. Eleventh Edition. New York: McGraw-Hill.
4. Chawla, D., & Sodhi, N. (2016). Research Methodology: Concepts and Cases. Second Edition. Vikas Publishing House.

Department of Physics

The Department offers a compulsory course on Engineering Physics and Engg. Physics Lab to all branches of first year B.Tech and also offers open electives to students of B.Tech. The department offers P.G. program in physics leading to M.Sc. physics in five specializations viz. Condensed Matter Physics, Optoelectronics, Nuclear Physics, Electronics and Theoretical Physics. The Department offers Ph.D program in physics in different areas like radiation and nuclear physics, nanomaterials, glasses and polymeric materials, thermoelectric materials, thin film based devices, solar cells, spectroscopy, non-linear optics and high energy physics.

The department has received several externally funded projects from Government of India and State Government (Rs. 550 lakhs). Currently about 100 Research Scholars are pursuing their PhD in Physics. Department has published more than 800 scopus indexed research papers in the last 10 years. The department laboratories are equipped with sophisticated instruments like vacuum coating unit (PVD and sputtering), SILAR, spin and dip coating units, spray pyrolysis coating, crystal growth unit, optical closed cycle variable temperature cryogenic system, He: Ne laser, Z - Scan System, XRD, UV-visible NIR spectrophotometer, spectrofluorometer, Keithley source/multimeters, particle detectors and thickness profilometer.

> Programs offered

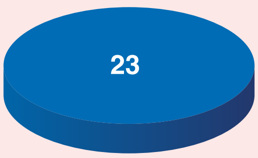
Postgraduate Program

- M.Sc in Physics

PhD

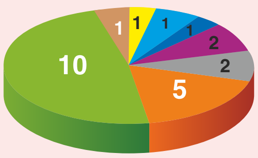
> Faculty Strength

Qualification-wise



- PhD

Cadre-wise



- Senior Professor
- Professor
- Associate Professor
- Associate Professor - Research
- Assistant Professor - Selection Grade
- Assistant Professor - Senior Scale
- Assistant Professor
- Adjunct Faculty

OPEN ELECTIVES

PHY 4311: FUNDAMENTALS OF ASTRONOMY & ASTROPHYSICS [3 0 0 3]

Introduction to astronomy and astrophysics. Properties of ordinary stars: Brightness of starlight; the electromagnetic spectrum; Colours of stars; stellar distances; absolute magnitudes; HR diagram. Stellar evolution: Formation of star; the main sequence; stellar structure; evolution off the main sequence; planetary nebulae; white dwarfs. Relativity: Special relativity; Time dilation; Length contraction; Doppler shift; Space-time. General Relativity: Curved space – time; principle of equivalence; bending electromagnetic radiation; Black holes- The Schwarzschild radius. The death of high mass stars: Supernovae; neutron stars; pulsars; stellar black holes. Normal Galaxies: Types of galaxies; Dark matter in galaxies. Cosmology: The scale of universe; expansion of the universe; open or closed universe; the big bang; the cosmic background radiation; big bang nucleosynthesis. Astronomical instruments.

References:

1. Marc L Kutner, Astronomy: A physical Perspective, Cambridge University Press,2003
2. Baidyanath Basu, An Introduction to Astrophysics, II Edn, PHI Learning Pvt. Ltd, 2011.
3. Michael Zeilik, Introductory Astronomy and Astrophysics, 4th edition, Saunders College Pub. 1992.

PHY 4312: PHYSICS OF ENGINEERING MATERIALS [3 0 0 3]

Semiconductors: Diffusion and drift processes, Crystal growth techniques, Preparation of semiconductor devices. Thin films, Nano-materials: bottom-up and top-down methods, Quantum dots and nano-carbon tubes, Dielectrics, Polarization and polarizability, ferro electricity, piezo electricity, applications of dielectric materials. Magnetic Materials and Super Conducting Materials: Applications of superconductors, Polymers and Liquid Crystals, Alloys: Different preparation routes and strengthening mechanisms in alloy, Composite materials: micromechanics of composites - Density, Mechanical and Thermal properties.

References:

1. Sze S. M., Physics of Semiconductor Devices, John Wiley & Sons, 2007
2. Chopra K. L.Thin Film Phenomena, Mc Graw Hill, 1969.
3. Nalwa H., Nanostructured Materials and Nanotechnology (2e), Academic, 2002.
4. Chawla K. K., Composite Materials- Science & Engineering (3e), Springer-Verlag, 2012.
5. Alloys: Preparation, Properties, Applications-FathiHabashi, Wiley, 2008.

PHY 4313: LASERS AND OPTOELECTRONICS [3 0 0 3]

Laser: Einstein coefficients. Light amplification. Threshold condition. Laser rate equations. Line shape function Variation of laser power around threshold and attainment of low threshold population. Optimum output coupling. Line broadening mechanisms-. Types of lasers: Continuous and Pulsed lasers. Laser Safety. Nonlinear optics: Introduction to Nonlinear Optics: Optics & Wave propagation in an anisotropic medium. Nonlinear optical process:

Optical fiber communication: Optical fibers: Numerical Aperture, Attenuation, types and pulse dispersion. Fiber Bragg Gratings. Fiber-optic components, Sources for Optical Transmitters, Detectors for Optical Receivers Performance of Optical Fiber Systems, Bit-Error Rates, Receiver Sensitivity, Attenuation and Dispersion Limited Systems-Power Budget, Time Budget. Attenuation and Dispersion Compensation and Management. Optoelectronic Devices: Mach-Zender interferometer modulator and switch, the optical direction coupler. LED's and laser diode. Optical detectors - pn detector, pin detector, avalanche photodiode, Solar cells, VCSELs, Fiber optic sensors. Erbium-Doped Fiber Amplifiers (EDFAs), Raman Fiber Amplifier (RFA)

References:

1. A. K. Ghatak and K. Thyagarajan, Optical Electronics. Cambridge University Press, 1989.
2. A. Ghatak and K. Thyagarajan, Introduction to Fiber Optics. Cambridge University Press, 1998.
3. R. W. Boyd, Nonlinear Optics. 3rd ed. Academic Press, 2008.
4. G. Keiser, Optical Fiber Communications. McGraw-Hill Companies, 2011.
5. S. M. Sze . Kwok K. Ng, Physics of Semiconducting Devices, 3rd ed. John Wiley & Sons, 2007.

PHY 4314: INTRODUCTION TO QUANTUM MECHANICS [3 0 0 3]

Limitations of classical physics, wave-particle duality, De Broglie's hypothesis, matter as wave packet, Heisenberg's uncertainty principle, Mathematical Formalism : operators; commutation relation; ortho normal functions; eigenvalues and eigenfunctions; the Dirac notation; the postulates of quantum mechanics.

Propeties of wave functions, expectation value, the Schrödinger Equation, time dependent Schrödinger equation, conservation of probability, Ehrenfest's theorem, time independent Schroedinger equation, stationary states, Schroedinger equation in one dimension : the infinite square potential well; the finite square potential well; the potential barrier; tunneling; the harmonic oscillator.

Schrödinger equation in spherical coordinates, separation of variables, the radial equation, the angular equation. Energy eigenvalues and eigenfunctions of the rigid rotator and the hydrogen atom; angular momentum. Identical particles in quantum mechanics. Applications of quantum mechanics :scanning tunneling microscopy, alpha decay.

References

1. Verma H.C., Quantum Physics (2e), Surya Publications. 2016.
2. Gasiorowicz S., Quantum Physics (3e), Wiley India Pvt Limited. 2007.
3. Jain M. C., Quantum Mechanics: A Textbook for Undergraduates, PHI Learning Private Limited 2012.

PHY 4315: FUNDAMENTALS OF VACUUM TECHNIQUES AND THIN FILMS [3 0 0 3]

Fundamentals of Vacuum – Gas flow regimes, throughput and pumping speed, conductance, continuum flow, molecular flow, the pumping process, pump-down time, and ultimate pressure, surface processes and outgassing. Vacuum Pumps and Gauges – Rotary pump, diffusion pump, turbo molecular pump, sorption pump, cryo-pump and getter pumps. Measurement of reduced pressures – the McLeod Guage, Pirani and thermo couple gauges, ionization gauges – hot cathode and cold cathode, calibration of vacuum gauges.

Thin film Deposition: Introduction to thin films, growth modes, Preparation of thin films: Physical methods–thermal evaporation, Knudsen cosine law. Sputtering: Cathodic sputtering – glow discharge sputtering, Molecular beam epitaxy. Chemical methods: Electro-deposition – Electrolyte deposition, electroless deposition, chemical vapor deposition, MOCVD, spray pyrolysis and spin coating. Thickness Measurement Techniques- Brief survey of different thickness measurement techniques- optical interference technique, mechanical method, gravimetry, quartz crystal oscillator. Applications of Thin films-Antireflection Coatings, Interference Filters, Thin Film Polarizers, Photon Detectors, Photovoltaic Devices: Solar Cells, Thin Film Transistors (TFTs), Thin Film Diodes.

References:

1. Austin Chambers, Modern Vacuum Physics, CRC Press (2000)
2. V V Rao, T B Ghosh and K L Chopra, Vacuum Science and Technology, Allied Publishers (2008)
3. Dorothy M. Hoffman, Bawa Singh and John H. Thomas, Handbook of Vacuum Science and Technology, Academic Press USA (1998)
4. Chopra K L, Thin Film Phenomena, McGraw Hill (1979)
5. K. L. Chopra and I. Kaur, Thin Film Device Applications, Plenum Press New York (1983)

PHY 4316: CLEAN ENERGY TECHNOLOGIES [3 0 0 3]

Energy Fundamentals- Classification of energy sources, Importance, salient features, heat transfer mechanisms, Solar energy-Radiation spectrum, Measurement of solar radiation, Basics of electrical parameters, Photovoltaic effect, Solar cell construction - basic principle and types, currently available solar cell technologies, Solar thermal systems, Thermoelectrics-Theories and Fundamentals, System Design Considerations for Thermoelectric Energy Recovery, Synthesis techniques, Applications, Wind energy-Origin of wind, factors affecting the distribution of wind energy on the surface of earth, variation of wind speed with height, estimation of wind energy at a site, wind turbine aerodynamics, wind energy storage, environmental aspects, major applications, Geothermal Energy and Ocean Energy-Origin and distribution, types, analysis, origin and nature of tidal energy, environmental impacts, Emerging technologies- Fuel cells, Hydrogen as energy carrier, production, storage, delivery, conversion, applications.

References:

1. Renewable energy resources, John Twidell and Tony Weir, Taylor and Francis, 2nd edition, (2006)
2. Fundamentals of solar cells: Photovoltaic solar energy conversion, Alan L. Fahrenbrunch, Richard H. Bube, Academic Press, (1983)
3. Non conventional energy resources, B H Khan, 3rd edition, McGraw Hill Education (India) Private Limited (2017)
4. Thermoelectrics and its energy harvesting, materials, preparation, and characterization in thermoelectrics, D. M. Rowe, CRC press, Taylor and Francis (2012)

PHY 4317: COMPUTATIONAL METHODS IN CONDENSED MATTER PHYSICS [3 0 0 3]

Introduction and Background: Quantum mechanics fundamentals, tight binding approximation, Hartree-Fock theory, Visualization of Crystal Structures: Differential and Integral methods and geometry optimization, Vesta for structural visualization, space group and symmetry of crystal systems, Basic Introduction on density functional theory: Density Functional Theory, K-S Equation, Exchange-Correlation Energy Functional, Structural optimization, LDA, GGA and HSE approximations, DFT+ Hubbard (or DFT+U) Calculations, Density of States, Band structure, Optical spectra, Applications of density of functional theory: Drug modelling, electronic structure calculations, Photocatalysis, Optoelectronic calculations, Validation of Experimental Findings using DFT approach.

References

1. David S. Sholl and Janice A. Steckel, Density Functional Theory - A Practical Introduction, John Wiley & Sons Inc, 2009
2. K. Momma and F. Izumi, "VESTA 3 for three-dimensional visualization of crystal, volumetric and morphology data," J. Appl. Crystallogr., 44, 1272-1276 (2011).
3. Engineering Mechanics by Manoj K. Harbola, Cengage Learning New Delhi 2012
4. Density Functional Theory: An Approach to the Quantum Many-Body Problem, Reiner M. Dreizler, 1990.

PHY 4318: ADVANCED TOPICS IN MODERN PHYSICS [3 0 0 3]

Special Theory of Relativity: Michelson-Morley Experiment, The Postulates of Special Theory of Relativity, Lorentz Transformation, Simultaneity, Time Dilation, Length Contraction, Velocity Addition, Mass in Relativity, Mass and Energy, Statistical Mechanics: Maxwell-Boltzmann Statistics, Bose-Einstein Statistics, Fermi-Dirac Statistics, Comparison of the Three Statistics, Density of States, Phase Volume and Eigenstates, Number of Eigenstates in an Energy Range, Elementary Particle Physics: Decay of elementary particles, Standard model, Unification schemes. Topics from Quantum Mechanics: Review of postulates of quantum mechanics, The EPR paradox, The Bell's theorem, Meaning of measurement, The quantum Zeno Paradox, Spin of electron.

References :

1. G. Aruldhas, Engineering Physics (1e), PHI Learning Private Learning, 2010.
2. Griffiths D. J., Introduction to Elementary Particles (1e), John Wiley & Sons, Singapore, 1987.
3. Griffiths D. J., Introduction to Quantum Mechanics (3e), Cambridge University Press, 2024.
4. https://onlinecourses.nptel.ac.in/noc23_ph22/preview

PHY 4319: INTRODUCTION TO QUANTUM COMPUTING [3 0 0 3]

Introduction and Background: Single qubit gates, Multi-qubit gates, Quantum circuits, Universal Gates, Rotation Gates, No Cloning Theorem, POVM measurements, Properties of the density operator, Reduced density operator, Schmidt decomposition and purifications, EPR and the Bell inequality, CHSH Inequality, Quantum teleportation, Application of quantum teleportation, Superdense coding, Quantum Key Distribution, Quantum parallelism, Quantum Algorithms: Deutsch algorithm, Deutsch-Josza algorithm, Simons algorithm, Quantum Fourier Transform, Circuit For Quantum Fourier Transform, Phase estimation algorithm, Grover's algorithm, Shor's Prime Factorisation Problem, Physical Realization of Quantum Computers: DiVincenzo's criteria, NMR and Nuclear Qubits, Qubits using Nitrogen vacancies in diamonds, Superconducting Qubits, Photonic Qubits, Trapped ions, Quantum Dots.

References:

1. Quantum Computation and Quantum Information, Michael A. Nielsen and Isaac L. Chuang, Cambridge University Press (10th Anniversary Edition) 2010.
2. An Introduction to Quantum Computing, Phillip Kaye, Raymond Laflamme and Michele Mosca, Oxford University Press (1st Ed.) 2007.
3. Quantum Computing: From Linear Algebra to Physical Realizations, Mikio Nakahara and Tetsuo Ohmi, CRC Press (1st Ed.) 2008.
4. Quantum Computing: A Beginner's Introduction, Parag K. Lala, McGraw-Hill Education (1st Ed.) 2019.

PHY 4320: SOLAR PHOTOVOLTAICS AND BATTERY TECHNOLOGY [3 0 0 3]

Solar Cell Technologies: Different generations, Si based solar cells, development of commercial Si solar cell, high efficiency Si solar cell, Arears of improvement and potential efficiency gain, thin film solar cell technology, common features, a-Si, CdTe, emerging technologies, organic solar cells, DSC, GaAs, Energy Density and Specific Energy, Charge and Discharge, Electrode Kinetics, Double-Layer Capacitance, Ion Transport, Conservation of Charge, Cell Voltage, Cell Temperature, Arrhenius Equation, Conservation of Energy, Side Reactions and Aging. Battery System Dynamics: Electrochemical Impedance Spectroscopy, Nyquist plot. Battery System Models: Lead–Acid Battery Model, Lithium-Ion Battery Model, Nickel-Metal Hydride Battery Model. State of Charge Estimation, SOH Estimation. Battery Management Systems: BMS Hardware, Charging Protocols, Pulse Power Capability, Dynamic Power Limits, Pack Management.

Reference:

1. C. S. Solanki, Solar Photovoltaics: Fundamentals, Technologies and Applications, New Delhi, India: PHI, 2017.
2. P. Würfel and U. Würfel, Physics of Solar Cells: From Basic Principles to Advanced Concepts, Wiley-VCH, 2016.
3. C. D. Rahn and C.-Y. Wang, Battery Systems Engineering. Hoboken, NJ, USA: Wiley, 2013.
4. J. Newman and K. E. Thomas-Alyea, Electrochemical Systems, 3rd ed. Hoboken, NJ, USA: Wiley-Interscience, 2004.

Department of
Chemistry

Chemistry department started its functioning since the inception of MIT. The department has made significant contribution in education and research in all areas of chemistry and allied branches. It offers M.Sc. and PhD programs in major areas of chemistry. Dept. offers engineering chemistry for undergraduate students of engineering. Students are provided with comprehensive practical and theoretical exposure of the subject. Research in the areas such as Synthetic Chemistry, Medicinal Chemistry, Green Chemistry, Corrosion control, Polymers, Super capacitors, Natural Products, Liquid crystals, Pervoskite based solar cells and Green hydrogen are being pursued. The faculty members have published large no. of research articles in Scopus indexed journals.

The Department of Chemistry has received a government research grant of ₹ 50 lakhs, reflecting its strong research capabilities and contributions. Currently, over 65 research scholars are pursuing their Ph.D. in the department. The department has achieved a QS World University Ranking in the 501-550 band for Chemistry, underscoring its academic and research excellence. Over the last 10 years, the department has published more than 750 research articles and 150 review papers in reputed Scopus- and Web of Science-indexed journals. The department is well-equipped with advanced instrumentation, including TGA/DTA/DSC, FTIR-ATR, Autolab, Biologic SP-150, Photoluminescence Spectrometer, Organic Parallel Synthesizer, Schrödinger software for molecular docking, Spin-Coater, UV-Visible-NIR Spectrophotometer, Labman Digital Rotational Viscometer, and other facilities supporting research in materials science and energy systems.

> Programs offered

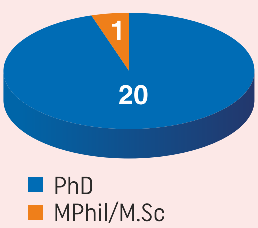
Postgraduate Program

- M.Sc in Chemistry (since 2009)
- M.Sc in Chemistry WILP for CIPLA (since 2024)

PhD

> Faxculty Strength

Qualification-wise



Cadre-wise

CHM 4441: ANALYTICAL TECHNIQUES AND INSTRUMENTATION [3 0 0 3]

Spectroscopic methods of analysis: Properties of EMR, General features of spectroscopy, types of molecular spectra, interaction of EMR with matter, instrumentation, applications, theory, instrumentation and applications theory, instrumentation and applications of microwave, raman, infrared, UV-visible, NMR spectroscopic techniques.

Chromatographic Techniques: General concepts, classification, principles, experimental techniques of CC, HPLC, TLC, GC and their applications. Electroanalytical methods: Basic principles and applications of conductometric, potentiometric titrations.

References:

1. D.A. Skoog, J, Holler, F.T.A, Nieman "Principles of Instrumental Analysis", (5e), Saunders, Philadelphia, 1992
2. D.A. Skoog, D.M. west and F.J Holler, "Fundamentals of Analytical Chemistry", (5e), Saunders college publishing, Philadelphia, 1988.
3. GH Jeffery, "Vogel's textbook of quantitative chemical analysis", John wiley and sons inc, (5e), 1989.

OPEN ELECTIVES

CHM 4311: ANALYTICAL METHODS AND INSTRUMENTATION [3 0 0 3]

Spectroscopic methods of analysis: Introduction, Energy concepts, Properties of EMR, Types of molecular spectra, Interaction of EMR with matter, Instrumentation, Applications.

Microwave spectroscopy: Introduction, Diatomic rigid rotor and non-rigid models, Instrumentation, Applications, Advantages and disadvantages.

Raman spectroscopy: Basic principles, Properties of Raman lines, classical and quantum theories, Techniques and instrumentation, Applications.

Infrared spectroscopy: Theory, Diatomic molecules as harmonic and anhormonic oscillators. Diatomic vibrating rotator, vibrations of polyatomic molecules, Instrumentation of dispersive and FT-IR, Double beam IR spectrometer, Uses of IR, Advantages, Limitations.

UV-visible spectroscopy: Theory, Types of transitions, Instrumentation, Double beam spectrophotometer, Applications, Spectrophotometry Beer's law, Deviations.

NMR spectroscopy: Basic principles, chemical shift, spin-spin coupling, instrumentation, applications of proton NMR spectroscopy. Chromatographic techniques: General concepts, classification, instrumentation, experimental techniques, applications, advantages and disadvantages of CC, HPLC, TLC & GC. Electroanalytical methods: Basic Principles of conductometric and potentiometric titrations, applications.

References:

1. D.A. Skoog, J. Holler, F.T.A Nieman, "Principles of Instrumental Analysis", (5e), Saunders, Philadelphia, 1992.
2. GH Jeffery, "Vogel's Textbook of Quantitative Chemical Analysis", (5e), John Wiley & Sons Inc, 1989
3. G.W. Ewing, "Instrumental Methods of Chemical Analysis", Mc-Graw-Hill, 1989

CHM 4312: SUSTAINABLE CHEMICAL PROCESSES AND PRODUCTS [3 0 0 3]

Introduction: Definition, twelve principles, evaluating products, processes, starting materials and reaction types, examples of green products, reactions, reagents, solvents, catalysts and starting materials, atom economy, reaction mass efficiency, effective mass yield, carbon efficiency and eco-factor, green chemistry matrices, life cycle analysis, product and process design for sustainability, chemical product legislation-REACH

Catalysis and green chemistry: Catalysis in the chemical industry-bulk chemicals; alkylation and selective oxidation reactions, fine chemicals; synthesis of certain chemical products, importance of selective catalysts in sustainable development, selectivity in catalysis, catalyst for clean technology, heterogenization, reparation of supported reagents, applications and analysis of eco-friendly approach of waste treatment.

Cleaner Production: Examples, process design aspects, high-throughput syntheses, scale up and industrial applications of clean synthesis, use of microwaves, ultraviolet and infrared radiations, insecticides based on natural products, eco-friendly bio-pesticides, industrial examples-polymer, pesticide, food and flavor, dye, paper and pulp, and pharmaceutical industries, use of enzymes in oxidation, reduction and hydrolysis reactions, electrochemical synthesis

References:

1. P.T. Anastas, J.C. Warner, "Green Chemistry: Theory and practice", Oxford Univ. Press, Oxford, 2008
2. A.S. Matlack, "Introduction to Green Chemistry", Marcel Dekker, New York, 2001
3. P.T. Anastas, R.H. Crabtree, "Handbook of Green Chemistry and Catalysis", Wiely-VCH, Weijeim, 2009

CHM 4313: FUNDAMENTALS OF INDUSTRIAL CATALYTIC PROCESSES [3 0 0 3]

Adsorption and Catalysis: Physisorption and chemisorption, adsorption isotherms, factors influencing adsorption, adsorption of gases by solids, adsorption from solution, introduction to catalysis, energetics, catalytic cycles.

Solutions and Solubility: Ideal and non-ideal solutions, Raoult's law, thermodynamics of ideal solutions, vapor pressure and boiling point composition curves, distillation behavior of completely miscible and immiscible liquid systems, azetropes.

Colligative Properties: Determination of molar masses from vapor pressure lowering, osmotic pressure, boiling point elevatiom and depression of freezing point, vanthoff's factor.

Colloids: Types, preparation and purification of sols, general properties, optical, electrical and kinetic properties of sols, stability of sols, application of colloids, emulsions and gels-types, preparation, properties and their applications.

References:

1. B.R Puri, L.R. Sharma, M.S. Pathania, "Principles of physical chemistry", (43e), vishal publications, New Delhi, 2012
2. S.H. Maron, C.F. Prutton, "Principles of physical chemistry", (4e), IBH publishing co. New Delhi, 1985
3. D.A. Skoog, D.M. West, F.J. Holler, R. Coruch, "Fundamentals of Analytical Chemistry", (9e)

COMMON OPEN ELECTIVE COURSE

IPE 4302: CREATIVITY, PROBLEM SOLVING AND INNOVATION [2 1 0 3]

Psychology of problem solving, methods of questioning, methods of learning, analyzing, summarizing and communicating information as written report and oral presentation, visualizing thinking, thinking fluency, fusion of ideas, making novel combinations, looking into the other world for finding solutions. Importance of play and relaxation, allowing subconscious mind to figure out the solution. Awakening the collaborative spirit by brain storming and collaboration to facilitate innovation. Review strategies for creative problem solving methods, Stanford d.School design thinking process, divergent thinking and convergent thinking, lateral thinking and the decision making. Strategy of making - from idea to innovation.

Reference:

1. Zig Zag, the surprising path to greater creativity by R Keith Sawyer 2013
2. Crackling Creativity, The secrets of creative genius by Michael Michalko 2001
3. Thinkertoys by Michael Michalko second edition 2006
4. Strategies for creative problem solving by H Scott Fogler & Steven E LeBlanc. Second edition 2008
5. De Bono's Thinking Course by Edward De Bone, Revised Edition 1994
6. Six Thinking Hats by Edward De Bono Revised and updated edition 1999
7. How to mind map by Tony Buzan2002
8. The Myths of Innovation by Scott Berkun. Expanded and revised edition 2010
9. They all laughed by Ira Flatow. 1992
10. 101 Creative problem solving techniques by James M Higgins 1994

UG program codes

Code	Description
0902	Bio Medical Engineering
0903	Chemical Engineering
0904	Civil Engineering
0905	Computer Science and Engineering
0906	Electrical and Electronics Engineering
0907	Electronics and Communication Engineering
0909	Mechanical Engineering
0911	Information Technology
0924	Biotechnology
0929	Mechatronics
0931	Industrial Engineering
0932	Electronics and Instrumentation Engineering
0933	Aeronautical Engineering
0934	Automobile Engineering
0953	Computer and Communication Engineering
0961	Cyber Physical Systems
0962	Computer Science and Engineering (Artificial Intelligence and Machine Learning)
0968	Data Science and Engineering

OPEN ELECTIVES

Subject code	Subject Name	Offering department	Applicable Programs
AAE 4311	Introduction to Aerospace Engineering	AAE	934, 902,924,903,904, 953, 905, 906, 907,932, 911, 909,929, 931,953,955,961,962, 968
AAE 4312	Introduction to Avionics and Navigation System	AAE	934, 902,924,903,904, 953, 905, 906, 907,932, 911, 909,929,931,953,955,961,962, 968
AAE 4313	Introduction to Automobile Engineering	AAE	933, 902,924,903,904, 953, 905, 906, 907,932, 911, 909,929,931,953,955,961,962, 968
AAE 4314	Alternatives Fuels for Sustainable Environment	AAE	933, 902,924,903,904, 953, 905, 906, 907,932, 911, 909,929,931, 953,955,961,962, 968
BME 4311	Bio-medical Instrumentation	BME	0903, 0904, 0905, 0906, 0907, 0909, 0911, 0924, 0929, 0931, 0933, 0934, 0953, 961,962,968
BME 4312	Bio-Mechanics	BME	0903, 0904, 0905, 0906, 0907, 0909, 0911, 0924, 0929, 0931, 0933, 0934, 0953, 961,962,968
BME 4313	Rehabilitation Engineering	BME	0903, 0904, 0905, 0906, 0907, 0909, 0911, 0924, 0929, 0931, 0933, 0934, 0953, 961,962,968
BME 4314	Introduction of Materials in Medicine	BME	0903, 0904, 0905, 0906, 0907, 0909, 0911, 0924, 0929, 0931, 0933, 0934, 0953, 961,962,968
BME 4315	Introduction to Nanotechnology & Characterization Techniques	BME	0903, 0904, 0905, 0906, 0907, 0909, 0911, 0924, 0929, 0931, 0933, 0934, 0953, 961,962,968
BME 4316	Nanomedicine	BME	0903, 0904, 0905, 0906, 0907, 0909, 0911, 0924, 0929, 0931, 0933, 0934, 0953, 961,962,968
BIO 4311	Introduction to Bioinformatics	BIO	Applicable to all the Programs except 924
BIO 4312	Body, Mind, and Medicine	BIO	Applicable to all the Programs except 924
BIO 4313	Bioinspired Design for Engineers	BIO	Applicable to all the Programs except 924
IIE 4308	Health Economics	BIO	Applicable to all the Programs except 924
ICT 4311	Computer Graphics and Animation	ICT	0933, 0934,0902,0924,0903,0904, 0906, 0907,0932,0909,0929,0931,0961
ICT 4312	Design and Development of Web Applications	ICT	0933, 0934,0902,0924,0903,0904, 0906, 0907,0932,0909,0929,,0931,0961
ICT 4313	Fundamentals of Data Structures and Algorithms	ICT	0933, 0934,0902,0924,0903,0904, 0906, 0907,0932,0909,0929,0931,0961
ICT 4314	Machine Learning Tools and Technologies	ICT	0933, 0934,0902,0924,0903,0904, 0906, 0907,0932,0909,0929,0931,0961
ICT 4315	Networking with TCP/IP	ICT	0933, 0934,0902,0924,0903,0904, 0906, 0907,0932,0909,0929,0931,0961
ICT 4316	Fundamentals of Cyber Security	ICT	0933, 0934,0902,0924,0903,0904, 0906, 0907,0932,0909,0929,0931,0961
ICT 4317	Game Theory & Applications	ICT	0933, 0934,0902,0924,0903,0904, 0906, 0907,0932,0909,0929,,0931,0961
CHE 4311	Industrial Pollution Control	CHE	Applicable to all programs except 903
CHE 4312	Risk and Safety Management in Industries	CHE	Applicable to all programs except 903
CHE 4313	Water Treatment Technology	CHE	Applicable to all programs except 903
CHE 4314	Introduction to Petroleum Engineering	CHE	Applicable to all programs except 903
CIE 4311	Air and Noise Pollution	CIE	0902, 0924, 0953, 0905, 0906, 0907, 0932, 0911, 0931, 0909, 0929, 0933, 0934, 0961, 0962, 0968
CIE 4312	Contract Management for Engineers	CIE	0933, 0934, 0902, 0924, 0903, 0953, 0905,0968, 0906, 0907, 0932, 0931, 0911, 0909, 0929, 0961, 0962, 0968

OPEN ELECTIVES

Subject code	Subject Name	Offering department	Applicable Programs
CIE 4313	Environmental Management	CIE	0933, 0934, 0902, 0924, 0903, 0953, 0905,0968, 0906, 0907, 0932, 0931, 0911, 0909, 0929, 0961, 0962, 0968
CIE 4314	Geology for Engineers	CIE	0933, 0934, 0902, 0924, 0903, 0953, 0905,0968, 0906, 0907, 0932, 0931, 0911, 0909, 0929, 0961, 0962, 0968
CIE 4315	Introduction to Remote Sensing and GIS	CIE	0902, 0924, 0903, 0953, 0905,0968, 0906, 0907, 0932, 0931, 0911, 0909, 0929, 0961, 0962, 0968
CIE 4316	Strength of Materials	CIE	0902, 0924, 0903, 0953, 0905,0968, 0906, 0907, 0932, , 0911, 0929, 0961, 0962, 0968
CSE 4311	Essentials of Industrial Computing	CSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0908, 0909, 0929, 0931, 0961
CSE 4312	Essentials of IT	CSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0908, 0909, 0929, 0931, 0961
CSE 4313	Linux Programming	CSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0908, 0909, 0929, 0931, 0961
CSE 4314	Principles of Database Systems	CSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0908, 0909, 0929, 0931, 0961
CSE 4315	Principles of Software Engineering	CSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0908, 0909, 0929, 0931, 0961
CSE 4316	Python Programming	CSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0908, 0909, 0929, 0931, 0961
CSE 4317	Web Programming	CSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0908, 0909, 0929, 0931, 0961
CSE 4318	iOS Application Development	CSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0908, 0909, 0929, 0931, 0961
CSE 4321	Introduction to Artificial Intelligence	CSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0908, 0909, 0929, 0931, 0961
CSE 4322	Introduction to Machine Learning	CSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0908, 0909, 0929, 0931, 0961
CSE 4323	Natural Language Processing with Python	CSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0908, 0909, 0929, 0931, 0961
CSE 4324	Introduction to Soft Computing Paradigms	CSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0908, 0909, 0929, 0931, 0961
ELE 4311	MATLAB for Engineers	ELE	902, 903, 904, 905, 907, 909, 911, 924, 929, 931, 932,933, 934, 953, 961, 962, 968
ELE 4312	Essentials of Energy Auditing	ELE	902, 903, 904, 905, 907, 909, 911, 924, 929, 931, 932,933, 934, 953, 961, 962, 968
ELE 4313	Solar Photovoltaics	ELE	902, 903, 904, 905, 907, 909, 911, 924, 929, 931, 932,933, 934, 953, 961, 962, 968
ELE 4314	Introduction to Renewable Energy	ELE	902, 903, 904, 905, 907, 909, 911, 924, 929, 931, 932,933, 934,953, 961, 962, 968
ELE 4315	Introduction to Lighting Design	ELE	902, 903, 904, 905, 907, 909, 911, 924, 929, 931, 932,933, 934, 953, 961, 962, 968
ELE 4316	Utilization Of Electrical Energy	ELE	902, 903, 904, 905, 907, 909, 911, 924, 929, 931, 932,933, 934,953, 961, 962, 968
ECE 4311	Consumer Electronics	ECE	All the Programs except 907
ECE 4312	Electronic Product Design & Packaging	ECE	All the Programs except 907
ECE 4313	Introduction to Communication Systems	ECE	All the Programs except 907
ECE 4314	MEMS Technology	ECE	All the Programs except 907
ECE 4315	Introduction to Nano science & Technology	ECE	All the Programs except 907
ECE 4316	Basics of Building Automation Systems	ECE	All the Programs except 907
ECE 4317	Intelligent Instrumentation System	ECE	903 , 904 , 905 , 909 , 911 , 924 , 929 , 931, 933 , 934 , 953, 961 , 962 , 968

OPEN ELECTIVES

Subject code	Subject Name	Offering department	Applicable Programs
ECE 4318	Computational Intelligence & Environmental Sustainability	ECE	All the Programs except 907
ECE 4319	Applications of Signal Processing	ECE	903 , 904 , 905 , 909 , 911 , 924 , 929 , 931, 933 , 934 , 953, 961 , 962 , 968
ECE 4320	Introduction to Biosensors	ECE	903 , 904 , 905 , 909 , 911 , 924 , 929 , 931, 933 , 934 , 953, 961 , 962 , 968
ECE 4321	Machine Learning in VLSI Computer Aided Design	ECE	All the Programs except 907
ICE 4311	Feedback Control Theory	ICE	902, 905, 909, 911, 924, 953, 962, 968
ICE 4312	Industrial Automation	ICE	906, 90
ICE 4313	Industrial Instrumentation	ICE	902, 906, 907, 909, 931, 933, 934
ICE 4314	Sensor Technology	ICE	907, 931, 933, 934
ICE 4315	Smart Sensor	ICE	902,906, 907
ICE 4316	Virtual Instrumentation	ICE	902, 906, 907
ICE 4317	Farm Automation	ICE	902, 903, 904, 905, 906, 907, 909, 911, 924, 929,931, 933, 934, 953, 962, 968
MIE 4311	Introduction to Composite Materials	MIE	902, 903, 904, 905, 906, 907, 911, 924, 929, 932, 933, 934, 953, 961, 962, 968
MIE 4312	Introduction to Biomechanics	MIE	903, 904, 905, 906, 907, 911, 924, 929, 932, 933, 934, 953, 961, 962, 968
MIE 4313	Introduction to Operations Research	MIE	902, 903, 904, 905, 906, 907, 911, 924, 929, 932, 933, 934, 953, 961, 962, 968
MIE 4314	Energy Engineering	MIE	902, 903, 904, 905, 906, 907, 911, 924, 929, 932, 933, 934, 953, 961, 962, 968
MIE 4315	Introduction to Finite Element Methods	MIE	902, 903, 904, 905, 906, 907, 911, 924, 929, 932, 933, 934, 953, 961, 962, 968
MIE 4316	Bio-Fluid Dynamics	MIE	902, 903, 904, 905, 906, 907, 911, 924, 929, 932, 933, 934, 953, 961, 962, 968
MIE 4317	Introduction to Engineering Asset Management	MIE	902, 903, 904, 905, 906, 907, 911, 924, 929, 932, 933, 934, 953, 961, 962, 968
MTE 4311	Autonomous Mobile Robots	MTE	Applicable to all the Programs except 929
MTE 4312	Farm Automation	MTE	Applicable to all the Programs except 929
MTE 4313	Hydraulics and Pneumatics Systems	MTE	Applicable to all the Programs except 929
MTE 4314	Industrial IoT	MTE	Applicable to all the Programs except 929
MTE 4315	Introduction to Industrial Robotics	MTE	Applicable to all the Programs except 929
CHM 4311	Analytical methods and Instrumentation	CHM	All the Programs except 903
CHM 4312	Sustainable Chemical Processes and Products	CHM	Applicable to all the Programs
CHM 4313	Fundamentals of Industrial catalytic processes	CHM	Applicable to all the Programs
PHY 4311	Fundamentals of Astronomy & Astrophysics	PHY	Applicable to all the Programs
PHY 4312	Physics of Engineering Materials	PHY	Applicable to all the Programs
PHY 4313	Lasers and optoelectronics	PHY	Applicable to all the Programs

OPEN ELECTIVES

Subject code	Subject Name	Offering department	Applicable Programs
PHY 4314	Introduction to Quantum Mechanics	PHY	Applicable to all the Programs
PHY 4315	Fundamentals of vacuum techniques and thin Films	PHY	Applicable to all the Programs
PHY 4316	Clean energy technologies	PHY	Applicable to all the Programs
HUM 4320	Research Methods in Management	HUM	Applicable to all the Programs
HUM 4321	Communicative English	HUM	Lateral Entry students only
HUM 4322	Film Studies	HUM	Applicable to all the Programs
HUM 4323	German for Beginners	HUM	Applicable to all the Programs
HUM 4324	Indo- European Intercultural Dynamics	HUM	Applicable to all the Programs
HUM 4325	Interpretation of Literary Texts	HUM	Applicable to all the Programs
HUM 4326	Public Speaking	HUM	Applicable to all the Programs
HUM 4327	Analytical Writing	HUM	Applicable to all the Programs
HUM 4328	Commonwealth Literature	HUM	Applicable to all the Programs
HUM 4329	Creative Communication Art, Media, Culture and Ideas	HUM	Applicable to all the Programs
HUM 4330	Applied Linguistics	HUM	Applicable to all the Programs
HUM 4331	Women's Writing	HUM	Applicable to all the Programs
HUM 4332	Culture and Society in Literature	HUM	Applicable to all the Programs
HUM 4333	Introduction to Psychology	HUM	Applicable to all the Programs
HUM 4334	Introduction to Philosophy Religion and Culture	HUM	Applicable to all the Programs
HUM 4335	Creative Writing	HUM	Applicable to all the Programs
HUM 4336	Graphic Novels History, Form and Culture	HUM	Applicable to all the Programs
HUM 4337	Introduction to Enterprise Risk Management	HUM	Applicable to all the Programs
MAT 5301	Applied Graph Theory	MAT	Applicable to all the Programs except 957
MAT 5302	Applied Linear Algebra	MAT	Applicable to all the Programs except 957
MAT 5304	Mathematical Modelling	MAT	Applicable to all the Programs except 957
MAT 5305	Optimization Techniques	MAT	Applicable to all the Programs except 957
MAT 5306	Stochastic Processes and Reliability	MAT	Applicable to all the Programs except 957
DSE 4311	Introduction to Database Systems with MYSQL	DSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0909, 0929, 0931
DSE 4312	Introduction to VR and AR Technologies	DSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0909, 0929, 0931
DSE 4313	Introduction to LINUX and Shell Scripting	DSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0909, 0929, 0931
DSE 4314	Introduction to Data Analytics	DSE	0933, 0934, 0902, 0924, 0903, 0904, 0906, 0907, 0932, 0909, 0929, 0931

Minor Specializations

Subject code	Subject Name	Offering Department	Applicable Programs
1. Aerodynamics			
AAE 4401	Applied Aerodynamics	AAE	933
AAE 4402	Turbomachinery Aerodynamics		
AAE 4403	Experimental Aerodynamics		
AAE 4404	High Speed Aerodynamics		
2. Avionics System Engineering			
AAE 4405	Unmanned Aircraft Systems, Sensors, and Instrumentation	AAE	933,907,953,932
AAE 4406	Antenna Design, Analysis, and its Applications		
AAE 4407	Aerospace Embedded Systems, Software, Safety and Security		
AAE 4408	Aircraft Communication and Networking		
3. Automotive System Engineering			
AAE 4409	Connected Vehicle Systems	AAE	934,909,929
AAE 4410	Advanced Drivetrain Systems		
AAE 4411	Engine Tribology		
AAE 4412	Actuation Systems		
4. Vehicle System Design			
AAE 4413	Engine Systems Design	AAE	934,909,929
AAE 4414	Automotive Ergonomics		
AAE 4415	Fatigue Failure and Analysis		
AAE 4416	Noise, Vibrations and Harshness		
5. Electric Vehicle Technology			
AAE 4417	Electrical Vehicle System Engineering	AAE	934,909,929
AAE 4418	Energy Storage System and Devices for Electric Vehicles		
AAE 4419	Electrical Vehicle Battery and Charging System		
AAE 4420	Motors and Drive Systems for Electric Vehicles		
6. Biomaterials			
BME 4401	Introduction to Biomedical nanotechnology	BME	902
BME 4402	Biomaterial Characterization Techniques		
BME 4403	Bio-fabrication		
BME 4404	Drug Delivery		
7. Informatics			
BME 4405	Artificial Intelligence	BME	902
BME 4406	Biomedical Signal Processing		
BME 4407	Decision Support system		
BME 4408	Medical Imaging		
8. Environmental Biotechnology			
BIO 4401	Bioremediation	BIO	924,903
BIO 4402	Biological Treatment of Wastewater		
BIO 4403	Biofuels Engineering		
BIO 4404	Solid Waste Management		

9. Pharmaceutical Biotechnology			
BIO 4405	Biomaterials & Drug Delivery Engineering Principles	BIO	924
BIO 4406	Biopharmaceutical Engineering		
BIO 4407	Biological Therapeutics		
BIO 4408	Molecular Modeling & Drug Design		
10. Petroleum Engineering			
CHE 4401	Oil and Gas Reservoir Engineering	CHE	903
CHE 4402	Petroleum Refinery Engineering (Theory & Lab)		
CHE 4403	Natural Gas Engineering		
CHE 4404	Process Integration for Petroleum Industries		
11. Pollution Control Engineering			
CHE 4405	Industrial Waste Water Engineering (Theory & Lab)	CHE	903
CHE 4406	Solid and Hazardous Waste Management		
CHE 4407	Air Pollution Monitoring and Control		
CHE 4408	Environmental Impact Assessment and Management Plan		
12. Renewable Energy Engineering			
CHE 4409	Renewable Energy	CHE	903, 933, 934
CHE 4410	Solar Energy		
CHE 4411	Fuel Cell and Hydrogen Energy		
CHE 4412	Bio Energy Engineering		
13. Building Construction and Management			
CIE 4401	Advances in Concrete Technology	CIE	904
CIE 4402	Building Codes and Functional Services		
CIE 4403	Construction Materials and Quality Management		
CIE 4404	Contract Management		
14. Environmental Engineering			
CIE 4405	Air Pollution and Control	CIE	904
CIE 4406	Industrial Waste Water Treatment		
CIE 4407	Solid Waste Management		
CIE 4408	Integrated Management of Watershed Ecology		
15. Structural Engineering			
CIE 4409	Structural Dynamics	CIE	904
CIE 4410	Design of Steel Structures		
CIE 4411	Finite Element Method of Analysis		
CIE 4412	Design of Foundation and Earth Retaining Structures		
16. Transportation Engineering			
CIE 4413	Urban Mass Transport System	CIE	904
CIE 4414	Urban Transport Planning		
CIE 4415	Pavement Material and Design		
CIE 4416	Traffic Systems and Engineering		
17. Computer Graphics & Visualization			
CSE 4401	Digital Image Processing	CSE	905
CSE 4402	Computer Graphics		
CSE 4403	Computer Vision		
CSE 4404	Augmented and Virtual Reality		

18. Computational Intelligence			
CSE 4405	Artificial Intelligence	CSE	905
CSE 4406	Soft Computing Paradigms		
CSE 4403	Computer Vision		
CSE 4408	Machine Learning		
19. Internet of Things			
CSE 4409	Introduction to IoT	CSE	905, 962
CSE 4410	IoT in Agriculture		
CSE 4411	IoT for Healthcare		
CSE 4412	Smart Cities		
20. Data Analytics			
CSE 4413	Data Warehouse and Data Mining	CSE	905
CSE 4414	Natural Language Processing		
CSE 4403	Computer Vision		
CSE 4416	Big Data Analytics		
21. Cyber Security			
CSE 4417	Network Security	CSE	905
CSE 4418	Cyber forensics		
CSE 4419	Artificial intelligence in Cyber security		
CSE 4420	Database and Application Security		
22. AI in Healthcare			
CSE 4421	AI for Medical Image Analysis	CSE	962
CSE 4422	Bio-Informatics		
CSE 4423	Healthcare Informatics		
CSE 4424	Applications of AI in Medicine		
23. Computer Vision			
CSE 4425	Deep Learning in Computer Vision	CSE	962
CSE 4426	Computer Vision for Assistive Technologies		
CSE 4427	Autonomous Systems		
CSE 4428	Augmented Reality		
24. Applied Natural Language Processing			
CSE 4429	Natural Language Processing	CSE	962
CSE 4430	Speech Processing		
CSE 4431	Machine Translation		
CSE 4432	Deep Learning for Natural Language Processing		
25. Cyber Security			
CSE 4433	Principles of Cryptography	CSE	962
CSE 4434	Information Security		
CSE 4435	Blockchain Technology		
CSE 4436	AI in Cyber Security		
26. Communication Systems			
ECE 4401	Machine Learning for Communication system	ECE	907
ECE 4402	B5G Communication Systems		
ECE 4403	Photonic communication system		
ECE 4404	Satellite based Wireless Communication		
27. VLSI Design			
ECE 4405	Low Power VLSI Design	ECE	906, 907, 932
ECE 4406	MOS Device Modelling		
ECE 4407	Digital Design Verification		
ECE 4408	Analog IC Design		

28. Illumination Technology			
ELE 4401	Lighting Science: Devices and Systems	ELE	906, 907, 932
ELE 4402	Integrated Lighting Design		
ELE 4403	Lighting Controls Technology & Applications		
ELE 4404	Solid State Lighting		
29. Electric Mobility			
ELE 4415	EV Battery Technology and Power Train Development	ELE	902, 906, 907, 909, 929, 931, 932, 934
ELE 4416	EV Charging Infrastructure, Vehicle Testing & Homologation		902, 906, 907, 932
ELE 4417	EV Vehicle Design & Analysis		902, 906, 907, 909, 929, 931, 932, 934
ELE 4418	EV Data Analytics & Cyber Security		902, 906, 907, 932
30. Computational Intelligence			
ELE 4409	Artificial Intelligence	ELE	902, 906, 907
ECE 4409	Machine Learning	ECE	
ELE 4410	Soft Computing Techniques	ELE	
ECE 4410	Computer Vision	ECE	
31. Embedded System			
ECE 4411	Embedded System Design	ECE	906, 907, 932
ELE 4411	FPGA Based System Design	ELE	
ECE 4412	Internet of Things	ECE	
ELE 4412	Real Time Systems	ELE	
32. Signal Processing			
ECE 4413	Advanced Digital Signal Processing	ECE	906, 907, 932
ELE 4413	Linear Algebra for Signal Processing	ELE	
ECE 4414	Digital Speech Processing	ECE	
ELE 4414	Digital Image Processing	ELE	
33. Control Systems			
ICE 4401	Modern Control Theory	ICE	906, 907, 929, 932, 961
ICE 4402	Nonlinear control theory		
ICE 4403	Digital Control Systems		
ICE 4404	System Identification		
34. Sensor Technology			
ICE 4405	Sensor Design	ICE	906, 907, 929, 932, 961
ICE 4406	Biosensors and BioMEMS		
ICE 4407	Multi Sensor Data Fusion		
ICE 4408	Automotive Sensors		
35. Systems Engineering			
ICE 4409	Introduction to Systems Engineering	ICE	902, 906, 907, 909, 929, 931, 932, 933, 934, 961
ICE 4410	System architecture and Design		
ICE 4411	SysML and MBSE		
ICE 4412	System Verification and Validation		
36. Smart Transportation Systems			
ICE 4413	Automotive Electronics	ICE	932,961
ICE 4414	In-vehicle Networking		
ICE 4415	Intelligent Transportation Systems		
ICE 4416	Advanced Driver Assistance Systems		

37. Computational Intelligence			
ICT 4401	Artificial Intelligence	ICT	911, 953
ICT 4402	Machine Learning		
ICT 4403	Foundations of Generative AI		
ICT 4404	Neural Computation and Applications		
38. Computer Graphics and Visualization			
ICT 4405	Computer Graphics	ICT	911, 953
ICT 4406	Digital Image Processing		
ICT 4407	Augmented and Virtual Reality		
ICT 4408	Computer Vision		
39. Data Analytics			
ICT 4409	Information Retrieval	ICT	911, 953
ICT 4410	Big Data Analytics		
ICT 4411	Social Network Analysis		
ICT 4412	Applied Data Analytics		
40. Cyber Security			
ICT 4413	Cyber Forensics and Cyber laws	ICT	911, 953
ICT 4414	Ethical hacking		
ICT 4415	Blockchain Technology		
ICT 4416	Artificial Intelligence in Cyber security.		
41. Software System Design			
ICT 4417	Advanced Software Engineering	ICT	911
ICT 4418	Software Architecture		
ICT 4419	Software Quality Management		
ICT 4420	Software Construction		
42. Machine Design			
MIE 4401	Design of Mechanical Systems	MIE	909, 934
MIE 4402	Introduction to Continuum Mechanics for Engineers		
MIE 4403	Lubrication and Rotor Dynamics		
MIE 4404	Modelling and Simulation of Dynamic Systems		
43. Manufacturing Technology			
MIE 4405	Additive Manufacturing	MIE	909, 934
MIE 4406	Non-traditional Manufacturing Techniques		
MIE 4407	Lean Manufacturing		
MIE 4408	Micro Machining		
44. Thermal Systems			
MIE 4409	Cryogenics	MIE	909
MIE 4410	Solar Thermal Systems		
MIE 4411	Design of Heat Exchangers		
MIE 4412	Jet Propulsion		
45. Materials Engineering			
MIE 4413	Processing of Polymers and Polymer Composites	MIE	909, 934
MIE 4414	Metal and Ceramic Composite Materials		
MIE 4415	Materials Characterization		
MIE 4416	Fiber Reinforced Composite Mechanics & Manufacturing Techniques		

46. Vehicle Technology			
MIE 4417	Automobile Engines and Combustion	MIE	909
MIE 4418	Automotive Transmission		
MIE 4419	Electric & Hybrid Vehicles		
MIE 4420	Autotronics		
47. Automation and Robotics			
MIE 4421	Robotics Mechanics and Control	MIE	909, 934
MIE 4422	Elements of Mechatronics Systems		
MIE 4423	Fluid Drives and Control		
MIE 4424	Mechanical Handling Systems and Equipment		
48. Quality Engineering			
MIE 4425	Statistical Quality Control	MIE	909, 933, 934
MIE 4426	Production Planning and Control		
MIE 4427	Operations Research		
MIE 4428	Total Quality Management		
49. Computer Techniques in Mechanical Engineering			
MIE 4429	Programming in Mechanical Engineering	MIE	909
MIE 4430	Metaheuristic Optimization Techniques		
MIE 4431	Machine Learning & its Applications		
MIE 4432	Microcontroller Based Automation		
50. Industrial Internet of Things			
MIE 4433	Industry 4.0	MIE	931
MIE 4434	Block Chain Technology		
MIE 4435	Artificial Intelligence for Industrial Engineering		
MIE 4436	Cyber Security		
51. Computer Organization and Programming			
MIE 4437	Basics of Computer Organization	MIE	931
MIE 4438	Basics of Operating System		
MIE 4439	Programming Using Python		
MIE 4440	Machine Learning		
52. EV Technology			
ELE 4415	EV Battery Technology and Powertrain Development	MTE	902, 906, 907, 909, 929, 931, 932, 934
AAE 4425	EV Product Development, Homologation & Hydrogen FCEV		909, 929, 931, 934
ELE 4417	EV Vehicle Design & Analysis		902, 906, 907, 909, 929, 931, 932, 934
AAE 4426	EV FEA Analysis		909, 929, 931, 934
53. Industrial IoT Systems			
MTE 4405	Database Management Systems	MTE	929
MTE 4406	Cyber Security for Industrial Automation		
MTE 4407	Internetworking for Industries		
MTE 4408	Principles of Cryptography		
54. Robotics and Automation			
MTE 4409	Artificial Intelligence for Robotic Vision	MTE	929, 933, 934
MTE 4410	Robot Dynamics and Control		
MTE 4411	Robot Path Planning and Mobile Robots		
MTE 4412	Soft Robotics		
55. Micro and Nano Systems			
MTE 4413	Semiconductor and VLSI systems	MTE	929
MTE 4414	Smart Materials for Micro and Nano Systems		
MTE 4415	Design of Micro and Nano Devices		
MTE 4416	Fabrication and Testing of Micro Systems		

56. Precision Agriculture Technology			
MTE 4417	Smart Farming Machinery	MTE	929
MTE 4418	Robotics and Automation in Agriculture		
MTE 4419	Food Process Automation		
MTE 4420	Digital Agriculture		
57. Computational Mathematics			
MAT 4401	Applied Statistics and Time Series Analysis	MAT	All the Programs
MAT 4402	Computational Linear Algebra		
MAT 4403	Computational Probability and Design of Experiments		
MAT 4404	Graphs and Matrices		
58. Business Management			
HUM 4401	Human Resource Management	HUM	All the Programs
HUM 4402	Marketing Management		
HUM 4403	Financial Management		
HUM 4404	Operation Management		
59. Finance & Investments			
HUM 4405	Financial System	HUM	All the Programs
HUM 4406	Security Analysis & Portfolio Management		
HUM 4403	Financial Management		
HUM 4407	Project Finance		
60. Financial Technology			
HUM 4408	Fintech Services	HUM	All the Programs
HUM 4409	Technologies for Finance		
HUM 4403	Financial Management		
HUM 4410	Financial Econometrics		
61. Entrepreneurship Development			
HUM 4411	Entrepreneurship	HUM	All the Programs
HUM 4412	Design Thinking		
HUM 4403	Financial Management		
HUM 4413	Intellectual Property Management		
62. People Management			
HUM 4401	Human Resource Management	HUM	All the Programs
HUM 4414	Organizational Behaviour		
HUM 4415	Professionalism & Ethics		
HUM 4416	Leadership & Decision Making		
63. Professional Communication			
HUM 4417	Public Speaking	HUM	All the Programs
HUM 4418	Intercultural Communication		
HUM 4419	Corporate Communication		
HUM 4420	Technical & Business Writing		
64. Modern Literature			
HUM 4421	Understanding Literature	HUM	All the Programs
HUM 4422	Twentieth Century Literature		
HUM 4423	Comparative Literature		
HUM 4424	Modern Indian Literature		

65. Multimodal Intelligent Systems			
DSE 4401	Information Retrieval	DSE	957, 968
DSE 4402	Natural Language Processing		
DSE 4403	Social Network Analysis		
DSE 4404	Computer Vision		
66. Network Analytics			
DSE 4405	Cloud Computing	DSE	957, 968
DSE 4406	Internet of Things		
DSE 4407	Enterprise Data Architecture		
DSE 4408	Blockchain Technology		
67. Applied Mathematics			
MAT 4405	Linear Optimization	MAT	All the Programs
MAT 4406	Non -Linear Optimization		
MAT 4407	Combinatorics and Design of Experiments		
MAT 4408	Game Theory and Statistical Decisions		
68. Advanced Applied Mathematics			
MAT 4409	Applied Graph Theory	MAT	905, 906, 907, 911, 953, 957, 962, 968
MAT 4410	Matrix Theory		
MAT 4411	Advanced Algorithms and Deep Learning		
MAT 4412	Algebraic Coding Theory		
69. Advanced Practices in Construction			
CIE 4417	Formwork Engineering Practices	CIE	904
CIE 4418	Deep Excavations, Foundations &Tunnels		
CIE 4419	Building Information Modelling in Construction		
CIE 4420	Sustainability Practices in Design of Building		
70. Integrated Building System Design			
CIE 4421	Pre-Engineered Buildings	CIE	904
CIE 4422	Mechanized Construction Techniques		
CIE 4423	Integrated Approach to Building Services		
CIE 4424	Concrete Building Systems Design		
71. Space Technology			
AAE 4421	Spaceflight Mechanics and Attitude Dynamics	AAE	933
AAE 4422	Spacecraft Systems and Engineering		
AAE 4423	Launch Vehicle Systems and Technologies		
AAE 4424	Space Data, Products and Services		

Undergraduate Programs offered

Bachelor of Technology (B. Tech.)
(8 Semesters, 160 credits)

Aeronautical Engineering
Automobile Engineering
Biomedical Engineering
Biotechnology
Chemical Engineering
Civil Engineering
Computer Science & Financial Technology
Computer Science and Engineering *
Cyber Physical Systems
Electrical and Electronics Engineering
Electronics and Communication Engineering
Electronics and Instrumentation Engineering
Electronics Engineering (VLSI Design and Technology)
Industrial Engineering
Mathematics and Computing
Mechanical Engineering
Mechanical Engineering
(Dual Degree Program with Deakins University)
Mechatronics
Mechatronics (Dual Degree Program with Deakins University)

Postgraduate Programs offered

Master of Technology (M. Tech.)

(4 Semesters, 80 credits)

Applied Computational Fluid Dynamics
Artificial Intelligence and Decision Sciences
Automobile Engineering
Avionics
Biomedical Engineering
Chemical Engineering
Computer Aided Analysis and Design
Computer Science and Engineering
(Information Security)
Computer Science and Engineering (Networking)
Construction Engineering and Management
Computer Science and Engineering
(Data Science)
Defence Technology
Digital Electronics and Communication
Electric Vehicle Technology
Embedded Control & Automation
Engineering Management
Environmental Engineering
Immersive Technologies
Industrial Automation and Robotics
Industrial Biotechnology
Manufacturing Technology & Automation
Medical Informatics
Microelectronics
Power Electronics and Drives
Software Engineering
Structural Engineering
Thermal Sciences and Energy Systems

Master of Computer Applications (MCA)

(4 Semesters, 80 credits)

Master of Science (M. Sc.)

(4 Semesters, 80 credits)

Applied Mathematics & Computing
Chemistry
Computational Molecular Sciences
Geology
Physics

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* BTech in Computer Science and Engineering with options for specializing in Artificial Intelligence and Machine Learning, Computer Networks and IoT, Data Science, Software Engineering. Options for choice of specialization will happen in the beginning of 3rd year based on CGPA obtained at the end of 2nd year.





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