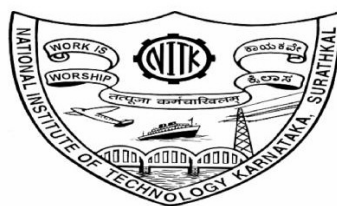


**CURRICULUM**  
**UNDER GRADUATE PROGRAMME**  
**B.Tech.**



**NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL**  
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**2019**

**MOTTO**

- \* Work is Worship

**VISION**

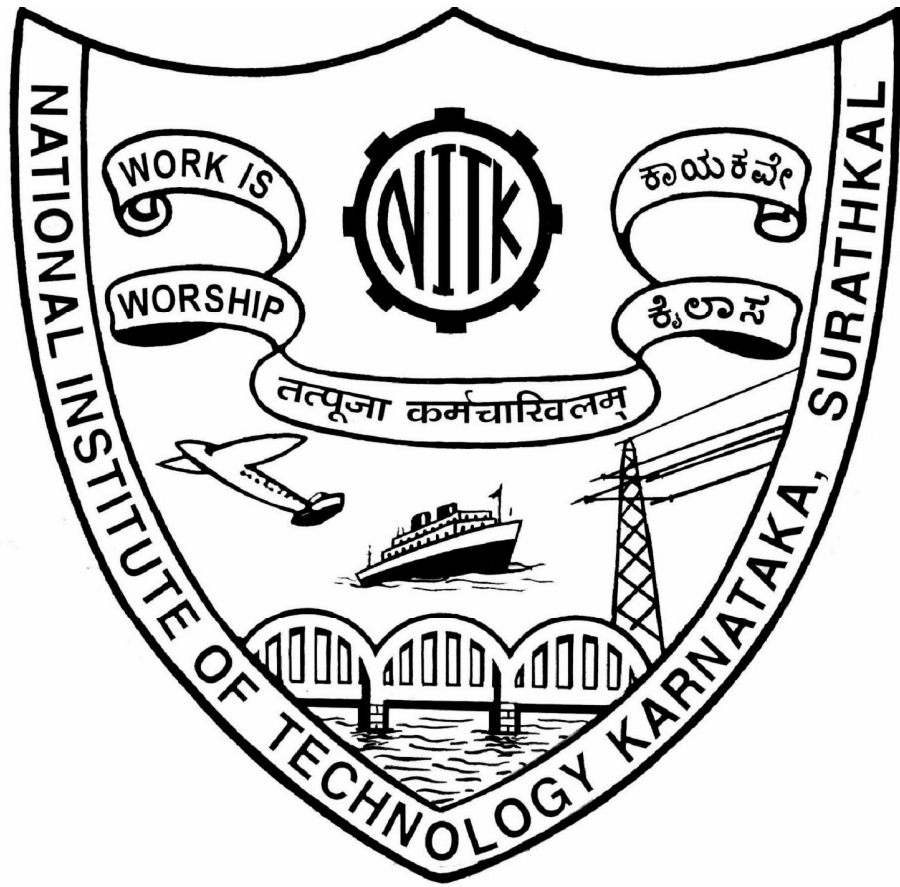
- \* To Facilitate Transformation of Students into- Good Human Beings, Responsible Citizens and Competent Professionals, focusing on Assimilation, Generation and Dissemination of Knowledge.

**MISSION**

- \* Impart Quality Education to Meet the Needs of Profession and Society and Achieve Excellence in Teaching-Learning and Research.
- \* Attract and Develop Talented and Committed Human Resource and Provide an Environment Conducive to Innovation, Creativity, Team-spirit and Entrepreneurial Leadership
- \* Facilitate Effective Interactions Among Faculty and Students and Foster Networking with Alumni, Industries, Institutions and Other Stake-holders.
- \* Practice and Promote High Standards of Professional Ethics, Transparency and Accountability.

# CURRICULUM

## UNDER GRADUATE PROGRAMMES





**CURRICULUM 2019**

**UNDER GRADUATE PROGRAMME**

**B.Tech.**

**SECTIONS**

- 1. Regulations (General)**
- 2. Regulations – UG**
- 3. Forms & Formats – UG**
- 4. Course Structure – UG**
- 5. Course Contents – UG**



## **REGULATIONS (General)**

**Common to all Degree Programmes**





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**REGULATIONS (General)**  
**Common to all Degree Programmes**

{also refer: REGULATIONS specific to the Degree Programmes}

**G1. INTRODUCTION:**

- G1.0 The General Regulations that are common to all Degree Programmes of NITK Surathkal, are presented here. Specific aspects of the Regulations pertaining to a particular Degree Programme are given separately along with the corresponding Curriculum.
- G1.1 The provisions contained in this set of Regulations govern the policies and procedures, on the admission of students, imparting instructions of courses, conducting of the examinations and evaluation and certification of students' performance leading to the said Degree Programme(s).
- G1.2 This set of Regulations, on approval by the Senate, may supersede all the corresponding earlier sets of Regulations of the Institute, along with all the amendments thereto, and shall be binding on all students undergoing the said Degree Programme(s).
- G1.3 This set of Regulations may evolve and get revised/refined or updated or amended or modified or changed through appropriate approvals from the Senate, from time to time, and shall be binding on all parties concerned, including the Students, Faculty, Staff, Departments, Institute Authorities.
- G1.4 In order to *guarantee fairness and justice* to all the parties concerned, in view of the periodic evolutionary refinements, any specific issues or matters of concern shall be addressed separately, by the *appropriate authorities*, as and when found necessary.
- G1.5 The effect of year -to-year (periodic) refinements in the Academic Regulations & Curriculum, on the students *admitted in earlier years*, shall be dealt with appropriately and carefully, so as to ensure that *those* students are not subjected to any unfair situation whatsoever, although they are required to conform to these revised set of Regulations & Curriculum, without any undue favour or considerations.
- G1.6 The Senate may consider any issues or matters of concern relating to any or all the Academic Activities of the Institute, for appropriate action, irrespective of whether a reference is made (or the nature and extent of any reference if so present) here in this set of Regulations or otherwise.
- G1.7 Whenever outside Experts need to be co-opted and/or invited for any of the Academic Committee Meetings, prior approval from the Chairman of the Senate/BOS shall be obtained, justifying the need, based on the agenda items of such Academic Committee Meetings. The outside experts shall be entitled for TA/DA/etc as per the prevailing Institute Rules.
- G1.8 All disputes arising from this set of Regulations must be addressed to the Senate. The decision of the Senate is final and binding on all parties concerned. Further, any legal disputes arising from this set of Regulations shall be limited to the legal jurisdiction determined by the location of the Institute and not that of any other parties.

**G2. DEFINITIONS:** Unless the context otherwise requires –

- **“Institute”/“NITK”/“NITKS”** means, National Institute of Technology Karnataka, Surathkal.
- **“BOG”** means, the Board of Governors (BOG) of the Institute.
- **“MHRD”** means, the Ministry of Human Resources Development, GOI.
- **“JEE”** means, Joint Entrance Examination.
- **“GATE”** means, Graduate Aptitude Test in Engineering.
- **“Senate”** means, the Faculty Senate of the Institute.
- **“Director”** means, the Director of the Institute.
- **“BOS”** means, the Board of Studies of the Institute.
- **“Dean (A)”** means, the Dean (Academic).
- **“Dean (FW)”** means, the Dean (Faculty Welfare)
- **“Dean (P&D)”** means, the Dean (Planning and Development)
- **“Dean (R&C)”** means, the Dean (Research & Consultancy)
- **“Dean (SW)”** means, Dean (Students Welfare).
- **“Dean (AA&IR)”** means, Dean (Alumni Affairs & Institutional Relations).
- **“NITKS Hostels”** means, NITK-Surathkal Hostels.
- **“HOD”** means, the Head of the Department.
- **“Programme Co-ordinator”** means, a faculty in charge of an academic programme, particularly in case of PG and/or Research degree programmes.
- **“Parent Department”** or **“Degree Awarding Department”** means, the department that offers the degree programme that a student undergoes, or the department to which the Research-Guide/Programme-Coordinator belongs.
- **“DAC”** or **“PAC”** means, the Departmental/Programme Academic Committee.
- **“DUGC”** means, the Departmental Under Graduate Committee.
- **“DPGC”** means, the Departmental Post Graduate Committee.
- **“PWEC”** means, the Project Work Evaluation Committee.
- **“DRPC”** means, Doctoral Research Programme Committee.
- **“RPAC”** means, Research Progress Assessment Committee.
- **“MTAC”** means Master’s Thesis Assessment Committee.
- **“DTAC”** means, Doctoral Thesis Assessment Committee.
- **“DAAB”** means, the Departmental Academic Appeals Board.
- **“Faculty Advisor”** means the Faculty Advisor or the Panel of Faculty Advisors, in a Parent Department, for a group(admission-batch) of students.
- **“Course”** means, a specific *subject* usually identified by its *course-number* and *course-title*, with a specified *syllabus*/course-description, a set of *references*, taught by some *teacher(s)*/course-instructor(s) to a specific *class* (group of students) during a specific *academic-session*/semester.
- **“Course Instructor”** means, the teacher or the Course Instructor of a Course.
- **“Class/Course Committee”** means, the Class/Course Committee of a class/course.
- **“Project Guide”** means, the faculty who guides the Major Project of the student.
- **“Research Guide”** means, the faculty who guides the Research student/scholar, including the Additional Guide.
- **“He”** includes both genders he and she; similarly, “his” and/or “him” includes “her” as well, in all the cases.
- **“Regulations”** means, this set of Academic Regulations.
- **“Curriculum”** includes the set of Academic Regulations, Course-Structure and Course-Contents.
- **“MOU”** means, Memorandum of Understanding.

**G3. ACADEMIC CALENDAR:**

- G3.1 The normal duration of the course leading to B.Tech degree will be *EIGHT* semesters.
- G3.2 The normal duration of the course leading to M.Tech. degree will be *FOUR* semesters.
- G3.3 The normal duration of the course leading to M.C.A. degree will be *SIX* semesters.
- G3.4 The normal duration of the course leading to M.B.A. degree will be *FOUR* semesters.
- G3.5 The normal duration of the course leading to M.Sc. degree will be *FOUR* semesters.
- G3.6 Each academic year shall be divided into 2 semesters, each of *20 weeks* duration, including evaluation and grade finalization, etc. The Academic Session in each semester shall provide for at least *70 Teaching Days*, with at least 40 hours of teaching contact periods in a five-days session per week. The semester that is typically from Mid-July to November is called the *ODD SEMESTER*, and the one that is from January to Mid-May is called the *EVEN SEMESTER*. Academic Session may be scheduled for the *Summer Session/Semester* as well.
- G3.7 The schedule of academic activities for a Semester, including the dates of registration, mid-semester examination, end-semester examination, inter-semester vacation, etc. shall be referred to as the Academic Calendar of the Semester, which shall be prepared by the Dean (Academic), approved by the Senate, and announced at least *TWO* weeks before the Closing Date of the previous Semester.
- G3.8 The Academic Calendar must be strictly adhered to, and all other activities including co-curricular and/or extra -curricular activities must be scheduled so as not to interfere with the Curricular Activities as stipulated in the Academic Calendar.
- G3.9 Under any circumstances when any of the Teaching Days gets declared as a Holiday or otherwise when the classes get suspended, irrespective of whatsoever be the reasons, appropriate makeup for such loss shall be made by having the class/lab/teaching sessions conducted on a suitable Saturday by following the particular Class Time Table of that Teaching Day which was so lost.

**G4. REGISTRATION:**

- G4.1 Every Student after consulting his Faculty-Advisor/Research-Guide is required to register for the approved courses with the DUGC/DPGC/DRPC of Parent Department at the commencement of each semester on the days fixed for such registration and notified in the academic calendar.
- G4.2 **Lower and Upper Limits for Course Credits Registered in a Semester, by a Full-Time Student of a Degree Programme:**  
A full time student of a particular degree programme shall register for the appropriate number of course credits in each semester/session that is within the minimum and maximum limits specific to that degree programme as stipulated in the specific Regulations pertaining to that degree programme.
- G4.3 **Mandatory Pre-Registration for higher semesters:**  
In order to facilitate proper planning of the academic activities of a semester, it is essential for the students to *declare their intent to register* for an elective course well in advance, before the actual start of the academic session, through the process of Pre-Registration, which is mandatory for all students of second or higher semesters.
- G4.4 All students (other than the freshly admitted students) intending to register for the next higher semester are required to have completed the *Mandatory Pre-Registration* of elective courses, at least *TWO* weeks before the Last Day of Classes in the current semester. To facilitate this Pre-registration all teaching departments shall announce the list of courses to be offered for the next higher semester, at least *FOUR* weeks before the Last Day of Classes in the current semester.

G4.5 PhD students can register for any of PG/PhD courses and the corresponding rules of evaluation will apply. Under Graduate students may be permitted to register for a few selected Post Graduate courses, in exceptionally rare circumstances, only if the DUGC/DPGC is convinced of the level of the academic achievement and the potential in a student.

**G4.6 Course Pre-Requisites:**

In order for a student to register for some courses, it may be required either to have exposure in, or to have completed satisfactorily, or to have prior earned credits in, some specified courses. In such instances, the DUGC/DPGC/DRPC shall specify clearly, any such course pre-requisites, as part of the curriculum.

G4.7 Students who do not register on the day announced for the purpose may be permitted *LATE REGISTRATION* up to the notified day in academic calendar on payment of late fee.

G4.8 REGISTRATION IN ABSENTIA will be allowed only in exceptional cases with the approval of the Dean (A) after the recommendation of DUGC/DPGC/DRPC through the authorized representatives of the student.

G4.9 A student will be permitted to register in the next semester only if he fulfills the following conditions:

- (a) satisfied all the Academic Requirements to continue with the programme of Studies without termination (refer Clause No: G10);
- (b) cleared all Institute, Hostel and Library dues and fines (if any) of the previous semesters;
- (c) paid all required advance payments of the Institute and hostel for the current semester;
- (d) not been debarred from registering on any specific ground by the Institute.

G4.10 Medium of Instruction/Evaluation/etc. shall all be : English.

**G5. EVALUATION SYSTEM:**

**G5.1 Course Credit Assignment:**

Every Course comprises of specific Lecture-Tutorial-Practical (L-T-P) Schedule. The Course Credits are fixed based on the following norms:

Lectures/ Tutorials : One hour per week is assigned one Credit.

Practicals : (i) a 3-hour session per week is assigned two Credits;

OR

(ii) a 2-hour session per week is assigned one Credit

For example, a theory course with a L-T-P schedule of 3-1-0 will be assigned 4 credits; a laboratory practical course with a L-T-P schedule of 0-0-3 will be assigned 2 credits.

G5.2 The Academic Performance Evaluation of a Student shall be according to a **Letter Grading System**, based on the **Class Performance Distribution**, and *not* based upon any fixed apriori mappings or any absolute scale conversions from the Raw-Scores Scale (e.g. percentage-marks) to the Grade-Points Scale. The entire evaluation system (including these *Regulations*) comprising of the *Policies, Procedures, Mechanisms, Guidelines*, etc., have-been/shall-be designed, developed, evolved, implemented and adhered to, in order to meet the most fundamental/basic *quality* characteristics of being: fair/justifiable, objective/unbiased, reliable/precise, robust/resilient, while also being flexible/responsive and transparent/verifiable. It is equally essential to maintain appropriate level of *confidentiality* in terms of certain specific details, in order to achieve the above *quality* characteristics.

G5.3 The *double-letter grade* (AA, AB, BB, BC, CC, CD, DD, FF) indicates the level of academic achievement, assessed on a decimal (0-10) scale.

**G5.4 Letter-Grades and Grade-Points:**

LETTER-GRADE	GRADE-POINTS	REMARKS
AA	10	
AB	9	
BB	8	
BC	7	
CC	6	
CD	5	
DD	4	
FF	0	Fail due to poor performance
FA	0	Fail due to attendance shortage
I	-	Incomplete
U	-	Audited
W	-	Withdrawal
S	-	Satisfactory
N	-	Unsatisfactory

G5.5 The *double-letter grade* awarded to a student in a course other than a 0-0-P (Practical) course, for which he has registered shall be based on his performance in quizzes, tutorials, assignments etc., as applicable, in addition to one mid-semester examination and one end-semester examination. The distribution of weightage among these components may be as follows:

End-Semester Examination	: 40 to 50% (3 - 4 hours duration)
Mid-Semester Examination	: 20 to 25% (1 – 1½ hours duration)
Quizzes, Tutorials, Assignments, etc. (continuous evaluation)	: 25 to 40% (to make up for 100%)

Any variation, other than the above distribution, requires the approval of the pertinent DUGC/DPGC/DRPC.

G5.6 For any Undergraduate/ Postgraduate course offered to more than one section/ Department a common question paper, scheme of evaluation and grading has to be followed for both mid semester and end semester examinations. The respective DUGC/DPGC may decide about the weightage to be given to each individual component, viz tutorials, assignments, mid semester and end semester examination etc.

G5.7 The *double-letter grade* awarded to a student in a 0-0-P (Practical) course, is based on an appropriate continuous evaluation scheme that the course instructor shall evolve, with the approval of the pertinent DUGC/DPGC/ DRPC.

G5.8 The Course Instructor shall communicate clearly to the students, by announcements in the class, and/or by displaying prominently in the departments notice boards /website, and also report in writing to the DUGC/DPGC/DRPC the course plan and the details of the *Evaluation Scheme*, including the distribution of the weightage for each of the components, as well as the requirements for receiving a 'U' grade for auditing the course; within the first week of the semester in which the course is offered; so that there would be no ambiguities in this regard at the end of the semester while finalizing the grades.

G5.9 For courses offered exclusively for the PhD programme, the method of evaluation will be decided by pertinent DRPC. It may be similar to PG course evaluations, or it may be based on combinations of (a) Report submitted by the student (under the guidance of the Instructor for that course), (b) an open seminar, (c) viva-voce examination. An appropriate letter grade shall be awarded after the completion of the evaluation.

#### G5.10 **Earned Credits**

This refers to the credits assigned to the course in which a student has obtained either 'S' grade, or any one of the *double-letter grades* 'AA', 'AB', 'BB', 'BC', 'CC', 'CD', 'DD' (but not 'FF' and 'FA').

#### G5.11 **Cutoff Marks for 'AA' & 'FF' and the Scale-Differential:**

The *minimum cutoff* marks for 'AA' grade as well as the *maximum cutoff* marks for 'FF' grade will be decided by the Course Instructor based on the specific relevant details of the Class Performance Distribution (using appropriate class performance statistics parameters, like the Class-Mean, Class-Standard-Deviation, etc). However as a general guideline approved by the senate the minimum cutoff marks for 'AA' and 'DD' grade have been fixed as 70% and 20% respectively. Faculty members who intend to give a 'AA' grade to those students getting marks less than 70% and 'DD' grade for those students who get marks less than 20% are required to give justification for the same to the DUGC/ DPGC /DRPC of their respective department.

The *Scale-Differential* is defined as the difference between the minimum cutoff marks for the 'AA' grade and the maximum cutoff marks for the 'FF' grade (normally expressed as a multiple of the class-standard-deviation parameter).

An appropriate value for the Scale-Differential shall be decided by the Course Instructor after having studied the specific relevant details of the Class Performance Distribution.

The *minimum/maximum cutoff* marks for the intermediate grades are determined by appropriate *partitioning/clustering method* based on the specific relevant details of the Class Performance Distribution.

#### G5.12 **Description of Grades:**

##### **AA Grade:**

An 'AA' grade stands for outstanding achievement, relative to the class, and the Course Instructor is supposed to take *utmost care* in awarding of this highest double-letter grade.

##### **DD Grade:**

The 'DD' grade stands for marginal performance and is the minimum passing double-letter grade.

##### **FF and FA Grades:**

The 'FF' grade denotes very poor performance, i.e. *failure* in a course due to poor performance and FA grade denotes poor attendance i.e. failure in a course due to attendance shortage (i.e. < 75%) and the Course Instructor is supposed to take *utmost care* while awarding these lowest double-letter grades. The students who have been awarded 'FF' grade in a course in any semester may be allowed to appear for a make-up end-semester examination. The make- up end- semester examination will be conducted possibly along with that arranged for those students who were awarded the 'I' grade, within the period announced in the academic calendar. If after considering make-up end-semester examination a student passes, then a minimum passing grade of 'DD' only be awarded, and if a student fails then a 'FF' grade will be awarded. Only regular registrants of a given course during a given academic semester who have obtained FF grade in the course will be permitted to appear for the makeup examination. Students who continue to have FF grade after the makeup examination are required to re- register for the course whenever it is offered subsequently. All the 'FF' (other than the courses for which 'DD' grade is obtained by the student in the make-up end-semester examinations conducted prior to the starting of next semester) and 'FA' grades secured in any course stay permanently on the grade card.

A student who obtains 'FA' grade in any course has to necessarily re-register for the course in the subsequent semesters/sessions whenever the course is offered until a passing grade is obtained. However, for an elective course in which 'FA' or 'FF' grade has been obtained, the student may either repeat the same course or register for any other elective course.

Only first year and final year courses may be offered during the summer session.

***I Grade:***

An 'I' grade denotes incomplete performance in any course due to absence at the end semester examination (see also Clause No: G8.3) . When the 'I' grade is converted to a regular double-letter grade, a penalty of ONE Grade-Point is imposed, by awarding the double-letter grade that is immediately below the one that the student would have otherwise received.

***U Grade:***

This grade is awarded in a course that the student opts to register for audit. It is not mandatory for the student to go through the entire regular process of evaluation in an audit course. However, the student has to go through some process of minimal level of evaluation and also the minimum attendance requirement, as stipulated by the Course Instructor and approved by the corresponding DUGC/DPGC/DRPC, for getting the "U" grade awarded in a course, failing which that course will not be listed in the Grade Card.

***W Grade:***

A 'W' grade is awarded when the student withdraws from the course. Withdrawal from a course is permitted only under extremely exceptional circumstances (like medical emergencies, family tragedies and/or other unavoidable contingencies) and has to be recommended by the DUGC/DPGC/DRPC and approved by the Dean (Academic). However, no withdrawal is permitted after the finalization of the grades in the semester. Also, the 'W' grade once recorded remains permanently in the Grade Card.

***S and N grades:***

These grades are awarded for the Mandatory Learning Courses. The 'S' grade denotes satisfactory performance and completion of a course. The 'N' grade is awarded for non-completion of course requirements and the student will have to register for the course until he obtains the 'S' grade. The 'N' grade secured in a course stays permanently on the Grade Card.

**G5.13 Evaluation of Performance:**

The overall performance of a student will be indicated by two indices: SGPA which is the Semester Grade Point Average and CGPA which is the Cumulative Grade Point Average.

SGPA for a semester is computed as follows:

$$\text{SGPA} = \frac{[\sum (\text{Course credits}) \times (\text{Grade Point})] \text{ for all courses with double-letter grades, including 'FF' and 'FA' (in that semester).}}{[\sum (\text{Course credits})] \text{ for all courses with double-letter grades, including 'FF' and 'FA' (in that semester).}}$$

CGPA is computed as follows:

$$\text{CGPA} = \frac{[\sum (\text{Course credits}) \times (\text{Grade Point})] \text{ for all courses with double-letter grades, including all 'FF' and 'FA' grades.}}{[\sum (\text{Course credits})] \text{ for all courses with double-letter grades, including all 'FF' and 'FA' grades.}}$$

\* Whenever a student reappears for a course in which he / she has been awarded 'FF' or 'FA' grade, the CGPA computations will not once again include the course credits for the failed courses in the denominator.

\* There is no equivalence between the CGPA Scale and Percentage. However  $\text{CGPA} \geq 6.0$  can be considered as equivalent to first class and  $5.0 \leq \text{CGPA} < 6.0$  can be considered as equivalent to Second Class. Notionally, CGPA may be multiplied by a factor of 10 to obtain numerical percentage.



**G5.14 Report of Marks, Grades and Class Performance Statistics:**

- (a) The final grades shall be displayed for at least *ONE* working-day, during which period a student can approach the concerned course instructor(s) for any clarification. The process of evaluation shall be transparent and the students shall be made aware of all the factors included in the evaluation. In case of any correction, the course instructor shall have to incorporate the same before finalization of the grades.
- (b) The course instructors shall submit the Report of Marks & Grades for each of the students in his course, along with the Summary Report of Marks & Grades containing the Class Performance Statistics, in the prescribed format, to the Chairman, DUGC/DPGC/DRPC by the stipulated date, for possible moderation (if and only when found necessary) and approval.
- (c) The DUGC/DPGC/DRPC shall submit the final approved Report of Marks & Grades along with Summary Report of Marks & Grades containing the class performance statistics, in the prescribed format, to the office of the Dean (Academic) within the stipulated date.
- (d) The Student Progress Report shall contain the Letter-Grade for each course; along with the SGPA, and the CGPA.

**G5.15 Appeal for review of Grades:**

- (a) The entire process of evaluation shall be made transparent, and the course instructor shall explain to a student why he gets whatever grade he is awarded, if and when required. A mechanism for review of grades is incorporated in the evaluation system. However, before appealing for such review, a student shall first approach the concerned Course Instructor and then the concerned DUGC/DPGC/DRPC, with the request to do the needful; and only in situations where satisfactory remedial measures have not been taken, the student may then appeal to the Departmental Academic Appeals Board (DAAB).
- (b) In case of any such grievances about the grades, the student may appeal for review of grades to the Departmental Academic Appeals Board (DAAB) before the date specified in Academic Calendar.
- (c) The fee for such an appeal will be decided by the Senate from time to time. If the appeal is upheld by DAAB, then the fee amount will be refunded to the student.

**G6. ADD / DROP / cU -options:**

**G6.1 ADD-option:**

A student has the option to ADD courses for registration till the date specified for late registration in the Academic Calendar.

**G6.2 DROP-option:**

On recommendation of the Teaching Department as well as the Parent Department, a student has the option to DROP courses from registration *until 2 weeks after the commencement of the classes in the semester*, as indicated in the Academic Calendar.

**G6.3 cU-option:**

A student can register for auditing a course, or a course can even be converted from Credit to Audit or from Audit to Credit, with the consent of the Faculty Advisor and Course Instructor *until 2 weeks after the commencement of the classes in the semester as indicated in the Academic Calendar*. However, CORE Courses shall not be made available for audit.

## **G7. ATTENDANCE REQUIREMENTS:**

- 7.1 All students must attend every lecture, tutorial and practical classes.
- 7.2 To account for approved leave of absence (eg. representing the Institute in sports, games or athletics; placement activities; NCC/NSS activities; etc.) and/or any other such contingencies like medical emergencies, etc., the attendance requirement shall be a *minimum of 75%* of the classes actually conducted.
- 7.3 A student with less than 75% attendance in a course during a semester, in lectures, tutorials and practicals taken together as applicable, will not be permitted to appear in the End Semester Examinations of the course in which the shortfall exists, irrespective of his academic performance, and irrespective of nature of his absence . He shall be awarded 'FA' grade in that course .
- 7.4 The course instructor handling a course must finalise the attendance 3 calendar days before the last day of classes in the current semester and communicate clearly to the students by displaying prominently in the department and also in report writing to the head of the department concerned.
- 7.5 The attendance records are to be maintained by the course instructor and he shall show it to the student, if and when required.

## **G8. ABSENCE DURING THE SEMESTER:**

### **G8.1 *Leave of Absence:***

- (a) If the period of leave is more than two days and less than two weeks, prior application for leave shall have to be submitted to the HOD concerned, with the recommendation of the Faculty-Advisor/Research-Guide stating fully the reasons for the leave requested, along with supporting documents.
- (b) If the period of leave is two weeks or more, prior application for leave shall have to be made to the Dean (Academic) with the recommendations of the Faculty-Advisor/ Research Guide, HOD concerned stating fully the reasons for the leave requested, along with supporting documents. The Dean (Academic) may, on receipt of such application, grant leave or also decide whether the student be asked to withdraw from the course for that particular semester because of long absence.
- (c) It will be the responsibility of the student to intimate the Course Instructors, and also the Dean (Students Welfare) as well as the Chief Warden of the hostel, regarding his absence before availing leave.

### **G8.2 *Absence during Mid-Semester Examination:***

A student who has been absent from a Mid Semester Examination due to illness and other contingencies may give a request for make-up examination within two weeks after the Mid Semester Examination to the HOD with necessary supporting documents and certifications from authorized personnel. The HOD may consider such requests depending on the merits of the case, and after consultation with the course instructor, may permit the make up Mid Semester Examination for the concerned student.

### **G8.3 *Absence during End-Semester Examination:***

In case of absence for an End Semester Examination, on medical grounds or other special circumstances, the student can apply for 'I' grade in that course with necessary supporting documents and certifications by authorized personnel to the HOD. The HOD may consider the request, depending on the merit of the case, and after consultation with the Course Instructor, permit the make up End Semester Examination for the concerned student (possibly arranged along with those students who were awarded the 'FF' grade). The student may subsequently complete all course requirements within the period announced in Academic Calendar (which may possibly be

extended till first week of next semester under special circumstances) and 'I' grade will then be converted to an appropriate Double-letter grade, as per Clause No: G5.12 (Description of Grades: "I" Grade, above). All the particulars of such a decision with date of finalizing the grade shall be communicated to Dean (Academic). If such an application for the 'I' grade is not made by the student then a double-letter grade will be awarded based on his in-semester performance.

## **G9. TRANSFER OF CREDITS**

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

- a) B.Tech students with consistent academic performance and CGPA  $\geq 7.5$  can credit courses approved by the concerned DUGC of the program, in other Institutions during 3<sup>rd</sup> and 4<sup>th</sup> year and during summer breaks.
- b) PG students with consistent academic performance and CGPA  $\geq 7.5$  can credit courses, approved by the concerned DPGC of the program in other Institutions during the summer vacation /project work.
- c) Credits transferred will not be used for SGPA/CGPA computations. However, credits transferred will be considered for overall credits requirements of the programme.
- d) Students can earn external credits only from IISC/IITs/NITs/IIMs and other Indian or foreign Universities/Institutes /Colleges with which NITK has an MOU (and that MOU must have a specific clause for provision of credit transfer by students)
- e) Credits transfer can be considered only for the course at same level i.e UG, PG etc.
- f) A student must provide all details (original or attested authentic copies) such as course contents, number of contact hours, course instructor /project guide and evaluation system for the course for which he is requesting a credits transfer. He shall also provide the approval or acceptance letter from the other side. These details will be evaluated by the concerned departmental academic bodies (DUGC or DPGC) before giving approval. These academic bodies will then decide the number of equivalent credits the student will get for such course(s) in NITK. The complete details will then be forwarded to Dean (A) for approval.
- g) The maximum number of credits that can be transferred by a student shall be limited to 20.
- h) In case of major project for PG student, the External Guide will evaluate for only 50% credits (which will account for credits transfer) and the internal PWEC will evaluate for the remaining 50% credits.
- i) A student has to get minimum passing grades/ marks for such courses for which the credits transfer are to be made.
- j) Credits transfers availed by a student shall be properly recorded on academic record(s) of the student.

## **G10. WITHDRAWAL FROM THE PROGRAMME:**

### **G10.1 *Temporary Withdrawal:***

- (a) A student who has been admitted to a degree programme of the Institute may be permitted to withdraw temporarily, for a period of one semester or more, on the grounds of prolonged illness or grave calamity in the family, etc., provided:

- (i) He applies to the Institute stating fully the reasons for withdrawal together with supporting documents and endorsement from his parent/guardian;
  - (ii) The Institute is satisfied that, without counting the period of withdrawal, the student is likely to complete his requirements of the degree within the time specified (refer: "Degree Requirements") ;
  - (iii) There are no outstanding dues with the Departments / Institute / Hostels / Library / etc.;
  - (iv) Scholarship holders are bound by the appropriate Rules applicable to them.
  - (v) The decision of the Director of the Institute regarding withdrawal of a student is final and binding.
- (b) Normally, a student will be permitted only one such temporary withdrawal during his tenure as a student and this withdrawal will not be counted for computing the duration of study.

#### **G10.2 *Permanent Withdrawal:***

Any student who withdraws admission before the closing date of admission for the Academic Session is eligible for the refund of the all the fees and deposits, after a deduction of a processing fee.

Once the admission for the year is closed, the following conditions govern withdrawal of admissions:

- (a) A student who wants to leave the Institute for good, will be permitted to do so (and take Transfer Certificate from the Institute, if needed), only after clearing all the dues, if any. Also, all the fees and charges already paid will not be refunded on any account.
- (b) Those Students who have received any scholarship, stipend or other forms of assistance from the Institute shall repay all such amounts in addition to those mentioned in Clause No: G10.2(a) above.
- (c) The decision of the Director of the Institute regarding all aspects of withdrawal of a student shall be final and binding.

#### **G11. CONDUCT AND DISCIPLINE:**

G11.1 Students shall conduct themselves within and outside the premises of the Institute in a manner befitting the students of an Institution of National Importance.

G11.2 As per the order of Honorable Supreme Court of India, ragging in any form is considered as a criminal offence and is banned. Any form of ragging will be severely dealt with.

G11.3 The following acts of omission and/or commission shall constitute gross violation of the code of conduct and are liable to invoke disciplinary measures:

- (a) Ragging.
- (b) Lack of courtesy and decorum; indecent behavior anywhere within or outside the campus.
- (c) Willful damage or stealthy removal of any property/belongings of the Institute/Hostel or of fellow students/citizens.
- (d) Possession, consumption or distribution of alcoholic drinks or any kind of narcotics or hallucinogenic drugs.
- (e) Mutilation or unauthorized possession of library books.
- (f) Noisy and unseemly behavior, disturbing studies of fellow students.
- (g) Hacking in computer systems (such as entering into other person's area without prior permission, manipulation and /or damage of computer hardware and software or any other cyber crime etc.)
- (h) Plagiarism of any nature.
- (i) Any other act of gross indiscipline as decided by the Senate from time to time.

Commensurate with the gravity of offense, the punishment may be: reprimand, fine, expulsion from the hostel, debarring from an examination, disallowing the use of certain facilities of the Institute, rustication for a specified period or even outright expulsion from the Institute, or even handing over

the case to appropriate law enforcement authorities or the judiciary, as required by the circumstances.

G11.4 For an offence committed in (i) a hostel (ii) a department or in a class room and (iii) elsewhere, the Chief Warden, the Head of the Department and the Dean (Students Welfare), respectively, shall have the authority to reprimand or impose fine.

G11.5 Cases of adoption of unfair means and/or any malpractice in an examination shall be reported to the Dean (Academic) for taking appropriate action.

G11.6 All cases of serious offence, possibly requiring punishment other than reprimand, shall be reported to the Director.

G11.7 The Institute Level Standing Disciplinary Action Committee constituted by the Director, shall be the authority to investigate the details of the offence, and recommend disciplinary action based on the nature and extent of the offence committed.

## **G12. RESIDENCE:**

G12.1 Institute is wholly residential and all full-time students shall be required to reside in the hostels.

G12.2 Under special circumstances, the Dean (Students Welfare) may permit a student to reside with his parent/guardian in the Institute campus or within a reasonable distance from the Institute.

G12.3 Students shall be required to abide by the Rules and Regulations of the NITKS Hostels as established by the Board of NITKS Hostels Management.

## **G13. GRADUATION REQUIREMENTS AND CONVOCATION:**

G13.1 A student shall be declared to be eligible for the award of the degree if he has:

- (a) Fulfilled Degree Requirements
- (b) No dues to the Institute, Departments, Hostels, Library, CCC, and any other centers
- (c) No disciplinary action pending against him.

G13.2 The award of the degree must be recommended by the concerned Departmental/Programme Academic Committee (DUGC/DPGC/DRPC) to the Senate, for approval and for further recommendation to the BOG.

G13.3 *Convocation:*

Degrees will be awarded in person for the students who have graduated during the preceding academic year. Degrees will be awarded in absentia to such students who are unable to attend the Convocation. Students are required to apply for the Convocation along with the prescribed fee, after having satisfactorily completed all the degree requirements (refer "Degree Requirements") within the specified date in order to arrange for the award of the degree during convocation.

## **G14. COMMITTEES / FUNCTIONARIES:**

The following committees shall be constituted common for the various degree programmes:

### **G14.1 Departmental Academic Appeals Board (DAAB):**

#### **Constitution:**

- |     |   |     |                     |
|-----|---|-----|---------------------|
| (a) | HOD of the teaching/parent Dept   | ... |                     |
| (b) | Three faculty members (1P + 1Asso.P<br>1Asst.P)                           | ... | Chairman<br>Members |
| (c) | One Professor from outside the Department<br>nominated by Dean (Academic) | ... | Member              |
| (d) | Faculty Advisor(s) of the Class from where the<br>Appeal originates       | ... | Member(s)           |

**Note:**

- There shall be one DAAB for every department.
- The Chairman may co-opt and/or invite more members.
- Depending on the prevailing circumstances, a Senior Professor of the Department, nominated by the Dean (Academic), shall act as Chairman instead of Head of the Department.
- If the concerned instructor is a member of DAAB then he shall keep himself out of the Board during deliberations.

**Functions (Highlights):**

- i. To receive grievance/ complaints in writing from the students regarding anomaly in award of grades due to bias, victimization, erratic evaluation, etc. and redress the complaints.
- ii. To interact with the concerned course instructor and the student separately before taking the decision.
- iii. The decision of the DAAB will be based on simple majority.
- iv. The recommendations of the DAAB shall be communicated to the Dean (Academic) for further appropriate action as required.

**G14.2 Class/Course Committee:**

Every Class (group of students registered for a course) of the Degree Programme shall have a Class/Course Committee, consisting of Faculty and Students.

**Constitution:**

- |  |     |                  |
|--|-----|------------------|
| (a) One Faculty of the Parent/Teaching Department, not associated with the class; nominated by the HOD.      | ... | Chairman         |
| (b) Faculty Advisor(s) for the Class   | ... | Member-Secretary |
| (c) Course Instructor(s)   | ... | Member(s)        |
| (d) <i>FOUR</i> to <i>SIX</i> students from the Class/Course to be chosen by the students amongst themselves | ... | Members          |

**Functions (Highlights):**

- i. The basic responsibilities of the Class/Course Committees are to review periodically the progress of the classes, to discuss problems concerning curriculum and syllabi and the conduct of the classes.
- ii. Each class/course committee will communicate its recommendations to the HOD/DUGC/DPGC/DRPC of the Parent/Teaching Department.
- iii. There shall be minimum one class committee meeting at the middle of every semester as indicated in the academic calendar. However additional class committee meetings may be convened as decided by DUGC/DPGC/Course Instructor.
- iv. During beginning of the semester, the Course Instructors shall present the method of evaluation and distribution of weightages for the various components.
- v. The minutes of each class/course committee meeting shall be recorded in a separate minutes register maintained in the Parent/Teaching Department.
- vi. Any appropriate responsibility or function assigned by the DUGC/DPGC or the Chairman of the DUGC/DPGC.

**G14.3 Faculty Advisor(s):**

The Faculty Advisor(s) will be appointed by the HOD of the parent department, who will be assigned a specific group (admission-batch) of students of the concerned parent department, and will be valid throughout their duration of study.

***Functions (Highlights):***

- i. To help the students in planning their courses and related activities during their study period.
- ii. To monitor, guide, advise and counsel the students on *all* academic matters.
- iii. To coordinate the activities regarding mandatory learning courses.

**G14.4 Course Instructor:**

***Functions (Highlights):***

- i. He shall follow all the Regulations related to teaching of a course and evaluation of students.
- ii. He shall be responsible for all the records (i.e., course registration, answer books, attendance, etc.) of the students registered for the course.
- iii. He shall conduct classes as prescribed in the Academic Calendar and as per the teaching assignment time table issued by the HOD.
- iv. He will arrange to distribute a course plan and the evaluation plan together with the course objectives, background materials to all the students within the first week of each semester.
- v. He will prepare an evaluation plan showing details of how the student's performance will be evaluated in the course.
- vi. He will properly document the students' performance and announce to the students (including on the notice board) as stipulated in the Regulations.
- vii. He will report to the HOD on a periodic (*monthly*) basis, the potential cases of very poor academic performance as well as those of low attendance, that would possibly result in a 'FF' or 'FA' grade at the end of the semester.

**G14.5 Departmental/Programme Academic Committee(s):**

***Constitution:***

The Departmental/ Programme Academic Committees are specific academic committees for each of the programmes/departments, like DUGC, DPGC, DRPC as given in the Regulations specific to such programmes/departments.

***Functions (Highlights):***

- i. Specific functions as given in the Regulations specific to the concerned academic programme.
- ii. Recommend to the BOS/Senate, appropriate measures to deal with the specific issues of concern, arising because of the effect of the year-to-year (periodic) refinements in the Academic Regulations & Curriculum, on the students *admitted in earlier years* (so as to ensure that *those* students are not subjected to any unfair situation whatsoever, although they are required to conform to these revised set of Regulations & Curriculum, without any undue favor or considerations) like the specific details of the credit requirements, etc., as and when such cases arise or need to be addressed, considering the nature and extent of the refinements, and implement the same with the appropriate approval of the BOS/Senate.
- iii. Any appropriate responsibility or function assigned by the Senate or the Chairman of the Senate or the BOS or the Chairman of the BOS.

\* \* \* \* \*

**REGULATIONS**  
**SPECIFIC TO**  
**UNDER GRADUATE PROGRAMMES**  
**B.Tech.**

**NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL**  
**Post Srinivasnagar, Mangalore - 575025, India. 2018**



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**REGULATIONS**  
**specific to**  
**B.Tech. Degree Programme**

{also refer: REGULATIONS (General) – Common to all Degree Programmes}

**1. DEGREE PROGRAMMES:**

1.1. Under Graduate B.Tech. Degree Programmes are offered in the following disciplines by the respective programme hosting departments listed below:

i.	Chemical Engineering	(CH)
ii.	Civil Engineering	(CV)
iii.	Computer Science & Engineering	(CO)
iv.	Electrical and Electronics Engineering	(EE)
v.	Electronics and Communication Engineering	(EC)
vi.	Information Technology	(IT)
vii.	Mechanical Engineering	(ME)
viii.	Metallurgical and Materials Engineering	(MT)
ix.	Mining Engineering	(MI)

Other teaching departments are:

x.	Applied Mechanics & Hydraulics	(AM)
xi.	Mathematical and Computational Sciences	(MA)
xii.	Physics	(PH)
xiii.	Chemistry	(CY)
xiv.	School of Management	(HU)

1.2 The provisions of these Regulations shall be applicable to any new disciplines that may be introduced from time to time and appended to the above list.

**2. ADMISSION:**

- 2.1 Admission to NITK, Surathkal will be made in accordance with the instructions received from MHRD from time to time. Seats are reserved for candidates belonging to Scheduled Castes and Scheduled Tribes, Other Backward Classes (OBC), Persons with Disability and other categories as per the guidelines issued by MHRD.
- 2.2 Admission to all courses will be made in the odd semester of each session at the first year level based on the relative performance in the Joint Entrance Examination Main (JEE-Main) and qualifying examination as per the guidelines issued by the MHRD, New Delhi from time to time. The candidates should have successfully passed 10+2 examination with the combination of subjects prescribed by the Competent Authority.
- 2.3 A limited number of admissions is offered to Foreign Nationals and Indians living abroad in accordance with the rules applicable for such admission issued, from time to time, by MHRD.
- 2.4 In special cases the Institute may admit students to the THIRD semester of the B.Tech. programme, on transfer, only from other NITs, observing the Guidelines applicable and subject to approval from MHRD. However, any such transfer to Third Semester at NITK from any other NIT shall be subject to the condition that no commitment shall be made on any Branch request, until after exhausting the chances for NITK students to avail the branch change facility, and provided there are clear vacancies.
- 2.5 Student Exchange Programmes and the Transfer of Credits, shall be as per the corresponding

MOU approved by Competent Authority.

- 2.6 If, at any time after admission, it is found that a candidate had not in fact fulfilled all the requirements stipulated in the offer of admission, in any form whatsoever, including possible misinformation etc., the Registrar shall report the matter to the Senate, recommending revoking the admission of the candidate.
- 2.7 The Institute reserves the right to cancel the admissions of any student and ask him to discontinue his studies at any stage of his career on the grounds of unsatisfactory academic performance or indiscipline or any misconduct.
- 2.8 The decision of the Senate regarding the admissions is final and binding.
- 2.9 Candidates must fulfil the medical standards required for admission as prescribed in the Institute Information Brochure or the Prospectus.
- 2.10 Every Under Graduate student of the Institute shall be associated with *Parent Department* (Degree Awarding Department) offering the degree programme that the student undergoes, *throughout* his study period, right from the very first day of admission into the program.

### 3. COURSE STRUCTURE :

- 3.1 The total course package for a B.Tech Degree Programme will typically consist of the following components.

(a) Foundation Courses FC 38 –50 Credits

A Foundation Course can be any of the following:

Basic Science Core Courses (BSC),  
Engineering Science Core Courses (ESC), and  
Humanities and Social Science Core Courses (HSC)

(b) Programme Core Courses PC ≥ 60 Credits

(c) Elective Courses ELE ≥ 20 Credits

An Elective Course can be any of the following:

Programme Specific Electives (PSE), Certified MOOCs  
(NPTEL/SWAYAM etc.) and Mini Projects.

(d) Project (Mini Projects and Major Project) MP 4 - 6 Credits

(e) Mandatory Learning Courses MLC 5 Credits

**The Minimum Credit Requirement for the B.Tech Degree is 150 to 160.**

- 3.2 The students have the option to register for certified MOOC courses (NPTEL/SWAYAM etc.) limited to 5 credits.

#### **Project (MP)**

Project work may consist of Major Project and Mini Projects (optional) offered by parent department. The Major Project is a course with 4- 6 credits and can comprise of Part I and Part II, spread over 1 or 2 semesters of final year, preferably during 7th and 8th semesters. DUGC may prescribe Mini Project as a requirement for the B. Tech Degree or in lieu of equivalent elective credits. The method of evaluation for major and minor projects shall be

evolved by pertinent DUGC and appropriate double-letter grade is awarded which will be considered for SGPA and CGPA calculation

**Mandatory Learning Courses:**

These are courses that must be completed by the student at appropriate time. The 'S' grade is awarded for satisfactory completion of the course and 'N' grade is awarded for non-completion of the course. The 'S' and 'N' grades do not carry grade-points and hence not included in the SGPA, CGPA computations

Courses that come under this category are the following:

- (a) **Environmental Studies:** This is a 1 credit course, coordinated by Department of Civil Engineering and the student is required to complete this course during 1<sup>st</sup> / 2<sup>nd</sup> semester
- (b) **Professional Ethics and Human Values:** This is a 1 credit course, coordinated by School of Management and the student is required to complete this course during 1<sup>st</sup> / 2<sup>nd</sup> semester
- (c) **Seminar:** The student will make presentations on topics of academic interest
- (d) **Practical Training:** The student may complete the training before the beginning of the 7<sup>th</sup> semester (or as stipulated by the DUGC) and register for it in 7<sup>th</sup> Semester. The duration and the details shall be decided by the Faculty Advisor with approval from DUGC

- 3.3 The Department Under Graduate Committee (DUGC) will discuss and recommend the exact credits offered for the programme for the above components 'a' to 'e'; the semester-wise distribution among them, as well as the syllabi of all undergraduate courses offered by the department from time to time before sending the same to the Board of Studies (BOS). The BOS will consider the proposals from the departments and make recommendations to the Senate for consideration and approval.

3.4 **Co-curricular and/or Extra-curricular activities:**

These are noncredit courses, with multiple options, to be completed at student's convenience.

The student shall complete *a total of at least 2 items (with at least one from each of the two groups)* described below. On successful completion, a *certificate* regarding the activity that a student has participated in, may be issued by the Faculty in-charge of that particular activity. With the recommendation of the Faculty in-charge of Co-Curricular / Extra-Curricular Activities, the Dean (Students Welfare) may approve the **Report of Satisfactory Completion of such Co-Curricular and Extra-Curricular Activities.**

The Co-curricular/Extra-curricular Activities are compulsory degree requirements.

**Group 1: Co-Curricular Activities**, which includes activities in professional societies like IEEE, ISTE, IE, CSI, Department Associations, Lab Development, Participation in Paper Presentation, Model Building, etc.

**Group 2: Extra-Curricular Activities**, such as NSS, NCC, NSO, Community Services, Social work, Yoga, Meditation, Language Course, Health Care Services, Activities in Alumni Association, Activities in *INCIDENT, Engineer*, Participation in Sports, Games, Various Clubs of Institute, SPICMACAY, etc.

3.5 **Lower and Upper Limits for Course Credits Registered in a Semester/Session, by a Full-Time Student of the B.Tech. Degree Programme:**

A full time student of the B.Tech. degree programme must register for a minimum of 12 credits, and up to a maximum of 30 credits. However the minimum/maximum credit limit can be relaxed by the Dean (Academic) on the recommendations of the DUGC, only under extremely exceptional circumstances. The maximum credits that a student can register in a summer session is 16.

**3.6 B.Tech. Students registering for Post Graduate courses as electives:**

In exceptional situations, with prior approval of the concerned DUGC, a B.Tech. student can register for a post graduate course as elective.

**3.7 Minor programme in B Tech**

- A student in a particular discipline can take additional specified courses totalling 15 to 20 credits in other disciplines. If he/she gets a GPA of 7.0 in these courses, then it will find a mention in their grade cards and degree certificate.
- A student can opt for Minors in Third Semester and register for Minor Courses from Third to Eighth Semesters. Students who have cleared all the courses of first and second semester in first attempt and have obtained a CGPA  $\geq 7$  and GPA (of common courses in the first year)  $\geq 7.0$  are eligible to register for minor courses.
- Allotment of minor will be based on merit list prepared on the basis of GPA of common courses in the first year.
- In case a student does not get a GPA of 7.0 in minor courses, then these courses can be counted towards their elective credit requirement.

**3.8 Honors programme in B Tech**

- A student in a particular discipline can take additional courses specified by respective DUGC at postgraduate level in the same discipline totaling 15 to 20 credits. If he/she gets a GPA of 6.0 and above in these courses, then it will find a mention in their grade cards and degree certificate.
- A student can opt for Honors in Third Semester and register for Honors Courses from Fifth to Eighth Semesters. Students who have cleared all the courses of first and second semester in first attempt and have obtained a CGPA of 8.0 and above are eligible to register for Honors courses.
- In case a student does not get a GPA of 6.0 and above in Honors courses, he/she is not eligible to receive Honors degree. However, these courses may then be counted towards their elective requirement.

**4. DEGREE REQUIREMENTS:**

The degree requirements of a student for the B.Tech programme are as follows:

**(a) Institute Requirements:**

- Minimum Earned Credit Requirement for Degree is 150 to 160.
- Satisfactory completion of all Mandatory Learning Courses
- Completion of the requirements on Co-curricular and/or Extra-curricular activities

**(b) Programme Requirements:**

Minimum Earned Credit Requirements on all Core Courses, Elective Courses and Major Project as specified by the DUGC and conforming to Clause No: 3 (Course Structure) above.

- The Maximum duration for a student for complying to the Degree Requirement is EIGHT years from date of first registration for his first semester.

**5. TERMINATION FROM THE PROGRAMME:**

A student shall be required to leave the Institute without the award of the Degree, under the following circumstances:

- If a student fails to earn the minimum credit specified below:

Check Point	Credit Threshold
End of FIRST year	15
End of SECOND year	40

End of THIRD year	60
End of FOURTH year	80

**Note:** The period of temporary withdrawal is not to be counted for the above Credit Threshold.

- (b) If a student is absent for more than 6 (Six) weeks at a stretch in a semester without sanctioned leave.
- (c) Based on disciplinary action suggested by the Senate, on the recommendation of the appropriate committee.

**NOTE:** Under any circumstances of termination, the conditions specified in Permanent Withdrawal (refer: Clause No: G10.2) shall also apply.

## 6. CHANGE OF BRANCH:

- 6.1 Normally a student admitted to a particular branch of the undergraduate programme will continue studying in that branch till completion. However, the Institute may permit a student admitted through JEE (Main) /DASA quota, to change from one branch of studies to another after the first two semesters. Such changes will be permitted, in accordance with the provisions laid down hereinafter, by the concerned competent authority.
- 6.2 Normally, only those students will be eligible for consideration of a change of branch, after the second semester, who have –
  - a) completed all the common credits required in the first two semesters of their studies, in their first attempt;
  - b) obtained a SGPA of not less than 8.00 (7.00 for SC/ST) in both the FIRST as well as the SECOND semester;
- 6.3 Application for change of branch must be made by the intending eligible students in the prescribed form and to be submitted before the last working day of the second semester as announced in the academic calendar.
- 6.4 Change of branch shall be strictly in order of merit of the applicants. For this purpose the CGPA obtained at the end of the second semester shall be considered. In case of a tie, the JEE (Main) rank / SAT Subject Test Score of the applicants will be considered. The change of branch is permitted only to vacancies as per eligibility and category of admission.
- 6.5 A common CGPA List shall be prepared at the end of the second semester, category wise to consider students for branch change.
- 6.6 The applicants may be allowed a change in branch, strictly in order of *inter se* merit, subject to the limitations as given below:
  - (a) The actual number of students in the third semester in any particular branch to which the transfer is to be made, should not exceed the sanctioned strength and the actual number of students in any branch from which transfer is being sought does not fall below 75% of the total sanctioned intake.
  - (b) If a student S1 is not permitted to change from branch A to B due to the clause 6.6 (a) above, any other student S2 from any branch with CGPA less than S1 will also not be permitted to change to branch B.
- 6.7 The process of change of branch shall be completed on the first day of registration for the third semester courses.

## 7. COMMITTEES / FUNCTIONARIES:

The following committees shall be constituted specifically for the Under Graduate (B.Tech.) degree programme:

### 7.1 Board of Studies (BOS-UG):

*Constitution:*

(a)	Dean (Academic)	...	Chairman
(b)	Dean (Faculty Welfare)	...	Member
(c)	Dean (Planning & Development)	...	Member
(d)	Dean (Students Welfare)	...	Member
(e)	Dean (R&C)	...	Member
(f)	Dean (AA&IR)	...	Member
(g)	Chairman of each DUGC/ his nominee	...	Member
(h)	BOG members representing the faculty	...	Members
(i)	Assistant Registrar (Academic)	...	Convenor
(j)	Dy. Registrar (Academic)	...	Secretary

**Note:**

- There shall be one BOS-UG for the entire Institute.
- The Chairman may co-opt and/or invite more members including outside experts.
- The quorum of each meeting will be *NINE*.

**Functions (Highlights):**

- i. To consider the recommendations of the DUGC on matters relating to undergraduate programme and to make suitable recommendations to the Senate.
- ii. To approve curriculum framed / revised by DUGC for the undergraduate courses of study.
- iii. To ensure that all norms and Regulations pertaining to undergraduate programme are strictly followed.
- iv. To make periodic review of these Regulations pertaining to undergraduate programme and to recommend to the Senate any modifications thereof.
- v. To review the academic performance and make suitable recommendations to the Senate regarding declaration of results, award of degrees etc.
- vi. To recommend to the Senate, the award of stipends, scholarships, medals & prizes etc.
- vii. To draw up general time table for the undergraduate course and finalise the UG academic calendar to be put up to the Senate for approval.
- viii. To review the cases of malpractice in examinations and to recommend to the Director the punishment in such cases.
- ix. To constitute a sub-committee for monitoring the implementation of the academic curriculum provided by the BOS and to provide guidance in curriculum assessment, evaluation process.
- x. To conduct at least one meeting each semester and send the Resolutions to the Chairman of the Senate, and also to maintain a record of the same in the Academic Section of the Dean (Academic ).
- xi. Any appropriate responsibility or function assigned by the Senate or the Chairman of the Senate.

## 7.2 Departmental Under Graduate Committee (DUGC):

### *Constitution:*

(a)	H.O.D. / Programme Co-ordinator	...	Chairman
(b)	Two Professors (by rotation for one year)	...	Members
(c)	Two Associate Professors (by rotation for one year)	...	Members
(d)	Two Assistants Professors (by rotation for one year)	...	Members

### **Note:**

- There shall be one DUGC for every department that is involved in the teaching for the B.Tech. Degree programme.
- The Secretary (DUGC) shall be nominated by the Chairman on rotation basis for a period of one year.
- The Chairman may co-opt and/or invite more members including at most three outside experts.
- The quorum for each meeting shall be five.

### *Functions (Highlights):*

- i. To monitor the conduct of all undergraduate courses of the department.
- ii. To ensure academic standard and excellence of the courses offered by the department.
- iii. To oversee the evaluation each of the students in a class, for each of the courses.
- iv. To develop/revise the curriculum for undergraduate courses offered by the department, and recommend the same to the BOS.
- v. Moderation (only if and when found necessary) in consultation with the Course Instructor, and approval of the finalized grades, before submission of the same to the Academic Section of the Dean (Academic).
- vi. To consolidate the registration of the student and communicate to Course Instructors, and also to the Academic Section of the Dean (Academic).
- vii. To conduct performance appraisal of Course Instructors.
- viii. To provide feedback of the performance appraisal to the Course Instructor and concerned authorities.
- ix. To consider any matter related to the undergraduate programme of the department.
- x. In cases where a course is taught by more than one faculty member, or by different faculty members for different sections of students, DUGC shall co-ordinate (only in case of need) among all such faculty members regarding the teaching and evaluation of such courses.
- xi. To conduct at least two meetings each semester and send the Resolutions of the meeting to the Academic Section of the Dean (Academic), and also to maintain a record of the same in the department.
- xii. Any appropriate responsibility or function assigned by the Senate or the Chairman of the Senate or the BOS or the Chairman of the BOS.

\* \* \* \* \*



## **FORMS & FORMATS**

### **Under Graduate Programmes**

**NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL**  
**Post Srinivasnagar, Mangalore - 575025, India.**  
**2019**

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**COURSE REGISTRATION FORM  
(Instructor Copy)**

Course Code:                      Course Title:                      L.T.P:                      Credits:

Course Instructor(s):                      Teaching Dept.:

Sl. No.	Register No.	Name of the student	Semester	Branch	Signature	D/U/cU/W
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						

D: Drop                      U: Audit                      cU: Credit-Audit Conversion                      W: Withdrawal

**Note:** The last column to be filled only if a student opts to drop / audit / credit-Audit conversion or withdrawal of the course.

Name & Signature of Course Instructor(s)  
with date

Name & Signature of HOD  
with date & Dept. seal

**COURSE REGISTRATION FORM (FACULTY ADVISOR COPY)**

**Name of Faculty Advisor:**

**Dept:**

**Semester:**

Sl.No.	Register No.	Name of the student	Course Number and Credits ( Ex: CV372(3) )										Signature
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													
16													
17													
18													
19													
20													
21													
22													
23													
24													
25													

A: ADD D: DROP U: Audit cU: Credit-Audit Conversion W: Withdrawal

\* Use separate card/s to enter D-U-cU-W options

**Note:** Faculty advisor has to ensure that the entries in Course Instructors copy, Student copy and FA copy are matching

Name & Signature of Faculty Advisor  
Date:

Name & Signature of HOD  
with Dept. Seal

**COURSE REGISTRATION FORM #**  
**(Student Copy)**

Reg. No.:

Dept.:

Semester & Programme:

Name of the student:

Fee Receipt No:

Sl. No.	Course No.	Course Title	Credits	Course Instructor's Name	Signature of Instructor
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

Signature of Student \*

Signature of Faculty Advisor \*

Signature of HOD \* with seal

Date:

**D / U / cU / W – Options**

Sl. No.	Course No.	Course Title	Credits	D/U/cU/W	Signature of Faculty Adviser	Signature of Instructor
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

D: Drop

U: Audit

cU: Credit-Audit Conversion

W: Withdrawal

Signature of Student \*\*

Signature of Faculty Advisor \*\*

Signature of HOD \*\* with seal

# It is mandatory for a student to preserve this card as a proof of his / her registration till the end of the programme.

\* To be signed by the student as soon as he/she completes the registration of all the courses and by the faculty advisor, the HOD after the last day of late registration announced in the academic calendar.

\* To be signed by the student, faculty advisor and the HOD at the end of each semester after verifying the options exercised by the student and to be returned to the student at the end of the semester.

Faculty Advisor has to ensure that the entries in the Faculty Advisor Copy, Course Instructor Copy, and Student Copy are matching.

STUDENT'S LEAVE APPLICATION

Name of the Student :

Reg. No./Admission-No./Roll-No.:

Programme / Branch / Semester / Class :

Period of Absence : From: To:

: Number-of-days of Leave =

Nature of Leave : **Casual-Leave / Medical-Leave / special permission to attend - Sports/Cultural-meet/Conference, etc.**

Reason for Leave-of-Absence :

Supporting Documents Attached :

Signature of Student :

Number of days of Leave : **already-availed | being-applied-now | still-available(un-availed)**  
: | |  
: | |

Forwarded by Faculty Advisor :

Remarks by Chairman :  
(DUGC/DPGC/DRPC)

Recommendation : **Approval / No-approval**

Signature of the **Recommending Authority** :  
with Date :

Decision : **Approved / No-approved**

Signature of the **Approving Authority** :  
with Date :

NOTE:

- (i) Chairman DUGC/DPGC/DRPC can approve the leave upto 14 days.  
(ii) If the leave is for more than 14 days, the leave application shall be forwarded to Dean(A) for approval.

## Course Evaluation Form for Lecture Courses

**PURPOSE:** The objective of this feedback is to collect information for assessing and improving the course and the instructor's teaching effectiveness

Course Code:

Course Title:

Type of Course: Core / Elective

Class Size:

Class Size:

Academic Year:

Semester & Programme:

Department:

Instructor's Name:

(Mark '√' in the appropriate box)

RATINGS					
5 - Strongly agree	4 - Agree	3 - Neither agree nor disagree	2 - Disagree	1 - Strongly disagree	
<b>COURSE</b>					
1	The course plan provided sufficient information on the objectives and contents				
2	The distribution of marks (for tests, assignments, tutorials and exams) was clearly stated in the course plan				
3	I found the course materials ( class notes, handouts, prescribed text books) useful				
4	The assignments, tutorials, quizzes etc. helped me to understand the course				
5	The tests and examinations covered to a large extent what was taught in the class				
6	I was satisfied with the course coverage				
7	The evaluation was fair and transparent				
8	The course helped me to acquire knowledge and skills				
9	This course motivated me to learn more				
10	Overall, the course was satisfactory				
<b>INSTRUCTOR</b>					
1	The instructor was generally well prepared for the classes				
2	The instructor presented the contents effectively				
3	The instructor generated interest in the subject				
4	The instructor delivered the lectures at an appropriate pace				
5	The instructor made use of appropriate teaching aids and methods				
6	The instructor encouraged students participation and interaction in the class				
7	The instructor provided timely and effective feedback regarding the assignments/tests/exams				
8	The instructor was available outside class hours for consultation				
9	The instructor was regular to the class				
10	Overall, the instructor was effective in his/her role as a teacher				

**SUGGESTIONS / COMMENTS: Please turn over**

**Note: This course feedback form to be collected by any faculty member other than the course instructor and to be handed over to the concerned course instructor.**

Please write below your suggestions/comments if any to improve the teaching-learning process:





## Course Evaluation Form for Practical Courses

**PURPOSE:** The objective of this feedback is to collect information for assessing and improving the course and the instructor's teaching effectiveness

Course Code:

Course Title:

Type of Course: Core / Elective

Class Size:

Academic Year:

Semester & Programme:

Department:

Instructor's Name:

(Mark '√' in the appropriate box )

(Mark ✓ in the appropriate box)

RATINGS						
5 - Strongly agree 4 - Agree 3 - Neither agree nor disagree 2 - Disagree 1- Strongly disagree						
LAB/PRACTICAL SESSIONS		5	4	3	2	1
1	The practical sessions/Experiments provided me an opportunity to understand the subject					
2	Handouts/laboratory manuals were available in advance					
3	Clear instructions to carryout the practical/Experiments were given in advance					
4	I was thoroughly prepared for all the practical/lab sessions					
5	The assistance given during the practical sessions was useful					
6	I was regular in submitting all my lab/practical reports					
7	The instructor's feedback on my report was prompt					
8	The instructor's feedback on my report was useful					
9	The evaluation was fair and transparent					
10	Overall, the lab/practical course was satisfactory					

**SUGGESTIONS / COMMENTS:** Please write below your suggestions/comments if any to improve the conduct of this lab/practical course

**Note:** This course feedback form to be collected by any faculty member other than the course instructor and to be handed over to the concerned course instructor.

**SUMMARY REPORT OF MARKS and GRADES**

Semester/Session & Year :

Course Number :

Course Title :

(L-T-P) Credits:

Name of the Instructor:

Department:

**CLASS PERFORMANCE DISTRIBUTION STATISTICS**

Class - Size (No. of students) =

Class - Max. Mark (Xmax) =

Class - Min. Marks (Xmin) =

Class - Mean Marks ( $\mu$ ) =

Standard - Deviation ( $\sigma$ ) =

A detailed *Histogram* of the Raw-Scores data is attached.

Grades	Cutoff Marks %		Number of Students
AA	= >		
AB	= >		
BB	= >		
BC	= >		
CC	= >		
CD	= >		
DD	= >		
FF	< =		
FA	Attendance less than 75%		

=====

Course-Instructor(s)  
Name & Signature  
with Date

Secretary-DUGC/DPGC/DRPC  
Name & Signature  
with Date

Chairman-DUGC/DPGC/DRPC  
Signature with Date  
& Dept. Seal

## REPORT of MARKS and GRADES

Semester/Session & Year :

Course Number : Course Title : (L-T-P) Credits :

Course Category : FC/BSC / ESC / HSC / PC / PSE / OE / PMP / MLC

Name of the Instructor : Department :

SL.No.	Reg. No.	Name	%Marks / % Attendance*	Letter-Grade
1.				
2.				
3.				
4.				
5.				
6.				
7.				
8.				
9.				
10.				
11.				
12.				
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29.				
30.				

\* For those students having less than 75% attendance and awarded 'FA' grade.

FC: Foundation Course

BSC: Basic Science Core;

ESC: Engineering Science Core;

PC: Programme Core;

PSE: Programme Specific Elective;

HSC: Humanities & Social Sciences Core;

OE: Open Elective;

MP: Project;

MLC: Mandatory Learning Course

Course-Instructor(s)  
Name & Signature  
with Date

Secretary-DUGC/DPGC/DRPC  
Name & Signature  
with Date

Chairman-DUGC/DPGC/DRPC  
Signature with Date  
& Dept. Seal

**RECORD OF CO-CURRICULAR & EXTRA-CURRICULAR ACTIVITIES**

1. Name (in Block Letters) \_\_\_\_\_

2. Admission No.: \_\_\_\_\_

3. Roll No. \_\_\_\_\_

**GROUP-1 CO-CURRICULAR ACTIVITIES (at least One)**

Activity	Period		* S/N	Name & Signature of Faculty in-charge	Students signature with date
	From	To			
Professional Societies (IE(I)/IEEE/CSI/ISTE/etc)					
Department Association					
Lab. Development					
Paper Presentation					
TechFest (ENGINEER)					

**GROUP-2 EXTRA-CURRICULAR ACTIVITIES (at least One)**

Activity	Period		* S/N	Name & Signature of Faculty in-charge	Students signature with date
	From	To			
NCC / NSS / NSO					
Science Education & Literacy					
SPICMACAY					
Community Services					
Social Work					
Yoga / Meditation					
Health Care Service					
Language course					
Sports (Mention Event)					
Alumni Association					
INCIDENT					

\* S: Satisfactory; N: Non-Satisfactory

**Dean (Students Welfare)**  
Signature with Date & Seal

## DECLARATION

*by the B.Tech. Student*

I/We hereby *declare* that the Project Work Report entitled

.....

.....

which is being submitted to the **National Institute of Technology**

**Karnataka, Surathkal** for the award of the Degree of Bachelor of

Technology in .....

.....

is a *bonafide report of the work carried out by me/us*. The material contained in this Project Work Report has not been submitted to any University or Institution for the award of any degree.

*Register Number, Name & Signature of the Student(s):*

(1)

(2)

(3)

(4)

Department of .....

Place: NITK, SURATHKAL

Date:

[declaration to be signed by the student(s) and incorporated as part of the Project Work Report]

## C E R T I F I C A T E

This is to *certify* that the B.Tech. Project Work Report entitled

.....

..... submitted by :

*Sl.No. Register Number                      & Name of Student(s)*

(1)

(2)

(3)

(4)

as the record of the work carried out by him/her/them, is *accepted*

*as the B.Tech. Project Work Report submission* in partial fulfillment of

the requirements for the award of degree of **Bachelor of Technology**

in .....

Guide(s)

(Name and

Signature with Date)

Chairman - DUGC

(Signature with Date and Sea

## **STRUCTURE - UG**

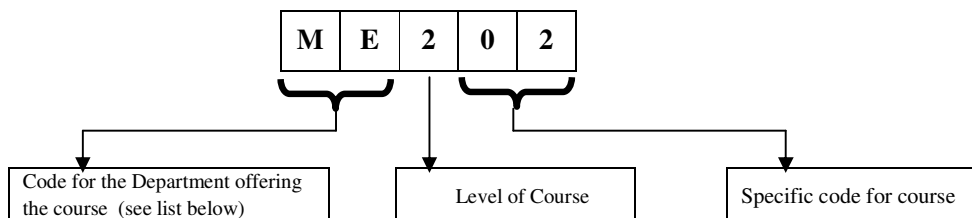
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iii) Computer Science & Engineering	10
iv) Electronics & Communication Engineering	13
v) Electrical & Electronics Engineering	16
vi) Information Technology	20
vii) Chemical Engineering	22
viii) Mechanical Engineering	24
ix) Metallurgical & Materials Engineering	27

# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

## Course Numbering Scheme

Course Numbers are denoted by character strings



Typically, courses whose three numerals are between 100 and 499 are taken by Under Graduate students and 600 to 999 by Post Graduate & Research students. Brief descriptions of courses for Under Graduate students are given in this booklet.

### List of Codes for Departments

Department Code	Name of the Department
AM	Applied Mechanics and Hydraulics
CV	Civil Engineering
MI	Mining Engineering
CS	Computer Science & Engineering
EC	Electronics & Communication Engineering
EE	Electrical & Electronics Engineering
IT	Information Technology
CH	Chemical Engineering
ME	Mechanical Engineering
MT	Metallurgical & Materials Engineering
CY	Chemistry
MA	Mathematical & Computational Sciences
PH	Physics
SM	School of Management

## Contact Hours and Credits

Every Course comprises of specific Lecture-Tutorial-Practical (L-T-P) Schedule. The Course Credits are fixed based on the following norms:

- Lectures/Tutorials - One hour per week is assigned one credit.  
Practicals - 3-hour session per week is assigned 2 credits OR 2-hour session per week is assigned 1 credit.

For example, a theory course with a L-T-P schedule of 3-1-0 will be assigned 4 credits; a laboratory practical course with a L-T-P schedule of 0-0-3 will be assigned 2 credits.

In this booklet, the number of credits and contact hours per week are given after the course number and course title.

Example: **ME202 FLUID MECHANICS AND MACHINERY (3-1-0) 4**

It is a 4 credit course consisting of : 3hr Lectures, 1hr Tutorial and 0hr Practical, per week.



## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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### First Year Bachelor of Technology

#### List of Courses Common to All Undergraduate Programmes

##### Foundation Courses (FC)

##### Basic Science Core (BSC)

MA110	Engineering Mathematics – I	(3-0-0) 3
MA111	Engineering Mathematics – II	(3-0-0) 3
PH110	Physics	(3-1-0) 4
PH111	Physics Laboratory	(0-0-2) 1
CY110	Chemistry	(3-0-0) 3
CY111	Chemistry Laboratory	(0-0-3) 2

##### Engineering Science Core (ESC)

AM110	Engineering Mechanics	(3-0-0) 3
ME111	Engineering Graphics	(1-0-3) 3
CS110	Computer Programming	(3-1-0) 4
CS111	Computer Programming Lab	(0-0-2) 1

##### Humanities and Social Science Core (HSC)

SM110	Professional Communication	(3-0-0) 3
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##### Mandatory Learning Courses (MLC)

CV110	Environmental Studies	(1-0-0) 1
SM111	Professional Ethics and Human Values	(1-0-0) 1

EC100 Elements of Electronics and Communication Engineering (2-0-0)2

*(For Computer Science, Mechanical, Civil, Mining, Metallurgy, Chemical Engineering branches only)*

EE110 Elements of Electrical Engineering (2-0-0)2

*(For Computer Science, Mechanical, Civil, Mining, Metallurgy, Chemical Engineering branches only)*

ME110 Elements of Mechanical Engineering (2-0-0)2

*(For Computer Science, IT, E & C, E & E, Civil, Mining, Metallurgy, Chemical Engineering branches only)*

#### Programme Specific Core Courses

##### Civil Engineering

CV100	Civil Engineering Materials and Construction	(3-1-0)4
-------	--	----------

##### Mining Engineering

MI101	Introduction to Mining Engineering	(3-0-0)3
-------	------------------------------------	----------

##### Computer Science And Engineering

CS112	Discrete Mathematical Structures	(3-1-0) 4
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##### Electronics And Communication Engineering

EC101	Joy of Electronics and Communication	(2-0-3)4
-------	--------------------------------------	----------

EC102	Linear Systems and Signals	(3-1-0)4
-------	----------------------------	----------

##### Electrical & Electronics Engineering

EE101	Analysis Of Electric Circuits	(3-1-0)4
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EE143	Mathematics For Electrical Engineers	(3-1-0)4
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##### Information Technology

IT110	Digital System Design	(3-0-2)4
-------	-----------------------	----------

IT150	Object Oriented Programming	(3-0-2)4
-------	-----------------------------	----------

##### Chemical Engineering

CH150	Process Calculations	(2-2-0)4
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##### Mechanical Engineering

ME112	Materials Science and Engineering	(3-0-0)3
-------	-----------------------------------	----------

ME113	Mechanics of Deformable Bodies	(3-0-0)3
-------	--------------------------------	----------

##### Metallurgical And Materials Engineering

MT160	Introduction to Material Science & Technology	(3-1-0)4
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# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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## Suggested Plan of Study:

### GROUP – I (S1-S6)

Semester →	I	II
	(Physics Cycle)	(Chemistry Cycle)
1	MA110	MA111
2	PH110	CY110
3	EE110	CS110
4	ME110	AM110
5	EC100	CS111
6	PH111	CY111
7	SM110	CV110
8	SM111	PSC
9	ME111	
10	PSC	

### GROUP – II (S7-S12)

Semester →	I	II
	(Chemistry Cycle)	(Physics Cycle)
1	MA110	MA111
2	CY110	PH110
3	CS110	EE110
4	AM110	ME110
5	CS111	EC100
6	CY111	PH111
7	CV110	SM110
8	PSC (Except CS)	SM111
9		ME111
10		PSC

- A. Sections S1 to S6 will be made up of students of CH, CV, ME, MI, MT ( IstSem Physics Cycle, IIndSem Chemistry Cycle)
- B. Sections S7 to S12 will be made up of students of CS, EC, EE and IT (IstSem Chemistry Cycle, IIndSem Physics Cycle)
- C. Program Specific Core will be done in ‘F’ slot, by the respective departments.
- D. Computer Science students, in Chemistry cycle ( i.e., IstSem) will do EC100 and EE110 in the D’ slot. It will be Mon, Wed : EC100 and Tue, Thu: EE110.
- E. Mechanical students instead of ME110, will be doing Program Specific Core in D’slot (in Ist Sem.) for 3 credits.

# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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## Department of Civil Engineering (CV) Bachelor of Technology in Civil Engineering

### Basic Science Core (BSC)– 16 Credits

MA110	Engineering Mathematics - I	(3-0-0)3
PH110	Physics	(3-1-0)4
PH111	Physics Lab	(0-0-2)1
MA111	Engineering Mathematics - II	(3-0-0)3
CY110	Chemistry	(3-0-0)3
CY111	Chemistry Lab	(0-0-3)2

### Engineering Science Core (ESC) - 17 Credits

EC100	Elements of Electronics and Communication Engineering	(2-0-0)2
AM110	Engineering Mechanics	(3-0-0)3
ME110	Elements of Mechanical Engineering	(2-0-0)2
ME111	Engineering Graphics	(1-0-3)3
EE110	Elements of Electrical Engineering	(2-0-0)2
CS110	Computer Programming	(3-1-0)4
CS111	Computer Programming Lab	(0-0-2)1

### Humanities and Social Science Core (HSC)- 9 Credits

SM110	Professional Communication	(3-0-0)3
SM300	Engineering Economics	(3-0-0)3
SM302	Principles of Management	(3-0-0)3

### Programme Core (PC)- 65 Credits

AM200	Mechanics of Materials	(3-0-0)3
AM216	Strength of Materials Lab	(0-0-3)2
AM218	Mechanics of Fluids	(3-0-0)3
AM219	Hydraulics Lab	(0-0-3)2
AM260	Water Resources Engineering	(3-0-0)3
CV100	Civil Engineering Materials and Construction	(3-1-0)4
CV201	Elements of Surveying	(3-0-0)3
CV202	Engineering Geology	(3-0-0)3
CV216	Civil Engineering Materials Lab.	(0-0-3)2
CV251	Design of RCC Structures	(3-0-0)3
CV252	Soil Mechanics	(3-0-0)3
CV253	Structural Analysis	(3-0-0)3
CV254	Highway and Traffic Engineering	(3-0-0)3
CV265	Surveying Practice	(0-0-3)2
CV266	Geology Lab	(0-0-3)2
CV267	Soil Mechanics Lab	(0-0-3)2
CV301	Environmental Engineering	(3-0-0)3
CV316	Building Design and Drawing	(1-0-3)3
CV351	Design of Steel Structures	(3-0-0)3
CV366	Highway Materials and Concrete Testing Lab	(0-0-3)2
CV367	Environmental Engineering Lab	(0-0-3)2
CV401	Estimation Costing and Specifications	(3-0-0)3
CV417	Structural Design and Drawing	(1-0-3)3
MA207	Numerical Methods	(3-0-0)3

### Programme Specific Electives (PSE)

CV268	Advanced Mining Geology	(3-0-0)3
CV321	Applied Soil Engineering	(3-0-0)3
CV322	Concrete Technology	(3-0-0)3
CV323	Architecture and Town Planning	(3-0-0)3
CV324	Analysis of Indeterminate Structures	(3-0-0)3
CV371	Railways, Tunnels, Harbours and Airports	(3-0-0)3
CV372	Design of PSC Structures	(3-0-0)3
CV373	Probability Methods in Civil Engineering	(3-0-0)3
CV385	Geoinformatics	(3-0-0)3
CV386	Rock Mechanics	(3-0-0)3

CV387	Applied Geology	(3-0-0)3
CV388	Advanced Surveying	(3-0-2)4
CV389	Advanced Structural Analysis	(3-0-0)3
CV421	Bridge Engineering	(3-0-0)3
CV422	Advanced Design of Structures - I	(3-0-0)3
CV423	Design of Foundations, Earth and Earth Retaining Structures	(3-0-0)3
CV424	Advanced Environmental Engineering	(3-0-0)3
CV425	Computer Aided Design and Applications in Civil Engineering	(2-0-3)4
CV426	Solid Waste Management	(3-0-0)3
CV427	Structural Dynamics and Wind Engineering	(3-0-0)3
CV471	Advanced Design of Structures - II	(3-0-0)3
CV472	Ground Improvement Techniques	(3-0-0)3
CV473	FEM Applications in Civil Engineering	(3-0-0)3
CV474	Elements of Earthquake Engineering	(3-0-0)3
CV475	Oil and Natural Gas Exploration	(3-0-0)3
CV476	Disaster Management and Mitigation	(3-0-0)3
CV477	Seismoresistant Concrete Structures	(3-0-0)3
CV485	Air Pollution and Noise Pollution	(3-0-0)3
CV486	Environmental Impact Assessment	(3-0-0)3
CV487	Construction and Project Management	(3-0-0)3
CV488	Ground Water Development and Management	(3-0-0)3
CV489	Retrofitting and Rehabilitation of Structures	(3-0-0)3
CV490	Non-destructive testing & evaluation for concrete structures	(3-0-0)3
CV491	Bituminous Materials, Mixtures and Pavements	(3-0-0)3
AM371	Open Channel Flow and Sediment transport	(3-0-0)3
AM372	Civil Engineering Systems	(3-0-0)3
AM400	Geographic Information System	(3-0-0)3
AM401	Satellite Digital Image Analysis	(3-0-0)3
AM402	Introduction to Geospatial Technology and Applications	(3-0-0)3
AM403	Global Positioning Systems	(3-0-0)3
AM421	Design and Drawing of Hydraulic Systems	(1-0-3)3
AM422	Fundamentals of Coastal Engineering	(3-0-0)3
AM423	Basics of Offshore Engineering	(3-0-0)3
AM424	Coastal Erosion and its Mitigation	(3-0-0)3
AM445	Fundamentals of Finite Element Method	(3-0-0)3
AM455	Engineering Optimization	(3-0-0)3
AM473	Water Resources Excess Management	(3-0-0)3
AM474	Computational Methods in Hydrology	(3-0-0)3
AM475	Ground Water Engineering	(3-0-0)3
AM477	Open Source Virtual Instrumentation	(3-0-0)3
AM478	Theory of Isotropic Elasticity	(3-0-0)3
AM380	Mini Project I	(0-0-3)2
AM381	Mini Project II	(0-0-3)2
CV380	Mini Project I	(0-0-3)2
CV381	Mini Project II	(0-0-3)2

### Major & Mini Projects (MP)- 6 Credits

CV449	Major Project - I	(0-0-3)2
CV499	Major Project - II	(0-0-6)4

### Mandatory Learning Courses (MLC) – 5 Credits

CV110	Environmental Studies	(1-0-0)1
SM111	Professional Ethics and Human Values	(1-0-0)1
CV390	Seminar	(0-0-2)1
CV440	Practical Training	(0-0-3)2

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

### Suggested Plan of Study

Number of Courses	Semester							
	I	II	III	IV	V	VI	VII	VIII
1	MA110	MA111	CV201	CV251	CV301	CV351	CV401	CV499
2	PH110	CY110	CV202	CV252	CV316	CV366	CV417	Elective
3	PH111	CY111	CV216	CV253	SM302	CV367	CV440	Elective
4	EC100	CS110	AM200	CV254	Elective	SM300	CV449	
5	EE110	CS111	AM216	CV265	Elective	CV390	Elective	
6	ME110	AM110	AM218	CV266	Elective	Elective	Elective	
7	ME111	CV100	AM219	CV267	Elective	Elective	Elective	
8	SM110	CV110	MA207	AM260	Mini Project*	Elective	Elective	
9	SM111					Mini Project*		

\* Mini Project courses (optional) will be offered in V and VI semesters only.

### Degree Requirements:

Category of Courses	Minimum Credits to be Earned
<u>Foundation Courses</u> Basic Science Core (BSC) Engineering Science Core (ESC) Humanities and Social Science Core (HSC)	16 17 09 <b>Total 42</b>
Programme Core (PC)	<b>65</b>
<u>Electives</u> Programme Specific Electives (PSE) and Open Electives	<b>39</b>
<u>Projects</u> Major Project (MP) Mini Project	6 0 - 4
Mandatory Learning Courses (MLC)	<b>5</b>
Total	<b>157</b>

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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**Courses Offered for B.Tech Minor Degree in Civil Engineering (Any five can be selected by the student):**

Semester	Course Code	Course	Credits
III	AM200	Mechanics of Materials	(3-0-0)3
	CV201	Elements of Surveying	(3-0-0)3
IV	CV252	Soil Mechanics	(3-0-0)3
V	CV350	Environmental Engineering	(3-0-0)3
VI	CV301	Highway and Traffic Engineering	(3-0-0)3
VII	CV400	Estimation, Costing and Specification	(3-0-0)3

Courses Offered for B.Tech Honors Degree in Civil Engineering:

As per of this B.Tech Honors programme, the Department of Civil Engineering proposes that the student is required to earn additional credits by registering for any five designated core courses of M.Tech Level to be offered in the E-slots for the 5<sup>th</sup>, 6<sup>th</sup> and 7<sup>th</sup> semester B.Tech based on the recommendation of the DFC from time to time in the Department of Civil Engineering and the Department of Applied Mechanics and Hydraulics. Such courses will not be offered at the 3<sup>rd</sup> and 4<sup>th</sup> semester due to prerequisites of the courses. See explanation given below:

- In B.Tech fifth semester, the students registering for honors are required to select 2 subjects from a set of 5 designated core PG subjects.
- Similarly, in B.Tech sixth semester, the students registering for Honors are required to select 2 subjects from another set of 5 designated core PG subjects.
- Also, in B.Tech seventh semester, the students registering for Honors are required to select 1 subject from another set of 5 designated core PG subjects.

# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL -

## Department of Mining Engineering (MI) Bachelor of Technology in Mining Engineering

### Basic Science Core (BSC)

MA110 Engineering Mathematics-I	(3-0-0)3
PH110 Physics	(3-1-0)4
PH111 Physics Laboratory	(0-0-2)1
MA111 Engineering Mathematics-II	(3-0-0)3
CY110 Chemistry	(3-0-0)3
CY111 Chemistry Laboratory	(0-0-3)2

### Engineering Science Core Courses (ESC)

EC100 Elements of Electronics and Communication Engineering	(2-0-0)2
EE110 Elements of Electrical Engg	(2-0-0)2
ME110 Elements of Mechanical Engg	(2-0-0)2
CS110 Computer Programming	(3-1-0)4
CS111 Computer Programming Lab	(0-0-2)1
AM110 Engineering Mechanics	(3-0-0)3
ME111 Engineering Graphics	(1-0-3)3
ME-200 Workshop	(0-0-2)1
ME-211 Thermodynamic & Fluid Mechanics	(3-0-0)3

### Humanities and Social Science & Mgt. Core (HSC)

SM110 Professional Communication	(3-0-0)3
SM300 Engineering Economics	(3-0-0)3
SM302 Principles of Management	(3-0-0)3

### Programme Specific Core (PSC)

MI101 Introduction to Mining Engineering	(3-0-0)3
MI201 Development of Mineral Deposits	(3-1-0)4
MI202 Mine Surveying	(3-1-0)4
MI203 Mine Surveying Lab	(0-0-3)2
CV203 Mining Geology	(3-0-0)3
CV218 Mining Geology Lab	(0-0-3)2
MI251 Mine Environment and Ventilation Engineering	(3-1-0)4
MI252 Mine Environment and Ventilation Engineering Lab	(0-0-3)2
MI253 Applied Mine Surveying Lab	(0-0-3)2
MI254 Mining Machinery	(3-1-0)4
MI255 Industrial Training in Mines-I	1
MI301 Surface Mining Technology	(3-1-0)4
MI302 Mine Hazards, Rescue and Recovery	(3-1-0)4
MI303 Underground Coal Mining Technology	(3-1-0)4
MI304 Industrial Training in Mines-II	1
MI351 Underground Metal Mining Technology	(3-1-0)4
MI352 Rock Mechanics	(3-1-0)4
MI353 Rock Mechanics Lab.	(0-0-3)2
MI354 Mine Systems Optimization	(3-1-0)4
MI355 Industrial and Professional Practice	1
MI401 Mineral Processing Technology	(3-1-0)4
MI402 Mineral Processing Technology Lab.	(0-0-3)2
MI403 Rock Fragmentation Engineering	(3-1-0)4
MI404 Mine Design Laboratory	(0-0-3)2

MI405 Industrial Training in Mines-III	1
MI451 Mine Legislation & Safety	(4-0-0)4

### Programme Specific Elective (PSE)

MI210 Drilling & Blasting Engineering	(3-0-0)3
MI211 Seabed Mining	(3-0-0)3
MI260 Applied Mine Surveying	(3-0-0)3
MI261 Electrical Machinery in Mines	(3-0-0)3
MI310 Noise Pollution & Control Engg.	(3-0-0)3
MI311 Rock Reinforcement Engg.	(3-0-0)3
MI312 Mine Power Systems	(3-0-0)3
MI360 Mine Health and Safety Engg.	(3-0-0)3
MI361 Advanced Surface Mining Technology	(3-0-0)3
MI362 Production Drilling for Oil Wells	(3-0-0)3
MI363 Mechanization and Materials Handling	(3-0-0)3
MI410 Advanced U/G Coal Mining Technology	(3-0-0)3
MI411 Strata Mechanics	(3-0-0)3
MI412 Geostatistics	(3-0-0)3
MI413 Applications of IT in Mining Projects	(3-0-0)3
MI414 Ore Reserve Estimation and Mine Valuation	(3-0-0)3
MI460 Coal Washing and Handling	(3-0-0)3
MI461 Surface Mine Design	(3-0-0)3
MI462 U/G Coal Mine Design	(3-0-0)3
MI463 U/G Metal Mine Design	(3-0-0)3
MI464 Environmental Management and Sustainable Development	(3-0-0)3

### Open Elective (OE)

MI471 Reliability Analysis of Engg. Systems	(3-0-0)3
MI472 Rock Excavation in Mines and Infrastructure Projects	(3-0-0)3
MI473 Stability of Rock Slopes	(3-0-0)3
MI474 Tunneling Engg.	(3-0-0)3
MI475 Numerical Modeling Techniques	(3-0-0)3
MI476 Industrial Engineering & Management	(3-0-0)3
MI477 Remote Sensing & Geoinformatics	(3-0-0)3
MI478 Safety Engineering	(3-0-0)3
MI479 Energy Resources Utilization and Climate Change	(3-0-0)3

### Project (MP)

MI449 Mine Design Project-I	(0 -0-3)2
MI499 Mine Design Project-II	(0 -0-6)4

### Mandatory Learning Courses

CV110 Environmental Studies	(1 -0-0)1
SM111 Professional Ethics and Human Values	(1 -0-0)1
MI452 Mine Projects Exposure	(0 -0-3)2
MI490 Seminar	1

### Minor Courses

MI480 Mining Technology	(3-1-0)4
MI481 Rock Excavation Engineering (3-1-0)4	
MI482 Mine Safety Engineering (3-1-0)4	
MI483 Mine Mechanisation (3-1-0)4	
MI484 Environmental Management (3-1-0)4	

### Students seeking Honours degree shall credit the following five PG courses offered by the Department of Mining Engg.

MI901 Applied Rock Mechanics	(3-1-0)4
MI804 Underground Space Technology	(3-1-0)4
MI916 Risk and Safety Management in Mines	(3-1-0)4
MI705 Project Management	(3-1-0)4
MI855 Reclamation Rehabilitation and Risk Management	(3-1-0)4

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

### Suggested Plan of Study

Semester →	II	III	IV	V	VI	VII	VIII
1	MI101	MI201	MI251	MI301	MI351	MI401	MI451
2		MI202	MI252	MI302	MI352	MI402	MI452
3		MI203	MI253	MI303	MI353	MI403	MI490
4		CV203	MI254	MI304	MI354	MI404	MI499
5		CV218	MI255	SM302	MI355	MI405	Elective I
6		Elective	ME200	Elective	SM300	MI449	Elective II
7		---	ME211		Elective	Elective I	
8		---	Elective			Elective II	

### Degree Requirements:

Category of Courses	Minimum Credits to be Earned
Basic Science Core(BSC)	16
Engineering Science Core(ESC)	21
Humanities and Social Sciences Core (HSC)	09
Programme Core (PC)	76
Electives	25
Project (MP)	06
Mandatory Learning Courses (MLC)	05
Total	158

# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

## Department of Computer Science & Engineering (CS)

### Bachelor of Computer Science & Engineering

#### Foundation Courses

#### Basic Science Core (BSC)

MA110	Engineering Mathematics I	(3-0-0) 3
PH110	Physics	(3-1-0) 4
PH111	Physics Laboratory	(0-0-2) 1
MA111	Engineering Mathematics II	(3-0-0) 3
CY110	Chemistry	(3-0-0) 3
CY111	Chemistry Laboratory	(0-0-3) 2

#### Engineering Science Core (ESC)

AM110	Engineering Mechanics	(3-0-0) 3
CS110	Computer Programming	(3-1-0) 4
CS111	Computer Programming Lab	(0-0-2) 1
EE110	Elements of Electrical Engineering	(2-0-0) 2
	Elements of Electronics &	(2-0-0) 2
EC100	Communication Engineering	
ME110	Elements of Mechanical Engineering	(2-0-0) 2
ME111	Engineering Graphics	(1-0-3) 3

#### Humanities and Social Science Core

SM110	Professional Communication	(3-0-0) 3
SM300	Engineering Economics	(3-0-0) 3
SM302	Principles of Management	(3-0-0) 3

#### Program Core (PC)

CS112	Discrete Mathematical Structures	(3-1-0) 4
CS200	Theory of Computation	(3-1-0) 4
CS201	Design of Digital Systems	(3-1-0) 4
CS202	Data Structures and Algorithms	(3-1-0) 4
CS203	Design of Digital Systems Lab	(0-0-3) 2
CS204	Data Structures and Algorithms Lab	(0-0-3) 2
MA204	Linear Algebra and Matrices	(3-0-0) 3
	Computer Organization and	
CS250	Architecture	(3-1-0) 4
CS251	Database Systems	(3-1-0) 4
CS252	Operating Systems	(3-1-0) 4
CS253	Design and Analysis of Algorithms	(3-1-0) 4
CS254	Database Systems Lab	(0-0-3) 2
CS255	Operating Systems Lab	(0-0-3) 2
CS300	Software Engineering	(3-1-0) 4
CS301	Computer Networks	(3-1-0) 4
CS302	Computer Networks Lab	(0-0-3) 2
CS303	Software Engineering Lab	(0-0-3) 2
CS304	Compiler Design	(3-1-0) 4
CS305	Compiler Design Lab	(0-0-3) 2
CS350	Cryptography and Applications	(3-1-0) 4
CS351	Machine Learning	(3-1-0) 4
CS352	Cryptography and Applications Lab	(0-0-3) 2
CS353	Machine Learning Lab	(0-0-3) 2

#### Program Specific Elective (PSE) Courses

CS360	Graph Theory	(3-1-0) 4
CS361	System Programming	(3-1-0) 4
CS362	Problem Solving Techniques	(3-1-0) 4
CS363	Computing Systems	(3-1-0) 4
CS364	Microprocessor Systems	(3-1-0) 4
CS365	Advanced Data Structures	(3-1-0) 4
CS366	Management Information Systems	(3-1-0) 4
CS367	Soft Computing	(3-1-0) 4
CS368	Computer Graphics	(3-1-0) 4
CS369	Object Oriented Programming	(3-1-0) 4
CS410	Simulation and Modeling	(3-1-0) 4

CS411	Software Testing	(3-1-0) 4
CS412	Formal Methods	(3-1-0) 4
CS413	Distributed Computing	(3-1-0) 4
CS414	Web Engineering	(3-1-0) 4
CS415	Wireless Networks	(3-1-0) 4
CS416	Data Warehousing and Mining	(3-1-0) 4
CS417	Parallel Programming	(3-1-0) 4
CS418	Topics in Information Security	(3-1-0) 4
CS419	Algorithmic Graph Theory	(3-1-0) 4
CS420	Artificial Intelligence	(3-1-0) 4
CS421	Digital Image Processing	(3-1-0) 4
CS422	Computational Geometry	(3-1-0) 4
CS460	Mobile Computing	(3-1-0) 4
CS461	Advanced Computer Networks	(3-1-0) 4
CS462	High Performance Computing	(3-1-0) 4
	Paradigms	
CS463	Network Security	(3-1-0) 4
CS464	Network Management	(3-1-0) 4
CS465	Distributed Database Systems	(3-1-0) 4
CS466	Cloud Computing	(3-1-0) 4
CS467	Heterogeneous Parallel Computing	(3-1-0) 4
CS468	Internet of Things	(3-1-0) 4
CS469	Software Based Networks	(3-1-0) 4
CS470	Database Security	(3-1-0) 4
CS471	Information Centric Networking	(3-1-0) 4
CS472	Quantitative Computer Architecture	(3-1-0) 4
CS473	Big Data Analytics	(3-1-0) 4
CS474	Social Network Analysis	(3-1-0) 4
CS475	Information Storage Management	(3-1-0) 4
CS476	Computer Vision	(3-1-0) 4
CS477	Speech Processing	(3-1-0) 4

#### Program Major Project (PMP)

CS450	Major Project	(0-1-9) 6
CS451	Mini Project	(0-0-3) 2

#### Mandatory Learning Courses (MLC)

CV110	Environmental Sciences	(1-0-0) 1
SM111	Professional Ethics & Human Values	(1-0-0) 1
CS355	Seminar	(0-0-3) 2
CS400	Practical Training	(0-0-2) 1

#### Minor Courses (For other Branch B.Tech Students)

CS202	Data Structures and Algorithms	(3-1-0) 4
CS251	Database Systems	(3-1-0) 4
CS252	Operating Systems	(3-1-0) 4
CS300	Software Engineering	(3-1-0) 4
CS351	Machine Learning	(3-1-0) 4

#### Honors Courses (For B.Tech - CSE Students)

CS701	High Performance Computing	(3-0-2) 4
CS750	Distributed Data Management	(3-0-2) 4
CS751	Network Engineering	(3-0-2) 4
CS850	Database Security	(3-0-2) 4
CS851	Network Security	(3-0-2) 4



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**Suggested Plan of Study:**

Semester→	II	III	IV	V	VI	VII	VIII
1	CS112	MA204	CS250	CS300	CS350	CS400	CS450
2		CS200	CS251	CS301	CS351	SM300	Elective
3		CS201	CS252	CS302	CS352	Elective	Elective
4		CS202	CS253	CS303	CS353	Elective	Elective
5		CS203	CS254	CS304	CS355	Elective	-
6		CS204	CS255	CS305	SM302	-	-

**Degree Requirements:**

Category of courses	Minimum credits to be earned
Foundation Courses	42
Program Core (PC)	73
Electives (PSE)	24
Major Project (PMP)	06
Mandatory Learning Courses (MLC)	05
Total	150

# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

## Department of Electronics and Communication Engineering (EC) Bachelor of Technology in Electronics and Communication Engineering

<b>Basic Science Core (BSC)</b>			EC352	Principles of Modern Radar and Techniques	(3-1-0) 4
MA110	Engineering Mathematics – I	(3-0-0) 3			
PH110	Physics	(3-1-0) 4	EC353	Modern Electronic Navigation Systems	(3-1-0) 4
PH111	Physics Laboratory	(0-0-2) 1			
MA111	Engineering Mathematics – II	(3-0-0) 3	EC354	Communication Networks	(3-1-0) 4
CY110	Chemistry	(3-0-0) 3	EC355	Wireless Mobile Communication	(3-1-0) 4
CY111	Chemistry Laboratory	(0-0-3) 2	EC356	Information Theory and Coding	(3-1-0) 4
			EC357	Adhoc and Sensor Networks	(3-1-0) 4
			EC358	Multimedia Communication Techniques	(3-1-0) 4
<b>Engineering Science Core (ESC)</b>					
ME110	Elements of Mechanical Engg.	(2-0-0) 2			
CS110	Computer Programming	(3-1-0) 4	EC359	Software Defined and Cognitive Radio	(3-1-0) 4
CS111	Computer Programming Lab	(0-0-2) 1			
AM110	Engineering Mechanics	(3-0-0) 3	EC440	VLSI CAD	(3-1-0) 4
ME111	Engineering Graphics	(1-0-3) 3	EC441	Mixed Signal Design	(3-1-0) 4
			EC442	Advanced Computer Architecture	(3-1-0) 4
			EC443	VLSI Testing and Testability	(3-1-0) 4
<b>Humanities and Social Science Core (HSC)</b>			EC444	Synthesis and Optimization of Digital Circuits	(3-1-0) 4
SM110	Professional Communication	(3-0-0) 3			
SM300	Engineering Economics	(3-0-0) 3			
SM302	Principles of Management	(3-0-0) 3	EC445	Techniques in Low Power VLSI Submicron Devices	(3-1-0) 4
			EC446	Active Filters	(3-1-0) 4
			EC447	Heterogeneous and Parallel Computing	(3-0-2) 4
<b>Program Core (PC)</b>			EC448	Algorithms and Architectures for Signal Processing	(3-1-0) 4
EC101	Joy of Electronics and Communication	(2-0-3) 4			
EC102	Circuits and Systems	(3-1-0) 4	EC449	Analog and Digital Filter Design	(3-1-0) 4
EC200	Digital System Design	(3-1-0) 4	EC450	Advanced Digital Signal Processing	(3-1-0) 4
EC201	Analog Electronics	(3-1-0) 4	EC451	Real Time Signal Processing	(2-0-3) 4
EC202	Analog and Digital Communication	(3-1-0) 4			
EC203	Linear Algebra and Probability Theory	(3-1-0) 4	EC452	Fourier and Wavelet Signal Processing	(3-1-0) 4
EC204	Digital System Design Lab	(0-0-3) 2	EC453	Mathematical Algorithms for Signal Processing	(3-1-0) 4
EC205	Analog Electronics Lab	(0-0-3) 2			
EC206	Microprocessors	(3-1-0) 4	EC454	Digital Signal Compression	(3-1-0) 4
EC207	Electromagnetic Waves and Transmission Lines	(3-1-0) 4	EC455	Dynamical Systems, Chaos and Fractals	(3-1-0) 4
EC208	Digital Signal Processing	(3-1-0) 4	EC456	Statistical Analysis	(3-1-0) 4
EC209	Control Systems	(3-1-0) 4	EC457	Stochastic Processes	(3-1-0) 4
EC210	Microprocessors Lab	(0-0-3) 2	EC458	Optimization	(3-1-0) 4
EC211	Digital Signal Processing Lab	(0-0-3) 2	EC459	Neural Networks and Deep Learning	(3-1-0) 4
EC300	VLSI Design	(3-1-0) 4	EC460	Spread Spectrum Communication	(3-1-0) 4
EC301	RF Components and Circuits	(3-1-0) 4			
EC302	VLSI Design Lab	(0-0-3) 2	EC461	Error Control Coding	(3-1-0) 4
EC303	Communication Lab-I	(0-0-3) 2	EC462	Optical Communication Systems and Networks	(3-1-0) 4
EC304	Communication Lab-II	(0-0-3) 2	EC463	Radar Signal Processing	(3-1-0) 4
			EC464	Algorithms for Parameter and State Estimation	(3-1-0) 4
<b>Program Specific Electives (PSE)</b>			EC465	Detection and Estimation Theory	(3-1-0) 4
EC340	Computer Organization and Architecture	(3-1-0) 4	EC466	Advanced Topics in Communication Engineering	(3-1-0) 4
EC341	Computer Arithmetic	(3-1-0) 4	EC467	Signal Integrity and EMI/ EMC	(3-1-0) 4
EC342	Embedded System Design	(2-0-3) 4	EC468	Introduction to Photonics	(3-1-0) 4
EC343	FPGA based System Design	(2-0-3) 4	EC469	MIMO Communication Systems	(3-1-0) 4
EC344	Analog Integrated Circuits	(3-1-0) 4	EC470	RF IC Design	(3-1-0) 4
EC345	Data Structures and Algorithms	(3-0-2) 4	EC471	Principles of Modern Radar-Advanced Techniques	(3-1-0) 4
EC346	Foundations of Machine Learning	(3-1-0) 4	EC472	Electronic Defense Systems	(3-1-0) 4
EC347	Speech and Audio Processing	(3-1-0) 4			
EC348	Image and Video Processing	(3-1-0) 4	EC473		
EC349	Applied Number Theory	(3-1-0) 4			
EC350	Numerical Analysis	(3-1-0) 4			
EC351	Satellite Communications	(3-1-0) 4			

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EC474	Principles of Modern Sonar Systems	(3-1-0) 4	<b>Minor Courses (MC)</b>	
EC475	Advanced Electromagnetics	(3-1-0) 4	EC391	Analog Electronic Circuits (3-0-0) 3
EC476	Milimeter Wave Communication	(3-1-0) 4	EC392	Digital Electronics (3-0-0) 3
EC477	Imaging, Informatics and Computational Physics	(3-1-0) 4	EC393	Signals and Systems (3-0-0) 3
EC280	Mini Project in Electrical Circuits and Systems	(0-0-3) 2	EC394	Communication Systems (3-0-0) 3
EC281	Mini Project in Digital System Design	(0-0-3) 2	EC395	Data Communication and Networks (3-0-0) 3
EC380	Mini Project in Communication Systems and Networks	(0-0-3) 2	<b>Project (MP)</b>	
EC381	Mini Project in Microprocessor and Embedded System	(0-0-3) 2	EC498	Major Project 6
EC382	Mini Project in Analog System Design	(0-0-3) 2	<b>Mandatory Learning Courses (MLC)</b>	
EC383	Mini Project in VLSI Design	(0-0-3) 2	CV110	Environmental Studies (1-0-0) 1
EC384	Mini Project in RF Design	(0-0-3) 2	SM111	Professional Ethics & Human Values (1-0-0) 1
EC385	Mini Project in Digital Signal Processing	(0-0-3) 2	EC390	Seminar (0-0-2) 1
			EC490	Practical Training (0-0-3) 2

# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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## Suggested Plan of Study:

Semester →	I	II	III	IV	V	VI	VII	VIII
1	EC101	EC102	EC200	EC206	EC300	SM302	Elective	Elective
2			EC201	EC207	EC301	Elective	Elective	Elective
3			EC202	EC208	SM300	Elective	Elective	Elective
4			EC203	EC209	Elective	Elective	EC498*	EC498*
5			EC204	EC210	EC302	EC304	EC490	
6			EC205	EC211	EC303	Elective Mini Project	Elective Mini Project	
7				Elective Mini Project	EC390			
8					Elective Mini Project			

\* EC498 Major Project is of one semester duration, to be credited in either 7<sup>th</sup> or 8<sup>th</sup> semester.

## Degree Requirements:

Category of Courses	Minimum Credits to be Earned
Foundation Courses:	38
Basic Science Courses(BSC)	16
Engineering Science Courses (ESC)	13
Humanities and Social Science Courses (HSC)	9
Program Core Courses:	62
Elective Courses:	39
Elective courses / Mini Projects* /MOOC/GIAN/Industry Courses**	
Major Project (MP): (One semester duration, to be credited in either 7th or 8th semester)	6
Mandatory Learning Courses (MLC):	5
Total Credits	150

\* At most 6 credits can be earned from Mini Projects

\*\* At most 5 credits can be earned from MOOC/GIAN/Industry Courses

Students seeking Honors degree shall credit PG courses offered by the Department of Electronics and Communication Engineering. The list of courses available for crediting in a given semester shall be decided by the DUGC. In addition, such students shall do their Major Project in the department. Minimum requirement for Honor Degree is 20 Credits.

# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

## Department of Electrical and Electronics Engineering (EE) Bachelor of Technology in Electrical and Electronics Engineering

<b>Foundation Courses (FC)</b>			EE347	Design & Development Task in Control Systems	(0-0-3)2
<b>Basic Science Core (BSC)</b>				Design & Development Task in Power Electronics & Drives	(0-0-3)2
MA110	Engineering Mathematics – I	(3-0-0)3	EE348	Energy Auditing	(3-1-0)4
PH110	Physics	(3-1-0)4	EE359	Microprocessors	(3-1-0)4
PH111	Physics Laboratory	(0-0-2)1	EE360	Power System Communications	(3-1-0)4
MA111	Engineering Mathematics - II	(3-0-0)3	EE361	Operation and control of Power Systems	(3-1-0)4
CY110	Chemistry	(3-0-0)3	EE362	Advanced Digital Signal Processing	(3-1-0)4
CY111	Chemistry Laboratory	(0-0-3)2	EE363	Special Machines and Drives	(3-1-0)4
<b>Engineering Science Core (ESC)</b>			EE366	Embedded System Design	(3-1-0)4
ME110	Elements of Mechanical Engineering	(2-0-0)2	EE369	Power Electronics Applications to Power Systems	(3-1-0)4
CS110	Computer Programming	(3-1-0)4	EE371	Electric Power Stations	(3-1-0)4
CS111	Computer Programming Laboratory	(0-0-2)1	EE373	Electric Energy Systems	(3-1-0)4
AM110	Engineering Mechanics	(3-0-0)3	EE374	Advanced Control Systems	(3-1-0)4
			EE376	Modeling and Simulation Techniques for Dynamic Systems	(3-1-0)4
ME111	Engineering Graphics	(1-0-3)3	EE377	Shell Scripting with Bash	(3-1-0)4
<b>Humanities and Social Science Core (HSC)</b>			EE378	Incremental Motion Control	(3-1-0)4
SM110	Professional Communication	(3-0-0)3	EE379	Virtual Instrumentation Laboratory	(0-0-3)2
SM300	Engineering Economics	(3-0-0)3	EE382	Energy Auditing Laboratory	(0-0-3)2
SM302	Principles of Management	(3-0-0)3	EE384		
<b>Programme Core (PC)</b>			EE385	Microprocessors Laboratory	(0-0-3)2
EE101	Analysis of Electric Circuits	(3-1-0)4	EE386	Digital Signal Processing Laboratory	(0-0-3)2
EE207	Electromagnetic Theory	(3-1-0)4	EE387	Advanced Digital Signal Processing Laboratory	(0-0-3)2
EE213	Electrical Machines-I	(3-1-3)6	EE389	Embedded System Design Laboratory	(0-0-3)2
	Electrical Measurements and Measuring Instruments	(3-1-3)6	EE392	Power System Operation Laboratory	(0-0-3)2
EE224	Analogue Electronic Circuits	(3-1-3)6	EE393	Dynamic System Simulation Laboratory	(0-0-3)2
EE143	Mathematics for Electrical Engineers	(3-1-0)	EE397	Design & development task in Signal processing	(0-0-3)2
EE256	Signals and Systems	(3-1-3)6	EE398	Design & development task in Power Systems	(0-0-3)2
EE258	Electrical Machines-II	(3-1-3)6	EE402	HVDC Transmission	(3-1-0)4
EE265	Power System Engineering-I	(3-1-0)4	EE404	Soft Computing and applications	(3-1-0)4
EE276	Digital Electronic Circuits	(3-1-3)6	EE406	Electromagnetic Compatibility	(3-1-0)4
EE308	Power Electronics	(3-1-0)4	EE408	Solid-State Drives	(3-1-0)4
EE326	Linear Control Theory	(3-1-0)4	EE410	Power System Protection	(3-1-0)4
EE350	Power System Engineering-II	(3-1-0)4	EE411	Operation Of Power Systems Under Deregulation	(3-1-0)4
<b>Programme Specific Electives (PSE)</b>			EE412	Random Signal Processing	(3-1-0)4
EE229	Polyphase Systems and Component – Transformations	(3-1-0)4	EE414	Non-Conventional Energy Systems	(3-1-0)4
EE253	Commutator Machines	(3-1-0)4	EE418	Advanced Power Electronics	(3-1-0)4
EE255	Introduction to Algorithms and Data Structures	(3-1-0)4	EE420	Power System Dynamics	(3-1-0)4
EE260	Digital Computer Organization and Architecture	(3-1-0)4	EE422	Principles of Switchgear and Protection	(3-1-0)4
EE281	Commutator Machines Laboratory	(0-0-3)2	EE423	Switchgear and Protection Laboratory	(0-0-3)2
EE295	Electrical Machine Winding Calculations-I	(0-2-3)4	EE427	Computer Networks	(3-1-0)4
EE296	Electrical Machine Winding Calculations-II	(0-2-3)4	EE428	The ARM Core: Architecture and Programming	(3-1-0)4
EE298	Elements of Analog and Digital Communication	(3-1-0)4	EE430	Robot Dynamics and Control	(3-1-0)4
EE303	Distribution Systems Planning and Control	(3-1-0)4	EE432	Machine Learning	(3-1-2)5
EE311	Digital System Design	(3-1-0)4	EE439	Advanced Power Electronics Laboratory	(0-0-3)2
EE312	Power System Harmonics	(3-1-0)4		Mathematical Morphology & applications to signal processing	(3-1-0)4
EE313	Digital Signal Processing	(3-1-0)4	EE443	Power System Simulation Laboratory-I	(0-0-3)2
EE319	Neural Networks and Applications	(3-1-0)4	EE445	Flexible AC Transmission Systems	(3-1-0)4
EE320	Electrical Safety, Operations, Regulations	(3-0-0)3	EE454	High-Voltage Engineering	(3-1-0)4
EE321	Linear and Nonlinear Systems	(3-1-0)4	EE456	Photovoltaics and Applications	(3-1-0)4
EE324	Electronic Measurements and Instrumentation	(3-1-0)4	EE458		
EE328	Network Synthesis	(3-1-0)4	EE464	Power Generation and Economics	(3-1-0)4
	Traveling Waves on Transmission Systems	(3-1-0)4	EE466	Utilization of Electrical Energy	(3-1-0)4
EE329	Distribution Systems Laboratory	(0-0-3)2	EE467	Industrial Electrical Systems	(3-0-0)3
EE334	Power Electronics Laboratory	(0-0-3)2	EE468	Advanced Electric Drives	(3-1-0)4
EE335	Digital System Design Laboratory	(0-0-3)2	EE469	Renewable Energy Systems	(3-0-0)3
EE337	Power System Harmonics Laboratory	(0-0-3)2	EE470	Computational Technique for large system analysis	(3-1-0)4
EE342	Electronic Measurement Laboratory	(0-0-3)2			
EE343	Statistical Foundation for Electrical Engineers	(3-1-0)4			

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

EE471	Power System Simulation Laboratory-II	(0-0-3)2	EE802	Compatibility Energy Management	(3-0-0) 3
EE472	Insulation and Testing Engineering	(3-1-0) 4	EE803	Microcontroller Based System Design	(3-0-0) 3
EE476	Optimisation Techniques	(3-1-0) 4	EE804	Electric Power Quality	(3-0-0) 3
EE478	An Introduction to the Intel IA-32 Architecture	(3-1-0) 4	EE805	Discrete Fourier Transforms and Digital Filter Design	(4-0-0) 4
EE489	Advanced Electric Drives Laboratory	(0-0-3) 2	EE806	Sensor Technology and Instrumentation Design	(3-0-0) 3
EE491	Insulation and Testing Engineering Laboratory	(0-0-3) 2	EE807	Optimization Techniques	(4-0-0) 4
EE500	System Analysis in Discrete Time	(3-1-0)4	EE808	Finite Element Methods and Applications	(3-0-0) 3
EE501	Analysis of Nonlinear Circuits	(3-1-0)4	EE809	DC-AC System Interaction	(3-1-0) 4
			EE810	Power System Transients and Overvoltages	(3-0-0) 3
			EE811	Distribution System Automation	(3-0-0) 3
			EE812	Energy Management Lab	(0-0-3) 2
			EE813	Electric Power Quality Lab	(0-0-3) 2
			EE814	Discrete Fourier Transforms and Digital Filter Design Lab	(0-0-3) 2
			EE815	Power Electronics Design Lab	(0-0-3) 2
			EE816	Distribution Automation Lab Power System Operation under	(0-0-3) 2
			EE817	Deregulations	(4-0-0) 4
			EE818	Advanced Semiconductor Devices	(3-0-0) 3
			EE820	Analysis Of Faulted Power Systems	(4-0-0)4
			EE850	FACTS and Custom Power Devices	(3-0-0) 3
			EE851	High-Voltage Testing and Measurements	(3-0-0) 3
			EE852	PV Power Systems	(3-0-0) 3
			EE853	Renewable Energy Systems	(3-0-0) 3
			EE854	Distributed Generation	(3-0-0) 3
			EE855	Communication Networks for Power Systems	(3-0-0) 3
			EE856	Application of Digital Signal Processing Techniques to Power Systems	(4-0-0) 4
			EE857	Design of Embedded Controllers	(3-0-0) 3
			EE858	Electric Drives	(3-0-0) 3
			EE859	Computational Methods for Large Power Systems	(4-0-0) 4
			EE860	Industrial Applications of HV and Fields LabVIEW™ -based Data Acquisition and	(3-0-0) 3
			EE861	Instrumentation Lab	(0-0-3) 2
			EE862	Computer Control of Energy Systems Lab	(0-0-3) 2
			EE863	Power System Signal Processing Lab	(0-0-3) 2
			EE864	Embedded Controllers Design Lab	(0-0-3) 2
			EE865	High-Voltage Testing Lab	(0-0-3) 2
			EE866	Gaseous Insulation & Gas Insulated System	(3-0-0) 3
			EE867	Power System Simulation Laboratory Switched Electric Networks - A Power	(0-0-3) 2
			EE868	Electronics Perspective	(4-0-0) 4
			EE869	Tensors	(4-0-0) 4
			EE870	Tensor Analysis of Networks	(4-0-0) 4
			EE871	Machine Learning	(3-1-2) 5
			EE872	Smart Grid Control and Operation	(4-0-0) 4
<b>Project (MP)</b>					
EE449	Major Project-I	(0-1-3) 3			
EE499	Major Project-II	(0-1-3) 3			
<b>Mandatory Learning Courses (MLC)</b>					
CV110	Environmental Studies	(1-0-0) 1			
SM111	Professional Ethics and Human Values	(1-0-0) 1			
EE448	Seminar	(0-0-2) 1			
EE498	Practical Training	(0-0-3) 2			
<b>Requirements for a Minor Degree in E&amp;E (20 credits)</b>					
EE230	Electric Circuits	(3-1-0) 4			
EE261	Basic Electric Machines	(3-1-0) 4			
EE310	Electric Power System	(3-1-0) 4			
EE370	Electrical and Electronics Measuring Instruments and Techniques	(3-1-0) 4			
EE415	Power Electronics in Power Control	(3-1-0) 4			
<b>Honors Degree in E&amp;E</b>					
Students seeking Honors degree shall credit five PG courses offered by the Department of Electrical and Electronics Engg. and as decided by DUGC from the following list. Minimum requirement for Honors degree is 20 credits					
Courses for Honors Degree					
EE700	Computer-Aided Protection of Power System	(4-0-0) 4			
EE701	Power Electronics: Modeling and Design	(4-0-0) 4			
EE702	Power System Modeling and Analysis	(4-0-0) 4			
EE703	Power System Modeling and Analysis Lab	(0-0-3) 2			
EE750	Computer Control of Energy Systems	(4-0-0) 4			
EE751	Control Systems	(4-0-0) 4			
EE800	Fuzzy-Neural Control	(4-0-0) 4			
EE801	EMI Testing and Design for	(4-0-0) 4			

# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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## Suggested Plan of Study

Semester →	I	II	III	IV	V	VI	VII	VIII
1	MA110	MA111	EE213	EE226	SM300	SM302	Elective	Elective
2	CY110	PH110	EE207	EE258	EE326	Elective	Elective	Elective
3	CY111	PH111	EE276	EE265	EE350	Elective	Elective	Elective
4	AM110	ME110	EE256	EE224	Elective	Elective	Elective	Elective
5	CS110	ME111	EE308	Elective	Elective	Elective	EE498	EE499
6	CS111	EE143	Elective	Elective	Elective	Elective	EE449	EE448
7	EE101	SM110	--	--	--	--	--	--
8	CV110	SM111	--	--	--	--	--	--

## Degree Requirements:

Category of Courses	Minimum Credits to be Earned
Foundation Courses (FC)	38
<i>Basic Science Core (BSC)</i>	16
<i>Engineering Science Core (ESC)</i>	13
<i>Humanities and Social Science Core (HSC)</i>	9
Programme Core (PC)	64
Electives	37
Project (MP): Major Project	6
Mandatory Learning Courses (MLC)	5
<b>Total</b>	<b>150</b>

# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

## Department of Information Technology (IT)

### Bachelor of Technology in Information Technology

#### Basic Science Core (BSC)

MA110	Engineering Mathematics – I	(3-0-0)	3
PH110	Physics	(3-1-0)	4
PH111	Physics Laboratory	(0-0-2)	1
MA111	Engineering Mathematics – II	(3-0-0)	3
CY110	Chemistry	(3-0-0)	3
CY111	Chemistry Laboratory	(0-0-3)	2

#### Engineering Science Core (ESC)

ME110	Elements of Mechanical Engineering	(2-0-0)	2
ME111	Engineering Graphics	(1-0-3)	3
AM110	Engineering Mechanics	(3-0-0)	3
CS110	Computer Programming	(3-1-0)	4
CS111	Computer Programming Lab	(0-0-2)	1

#### Humanities and Social Science Core (HSC)

SM110	Professional Communication	(3-0-0)	3
SM300	Engineering Economics	(3-0-0)	3
SM302	Principles of Management	(3-0-0)	3

#### Programme Core (PC)

IT110	Digital System Design	(3-0-2)	4
IT150	Object Oriented Programming	(3-0-2)	4
IT200	Computer Communication and Networking	(4-0-0)	4
IT201	Computer Organization and Architecture	(3-0-0)	3
IT202	Data Structures and Algorithms-I	(3-0-0)	3
IT203	Discrete Mathematics	(3-0-0)	3
IT204	Signals and Systems	(3-0-2)	4
IT205	Computer Networking Lab	(0-0-3)	2
IT206	Data Structures and Algorithms-II Lab	(0-0-3)	2
IT250	Automata and Compiler Design	(3-0-2)	4
IT251	Data Structures and Algorithms-II	(3-0-2)	4
IT252	Database Systems	(3-0-2)	4
IT253	Operating Systems	(3-0-2)	4
IT254	Web Technologies and Applications	(3-0-2)	4
IT300	Design and Analysis of Algorithms	(3-0-2)	4
IT301	Parallel Computing	(3-0-2)	4
IT302	Probability and Statistics	(3-0-2)	4
IT303	Software Engineering	(3-0-2)	4
IT350	Data Analytics	(3-0-2)	4
IT351	Human Computer Interaction	(3-0-2)	4
IT352	Information Assurance and Security	(3-0-2)	4

#### Major Project (MP)

IT449	Major Project-I	(0-0-3)	2
IT499	Major Project-II	(0-0-6)	4

#### Mandatory Learning Courses (MLC)

CV110	Environmental Studies	(1-0-0)	1
SM111	Professional Ethics and Human Values	(1-0-0)	1
IT290	Seminar		1
IT440	Practical Training		2

#### Programme Specific Electives (PSE)

IT360	Information Systems	(3-0-2)	4
IT361	Paradigms of Programming	(3-0-2)	4
IT362	Computer Graphics	(3-0-2)	4
IT363	Microprocessors and Interfacing	(3-0-2)	4
IT364	Performance Modeling	(3-0-2)	4
IT365	Advanced Computer Networks	(3-0-2)	4
IT366	Object Oriented Analysis and Design	(3-0-2)	4
IT400	Perceptual Audio Processing	(3-0-2)	4
IT401	Perceptual Video Processing	(3-0-2)	4
IT402	Soft Computing	(3-0-2)	4
IT403	Genetic Algorithms	(3-0-2)	4
IT404	Artificial Neural Networks	(3-0-2)	4
IT405	Fuzzy System Models	(3-0-0)	3
IT406	Distributed Computing Systems	(3-0-2)	4
IT407	Technologies for Internet of Things	(3-0-2)	4
IT408	Mobile Computing	(3-0-0)	3
IT409	Embedded Systems	(3-0-0)	3
IT410	Bioinformatics	(3-0-0)	3
IT411	Knowledge Management	(3-0-0)	3
IT412	Time Series Analysis	(3-0-0)	3
IT413	System Integration	(3-0-0)	3
IT414	Data Warehousing and Data Mining	(3-0-2)	4
IT415	Middleware Technologies	(3-0-2)	4
IT416	Computer Vision	(3-0-2)	4
IT417	Pattern Recognition	(3-0-2)	4
IT418	Cloud Computing	(3-0-2)	4
IT419	Wireless Sensor Networks	(3-0-2)	4
IT420	Mobile Adhoc Networks	(3-0-2)	4
IT421	Semantic Web Technologies	(3-0-2)	4
IT422	Virtual Reality	(3-0-2)	4
IT423	Rich Internet Applications	(3-0-2)	4
IT450	Web Services	(3-0-0)	3
IT451	Software Architecture	(3-0-0)	3
IT452	Advanced Computer Architecture	(3-0-0)	3
IT453	Transaction Processing	(3-0-0)	3
IT454	Software Quality Assurance	(3-0-0)	3
IT455	Information Technology for Healthcare	(3-0-0)	3
IT456	Enterprise Resource Planning and Systems	(3-0-0)	3
IT457	Natural Language Processing	(3-0-2)	4
IT458	Information Retrieval	(3-0-2)	4
IT459	Simulation and Modelling	(3-0-2)	4
IT460	E-Commerce	(3-0-0)	3
IT461	Advanced Database Systems	(3-0-2)	4
IT462	Number Theory and Cryptography	(3-0-2)	4
IT463	Linux Kernel Internals	(3-0-2)	4
IT464	Foundations of Machine Learning	(3-0-2)	4
IT465	Cryptocurrencies and Blockchain Technologies	(3-0-2)	4

#### B.Tech (Minor) in Information Technology for Other Branches

IT210	Data Structures and Algorithms	(3-0-2)	4
IT252	Database Systems	(3-0-2)	4
IT254	Web Technologies and Applications	(3-0-2)	4
IT301	Parallel Computing	(3-0-2)	4
IT350	Data Analytics	(3-0-2)	4

For B.Tech (Honors) in Information Technology :

Students seeking Honors degree shall credit five courses of M.Tech (IT) including Program Core/Electives, offered by the Department of Information Technology and as decided by DUGC with 20 credits.

For other details, please see M.Tech (IT) Curriculum.



# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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## Suggested Plan of Study

Semester →	I	II	III	IV	V	VI	VII	VIII
<b>1</b>	MA110	MA111	IT200	IT250	IT300	IT350	IT440	IT499
<b>2</b>	CY110	PH110	IT201	IT251	IT301	IT351	IT449	Elective-5
<b>3</b>	CY111	PH111	IT202	IT252	IT302	IT352	Elective-2	Elective-6
<b>4</b>	AM110	ME110	IT203	IT253	IT303	SM302	Elective-3	Elective-7
<b>5</b>	CS110	ME111	IT204	IT254	SM300	Elective-1	Elective-4	---
<b>6</b>	CS111	SM110	IT205	IT290	---	---	---	---
<b>7</b>	CV110	SM111	IT206	---	---	---	---	---
<b>8</b>	IT110	IT150	---	---	---	---	---	---

## Degree Requirements:

Category of Courses	Minimum Credits to be Earned
Basic Science Core (BSC)	16
Engineering Science Core (ESC)	13
Humanities and Social Sciences Core (HSC)	9
Programme Core (PC)	77
Electives (ELE): Programme Specific Electives (PSE)	24
Major Project (MP)	6
Mandatory Learning Courses (MLC)	5
Total	150

# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

## Department of Chemical Engineering Bachelor of Technology in Chemical Engineering

### Basic Science Core (BSC)

MA110	Engineering Mathematics I	(3-0-0)3
PH110	Physics	(3-1-0)4
PH111	Physics Laboratory	(0-0-2)1
MA111	Engineering Mathematics II	(3-0-0)3
CY110	Chemistry	(3-0-0)3
CY111	Chemistry Laboratory	(0-0-3)2
CY205	Organic Chemistry	(3-0-0)3
CY255	Technical Analysis Laboratory	(0-0-4)2
CY300	Instrumental Methods of Analysis	(3-0-0)3

### Engineering Science Core (ESC)

EE110	Elements of Electrical Engineering	(2-0-0)2
EC100	Elements of Electronics & Communication Engineering	(2-0-0)2
ME110	Elements of Mechanical Engineering	(2-0-0)2
CS110	Computer Programming	(3-1-0)4
CS111	Computer Programming Lab	(0-0-2)1
AM110	Engineering Mechanics	(3-0-0)3
ME111	Engineering Graphics	(1-0-3)3

### Humanities and Social Sciences Core (HSC)

SM110	Professional Communication	(3-0-0)3
SM300	Engineering Economics	(3-0-0)3
SM302	Principles of Management	(3-0-0)3

### Programme Core (PC)

CH150	Process Calculations	(2-2-0)4
CH200	Momentum Transfer	(3-1-0)4
CH201	Particulate Technology	(2-1-0)3
CH202	Chemical Engg. Thermodynamics	(3-1-0)4
CH203	Transport Phenomena	(2-2-0)4
MA207	Numerical Methods	(3-0-0)3
MA211	Laplace and Z Transforms	(1-0-0)1
CH204	Computer Simulation Lab	(0-0-3)2
CH250	Heat Transfer	(3-1-0)4
CH251	Mass Transfer-I	(3-1-0)4
CH252	Chemical Reaction Engg.-I	(2-1-0)3
CH253	Momentum Transfer Lab	(0-0-3)2
CH254	Particulate Technology Lab	(0-0-3)2
CH300	Chemical Reaction Engineering – II	(2-1-0)3
CH301	Mass Transfer – II	(3-1-0)4
CH302	Process Dynamics & Control	(3-1-0)4
CH303	Heat Transfer Operations Lab	(0-0-3)2
CH350	Chemical Process Industries	(3-0-0)3
CH351	Process Design of Chemical Equipment	(3-1-0)4
CH352	Mass Transfer Operations Lab	(0-0-3)2
CH353	Design and Simulation Lab	(0-0-2)1

CH400	Pollution Control and Safety in Process Industries	(3-0-0)3
CH401	Chemical Reaction Engg. & Process Control Lab	(0-0-3)2

### Major Project (MP)

CH449	Major Project I	(0-0-3) 2
CH499	Major Project II	(0-0-6) 4

### Mandatory Learning Courses (MLC)

SM 11	Professional Ethics and Human values	(1-0-0)1
CV110	Environmental Sciences	(1-0-0)1
CH440	Practical Training	01
CH448	Seminar	02

### Electives (Ele)

CH450	Process Instrumentation	(3-0-0)3
CH451	Energy Technology	(3-0-0)3
CH452	Petroleum Refining Processes	(3-0-0)3
CH453	Biochemical Engineering	(3-0-0)3
CH454	Introduction to Molecular Simulations	(2-0-2)3
CH455	Energy Conservation & Management in Process Industries	(3-0-0)3
CH456	Fuel Cell Engineering	(3-0-0)3
CH457	Chemical Project Engineering	(3-0-0)3
CH458	Biology for Chemical Engineers	(3-0-0)3

### Minor Degree Courses

CH150	Process Calculations	(2-2-0)4
CH202	Chemical Engineering Thermodynamics	(3-1-0)4
CH203	Transport Phenomena	(2-2-0)4
CH252	Chemical Reaction Engineering I	(2-1-0)3
CH302	Process Dynamics and Control	(3-1-0)4
Minimum Credits to be earned		19

### Courses for Honours Degree in Chemical Engineering

CH701	Molecular and Turbulent Transport	(3-1-0) 4
CH702	Process System Analysis and Control	(3-1-0) 4
CH705	Process Modelling and Simulation	(3-0-2) 4
CH706	Statistical and Irreversible Thermodynamics	(3-1-0) 4
CH707	Chemical Reactor Design	(3-1-0) 4
CH764	Bioreactor Engineering	(3-1-0) 4
Minimum Credits to be earned		20

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

### Suggested Plan of Study:

Slot/Semester	I	II	III	IV	V	VI	VII	VIII
1	MA110	MA111	CH200	CH250	CH300	CH350	CH400	CH499
2	PH110	CY110	CH201	CH251	CH301	CH351	CH401	<i>Elective</i>
3	PH111	CY111	CH202	CH252	CH302	SM302	CH440	<i>Elective</i>
4	EE110	AM110	CH203	CY205	SM300	CY300	CH448	<i>Elective</i>
5	EC100	CS110	MA207	CH253	CH303	CH352	CH449	<i>Elective</i>
6	ME110	CS111	MA211	CH254	CY255	CH353	<i>Elective</i>	
7	ME111	CH150	CH204			<i>Elective</i>	<i>Elective</i>	
8	SM100	CV110						
9	SM111							

### Degree Requirements:

Category of Courses	Minimum Credits to be earned
Foundation Courses	
Basic Science Core (BSC)	24
Engineering Science Core (ESC)	17
Humanities and Social Sciences Core (HSC)	09
Programme Core (PC)	68
Elective Courses (Ele)	21
Mandatory Learning Courses (MLC)	05
Major Project (MP)	06
Total	150

# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

## Department of Mechanical Engineering

### Bachelor of Technology in Mechanical Engineering

<b>Foundation Courses:</b>			ME353	Automation Systems	(3-0-0)3
<b>Basic Science Core (BSC)</b>			ME354	Operations Research	(3-0-0)3
MA110	Engineering Mathematics - I	(3-0-0)3	ME451	Mechanical Lab - II	(0-0-3)2
MA111	Engineering Mathematics - II	(3-0-0)3	ME452	Machine Shop - II	(0-0-3)2
CY110	Chemistry	(3-0-0)3	<b>Electives</b>		
CY111	Chemistry Laboratory	(0-0-3)2	ME311	Finite Element Method	(3-0-0)3
PH110	Physics	(3-1-0)4	ME312	Theory of Elasticity	(3-0-0)3
PH111	Physics Laboratory	(0-0-2)1	ME313	Mechatronic Systems	(3-0-0)3
MA207	Numerical Methods	(3-0-0)3	ME314	Product Design and Development	(3-0-0)3
MA208	Probability Theory and Applications	(3-0-0)3	ME315	Theory of Metal Forming	(3-0-0)3
<b>Engineering Science Core Courses (ESC)</b>			ME316	Welding Technology	(3-0-0)3
AM110	Engineering Mechanics	(3-0-0)3	ME317	Basics of Computational Fluid Dynamics	(3-0-0)3
CS110	Computer Programming	(3-1-0)4	ME318	Principles of Turbomachinery	(3-0-0)3
CS111	Computer Programming Laboratory	(0-0-2)1	ME411	Theory of Fatigue and Analysis	(3-0-0)3
EE110	Elements of Electrical Engineering	(2-0-0)2	ME412	Experimental Stress Analysis	(3-0-0)3
EC100	Elements of Electronics and Communications Engineering	(2-0-0)2	ME413	Synthesis of Mechanisms	(3-0-0)3
ME111	Engineering Graphics	(1-0-3)3	ME414	Microsystem Technology	(3-0-0)3
AM217	Mechanics of Solids Lab	(0-0-2)1	ME415	Hydraulics and Pneumatic Control	(3-0-0)3
AM317	Fluid Mechanics and Machinery Lab	(0-0-2)1	ME416	Robotics	(3-0-0)3
<b>Humanities and Social Science Core (HSC)</b>			ME417	Non-Destructive Evaluation	(3-0-0)3
SM110	Professional Communication	(3-0-0)3	ME418	Production and Operations Management	(3-0-0)3
SM300	Engineering Economics	(3-0-0)3	ME419	Processing of Composites	(3-0-0)3
SM302	Principles of Management	(3-0-0)3	ME420	IC Engines	(3-0-0)3
<b>Programme Core (PC)</b>			ME421	Refrigeration and Air Conditioning	(3-0-0)3
ME112	Materials Science and Engineering	(3-0-0)3	ME422	Mechanics of Compressible Flow	(3-0-0)3
ME113	Mechanics of Deformable Bodies	(3-0-0)3	ME423	Multi Body Dynamics	(3-0-0)3
ME201	Basic Engineering Thermodynamics	(3-1-0)4	ME424	Vehicle Dynamics	(3-0-0)3
ME202	Fluid Mechanics and Machinery	(3-1-0)4	ME425	Contemporary Concepts in Product Design	(3-0-0)3
ME203	Mechanics of Machinery	(3-1-0)4	ME426	Automotive Electronics	(3-0-0)3
ME204	Basic Manufacturing Processes	(3-1-0)4	ME427	Introduction to Additive Manufacturing	(3-0-0)3
ME205	Workshop Practice	(0-0-3)2	ME428	Non-Traditional Machining Processes	(3-0-0)3
ME251	Applied Thermodynamics	(3-0-0)3	ME429	Energy Auditing and Management	(3-0-0)3
ME252	Analysis and Design of Machine Components	(3-1-0)4	ME430	Gas Turbines and Jet Propulsion	(3-0-0)3
ME253	Computer Aided Engineering	(3-0-0)3	ME431	Continuum Mechanics	(3-0-0)3
ME254	Manufacturing Technology	(3-0-0)3	<b>Project (MP)</b>		
ME255	Engineering Drawing	(1-0-3)3	ME498	Major Project - 1	(0-0-4)2
ME301	Metrology and Instrumentation	(4-0-0)4	ME499	Major Project - 2	(0-0-6)3
ME302	Heat Transfer	(3-0-0)3	<b>Mandatory Learning Courses (MLC)</b>		
ME303	Design of Mechanical Drives	(3-0-0)3	SM111	Professional Ethics & Human Values	(1-0-0)1
ME304	Automobile Engineering	(3-0-0)3	CV110	Environmental Studies	(1-0-0)1
ME305	Control Engineering	(3-0-0)3	ME440	Practical Training / Internship	(0-0-3)2
ME306	Metrology and CAD Lab	(0-0-3)2	ME490	Seminar	(0-0-2)1
ME307	Machine Shop - 1	(0-0-3)2	<b>Minor Courses</b>		
ME308	Mechanical Lab - 1	(0-0-3)2	ME501	Manufacturing Engineering	(3-1-0) 4
ME351	Energy Engineering	(3-0-0)3	ME502	Thermal Engineering	(3-1-0) 4
ME352	Machine Dynamics and Vibrations	(3-1-0)4	ME503	Mechanical Design	(3-1-0) 4
			ME504	Production Management	(3-1-0) 4
			ME505	Industrial Automation	(3-1-0) 4

**Honors Degree in Mechanical Engineering:** Students seeking Honors degree shall credit five PG courses offered by the Department of Mechanical Engg. and as decided by DUGC. Minimum requirement for Honors degree is 15 credits.

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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### Suggested Plan of Study

Sem →	I	II	III	IV	V	VI	VII	VIII
1	ME112/ ME113	ME113/ ME112	MA207	MA208	ME301	ME351	Elective-2	Elective-5
2			ME201	ME251	ME302	ME352	Elective-3	Elective-6
3			ME202	ME252	ME303	ME353	Elective-4	Elective-7
4			ME203	ME253	ME304	ME354	ME498	ME440
5			ME204	ME254	ME305	SM300		ME451
6			AM217/ME205	ME255	SM302	Elective-1		ME452
7				ME205 / AM217	ME306 / ME307	ME307 / ME306		ME499
8					AM317/ME308	ME308/AM317		ME490

### Degree Requirements:

Category of Courses	Minimum Credits to be Earned
Foundation Courses:	48
Programme core:	79
Programme Electives:	21
Project (MP):	05
Mandatory Learning Courses (MLC):	05
Total:	158

# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

## Department of Metallurgical and Material Engineering

### Bachelor of Technology in Metallurgical and Materials Engineering

#### Basic Science Core (BSC)

MA110	Engineering Mathematics – I	(3-0-0)3	MT353	Ceramics and Polymers Lab	(0-0-3)2
PH110	Physics	(3-1-0)4	MT354	Heat Treatment Lab	(0-0-3)2
PH111	Physics Laboratory	(0-0-2)1	MT400	Corrosion Engineering	(3-0-1)4
MA111	Engineering Mathematics – II	(3-0-0)3	MT401	Metal Forming	(2-0-1)3
CY110	Chemistry	(3-0-0)3			
CY111	Chemistry Laboratory	(0-0-3)2			

#### Engineering Science Core (ESC)

AM110	Engineering Mechanics	(3-0-0)3			
EC100	Elements of Electronics and Communication Engg	(2-0-0)2			
EE110	Elements of Electrical Engg.	(2-0-0)2			
ME110	Elements of Mechanical Engg.	(2-0-0)2			
CS110	Computer Programming	(3-1-0)4			
CS111	Computer Programming Lab	(0-0-2)1			
ME111	Engineering Graphics	(1-0-3)3			
AM200	Mechanics of Materials	(3-0-0)3			
ME200	Workshop	(0-0-2)1			

#### Humanities and Social Science Core (HSC)

SM110	Professional Communication	(3-0-0)3			
SM302	Principles of Management	(3-0-0)3			

#### Programme Core (PC)

MT160	Introduction to Materials Science & Technology	(3-1-0)4			
MT200	Testing of Materials	(2-0-1)3			
MT201	Metallurgical Thermodynamics & Kinetics	(3-1-0)4			
MT202	Physical Metallurgy	(3-1-0)4			
MT203	Polymer Science and Technology	(3-0-0)3			
MT204	Mineral Processing and Beneficiation	(3-0-1)4			
MT251	Transport Phenomena	(3-1-0)4			
MT252	Phase Diagrams	(3-1-0)4			
MT253	Principles of Extractive Metallurgy	(3-1-0)4			
MT254	X-ray Diffraction & Electron Microscopy	(3-1-0)4			
MT255	Instrumental Methods of Analysis	(3-0-1)4			
MT256	Measurements and Control	(3-0-0)3			
MT300	Production of Iron and Ferro Alloys	(3-0-0)3			
MT301	Heat Treatment	(3-1-0)4			
MT302	Machine Design	(3-1-0)4			
MT303	Electronic Properties of Materials	(3-0-0)3			
MT304	Physical Metallurgy Lab	(0-0-3)2			
MT305	Extractive Metallurgy Lab	(0-0-3)2			
MT350	Production of Steel	(3-0-0)3			
MT351	Ceramics and Refractories	(3-0-0)3			
MT352	Metallography Lab	(0-0-3)2			

#### Electives (Ele)

MT306	Fatigue, Fracture and Creep	(3-0-0)3
MT307	Fuels and Furnaces	(2-1-0)3
MT355	Powder Metallurgy	(3-0-0)3
MT356	Joining of Metals	(3-0-0)3
MT357	Aerospace Materials	(3-0-0)3
MT402	Foundry Technology	(2-0-1)3
MT403	Phase Transformations	(3-0-0)3
MT404	Extraction of Non-Ferrous Metals	(3-0-0)3
MT405	Secondary Refining of Steels	(3-0-0)3
MT406	Process Plant Materials	(3-0-0)3
MT407	Advanced Engineering Materials	(3-0-0)3
MT408	Thin Films, Coatings and Applications	(3-0-0)3
MT409	Nuclear Materials	(3-0-0)3
MT410	Fracture of Engineering Materials	(3-0-0)3
MT451	Composite Materials	(3-0-0)3
MT452	Advanced Welding Technology	(3-0-0)3
MT453	Surface Engineering	(3-0-0)3
MT454	Modeling & Simulation in Materials Processes	(3-0-0)3
MT455	Science & Technology of Nanomaterials	(3-0-0)3
MT456	Advanced Microscopic Techniques	(3-0-0)3
MT457	Smart Materials and Sensors	(3-0-0)3

#### Project (MP)

MT442	Major Project – I	(0-0-2)1
MT492	Major Project – II	(0-0-6)3

#### Mandatory Learning Courses (MLC)

CV110	Environmental Studies	(1-0-0)1
SM111	Professional Ethics & Human Values	(1-0-0)1
MT440	Practical Training	(0-0-3)2
MT441	Seminar	(0-0-2)1

#### Courses for Minor in Metallurgical and Materials Engg

MT202	Physical Metallurgy	(3-1-0)4
MT203	Polymer Science and Technology	(3-0-0)3
MT252	Phase Diagrams	(3-1-0)4
MT253	Principles of Extractive Metallurgy	(3-1-0)4
MT351	Ceramics and Refractories	(3-0-0)3

#### Total credits: 18

Students seeking Honors degree shall credit five PG courses offered by the Department of Metallurgical and Materials Engg. and as decided by DUGC. Minimum requirement for Honors degree is 15 credits.

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### Suggested Plan of Study:

Semester →	II	III	IV	V	VI	VII	VIII
1	MT160	MT200	MT251	MT300	MT350	MT400	Elective
2		MT201	MT252	MT301	MT351	MT401	Elective
3		MT202	MT253	MT302	MT352	MT440	Elective
4		MT203	MT254	MT303	MT353	MT441	MT492
5		MT204	MT255	MT304	MT354	MT442	
6		AM200	MT256	MT305	Elective	Elective	
7		ME200		SM302	Elective	Elective	
8							
9							
10							

### Degree Requirements:

Category of Courses	Minimum credits to be Earned
Foundation Courses (FC) [Including Basic Science Core (BSC)- 16, Engineering Science Core (ESC)-21 and Humanities and Social Science Core (HSC)- 6]	43
Programme Core (PC)	82
Electives (E)	21
Project (MP)	4
Mandatory Learning Courses (MLC)	5
Total	155

# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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## COURSE CONTENTS - UG

### Departments

i.	Dept. of Applied Mechanics & Hydraulics	02
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v.	Dept. of Electronics & Communication Engineering	41
vi.	Dept. of Electrical & Electronics Engineering	59
vii.	Dept. of Information Technology	76
viii.	Dept. of Chemical Engineering	91
ix.	Dept. of Mechanical Engineering	97
x.	Dept. of Metallurgical & Materials Engineering	110
xi.	Dept. of Chemistry	123
xii.	Dept. of Physics	128
xiii.	Dept. of Mathematical & Computational Sciences	130
xiv.	School of Management	137



# NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

## Department of Applied Mechanics and Hydraulics

### **AM110 ENGINEERING MECHANICS**

**(3-0-0) 3**

Fundamentals of force system, Concept of Rigid body and deformable bodies, Free body diagrams. Support Reactions-Determinate and Indeterminate structures. Analysis of Trusses, Frames and Machines. Centroid and Moment of Inertia of plane areas. Shear Force and Bending Moment Diagrams. Simple stress and strain, Hooke's Law, Mechanical properties of materials, Elastic Constants.

*Merian, J.L, Kraige, L.G. Engineering Mechanics – Statics, 5<sup>th</sup> Edition, Wiley Publishers, New-Delhi, 2007.*

*Beer & Johnston, Mechanics for Engineers, 4<sup>th</sup> Edition, McGraw – Hill, New Delhi, 1987.*

*Timoshenko, S.P., Young, D.H., Rao, J.V. Engineering Machines, 4<sup>th</sup> Edition, McGraw-Hill, Singapore, 1956.*

*Singer, F.L. Strength of Materials, Third Edition, Harper and Row Publishers, New York, 1980.*

*Hearn, E.J., Mechanics of Materials, Pergaman Press, England, 1972.*

*Beer and Johnston E. R. Mechanics of Materials, 3<sup>rd</sup> Edition, Tata McGraw Hill, New Delhi, 2007.*

### **AM200 MECHANICS OF MATERIALS**

**(3-0-0) 3 PREREQ: AM110**

Simple flexure theory, Bending stress and shearing stress distribution across sections. Deflection of beams, Macaulay's method for deflection of statically determinate beams. Compound stresses - analytical method, graphical method - Mohr's circle of stresses. Torsion, Transmission of power through hollow and solid shafts. Beams of uniform strength, springs, Combined bending and torsion, Strain energy, Theories of failure, Columns & struts, Thick and thin pressure vessels.

*Singer, F.L. Strength of Materials, 3<sup>rd</sup> Edition, Harper and Row Publishers, New York, 1980.*

*Hearn, E.J., Mechanics of Materials, Pergaman Press, England, 1972.*

*Beer and Johnston E. R. Mechanics of Materials, 3<sup>rd</sup> Edition, Tata McGraw Hill, New-Delhi, 2007.*

### **AM216 STRENGTH OF MATERIALS LAB**

**(0-0-3) 2**

Tension test on mild steel and cast iron, Compression test on mild steel and cast iron, Torsion test on mild steel rod, Rockwell and Brinell hardness tests, Impact test (Charpy and Izod) on mild steel, Bending test on mild steel rod and wood, Shear test on mild steel plate and rod, tests on leaf and helical spring. Demonstration on fatigue test.

*Hearn, E.J., Mechanics of Materials, Pergaman Press, England, 1972.*

*Beer and Johnston E. R. Mechanics of Materials, 3<sup>rd</sup> Edition, Tata McGraw Hill, New-Delhi, 2007.*

### **AM217 MECHANICS OF SOLIDS LAB**

**(0-0-2) 1**

Tension tests on mild steel and cast iron, Compression tests on mild steel and cast iron, Shear tests, Bending test on mild steel, Torsion test, Hardness test and Impact test. Demonstration on fatigue test and springs

*Hearn, E.J., Mechanics of Materials, Pergaman Press, England, 1972.*

*Beer and Johnston E. R. Mechanics of Materials, 3<sup>rd</sup> Edition, Tata McGraw Hill, New-Delhi, 2007.*

### **AM218 MECHANICS OF FLUIDS**

**(3-0-0) 3**

Properties and classification of fluids. Basic equation of fluid statics. Manometers. Buoyant force. Kinematics of fluid flow. Continuity equation. Bernoulli's equation. Momentum equation. Flow measurements: Brief introduction. Dimensional analysis. Model law. Basics of pipe flow. Hagen-Poiseuille equation. Darcy-Weisbach equation. Moody's diagram. Uniform flow in open channels.

*Modi, P.N and Seth, S.M., Hydraulics and Fluid Mechanics, Standard Book House, Delhi, 2010.*

*Streeter. V.L and Wylie. E.B., Fluid Mechanics, McGraw Hill Book Company, New York, 1997.*

*Ven Te Chow, Open Channel Hydraulics, McGraw Hill, New York 1959.*

### **AM260 WATER RESOURCES ENGINEERING**

**(3-0-0) 3 PREREQ: AM250**

Hydrology: Hydrologic cycle, Water budget, Catchment. Precipitation: types, measurement, intensity, duration, temporal and spatial analysis. Infiltration, soil moisture, evaporation, transpiration, Groundwater. Runoff: components, factors, hydrographs, unit hydrograph, flood estimation. Irrigation: objectives, methods, irrigation water requirements. Components of irrigation system and design principles. Water Power Engineering: Basic principles, types of schemes

*Subramanya K, Engineering Hydrology, Tata McGraw Hill, 3<sup>rd</sup> Edition, 2008.*

*Garg S. K, Irrigation Engineering and Hydraulic Structures, Khanna Publishers, 2008.*

*Ven Te Chow, LW Mays and DR Maidment., Applied Hydrology, McGraw Hill, 1988.*

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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### AM219 HYDRAULICS LAB

(0-0-3) 2 PREREQ: AM250

Calibration of V notch, Rectangular Notch; Venturimeter, Orifice meter, Water meter. Friction factor of pipes. Impact of jet on vanes. Tests on centrifugal pump, reciprocating pump, Pelton wheel turbine, Francis turbine. Hydraulics jump, Syphons, Demonstration experiments (pressure gauge, Pitot tube, Kaplan turbine)

*Modi, P.N and Seth, S.M., Hydraulics and Fluid Mechanics, Standard Book House, Delhi, 2010*

### AM317 FLUID MECHANICS AND MACHINERY LAB

(0-0-2) 1 PREREQ: ME202

Calibration of V notch, Venturimeter, Orifice meter, Water meter. Friction factor of pipes. Impact of jet on vanes. Tests on centrifugal pump, reciprocating pump, Pelton wheel turbine. Demonstration experiments (pressure gauge, Pitot tube, Kaplan turbine)

*Modi, P.N and Seth, S.M., Hydraulics and Fluid Mechanics, Standard Book House,*

### AM371 OPEN CHANNEL FLOW AND SEDIMENT TRANSPORT

(3-0-0) 3 PREREQ: AM250

Steady GVF, SVF, RVF. Unsteady flow: basic equations, velocity of flood wave discharge, flood routing. Bulk properties of sediments, various related theories such as competent velocity concepts, lift concept, critical tractive force concept, Shield's analysis, regimes of flow, bed forms, resistance to flow, bed and suspended load transport, reservoir sedimentation, aggradation and degradation of rivers, local scour, sediment samplers.

*Subramanya. K, Open channel flow, Tata McGraw Hill, 3rd Edition, 2010. Graf, W. H.*

*Hydraulics of sediment transport, McGraw Hill, 1984.*

*Garde and Rangaraju, Sediment transport, Wiley Eastern, 2nd Edition, 1985 Chow, V.*

*T. open channel flow*

### AM372 CIVIL ENGINEERING SYSTEMS

(3-0-0) 3

Introduction to systems approach, simple and complex system, unique features of complex system. Unconstrained optimization, concave & convex functions, constrained optimization - KT conditions, Lagrangian multiplier method. Introduction to LP, Simplex method, Two phase method, Duality in LP, Introduction to DP, Network model, Allocation model. Some typical case studies.

*Rao. S.S., Engineering Optimization, Wiley-IEEE, 3rd Edition, 1996.*

*Taha, H.A, Operation Research, Prentice Hall, 6th Edition, 1997.*

*Panik M. .J., Classical optimization foundation, North Holland Pub. Co., 1976.*

### AM380 MINI PROJECT – I

(0-0-3) 2

Experimental work either in the field or in the laboratory or design tasks of relatively smaller magnitude compared to Major Project work and in line with the guidelines formulated by the DUGC (AM).

### AM381 MINI PROJECT – II

(0-0-3) 2

Experimental work either in the field or in the laboratory or design tasks of relatively smaller magnitude compared to Major Project work and in line with the guidelines formulated by the DUGC (AM).

### AM400 GEOGRAPHIC INFORMATION SYSTEMS

(3-0-0) 3

Components of GIS, functions, Coordinate Systems, Raster and vector-based GIS and data structures, Spatial data sources Geo-relational Vector data model, Object based vector data model, raster data model, data input, geometric Transformation, Spatial data editing, Attribute data input and management, vector data analysis, Raster data analysis., Applications of GIS in several domains

*Kang-tsung Chang, Introduction to Geographic Information Systems, 4<sup>th</sup> edition Tata McGraw Hill Burrough & McDonnell, Principles of Geographical Information Systems, Oxford University Press*

*Yang, Snyder & Tobler, Map projection Transformation principles and applications, Taylor and Francis*

### AM401 SATELLITE DIGITAL IMAGE ANALYSIS

(3-0-0) 3

Introduction to Remote sensing and Digital image Processing, Remote sensing data collection Alternatives, Hardware and software issues, Image Quality assessment, Electromagnetic Energy Radiation Principles and radiometric correction, Geometric correction, Image Enhancement, Pattern Recognition, Information extraction from MSS and Hyperspectral data, Change detection studies.

*Jensen J.R Remote Sensing of the Environment An Earth Resource Perspective Second Edition, Dorling Kindersley*

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India Pvt Ltd.

Jensen J.R *Introduction to Digital Image Processing: A remote sensing Perspective*. Prentice- Hall, 2005. Lillesand, T.M., R.W. Kiefer, and J.W. Chipman. *Remote Sensing and Image Interpretation*. 5th Edition. John Wiley and Sons. 2004.

### AM402 INTRODUCTION TO GEOSPATIAL TECHNOLOGIES AND APPLICATIONS (3-0-0)3

Introduction to Geographic Information Systems, spatial data sources and models, spatial data analysis and applications, GPS principles and applications, introduction to satellite remote sensing, sensors and resolution, image processing methods classification, accuracy assessment in GIS and GPS, change detection; applications of GIS, remote sensing and GPS in resources management, environmental monitoring, optimal site selection, rural and urban development.

Chang K., *Introduction to Geographic Information Systems*, 8<sup>th</sup> Edition, McGraw-Hill, New York, 2006.

Hofman-Wellenhof. B., Wein. *Global Positioning System: theory and practice*, Springer 2001

Lillesand, T. and Kiefer, R.W., *Remote Sensing and Image Interpretation*, 5th edn., 2004

Richards, J.A. and Jia, X., *Remote Sensing Digital Image Analysis*, 4th ed., Springer, 2006.

### AM403 GLOBAL POSITIONING SYSTEMS (3-0-0) 3

Introduction to GPS, GPS details, GPS Errors and Biases , Datum, Coordinate Systems and Map Projections , GPS Positioning Modes, Ambiguity-Resolution Techniques, GPS Data and Correction Services, GPS standard Formats, GPS integration, GPS applications, Other Satellite Navigation Systems Ahmed El- Rabbany " *Introduction to GPS*" Artech House Rao,

K.N. R *Fundamentals of Satellite Communications PHI*, 2004

### AM421 DESIGN & DRAWING OF HYDRAULIC STRUCTURES (1-0-3) 3 PREREQ: AM 300

Introduction to Lacey's regime theory, Khosla's theory, Bligh's creep theory, Hydraulic design and drawing of following structures: i. Earthen dam; ii. Gravity dam (OS); iii. Gravity dam (NOS); iv. Surplus weir; v. Canal drop; vi. Canal regulator; vii. Tank sluice with tower head; viii. Direct sluice; ix. Aquaduct.

Punmia, B.C and Lal, P.B.B. *Irrigation & Water Power Engineering*, Standard Book House, 2nd Edition, 1990.

Michel, W.H. *Manual of Irrigation Engineering*, Hubbard Press, 1997.

C.S. Murthy, *Water Resources Engineering: Principles and Practices*, New Age International, 1997.

### AM422 FUNDAMENTALS OF COASTAL ENGINEERING (3-0-0) 3 PREREQ : AM250

Basic Wave Hydrodynamics, Linear Wave Theory, Wave Phenomena, Generation of Wind Waves, Wave Spectrum, Wave Forecasting, Basics of Wave Structure Interaction, Coastal Processes - Littoral Drift, Coastal Erosion and Protection (Hard and Soft Options), Design Principles of Breakwaters.

*Shore Protection Manual*, U.S. Army Corps of Engineers, Coastal Engineering Research Center, 1984. US Army Corps of Engineers, 'Shore protection manual (SPM)', Vol. 1 & 2, Coastal Engg Res. Centre, US Govt. Printing Office, Washington D.C. USA, 1984.

US Army Corps of Engineers, 'Coastal Engg. Manual (CEM)', Parts 1 to 6, Coastal Engg Res. Centre, Washington D.C. USA., 2006.

Ippen A.T., *Estuary & Coastline Hydrodynamics*, McGraw Hill, New York, USA, 1996.

### AM423 BASICS OF OFFSHORE ENGINEERING (3-0-0) 3 PREREQ: AM 250

Ocean Waves, Currents, Winds, Ice and Mud loading, Basics of Offshore Structures - Jacket, Tower, Gravity platforms, Hybrid Structures and factors governing their selection, Linear wave theory, Morison equation. Linear dynamic analysis, Pile foundations, Bearings capacity of footings, Corrosion and under water Welding.

US Army Corps of Engineers, 'Shore protection manual (SPM)', Vol. 1 & 2, Coastal Engg Res. Centre, US Govt. Printing Office, Washington D.C. USA., 1984.

US Army Corps of Engineers, 'Coastal Engg. Manual (CEM)', Parts 1 to 6, Coastal Engg Res. Centre, Washington D.C., USA, 2006.

Weigel R.L., *Recommended practice for Planning, Designing, & Construction of Fixed Offshore Structures - Oceanographical Engg.*, Prentice Hall, 1969.

Pilarczyk K. W. and Zeidler R. B., "Offshore breakwaters and Shoreline Evolution Control", A. A. Balkema Publishers, Rotterdam, The Netherlands, 1996.

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

### AM424 COASTAL EROSION & ITS MITIGATION

(3-0-0) 3 PREREQ : AM 250

Origin of Coasts, Sediment Transport and Budgeting, Coastal Erosion and Mitigation: A Global Scenario and Indian Perspective, Coastal Processes, Planning and Design of Coastal Protection Works, Soft and Hard Options, Innovative Technologies, Remote Sensing, Geographical Information System and Artificial Neural Network in Coastal Engineering, Performance of Coastal Protection Works in India, Coastal Zone Regulation, Integrated Coastal Zone Management, Coastal Pollution and Environmental Impact Assessment.

*Bruun, P., Port Engineering, Vol. I*

*Shore Protection Manual, U.S.Army Corps of Engineers, Coastal Engineering Research Center, U.S.Govt. Printing office, Washington D.C., Vol. 1 & 2. 1984.*

*Ippen A.T., Estuary and Coast line Hydrodynamics McGraw Hill, 1966*

### AM445 FUNDAMENTALS OF FINITE ELEMENT METHOD

(3-0-0) 3

Direct approach. Basic structural elements. Finite difference method, Galerkin weighted residual approach, Rayleigh Ritz method, Element properties. Linear and quadratic elements, shape functions. Isoparametric elements. Numerical integration using Gauss-Legendre quadratures, 1-D problems. Shape function for 4, 8 and 9 nodal quadrilateral elements, Stiffness matrix and consistent load vector, Evaluation of element matrices using numerical integration.

*Robert D Cook, David S Malkus, Michael E Plesha, 'Concepts and Applications of Finite Element Analysis', 4th edition, John Wiley and Sons, Inc., 2003.*

*Reddy J.N., An Introduction to Finite Element Method, McGraw Hill – 2000.*

*Rao. S.S., Finite Element Methods in Engineering, Butterworth and Heinemann, 2001.*

*L.T. Segerlind, Applied Finite Element Analysis, John-Wiley, 2nd edition, 1984.*

### AM455 ENGINEERING OPTIMIZATION

(3-0-0) 3

Optimization, Formulation of linear Optimization problems, Linear Programming model, Graphical method, Simplex method, Finding a feasible basis - Big M and two phase Simplex method, Duality in Linear Programme. Primal-dual relationship. Sensitivity analysis. Network analysis: Transportation problem. Dynamic Programming (DP); Non-linear Programming-unconstrained and constrained optimization, Lagrange multipliers and Kuhn - Tucker conditions.

*F.S.Hiller and G.J.Liberman, Introduction to Operations Research.*

*Ravindran, D. T. Philips and J.J.Solberg, Operations Research - Principles and Practice.*

*Hadly.G, Linear Programming(LP)*

*S.S.Rao, Engineering Optimisation*

### AM473 WATER RESOURCES EXCESS MANAGEMENT

(3-0-0) 3 PREREQ : AM 300

Excess rainfall, Direct runoff, Peak flow estimation, Frequency and Return Period, Risk, Design storm, Design Storm Hydrograph. Flow routing. Drainage of urban areas, System components and Design principles, Storm water management.

*Ven Te Chow, LW Mays and DR Maidment., Applied Hydrology, McGraw Hill, 1988.*

*American Society of Civil Engineers Task Committee on Hydrology Handbook, Hydrology Handbook, 2<sup>nd</sup> edition, ASCE Manuals & Reports on Engg. Practice No.28, 1996*

*Mays. L.W. Water Resources Handbook, McGraw Hill, 2007.*

### AM474 COMPUTATIONAL METHODS IN HYDROLOGY

(3-0-0) 3 PREREQ : AM 300

Introduction, Hydrometeorological measurements, Hydrological models, catchment simulation. Continuity, momentum and energy equations, differential equations in hydrology. Finite difference technique, Finite element method, Galerkin method, steady and transient problems. Model application, flow routing, wave motion, unsaturated /saturated ground water flow.

*Maidment, D. Hand Book of Hydrology, McGraw Hill, 1st edition, 1993.*

*Huyakorn and Pinder, Computational methods in subsurface flow, Academic Press, New York, 1983. Zienkiewicz O.C. and Morgan, K., Finite elements and approximation, John Wiley, 2006.*

### AM475 GROUNDWATER ENGINEERING

(3-0-0) 3 PREREQ : AM 300

Fundamentals of ground water flow, Mechanics of well flow, Image well theory, Well design, Well characteristics, Production tests and maintenance. Pollution of aquifers: salt water intrusion, Aquifer remediation and management, Groundwater recharge, Rainwater harvesting, Ground water rights.

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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Todd D.K, *Ground water hydrology*, 3rd edition, Wiley, 2008.

Walton, W.C., *Ground water resource evaluation*. McGraw Hill, 1970. Raghunath, H.M., *Ground Water*, New Age International, 3rd edition, 1998. Karanth, K. *Groundwater Assessment and Management*, Tata McGraw Hill, 2007.

### AM477 OPEN SOURCE VIRTUAL INSTRUMENTATION

(2-0-2) 3

Introduction to Open Source Virtual Instrumentation, Basics of Open Source Programming and data acquisition, Basics of Open source Sensors, actuators and its characteristics, Design and development of Smart Management Systems using Virtual Instrumentation. Lab component : Open source technique for identification of natural frequency of simplified real world system. Experimental methods of system parameter identification. Experiment on smart monitoring of Agricultural related sensors, pumps, energy meter, Experiment on development of Smart Management Systems.

D Patranabis *Sensors and Transducers*, Phl 2nd Edition, 2003.

J.P Holman *Experimental Methods for Engineers*, McGrawHill 6th Edition, 2000.

Matt Richardson, Shawn Wallace, *Getting Started with Raspberry Pi Maker Media Inc.*, 2012.

### AM478 THEORY OF ISOTROPIC ELASTICITY

(3-0-0) 3 PREREQ.: AM200 or AM201

Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant's principle - Principal Stresses, Stress Ellipsoid - Stress invariants. Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams. Equations of equilibrium, Strain - displacement relations, Stress - strain relations, Airy's stress function, Axi - symmetric problems, Introduction to Dunder's table, Curved beam analysis, Kirsch, Michell's and Boussinesque problems - Rotating discs. Navier's theory, St. Venant's theory, Prandtl's theory on torsion, semi - inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections.

Wang, C. T., *Applied Elasticity*, McGraw - Hill Co., New York, 1993.

Sokolnikoff, I. S., *Mathematical Theory of Elasticity*, McGraw - Hill, New York, 1978.

Volterra & J.H. Caines, *Advanced Strength of Materials*, Prentice Hall, New Jersey, 1991

Barber, J. R., *Elasticity*, Kluwer Academic Publishers, 2004

Timoshenko, S., and Goodier, T.N., *Theory of Elasticity*, McGraw - Hill Ltd., Tokyo, 1990.

Ansel C Ugural and Saul K Fenster, 'Advanced Strength and Applied Elasticity', 4th Edition, Prentice Hall, New Jersey, 2003.

Bhaskar, K., and Varadan, T. K., *Theory of Isotropic/Orthotropic Elasticity*, CRC Press USA, 2009.

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## Department of Civil Engineering

### **CV100 CIVIL ENGINEERING MATERIALS AND CONSTRUCTION**

**(3-1-0) 4**

Traditional materials : stone, brick, tiles-roofing and flooring, steel, timber, lime, cement, their manufacture, properties and codal requirements. Mortar, cement concrete, properties, specifications and tests for quality control. Reinforced concrete, fibre reinforced concrete and ferrocement applications. Paints, enamels, varnishes, tar, bitumen, asphalt, properties and use. Modern materials: plastics, rubber, polymer, fibre reinforced plastics, manufacture, properties and use. Introduction to composites and smart materials. Building Construction: Foundations; Stone Masonry - Random rubble and Ashlar,; Brick Masonry -Rules for bonding, stretcher and header bonds and English Bond for 1 and 1 V brick thickness,; Doors and Windows; RCC Stairs and design of a dog-legged stair; Pitched Roofs and Simple Trusses; RC Constructions - Lintels and sunshades, beams and one-way and two-way slabs.

S.K. Duggal, Building Materials, Oxford & IBH publishing Co. Ltd., New Delhi

2000 M.S. Shetty, Cement Technology, Theory and Practice, S.C. Chand & Co. Ltd.,

2002 B.C.Punmia, Building Construction

### **CV110 ENVIRONMENTAL STUDIES**

**(1-0-0) 1**

Definition, scope and importance of Environmental Studies, Need for public awareness. Natural Resources Renewable and Non-renewable Resources. Natural resources and associated problems. Concept of an ecosystem: Structure and function of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains and ecological pyramids, Biodiversity and Its Conservation, Environmental Pollution: Definition, Causes, effects and control measures. Pollution case studies. Disaster management, Social Issues and the Environment, Environmental ethics, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation,

Consumerism and waste products, Acts related to Environment Protection, Issues involved in enforcement of environmental legislation, Human Population and the Environment, Field work equal to 5 lecture hours. R.

Rajagopalan, Environmental Studies, Oxford IBH Pub,2011.

Benny Joseph, Environmental Studies, McGraw Hill Pub,2008.

ErachBharucha, Textbook for Environmental Studies, Pub., UGC,2004.

Masters, Gilbert M. Introduction to Environmental Engineering and Sciences, Prentice Hall India,2008.

### **CV201 ELEMENTS OF SURVEYING**

**(3-0-0) 3**

Introduction to Surveying, Chain Surveying, Compass Surveying, Errors, Accuracy and precision. Introduction to plane table surveying. Levelling, contouring, Theodolite traverse. Introduction to tachometric surveying and Trigonometric leveling. Horizontal curves. Introduction to vertical curves.

Electronic distance measurements - Introduction. Minor Instruments, Digital Theodolite and total Station.

B.C. Punmia,Surveying Vol. I and II -STD

K. R. Arora,Surveying Vol-I &II- STD Book, New Delhi.

S.K. Roy,Fundamentals of surveying -Prentice - Hall of India, New Delhi.

### **CV202 ENGINEERING GEOLOGY**

**(3-0-0) 3**

General Geology, Physical Geology, Mineralogy, Petrology. Study of Igneous, Sedimentary, Metamorphic rocks, Physico - mechanical properties of rocks.

Structural geology : Study of folds, faults, Joints, unconformities: resource engg., remote sensing applications, Hydrogeology : Aquifers, geophysical exploration, selection of dam sites, tunnels, landslide control measures, environmental geology.

Parbin Singh, Engineering and General Geology, Katson Pub., Delhi, Sixth edition 2001.

Blyth. F.G.H & De Freitas M.H. Engineering Geology, ELBS, 7<sup>th</sup> Edition, 1984

D.V.Reddy, Engineering Geology for Civil Engineers, Oxford IBH Publishers,1995,1997.

### **CV203 MINING GEOLOGY**

**(3-0-0) 3**

Physical Geology; Interior of the earth, Geological processes, Geological hazards. Mineralogy; physical properties, Quartz, Silicates, carbonate minerals, petrology; study of Igneous, Sedimentary, Metamorphic rocks.

Stratigraphy; principles, geological time scale, Dharwars, Gondwana, tertiary systems. Paleontology; fossils and their uses, fossil fuels; coal and petroleum geology.

Parbin Singh, Engineering and General Geology, Katson Pub. Delhi, 6th Edition 2001

MukerjeeP.K. A text book of Geology, World Press Pvt. Ltd. 11th Edition, 1990

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### **CV216 CIVIL ENGINEERING MATERIALS LAB**

**(0-0-3) 2**

Sampling and testing of materials as per BIS specifications and codal requirements. Cement, fine and coarse aggregates, bricks, roofing and flooring tiles.

V.V. Sastry & M.L. Gambhir, Laboratory Manual of Concrete Testing (Part - I), Dhanpat Rai & Sons, New Delhi 1992.

Relevant BIS codes for testing of materials.

### **CV218 MINING GEOLOGY LABORATORY**

**(0-0-3) 2**

Mineralogy; Megascopic study of minerals, Microscopic study of minerals, Petrology; Megascopic study of rocks, Microscopic study of rocks.

Paleontology; Identification and description of fossils Crystallography; Study of crystals through crystal models

Simmons & Schudren guide, Rocks and Minerals

Cornelius S. Hurlbut. Jr. Dana's manual of Mineralogy, John Wiley and Sons, 1985

### **CV251 DESIGN OF RCC STRUCTURES**

**(3-0-0) 3**

Strength properties and behaviour of concrete and reinforcing steel. Basic principles of working stress design.

Limit state design concepts. Designing of members subjected to flexure, shear, torsion, axial forces and combinations, uniaxial and biaxial bending of columns. Design of simply supported and continuous beams and slabs; two-way slabs, isolated and combined footings. Computation of deflection and crack width. Ashok K Jain, Reinforced Limit State Design, Nem Chand & Bros. Roorkee, 1998.

Unnikrishna Pillai and Devadas Menon, Reinforced Concrete Design, Tata- McGrawhill, 1997.

### **CV252 SOIL MECHANICS**

**(3-0-0) 3**

Soil formation, Three-phase system, Index properties of soils, Soil classification, Hydraulics of soils, Stress distribution in soils, Soil compaction, One dimensional consolidation, Effective stress and pore water pressure, Shear strength of soils.

T.W.Lambe and R.V.Whitman, Soil Mechanics, John Wiley and Sons, Inc, New York. V.N.S.Murthy, Soil Mechanics and Foundation Engineering, Dhanpat Roy and Sons, New-Delhi. Relevant IS Codes(Latest editions).

### **CV253 STRUCTURAL ANALYSIS**

**(3-0-0) 3**

Conditions of equilibrium, degrees of freedom, determinate and indeterminate structures, Linear and non- linear structural systems. Deflection of beams: Moment area method and conjugate beam method, the first theorem of Castigliano, Betti's law, Clark Maxwell's Theorem of reciprocal deflection, strain energy method and unit load method. Redundant Structures: The second theorem of Castigliano, Consistent deformation method, slope deflection method. Rolling loads and influence lines: Statically determinate beams and bridge trusses, series of loads and uniformly distributed loads, criteria for maximum and absolute maximum moments and shears. Three-hinged arches, influence lines, Cables and suspension bridges, suspension bridge with three hinged stiffening girders and influence line diagrams.

Norris and Wilber, Elementary structural analysis.

C.K. Wang, Statically indeterminate structures

### **CV254 HIGHWAY AND TRAFFIC ENGINEERING**

**(3-0-0) 3**

Introduction: Initial recommendations for highway planning in India, saturation system, Third 20 year road development plan and fundamentals of transportation systems, planning on trip generation, distribution, assignment and modal split.

Traffic Engineering: Vehicular and road user characteristics, traffic studies, junctions and signals, traffic control

devices Highway alignment and geometric design: Highway alignment, cross-sectional elements, horizontal alignment and vertical alignment Highway design and construction: design of flexible and rigid pavements, WBM and bituminous concrete roads and highway maintenance.

S.K. Khanna and C.E.G. Justo, Highway Engineering, Nemchand Bros., Roorkee

L.R. Kadiyali, Traffic and Transport Planning, Khanna Publishers, New Delhi

### **CV265 SURVEYING PRACTICE**

**(0-0-3) 2**

Chain, Compass, Plane table leveling theodolite and tacheometric surveying, curve Setting, Demonstration of Total Station.

P.C. Punmia, Surveying Vol. I and II -STD

K. R. Arora, Surveying Vol-I & II- STD Book, New Delhi.

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### **CV266 GEOLOGY LAB**

**(0-0-3) 2**

Mineralogy: Identification and description of important rock -forming and ore minerals. Petrology: Identification and description of Igneous, Sedimentary, Metamorphic rocks.

Structural Geology: Interpretation of geological and Structural geological maps, Solving Dip and strike problems.

K.M. Gurappa, Structural geology Manual

B.S. SathyaNarayanawamy Engineering Geology Laboratory Manual, Eurasia pub.

### **CV267 SOIL MECHANICS LAB**

**(0-0-3) 2**

Identification of soils, Index properties of soils, Soil permeability, Light compaction test, Coefficient of consolidation, Direct shear test, Unconfined comp. Test, Triaxial comp. Test and Vane shear test, CBR test.

T.W.Lambe, Soil Testing for Engineers, John Wiley and Sons, Inc, New York. SP36 Part 1 and Part 2 (Latest editions).

### **CV268 ADVANCED MINING GEOLOGY**

**(3-0-0) 3**

Structural Geology; Dip and Strike, study of folds, faults, Joints, unconformities, Economic Geology; Magmatic, Hydrothermal, Sedimentary, Metamorphic deposits, oxidation and supergene enrichment, study of Gold, Iron, copper, lead, Zinc Chromite, manganese, bauxite, mica, asbestos, magnetite, borytes deposits.

Exploration Geology; Principles, Stage of mineral exploration, Geological, Geophysical, geochemical and remote sensing methods of exploration. Applied Geology; Sampling, guides for locating ore deposits, geological mapping, Hydrogeology.

ArogyaSwamy, Courses in Mining Geology, Oxford & IBH, 1988

Bateman A.M., Economic mineral deposits, John Wiley & Sons

Billings, Structural Geology

### **CV301 ENVIRONMENTAL ENGINEERING**

**(3-0-0) 3**

Essentials of water and wastewater engineering systems, quantities, sources, water distribution systems, planning and analysis. Wastewater collection. House drainage. Water and wastewater characteristics.

Drinking water standards. Unit operations and processes of water and wastewater treatment. Design of treatment units.

Fair & Geyer, Water Supply and Waste water disposal, John Wiley Publications

B.C. Punmia & Ashok Jain, Water supply Engineering & Wastewater Engineering, Arihant Publications

### **CV316 BUILDING DESIGN AND DRAWING**

**(1-0-3) 3**

Foundations; Doors and Windows; Stairs - proportioning and designing of different types of staircases for residential and commercial buildings; Different types of roofs and trusses. Functional design of buildings: To draw the line-diagram, plan, elevation and section and line-sketches of different types of buildings (school, hospital, hostel, residential, office etc.). Introduction to AutoCAD.

Shah and Kale, Principles of Building Drawing Sharma and Kaul,

Text of building construction B.C. Punmia, Building construction

### **CV351 DESIGN OF STEEL STRUCTURES**

**(3-0-0) 3**

General principles of elastic method of design of steel structures. Bolted and welded connections, Tension and compression members, laterally supported and unsupported beams, unsymmetrical bending, built up beams, plate girders, members subjected to axial force and uniaxial and biaxial moments. Introduction to the limit state design philosophy of steel structures.

A.S. Arya and J.L. Ajmani, Design of steel structures, Nem Chand Bros, Roorkee.

Ramachandra, Vol I & II, Design of steel structures, Standard Book House, New Delhi.

S.K. Duggal, Design of Steel Structures, Tata McGraw Hill, Publishing Co. Ltd., New Delhi. Related IS Codes

### **CV366 HIGHWAY MATERIALS AND CONCRETE TESTING LAB**

**(0-0-3) 2**

Tests on highway materials, aggregates and bituminous materials; tests on fresh concrete; workability tests; tests on hardened concrete; strength tests; destructive and non-destructive testing; tests on R.C. beams and columns.

S.K. Khanna and C.E.G. Justo, Highway materials Testing - Nem Chand Bros, Roorkee

V.V. Sastry and M.L. Gambir, Laboratory manual on concrete testing (Part II).

### **CV367 ENVIRONMENTAL ENGINEERING LAB**

**(0-0-3) 2**

pH, colour, turbidity; Solids - suspended, dissolved, settleable and volatile; Dissolved oxygen, BOD,



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COD; Determination of fluorides and iron; hardness, chlorides; Nitrite-Nitrogen and Ammonical -nitrogen; Available chlorine in bleaching powder, residual chlorine in water and chlorine demand; Bacteriological quality of water- presumptive test, confirmation test and determination of MPN; Jar test

Kotaiah B. and Kumaraswamy N, "Environmental Engineering Laboratory Manual", Charitor Publishing House, India.

APHA, "Standard Methods for testing of water and wastewater, 21<sup>st</sup> Edition, American Public Health Association, Washington, D. C.

BIS-10500: Indian Standards Code for Water

BIS-3025: Indian Standards Code for Testing of Water

### **CV401 ESTIMATION, COSTING AND SPECIFICATIONS**

**(3-0-0) 3**

Methods of estimating, measurements, taking out quantities, typical estimates for buildings, and Civil Engineering works, Specifications for all types of building items. Analysis of rates, data for various building items, Earthwork calculations. Introduction to Departmental procedures, tender, contracts, arbitration, valuation of buildings.

B.N. Dutta, Estimating and Costing in Civil Engineering Theory and Practice.

M. Chakroborti, Estimating, Costing & Specifications in Civil Engineering.

S.C. Rangawala - Valuation of Real Properties, Charotar Publishing House.

### **CV417 STRUCTURAL DESIGN AND DRAWING PREREQ: CV251, CV351**

**(1-0-3) 3**

R.C. design- R.C. staircases, retaining walls - Cantilever and Counterfort type, Water tank- rectangular and circular tanks, underground and resting on ground. Framed structures.

Steel design - Connections: Column splices, column bases, beam - columns, Steel purlins and roof trusses, connection between roof truss and supporting column, bracing systems.

N. Krishna Raju, Structural Design and Drawing - R.C. and Steel, University Press, Hyderabad.

D. Krishna Murthy, Structural Design & Drawing, Vol II&III, C.B.S. Publishing Co., New Delhi.

### **CV321 APPLIED SOIL ENGINEERING**

**PREREQ: CV 252**

**(3-0-0) 3**

Soil exploration, Earth pressure and its determination, Bearing capacity - Theoretical methods and Insitu tests, Stability of slopes by various approaches, Load carrying capacity of single and group of piles. Ground improvement methods. Introduction to soil dynamics.

B.M. Das, Principles of Geotechnical Engineering, The PWS Series in Civil Engg.

V.N.S. Murthy, Soil Mechanics and Foundation Engineering, Dhanpat Rai & Sons, New Delhi.

### **CV322 CONCRETE TECHNOLOGY**

**(3-0-0) 3**

Concrete making materials - Manufacture of Cements, types of cements and aggregates, properties and testing, Water, admixtures. Fresh concrete, workability, Compaction, Curing. Strength of Concrete, elasticity, shrinkage and creep. Durability of Concrete. Testing of hardened concrete, destructive and non-destructive testing methods, Concrete mix design, Quality Control and acceptance Criteria. Special Concretes, Concrete chemicals.

A.M. Neville, Properties of Concrete, The English Language Book Society and Pitman Publishing Co. London, U.K.

M.S. Shetty, Concrete Technology - Theory and Practice, S. Chand & Co. Ltd., New Delhi.

### **CV323 ARCHITECTURE AND TOWN PLANNING**

**(3-0-0) 3**

Town Planning and Architecture: An overview of ancient human settlements; Indus Valley, Manasura's classification of villages, Dantaka Village, Slums, Housing Bye-laws, Neighbourhood units, objectives and principles of town planning, Master-Plan, Zoning, Aesthetics and Principles of Architectural Composition. S.C. Rangawala, Principles of Town Planning

Sir. Banister Fletcher, Comparative Architecture

Talbot Hamlin, Forms and Functions of Twentieth Century Architecture; Vol II

### **CV324 ANALYSIS OF INDETERMINATE STRUCTURES**

**(3-0-0) 3**

Analysis of statically indeterminate Structures, Moment distribution Method, Kani's Method, Matrix method: introduction to flexibility and stiffness methods, two hinged arches, influence lines for indeterminate beams and arches, analysis of multistorey frames by approximate methods, substitute frame, portal and cantilever methods, plastic analysis of simple beams and portal frames.

S.P. Timoshenko, Theory of structures

M.B. Kanchi, Matrix method of structural analysis

### **CV371 RAILWAYS, TUNNELS, HARBOURS AND AIRPORTS**

**(3-0-0) 3**

Railways: Rail gauges; coning; adzing; railway track components, functions, requirements, and width of formation;

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creep; tractive resistance; geometric design; points and crossings; stations and yards; signaling and interlocking.  
Docks & Harbors: Types of harbors, tides, wind and waves, breakwaters, docks, quays, Transit sheds, warehouses, navigational aids

Tunnels: Introduction to tunneling, tunneling through soils, soft and hard rocks, tunnel ventilation

Airports: Introduction to airport planning and development, Airport design standards, airport planning

S.P. Arora & S.C. Saxena, A text Book of Railway Engineering Srinivasan, Docks, Harbors and Tunnels.

S.K. Khanna, M.G. Arora and S.S. Jain, Airport Planning and Design

### **CV372 DESIGN OF P.S.C. STRUCTURES**

**(3-0-0) 3**

Materials- Pre and post tensioning methods; losses in pre-stressing; stresses in concrete due to pre-stress and loads; prediction of long term and short term deflections; limit state of collapse in flexure and shear -Limit state of serviceability; transmission length; anchorage zone stresses; design of end-block; design of pre and post-tensioned beams; analysis of continuous beams; concordant cable profiles; analysis of composite beams; determination of stress distribution in a composite sections.

N. Krishna Raju, Pre-stressed concrete, Tata-McGraw Hill, New Delhi.

T. Y. Lin and N. H. Burns, Design of pre-stressed concrete structures, John Wiley and Sons, New York.

### **CV373 PROBABILITY METHODS IN CIVIL ENGINEERING**

**(3-0-0) 3**

Role of probability in civil engineering problems; Definition of basic random events; Application of set theory in definition of composite event operations; Probability of events and definition of probability axioms; Random variables; Probability definitions; Moments and expectations; Functions of random variables; Common probability models; Statistics and sampling; Regression and correlation analyses; Estimation of distribution parameters from statistics; Hypothesis testing and significance; Bayesian updating of distributions; Uncertainty quantification; Probabilistic analysis; Methods of structural reliability; Applications to design of civil engineering systems.

A.H-S. Ang & W.H. Tang, Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering, Wiley, 2006

A. Haldar & S. Mahadevan, Probability, Reliability, and Statistical Methods in Engineering Design, Wiley, 1999

### **CV 380 MINI PROJECT - I**

**(0-0-3)2**

Experimental work either in the field or in the laboratory or design task of relatively smaller magnitude compared to Major project and in line with the guidelines formulated by the DUGC.

### **CV381 MINI PROJECT - II**

**(0-0-3)2**

### **CV385 GEOINFORMATICS**

**(3-0-0) 3**

Introduction to geoinformatics: Principles of Remote sensing Satellites and Sensors, Aerial photography, elements of photo-grammetry, Satellite data products, Visual interpretation, Digital interpretations. Introduction to GIS principles, Generation of thematic maps, Georeferencing, Digitization, overlay analyses, Map projections : Global positioning system: Application of RS and GIS in mining; Geological mapping, geomorphological mapping, oil and mineral exploration, Ground water and surface water potential mapping, Natural hazard and disaster (Earthquakes, volcanic eruptions, Landslides, Avalanches, flood, drought etc.) Zone mapping, Forecasting, estimation of losses and management, monitoring ocean productivity and coastal zone management, computer applications in mining.

Lillesand, Thomas and Kiefer, Remote Sensing and image interpretation, John Wiley and Sons.

Burrough and Mc Dennell, principles of Geographical information systems, Oxford University Press.

### **CV386 ROCK MECHANICS**

**(3-0-0) 3**

Introduction to rock mechanics, Engineering classification of rocks, Engineering properties of intact rocks, Determination of in situ properties - shear strength, deformation, in situ stress, strength of jointed rocks, application to rock slopes, rock blasting, ground improvement techniques in rocks and bearing capacity. Jaegar and Cook, Foundation of rock masses.

Goodman, Introduction to rock mechanics, Wiley international

### **CV387 APPLIED GEOLOGY**

**(3-0-0) 3 PREREQ: CV202**

Introduction, interior of the earth, Geological process, Geological hazards, Natural resources; Minerals, rocks, water, soil; Engineering properties of rocks, Structural geology, stratigraphy, Hydrogeology; artificial recharge structures, rain water harvesting, ground water exploration, geophysical exploration, Remote sensing and GIS applications. Economic Geology, process of formation of mineral deposits, ore genesis, ore dressing, Indian mineral

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deposits, Environmental geology, Application of geology in Civil Engg. projects like Dams, tunnels, bridges etc., Blyth, F.G.H & De Freitas M.H., Engineering Geology, ELBS, 7<sup>th</sup> Edition, 1984.  
Robert F. Legget, Geology and Engineering, Mcgraw Hill

### **CV388 ADVANCED SURVEYING**

**(3-0-2) 4 PREREQ CV201**

Introduction to tacheometricsurveying, tacheometric levelling and errors in tacheometriclevelling; Fundamentals of geodetic surveying; theory of errors and triangulation adjustments; Electronic distance measurement; Hydrographic surveying including three-point problems; photogrammetric surveying including aerial photogrammetry; fundamentals on the use of digital theodolites and total stations.

B.C. Punmia, Surveying Vol. 2 and 3

T.P. Kanetkar & Kulkarni, Surveying and leveling Vol. 2

S.K. Roy, Fundamentals of surveying

David Clark, Plane and geodetic surveying Vol.2

### **CV389 ADVANCED STRUCTURAL ANALYSIS**

**(3-0-0) 3**

Matrix method of structural analysis: flexibility and stiffness formulation - Direct stiffness method. Analysis of Beams of non-uniform cross-section. Unsymmetrical bending of beams. Analysis of beams curved in plan. Introduction to analysis of shell roofs.

Genaro, Advanced Structural Analysis.

G.S. Ramaswamy, Design and Construction of shell roofs.

### **CV390 SEMINAR**

**(0-0-2) 1**

This course is a 1 credit course to be completed during 6th semester. The student will make presentations on topics of academic interest.

### **CV401 BRIDGE ENGINEERING**

**(3-0-0) 3 PREREQ: CV251**

Bridge site investigation and planning, bridge hydrology, Standards of loading for highway and railway bridges, Culverts, bridges superstructures, Design of R.C.C. beam and slab bridges, load distribution methods, Bearings, Design of bridge substructures and foundations, Design principles of prestressed concrete, steel and composite bridges, Introduction to cable stayed and suspension bridges, flyovers, temporary and movable bridges, construction and maintenance of bridges and flyovers.

D.J. Victor, Essentials of Bridge Engineering, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

N. Krishna Raju, Design of Bridges, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

### **CV422 ADVANCED DESIGN OF STRUCTURES – I**

**(3-0-0) 3 PREREQ: CV251**

Design of R.C. flat slabs, continuous beams and portal frames, redistribution of moments. Yieldline analysis of slabs, Deep beams, Curved beams, Elevated water tanks and supporting structures, Chimneys, Silos and Bunkers.

N. Krishna Raju, Advanced Reinforced Concrete Design, C.B.S. Publishers and Distributors, Delhi.

P.C. Varghese, Advanced Reinforced Concrete Design, Prentice - Hall of India, Pvt. Ltd., New Delhi.

### **CV423 DESIGN OF FOUNDATIONS, EARTH AND EARTH RETAINING STRUCTURES**

**(3-0-0) 3 PREREQ: CV252, CV321**

Loads for foundation design, Depth of foundation, proportioning of footings, Geotechnical and structural design of isolated, combined and raft foundations. Analysis of pile groups. Design of piles and pile cap. Design of cantilever, counterfort and soil reinforced retaining walls.

Swami Saran, Design of Substructures, Oxford and IBH Publishers.

J.E. Bowles, Analysis & Design of Foundations, Mc Graw Hill. Relevant IS Codes.

### **CV424 ADVANCED ENVIRONMENTAL ENGINEERING**

**(3-0-0) 3 PREREQ: CV350**

Water-pollution control: Effluent standards. Disposal of wastewater. Stream sanitation. Water quality indices; Solid waste management: Characteristics, treatment disposal; Air Pollution Control: Sources and Characteristics, effects, Control; Noise Pollution Control, measurement & analysis; Hazardous solid waste: Classified wastes, Disposal of hospital wastes; EIA: Introduction, case studies

Metcalf & Eddy, Waste Water Engineering Treatment, Disposal & Reuse, Tata Mcgraw Hill Publishers

Sincero & Sincero, Environmental Engineering, Prentice Hall Inc.

### **CV425 COMPUTER AIDED DESIGN & APPLICATIONS IN CIVIL ENGINEERING**

**(2-0-3) 4**

Object oriented programming, Application programs to solve problems in structural analysis, surveying, soil

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mechanics, transportation engineering and numerical analysis. Design of structural elements and programming concepts. Programs for the design of beams, slabs and columns by Limit state theory.

E. Balaguruswamy, Object oriented programming in C++, McGraw Hill Publishers

V.L.Shah, Computer aided design in reinforced concrete, Structures publishers.

### **CV426 SOLID WASTE MANAGEMENT**

**(3-0-0) 3**

Characterization of Municipal wastes; Waste Collection, Disposal and Management-Laws and guidelines; Utilization of municipal wastes for bio-gasification and manure; landfill; Recent technological advances in composting and thermal gasification; utilization and management of nonhazardous and hazardous waste; Case studies.

George Tchobanoglous, Frank Kreith, Handbook of Solid Waste Management, McGraw-Hill, 2002. CPHEEO Manual on Solid Waste Management, 2000.

Asian Productivity Organization Report on Solid-Waste Management: Issues and Challenges in Asia, Environmental Management Centre, 2005

Thomas H. Christensen, Solid Waste Technology & Management: Volume 1 & 2, A John Wiley & Sons, 2010

Michael D. LaGrega, Phillip L. Buckingham, Jeffrey C. Evans. Hazardous Waste Management, Waveland Press Inc., 2010

### **CV438 STRUCTURAL DYNAMICS AND WIND ENGINEERING**

**(3-0-0) 3**

Vibration of SDOF systems - Free and Forced vibrations, effect of damping, response spectrum, MDOF systems - Natural frequencies and modes, Eigenvalue problem, mode superposition method, Wind effects- Mean Wind speed, turbulence, spectrum of turbulence, Aerodynamic instabilities, Aerodynamic damping, Along - wind and Across - wind responses.

Clough and Penzien, Dynamics of Structures, McGraw Hill, New York.

J.W. Simth, Vibration of Structures, Chapman and Hall Ltd., New York.

Scanlan and Sachi, Wind Engineering

### **CV440 PRACTICAL TRAINING**

**2**

This course is a 2 credit course. A student may complete the training before the beginning of 7th semester (or as stipulated by DUGC) and register for it in the 7th Semester. The duration and the details shall be decided by the faculty advisor, with approval from DUGC.

### **CV471 ADVANCED DESIGN OF STRUCTURES – II**

**(3-0-0) 3 PREREQ: CV251**

R.C. domes and shell roofs, membrane and beam method of analysis, Multistoried building systems; Grid floors, Composite steel and in-situ concrete beams & slabs. Communication and transmission line steel towers. P.

Dayaratnam, Design of Reinforced concrete structures, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

P. Dayaratnam, Design of Steel Structures, A.H. Wheeler & Co. Ltd. Allahabad.

N. Krishna Raju, Advanced Reinforced Concrete Design, C.B.S. Pub. and Distributors, New Delhi.

### **CV472 GROUND IMPROVEMENT TECHNIQUES**

**(3-0-0) 3 PREREQ: CV252, CV321**

Need and Objectives, Mechanical Modification-Compaction control, Vibro flotation, Hydraulic modification - Dewatering methods, Electro-Osmosis, Vertical drains, Physical and chemical modification - grouting, shortcreting, ground freezing. Modification by inclusions and Confinement. Stone columns, lime columns, Sand drains and Compaction piles.

M.R. Hausmann(1990) Engineering Principles of Ground Modifications, McGraw Hill Publishing Co.

Purushotham Raj, Ground Improvement Techniques, Laxmi Publications, New Delhi.

### **CV473 FEM APPLICATIONS IN CIVIL ENGG.**

**(3-0-0) 3**

Types of elements - Boundary value and initial value problems - Approximate methods - Principles and steps in Finite Element Analysis - Generalized and natural co-ordinates - Direct stiffness approach- Analysis of 2D Trusses, beams, and Plane frames. Introduction to continuum problems - Triangular elements for plane stress problems - Numerical Integration.

T.R. Chandrupatla & Ashok D. Belegundu, Introduction to Finite Elements in Engg. - Prentice Hall.

O. C. Zienkiewicz and K Morgan, Finite Elements & Approximation, John Wiley & Sons.

### **CV474 ELEMENTS OF EARTHQUAKE ENGINEERING**

**(3-0-0) 3**

Engineering seismology - Plate tectonics, Earthquake mechanism, Seismic zoning map of India, seismic waves, earthquake magnitude and intensity, seismic vulnerability, hazard and risk, Introduction to the theory of vibrations -

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simple SDOF systems, response spectra, Performance of structures, Lessons from past earthquakes, causes of failure and damage

Aseismic design of structures - Philosophy & Principles of earthquake resistant design, building forms and architectural design concepts, Introduction to seismic codes, Calculation of equivalent static earthquake forces.

Restoration and retrofitting of existing structures.

A.K.Chopra, Dynamics of Structures, Prentice Hall, 2002 IITKanpur, Earthquake Tips, [www.nicee.org](http://www.nicee.org)

### CV475 OIL AND NATURAL GAS EXPLORATION

(3-0-0) 3

Geology of oil and Natural gas fields: Introduction to petroleum, Economic Importance, Geological factors, Reservoir Sedimentology and Sequence Stratigraphy of oil and natural, Structural Geology and Basin Development, oil and natural gas deposit distribution in India, Gas hydrated deposits in India and in the world. Exploration of oil and natural gas deposits: Remote Sensing, GIS, GPS, geological, geophysical and geochemical methods of exploration of oil and natural gas deposits.

Reservoir Engineering; Drilling and Production Engineering (drilling Methods of oil and natural gas wells, drilling technologies for deep water areas); Refining Engineering.

Safety and Environmental Engineering: Safety norms and regulations; Environmental norms and regulations; safety auditing; environmental auditing; carbon credits; preparation of EIA reports; principles of developing green belt around petroleum installations to minimize carbon footprints.

A. I. Levorsen, 1967, Geology of Petroleum

Reddy D V, 2010, Engineering Geology, Vikas Publishers.

Azar J J, Samuel G R, 2007, Drilling Engineering. Pennwell Corporation.

Edwin S. Robinson and CahitCoruh, 1988, Basic Exploration Geophysics, John Wiley and Sons.

### CV476 DISASTER MANAGEMENT & MITIGATION

(3-0-0)3

Concepts of disaster; Types of disasters - natural and manmade: Cyclone, flood, landslide, land subsidence, fire and earthquake, tsunami, coastal erosion, river erosion, chemical spills, nuclear disasters, mine disasters etc.; Psychological and Social Dimensions in Disasters, Trauma and Stress. Techniques of monitoring and design against disasters; forecasting and early warning; communications & IT Tools; disaster risk reduction through prevention, preparedness, mitigation, response, recovery, rehabilitation and reconstruction. Management issues related to disaster, national Policy on disaster management, legislative responsibilities; mitigation through capacity building, disaster mapping, assessment, pre-disaster risk & vulnerability reduction, post disaster recovery & rehabilitation; Participation by voluntary Agencies & Community at various stages of disaster management; disaster related infrastructure development. <http://ndma.gov.in/> (Home page of National Disaster Management Authority).

<http://www.ndmindia.nic.in/> (National Disaster Management in India, Ministry of Home Affairs).

Pradeep Sahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.

Singh B.K., 2008, Handbook of Disaster Management: techniques & Guidelines, Rajat Publication. Ghosh G.K., 2006, Disaster Management ,APH Publishing Corporation.

### CV477 SEISMORESISTANT CONCRETE STRUCTURES

(3-0-0)3

Introduction to dynamic response of structures- Dynamic equilibrium, SDOF and MDOF. Earthquake ground motion and response spectra- Characteristics of ground motion, earthquake response spectra. Seismoresistant architecture, IS 1893(Part1):2002 codal provisions, Simplified modal response spectrum analysis- Example problems. Earthquake resistant design of RC elements, Shear walls - Response of concrete and steel to monotonic cyclic loading, Codal provisions of IS 13920:1993. Design example of a multi-storey building. Seismic retrofitting strategies – considerations, classification, case studies. (IS 13935:1993) Base isolation-Isolation system components, Isolator design procedures.(Mini project on analysis and design of a multi storey building)

The Seismic Design Handbook., Farzad Naeim, International code council, Kluwar Academic publishers (USA), 2001

George. G. Penelis and Andreas J. Kappos, Earthquake resistant concrete structures, E & FN Spon Chapman, Hall London, 1997

FarzadNaeim and James M Kelley, Design of seismic isolated structures, John Wiley and sons Inc. 1999

IS codes: IS 1893(Part1):2002, IS 13920:1993, IS 13935:1993

A.K. Chopra, Dynamics of structures - Theory and applications to earthquake engineering, Pearson Education, 2001

Pankaj Agarwal, Manish Shrikhande Earthquake Resistant Design of Structures, Prentice- Hall India, 2006

### CV485 AIR POLLUTION AND NOISE POLLUTION

(3-0-0) 3

Natural and man-made air pollution, sources, effects, control. Noise pollution - sources, measurement,

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mitigation.

Wark Kenneth and Warner C.F., Air Pollution its Origin and Control, Harper and Row, Publ.

Sincero A.P. and Sincero G.A. Environmental Engineering, Prentice Hall.

### **CV486 ENVIRONMENTAL IMPACT ASSESSMENT**

**(3-0-0) 3**

Introduction of EIA - Environmental impact Statement (EIS) and Environmental Impact Analysis (EIA) - Meaning and objective of EIA; Environmental Impact Prediction - Planning and Management of Impact Studies - ISO 14000 Series - Environmental monitoring and mitigation measures. Canter, R.L., Environmental Impact Assessment, McGraw Hill Inc.,

John G.Rau and David C. Wooten (Ed)., Environmental Impact Analysis Handbook, McGraw Hill Book,1980.

Peter Wathern (Ed)., Environmental Impact Assessment, Theory and Practice, Unwin Hyman Ltd., London, 1988.

Munn, R.E., (Ed)., Environmental Impact Assessment, Principles and Procedures, Published on behalf of Scope, Unwin Brothers Ltd., Surrey, London, 1979.

### **CV487 CONSTRUCTION AND PROJECT MANAGEMENT**

**(3-0-0) 3**

Introduction: project forms, management objectives and functions; organizational chart of a construction company; manager's duties and responsibilities; public relations; Leadership and team - work; ethics, morale, delegation and accountability. Man and Machine: Man-power planning, training, recruitment, motivation, welfare measures and safety laws; machinery for Civil Engg., earth movers and hauling costs, factors affecting purchase, rent, and lease of equipment, and cost-benefit estimation. Planning, scheduling and Project Management: Planning stages, construction schedules project specification, monitoring and evaluation; Bar-chart, CPM, PERT, network-formulation and time computation. Departmental Procedures: specifications, tendering, contracting and arbitration  
Lionel Stebling, Project and Quality Management

P.P. Dharwadkar, Management in Construction Industry, Oxford IBH, New Delhi

J.O.Brien, Construction Management, McGraw Hill

J.M.Antill & R.W. Woodhead, Critical Path Methods in Construction, Wiley

B.C. Punmia & K.K. Khandelwal, Project Planning and control with PERT and CPM,

PWD Codes A and D

### **CV488 GROUND WATER DEVELOPMENT AND MANAGEMENT**

**(3-0-0) 3**

Hydrological cycle, Hydrological properties of rocks, Distribution of ground water, Ground water movement- Darcy's law, Flow nets. Aquifer parameters, Parameter estimation, pump test and recovery test-Thei's, Theim's, Jacob's equations. Ground water exploration-Geophysical techniques RS, GIS, GPS, Construction of wells, Springs. Ground water recharge, Rain Water harvesting, Water conservation techniques. Ground water quality, Ground water pollution, Environmental issues. Ground water budget, Ground water management. Ground water legislation

Todd D. K. Ground water hydrology, 3rd edition, Wiley, 2008.

Walton, W. C., Ground water resource evaluation. McGraw Hill, 1970. Raghunath, H. M, Ground water, New Age International, 3rd edition, 1998.

Karanth, K. Groundwater Assessment and Management, Tata McGraw Hill, 2007.

### **CV489 RETROFITTING AND REHABILITATION OF STRUCTURES**

**(3-0-0) 3**

Introduction, Causes of Deterioration, Deterioration process, Planning, Investigation and diagnosis, Assessment of distress structures, Assessment procedure for evaluation of structures and demolition procedures, Testing techniques, Interpretation of results, Repair and renovation Repair materials, techniques, Surface coatings, Protection, Seismic retrofitting.

Allen, R.T.L. and Edwards, S.C., 'The repair of concrete structures'

Key, T., 'Assessment and renovation of concrete structures'

Emmons, P.H., 'Concrete repair and maintenance illustrated'

### **CV490 NON DESTRUCTIVE TESTING & EVALUATION FOR CONCRETE STRUCTURES**

**(3-0-0) 3**

Fundamentals and basic concepts of Non Destructive Testing and Evaluation . Principle and applications of different Non Destructive Evaluation tools viz., Ultrasonics, radiography , electromagnetic methods, acoustic emission , thermography for testing and evaluation of concrete structures.

Guidebook on non destructive testing of concrete structures-International Atomic Energy Agency, Vienna , 2002

Nondestructive Evaluation –Theory Techniques and Applications by P.J Shull Marcell Decker Inc., NY 2002

Non destructive Testing and Evaluation of Materials Tata McGraw Hill Education Private Limited Second Edition 2011

Acoustic Emission testing –Basic for Research-Applications in Civil Engineering Chriastan U Grosse,

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MasayasuOhtsu , Springer:2008  
Current Literature

### **CV491 BITUMINOUS MATERIALS, MIXTURES, AND PAVEMENTS**

**(3-0-0)3**

Introduction to bituminous materials, processing of petroleum crude. Bituminous binders - types, characteristics, test protocols, and recent developments in binder modifications. Aggregates - production, properties, test methods, grading, and blending. Bituminous mixtures - types, characteristics, mix design methods, and tests. Bituminous pavement construction - mixture production, transportation, placement, compaction and finishing operation. Bituminous Pavements - different bituminous layers, and specifications.

Hot Mix Asphalt Materials, Mixture Design and Construction, Third Edition, National Asphalt Pavement Association, Research and Education Foundation, Lanham, Maryland, 2009.

Bituminous Road Construction in India, by P.S.Kandhal, PHI Learning Private Limited; Revised edition, 2016.

Relevant Standards and Guidelines published by the Bureau of Indian Standards (BIS) and the American Standard for Testing and Materials (ASTM) International.

<b>CV449</b>	<b>Major Project I</b>	<b>(0-0-3)2</b>
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<b>CV499</b>	<b>Major Project II</b>	<b>(0-0-6)4</b>
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## Department of Mining Engineering

### **MI101 INTRODUCTION TO MINING ENGINEERING**

**(3-0-0)3**

Introduction to Indian Mining Industry, National and International Scenario, Unit Operations-Drilling, Blasting, Excavation, Transportation, Size reduction. Introduction to Mining Methods Environmental Impacts. Safety.

*Deshmukh D.J Elements of Mining Engineering Vol.I Central Techno Publications Nagpur, 1998*

*Hartman H.L –Introductory Mining Engineering, Wiley Interscience, New York, 1987*

*Mishra, G.B, Surface Mining Dhanad Publishers, Dhanbad, 1994*

### **MI201 DEVELOPMENT OF MINERAL DEPOSITS**

**(3-1-0)4**

Methods of shaft construction, Widening and deepening of shafts. Special methods of shaft sinking under difficult conditions. Methods of raising. Drivage of horizontal openings: Conventional and mechanized systems. Tunneling under difficult conditions. Supports: supporting roadways and mine faces using timber, steel (friction and hydraulic); Roof bolting and roof stitching. Over view of mining industries and relevant mining laws.

*Tatiya R.R., Surface and underground excavation: methods, techniques and equipment, A. A. Balkema publishers, 2005.*

*Deshmukh, D. J., Elements of Mining Engineering, Vol. I, Central Techno Publications, Nagpur, 1998.*

*Onika D., Design of Mine Excavations, Mir Publishers, Moscow, 1973.*

*Pokrovskiy., Driving of Horizontal Workings, Mir Publishers, Moscow, 1992.*

### **MI202 MINE SURVEYING**

**(3-1-0)4**

Principles of mine surveying and its scope. Plane and geodetic surveying. Compass surveying. Leveling. Theodolites: Construction and operation. Tests and adjustments. Angle measurement. Errors in measurement. Traversing. Balancing of traverse. Calculation of coordinates and plotting. Contouring, Interpolation of contours. Calculation of areas and volumes. Dip, fault and borehole problems.

*Punmia, B. C., Surveying Vol- I & II, Laxmi Publishers, New Delhi, 2008.*

*Kanetkar, T.P., Surveying, Vol- I & II, Tata McGraw Hill, New Delhi, 2007.*

*Ghatak, S., Mine Surveying and Levelling – Vol I, II & III, Coal Field Publishers, Asansol, 2005.*

### **MI203 MINE SURVEYING LAB**

**(0-0-3)2**

A total of 10 to 12 experiments shall be carried out pertaining to the subject.

### **MI210 DRILLING & BLASTING ENGINEERING**

**(3-0-0)3**

Applications of drilling in mining industry. Classification and mechanism of rock drilling methods. Different types of drill machines. Alignment and deviation of bore holes. Factors influencing drilling in percussive and rotary methods. Developments in explosives and initiating devices. Properties of explosives. Safety aspects. Exploders & Circuit testers.

*Das, S. K., Explosives and Blasting Practices in Mines, Lovely Prakashan, Dhanbad, 2001.*

*Pradhan, G. K. & Sandhu, M. S., Blasting Safety Manual, 2002*

*Deshmukh D.J. Elements of Mining Technology Vol. I; Vidyasewa Prakashan, Nagpur, 1994*

*Chug, C. P. Manual of drilling Technology, Oxonian Press Pvt. Ltd., Delhi, 1985.*

### **MI211 SEABED MINING**

**(3-0-0)3**

Resources from the seabed. Exploring and extraction of minerals from seabed. Comparison of seabed mining with traditional in-land mining. Mining systems - hydraulic mining, continuous line bucket (CLB) mining, modular or shuttle mining systems. Alternative systems for deep sea mining, transport and processing. Ore transfer technology. Environmental impact of seabed mining. Economics. Indian scenario - phase wise development of seabed mining. Vessels for conducting survey, research and extraction of ore reserves.

*Hartman, H.L., Introductory Mining Engineering; Wiley Interscience, New York, 1987.*

*Manjula, R. Shyam, Metals from the seabed: Prospects for Mining Polymetallic Nodules of India. Oxford & IBH Publishing Co., New Delhi, 1982.*

### **MI251 MINE ENVIRONMENT & VENTILATION ENGINEERING**

**(3-1-0)4**

Mine gases. Mine illumination. Heat and humidity. Cooling power of mine air. Air conditioning. Airflow in mines. Natural and mechanical ventilation. Ventilation networks. Computer aided design of ventilation systems.

*Mishra, G.B. – Mine Environment and Ventilation; Oxford University Press, Delhi, 1986.*

*Vutukuri, V.S. & Lama, R.D. – Environmental Engineering in Mines; Cambridge University Press, Cambridge, 1986.*

*Harsha Vardhan –An Introduction to Underground Mine Environment and Ventilation available online atNPTEL*



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website

Hartman, H. L. –*Mine Ventilation & Air Conditioning*; John Wiley & Sons; New York, 1982.

### MI252 MINE ENVIRONMENT & VENTILATION ENGINEERING LAB

(0-0-3)2

A total of 10 to 12 experiments shall be carried out pertaining to the subject.

### MI253 APPLIED MINE SURVEYING LAB

(0-0-3)2

A total of 10 to 12 experiments shall be carried out pertaining to the subject.

### MI254 MINING MACHINERY

(3-1-0)4

Basic principles of transport of men, materials and mineral in underground mines. Techno- economic indices of transportation systems. Pit top and pit bottom lay outs. Motive power used in mines. Types of compressors used in mines. Wire ropes: construction, classification, application, inspection, maintenance and calculations. Capping and slicing of ropes. Suspension gear for drum and Koepe winding. Rope haulages: Types, principle of operation, suitability, safety appliances, calculations. Winding: Drum winding and Koepe winding, Braking systems – mechanical and electrical. Man riding systems. Drainage and Pumping. Sumps.

Ramlu M.A. *Mine Hoisting*. Oxford & IBH. New Delhi 1996.

Walker S.C. *Mine Winding and Transport*. Elsevier, Amsterdam 1988.

Deshmukh D.J. *Elements of Mining Technology Vol. III*; Vidyasewa Prakashan, Nagpur, 1994

Reese, C., *Material Handling Systems: Designing for Safety and Health*, CRC Press, 2000.

### MI255 INDUSTRIAL TRAINING IN MINES-1

(0-0-0)1

Industrial training should be taken up at the end of III semester, preferably in surface mines. Relevant information pertaining to the development and extraction of mineral deposits by surface mining methods, details of different equipments, layouts and other techno-economic data should be collected. Information regarding safety aspects, manpower, production and productivity, management practices and environmental protection measures should also be included in the report.

### MI260 APPLIED MINE SURVEYING

(3-0-0)3

Triangulation: Station marks, signals and towers. Satellite station and reduction to center. Tacheometry: Tangential method and movable bar method. Curve ranging: Different methods of curve ranging. Laying of curves in underground. Aerial photogrammetry, Field astronomy, Correlation survey: Connection of underground and surface survey. Total station. GPS. DGPS. Introduction to Terrestrial Laser Scanner and Drone Surveying.

Punmia, B. C. *Surveying Vol- I, II & III*, Laxmi Publishers, New Delhi, 2008.

Kanetkar, T.P. *Surveying, Vol- I, II & III*, Tata McGraw Hill, New Delhi, 2007.

Ghatak, S., *Mine Surveying and Levelling – Vol I, II & III*, Coal Field Publishers, Asansol, 2005.

*Operational Manuals of Lawrence & Mayo*, Bangalore.

### MI261 ELECTRICAL MACHINERY IN MINES

(3-0-0)3

Three-phase circuit analysis, magnetic circuits, transformers, transformer losses, tests on transformers, electromechanical energy conversion, direct current motors and generators, induction motors, synchronous motors, control of speed and torque of DC and AC motors, intrinsically safe and flame-proof equipment, design of substations, switchhouses and power centers, power distribution systems in surface and underground mines, legislative and safety aspects.

Morley, L.A., *Mine Power Systems*, US Bureau of Mines Information Circular 9258, 1990.

Gross, C. A., *Electric Machines*, 1<sup>st</sup> Edition, CRC Press, 2006.

Kothari, D.P. and Nagrath, I.J., *Electric Machines*, 5<sup>th</sup> Edition, McGraw Hill, 2017.

### MI301 SURFACE MINING TECHNOLOGY

(3-1-0)4

Status and scope of surface mining. Elements of surface mining. Unit operations – Drilling, Blasting, Excavation and Transporting. Details of principal production equipment. Layout of workings and waste dumps. Environmental management and reclamation in mines. Operational details of major surface mines with special reference to coal, lignite, iron, limestone etc. Techno-economic evaluation of surface mining projects. Problems in deep mining.

S.K. Das, *Surface Mining Technology*, Lovely Prakashan, Dhanbad, 1984.

Misra, G.B., *Surface Mining*, Dhanbad Publishers, Dhanbad, 1994.

Deshmukh, D. J. *Elements of Mining Technology, Vol. I, II & III*, Central Techno Publishers, Dhanbad, 1988.

### MI302 MINE HAZARDS, RESCUE AND RECOVERY

(3-1-0)4

Spontaneous combustion. Surface and underground fires. Fire extinguishers. Isolation/Explosion proof stopping.

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Reopening of sealed off areas. Mine explosions. Inundation. Approaching water logged areas and old workings. Water dams and design. Rescue & recovery equipment's for use in mines. Rescue organization. Examples of major mine disasters in India & abroad.

*Ramlu, M.A. Mine Fires, Explosions, Rescue, Recovery & Inundations; Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, 1991.*

*Rakesh & Lele, M.G. Inundation in Mines; Mrs. Asha Lata, Varanasi, 1970.*

### MI303 UNDERGROUND COAL MINING TECHNOLOGY

(3-1-0)4

Status and scope of underground coal mining. Classification of coal reserves. Opening up of deposit. Horizon mining. Basic coal mining methods. Bord and pillar mining: development & depillaring with semi-mechanised and mechanized board and pillar mining. Longwall mining. Thick-seam mining: Classification of thick seam mining methods, inclined slicing with caving; sub-level caving. Hydraulic Mining. Underground gassification of coal.

*Singh, R.D. Principles and Practices of Modern Coal Mining, 1997. ISBN 81-224-0974-1*

*Singh, T.N. Underground Mining of Coal, Oxford & IBH, 1992.*

### MI304 INDUSTRIAL TRAINING IN MINES - II

(0-0-0)1

Industrial Training – II should be taken up at the end of IV semester, preferably in underground coal mines. Relevant information pertaining to the development and extraction of coal by underground mining methods, details of different equipments working in the mines and their operational information, layouts and other techno- economic data, information regarding safety aspects, man-power, production and productivity, management practices and environmental protection measures should be included.

### MI310 NOISE POLLUTION AND CONTROL ENGINEERING

(3-0-0)3

Basics of sound. Frequency analysis. Equipment's used for noise measurement. Various standards in India & abroad on noise exposure. Effects of noise exposure. Community noise. Industrial noise control & hearing testing. Environmental noise measurement. Noise measurement & control of HEMM, Coal handling & preparation plants, Jackhammer drills. Noise control measures for DG sets. Human vibration: measurement, control and standards. Health effect of vibration-Handarm and Whole-body vibration. Parameters influencing human response to vibration.

*Harris, C.M : Handbook of Noise Control, McGraw- Hill Book Company, 1979.*

*Albert Thumann & Richard K. Miller : Secrets of Noise Control, The Fairmont Press, Georgia, 1976.*

*ISO 2631-1: Mechanical vibration and shock-Evaluation of human exposure to whole-body vibration-second edition 1997-05-01.*

### MI311 ROCK REINFORCEMENT ENGINEERING

(3-0-0)3

Roof bolting. Cable bolting. Shotcreting. Cavability of rocks – effect on supports design. Longwall supports. Lining of tunnels and shafts. Yieldable arches and ring sets. Reinforcement of pillars. Stabilization of slopes. Roof convergence. Stope closure. Back filling. Mechanical behavior and monitoring of various supports. Capital investment for supports, cost control process.

*Biron, C and Ariglu, E., Design of Supports in Mines, John Wiley & Sons, 1983.*

*Britton, S.G., Construction Engineering in Underground Coal Mines, SME, 1983.*

### MI312 MINE POWER SYSTEMS

(3-0-0)3

Electric power in mining, three-phase circuit analysis, mine power system components, distribution of electrical power in surface and underground mines, grounding systems, ground wire monitoring, distribution cable construction and selection, power flow calculations, power factor correction, design of substations, switchhouses and power centers, method of symmetrical components, mine power system fault analysis, transients and overvoltages, protective equipment and relaying, legislative and safety aspects.

*Morley, L.A., Mine Power Systems, US Bureau of Mines Information Circular 9258, 1990.*

*Stevenson, W.D., Elements of Power System Analysis, 4<sup>th</sup> Edition, McGraw Hill, 1982.*

*Kothari, D.P. and Nagrath, I.J., Modern Power System Analysis, 4<sup>th</sup> Edition, McGraw Hill, 2011.*

### MI351 UNDERGROUND METAL MINING TECHNOLOGY

(3-1-0)4

Development and opening up of underground deposits. Choice and suitability of entries. Draw points and ore passes. Different methods of stoping. Problems encountered in deep mines and measures to tackle them. Introduction to solution mining and in-situ leaching. Case studies from Indian Mines.

*Hartman, H.L. Introductory Mining Engineering. John Wiley & Sons, 1987.*

*Hustrulid, W.A., SME Handbook on Metalliferous Mining, 1985.*

*Niosh Snowden, Geological and Mining Reports of Underground Metal Mining: Volume II, Wide Publishing, India, 2016.*

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Ratan Raj Tatiya, *Surface and Underground Excavations, 2nd Edition : Methods, Techniques and Equipment*, [Taylor & Francis Ltd](#), London, United Kingdom, 2013.

### MI352 ROCK MECHANICS

(3-1-0)4

Physical properties, Physico-mechanical properties of rocks, Elastic constants under static and dynamic loading. Determination of in-situ strength properties of rocks and Nondestructive testing, Analysis of stresses and strains. Mohr's representation of stress and strain. Stress – strain relations. Behaviour of rocks under stress. Engineering classification of rock mass, Rock fracture mechanics. Stress distribution around different mine openings.

Obert, L. & Duvall, W.I.- *Rock Mechanics and design of structures in rock*; John Wiley & Sons, New York, 1967.

Wittke, W., *Rock Mechanics*, Springer-Verlag, Berlin, 1990.

### MI353 ROCK MECHANICS LAB

(0-0-3)2

A total of 10 to 12 experiments shall be carried out pertaining to the subject.

### MI354 MINE SYSTEMS OPTIMIZATION

(3-1-0)4

Introduction to systems concept, analysis and systems engineering; models in system analysis; linear programming; integer programming; network techniques for mining projects; CPM and PERT techniques; dynamic programming; transportation and assignment models; decision theory; inventory control; queuing theory; simulation techniques for equipment selection and production scheduling; significance of management information systems in controlling and managing the mining activities.

Sharma, J.K., *Mathematical Models in Operations Research*, Tata Mcgraw-Hill, New Delhi, 1989.

Cummins, A.B., *Mining Engineers Handbook, Vol. II, SME, AIME*, New York, 1973.

Taha, H.A., *Operations Research: An Introduction, 8th Edition*, Pearson, 2006.

### MI355 INDUSTRIAL AND PROFESSIONAL PRACTICE

(0-0-0)1

Mine camp to be held at the end of V semester. Relevant information pertaining to the development and extraction by mining methods, details of different equipments working in the mines and their operational information, layouts and other techno-economic data, information regarding safety aspects, man-power, production and productivity, management practices and environmental protection measures should be included in the report.

### MI360 MINE HEALTH AND SAFETY ENGINEERING

(3-0-0)3

Mine accidents, Accident analysis and prevention, Accident report, Risk assessment & preparation of safety management Plan. Safety audits. Occupational hazards in mines, Hazard analysis. Hazard control by engineering approach, Hazard control by system approach. Economics of safety and cost-effectiveness. Occupational health and safety, Occupational diseases, Problems of safety and health in contractual work, Behavior based safety, Ergonomics and its application in mining.

Ridley, J & Channing, J.; *Safety at Work*; Butterworth-Heinemann, Oxford, 2001.

L.C. Kaku: *A Study of Mine management, Legislation & General Safety*

S. Ghatak: *A Study of Mine management, Legislation & General Safety*

C.P. Singh: *Occupational safety and health in Industries and mines*

### MI361 ADVANCED SURFACE MINING TECHNOLOGY

(3-0-0)3

Analysis of elements of surface mining operations. Classification of surface mining equipment systems vis-à-vis unit operations. Equipment selection criteria and procedures, application and selection. Types, basic operations, maintenance and capacity utilization, applicability and selection considerations. Computations for the capacity and number of machines vis-à-vis mine production. Dump planning. Minimization of adverse impacts and maximization of use of mineral resources. Cost Estimation. Conversion of old underground workings into surface mines.

Amithosh Dey, *Latest Development of Heavy Earth Moving Machinery*, Annapurna Publishers, Dhanbad, 1995.

Martin, J. W., Martin T. J., Bennett, T. P. & Martin, K. M. *Surface Mining Equipment*, Martin Consultants Inc., USA, 1982.

### MI362 PRODUCTION DRILLING FOR OIL WELLS

(3-0-0)3

Geography of petroleum and natural gas. Characterization of crude and natural gas deposits. Well logging. Interpretation and use of information in petroleum and natural gas engineering. Drilling technology for mining of crude and gas. Well completion and stimulation.

Chugh, C.P., *Drilling Technology Handbook*, Oxford & IBH Pub. Co, 1988.

Hartman, H.L., *Introductory Mining Engineering*; Wiley Interscience, New York, 1987.

S.Mcalecse, *Operational Aspects of Oil and Gas Well Testing: Volume I*, Elsevier Science & Technology, Elsevier

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*Science Ltd, Oxford, United Kingdom, 2000.*

### **MI363 MECHANIZATION AND MATERIALS HANDLING**

**(3-0-0)3**

Locomotive haulage, rolling stocks, conveyors, belt conveyor calculations, safety devices for conveyors, face machinery, calculation of productivity of loading machines, material handling systems, elements of material handling systems in large opencast projects, high-angle conveyors, pipeline transportation, aerial ropeways, aerial ropeway calculations, equipment for hydraulic and pneumatic stowing, roof bolting machines, variable and thyristor drives, remote control, monitoring and automation of mining processes.

*Ramlu, M.A., Mine Hoisting, Oxford & IBH, New Delhi, 1996.*

*Walker, S.C., Mine Winding and Transport, Elsevier, Amsterdam, 1988.*

*Deshmukh, D.J., Elements of Mining Technology Vol. III; Vidyasewa Prakashan, Nagpur, 1994.*

*Reese, C., Material Handling Systems: Designing for Safety and Health, CRC Press, 2000.*

### **MI401 MINERAL PROCESSING TECHNOLOGY**

**(3-1-0)4**

Scope and objective of mineral processing. Ore handling and storage. Ore sorting, Sampling techniques and devices. Liberation and comminution, Laboratory and industrial sizing. Concentration methods. Magnetic and high tension separation. Froth flotation. Classifiers. Coal quality. Coal preparation for coarse and fine coal. Washability curves and washability number. Dewatering devices. Drying and tailings disposal.

*Wills, B.A., Mineral Processing Technology ; Pergamon Press – 4th Edition , 1989.*

*Weiss, N.L. , Mineral processing Handbook – Vol. I & II, S.M.E., 1985.*

*Maurice C. Fuerstenau , Edited by Kenneth N. Han , Principles of Mineral Processing, Society for Mining, Metallurgy, and Exploration , United States, 2003.*

*Ashok Gupta , Denis S. Yan ., Mineral Processing Design and Operations : An Introduction, Elsevier Science & Technology, Oxford, United Kingdom, 2016.*

*G S Ramakrishna Rao , Mineral Processing Techniques Basics and Related Issues, Zorba Publishers , India, 2014.*

### **MI402 MINERAL PROCESSING TECHNOLOGY LAB**

**(0-0-3)2**

A total of 10 to 12 experiments shall be carried out pertaining to the subject.

### **MI403 ROCK FRAGMENTATION ENGINEERING**

**(3-1-0)4**

Bulk explosive systems. Substitutes for explosives. Mechanisms of rock fragmentation due to blasting. Fragmentation prediction and assessment. Blast design. Theory of shaped charges. Recent advances in blasting techniques in both underground and surface mines. Blasting in construction projects. Special techniques of blasting. Underwater blasting. Environmental effects and their control. Controlled blasting techniques. Economic evaluation of blasting operations.

*Konya, C.G. Blast design, CRC Press, London, 1989.*

*Persson, Rock fragmentation. International development Corporation, Sweden, 1986.*

*Sastry, V.R., Advances in Drilling & Blasting, Allied Publishers, 1993.*

### **MI404 MINE DESIGN LABORATORY**

**(0-0-3)2**

A total of 10 to 12 experiments shall be carried out pertaining to the subject.

### **MI405 INDUSTRIAL TRAINING IN MINES - III**

**(0-0-0)1**

A detailed report of the industrial training undergone at the end of VI semester, preferably in underground metal mines, should be submitted. The report should consist of all details about opening up of the deposit, development and stopping techniques, specifications and operational details of equipment working in the mine, ventilation scheme, power distribution, safety aspects, management practices and environment protection measures and the relevant lay outs. Current techno-economic indices should be a part of the report.

### **MI410 ADVANCED U/G COAL MINING TECHNOLOGY**

**(3-0-0)3**

Planning considerations for inclines and shafts, considerations for their location and construction. Location of shaft using sieve analysis; Design of shaft pillar. Bord & pillar mining- design of pillar, design of panel, barrier pillar. Planning inputs for development and depillaring by continuous miners. Longwall face support and machinery, Extraction of pillars in thick and steep seams with caving and stowing. Planning inputs for longwall panel. Selection design and development of most suitable mining method based on Physico - mechanical properties. Production planning. Production cost estimation. Punch entries. High wall mining. Caving characteristics of roof rocks. Shield Mining.

*Singh, R.D. Principles and Practices of Modern Coal Mining, 1997, ISBN 81-224-0974-1*

*Singh, T.N., Thick seam Mining, Oxford & IBH, 1992.*

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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*Vorbjev & Deshmukh, Advanced Coal Mining, Tata McGill, 1988.*

*Mathur, S.P., Advanced Coal Mining, M.S. Enterprises Bilaspur, 1999.*

### MI411 STRATA MECHANICS

(3-0-0)3

Definition and concepts of ground control in mines; State of stress in underground openings- premining and induced stresses, influence of water, time, temperature on stress behaviour. Design of structure in rock, Design of pillars, Cavability characteristics & cavability index, design of supports. Subsidence- Concept, prediction and determination, measurement techniques, subsidence damage and its prevention. Rock bursts and bumps – mechanisms, prediction and estimation of damage.

*Obert L. and Duvall W.I. – Rock Mechanics and The Design of Structures In Rocks; John Wiley & Sons, New York, 1967.*

*Peng, S.S. Coal Mine Ground Control ; John Wiley & Sons, New York, 1978.*

*Biron C. and Arioglu E- Design of Supports in Mines; John Wiley & Sons, New York, 1983.*

### MI412 GEOSTATISTICS

(3-0-0)3

Sampling Methods – Theory and Concepts. Classical Statistical methods: Univariate and Bivariate; Exploratory data analysis. Probability distributions: application in ore reserve estimation. Concepts of Geostatistics; Semi-variogram: Kriging; Geostatistical conditional simulation. Practical applications of Geostatistics in geotechnical investigation. *S.M Gandhi and B.C Sarkar Essentials of mineral exploration and evaluation, Elsevier publications 2016*

*Chilès, J.-P., and P. Delfiner (1999), Geostatistics - Modeling Spatial Uncertainty, John Wiley & Sons, Inc., New York, USA.*

*Lantuéjoul, C. (2002), Geostatistical simulation: Models and algorithms, 232 pp., Springer, Berlin.*

*Kitanidis, P.K. (1997) Introduction to Geostatistics: Applications in Hydrogeology, Cambridge University Press.*

### MI413 APPLICATION OF IT IN MINING PROJECTS

(3-0-0)3

Development of algorithms and flow charts related to mining projects. Overview of mine planning software's. IT applications in: pit limits determination, reliability of equipment & preventive maintenance, blast design, ventilation planning, safety data base management system and mine safety automation, Computer aided production planning and scheduling in mines. Selected topics to be cover on IT applications in mining.

*Ram, R. V. et. al. ITs in Mineral Industry, Oxford & IBH, 1994*

*Husterilid, Open Pit Mine Planning and Design, Bulkema, 1995.*

*SURPAC Software manual: www. gemcomsurpac.com Isograph*

*Reliability Workbench Version 13.0 User Guide*

*GIAN Course on IT application and data analysis in mining and other core industries.*

### MI414 ORE RESERVE ESTIMATION AND MINE VALUATION

(3-0-0)3

National mineral resources; national mineral policy and strategies for development of mining industry; resource conservation; technology import, taxation, royalty and subsidies; mineral trade; concept of derivatives in mineral trade; pricing mechanism of minerals; sampling; estimation of reserves; economic block model concept; valuation of mines and mineral properties, life of a mining project; project evaluation; determination of optimum size of mine; risk analysis in mineral investment decisions.

*Annels, A.E., Mineral Deposit Evaluation: A Practical Approach, Chapman Hall, 1991.*

*Deshmukh, R.T., Mine and Mineral Economics, Emdee Publishers, 1986.*

*Edwards, A. C., Mineral Resource and Ore Reserve Estimation, Australasian Institute of Mining and Metallurgy, 2001.*

### MI449 MINE DESIGN PROJECT- I

(0-0-3)2

A small project of relevance to mining will be taken up by the student

### MI451 MINE LEGISLATION & SAFETY

(4-0-0)4

Important statutory provisions related to Payment of Wages Act, History and development of mine Legislation in India (In brief) and NCWA, provident Fund Act, Mines Act- 1952, Mines Rules- 1955, Coal Mines Regulations-2017, Metalliferous Mines Regulations-1961, Mines and Minerals (Regulation and Development) Act 1958, Mineral Conservation and Development Rules 2016. Mines Rescue Rules-1985. Vocational Training Rules-1966, Indian Electricity Rules-1956. Accident- causes and preventive measures for various accidents in mines; Accident analysis statistics; Accident cost, Accident enquiry report, safety management and audit.

*Rakesh and Prasad, Legislation in Indian Mines – A critical appraisal, Ashalata Pub., Varanasi, 1986.*

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*Singh, C.P. Occupational Safety and Health in Industries and Mines, Tata McGraw, 2004.*

### **MI452 MINE PROJECTS EXPOSURE**

**(0-0-0)1**

Comprehensive report about the short visits made to different mines and other industries will be submitted at the end of VIII Semester

### **MI490 SEMINAR**

**(0-0-3)2**

A topic of relevance to the mining industry to be chosen and the seminar be delivered with audio – visual aids. A write up of the same should also be submitted.

### **MI499 MINE DESIGN PROJECT- II**

**(0-0-6)4**

A major project of relevance to mining will be taken up by the student

### **MI460 COAL WASHING AND HANDLING**

**(3-0-0)3**

Coking and non-coking coal. Coal washeries, sink and float tests on coal, washability index, optimum degree of washability and washability number, application of jigs, heavy media cyclone, Coal cleaning techniques for fine coal and coarse coal, coal flotation, beneficiation of non-coking coal, automation and quality control in preparation plants. Environmental management in coal preparation. Coal gasification, liquefaction and new products from coal. homogenization and blending systems.

*Weiss, N.L., Mineral Processing Handbook- Volume-II, Published by SME, 1985.*

*Muthui Richard K, Rop Bernard K, Kabugu M, Coal Handling and Equipment Selection, LAP Lambert Academic Publishing, United States, 2014.*

### **MI461 SURFACE MINE DESIGN**

**(3-0-0)3**

Preliminary investigations. Stages of planning. Feasibility Report. Planning inputs. MMDR and MCDR. Project scheduling and monitoring. Estimation of mine life. Determination of ultimate pit limits. Interrelation and planning of unit operations. Equipment selection. Transport and dumping subsystems. Design of haul roads. Extraction methods for beach sand deposits. Mining of developed coal seams. Selective mining. Estimation of productivity & profitability. Quality control. Introduction to mine design softwares.

*Rzhevsky, V.V. Opencast Mining Unit Operations, Mir Publisher, 1983.*

*Rshensky V.V. Opencast Mining Technology and Integrated Mechanisations, Mir Publishers, 1985.*

*W.Hustrulid and M.Kuchta, Open Pit Mine Planning & Design, Vol. 1 & 2, Taylor & Francis, 2006.*

### **MI462 UNDERGROUND COAL MINE DESIGN**

**(3-0-0)3**

Objectives and Stages of Planning. Feasibility report. Detail project report (DPR); Determination of mine design parameters. Planning input for selection of mining method. Estimation of mine life. Design and production planning. Introduction to mine design software. Production cost analysis. Selection criteria for face and underground transport equipment. Planning and design layouts for ventilation, drainage and power supply. Ventilation management. Productivity and quality control; planning of deep underground coal mines; Automation in underground coal mines.

*Peng, S.S. Longwall Mining, Department of Mining Engineering, West Virginia University, 2006*

*Mathr, S.P. Coal Mining, M.S. Enterprises Bilaspur, 1999.*

### **MI463 UNDERGROUND METAL MINE DESIGN**

**(3-0-0)3**

Planning and scheduling of insets, shaft bottoms, winding and transportation systems. Surface lay outs including mill and concentrator plants. Determination of number and dimensions of stopes. Planning and scheduling of a cycle of operations. Concept of ore blending. Overall planning and scheduling of activities in metal mining and processing. Case studies of planning of mining operations.

*Agoshkov M., et. Al., Mining of Ores and Non- Metallic Minerals, Mir Publishers, Moscow, 1983.*

*Hartman, H.L. Introductory Mining Engineering, John Willey & Sons, 2007.*

*Niosh Snowden, Geological and Mining Reports of Underground Metal Mining: VolumeII, Wide Publishing, India, 2016.*

*Ratan Raj Tatiya, Surface and Underground Excavations, 2nd Edition : Methods, Techniques and Equipment, [Taylor & Francis Ltd](#), London, United Kingdom, 2013.*

### **MI464 ENVIRONMENTAL MANAGEMENT AND SUSTAINABLE DEVELOPMENT**

**(3-0-0)3**

Environmental problems due to mines and quarries. Land degradation. Pollution due to mining in terms of air and water. Acid Mine Drainage, Socio- economic impacts. Control measures. Pollution due to noise and vibrations. Effluents discharge. Reclamation of mined out and subsided areas. Mine closure. Environmental legislation and policies. Environmental Management Plan. Environmental Impact Assessment. Risk Analysis. Disaster management

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plan. Preparation of EMP for various mineral industries. Cost of environmental management. Environmental audit.  
*Dhar, B.B., Environmental Management of Mining Operations, Ashish Publication House, New Delhi, 1991.*  
*Chadwick et al., Environmental Impacts of Coal Mining and Utilization, Pergamon Press, 1992.*

### MI471 RELIABILITY ANALYSIS OF ENGG. SYSTEMS

(3-0-0)3

Reliability definition. Failure data analysis of mining equipment's. System of reliability. Reliability improvement. Maintenance of mining machinery, MIS for maintenance function. Maintenance planning and scheduling. Statistical analysis and data distributions of failure data. Availability and maintainability. Reliability and availability of repairable and non-repairable system. Systems with preventive and corrective maintenance. Reliability evaluation. Reliability prediction and modelling. Application of reliability in engineering systems and case studies. Applications of reliability software's in engineering.

*Patrick D. T. O' Connor. "Practical Reliability Engineering". Wiley India Pvt. Ltd., 4th Edition, 2012.*

*L. S. Srinath. "Reliability Engineering". East-West Press, 4<sup>th</sup> Edition, 2005.*

*John Davidson (Ed). The Reliability of Mechanical Systems. I Mech E. London 1994.*

*John P. Bentley. An Introduction to reliability & Quality Engineering. Longman Scientific & Technical, England, 1993.*

### MI472 ROCK EXCAVATION IN MINES & INFRASTRUCTURE PROJECTS

(3-0-0)3

Rock excavation by different methods in mining and infrastructure projects. Excavation and material handling equipment. Selection of equipment. Excavation in sensitive areas. Project Planning and Management. Practical examples in mining projects, ports, tunneling projects, pipeline excavations, canal excavation projects, hydel projects, Caveens/ large excavations etc. Environmental planning, environmental impact assessment and Management. Project economics.

*Stack, B., Mining and Tunneling Machine, 1978.*

*Martin, J. W., Martin T. J., Bennett, T. P. & Martin, K. M. Surface Mining Equipment, Martin Consultants Inc., USA, 1982.*

### MI473 STABILITY OF ROCK SLOPES

(3-0-0)3

Mechanisms of slope failures. Field investigations and data collection. Design of slopes - physical, empirical, probabilistic methods, analytical (limit equilibrium analysis) and numerical (continuum models, discontinuum and crack propagation models) modeling. Stabilization and reinforcement of slopes. Slope failure monitoring-modern techniques (SSR). Softwares for slope stability analysis. Case studies.

*Hoek, E. and Bray, J.W; Rock Slope Engineering; John Wiley & Sons; New York; 1984*

*Brawner, C.O; Stability in surface mining, SME of USA; New York, 1982. Giani, F;*

*Rock Slope Stability Analysis; Balkema; Rotterdam; 1992.*

### MI474 TUNNELLING ENGINEERING

(3-0-0)3

Design principles of underground openings, single and multiple openings with different orientation. Dimensions, shape, structural behavior and sequence of excavations in tunnels. Rock conditions and initial state of stresses. Computer aided tunnel design. Tunnel driving techniques. Tunnel supports, automation of supports, Shield tunneling system with road headers. Field instrumentation, Tunnel stability analysis, Case studies.

*Bieniawski, Z.T., Rock Mechanics and Design in Mining and Tunnelling, Rotterdam : A.A. Balkema, 1984.*

*Pokorovski, Driving Horizontal Workings and Tunnel, Mir Publishers, 1980*

### MI475 NUMERICAL MODELLING TECHNIQUES

(3-0-0)3

Development and use of numerical modeling in rock excavations. Finite element (2D and 3D). Boundary element (2D and 3D). Displacement and continuity. Basic equations for mathematical modeling of rock mass. Static and dynamic behavior of rock mass. Elastic-linear and non-linear, elastoplastic and time dependent models. Case studies.

*Kidybinski A. & Kwasniewski M. (Eds); Modelling of Mine Structures, A.A. Balkema, Rotterdam, 1988.*

*Kidybinski A. & Dubinski J. (Eds); Strata Control in Deep Mines, A.A. Balkema, Rotterdam, 1990.*

### MI476 INDUSTRIAL ENGINEERING & MANAGEMENT

(3-0-0)3

Concepts of Management and Organisation, Functions of Management, Organisational Structures, Basic concepts related to Organisation Departmentation, Motivation, Leadership, Group dynamics, Conflict management, Work study, Time study, Job Evaluation, Project management, Network techniques, Human Resource Management.

*Khanna, O.P., Rai, D. Industrial Engineering and Management, 2005.*

*Stoner, Freeman, Gilbert, Management, 6th Ed, Pearson Education, New Delhi, 2005.*

*Ralph M Barnes, Motion and Time Studies, John Wiley and Sons, 2004.*

*Chase, Jacobs, Aquilano, Operations Management, TMH 10th Edition, 2003.*

**MI477 REMOTE SENSING AND GEOINFORMATICS**

**(3-0-0)3**

Concept of GPS. Application of remote sensing to mining projects. Satellite signals. GPS instruments. Sensors and platforms. Image Processing and interpretation. Data processing. Concepts of GIS. Components, data acquisition, topology and spatial relationships, data storage verification and editing, network systems, data manipulation and analysis. Spatial and mathematical operations in GIS. Various GIS packages and their salient features.

*Basudev Bhatta, Remote sensing and GIS, II Edition, Oxford Publishing House, 2016.*

*George Jeoseph, Fundamentals of Remote Sensing, II Edition, Universal Press, 2017.*

*Lillisand, Keifer and Chipman, Remote Sensing and Image Interpretation, VI Edition, Wiley Publishers.*

*Hassan A. Karimi, Handbook of Research in Geoinformatics, Information Science Reference, 2017.*

**MI478 SAFETY ENGINEERING**

**(3-0-0)3**

Basic concept of risk; Difference between hazards and risks; Risk components and types, Risk management objectives, Risk management process; Hazards Identification and Risk Assessment (HIRA). Type of injury. Causes of injury, statistical analysis of injury data. Accident and preventive measures for various accidents in mines; Accident analysis and accident statistics; Economic evaluation of accident, Accident investigation report. Safety management and audit. Ergonomics and its application in safety engineering. Behavior base safety.

*Ridley, J & Channing, J.; Safety at Work; Butterworth-Heinemann, Oxford, 2001.*

*L.C. Kaku: A Study of Mine management, Legislation & General Safety.*

*S. Ghatak: A Study of Mine management, Legislation & General Safety.*

*C.P. Singh: Occupational safety and health in Industries and mines*

*Seppo Väyrynen · Kari Häkkinen Toivo Niskanen: Integrated occupational safety and health management by springer publications. SBN 978-3-319-13179-5 ISBN 978-3-319-13180-1 (eBook) DOI 10.1007/978-3-319-13180-1*

**MI479 ENERGY RESOURCES UTILIZATION AND CLIMATE CHANGE**

**(3-0-0)3**

Trends in Energy Supply & Quality of Life; Energy Demand & Supply Options; Energy Resources - their distribution & Utilisation ; Non-Conventional Hydrocarbons; Concepts of Energy & Exergy flows; Sustainability and Climate Change; Environmental Economics. Carbon Emissions; Potential Impacts; Climate Change Prediction Models - Basics; Global Climate Change negotiations – Problems and Issues; Carbon sequestration – Capture & Storage.

*David Coley, Energy & Climate Change — Creating Sustainable Future, John Wiley & Sons Ltd, 2008*

*Chris Goodall, Ten Technologies to Fix Energy and Climate, Second edition Profile Books, 2009*

*Anilla Cherian, Energy and Global Climate Change: Bridging the Sustainable*

*Development Divide, John Wiley & Sons, 2015*

**Courses for Minor in Mining Engineering**

**MI480 MINING TECHNOLOGY**

**(3-1-0) 4**

Introduction to mining projects. Roll of mining industry in development of nation. Mine development. Basics of underground coal mining technologies. Basics of underground metal mining technologies. Basics of surface mining technologies. Application of mechanical, civil, electrical, electronics and IT in mining projects.

*Tatiya R.R., Surface and underground excavation: methods, techniques and equipment, A. A. Balkema publishers, 2005.*

*Walker S.C. Mine Winding and Transport. Elsevier, Amsterdam 1988.*

*Gross, C. A., Electric Machines, 1<sup>st</sup> Edition, CRC Press, 2006.*

*Isograph Reliability Workbench Version 13.0 User Guide*

*GIAN Course on IT application and data analysis in mining and other core industries.*

**MI481 ROCK EXCAVATION ENGINEERING**

**(3-1-0)4**

Rock excavation in mining and infrastructure projects. Methodologies. Mines. CNG Pipeline projects. Hydel projects, Tunnels. U/G Caverns. Ports. Material handling equipment. Selection of equipment. Excavation in sensitive areas. Project Planning and Management. Environmental impact assessment and Management. Project economics.

*Stack, B., Mining and Tunneling Machine, 1978.*

*Martin, J. W., Martin T. J., Bennett, T. P. & Martin, K. M. Surface Mining Equipment, Martin Consultants Inc., USA, 1982.*

**MI482 MINE SAFETY ENGINEERING**

**(3-1-0)4**

Accident- causes and preventive measures for various accidents in mines; Accident analysis statistics. Accident cost. Accident report, Risk assessment & preparation of safety management Plan. Safety audits. Occupational hazards in



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mines, Hazard analysis. Hazard control by engineering approach, Hazard control by system approach. Economics of safety and cost-effectiveness. Occupational health and safety, Occupational diseases, Problems of safety and health in contractual work, Behavior based safety, Ergonomics and its application in mining.

*Ridley, J & Channing, J.; Safety at Work; Butterworth-Heinemann, Oxford, 2001.*

*L.C. Kaku: A Study of Mine management, Legislation & General Safety*

*S. Ghatak: A Study of Mine management, Legislation & General Safety*

*C.P. Singh: Occupational safety and health in Industries and mines*

Rakesh and Prasad, Legislation in Indian Mines – A critical appraisal, Ashalata Pub., Varanasi, 1986.

Singh, C.P. Occupational Safety and Health in Industries and Mines, Tata McGill, 2004.

### **MI483 MINE MECHANISATION**

**(3-1-0)4**

Equipment for excavation, transportation, processing. Selection of equipment. Tendering and processing.

Maintenance. Inventory. Automation. New developments. Productivity of machines. Economics.

*Amithosh Dey, Latest Development of Heavy Earth Moving Machinery, Annapurna Publishers, Dhanbad, 1995.*

*Reese, C., Material Handling Systems: Designing for Safety and Health, CRC Press, 2000.*

*Martin, J. W., Martin T. J., Bennett, T. P. & Martin, K. M. Surface Mining Equipment, Martin Consultants Inc., USA, 1982.*

### **MI484 ENVIRONMENTAL MANAGEMNET**

**(3-1-0)4**

Environmental issues. Pollution due to mining in terms of land degradation, air and water, noise and vibrations.

Socio-economic impacts. Waste management. Reclamation and rehabilitation. Environmental Impact Assessment.

Risk Analysis. Disaster management. Environmental audit. Environmental economics.

Dhar, B.B., Environmental Management of Mining Operations, Ashish Publication House, New Delhi, 1991.

Chadwick et al., Environmental Impacts of Coal Mining and Utilization, Pergamon Press, 1992.

### **Courses for Honors in Mining Engineering (Refer PG and PhD curriculum for details)**

**MI705 Project Management**

**(3-1-0)4**

**MI804 Underground Space Technology**

**(3-1-0)4**

**MI855 Reclamation Rehabilitation and Risk Management**

**(3-1-0)4**

**MI901 Applied Rock Mechanics**

**(3-1-0)4**

**MI916 Risk and Safety Management in Mines**

**(3-1-0)4**

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## Department of Computer Science & Engineering

### **CS110 COMPUTER PROGRAMMING**

**(3-1-0) 4**

Introduction to computer hardware, Computer Security, Introduction to C Programming language, C fundamentals, C input/output functions, Operators and Expressions in C, Decision making and branching, Decision making and Looping, Arrays, Strings, Functions in C, Structures and Unions, Pointers in C, File management in C, Problem solving approaches using C.

*Brian Kernighan and Dennis Ritchie "The C Programming Language" Prentice Hall; 2 edition ,April 1988*

*Byron S Gottfried "Programming with C", Schaum's Outline Series, Tata McGraw-Hill, 2005*

*R.G. Dromey, "How to solve it by computer" Pearson Education India; 1 edition ,2006*

*Deitel&Deitel , "C++ How To Program" Pearson; 10 edition ,March 2016*

### **CS111 COMPUTER PROGRAMMING LAB**

**(0-0-2) 1**

UNIX shell commands, Basic Input-Output functions, Operators and Expressions, Decision making and Branching constructs, Decision making and looping constructs, Arrays, Strings, Functions and Recursions, Structures and Union, Bit Operations, Pointers, Files and file operations, Laboratory Instructions.

*B Brian Kernighan and Dennis Ritchie "The C Programming Language " Prentice Hall; 2 edition, April,*

*1988. Yashwanth Kanetkar, "Let Us C", BPB Publications, BPB Publications; 15th edition ,July 2016*

*E. Balagurusamy, "Programming in ANSI C", McGraw Hill Education India Private Limited; Seventh edition, July 2017.*

*Byron S Gottfried "Programming with C", Schaum's Outline Series, Tata McGraw-Hill, 2005.*

*Balagurusamy, "Object oriented programming using C++", PHI, August 2010.*

*Herbert Schildt, "C: The Complete Reference", McGraw Hill Education; 4th edition July 2017.*

### **CS112 DISCRETE MATHEMATICAL STRUCTURES**

**(3-1-0) 4**

Fundamentals of Discrete Mathematics: Counting, Logic, Set Theory, Proof Techniques, Relations and Functions: Generating functions, Recursive relations; Introduction to Graph Theory: Vertex degrees, paths, Planar graphs, Trees; Basic Algebra: Groups, Monoids, Rings.

*R.P. Grimaldi, B.V. Ramana, Discrete and Combinatorial Mathematics: An Applied Introduction, 5th Edition, Pearson, 2008.*

*B. Kolman, R.C. Busby, S.C. Ross, Discrete Mathematical Structures, Pearson Education India; 6 edition , 2015.*

*Kenneth Rossen, Discrete Mathematics and its Application, 7th Edition, McGraw-Hill, 2011.*

*L. Lovasz, Combinatorial Problems and Exercises, 2nd Edition, North Holland, 1993.*

### **CS200 THEORY OF COMPUTATION**

**(3-1-0) 4**

Formal Languages and Automata Theory: Generative grammar, Chomsky hierarchy, Finite state Automata: Definition, Concept of Non-determinism, Equivalence of deterministic and Non-deterministic Automata, regular languages; Closure properties. Pushdown Automata: Definition, Equivalence between NPDA and context free grammars, Pumping Lemma for C.F.L's, Decision problems, Closure properties. Turing machines: Definition, extension to Turing machines: Multi-track, Multi-tape, and Non determinism. TM as an acceptor, TM as a computing device; P, NP, NP-Hard & NP-Complete problems

*J.E.Hopcroft and J.D.Ullman, Introduction to automata, Languages and computation, Addison Wesley, 1969*

*M. Sipser, Theory of Computation, Cengage, 2013.*

*H.E.Lewis and C.H. Papadimitiou, Elements of the Theory of Computation, Prentice-Hall of India, 1981.*

*Derickwood, Theory of Computation, John Wiley & Sons, 1987.*

### **CS201 DESIGN OF DIGITAL SYSTEMS**

**(3-1-0) 4**

Number systems; Switching algebra and logic circuits; Combinational and sequential circuits and their algorithmic synthesis; Logic optimization: two level, multi-level, circuits; Computer aided synthesis and optimization; Hardware modeling using VHDL; Introduction to VLSI design: MOS devices, system level design; Introduction to VLSI testing: fault models, testing combinational and sequential circuits.

*Alan B. Marcovitz, "Introduction To Logic Design", McGraw-Hill, 3rd Edition, 2009.*

*Giovanni De Micheli, "Synthesis and Optimization of Digital circuits", McGraw-Hill., 2003*

*ZviKohavi, "Switching and finite automata theory", McGraw-Hill, 1978.*

*Morris Mano, "Digital Design with an Introduction to Verilog", Pearson Education India, 5th Edition, 2013.*

### **CS202 DATA STRUCTURES AND ALGORITHMS**

**(3-1-0) 4**

Introduction to basic data structures and algorithms, Dynamic memory allocation, Algorithm analysis and design

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techniques. Classical Searching & Sorting Algorithms, Linked List and its applications, Stacks and Queues.

Recursion and evaluation of arithmetic expressions. Introduction to Tree: Tree Traversals, Binary Search Trees, AVL Tree, Priority queues and Binary Heaps, Introduction to Graphs: Graph representations, Graph Traversals, Shortest path algorithms, Topological sort, Minimum spanning Trees, Graph applications, Hashing.

*Alfred V Aho, John E Hopcroft, Jeffrey D Ullman, "Data Structures and Algorithms", Addison Wesley, 2003.*

*Horowitz and Sahni, "Fundamentals of Data Structures and Algorithms in C++", Universities Press, 2007.*

*Clifford A Shaffer, A Practical Introduction to Data Structures and Algorithms, Prentice Hall International, 1997. William K Pratt, Digital Image Processing, Wiley-Interscience Publication, Third Edition, 2001.*

*Mark Allen Weiss, Algorithms Data structures and problem solving with C++, Addison Wesley, 1996*

*J Kleinberg, E Tardos, "Algorithm Design", Addison-Wesley, 2005.*

*Jean Paul Trembley and Paul G Sorenson, "An Introduction to Data Structures with Applications", Tata McGraw Hill, 2001.*

### **CS203                      DESIGN OF DIGITAL SYSTEMS LAB                      (0-0-3) 2**

Hardware level implementation: Gates, Adders, Subtractor, Encoders, Decoders, Code Conversion, Multiplexers, Flip Flops, Shift Registers, Counters. Gate-Level, Dataflow And Behavioral Modelling: Gate, Adders, Subtractor, Multiplier, Multiplexers, Counters, Design Of FSM: Moore Machine, Mealy Machine.

*J. Bhasker, "VHDL primer", Prentice Hall, 3rd Edition, 1999.*

*Douglas Perry, "VHDL: Programming by Examples", McGraw-Hill, 4th Edition, 2002.*

*Peter Ashenden, "The Designer Guide to VHDL", Elsevier, 2008.*

*Morris Mano, "Digital Design with an Introduction to Verilog", Pearson Education India, 5th Edition, 2013*

### **CS204                      DATA STRUCTURES AND ALGORITHMS LAB                      (0-0-3) 2**

Experiments based on creating and manipulating various data structures: Arrays, Lists, Stacks, Queues, Trees, Heaps, Hash Tables, Balanced Trees, Graphs. Algorithms for sorting and searching, Order Statistics, Depth-First and Breadth-First Search, Shortest Paths and Minimum Spanning Tree.

*Alfred V Aho, John E Hopcroft, Jeffrey D Ullman, "Data Structures and Algorithms", Addison Wesley, 2003.*

*Horowitz and Sahni, "Fundamentals of Data Structures and Algorithms in C++", Universities Press, 2007.*

*Mark Allen Weiss, Algorithms Data structures and problem solving with C++, Addison Wesley, 1996*

### **MA204                      LINEAR ALGEBRA AND MATRICES                      (3-0-0) 3**

Refer MA204 syllabus in MACS dept.

### **CS250                      COMPUTER ORGANIZATION AND ARCHITECTURE                      (3-1-0) 4**

Introduction to computers and data. High level system block diagram. Definitions. Representation of integer and floating point numbers. Example RISC ISA – encoding, programming. Compilation stages, Object code. ALU design, Processor data path, Control unit design. Memory hierarchy. I/O subsystem concepts. Introduction to parallelism.

*David A Patterson and John L Hennessy. Computer Organization and Design – The Hardware/Software Interface. 4e (ARM Edition), 2012/5e (MIPS Edition), 2014/6e (RISC-V Edition), 2017. Elsevier. M. Morris Mano. Computer System Architecture. 3e. Pearson. 2007.*

*Hamacher, Vranesic, Zaky. Computer Organization. 5e. Tata McGraw Hill. 2011.*

*John P Hayes. Computer Architecture and Organization. 3e. McGraw Hill. 1998.*

*David M. Harris and Sarah L. Harris, Reference for some of the assignments, Digital Design and Computer Architecture. 2e. Elsevier. 2013.*

### **CS251                      DATABASE SYSTEMS                      (3-1-0) 4**

Database system concepts and architecture, Database design and ER models, Relational model, Relational algebra and SQL, Functional dependencies, Normal forms, Database storage and indexing, Query processing, Query optimization, Concurrency control, Database recovery, Database security, NoSQL databases.

*Elmasri, R., Navathe, S., Fundamentals of Database Systems, Fifth Edition, Addison-Wesley, 2006.*

*Silberschatz, H. F. Korth, and S. Sudarshan, Database System Concepts, Sixth Edition, McGraw-Hill, 2011.*

*Raghu Ramakrishnan & Johannes Gehrke, Database Management Systems, Third Edition, WCB/McGraw Hill, 2003*

*Peter Rob and Carlos Coronel, Database Systems- Design, Implementation and Management (7/e), Cengage Learning, 2007.*

### **CS252                      OPERATING SYSTEMS                      (3-1-0) 4**

Introduction to operating systems, Process concepts, Scheduling algorithms, CPU scheduling, Multithreading models, Concurrent processes, Deadlocks, Virtual and physical memory management, Disk scheduling, File systems,

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Performance evaluation, Operating system security, Case studies-The UNIX operating system.

Silberschartz, Galvin & Gagne, "Operating System Concepts", 9<sup>th</sup> Edition, John Wiley & Sons, 2013

MelinMilenkovic, "Operating Systems: Concepts and Design", McGraw Hill, New York, 2000.

Andrew S. Tanenbaum, Vrije University, Amsterdam, The Netherlands, Herbert Bos, "Modern Operating Systems" 2015

Sumitabha Das, Unix Concept and applications, TataMcgraw-Hill, 2003

### **CS253 DESIGN AND ANALYSIS OF ALGORITHMS (3-1-0) 4**

Models of computation, Algorithm analysis, Time and space complexity, Average and worst case analysis, Lower bounds. Algorithm design techniques: Divide and conquer, Greedy, Dynamic programming, Amortization, Randomization. Problem classes: P, NP, PSPACE; Reducibility, NP-hard and NP-complete problems. Approximation algorithms for some NP-hard problems.

Cormen, Leiserson, Rivest, and Stein, "Introduction to Algorithms", MIT Press, Third Edition, 2009. Dasgupta,

Papadimitrou and Vazirani, "Algorithms", McGraw-Hill Education, 2006. Horowitz, Sahni, and Rajasekaran,

"Computer Algorithms" Silicon Press, 2007.

Kleinberg and Tardos, "Algorithm Design", Pearson, 2005.

Goodrich and Tamassia, "Algorithm Design", Wiley, 2001.

### **CS254 DATABASE SYSTEMS LAB (0-0-3) 2**

Design database using data modeling tools, Understanding integrity constraints, Learning various SQL statements to create, update, Query and manage a database. Writing complex queries using join and sub query. Design of database applications and user interfaces using web or mobile app frontends. Learn advanced database concepts through real time case studies.

Ramez Elmasri and Shamkant B.Navathe, Fundamentals of Database Systems, Pearson Education, 7th edition, 2016.

Raghu Rama Krishnan, Database Management Systems, Tata Mcgraw Hill, 3rd Edition, 2014.

VikramVaswani, MySQL(TM): The Complete Reference, McGraw Hill Education; 1 edition, 2017

James Groff (Author), Paul Weinberg (Author), And Oppel, SQL The Complete Reference, 3rd Edition, 2017

### **CS255 OPERATING SYSTEMS LAB (0-0-3) 2**

Linux and/or other OS based exercises to practice/simulate: Scheduling, Memory management algorithms, Concurrent programming, Use of threads and processes, Kernel reconfiguration, Device drivers and systems administration of different operating systems, Writing utilities and OS performance tuning

Silberschartz, Galvin & Gagne, "Operating System Concepts", 9<sup>th</sup> Edition, John Wiley & Sons, 2013 Melin

Milenkovic, "Operating Systems: Concepts and Design", McGraw Hill, New York, 2000.

Andrew S. Tanenbaum, Vrije University, Amsterdam, The Netherlands, Herbert Bos, "Modern Operating Systems" 2015

Sumitabha Das, "Unix Concept and applications" McGraw Hill publications, 2008

### **SM300 ENGINEERING ECONOMICS (3-0-0) 3**

Refer SM300 syllabus in School of Management dept

### **SM302 PRINCIPLES OF MANAGEMENT (3-0-0) 3**

Refer SM302 syllabus in School of Management dept

### **CS300 SOFTWARE ENGINEERING (3-1-0) 4**

Introduction to software engineering, Software development life cycle & various models, Requirements engineering, Software specification, Software metrics, Software design, Object oriented software engineering, Software testing & various testing mechanisms, Software verification and validation, Verifying performances, Verifying reliability, Software cost estimation models, Software complexity analysis models, Economics of software development, Software development tools including CASE tools, Software project management, Automated testing and analysis of large-scale modern software systems, Applications-cloud computing, Big Data & others.

Roger S. Pressman, Software Engineering: A Practitioner's Approach, McGraw-Hill, Eight Editions.

Ian Sommerville, Software Engineering, Addison-Wesley, 9th edition, 2010.

R. Fairley, Software Engineering Concepts McGraw-Hill, 1995.

Rajib Mall, Fundamentals of Software Engineering, Prentice Hall India, 2009.

Pankaj Jalote, An Integrated Approach to software Engineering, Narosa Pub., 2002.

### **CS301 COMPUTER NETWORKS (3-1-0) 4**

Different components of One Way Delay (OWD), Decoupling bandwidth and latency, Network architecture vs

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application architecture, Process to process communication, Services offered by TCP and UDP, Application layer protocols (HTTP, FTP, SMTP, DNS), IPv4 and IPv6 addressing, Dynamic Host Configuration Protocol (DHCP) and Network Address Translation (NAT), Principles of reliability and congestion control, Internals of TCP and UDP, Routing algorithms for the internet and virtual circuits.

Kurose, James F. *Computer networking: A top-down approach featuring the internet*, 6/E. Pearson Education India, 2005/2012

Kevin R Fall and W. Richard Stevens. *TCP/IP illustrated, volume 1: The protocols*. Addison-Wesley, 2011.

Ilya Grigorik, *High Performance Browser Networking: What every web developer should know about networking and web performance*. "O'Reilly Media, Inc.", 2013.

Peterson, L. L., & Davie, B. S. *Computer networks: A Systems Approach*. Elsevier, 2007.

Tanenbaum, A. S., & Wetherall, D. (1996). *Computer networks (pp. I-XVII)*. Prentice hall, 1996.

### CS302 COMPUTER NETWORKS LAB

(0-0-3) 2

Design and analysis of various network topologies and protocols (HTTP, TCP, UDP, DHCP, IP {v4, v6} and NAT), Socket programming (BSD, ZeroMQ), Analysis of packets using Wireshark, Network simulations, Understanding linux network stack.

James F. Kurose, *Computer networking: A top-down approach featuring the internet*, 6/E. Pearson Education India, 2005/2012

Ilya Grigori, *High Performance Browser Networking: What every web developer should know about networking and web performance*. "O'Reilly Media, Inc.", 2013.

Online Resources: Interactive animations, Video notes from Kurose and Ross 2012, Wireshark assignments, Presentation slides, interactive exercises from the following link:  
[http://wps.pearsoned.com/ecs\\_kurose\\_compnetw\\_6/216/55463/14198700.cw/](http://wps.pearsoned.com/ecs_kurose_compnetw_6/216/55463/14198700.cw/)

### CS303 SOFTWARE ENGINEERING LAB

(0-0-3) 2

Mini project to be designed to give exposure to the latest developments in software engineering and to understand the use of project management skills; Use of CASE tools.

R.S. Pressman, *Software Engineering*, McGraw-Hill, 2002

Pankaj Jalote, *An Integrated Approach to software Engineering*, Narosa Pub., 2002.

### CS304 COMPILER DESIGN

(3-1-0) 4

Introduction to language processing; Lexical analysis, Regular languages and finite automata; syntactic analysis, Context-free languages; Semantic analysis and syntax-directed translation; Error analysis; Intermediate representation and intermediate code generation; The procedure abstraction, Run-time environments and storage allocation; Code generation, Instruction selection, Register allocation; Code optimization, Data-flow analysis and control flow analysis.

Aho, Lam, Sethi, Ullman *Compilers: Principles, Techniques, and Tools*, Addison-Wesley, (2007/2013) ISBN-10: 0321486811

Y. N. Srikant and Priti Shankar: *The Compiler Design Handbook: Optimizations and Machine Code Generation*, CRC Press, 2002. ISBN 084931240X

Tremblay and Sorenson: *The Theory and Practice of Compiler Writing*, McGraw-Hill, 1985.

Grune, Bal, Jacobs, Langendoen: *Modern Compiler Design*, John Wiley and Sons, (2000)

Steven Muchnick: *Advanced Compiler Design and Implementation*, Morgan Kaufmann, 1997. ISBN 1-558-60320-4.

Keith Cooper, Linda Torczon: *Engineering a Compiler*, Morgan Kaufmann; 2 edition (2011)

Andrew Appel: *Modern Compiler Implementation in Java*, Cambridge University Press, (2002)

### CS305 COMPILER DESIGN LAB

(0-0-3) 2

Implement a lexical analyser for the C programming language using the grammar for the language given in the book "The C Programming Language", 2e, by B Kernighan and D Ritchie. (Use lex/flex for creating the lexical analyser). Implement a desk calculator using operator precedence parsing. Implement a parser for the C programming language using YACC/Bison.

Implement a semantic checker for the C programming language (perform semantic analysis such as type and scope analysis and declaration processing, and integrate such analyses with the parser) using YACC/Bison. Create a translator that would translate input into three-address intermediate code using LEX and YACC.

Andrew Appel: *Modern Compiler Implementation in Java*, Cambridge University Press, (2002).

John R. Levine, Tony Mason, Doug Brown: *Lex&Yacc*, 2nd/updated edition, O'Reilly & Associates, (October 1992).

Robert Morgan: *Building an Optimizing Compiler*, Digital Press, 1998. ISBN 1- 55558- 179- X

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### CS350 CRYPTOGRAPHY AND APPLICATIONS (3-1-0) 4

Cyber security and cybercrimes, Types of attacks, Case study, Elementary number theory, Primality, abstract algebra., Symmetric cryptography, Asymmetric cryptography, Key management, Integrity and authentication,

Cryptographic application in data networks, Applications in software systems, Security aware software development life cycle, Ethical hacking and secure coding.

*Neal Koblitz, A Course in Number Theory and Cryptography, Springer, 1987.*

*Ivan Niven, Herbert S. Zuckerman. Hugh L. Montgomery, An Introduction to The Theory of Numbers, John Wiley, 2008.*

*Alfred Menezes, Paul van Oorschot, Scott Vanstone, Hand book of Applied Cryptography, CRC, 1997.*

*William Stallings, Cryptography and Network Security-Principle and Practice, Prentice Hall, 2016.*

### CS351 MACHINE LEARNING (3-1-0)4

Goals and applications of machine learning, Types of learning, Inductive classification, Linear regression, Decision trees, Probability and Bayes learning, Experimental evaluation of learning algorithms, Logistic regression, Support vector machine, Kernel function and Kernel SVM, Artificial neural networks (Perceptrons, Multilayer neural networks, Back propagation algorithm, Different activation functions), Computational learning theory, Clustering and unsupervised learning.

*Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2017.*

*Alpaydin, E. "Introduction to machine learning", MIT press, 2014.*

*Marsland, S. "Machine learning: an algorithmic perspective", CRC press, 2015.*

*Christopher M Bishop, "Pattern recognition and machine learning" Springer Science Business Media, 2006*

*Richard O. Duda, [Peter E. Hart](#), [David G. Stork](#), "Pattern Classification" Second edition John Wiley, 2001.*

### CS352 CRYPTOGRAPHY AND APPLICATIONS LAB (0-0-3) 2

Implementation of different number theory primitives, Primality test, Symmetric and asymmetric ciphers, Hash functions, Digital signatures, Key exchange protocols.

*Neal Koblitz, A Course in Number Theory and Cryptography, Springer, 1987.*

*Ivan Niven, Herbert S. Zuckerman. Hugh L. Montgomery, An Introduction to The Theory of Numbers, John Wiley, 2008.*

*Alfred Menezes, Paul van Oorschot, Scott Vanstone, Hand book of Applied Cryptography, CRC, 1996.*

*William Stallings, Cryptography and Network Security-Principle and Practice, Prentice Hall, 2016.*

### CS353 MACHINE LEARNING LAB (0-0-3)2

Implementation of various machine learning algorithms (with and without using frameworks), Mini projects to design solutions for various real world problems using machine learning tools.

*Tom M Mitchell, "Machine Learning", McGraw Hill Education, 2017.*

*Christopher M Bishop, "Pattern recognition and machine learning", Springer New York, 2016.*

*Goodfellow, I., Bengio, Y., Courville, A., & Bengio, Y., "Deep learning" (Vol. 1). Cambridge: MIT press, 2016.*

*Richard O. Duda, [Peter E. Hart](#), [David G. Stork](#), "Pattern Classification" Second edition John Wiley, 2001.*

### CS355 SEMINAR (0-0-3) 2

This course is a 2 credit course to be completed during 6<sup>th</sup> semester. Students will have to choose a topic in CSE's current trends or industry practices, prepare a write up, present it along with a suitable demonstration. Evaluation will be based on the relevance of topic, communication skills, and the reporting / documenting procedure.

### CS360 GRAPH THEORY (3-1-0) 4

Graphs, Preliminaries on Graphs, Matchings in Bipartite graphs- Konig 's theorem, Hall's theorem. Matchings in general graphs- Tutte's theorem, 2-connected graphs, Ear-decomposition, Menger's theorem, Dirac's extensions for Menger 's theorem. Edge connectivity, Vertex coloring- Greedy coloring, Degeneracy of graphs, Coloring of planar graphs, Brook's theorem, Edge coloring- Konig's theorem, Vizing's theorem, Perfect graphs. Hamiltonian graphs, Ramsey theoretic problems, Structure of minimum cuts in a graphs, Discharging method, Network flows.

*R. Diestel, Graph Theory, Second edition, Springer, 2000.*

*D. West, Introduction to Graph Theory, Second Edition, PHI, 2003.*

*J. A. Bondy and U. S. R. Murty, Graph Theory with Applications, North Holland, 1976.*

*A. Schrijver, A course in Combinatorial Optimization, Cambridge university press, 2000.*

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### **CS361                    SYSTEM PROGRAMMING**

**(3-1-0) 4**

System APIs, GNU libc. UNIX systems, File I/O, filters and file manipulation. Command line arguments and environment variables. Terminal handling and text based screen applications. Interrupt handling. Finding the time. Mixing C and scripts. Resource management algorithms. Distributed systems concepts, Concurrent programming.

*Anthony Richard John, Systems Programming: Designing and Developing Distributed Applications, Morgan Kaufmann, 2015.*

*Adam Hoover, System Programming with C and Unix, Pearson, 2009*

*Robert Love, Linux Kernel Development. Addison-Wesley Professional, 2010*

*Robert Love, Linux System Programming, O'Reilly Media; 2 edition. 2013*

### **CS362                    PROBLEM SOLVING TECHNIQUES**

**(3-1-0) 4**

Basic problem solving strategies, Problem simplification and decomposition techniques, Algorithmic solutions and their correctness, Recursion, Simulation, Decision trees, Graphs and networks, Computer organization and programming constructs and basic operating system and debugging tools.

*Delores M. Etter. Engineering Problem Solving with C, 3rd Edition, Prentice Hall, 2005.*

*Jeri R. Hanly and Elliot B. Koffman, Problem Solving and Program Design in C, Pearson Education, Inc., ISBN: 0-321-21055-7, 2008*

*D.S. Malik, Thomson, C++ Programming: From Problem Analysis to Program Design, Third Edition, Course Technology, 2007*

### **CS363                    COMPUTING SYSTEMS**

**(3-1-0) 4**

Advanced processors, Memory systems, Virtual machines, RAID, Persistent NVMs, Input/Output systems, Parallelism, Shared memory and message passing multiprocessors, Hardware implementation of locks. Simulation of computing systems, Interconnection networks.

*Randal E Bryant, David R O'Hallaron. Computer Systems: A Programmer's Perspective, 2e., 2010*

*John L Hennessy and David A Patterson, Computer Architecture: A Quantitative Approach, 6e, 2018.*

*L. Eeckhout, Computer Architecture Performance Evaluation Methods, Synthesis Lectures on Computer Architecture, Morgan Claypool, 2010.*

### **CS364                    MICROPROCESSOR SYSTEMS**

**(3-1-0) 4**

Microprocessor architecture, 8086, Instruction set, Subroutines, Programming examples, Software development with interrupts; Intel 80286, 80386; Programmable peripheral devices, 8255, 8253, 8259, 8257, Motorola 68000 processors, 68020, 68030; Mother boards, I/O bus, I/O channel, BIOS, DOS, PC bus, Multibus I & II, VME, CRT controller, Floppy disc controller, Hard disc controller, CDROM drive, Serial communication controller, Pen drive, Mouse drive.

*Douglas V. Hall, Microprocessors & Interfacing Barry B. Brey, "The Intel Microprocessors: Architecture, Programming & Interfacing" PHI, 6th Edition, 2003.*

*Lice & Gibson, "Microcomputer System 8086 / 8088" PHI, 2nd Edition*

### **CS365                    ADVANCED DATA STRUCTURES**

**(3-1-0) 4**

Data structures and its operations, Trees, Heaps, Advanced graph algorithms and applications, Internet Algorithms, Compression algorithms, Search engine algorithms, Spiders and crawlers, Integer and polynomial arithmetic, Modular arithmetic, NP-Completeness and approximation algorithms.

*Thomas Cormen, Charles E Leiserson and Ronald D River, Introduction to Algorithms, PHI, 2001. Mark Allen*

*Weiss, Algorithms, Data Structures and Problem Solving with C++, Addison Wesley, 2002. Fundamentals of data structures in C++, by E. Horowitz, S. Sahni, and D. Mehta, Second Edition, Silicon Press, 2007*

### **CS366                    MANAGEMENT INFORMATION SYSTEMS**

**(3-1-0) 4**

Functions of management, Organization environment, Organization structure, System concepts, Stakeholders analysis, Framework for information systems (IS), Decision making process, Problem solving process, Definition of Management Information System (MIS), EIS, DSS, Artificial intelligence, Expert systems, Computer hardware, Hardware standards, Computer software file and database management, Communication systems, Common network components, Distributed systems, Design of MIS, Applications of MIS to business, Case studies.

*Kenneth C. Laudon and Jane Price Laudon, Management Information Systems, Managing the Digital firm, Pearson Education, Asia, 2002.*

*Gordon B. Davis, Management Information System: Conceptual Foundations, Structure & Development, McGraw-Hill, 1974.*

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Joyce J Elam, *Case series for Management Information Systems*, Simon and Schuster Custom Publishing, 1996.

### **CS367                      SOFT COMPUTING                      (3-1-0) 4**

Introduction to soft computing, Fuzzy logic, Applications of fuzzy logic, Genetic algorithms, Artificial neural networks; Supervised, unsupervised and reinforcement learning; Basic neural network models, Adaline, Linear and nonlinear activation functions, Loss functions, Gradient descent method, Back propagation algorithm, Multi-layer neural networks.

J.-S. R. Jang, C.-T. Sun, and E. Mizutani, *Neuro-Fuzzy and soft Computing*, PHI Learning, 2009.

G. J Klir and B Yuan. "Fuzzy Sets and Fuzzy Logic: Theory and Applications", Prentice Hall.

Martin T Hagan et.al., "Neural network design" (2nd edition), 2014

Melanie Mitchell, *An Introduction to Genetic Algorithms*, MIT Press, 2000.

Taqiq Rashid, "Make your own Neural Network", 2016

David E. Goldberg, *Genetic Algorithms In Search, Optimization And Machine Learning*, Pearson Education, 2002.

### **CS368                      COMPUTER GRAPHICS                      (3-1-0) 4**

Introduction to computer graphics: Basic raster graphics algorithms for drawing 2D primitives, 2D transformations, Window-to-viewport transformation, Input devices and interactive techniques. 3D graphic: Viewing in 3D, Projections, Basics of solid modeling, 3D transformations. Multimedia building blocks: Audio - basic sound concepts, Music, Speech, MIDI versus digital audio, Audio file formats, Sound for the web, Images and graphics-basic concepts, Computer image processing. Video and animation –basic concepts, Animation techniques, Animation for the web.

Foley J. D., Van Dam A., Feiner S. K. & Hughes J. F., *Computer Graphics Principles and Practice*, Second Edition, Addison Wesley

Hearn D. & Baker P.M, *Computer Graphics*, Prentice Hall India

Koegel Buford J. F., *Multimedia System*, Addison Wesley

### **CS369                      OBJECT ORIENTED PROGRAMMING                      (3-1-0)4**

Programming paradigms, Software design principles, Objects and classes, Operator overloading, Inheritance, Exception handling, Templates, Case studies.

Bjarne Stroustrup, "The C++ Programming Language", Addison Wesley, 2004.

Stanley B Lippman, "The C++ Primer", Addison Wesley, 2005.

Grady Booch, James Rumbaugh, Ivar Jacobson, "Unified Modeling Language User Guide", Addison-Wesley Professional, 1998.

Craig Larman, "Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development", Prentice Hall Edition, 2004.

### **CS400                      PRACTICAL TRAINING                      (0-0-2) 1**

The student has to undergo a training programme or any equivalent programme fixed by the DUGC of department. This will be done during vacation period of second or third year (6 to 8 weeks). A report will be submitted by the student. Evaluation is based on the seminar and report.

### **CS410                      SIMULATION AND MODELING                      (3-1-0) 4**

Introduction to Modeling and simulation concepts. Levels of simulation for digital, analog & mixed mode circuits. IC CAD Overview. Device Simulation. Electrical simulation techniques. Relaxation based simulation techniques. Gate level simulation, Switch level timing simulation. Mixed mode interface, Simulation and implementation, Analog multi-level simulation. Discrete time models, Event driven simulation, Logic simulation, Timing verification in ICs, Setup and hold times for clocked devices.

R. Saleh, S. Jou & A.R.Newton, *Mixed mode simulation and analog multilevel simulation*, Kluwer Academic Pub. 1994.

V.Litovski & M. Zwolinski, *VLSI circuit simulation & Optimization*, Chapman & Hall, 1997.

J Baker, Li & Boyce, *CMOS Circuit Design & Simulation*, PHI, 2000

### **CS411                      SOFTWARE TESTING                      (3-1-0) 4**

Software testing concepts & principles, Testing strategies, Testability and related issues, Methods for developing the strategy, Life cycle testing, Installation phase testing and various phases of testing; Tools and techniques for software testing, Testing object oriented software, Testing in practice, State-of-art testing and bug detection techniques, Evaluating software quality, Test automation, Testers' workbench.

Ilene Burnstein, "Practical Software Testing", Springer Professional Computing, 2003.

Glenford J. Myers, *The Art of Software Testing*, John Wiley & Sons, 1979.



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*Cem Kaner, Jack Falk, Hung Quoc Nguyen, Testing Computer Software, 2nd Ed, Intl. Thomson Computer Press, 2008.*

*Ron Patton, "Software Testing", Second Edition, Sams Publishing, Pearson education, 2007.*

*Renu Rajani, Pradeep Oak, "Software Testing – Effective Methods, Tools and Techniques", Tata McGraw Hill, 2004.*

### **CS412 FORMAL METHODS (3-1-0) 4**

Formal methods in computing specification; Formal description techniques in communication software systems; Formal methods in object orientation and software engineering, Proof methods and techniques, Temporal and model logic.

*Jan Ven Lecuwen—Formal Model and Semantics, Elsevier-MIT Press,*

*1992 Arindama Singh—Logic for Computer Science, PHI, IEEE, 2003*

*Larry Wall, Tom Christensen and Randal Schwartz, Programming Perl, O'Reilly & Associates, Inc. 1996*

### **CS413 DISTRIBUTED COMPUTING (3-1-0) 4**

Distributed systems and applications, Message passing mechanisms IPC and RPC. Processes: Threads, Clients, Servers, Code Migration, Agents. Naming: Naming entities, Mobile entities, Distributed operating systems, Distributed file systems and services. Synchronization: logical clocks, Global state, Distributed transactions, Consistency and replication: models, protocols, examples. Fault tolerance: Process resilience, Reliable communication, Recovery. Security management. Distributed file and Web-based systems, Social computing.

*Andrew S. Tanenbaum and Maarten Van Steen, Distributed Systems: Principles and Paradigms, John Wiley & Sons, Inc ISBN number: 9780132392273, 2004.*

*Pradeep Sinha, Distributed Operating Systems Concepts and Design, PHI, 2000.*

*George Coulouris, Jean Dollimore & Time Kindberg, Distributed Systems: Concepts & design, 2nd ed Addison Wesley 2003.*

*Gerard Tel. Introduction to Distributed Algorithms, Cambridge University press, 2000.*

### **CS414 WEB ENGINEERING (3-1-0) 4**

Requirements specification and analysis, Web-based systems development methodologies and techniques, Migration of legacy systems to web environments, Web-based real-time applications development, Testing, Verification and validation, Quality assessment, Control and assurance, Configuration and project management, "Web metrics"-generating metrics for estimation of development efforts, Performance specification and evaluation, Update and maintenance, Development models, Teams, Staffing, Integration with legacy systems, Human and cultural aspects, User-centric development, User modeling and user involvement and feedback, End-user application development.

*Martin , Geert-Jan , Daniel , Bebo White, Journal of Web Engineering, Rinton Press, IEEE & ACM Publication, 2002.*

*Cato & John, User Centered web design, Pearson Education, 2001.*

*Kappel, G., Proll, B. Reich, S. & Retschitzegger, W. Web Engineering, 1s ed. Wiley & Sons.*

### **CS415 WIRELESS NETWORKS (3-1-0) 4**

Different types of wireless technologies such as: Cellular networks, Wi-Fi, Underwater acoustic networks. Different versions of 802.11 such as: Wireless access for vehicular environments, Gigabit Wi-Fi, and others. Rate adaptations algorithms such as: Auto rate fallback, Adaptive auto rate fallback, ONOE, Sample rate, Minstrel and others. Performance problems in wireless networks, Introduction to wireless TCP, Importance of explicit congestion notification in wireless networks. Different types of wireless routing protocols such as Ad hoc on demand distance vector, Ad hoc on demand multipath distance vector, Destination sequenced distance vector, Dynamic source routing and others.

*Ilya Grigori, High Performance Browser Networking: What every web developer should know about networking and web performance. " O'Reilly Media, Inc.", 2013.*

*C. S. R. Murthy, Ad hoc wireless networks: Architectures and Protocols. Pearson Education India, 2004.*

*Online Resources: Technical papers in course related topics and IEEE Standards documents.*

### **CS416 DATA WAREHOUSING AND MINING (3-1-0) 4**

Data warehousing, design, indexing. Data mining functionalities, Issues in data mining, Data warehouse and OLAP technology for data mining, Association rule mining, Sequential pattern mining, Classification and prediction, Cluster analysis, Outlier analysis, Text mining, Applications in data mining

*Jiawei Han, Micheline Kamber, "Data Mining: Concepts and Techniques", Morgan Kaufmann, Third edition, 2011.*

*Alex Berson, Stephen J. Smith, "Data Warehousing, Data Mining & OLAP", Tata McGraw Hill, Tenth Reprint,*

2007.

G. K. Gupta, "Introduction to Data Mining with Case Studies", Eastern Economy Edition, Prentice Hall of India, Third Edition, 2014.

Ian.H.Witten, Eibe Frank and Mark.A.Hall, "Data Mining: Practical Machine Learning Tools and Techniques", Morgan Kaufmann, Third edition, 2011.

#### **CS417 PARALLEL PROGRAMMING**

**(3-1-0) 4**

Programming paradigms: Multithreaded parallel programming, Shared memory parallel programming, Message passing parallel programming, General purpose graphics processing units parallel programming, OpenCL, Many integrated core parallel programming. Important publications from literature

Bil Lewis, Daniel J Berg, *Pthreads Primer – A guide to Multithreaded Programming*. Prentice Hall. (SunSoft Press, 1996)

Barbara M Chapman, *Using Open MP*, The MIT Press, 2007.

William Gropp, Ewing Lusk, and Anthony Skjellum, *Using MPI. 3e*. The MIT Press. 2014. Wen-Mei W Hwu, David B Kirk, *Programming Massively Parallel Processors: A Hands-on Approach*, Morgan Kaufmann, 3e, 2016.

Rezaur Rahman, *Intel Xeon Phi Coprocessor Architecture and Tools*, Apress Open, 2013.

#### **CS418 TOPICS IN INFORMATION SECURITY**

**(3-1-0) 4**

Introduction of computer/information security, Design principles, Complete mediation. Access control matrix, Security policies, Confidentiality policies, Integrity policies, Hybrid policies, Role-based access control, Fine-grained role based access control - temporal role based access control, Spatio-temporal role based access control. Attribute based access control.

Matt Bishop, *Introduction to Computer Security*, Addison Wesley, 2005.

R. Sandhu, E. J. Coyne, H. L. Feinstein and C. E. Youman. *Role-based Access Control Models*. IEEE Computer, pages 38-47, February 1996.

E. Bertino, P. A. Bonatti, and E. Ferrari. *TRBAC: A temporal role-based access control model*. ACM Transactions on Information and System Security, volume 4, issue 3, pages 191-233, August 2001.

S. Aich, S. Mondal, S. Sural, and A. K. Majumdar. *ESTARBAC: Role based access control with spatiotemporal context for mobile applications*. Transactions on Computational Science IV, pages 177-199, March 2009.

C. Hu. Vincent, D. F. Ferraiolo, R. Kuhn, A. Schnitzer, K. Sandlin, R. Miller, and K. Scarfone. "Guide to attribute based access control definition and considerations," National Institute of Standards and Technology, 2014.

#### **CS419 ALGORITHMIC GRAPH THEORY**

**(3-1-0) 4**

Graphs, Preliminaries on graphs, Cardinality matching in bipartite graphs, Weighted matching in bipartite graphs, Edmonds matching algorithm for general graphs, Algorithms for vertex cover in bipartite graphs. Flow networks, Ford-fulkerson algorithm, Dinitz algorithm, Application of flows, Connectivity, Structure of min-cuts, Algorithms for interval graphs, Chordal graphs, Tree-width, Algorithms based on tree-decompositions, Approximation algorithms, Parameterized algorithms, Exact exponential algorithms.

R. Diestel, *Graph Theory*, Second edition, Springer, 2000.

D. West, *Introduction to Graph Theory*, Second Edition, PHI, 2003.

J. A. Bondy and U. S. R. Murty, *Graph Theory with Applications*, North Holland, 1976.

A. Schrijver, *A course in Combinatorial Optimization*, Cambridge University Press, 2004.

T.H Cormen, C.E Leiserson, R.L. Rivest, C. Stein, *Introduction To Algorithms*, Third edition, PHI, 2009.

J. Kleinberg and E. Tardos, *Algorithm Design*, Pearson Education, 2006.

#### **CS420 ARTIFICIAL INTELLIGENCE**

**(3-1-0) 4**

Alpha-Beta Pruning, propositional logic, First order logic, Unification, Forward and backward chaining, Resolution, Reasoning systems, Theorem proving in first order logic, Truth maintenance systems. Planning, Partial order planning, Uncertain knowledge and reasoning, Bayesian networks, overview of different types of learning, Learning in neural and belief networks, Expert systems, architecture of expert systems, Applications of AI.

Stuard Russell and Peter Norvig, *Artificial Intelligence. A Modern Approach*, 3rd edition, Prentice Hall, Inc., 2010

Dan W.Patterson, *Introduction to Artificial Intelligence and Expert Systems*, Prentice-Hall; 2nd edition 1990.

Elaine Rich, Kevin Knight, Shivashankar B. Nair, *Artificial Intelligence (Third Edition)*, Tata McGraw-Hill Education Pvt. Ltd., 2008

#### **CS421 DIGITAL IMAGE PROCESSING**

**(3-1-0) 4**

Introduction to image processing, Applications, Image sampling and quantization, Basic relationship between pixels, Basic gray level transformations, Point operations, Histogram processing, Spatial operations, Convolution, Image smoothing and sharpening, Introduction to Fourier transform and frequency domain, Smoothing and sharpening in

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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frequency domain, Implementation of frequency domain filters, Noise models, Noise reduction in spatial domain and frequency domain, State-of-the-art filters for denoising images corrupted with various kinds of noise, Morphological image processing, Image segmentation, Color image processing.

Rafael C. González, Richard E. Woods, "Digital Image Processing", 3<sup>rd</sup> Ed., PHI, 2007.

Anil K. Jain, "Fundamentals of Digital image Processing", Prentice Hall, US Ed., 1989.

Rafael C. González, Richard Eugene Woods, Steven L. Eddins, "Digital Image Processing using MATLAB", Pearson Education India, 2004.

William K Pratt, Digital Image Processing, Wiley-Interscience Publication, Third Edition, 2001.

AL Bovik (Editor), "Handbook of Image and Video Processing", Academic Press, 2010.

### **CS422 COMPUTATIONAL GEOMETRY (3-1-0) 4**

Introduction: Historical perspective, Geometric preliminaries. Convex hulls algorithms in 2D and 3D, lower bounds. Triangulations: Polygon triangulations, Representations, Point-set triangulations. Voronoi diagrams: Algorithms, Closest pair problems. Delaunay triangulations: algorithms (divide-and-conquer, flip, incremental), Duality of voronoi diagrams, Properties (min-max angle). Geometric searching: Point-location, 2D linear programming with prune and search. Visibility: Algorithms for weak and strong visibility, Visibility with reflections, Art-gallery problems. Arrangements of lines: 2D arrangements, zone theorem, Many-faces complexity, algorithms. Sweep techniques: Plane sweep for segment intersections, Fortune's sweep for Voronoi diagrams, Topological sweep for line arrangements. Combinatorial geometry: Ham-sandwich cuts, Helly's theorems, k-sets. Rectilinear geometry: Intersection and union of rectangles, Rectangle searching. Robust geometric computing. Applications of computational geometry.

Mark de Berg, Otfried Schwarzkopf, Marc van Kreveld and Mark Overmars, Computational Geometry: Algorithms and Applications, Springer.

F. P. Preparata and Michael I. Shamos, Computational Geometry: An Introduction, Springer.

Joseph O' Rourke, Computational Geometry in C, Cambridge University Press.

Lecture Notes by David Mount.

### **CS450 MAJOR PROJECT (0-1-9) 6**

The students jointly or individually will select a project work based on a topic of interest under the supervision of project guide. The project work will be evaluated periodically.

### **CS451 MINI PROJECT (0-0-3) 2**

Design, Analyse and implement solutions to different Computer Science and Engineering problems.

### **CS460 MOBILE COMPUTING (3-1-0) 4**

History and evolution of different generations of cellular networks, Radio propagation characteristics: Models for path loss, Shadowing and multipath fading, Jakes channel model, Digital modulation for mobile radio, Channel coding techniques, Multiple access techniques used in wireless mobile communications. Frequency reuse: The basic theory of hexagonal cell layout: Spectrum efficiency, FDM / TDM cellular systems: Channel allocation schemes, Handover analysis, Erlang capacity comparison of FDM / TDM systems and cellular CDMA. Discussion of GSM and CDMA cellular standards, Signaling and call control: Mobility management, location tracking. Wireless data networking, Packet error modeling on fading channels, Performance analysis of link and transport layer protocols over wireless channels: Mobile data networking (Mobile IP), Use cases of SDN and NFV in Cellular Network Management.

Rappaport, T. S. Wireless Communications: Principles and Practice (Vol. 2). New Jersey: Prentice Hall PTR, 1996.

Murthy, C. S. R. Ad hoc wireless networks: Architectures and Protocols. Pearson Education India, 2004.

Kumar, A., Manjunath, D., & Kuri, J. Communication networking: an analytical approach. Elsevier, 2004.

### **CS461 ADVANCED COMPUTER NETWORKS (3-1-0) 4**

Different types of optimizations proposed for improving the performance of TCP/IP: TCP Fast Open, window scaling, Slow start restart, Proportional rate reduction, Increasing initial congestion window. Problems of UDP and peer to peer applications with NAT, Linux queue disciplines such as Random early detection, Proportional integral controller, Controlled delay and explicit congestion notification (ECN). Differences between the internet architecture and data center network architecture, Performance problems in data center networks and existing solutions, the need for software defined networks in Data center networks, and the importance of network function virtualization.

Kurose, James F. Computer networking: A top-down approach featuring the internet, 6/E. Pearson Education India, 2005/2012

Grigorik, Ilya. High Performance Browser Networking: What every web developer should know about networking and web performance. " O'Reilly Media, Inc.", 2013.

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Khan, S. U., & Zomaya, A. Y. (Eds.). (2015). *Handbook on data centers*. Springer, 2015.

Peterson, L. L., & Davie, B. S. *Computer networks: A Systems Approach*. Elsevier, 2007.

### **CS462 HIGH PERFORMANCE COMPUTING PARADIGMS (3-1-0) 4**

Modern Processor Architecture, Basic Optimizations on Serial programs, Parallel computer architecture, Parallelization Basics, Shared Memory Parallel Programming, Distributed Memory Parallel Programming.

Georg Hager and Gerhard Wellein, *Introduction to High Performance Computing for Scientists and Engineers*, Chapman & Hall/CRC Computational Science, 2010.

M. W. Berry, K. A. Gallivan, E. Gallopoulos, A. Grama, B. Phillippe, Y. Saad, F. Saied, "High-Performance Scientific Computing: Algorithms and Applications", Springer London, 2012.

Marco Vanneschi, *High Performance Computing – Parallel Processing Models and Architectures*, Pisa University Press, 2014.

### **CS463 NETWORK SECURITY (3-1-0) 4**

Introduction to network security, Network security concepts, Attacks to networks and countermeasures, World wide web and internet security, Security protocols, Wireless security protocols, Intrusion detection and prevention systems, Organizational security issues, Security policies for network operations, Disaster recovery and business continuity.

Kaufman, Perlman and Speciner. *Network Security: Private Communication in a Public World*. Prentice Hall, 2nd edition. 2002.

Mark Ciampa, "Security+ Guide to Network Security Fundamentals", 2nd Edition, Cengage Learning, 2012.

William Stallings, *Network Security Essentials - Applications and Standard*, Pearson Education, 2004.

### **CS464 NETWORK MANAGEMENT (3-1-0) 4**

Network management overview, Network management, SNMP and network management, TMN, network management applications, Management of heterogeneous network with intelligent agents, Network security management, Internet management (IEEE Communication May, Oct. 03), QoS in IP network, Basic methods & theory for survivable network design & operation, Network planning, Network management standards. Case study of network management tools used at NITK central computing center. Use cases of software based networks for managing networks.

Subramanian, M. *Network management: Principles and Practice*. Pearson Education India, 2010.

Burke, J. R., Richard, B., & Burke, R. *Network management: concepts and practice, a hands-on approach*. London: Pearson Education, 2004.

### **CS465 DISTRIBUTED DATABASE SYSTEMS (3-1-0) 4**

Introduction, Design issues, DDBMS architecture, DDBMS design, Database integration, Data and access control, Overview of query processing, Query decomposition and data localization, optimization of distributed queries, Multi-database query processing, Transaction management, Distributed concurrency control, Distributed DBMS reliability, Data replication, Overview of parallel database systems, Introduction to peer-to-peer and Web data management.

M.T. Ozsu and P. Valduriez, *Principles of Distributed Database Systems, Third Edition*, Springer-Verlag New York, 2011.

Ceri and Pelagatti, *Distributed Database Principles and Systems*, McGraw Hill. 2017

D. Bell and J. Grimson, *Distributed Database Systems*, Addison-Wesley, 1992.

### **CS466 CLOUD COMPUTING (3-1-0) 4**

Concept of cloud computing and evolution. Define SLAs and SLOs and illustrate their importance in Cloud Computing, Threats in cloud security, Common cloud providers and their associated cloud stacks and popular cloud use case scenarios. Cloud infrastructure: Cloud Reference Architecture. Cloud software deployment considerations such as scaling strategies, Load balancing, Fault tolerance, and Optimizing for cost. Cloud resource management: Virtualizing CPUs, full virtualization, Para-virtualization, and Memory virtualization. Cloud storage: Organization of data and storage. Various types of data within the data taxonomy and classify different data types within the data taxonomy. HDFS, Google GFS, Big-Table. Programming models: Fundamental aspects of parallel and distributed programming models. Cloud programming models (Map reduce, Spark, Graph Lab and Spark Streaming). The main execution flow, scheduling and fault tolerance concepts in the Map-reduce programming model.

Anthony T Velte, *Cloud Computing: A Practical Approach*, McGraw Hill, 2010

J. Lin and C. Dyer, *Data Intensive Text Processing with MapReduce*, Morgan and Claypool, 2010

T. Velte, A. Velte, R. Elsenpeter, *Cloud Computing, A Practical Approach*, McGraw Hill, 2009

Rajkumar Buyya, James Broberg, Andrzej M., *Cloud Computing: Principles and Paradigms*, Wiley, 2010.

Jimmy Lin and Chris Dyer, *Data-Intensive Text Processing with Mapreduce*

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*Morgan and Claypool, 2010.*

*Dan Marinescu, Cloud Computing: Theory and Practice, Morgan Kaufmann, 2013*

### **CS467 HETEROGENEOUS PARALLEL COMPUTING (3-1-0) 4**

Graphics Processing Units: Architecture, Programming frameworks. General Purpose GPU programming. Xeon Phi: Architecture and Programming. Heterogeneous parallel algorithms and case studies.

*Wen-Mei W Hwu, David B Kirk, Programming Massively Parallel Processors A Hands-on Approach, Morgan Kaufmann, 3e. December 2016*

*Rezaur Rahman, Intel Xeon Phi Coprocessor Architecture and Tools, Apress Open, 2013.*

*Recent publications in IPDPS, PACT, and similar.*

### **CS468 INTERNET OF THINGS (3-1-0) 4**

Internet of Things (IoT) Enabling Technologies, IoT and M2M, IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology, IoT architecture, IoT Protocols, Building IoT with Raspberry Pi & Arduino, Data Analytics for IoT, Cloud for IoT, Case studies and real world applications.

*Arshdeep Bahga, Vijay Madisetti, —Internet of Things – A hands-on approach, Universities Press, 2015*

*Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), —Architecting the Internet of Things, Springer, 2011.*

*Honbo Zhou, —The Internet of Things in the Cloud: A Middleware Perspective, CRC Press, 2012.*

*Jan Holler, Vlasios Tsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.*

### **CS469 SOFTWARE BASED NETWORKS (3-1-0) 4**

Traditional IP Control Plane and Router Implementation, History and Evolution of Software Defined Networking, Data and Control plane separation: Concepts, Advantages and Disadvantages. OpenFlow Protocol and Applications. Data plane: programmable network hardware, programming SDN using Pyretic, Frenetic or P4. Control plane: Open Network Operating System (ONOS), Floodlight and Open Daylight projects. Network Function Virtualization: Network Middleboxes, Introduction to Virtualization: VMs and Containers, Introduction to Network Function Virtualization (NFV), Enhancing the Data Plane: Flow Tags, Function Placement and Routing.

*Goransson, P., Black, C., & Culver, T. Software defined networks: a comprehensive approach. Morgan Kaufmann, 2016.*

*Nadeau, T. D., & Gray, K. SDN: Software Defined Networks: An Authoritative Review of Network Programmability Technologies. "O'Reilly Media, Inc.", 2013.*

*Gray, K., & Nadeau, T. D. Network function virtualization. Morgan Kaufmann, 2016.*

### **CS470 DATABASE SECURITY (3-1-0) 4**

Security architecture, Database Security, Operating system security, Application Security Models, Access Control models, Statistical DB security, Database auditing, Compliance Storage, Data Privacy, Steganographic File Systems, Privacy Preserving Data Mining, Database as a Service, Searchable encryption techniques.

*Hassan A. Afyouni, "Database Security and Auditing", Third Edition, Cengage Learning,*

*2009. Alfred Basta, Melissa Zgola, Database Security, Cengage Learning, ISBN 1435453905, 2011*

*Charu C. Aggarwal, Philip S Yu, "Privacy Preserving Data Mining": Models and Algorithms, Kluwer Academic Publishers, 2008.*

*Ron Ben Natan, "Implementing Database Security and Auditing", Elsevier Digital Press, 2005.*

*David C. Knox: Effective Oracle Database 10g Security by Design, McGraw-Hill, 2004.*

*Ron Ben-Natan, HOWTO Secure and Audit Oracle 10g and 11g, Publisher: Auerbach Publications; 1 edition (March 10, 2009)*

### **CS471 INFORMATION CENTRIC NETWORKING (3-1-0) 4**

Introduction to Information Centric Networking (ICN), Different types of ICN: NDN and CCN, Autonomous System (AS) Architecture and AS types, Domain Name System (DNS), Name resolution methods in ICN, Intra-AS routing protocols - Open Shortest Path First (OSPF), Intra-AS routing methods in ICN, Locating content and caching content, ICN applications: Case study.

*Amin, K. Computational Intelligence for Security in Named Data Networking Lambert Academic Publishing, 2015.*

*Ahmed, S. H., Bouk, S. H., Kim, D., & Sarkar, M. Bringing Named Data Networks into Smart Cities. Smart Cities: Foundations, Principles, and Applications, 275-309, 2017.*

**CS472                      QUANTITATIVE COMPUTER ARCHITECTURE                      (3-1-0) 4**

Instruction Level Parallelism: Pipelining, Hazards, Compiler techniques for ILP, Branch prediction, Static and Dynamic Scheduling, Speculation, Limits of ILP. Multicore Memory Hierarchy: Cache tradeoffs, Basic and Advanced optimizations, Virtual Memory, DRAM optimizations. Multiprocessors: Symmetric and Distributed architectures, Cache coherence protocols - Snoopy and Directory based, ISA support for Synchronization, Memory Consistency Models. Interconnection Networks: Architectures, Topologies, Performance, Routing, Flow control, Future of NoCs. VLSI: Transistor Theory. Moore's Law. Delay, Power, Energy, Temperature dependence in integrated circuits.

*John Hennessy and David Patterson. Computer Architecture - A Quantitative Approach. 6ed or 5ed. Morgan Kaufmann, 2011*

*John P. Shen and Mikko H. Lipasti. Modern Processor Design - Fundamentals of Superscalar Processors. Tata McGraw Hill, 2010*

*William J Dally and Brian Towles. Principles and Practices of Interconnection Networks. Morgan Kaufmann. 2004.*

*Mark Hill/Margaret Martonosi (eds.). Synthesis Lectures on Computer Architecture, Morgan and Claypool, 2006 -- 2018.*

**CS473                      BIG DATA ANALYTICS                      (3-1-0) 4**

Big Data Characteristic Features, Structure of Big Data, Best Practices for Big data Analytics, Lambda calculus and data analysis, Analytics process, methods and tools, Predictive analytics and visualization, Mining data streams, Big data frameworks, Modern data analytic tools,.

*Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2014.*

*Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, Second Edition, 2007.*

*Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics, Wiley and SAS Business Series, 2012.*

*David Loshin, "Big Data Analytics: From Strategic Planning to Enterprise Integration with Tools, Techniques, NoSQL, and Graph", 2013.*

*Michael Minelli, Michelle Chambers, and Ambiga Dhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.*

**CS474                      SOCIAL NETWORK ANALYSIS                      (3-1-0) 4**

Emergence of the Social Web, Statistical Properties of Social Networks, Network analysis -concepts and measures, Community detection, Influence maximization, Link mining and prediction, Social network based recommender systems, Anomaly detection in social networks, Mining Discussion networks, Visualizing Online Social Networks, Evolution in Social Networks.

*Ajith Abraham, Aboul Ella Hassanien, Václav Snášel, - Computational Social Network Analysis: Trends, Tools and Research Advances, Springer, 2012*

*Borko Furht, —Handbook of Social Network Technologies and Applications, Springer, 1st edition, 2011*

*Charu C. Aggarwal, —Social Network Data Analytics, Springer; 2014*

*Giles, Mark Smith, John Yen, —Advances in Social Network Mining and Analysis, Springer, 2010.*

*Reza Zafarani, Mohammad Ali Abbasi, Huan Liu, "Social Media Mining", Cambridge University Press, 2014.*

**CS475                      INFORMATION STORAGE MANAGEMENT                      (3-1-0) 4**

Storage technology, challenges in data storage and data management, Core elements of a data center infrastructure, Storage system Architecture, integrated and modular storage systems, an intelligent storage system, networked storage, Monitoring and managing data centers, Storage security and storage visualization.

*EMC Corporation, "Information Storage and Management: Storing, Managing, and Protecting Digital Information", Wiley, India, 2010*

*Marc Farley, —Building Storage Networks, Tata McGraw Hill, Osborne, 2001. Robert Spalding, —Storage Networks: The Complete Reference—, Tata McGraw Hill , Osborne, 2003*

**CS476                      COMPUTER VISION                      (3-1-0) 4**

Geometry of image formation, feature detection and matching, Feature-based alignment, Image classification, Image recognition, Image stitching, Stereo correspondence, Image-based rendering, video surveillance techniques, deep learning with neural networks, applications.

*Ballard D., Brown C., Computer Vision, Prentice Hall, 2003*

*David A. Forsyth, Jean Ponce, Computer Vision: A Modern Approach, Pearson; 2 edition, 2011*

*Rick Szeliski, Computer Vision: Algorithms and Applications, available online , 2010*

*Simon J.D. Prince. Computer Vision: Models, Learning, and Inference, 2012*

*Forsyth and Ponce. Computer Vision: A modern approach, 2003*

*Richard Szeliski. Computer Vision: Algorithms and Applications, 2010*

**CS477**

**SPEECH PROCESSING**

**(3-1-0) 4**

Mathematical foundations of signal processing, Speech production and perception, Speech signal analysis: Short time speech analysis, Time domain analysis, Frequency domain analysis, LPC (Linear predictive coding) analysis; Issues in speech processing: Speech synthesis, Speech recognition, Speaker identification, Emotion analysis, Language identification; Introduction to advanced topics in speech processing: Pattern classifiers.

*Douglas O'Shaughnessy, Speech Communications Human and Machines (Second Edition)*

*Rabiner and Juang, Fundamentals of speech recognition, 1999*

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## Department of Electronics and Communication Engineering

### **EC100                    ELEMENTS OF ELECTRONICS & COMMUNICATION ENGINEERING                    (2-0-0) 2**

(For Computer Science, Mechanical, Civil, Mining, Metallurgy, Chemical Engineering branches only)

RC & RL Circuits – low pass, high pass, transient analysis for pulse input; Diode: Principle, Characteristics, Applications & Types, Transistor: Principle, Operation, Biasing (DC analysis of CE, CB and CC configuration), Transistor as a switch; Digital Circuits: Basic Logic gates, Universal gates, Boolean Algebra, Combinational circuits, Op-amps & their Applications, Introduction to few systems (only Block level) : ADC, DAC, Linear power supply, SMPS, UPS, Principles of Communication Systems.

*Albert Malvino, Electronic Principles, Tata McGraw Hill, 1995*

*Boylstead and Nashelsky, Electronic Devices and Circuits, PHI, 1998*

*George Kennedy & Bernard Davis, Electronic Communication System, Tata McGraw Hill,*

*1996 Wayne Tomasi, Electronic Communication Systems, Pearson Education, 2003 Ramakant*

*A Gayakwad, OP-AMPS and Linear Integrated Circuits, Prentice Hall, 1999*

### **EC101                    JOY OF ELECTRONICS AND COMMUNICATION                    (2-0-3) 4**

Study and hands on exposure of Electronic devices, instruments and circuits required for system design. Validation of relevant concepts using hardware/software tools.

*Class notes and lab manual*

### **EC102                    CIRCUITS AND SYSTEMS                    (3-1-0) 4**

DC Circuit Analysis - Circuit concept, circuit elements, independent and dependent sources, network reduction techniques (star-delta), network equations, node voltage and mesh current analysis, Network Theorems - Superposition, Thevenin's and Maximum power transfer theorems. First order systems - Analysis of RL and RC circuits, representation of systems using differential equations, solution of differential equations, Transient and steady state response, time constant, initial conditions, coupled circuits. Laplace Transform: Definition and properties, inverse transforms, partial fraction expansion. Second order systems - RLC circuits, characteristic equation, damping, natural frequency, time domain specifications of systems. Transform domain analysis of circuits, equivalent sources for initial conditions, transform circuits, Impedance functions and Network Theorems, transfer function, impulse response, convolution, linear time invariant systems, poles and zeros, stability, steady state sinusoidal response. Discrete time signals - sampling of sinusoids, complex exponentials and phasor, Spectrum representation – spectrum of sum of sinusoids, Periodic signals, Fourier series representation, sinusoidal synthesis, spectrum view on sampling, aliasing, sampling theorem, reconstruction. Discrete time systems – moving average filter, general FIR filter, impulse response, implementation of FIR filter, convolution, linear time-invariant systems, frequency response of FIR systems, examples of FIR filtering in signal denoising

*W.Nillson and SA Riedel, Electric Circuits, PHI, 2000*

*RC.Dorf and J.A. Svoboda, Introduction to Electric Circuits, Wiley, 2009*

*Mc Chellan, R.W. Schafer & Yoder, Signal Processing First, Pearson 2003.*

### **EC200                    DIGITAL SYSTEM DESIGN                    (3-1-0) 4**

Introduction to Digital Systems and Boolean Algebra Binary, Logic Minimization and Implementation, Karnaugh-maps, NAND and NOR implementation, Quine-McCluskey method, Logic families, Combinational Logic Multi levelgate circuits, Parity circuits and comparators, Representation of signed numbers, Introduction to HDL (VHDL/Verilog), Register transfer language, Sequential Logic Latches and flip-flops, Registers and counters, HDLdescription of sequential circuits, State Machine Design, State machine as a sequential controller, Moore and Mealy state machines, Derivation of state graph and tables, Sequence detector, equivalent state machines, State machine modelling based on HDL, Linked state machines, Advanced Topics: Static and Dynamic hazards; race free design; Charles. H. Roth, Jr., *Fundamentals of Logic Design, Fifth Edition, Thomson Brooks /Cole, 2005.*

*J.F.Wakerly, Digital Design Principles and Practices, PH, 1999.*

*D.D. Givone, Digital Principles and Design, TMH, 2002*

*Morris. M. Mano, Michael D. Ciletti, Digital Design, Fourth Edition, Prentice-Hall India. 2008.*

*S. Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, Second Edition, Pearson Education, 2004.*

*S. Brown and Z. Vranesic, Fundamentals of digital logic with Verilog design, Third Edition, McGraw-Hill, 2013*

*Charles. H. Roth, Jr., Digital System Design using VHDL, Indian Edition, Thomson Brooks /Cole, 2006.*

### **EC201                    ANALOG ELECTRONICS                    (3-1-0) 4**

Voltage and current sources, Controlled sources, Two port networks:, ladder networks, Feedback Concepts: Feedback



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topologies, Positive and Negative feedback, Sensitivity factor, Basic amplifiers and their two port representation, Effect of Negative feedback on basic amplifiers, Instability in amplifiers, Barkhausen condition for Oscillations, Nyquist stability criterion, Operational Amplifiers, Non-idealities of opamps and their effects: Finite gain, finite bandwidth, Offset voltages and currents, Common-mode rejection ratio, Power supply rejection ratio, Slew rate, Filters : Second order filter transfer function (low pass, high pass, band pass and band reject) , Butterworth response, Emulation of inductor using Transconductors,, Sallen-Key biquadratic filters, Tow-Thomas biquad, Realization of higher order filters, All-pass filter (active phase shifters), Comparator, Schmitt trigger (inverting & non inverting), astable multivibrator, Triangular wave generator, Precision rectifiers, Voltage Controlled Oscillators, Phase Locked Loops

*Behzad Razavi, Fundamentals of Microelectronics, Second edition, Wiley, 2013*

*A. Sedra, K. Smith, Microelectronic Circuits: Theory and Applications OUP 6<sup>th</sup> Ed. 2013*

*Sergio Franco, Design with OPAMPS and Linear Integrated circuits, Tata McGraw Hill, 2002.*

### **EC202 ANALOG & DIGITAL COMMUNICATION (3-1-0) 4**

Review of Communication Signals and Systems, Amplitude Modulation, Analytical signals, Complex envelope representation, FDM, Super Heterodyne receiver, Angle Modulation: FM and PM signal generation, Demodulation of FM signals, FM broadcasting, and FM stereo, Noise Performance of Analog Communication Systems, Capture effect, Pre-emphasis and De-emphasis in FM Systems. Digital Communications: Sampling theorem for low pass & band pass signals; Baseband Modulation: Pulse modulation, Pass band Modulation: ASK, FSK, PSK, M-ary systems. Matched filter, Correlation receiver, performance of optimum detector, Synchronization. CPM, Digital Transmission through Band-limited AWGN Channels: Zero-ISI (Nyquist criterion), Partial response signals, Detection of partial response signals, Maximum likelihood sequence detection, Error probability, Channel Equalization: ZF, MSE, Adaptive Equalizers.

*M. F. Mesiya, "Contemporary Communication Systems", McGrawHill, 2013.*

*Taub and Schilling, "Principles of Communication systems", Second Edition, Tata McGrawHill, 2006 (34th reprint).*

*Proakis and Salehi, "Fundamentals of Communication Systems", Second Edition, Pearson International, 2014.*

*U. Madhow, "Fundamentals of Digital Communication," Cambridge University Press, 2008.*

*Won Y Yang , Prashanth Kumar H., "MATLAB/Simulink for Digital Communication", Second Edition, SIP-*

*Hongrung (S. Korea), 2012.*

*Simon Haykin, "Communication Systems", Fourth Edition, Wiley, 2000.*

### **EC203 LINEAR ALGEBRA AND PROBABILITY THEORY (3-1-0) 4**

System of Equations, basic solutions, Echelon matrices, Linear independence, Rank, Inverse, Similarity, Eigen value analysis and Diagonalization, Vector Spaces: Linear Transformations, Subspaces, Linear Independence, Basis, Orthogonal Transformations. Probability – Review of probability, Joint and Conditional probability, Bayes theorem. Random Variable - Definition, discrete and continuous, probability distribution and density, mass functions, Joint and conditional distributions, Expectation, random vectors, vectorised expectation – mean and covariance, Random processes – definition, characterization, Stationarity. Gaussian random process, Central limit theorem.

*Gilbert Strang: Linear algebra and its applications, Thomson Brooks, 2006.*

*Edgar G. Goodaire, Linear Algebra: A Pure & Applied First Course, World Scientific, 2014.*

*Dimitri P. Bertsekas, John N. Tsitsiklis, Introduction to Probability, 2nd Ed, Athena Scientific, 2008.*

*Alberto Leon-Garcia, Probability, Statistics, and Random Processes for Electrical Engineering, 3rd Ed, Addison-Wesley, 1994.*

*A Papoulis , S Pillai, Probability, Random Variables and Stochastic Processes, 4th Ed, McGraw-Hill, 2002.*

### **EC204 DIGITAL SYSTEM DESIGN LAB (0-0-3) 2**

Experiments using basic logic gates; Design of combinational circuits using HDL. Design of adders and magnitude comparators; realization using multiplexers and other approaches; Design of sequential circuits including flip-flops, counters and registers.

*Class notes & Lab manual*

### **EC205 ANALOG ELECTRONICS LAB (0-0-3) 2**

Design of full wave rectifier; Regulated Power Supply, Design with RC circuits – AC analysis, OPAMPS Linear applications, OPAMP non-linear applications. *Simulation Experiments:* Above experiments will be validated through simulation.

*Class notes & Lab manual*

**EC206                      MICROPROCESSORS**

**(3-1-0) 4**

Introduction to computer organization, CISC and RISC processors, concept of pipelining, concept of Microcomputer and microcontroller. Introduction to ARM based processor: Processor overview, introduction to programming model, processor and memory organization, concept of stack, introduction to processor instruction set, addressing modes, instruction encoding. Processor implementation, organization and execution: Instruction datapath, timing, processor modes, exceptions, protected mode operation. Hardware interfacing: Introduction to memory, IO interfacing, Concepts of memory mapped and IO, mapped IO.

*Steve Furber, "ARM System Architecture", Edison Wesley Longman, 1996.*

*William Hohl, "ARM Assembly Language- Fundamentals and Techniques ", CRC Press, 2009*

*Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Elsevier, 2004.*

*D.A. Patterson and J. Hennessy, Computer Organization & Design, The Hardware/software interface, Elsevier Inc, ARM Edition, 2010.*

*Lab manuals Online ARM programming reference and guide*

**EC207                      ELECTROMAGNETIC WAVES AND TRANSMISSION LINES**

**(3-1-0) 4**

Review of coordinate systems, vector calculus, static electric and magnetic Fields; derivation and solution to Maxwell's Equations. Plane wave propagation in different media. Power and Poynting 's Theorem. Reflection, Transmission, and Refraction of Waves at Media Interfaces, Polarization. Comparison of circuit and field theory concepts. Guided Waves in Transmission Lines, Smith Charts, Transients in Transmission Lines, Impedance matching, Metallic Waveguides, Introduction to planar and dielectric Waveguides.

*Martin A. Plonus, Applied Electromagnetics, McGrawHill, 1988*

*Matthew N. O. Sadiku, Elements of Electromagnetics 6th Edition, Oxford University Press 2015*

*Umran S. Inan and Aziz Inan, Engineering Electromagnetics, Prentice Hall, 1999*

*David H. Staelin, Ann W. Morgenthaler, Jin Au Kong, Electromagnetic Waves, Prentice Hall, 1994.*

*John D Ryder, Networks, Lines and Fields, Second Edition, 2015.*

*Basu B. N, Engineering Electromagnetics Essentials, Universities Press, 2015.*

**EC208                      DIGITAL SIGNAL PROCESSING**

**(3-1-0) 4**

Time domain analysis of discrete-time systems - Basic discrete time signals, operations and properties, mathematical view, Introduction to sampling, Nyquist theorem. Systems – properties, linear time invariant systems, impulse response, convolution, causality and stability. Difference equations. Transform domain analysis of discrete-time systems -Z Transform – definition and properties, ROC, transfer function, poles and zeroes, application to discrete systems.

Representation of systems – signal flow graph, realization of z-domain transfer function. Frequency domain analysis of discrete-time systems -Fourier series and fourier transform. Relation between continuous and discrete time spectra, aliasing, reconstruction. DFS properties, Properties and applications of DTFT. Relationship between time, Z and frequency domains, Relation between frequency domain representation in continuous and discrete domain.

Sampling in frequency domain, DFT, Properties of DFT. Linear convolution using DFT. FFT- DIT and DIF, Basics of Multirate signal processing Decimation and interpolation. Digital Filter Design- Characteristics of Digital Filters, Filter structures, FIR filter design – window method, frequency sampling method, Relation between S and Z domains, IIR filter design – Butterworth and Chebyshev

*J. G. Proakis and D. G. Manolakis, Digital Signal Processing Principles, Algorithms and Applications Fourth Edition, 2011*

*A. V. Oppenheim and R.W. Schaffer, Discrete Time Signal Processing, 2002*

*Paolo Prandoni and Martin Vetterli, Signal Processing for Communications, (<http://www.sp4comm.org/download.html>), 2013*

*Ifeachor and Jervis, DSP – A practical approach, Pearson, 2002*

**EC209                      CONTROL SYSTEMS**

**(3-1-0) 4**

History of control and feedback, linear systems, dynamic systems, modeling and analysis, electrical and mechanical systems, block diagram and signal flow graphs, continuous and discrete time representation, time domain and frequency domain analysis, root-locus, Bode plot, phase and gain margins, polar plots, Nyquist plots, concept of stability, controllability, observability, transfer function approach to modeling, transient analysis and frequency domain analysis, quantization and error effects, design of control systems, design specifications, lead and lag compensator, PI, PD, PID controllers, state-space representation of dynamic systems, state space transfer function, design based on state space models, quadratic optimum control.

*Bernard Friedland, Control System Design: An Introduction to State-Space Methods, Dover 2005.*

*Farid Golnaraghi, Benjamin C. Kuo; Automatic Control Systems, 9th ed, John Wiley & Sons, 2010.*

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*Katsuhiko Ogata; Modern Control Engineering, 5th ed, Pearson India Education Services Pvt Ltd, 2015.*

*Richard C. Dorf, Robert H. Bishop; Modern Control Systems, 12th ed, Pearson Education Limited, 2014.*

### **EC210 MICROPROCESSOR LAB (0-0-3) 2**

The lab experiments will introduce students to assembly language programming and embedded programming. Students will create embedded programs on an ARM processor to generate analog traces, interface to peripherals. Advanced experiments will explore performance issues.  
*Class notes and Lab manual.*

### **EC211 DIGITAL SIGNAL PROCESSING LAB (0-0-3) 2**

Simulation exercises on linear equation solvers: Digital Filter Design, DFT and spectral analysis, identification of sinusoids in noise. Speech processing, Image processing, Real time experiments using fixed point DSP processor (Assembly language programming) Waveform generation, Data I/O effect of sampling and quantization, Digital Filter Implementation FIR and IIR filter, Implementation of FFT.

### **EC300 VLSI DESIGN (3-1-0) 4**

Introduction to MOSFETs, MOSFET Equivalent Circuits. MOSFET logic circuits: NMOS inverter, CMOS inverter, CMOS Processing Technology. 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. Power dissipation, Packaging, Scaling of MOS transistor dimensions. CMOS subsystem design. Datapath operations: Addition, Multiplication, Counters, Shifters, Memory elements.

*Jan M. Rabaey, A. Chandrakasan, and B. Nikolic, Digital Integrated Circuits: A design Perspective, Pearson Education, 2002*

*S. M. Kang & Y. Leblebici, CMOS Digital Integrated Circuits, McGraw Hill,*

*2002 Ken Martin, Digital Integrated Circuit Design, Oxford Press, 2000.*

*Neil H. E. Weste, David Money Harris, Integrated Circuit Design, Fourth Edition, 2011*

### **EC301 RF COMPONENTS AND CIRCUITS (3-1-0) 4**

Review of Electromagnetic Theory, Hertzian Dipole; Antenna Characteristics, Wireless Systems and Friis Transmission Formula; Types of Antennas, Antenna Arrays, Microstrip antennas; Radio wave propagation. Impedance matching, S-parameters, passive and active microwave components. Ferrite devices, microwave filters, noise and nonlinearity, mixers and amplifiers. Introduction to radar systems.

*C. A. Balanis, Antenna Theory: Analysis and Design. 4th edition. John Wiley, 2012.*

*Harish, A.R.; Sachidananda, M., Antennas and Wave Propagation, Oxford University Press, 2007*

*Warren Stutzman and Gary Thiele, Antenna Theory and Design, 3rd edition, John Wiley & Sons, 2013. David M. Pozar, Microwave Engineering, 4th Edition, Wiley, 2011*

*Samuel Y. Liao, Microwave Devices and Circuits, Pearson, 3rd Edition, 2008*

*M. Kulkarni, Microwave and Radar Engineering, Umesh Publishing House, 5th Edition, 2014.*

### **EC302 VLSI DESIGN LAB (0-0-3) 2**

Design, Simulation and layout of basic digital blocks, Design project using EDA tools  
*Class notes and Lab manual.*

### **EC303 COMMUNICATION LAB- I (0-0-3) 2**

Design experiments (both hardware design and simulation) to support the contents of Analog and Digital communication and Electromagnetic Waves and Transmission Lines, Use of Simulation tools to simulate and verify various fundamental ideas in the above courses.

*Class notes & Lab manual*

### **EC304 COMMUNICATION LAB- II (0-0-3) 2**

Design experiments (both hardware design and simulation) to support the contents of Electromagnetic Waves and Transmission Lines, RF Circuits and Components, Communication networks Use of Simulation tools to simulate and verify various fundamental ideas in the above courses.

*Class notes & Lab manual*

### **EC340 COMPUTER ORGANIZATION AND ARCHITECTURE (3-1-0) 4**

Digital Computer Organization, CPU Design, CPU Design Timing and Control, Micro programmed Control, Pipeline Concept, Memory Organization, Cache Memory Architecture, RAM Architecture SRAM and DRAM Architectures,

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Secondary Storage Organization.

*John Hayes, Computer Architecture and Organization, 3rd Ed. McGraw Hill 2017.*

*John Hennessy and David Patterson, Computer Architecture - A Quantitative Approach 6th Edition, Morgan Kaufmann, 2017*

*John Hennessy and David Patterson, Computer Architecture - A Quantitative Approach 5th Edition, Morgan Kaufmann, 2011*

### **EC341 COMPUTER ARITHMETIC (3-1-0) 4**

Number Representation : Numbers and Arithmetic, Representing Signed Number, Redundant Number Systems, Residue Number Systems, Double base number systems, Addition/Subtraction: Basic Addition and Counting, Carry-Look ahead Adder, Variations in Fast Adders, Multi-Operand Addition, Multiplication: Basic Multiplication Schemes, High-Radix Multipliers, Tree and Array Multipliers, Variations in Multipliers, Division: Basic Division Schemes, High-Radix Dividers, Variations in Dividers, Division by Convergence, Real Arithmetic: Representing the Real Numbers, Floating-Point Arithmetic, Arithmetic Errors and Error Control, Precise and Certifiable Arithmetic, Function Evaluation: Square-Rooting Methods, The CORDIC Algorithms, Variations in Function Evaluation, Arithmetic by Table Lookup, Implementation Topics : High Throughput Arithmetic, Low-Power Arithmetic, Fault-Tolerant Arithmetic, Past, Present, and Future

*I. Koren, Computer Arithmetic Algorithms, 2nd Edition, A. K. Peters (part of CRC Press),*

*2002 M. Ercegovac and T. Lang, Digital Arithmetic, Morgan Kaufman, 2003.*

*B. Parhami, Computer Arithmetic: Algorithms and Hardware Design, Oxford University Press 2000.*

*Literature from the web including the proceedings of IEEE Intl. Conference on Computer Arithmetic.*

### **EC342 EMBEDDED SYSTEM DESIGN (2-0-3) 4**

Introduction: Overview of embedded systems, embedded system design challenges, common design metrics and optimizing. Survey of different embedded system design technologies & trade-offs. Embedded microcontroller cores, embedded memories, Examples of embedded systems. Architecture for embedded system, High performance processors – strong ARM processors, programming, interrupt structure, I/O architecture, Technological aspects of embedded systems: interfacing between analog and digital blocks, signal conditioning, Digital signal processing, Subsystem interfacing, interfacing with external systems. Software aspects of embedded systems: real time programming languages and operating systems for embedded systems – RTOS requirements, kernel types, scheduling, context switching, latency, inter-task communication and synchronization, Case studies.

*Jack Ganssle, The Art of Designing Embedded Systems, Elsevier, 1999.*

*J.W. Valvano, Embedded Microcomputer System: Real Time Interfacing, Brooks/Cole, 2000.*

*David Simon, An Embedded Software Primer, Addison Wesley, 2000.*

*H. Kopetz, Real-time Systems, Kluwer, 1997*

*R. Gupta, Co-synthesis of Hardware and Software for Embedded Systems, Kluwer 1995.*

*Gomaa, Software Design Methods for Concurrent and Real-time Systems, Addison-Wesley, 1993.*

*Steve Furber, "ARM System Architecture", Edison Wesley Longman, 1996.*

*Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM System Developer's Guide: Designing and Optimizing System Software", Elsevier, 2004.*

### **EC343 FPGA BASED SYSTEM DESIGN (2-0-3) 4**

Digital system design options and trade-offs, Design methodology and technology overview, High Level System Architecture and Specification: Behavioral modeling and simulation, Hardware description languages, combinational and sequential design, state machine design, synthesis issues, test benches. Overview of FPGA architectures and technologies: FPGA Architectural options, granularity of function and wiring resources, coarse vs fine grained, vendor specific issues (emphasis on Xilinx and Altera), Logic block architecture: FPGA logic cells, timing models, power dissipation I/O block architecture: Input and Output cell characteristics, clock input, Timing, Power dissipation, Programmable interconnect - Partitioning and Placement, Routing resources, delays; Applications - Embedded system design using FPGAs, DSP using FPGAs, Dynamic architecture using FPGAs, reconfigurable systems, application case studies. Simulation / implementation exercises of combinational, sequential and DSP kernels on Xilinx / Altera boards.

*M.J.S. Smith, Application Specific Integrated Circuits, Pearson, 2000*

*Peter Ashenden, Digital Design using VHDL, Elsevier, 2007 Peter*

*Ashenden, Digital Design using Verilog, Elsevier, 2007*

*Clive Maxfield, The Design Warriors's Guide to FPGAs, Elsevier, 2004*

### **EC344 ANALOG INTEGRATED CIRCUITS (3-1-0) 4**

MOSFET - Review of current equation, regions of operation, small signal model. Current mirrors, Single-ended

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amplifiers: CS amplifier CG and CD amplifiers, CMOS differential amplifiers: DC analysis and small signal analysis of differential amplifier with Resistive load, current mirror load and current source load, Input common-mode range and Common -mode feedback circuits. OTAs vs Opamps. Slew rate, CMRR, PSRR. Two stage amplifiers, Compensation in amplifiers (Dominant pole compensation).

*Behzad Razavi, Fundamentals of Microelectronics, Second edition, Wiley, 2013*  
*Sedra and Smith, Microelectronics Circuits, Oxford Univ. Press, 2004*

### EC345 DATA STRUCTURES AND ALGORITHMS

(3-0-2) 4

Algorithm analysis, Asymptotic notations. Divide and Conquer algorithms, Analysis of divide and conquer algorithms, master method, examples - merge sort, quick sort, binary search, Data structures, Linked list, stacks and queues, insertion/deletion and analysis, Binary search trees Hash Tables – hash function and properties, collision handling, bloom filters, Greedy algorithms and Dynamic programming examples. Graph traversal , DFS, BFS, shortest path algorithms Dijkstra's and Bellman Ford algorithm, Minimum spanning trees, min cut . *Sartaj Sahni, Data Structures, Algorithms and Applications in C++, Universities Press, 2005* A.V. Aho, J.E. Hopcroft and J. D. Ullman, *Data structures and Algorithms, Pearson, 2004*. T.H.Cormen, C.E. Leiserson, R.L. Rivest, C. Stein, *Introduction to Algorithms, PHI, 2004*. Mark Allen Weiss, *Algorithms, Data structures and problem solving with C++, Pearson, 2002*.

### EC346 FOUNDATIONS OF MACHINE LEARNING

(3-1-0) 4

Statistical foundations, Different Paradigms of Pattern Recognition, Probability estimation, Proximity measures, Feature extraction, Feature extraction, Different approaches to Feature selection, Nearest Neighbour Classifier and variants, Efficient implementations, Prototype selection. Bayes classification. Linear models, regression, logistic regression, neural networks, objective function and learning, backpropagation. Kernel based methods, support vector machines. Dimensionality reduction, principal component analysis, reconstruction, discriminant analysis. Clustering, K-means algorithm, distance measure, objective function, initialization. Anomaly detection, recommender systems. Scaling of algorithms.

*R. O. Duda, P. E. Hart and D. G. Stork Pattern Classification, Wiley Publications, 2001*

*D. McKay Information Theory, Inference, and Learning Algorithms, Cambridge University Press 2003*

*C. M. Bishop Pattern Recognition and Machine Learning, Springer, 2006*

### EC347 SPEECH AND AUDIO PROCESSING

(3-1-0) 4

Speech Production–human speech production mechanism, acoustic theory of speech production, digital models for speech production. Speech perception– human hearing, auditory psychophysics, JND, pitch perception, auditory masking, models for speech perception. Speech Analysis–Time and frequency domain analysis of speech, speech parameter estimation, Linear prediction. Speech compression –quality measures, waveform coding, source coders, Speech compression standards for personal communication systems. Audio processing–characteristics of audio signals, sampling, Audio compression techniques, Standards for audio compression in multimedia applications, MPEG audio encoding and decoding, audio databases and applications. Speech synthesis–text to speech synthesis, letter to sound rules, syntactic analysis, timing and pitch segmental analysis. Speech recognition–Segmental feature extraction, DTW, HMMs, approaches for speaker, speech and language recognition and verification

*Douglas O'Shaughnessy, Speech Communication–Human and Machine, IEEE Press, 2000*

*L R Rabiner, Digital Processing of Speech Signals, Pearson, 1978* T.F Quatieri, *Discrete-time speech signal processing: Principles and Practise Pearson, 2002*

*Zi Nian Li, Fundamentals of Multimedia, Pearson Education, 2003*

### EC348 IMAGE AND VIDEO PROCESSING

(3-1-0) 4

Digital image fundamentals–image acquisition, representation, visual perception, quality measures, sampling and quantization, basic relationship between pixels, imaging geometry, color spaces, Video spaces, analog and digital video interfaces, video standards. Two dimensional systems – properties, analysis in spatial, frequency and transform domains. Image transforms - DFT, DCT, Sine, Hadamard, Haar, Slant, KL transform, Wavelet transform. Image enhancement–point processing, spatial filtering, Image restoration–inverse filtering, de-blurring Video processing–display enhancement, video mixing, video scaling, scan rate conversion, Image compression–lossless and lossy compression techniques, standards for image compression-JPEG, JPEG2000. Video compression–motion estimation, intra and interframe prediction, perceptual coding, standards- MPEG, H.264 Image segmentation–feature extraction, region oriented segmentation, descriptors, morphology, Image recognition

*R. C. Gonzalez and R E Woods, Digital Image Processing, Pearson Education,*

*2002* A K Jain, *Fundamentals of Digital Image Processing, Pearson*

*Education, 1989* W Pratt, *Digital Image Processing, Wiley , 2001*

*Al Bovik, Handbook of Image and Video, Academic Press,*

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2000 Keith Jack, *Video Demystified*, LLH 2001

### **EC349 APPLIED NUMBER THEORY (3-1-0) 4**

Prime numbers, Divisibility and GCD, Congruences, Powers, Fermat's Little theorem, Euler's theorem, Euler's totient function, Chinese Remainder theorem, Diophantine equations, Residue Number system (RNS), Double base number system (DBNS), Signal Processing and Number Theory: Review of DFT and circular convolution, Number theory and DFT, Consequences of Euler's theorem for Signal Processing, Communication Engg: PN sequences, Polynomials and Euclidean algorithm, Generation of PN sequences application of PN sequences.

*Thomas Koshy, Elementary Number Theory with Applications, 2nd Ed, Associated Press, 2007.*

*Amos R. Omondi and Benjamin Premkumar, Residue Number Systems: Theory and Implementation, World Scientific, 2007.*

*Hari Krishna Garg, Digital Signal Processing Algorithms: Number Theory, Convolution, Fast Fourier Transforms, and Applications, 1st Ed, CRC Press, 2000.*

### **EC350 NUMERICAL ANALYSIS (3-1-0) 4**

Preliminaries on numerical analysis, Errors and measuring efficiency, Review of Linear Algebra, Iterative techniques in matrix algebra, elimination method, inverse of a matrix, ill conditioned systems, eigen values, eigen vectors, LU and QR factorization. Solving nonlinear equations, bisection, Newton's method, Mullers method, fixed point interpolation, steepest descent. Interpolation and curve fitting: interpolating polynomials, spline curves, interpolation on a surface, least square approximations. Approximation of functions: Fourier basis and orthogonal polynomials, rational function approximation. Numerical differentiation and integration, solution of ordinary differential equations: Taylor series method, Euler method, Runge-Kutta method. Solution of partial differential equations, finite element methods, optimization.

*Francis B. Hildebrand, Introduction to Numerical Analysis, 2nd Ed, Dover.*

*SD Conte, C de Boor, Elementary numerical analysis: An algorithmic approach, 3rd Ed, Mc Graw Hill, 1981.*

*R.L. Burden & J.D. Faires, Numerical Analysis, 9th Ed, Brooks/Cole, Cengage Learning, 2011.*

### **EC351 SATELLITE COMMUNICATIONS (3-1-0) 4**

Introduction to satellite Communications, Space craft, space craft sub systems, Altitude and orbit control systems, Telemetry, tracking and command, Power Systems, Communication sub systems, description of communication systems, transponders, Space craft antennas, Equipment reliability and space qualification, Multiple access systems, FDMA, FDM/FM/FDMA, TDMA, CDMA spread spectrum transmission and reception. Applicability of CDMA to commercial systems, demand access in the INTELSAT. TDMA system, SPADE, the INMARSAT system, Earth station, Satellite television networks.

*T. Pratt, Satellite communications, John Wiley, 2002*

*T. T. Ha., Digital satellite communication, Collier Macmillan, 1986*

### **EC352 PRINCIPLES OF MODERN RADAR AND TECHNIQUES (3-1-0) 4**

Introduction and Radar Overview, The Radar Range Equation, Radar Search and Overview of Detection in Interference; External Factors: Propagation Effects and Mechanisms, characteristics of Clutter Target Reflectivity, Target Fluctuation Models, Doppler Phenomenology and Data Acquisition Subsystems: Radar Antennas, Radar Transmitters, Radar Receivers, Radar Exciters, and The Radar Signal Processor

*Mark A Richards, Principles of modern radar (POMR)-Basic principles(Vol-1), Scitech publishers*

*R. Skolnik, Modern Radar Systems, 3rd edition, Mc-Graw Hill Publishers*

### **EC353 MODERN ELECTRONIC NAVIGATION SYSTEMS (3-1-0) 4**

GNSS overview: GPS, GLONASS, Galileo; Fundamentals of Satellite and Inertial Navigation, Signal Characteristics and Information Extraction; Receiver and Antenna Design. Differential GNSS. Kalman filtering, Inertial Navigation systems.

*Mohinder S. Grewal, Lawrence R. Weill, Angus P. Andrews, Global positioning systems, inertial navigation and integration, Second edition, Wiley, 2010*

### **EC354 COMMUNICATION NETWORKS (3-1-0) 4**

Switching techniques, Multiplexing and Multiple Access techniques, Packet Switched Networks. OSI and TCP/IP Models, Internet protocols and addressing, networking devices, data links and transmission, LANs and Network of LANs, Wireless Networks and Mobile IP, Routing and internetworking, transport and end to end protocols, congestion control techniques, Application Layer and network management, Network Security. Packet Queues and delays, Little's theorem, Birth and death process, Queuing disciplines, M/M/1 Queues, Burkes and Jackson theorems. Traffic models, ISDN, ATM Networks, Quality of service and resource allocation, VPNs and MPLS, Cellular

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Telephone and Optical

networks, VOIP and Multimedia networking. Mobile Adhoc Networks and Wireless Sensor Networks Nader F. Mir, *Computer and Communication Networks*, Pearson Education, 2007

Garcia and Widjaja, *Communication Networks*, McGraw Hill, 2006

J.F. Hayes, *Modelling and analysis of Computer Comm. Networks*, Plenum, 1984.

Jean Walrand & Pravin Varaiya, *High Performance Communication Networks*, Morgan Kaufmann Publishers, 2002

### **EC355 WIRELESS MOBILE COMMUNICATION (3-1-0) 4**

Concepts of cellular communication, Geometry of hexagonal cells; Co-channel interference, cellular system design in worst case, co-channel interference with the use of directional antennas, Cell splitting, Frequency allocation in mobile, Power control, JDC, JDC frame structure, TDMA, TDMA frame, delayed in TDMA, advantages CDMA, Capacity Comparison of FDM /TDM systems and cellular CDMA. Standards for Wireless mobile communication, Micro cells, high way micro cells, spectral efficiency, traffic carried, Signalling and call control; Mobility management, Location tracking. Wireless data networking.

G.L. Sterber, *Principles of Mobile Communications*, Kluwer Academic, 1996.

T.S .Rappaport, *Wireless communications, Principles and Practice*, , Pearson Edn, 2002.

William C.Y. Lee, *Mobile cellular telecommunication systems: Analog & Digital Systems*, McGraw Hill, 1995.

### **EC356 INFORMATION THEORY AND CODING (3-1-0) 4**

Communication systems and Information Theory, Measures of Information, Coding for Discrete sources, Discrete memory-less channels and capacity, Noisy channel coding theorem, Techniques for coding and decoding, Waveform channels, Source coding with Fidelity criterion.

Thomas M Cover & Joy A Thomas, *Elements of Information Theory*, John Wiley, 1991

R.G.Gallagher, *Information Theory and Reliable Communication*, Addison Wesley, 1987.

A.J.Viterbi & J.K. Omura, *Principles of Digital Communications and Coding*, McGraw Hill, 1979.

### **EC357 ADHOC AND SENSOR NETWORKS (3-1-0) 4**

Mobile ad hoc networks and wireless sensor networks concepts and architectures. Routing: proactive routing, Broadcasting and multicasting, TCP over mobile ad hoc networks, Wireless LAN (WiFi) standards, Medium Access Control Protocol issues power control, spatial reusability, and QoS, Bluetooth, Wireless sensor networks architecture: hardware and software components of a sensor node, OS for WSN, WSN MAC layer strategies; naming and addressing; Clock Synchronization; Node Localization; WSN Routing.

C Sivarama Murthy and B S Manoj, *Ad-Hoc Wireless Networks, Architectures and Protocols*, PH , 2004.

Labiod.H, *Wireless Adhoc and sensor networks*, Wiley, 2008.

Li,X , *Wireless ad hoc and sensor networks: theory and applications*, Cambridge University Press, 2008

### **EC358 MULTIMEDIA COMMUNICATION TECHNIQUES (3-1-0) 4**

Representation of Multimedia Data, Concept of Non-Temporal and Temporal Media, Multimedia Presentations, Synchronization. Compression of Multimedia Data, Basic concepts of Compression, Audio Compression Introduction to Speech and Audio Compression, Multimedia System Design, General Purpose Architecture for Multimedia Processing, Operating System support for Multimedia, Data, Resource Scheduling with real-time considerations, File System, I/O Device, Management, Delivery of Multimedia data, Network and Transport Protocols, QoS issues, RTP and RSVP, Video-conferencing and video-conferencing standards, Overview of Voice over IP, Multimedia Information Management, Multimedia Data base Design, Content Based Information Retrieval, Image Retrieval, Video Retrieval, Overview of MPEG-7.

Ralt Steinmetz and Klara Nahrstedt, *Multimedia : Computing, Communication & Applications*,

Pearson Education Publications, 2004.

### **EC359 SOFTWARE DEFINED AND COGNITIVE RADIO (3-1-0) 4**

Cognitive radio: goals, benefits, definitions, architectures, Spectrum-Licensed, unlicensed, shared unlicensed, opportunistic unlicensed, Current spectral usage and issues, Regulations, regulation changes, Spectral awareness, Spectrum adaptation, Dynamic frequency selection, Spectrum Sharing priority allocation, Adaptive bandwidth control Policies, Adaptation and optimization- link adaptation, incremental redundancy, jointly adaptive source and channel coding, Digital signal processing role in SDR, Cross- layer optimization (adaptation), Current cellular cognitive features-Hand -off, Channel allocation, cellular network design, Link adaptation, incremental redundancy, Interference avoidance, detection, and cancellation, Power control, Femto cells and relation to cognitive radio. 2.5G/3G/4G cognitive features, Multi-carrier system adaptation (OFDM(A) adaptive features), Collaboration and

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Hoseyin Arslan (Ed.), "Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems," Ser. Signals and Communication Technology, xviii, I. edition, Springer, August 2007

Jeffrey H. Reed, "Software Radio: A Modern Approach to Radio Engineering," Prentice Hall PTR, 2002.

*Markus Dillinger and Kambiz Madani and Nancy Alonistioti, "Software Defined Radio: Architectures, Systems and Functions," John Wiley and Sons Ltd., 2003.*

Introduction to VLSI design automation: VLSI design methodologies, use of VLSI EDA tools, Algorithmic Graph Theory, computational Complexity; Partitioning: KL algorithm, FM algorithm, EIG Algorithm, Simulated Annealing. Floorplanning and placement: Sliced and non-sliced planning, Polish expression, Simulated annealing, partition based placement; ILP & mathematical programming, partition based, force directed, Fast-Place, quadratic placement algorithms. Routing: Global routing, detailed routing, graph models, Line Search, Maze Routing, Channel routing; via minimization, clock and power routing. High Level Synthesis: Introduction to HDL, HDL to DFG, operation scheduling: constrained and unconstrained scheduling, ASAP, ALAP, List scheduling, Force directed scheduling, operator binding; Static Timing Analysis: Delay models, setup time, hold time, cycle time, critical paths, Topological vs logical timing analysis, False paths, Arrival time, Required arrival Time, Slacks. Advanced VLSI Design Automation: Physical Synthesis, Optical Proximity correction, Interconnect issues

*Sadiq M. Sait & Habib Youssef, VLSI Physical Design Automation: Theory and Practice, World Scientific Publishing, 1999*

Sample and Hold Circuits: Basic S/H circuit, effect of charge injection, compensating for charge injection, bias dependency, bias independent S/H. D/A Converter – General considerations, Static non-idealities and Dynamic nonidealities; Current-steering DAC – Binary weighted DAC, Thermometer DAC, Design issues, Effect of Mismatches. A/D converter – General considerations, static and dynamic non-idealities. Flash ADC – Basic architecture, Design issues, Comparator and Latch, Effect of non-idealities, Interpolative and Folding architectures. Successive Approximation ADC; Pipeline ADC. Over sampling ADC – Noise shaping, Sigma-Delta modulator.

*Rudy J. van de Plassche, CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters, Springer, 2003*

Instruction Level Parallelism: Pipelining, Hazards, Instruction Level Parallelism, Branch prediction, Static and Dynamic Scheduling, Speculation, Limits of ILP. Multicore Memory Hierarchy: Cache trade-offs, Basic and Advanced optimizations, Virtual Memory, DRAM optimizations. Multiprocessors: Symmetric and Distributed architectures, Cache coherence protocols - Snoopy and Directory based, ISA support for Synchronization, Memory Consistency Models. Interconnection Networks: Architectures, Topologies, Performance, Routing, Flow control, Future of NoCs.

D. A. Patterson and J. Hennessy, *Computer Organization and Design*, Harcourt Asia, 1998.



*Behrooz Parhami, Computer Arithmetic Algorithms and Hardware Design, Oxford, 2000.*

## **EC443                      VLSI TESTING AND TESTABILITY                      (3-1-0) 4**

Overview of testing and verification, Defects and their modeling as faults at gate level and transistor level. Functional V/s. Structural approach to testing. Complexity of testing problem. Controllability and observability. Generating test for a signal stuck-at-fault in combinational logic. Algebraic algorithms. Test optimization and fault coverage. Logic Level Simulation – Delay Models, Event driven simulation, general fault simulation (serial, parallel, deductive and concurrent). Testing of sequential circuits. Observability through the addition of DFT hardware, Adhoc and structured approaches to DFT – various kinds of scan design. Fault models for PLAs, bridging and delay faults and their tests. Memory testing, testing with random patterns. LFSRs and their use in random test generation and response compression (including MISRs ), Built-in self-test.

*M. Abramovici, M. A. Breuer, and A. D. Friedman, Digital Systems Testing and Testable Design, IEEE Press, 1994.*

*M. L. Bushnel and V. D. Agarwal, Essentials of Testing for Digital, Memory and Mixed – Signal VLSI Circuits, Kluwer Academic Publishers, 2000.*

*Ajai Jain, Learning Module for the course - VLSI Testing and Testability, IIT, Kanpur, 2001.*

## **EC444                      SYNTHESIS AND OPTIMIZATION OF DIGITAL CIRCUITS                      (3-1-0) 4**

Introduction to Computer aided synthesis and optimization. Hardware Modeling. Advanced Boolean Algebra and Applications – Boolean functions, representations, Shannon co-factors, satisfiability and cover, Binary Decision Diagrams, Representing Boolean functions, ROBDD, ITE operator, Variable ordering- choice of variables, application of BDD to synthesize Boolean functions, Two level combinational logic optimization, Multiple level combinational optimization. Sequential logic optimization. Cell Library Binding. Algorithms for Technology mapping – Structural and Boolean matching, Simulation & Static Timing analysis - Event driven simulation – zero delay, unit delay and nominal delay simulation, Timing analysis at the logic level, Delay models, Delay graph, static sensitization, State of the art and future trends: System level synthesis.

*Giovanni De Micheli, Synthesis and Optimization of Digital Circuits, McGraw Hill, 1994.*

*Srinivas Devadas, Abhijith Ghosh and Kurt Keutzer, Logic Synthesis”, Kluwer Academic, 1998.*

*G. D. Hachtel and F. Somenzi, Logic Synthesis and Verification Algorithms, Kluwer Academic Publishers, 1996.*

*S. Hassoun and T. Sasao, (Editors), Logic Synthesis and Verification, Kluwer Academic publishers, 2002*

## **EC445                      TECHNIQUES IN LOW POWER VLSI                      (3-1-0) 4**

Introduction to Low Power VLSI. Modeling and Sources of Power consumption. Power estimation at different design levels. Power optimization for combinational circuits and sequential circuits Voltage scaling Approaches. Low energy computing using energy recovery techniques. Low Power SRAM architectures. Software design for low power. Computer Aided Design Tools. Case studies Recent trends in low-power design for mobile and embedded application.

*Kaushik Roy, Sharat Prasad, Low-Power CMOS VLSI design, John Wiley, 2000.*

*K.-S. Yeo and K. Roy, Low-Voltage Low-Power Subsystems, McGraw Hill, 2004.*

*Anantha P.Chandrakasan & Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer,*

*1995. Gary K. Yeap, Practical Low Power Digital VLSI Design, Kluwer Academic Publications, 1998*

*L. Benini and G. De Micheli, Dynamic Power Management Design Techniques and CAD Tools, Springer, 1998.*

*S. G. Narendra and A. Chandrakasan, Leakage in Nanometer CMOS Technologies, Springer, 2005.*

*Edgar Sánchez-Sinencio, Andreas G. Andreou, Low- Voltage/Low-Power Integrated Circuits and Systems: Low-Voltage Mixed-Signal Circuits IEEE Press Series on Microelectronic Systems 1999*

## **EC446                      SUBMICRON DEVICES                      (3-1-0) 4**

Review of basic device physics, Electronic structure of semiconductors, Diodes, MOS capacitor. Transistor theory. Scaling - Moore's law on technology scaling, MOS device scaling theory, Short channel effects, sub threshold leakage, Punch through, DIBL, High field mobility, Velocity saturation and overshoot. Reliability. Various definitions of channel length, Performance metric of digital technology, Transistor design trade- offs, Technology case studies, Silicon on Insulator (SOI) devices, Partially depleted and fully depleted SOI, Floating body effects, SOI for low power, Interconnects in sub-micron technology, Foundry technology, International Technology Roadmap for Semiconductors (ITRS).

*J. A. del Alamo Integrated Microelectronic Devices: Physics and Modeling, Pearson, 2017*

*Yaun Taur, Tak H. Ning, Fundamentals of modern VLSI devices, Cambridge university press, 1998.*

*B. G. Streetman & S. Banerjee, Solid State Electronic Devices, Prentice Hall, 1999.*

*M. K. Achuthan and K. N. Bhat, Fundamentals of Semiconductor Devices, McGraw Hill, 2006*

*Nandita Dasgupta, Amitava Dasgupta, Semiconductor Devices: Modelling And Technology, Phi,*

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2009 A. K. Dutta, *Semiconductor Devices and Circuits*, Oxford Univ. Press, 2008. ITRS Road map - <http://public.itrs.net/>

### **EC447 ACTIVE FILTERS (3-1-0) 4**

Butterworth, Chebyshev & Inverse-Chebyshev filter response and pole locations, LC ladder filter – prototype & synthesis; Frequency transformation of lowpass filter. Impedance converters; Gm-C filters – Gm-C biquad, Q enhancement, Automatic Tuning; Active-RC filters – Comparison with Gm-C filter, Issues in realizing high frequency active-RC filters, Switched Capacitor Filters.

*R. Schaumann and M.E. Van Valkenburg, Design of Analog Filters, Oxford University Press, 2003.*

*P. V. Ananda Mohan, Current-Mode VLSI Analog Filters - Design and Applications, Birkhauser, 2003*

*M.E. Van Valkenburg, Analog Filter Design, Oxford University Press, 1995.*

### **EC448 HETEROGENEOUS AND PARALLEL COMPUTING (3-0-2) 4**

Heterogeneous platform and GPU architecture. Introduction to OpenCL. OpenCL device architecture. Concurrency and execution model. Programming examples like vector addition, convolution and matrix multiplication. Application case studies.

*Benedict R. Gaster, Lee Howes, David R. Kaeli, Perhaad Mistry, Dana Schaa, "Heterogeneous Computing with OpenCL" - Revised OpenCL 1.2 Edition, Morgan Kaufmann, 2013.*

*Aaftab Munshi, Benedict R. Gaster, Timothy G. Mattson, James Fung, Dan Ginsburg, "OpenCL Programming Guide", Addison-Wesley, 2012.*

*David B. Kirk and Wen-mei W. Hwu, "Programming Massively Parallel Processors - A Hands-on Approach", Second Edition, Morgan Kaufmann, 2013.*

*AMD Accelerated Parallel Processing OpenCL User Guide, AMD, 2014.*

### **EC449 ALGORITHMS AND ARCHITECTURES FOR SIGNAL PROCESSING (3-1-0) 4**

Representation of digital signal processing systems: block diagrams, signal flow graphs, data-flow graphs, dependence graphs; pipelining and parallel processing for high-speed and low power realizations; iteration bound, algorithms to compute iteration bound, retiming of data- flow graphs; unfolding transformation of data- flow graphs; systolic architecture design, architectures for real and complex fast Fourier transforms; stochastic logic based computing, computing digital filters, arithmetic functions and machine learning functions using stochastic computing; Neural Network architectures.

*K.K. Parhi, VLSI Digital signal processing systems: Design and implementation, John Wiley,*

*1999. Lars Wanhammar, DSP Integrated Circuits, Academic Press, 1999*

*Sen M. Kuo Bob H. Lee Wenshun Tian, "Real-Time Digital Signal Processing: Implementations and Applications", 2006 John Wiley & Sons, Ltd*

*Roger Woods, John McAllister, Gaye Lightbody, Ying Yi, "FPGA Based Implementation of Signal Processing Systems", John Wile, 2017*

*U. Meyer-Baese, "Digital Signal Processing with Field Programmable Gate Arrays", 4<sup>th</sup> Ed. Springer, 2014*

### **EC450 ANALOG AND DIGITAL FILTER DESIGN (3-1-0) 4**

Introduction to filters and filter specifications. The Butterworth, Chebyshev, Elliptic, and Bessel filters and their realization, Frequency transformations, Analog filter design. Sampling; the Digital filter problem. IIR Filter design using the impulse invariant and bilinear transformation methods. The poles and zeros of the Butterworth and Chebyshev digital filter equivalents. Realization of Digital IIR filters Tradeoffs between aliasing and complexities of Analog filter realizations Direct design of IIR filters. FIR Filter Design: Exactly linear phase filters. Windowing methods. Kaiser window and its properties. Filter design using Kaiser window, Frequency sampling, Optimal FIR Filter design, Real-time implementation of digital filters – coefficient quantisation and finite word length effects.

*A.Ambardar, Analog and Digital Signal Processing, Brooks Cole, 1999.*

*Ifeachor and Jervis, DSP – A practical approach, Pearson, 2002*

*Sanjit K. Mitra, Digital Signal Processing : A computer based Approach, TMH, 2002*

*Andreas Antoniou, Digital Filter Design, TMH*

### **EC451 ADVANCED DIGITAL SIGNAL PROCESSING (3-1-0) 4**

Power spectral estimation; Parametric and non-parametric methods of spectral estimation, Linear prediction, Higher order spectral estimation; Adaptive filters and applications. Recursive estimation and Kalman filters Multirate Signal Processing: Decimation Interpolation, DFT filter banks, QMF filter banks, Multiresolution Signal analysis wavelets theory of sub band decompositions, Sub band coding and wavelet transforms, Application of wavelet transforms.

*P.P. Vaidyanathan, Multirate systems and Filter banks, Prentice Hall,*

*1993. S.J. Orfanidis, Optimum Signal Processing, McGraw Hill, 1989.*

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*S. Haykin, Adaptive Filter Theory, Pearson, 1996*

### **EC452 REAL TIME SIGNAL PROCESSING (2-0-3) 4**

Introduction to DSP systems and architecture; Arithmetic: Fixed point, floating point and residue arithmetic, Cordic architectures; Real time implementation of SP algorithms on Digital Signal Processors: Architecture and programming; Real time implementation of SP algorithms on Reconfigurable architectures: Architecture and design flow; Issues in implementation of convolution, FIR, IIR and adaptive filters, DCT, Image Filtering, Dynamically reconfigurable architectures for SP, Software Configurable processors, Application case studies in multimedia compression and communication.

*Behrooz Parhami, "Computer Arithmetic Algorithms and Hardware Design", Oxford, 2000.*

*Rulph Chassaing, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", Wiley, 2005*

*U. Meyer Baesse, "Digital Signal Processing with FPGAs", Springer, 2001*

*Shehrzad Qureshi, "Embedded Image Processing on the TMS320C6000 DSP" Springer, 2005*

### **EC453 FOURIER AND WAVELET SIGNAL PROCESSING (3-1-0) 4**

Hilbert Spaces, Review of sequences and discrete time systems, functions, DTFT, convergence, multi rate systems, polyphase representation, stochastic processes and systems. Continuous time systems, Fourier transform, definition, existence, spectral decay, Fourier series. Sampling and Interpolation–finite dimensional vectors, sequences, functions, periodic functions, approximation and compression polynomial and spline approximation. Localization and uncertainty.

Filter banks–Localization, two channel orthogonal filter banks, design, biorthogonal filter banks, design.

Local Fourier bases–N channel filter banks, exponentially modulation filter banks, cosine modulated filter banks.

Wavelet bases on sequences, Tree structured filter banks, orthogonal, biorthogonal bases, wavelet packets, frames.

Wavelet bases on functions–local Fourier transforms.

*Martin Vetterli Jelena Kovacevic & Vivek K. Goyal, Foundations of Signal Processing, Cambridge University Press, 2015*

*J. Kovacevic, V. K. Goyal and Martin Vetterli, Fourier and Wavelet Signal Processing, Cambridge University Press, 2013*

### **EC454 MATHEMATICAL ALGORITHMS FOR SIGNAL PROCESSING (3-1-0) 4**

Mathematical Foundations–mathematical models, random variables and random processes, Markov and hidden Markov models. Representations and approximations - orthogonality, least squares, MMSE filtering, frequency domain optimal filtering, minimum norm solutions, Iterated reweighted least squares. Linear Operators – Operator norms, adjoint and transposes, geometry of linear equations, least squares and pseudo inverses, applications to linear models.

Subspace methods – Eigen decomposition, KL transform and low rank approximation, Eigen filters, signal subspace techniques – MUSIC, ESPRIT. SVD – matrix structure, pseudo inverse and SVD, system identification using SVD, Total least squares, partial total least squares. Special matrices–Toeplitz matrices, optimal predictors and lattice filters, circulant matrices, properties.

*Todd Moon and WC Stirling, Mathematical Methods and Algorithms for Signal Processing, Pearson Education, 2000*

*Steven, M. Kay, Modern spectral estimation: theory and application, Prentice Hall, 1988*

### **EC455 DIGITAL SIGNAL COMPRESSION (3-1-0) 4**

Data Compression. Speech & image waveform characterization. Predictive coding. Transform coding. Subband coding, VQ based compression, Fractal coding of images. High quality video & audio compression for digital broadcasting. Standards for digital signal compression-data, speech, audio, image & video.

*D. Salomon, Data Compression – the complete reference, Springer, 2000.*

*K. Sayood, Introduction to Data Compression, Pearson Education, 2000.*

*M.Nelson, The data compression book, BPB Publications, 2002.*

*Jayant & Noll, Digital coding of waveforms-Principles and applications to speech & video, PH, 1984.*

### **EC456 DYNAMICAL SYSTEMS, CHAOS AND FRACTALS (3-1-0) 4**

Preliminaries on systems, Eigen values and Eigen vectors, solutions of linear ODEs. Dynamics of linear and nonlinear systems, solutions, attractors, equilibrium point, limit cycles, stability, Linear systems: solutions, stability of autonomous systems, BIBO stability, relation to frequency domain analysis, Nonlinear systems: large-scale notions of stability (Lyapunov functions), linearization. Vector fields of nonlinear systems, limit cycles, Lorenz and Rossler equation, Chua's circuit, Discrete dynamical systems, logistic maps, two dimensional maps, bifurcations, flows,

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phase plane analysis. Introduction to fractals, Mandelbrot and Julia sets, iterated function systems, strange attractors, fractal dimension, stable and unstable manifolds, analysis of chaotic time series, multifractals.

Applications in control theory, signal processing, digital image modelling, synthesis and compression, chaos communication and Cryptography. Other applications in engineering, natural and social sciences, medicine, economics, ecology, bio and life sciences, and environmental sciences.

*S. Stenborg, Dynamical systems, Dover 2010.*

*MW Hirsch, S. Smale, RL Devaney, Differential equations, dynamical systems, and an introduction to chaos, Academic Press. 2012.*

*Steven H. Strogatz, Nonlinear dynamics and chaos: with applications to physics, biology, chemistry, and engineering, West-view Press, 2015.*

*E. Ott, Chaos in dynamical systems, 2nd ed Cambridge University Press, 2002.*

*S. Wiggins, Introduction to applied nonlinear dynamical systems and chaos, Springer-Verlag, 1990.*

*Denny Gulick, Encounters with chaos and fractals, 2nd ed CRC Press, 2012.*

*J.M. Bahi, C. Guyeux, Discrete dynamical systems and chaotic machines: theory and applications, CRC Press, 2013.*

*M. Barnsley, Fractals everywhere, Academic Press, 1993.*

### EC457 STATISTICAL ANALYSIS

(3-1-0) 4

Preliminaries on matrix theory and probability distributions. Sampling theory: random samples, sampling distribution, statistical inference, estimation of mean and variances, hypothesis testing, statistical tests, goodness of fit. Data analysis: correlation and regression, simple linear regression, multiple linear regressions, logistic regression, nonlinear regression. The Multivariate Normal Distribution, Estimation of the Mean Vector and the Covariance Matrix, The Distributions and Uses of Sample Correlation Coefficients, The Generalized T<sup>2</sup>-Statistic, Classification of Observations, The Distribution of the Sample Covariance Matrix and the Sample Generalized Variance, Testing the General Linear Hypothesis: Multivariate Analysis of Variance, Testing Independence of Sets of Variates, Testing Hypotheses of Equality of Covariance Matrices and Equality of Mean Vectors and Covariance Matrices, Principal Components, Canonical Correlations and Canonical Variables, The Distributions of Characteristic Roots and Vectors, Factor Analysis, Pattern of Dependence, Graphical Models.

*Sam Kash Kachigan, Statistical Analysis: An Interdisciplinary Introduction to Univariate and Multivariate Methods, Radius Press, 1986.*

*RA Johnson, DW Wichern, Applied multivariate statistical analysis, 6th ed, PHI, 2012.*

*T. W. Anderson, An Introduction To Multivariate Statistical Analysis, 3rd Edition, Wiley, 2003.*

*Sam Kash Kachigan, Multivariate Statistical Analysis: A Conceptual Introduction, Radius Press, 1991.*

*Robert Nisbet, John Elder and Gary Miner, Handbook of Statistical Analysis and Data Mining applications, Elsevier Inc 2009.*

### EC458 STOCHASTIC PROCESSES

(3-1-0) 4

Review of Probability theory and stochastic processes, stochastic processes and linear systems, Gaussian random process, spectral analysis of stationary processes, Power Spectral Densities, Stationarity and Ergodicity, Poisson processes, renewal processes, Brownian motion. Optimal Linear Systems, Wiener Filters, discrete and continuous time Markov chains, discrete time branching processes, birth and death processes, random walks, large deviations and Martingales. Queueing theory Diffusion processes and stochastic differential equations, the Fokker-Planck and Langevin Equations. Applications – Modeling of neural processes, finance, and processes in natural and social sciences.

*Richard Durrett, Essentials of Stochastic Processes (Springer Texts in Statistics) May 2001.*

*R G Gallager, Stochastic processes: theory for applications, 2013.*

*W. Paul and J. Baschnagel: Stochastic Processes – From Physics to Finance, Springer, 1999.*

*Frank Beichelt, L. Paul Fatti, Stochastic Processes and Their Applications, CRC Press, 2001.*

*Petar Todorovic, An Introduction to Stochastic Processes and Their Applications, Springer, 1992.*

### EC459 OPTIMIZATION

(3-1-0) 4

Convex sets and Convex functions, Level sets and Gradients, Unconstrained Optimization: Search methods, Gradients Methods, Newton Method, Conjugate Direction Methods, Quasi-Newton Methods. Linear Programming: Standard Form Linear Programs, Simplex method, Duality and Non Simplex Methods. Nonlinear Constrained Optimization: Problems with equality constraints, Problems with Inequality Constraints, Convex Optimization Problems, Algorithms for Constrained Optimization: Projected Gradient Methods and Penalty Methods.

*Lieven Vandenbergh and Stephen P. Boyd, Convex Optimization, Cambridge University Press, 2004.*

*Dimitris Bertsimas, John N. Tsitsiklis, Introduction to Linear Optimization, Athena Scientific Series, 1997.*

*Aharon Ben-Tal and Arkadi Nemirovski, Lectures on Modern Convex Optimization: Analysis, Algorithms, and*

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*Engineering Applications, SIAM, 2001.*

### **EC460 NEURAL NETWORKS AND DEEP LEARNING (3-1-0) 4**

Linear Regression, Logistic regression, Basic neuron structure, Perceptron, error functions, optimization – gradient descent, Multilayer perceptron, transfer function, nonlinearities, learning, backpropagation, function approximations, overfitting, underfitting, Deep networks, challenges, regularization techniques – Norm penalties, early stopping, drop outs, dataset augmentation, bagging and ensemble methods, Convolutional Networks – Convolution, pooling, variants, transfer learning, Sequence Modeling – Recurrent neural networks, Bidirectional RNNs, architectures, LSTM, Application examples – Computer Vision, Speech recognition, NLP.

*Simon S. Haykin, Neural Networks and Learning Machines, 3rd Ed, Pearson, 2009.*

*José C. Principe, Neil R. Euliano, W. Curt Lefebvre, Neural and Adaptive Systems: Fundamentals through Simulations, John Wiley and Sons, 2000.*

*Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press, 2016.*

### **EC461 SPREAD SPECTRUM COMMUNICATION (3-1-0) 4**

Spread spectrum overview, Spreading techniques, Pseudo noise sequences, Direct sequence spread spectrum system, Frequency hop spread spectrum system, Hybrid systems, Synchronization, Jamming considerations, Commercial applications, Cellular systems, Performance of spread spectrum systems.

*R.L.Peterson, Introduction to spread spectrum communication, PH, 1995.*

*B.Sklar, Digital Communications, Pearson Education, 2001.*

*M.K.Simon, Spread spectrum communications Handbook, McGraw-Hill, 2001.*

*J.S.Lee, CDMA Systems Engineering handbook, Artech House, 1998*

### **EC462 ERROR CONTROL CODING (3-1-0) 4**

Coding for reliable digital transmission and storage. Groups, Rings, Vector Spaces, Galois Fields, Polynomial rings, Channel models, Linear Block codes, Cyclic codes, BCH codes, Reed Solomon Codes, Berlekamp-Massey and Euclid decoding algorithm, Decoding beyond the minimum distance parameter, Applications of Reed-Solomon codes, Convolutional codes, Decoding algorithms for Convolutional codes, Viterbi, Stack and Fano algorithms, Application of Convolutional codes. Codes based on the Fourier Transform, Algorithms based on the Fourier Transform, Trellis coded modulation, Combinatorial description of Block and Convolutional codes, Algorithms for the construction of minimal and tail biting trellises, Soft decision decoding algorithms, Iterative decoding algorithms, Turbo-decoding, Two-way algorithm, LDPC codes, Use of LDPC codes in digital video broadcasting, belief propagation (BP) algorithms, Space-Time codes.

*Shu Lin and Daniel J. Costello Jr., Error Control Coding: Fundamentals and Applications, Prentice Hall, 2003.*

*S. B Wicker, Error Control Systems for Digital Communication and Storage, Prentice Hall International, 1995.*

*Blahut R. E, Theory and Practise of Error Control Codes, Addison Wesley, 1983.*

### **EC463 OPTICAL COMMUNICATION SYSTEMS AND NETWORKS (3-1-0) 4**

Introduction to Optical Fibers, Ray Optics-Optical Fiber Modes and Configurations. Signal degradation in Optical Fibers. Optical Sources and Detectors. Optical Communication Systems and Networks. Basic concepts of SONET/SDH Networks.

*J.Senior, Optical Communication, Principles and Practice, Prentice Hall of India, 1994/latest edition. Gerd Keiser,*

*Optical Fiber Communication McGraw –Hill International, Singapore, 3rd ed., 2000/latest Edition*

*J.Gower, Optical Communication System, Prentice Hall of India, 2001.*

### **EC464 RADAR SIGNAL PROCESSING (3-1-0) 4**

Introduction to Radar Systems and Signal Processing, Signal Models, Pulsed Radar Data Acquisition Radar Waveforms, Doppler Processing, Detection Fundamentals, Introduction to Synthetic Aperture Imaging, and Introduction to Beamforming and Space-Time Adaptive Processing.

*Mark A Richards, Fundamentals of radar signal Processing, McGraw Hill edition, 2nd edition, 2013*

*Peebles P. Z, Radar Principles, John Wiley and Sons, 1998*

### **EC465 ALGORITHMS FOR PARAMETER AND STATE ESTIMATION (3-1-0) 4**

Maximum likelihood (ML) estimation, Maximum a posteriori (MAP) estimation, Least squares (LS) estimation, Minimum mean square error (MMSE) estimation, Linear MMSE (LMMSE) estimation. LS estimation for linear and nonlinear systems, modelling stochastic dynamic systems, the Kalman filter for discrete time linear dynamic systems with Gaussian noise. Steady state filters for noisy dynamic systems, adaptive multiple model estimation techniques. Nonlinear estimation techniques, computational aspects of discrete time estimation.

*Y. Bar-Shalom, X. Rong Li and T. Kirubarajan, Estimation with Applications to Tracking and Navigation, John*

Wiley & Sons, 2001.

F. L. Lewis, *Optimal Estimation*, John Wiley & Sons, 1986.

R. G. Brown and P. Y. C. Hwang, *Introduction to Random Signals and Applied Kalman Filtering*, John Wiley & Sons, 1992.

**EC466 DETECTION AND ESTIMATION THEORY (3-1-0) 4**

Preliminaries on probability and random processes. Hypothesis testing: Neyman-Pearson theorem, likelihood ratio test and generalized likelihood ratio test, uniformly most powerful test, multiple- decision problem, detection of deterministic and random signals in Gaussian noise, detection in nonGaussian noise, sequential detection. Parameter estimation: unbiasedness, consistency, Cramer-Rao bound, sufficient statistics, Rao-Blackwell theorem, best linear unbiased estimation, maximum likelihood estimation, method of moments. Bayesian estimation: MMSE and MAP estimators, Levinson-Durbin and innovation algorithms, Wiener filter, Kalman filter. Applications in Wireless Communication, Radar Systems, Speech, Image and Video processing and applications relevant to Engineering.

Steven Kay, *Fundamentals of Statistical Signal Processing - Detection Theory* (Vol. 2), Prentice Hall, 1998. Steven Kay, *Fundamentals of Statistical Signal Processing - Estimation Theory* (Vol. 1), Prentice Hall, 1993.

H. V. Poor, *An Introduction to Signal Detection and Estimation*, Springer-Verlag, 2nd edition, 1994.

H. L. Van Trees, *Detection, Estimation and Modulation Theory, Parts 1 and 2*, John Wiley Inter- Science, 2002

M. D. Srinath, P. K. Rajasekaran and R. Vishwanathan, *An Introduction to Statistical Signal Processing with Applications*, Prentice-Hall, 1996.

Kailath, T. and Hassibi, *Linear Estimation*, Pearson, 2000.

**EC467 ADVANCED TOPICS IN COMMUNICATION ENGINEERING (3-1-0) 4**

Fading Channels, characterizing Mobile radio propagation, Signal time spreading, time variance of channel, mitigating the degradation effects of fading, characterizing fading channels, Fundamentals of Statistical Detection Theory, Baye's Theorem, Decision theory, Neyman Pearson Theorem, Receiver operating characteristics, Bayes's risk. Multiple hypothesis testing, minimum Baye's risk detection for binary hypothesis and multiple hypothesis, Orthogonal Frequency Division Multiplexing, OFDM transmission technique, synchronization, modulation, demodulation, amplitude limitation of OFDM signals. Space Time Wireless Communications, Introduction, space time propagation, space time channel and signal models, spatial diversity, space time OFDM

J.G.Proakis & M.Salehi, *Digital Communication*, 5th edition, McGraw Hill 2007.

Stevan M Kay, *Fundamentals of Statistical signal processing, Vol. II, Detection Theory*, PHI, 1998.

A.Paulraj, R.Nabar & D.Gore, *Introduction to Space Time Wireless Communications*, Cambridge University, 2003.

**EC468 SIGNAL INTEGRITY AND EMI/EMC (3-1-0) 4**

Fundamentals, Basics of EMI/EMC: coupling mechanisms, why to consider EMC, typical sources and victims, time domain vs. frequency domain, near vs. far field, non-ideal components, controlling signal return currents, differential vs. common mode currents, radiation and pickup from loop and dipoles, the "hidden schematic" idea, etc. High Speed/Frequency Effects In Electronic Circuits, Components In RF/EMI/ EMC /Si, Transmission Lines: Controlling Propagation, Matching, Signal Integrity Parameters, undesired effects, propagation time and delay, reflections and ringing, crosstalk (near and far) and jitter. Delays. Jitter. Signal ground versus safety ground, grounding strategies, ground loops, techniques to minimize ground impedance Grounding, Filtering, Printed Circuit Boards (PCBs), Shielding, Cables, Transients, Diagnostics and Troubleshooting Techniques.

Huray P.G.: *The Foundations of Signal Integrity*. J. Wiley & Sons, Hoboken, 2010

Hall S.H., Heck H.L.: *Advanced Signal Integrity for High-Speed Digital Designs*. Wiley-IEEE Press, 2009.

Bogatin E.: *Signal Integrity – Simplified*. Prentice Hall, 2004.

Johnson H. W.: *High Speed Signal Propagation: Advanced Black Magic*. Prentice Hall, 2003.

Caniggia S., Maradei F.: *Signal Integrity and Radiated Emission of High-Speed Digital Systems*. John Wiley & Sons, 2009.

**EC469 INTRODUCTION TO PHOTONICS (3-1-0) 4**

Photonic Crystals: Electromagnetic wave in periodic medium, Symmetry, 1D photonic crystals: photonic band gap, omnidirectional reflector, 2D photonic crystals: photonic crystal waveguides, micro cavity, negative refraction, self-collimation, photonic crystal fibre, One-way waveguide, 3D photonic crystals: self-assembled photonic crystal, holographically fabricated photonic crystal. Plasmonics, - Optics in metal, Surface Plasmon polariton, Localized surface plasmon, Phonon polariton, Plasmon waveguides, Transmission through sub-wavelength aperture, Enhancement of fluorescence and nonlinearity, Applications in Biomedical Engineering. Metamaterials, Effective medium theory, Negative refractive index, Super lens, Transformation optics, Invisibility cloak.

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*Lukas Novotny and Bert Hecht, Principles of Nano-Optics, Cambridge University Press, 2012*

*Herve Rigneault, Jean-Michel Lourtioz, Claude Delalande, Juan Ariel Levenson, Nanophotonics, Wiley-ISTE, 2006.*

*Mark L. Brongersma, Pieter G. Kik, Surface Plasmon Nanophotonics, Springer, 2007*

*P.N. Prasad, Nanophotonics, John Wiley and Sons, 2004*

*John D. Joannopoulos, Robert D. Meade, Joshua N. Winn, Photonic Crystals, Princeton University Press Princeton, NJ, USA 2008.*

### **EC470 MIMO COMMUNICATION SYSTEMS**

**(3-1-0) 4**

Overview of fundamentals of Digital Communications, The Wireless Channel, Detection, Diversity and Channel Uncertainty, Capacity of Wireless channels, Spatial Multiplexing and Channel modelling, Capacity and Multiplexing architectures, Diversity-Multiplexing trade-off and Universal Space Time Codes, Multi-user Communication.

*D. Tse, Pramod Viswanath, Fundamentals of Wireless Communications, Cambridge University Press,*

*2005. E. Biglieri, Coding for Wireless Channels, Springer, 2007*

*E. Biglieri et al., MIMO Wireless Communications, Cambridge University Press, 2007.*

### **EC471 RF IC DESIGN**

**(3-1-0) 4**

Basic concepts in RF Design – harmonics, gain compression, desensitization, blocking, cross modulation, intermodulation, inter symbol interference, noise figure, Friis formula, sensitivity and dynamic range; Receiver architectures – heterodyne receivers, homodyne receivers, image-reject receivers, digital-IF receivers and subsampling receivers; Transmitter architectures – direct-conversion transmitters, two-step transmitters; Low noise amplifier (LNA) – general considerations, input matching, CMOS LNAs; Down conversion mixers – general considerations, spur-chart, CMOS mixers; Oscillators – Basic topologies, VCO, phase noise, CMOS LC oscillators; PLLs – Basic concepts, phase noise in PLLs, different architectures.

*Behzad Razavi, RF Microelectronics, Prentice Hall PTR, 1997*

*Thomas H. Lee, The design of CMOS radio -frequency integrated circuit, Cambridge University Press,*

*2006 Chris Bowick, RF Circuit Design, Newnes, 2007*

### **EC472 PRINCIPLES OF MODERN RADAR - ADVANCED TECHNIQUES**

**(3-1-0) 4**

Advanced Techniques in Modern Radar, Advanced Pulse Compression Waveform Modulations and Techniques, Optimal and Adaptive MIMO Waveform Design, MIMO Radar, Synthetic Aperture Radar, Array Processing and Interference, Mitigation Techniques, Human Detection With Radar: Dismount Detection, Advanced Processing Methods for Passive Bistatic Radar Systems

*Mark A Richards, Principles of modern radar(POMR)-Advanced Techniques(Vol-II), Scitech publishers,*

### **EC473 ELECTRONIC DEFENCE SYSTEMS**

**(3-1-0) 4**

Electronic Defence: Introduction, Systems in use in Armed forces; Sensors: Radar Sensors, Infrared sensors; Weapon systems: Artillery systems, missile systems; Electronic Intercept Systems: Introduction The Equation of a Passive System, Radar Warning Receivers; Electronic Countermeasures Systems Introduction, Operational Jamming Modes: SPJ, SOJ, and EJ, Onboard ECM Systems, .Electronic Counter-Countermeasures Systems: Introduction, Search Radar Counter-Countermeasures; New Electronic Defence Techniques and Technologies: Introduction, New Electronic Defence Architectures, ESM Antennas, Wideband Front End and Digital Receiver.

*Filippo Neri, Introduction to Electronic Defence Systems, Second Edition, Artech House, London,*

### **EC474 PRINCIPLES OF MODERN SONAR SYSTEMS**

**(3-1-0)4**

Sound: wave motion, sound pressure etc. Arrays: Need for projector arrays, Need for hydrophone arrays etc. Propagation of Sound in the Sea : Propagation loss, Losses: Spreading losses, Absorption losses. Target Strength: Definition, Formulae, Measurement, Dependence on pulse type and duration. Noise in Sonar Systems: Sources of noise, Thermal noise, Noise from the sea, Noise from a vessel. Reverberation: Sources of reverberation, Scattering and reflection; The Sonar Equations: What are they? What are their uses? The basic sonar equation, The basic passive equation; Passive Sonar: Radiated noise, Radiated noise: source level, nature of radiated noise. Active sonar: Pulse types, CW processing, FM processing, Active sonar equations.

*A. D. Waite, Sonar for practicing Engineers, 3rd edition, Wiley, 2002.*

*Principles of sonar performance modelling, Michel A Ainslie, Springer,2010.*

### **EC475 ADVANCED ELECTROMAGNETICS**

**(3-1-0) 4**

Circuit-field relationship, electrical properties of matter, review of wave propagation, polarization and reflection, EM Theorems, Dielectric waveguides, surface waves, leaky waves, artificial impedance surfaces, Electromagnetic scattering-cylindrical wave radiation by Infinite line source, planar surface wave scattering, circular cylinder and

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sphere scattering, volume scattering, particle scattering, Introduction to metamaterials-characterization and dispersion relations of left handed materials, EM problems solving Computational EM-differential and integral techniques-FDTD and Method of moments, Green's function technique-Series and closed forms, Identities, scalar Helmholtz equations, dyadic Greens function, Green's function for planar layered media.

*C. A. Balanis, Advanced Electromagnetics, Second edition, John Wiley & Sons, Inc., 2012. R.F. Harrington, Time Harmonic Electromagnetic Fields, IEEE Press, 1961(First published) Kong, J. A. Electromagnetic Wave Theory. Cambridge, MA: EMW Publishing, 2000.*

### **EC476 MILLIMETER WAVE COMMUNICATION (3-1-0) 4**

Millimeter wave characteristics and implementation challenges, radio wave propagation for mm wave, Millimeter wave generation and amplification, HEMT, transistor configurations, Analog mm wave components, Consumption factor theory, Trends and architectures for mm wave wireless, ADC's and DAC's, Modulation for millimeter wave communications, Millimeter wave link budget, Transceiver architecture, Massive MIMO Communications, Potential benefits for mm wave systems, Spatial, Temporal and Frequency diversity, Dynamic spatial, frequency and modulation allocation, Antenna beam width, polarization, advanced beam steering and beam forming, mm wave design consideration, On-chip and In package mm wave antennas, Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays, Device to Device communications over 5G systems, Design techniques of 5G mobile.

*K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.*

*Robert W. Heath, Robert C. Daniel, James N. T.S. Rappaport, Murdock, "Millimeter Wave Wireless Communications", PH, 2014.*

*Xiang, W.Zheng, K. Shen, X.S, "5G Mobile Communications", Springer, 2016.*

### **EC477 IMAGING, INFORMATICS AND COMPUTATIONAL PHYSICS (3-1-0) 4**

Physics of imaging, material structure, Imaging methods and modalities, computational aspects, theoretical and applied; modalities in medical imaging, geophysics, applied physics, biology, astronomy, remote sensing and optics; methods and applications in nuclear medical imaging physics and radiology, image guided radiotherapy; computational photography, inverse problems and reconstruction, image informatics; use of optimization, compressed sensing and pattern recognition and machine learning theory; applications of deep learning and artificial intelligence.

*Kedar Khare, Fourier Optics and Computational Imaging, Wiley, 2015.*

*H. K. Huang, PACS and Imaging Informatics: Basic Principles and Applications 2<sup>nd</sup> Edition, Wiley-Blackwell, 2010.*

*E. Russell Ritenour and William Hendee, Medical Imaging Physics, Wiley 2002.*

*B. H Brown, R. H Smallwood, D. C. Barber, P.V Lawford, D.R Hose, Medical Physics and Biomedical Engineering, CRC Press 1998*

*S Webb, The Physics of Medical Imaging, Institute of Physics, 1988.*

*Paul Suetens, Fundamentals of Medical Imaging, Cambridge University Press, 2009.*

*Thayalan K, The Physics of Radiology and Imaging, Jaypee Brothers 2014.*

*Tetsuo Asano, Geometry, Morphology and Computational Imaging, Springer 2002.*

<b>EC280</b>	<b>MINI PROJECT IN ELECTRICAL CIRCUITS &amp; SYSTEMS</b>	<b>(0-0-3) 2</b>
<b>EC281</b>	<b>MINI PROJECT IN DIGITAL SYSTEM DESIGN</b>	<b>(0-0-3) 2</b>
<b>EC380</b>	<b>MINI PROJECT IN COMMUNICATION SYSTEMS AND NETWORKS</b>	<b>(0-0-3) 2</b>
<b>EC381</b>	<b>MINI PROJECT IN MICROPROCESSOR &amp; EMBEDDED SYSTEM</b>	<b>(0-0-3) 2</b>
<b>EC382</b>	<b>MINI PROJECT IN ANALOG SYSTEM DESIGN</b>	<b>(0-0-3) 2</b>
<b>EC383</b>	<b>MINI PROJECT IN VLSI DESIGN</b>	<b>(0-0-3) 2</b>
<b>EC384</b>	<b>MINI PROJECT IN RF DESIGN</b>	<b>(0-0-3) 2</b>
<b>EC385</b>	<b>MINI PROJECT IN DIGITAL SIGNAL PROCESSING</b>	<b>(0-0-3) 2</b>

*The contents of these mini projects will be defined by the course instructor.*

### **COURSES FOR MINOR STREAM**

#### **EC391 ANALOG ELECTRONIC CIRCUITS (3-0-0) 3**

Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier models, concept of negative feedback and virtual short, Analysis of simple operational amplifier circuits, Frequency response of amplifiers, Bode plots. Feedback: Feedback topologies and analysis for discrete transistor amplifiers, stability of feedback circuits using Barkhausen criteria. Linear applications of operational amplifiers: Instrumentation and Isolation amplifiers, Current and voltage sources, Non-linear applications of operational amplifiers: Comparators,



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clippers and clampers, Precision rectifiers, Waveform Generation: Sinusoidal feedback oscillators, Relaxation oscillators, square-triangle oscillators. Practical operational amplifiers: Non-idealities and their on circuit performance. Analog and Digital interface circuits: Relays, S/H circuits, Opto-couplers, A/D, D/A Converters.  
*Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, Pearson, 2015*

### EC392 DIGITAL ELECTRONICS

(3-0-0) 3

Introduction to Boolean Algebra and Switching Functions, Boolean Minimization, Finite State Machines, Design of synchronous FSMs, FSM Minimization, Bipolar Logic Families – TTL, MOS logic families (NMOS and CMOS), and their electrical behaviour. Memory Elements, Timing circuits, Elementary combinational and sequential digital circuits: adders, comparators, shift registers, counters. Logic Implementation using Programmable Devices (ROM, PLA, FPGA).

*Morris. M. Mano, Michael D. Ciletti, Digital Design, Fourth Edition, Prentice-Hall India, 2008.*

*Charles. H. Roth, Jr., Fundamentals of Logic Design, Fifth Edition, Thomson Brooks/Cole, 2005.*

*J.F.Wakerly, Digital Design Principles and Practices, PH, 1999.*

*D.D. Givone, Digital Principles and Design, TMH, 2002*

### EC393 SIGNALS AND SYSTEMS

(3-0-0) 3

Sinusoids –complex exponentials and phasor, Spectrum representation – spectrum of sum of sinusoids, Periodic signals, Fourier series representation, synthesis. Sampling and aliasing – sampling of sinusoidal signals, aliasing, sampling theorem, reconstruction. Discrete time FIR systems – moving average filter, general FIR filter, impulse filter, implementation of FIR filters, LTI systems, convolution, frequency response of FIR systems. Z Transform: Definition and properties, ROC, inverse Z transform, transfer function, poles and zeros, application of Z transforms to discrete-time systems. Discrete time IIR systems – Impulse response, step response, representation of LTI systems, frequency response of IIR systems. Applications of DSP – Sinusoidal synthesis, Image denoising,

*Mc Chellan, R.W. Schafer & Yoder, Signal Processing First, Pearson 2003.*

*Sergio Franco, Design with OPAMPS and Linear Integrated circuits, Tata McGraw Hill, 2002.*

*Ron Mancini, Op Amp for Everyone, Texas Instruments, 2002*

### EC394 COMMUNICATION SYSTEMS

(3-0-0) 3

Amplitude Modulation, Time & Frequency domain description, Modulation techniques, Switching modulator, Demodulation techniques, Envelope detector, Coherent detection, Costas Receiver, The Superheterodyne Receiver, Quadrature Carrier Multiplexing, Single side band and vestigial sideband modulation, Frequency Translation, Frequency Division Multiplexing. Angle Modulation, Basic definitions, Frequency Modulation, Narrow Band FM, Wide Band FM, Transmission bandwidth of FM Signals, Generation of FM Signals, Demodulation of FM Signals, FM Stereo Multiplexing, Phase-Locked Loops and their application in FM demodulation. Theme example: FM stereo broadcast. Noise in Analog Modulation, Introduction, Receiver Model, Noise in DSB-SC receivers, Noise in AM receivers, Threshold effect, Noise in FM receivers, Capture effect, FM threshold effect, FM threshold reduction, Pre-emphasis and Deemphasis in FM. Digital Representation of analog signals, The Sampling process, Pulse Amplitude Modulation, Time Division Multiplexing, Pulse-Position Modulation, Generation of PPM Waves, Detection of PPM Waves, Quantization Process, Quantization Noise, Pulse Code Modulation: Sampling, Quantization, Encoding, Regeneration, Decoding, Filtering, Multiplexing, Application to Vocoders.

*M. F. Mesiya, "Contemporary Communication Systems", McGrawHill, 2013.*

*Steven W. Ellingson, "Radio Systems Engineering", Cambridge University Press, 2016.*

*Taub and Schilling, "Principles of Communication systems", Second Edition, Tata McGrawHill, 2006 Proakis and*

*Salehi, "Fundamentals of Communication Systems", Second Edition, Pearson International, 2014.*

*Simon Haykin, "Communication Systems", Fourth Edition, Wiley, 2000.*

### EC395 DATA COMMUNICATION AND NETWORKS

(3-0-0) 3

Data encoding and transmission concepts, Digital data transmission, NRZ encoding, Multilevel binary encoding, Biphasic encoding, Scrambling techniques, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), Phase Shift Keying (PSK), Performance of digital and analog modulation schemes, Quadrature Amplitude Modulation (QAM), Pulse Code Modulation, Non-linear encoding, Delta modulation, Asynchronous transmission, Synchronous transmission, Ethernet link layer frame example. Switching techniques, Multiplexing and Multiple Access techniques, Packet Switched Networks. OSI and TCP/IP Models, Internet protocols and addressing, networking devices, data links and transmission, LANs and Network of LANS, Wireless Networks and Mobile IP, Routing and internetworking, transport and end to end protocols, congestion control techniques, Application Layer and network management, Network Security. Packet Queues and delays, Little's theorem, Birth and death process, Queuing

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disciplines, M/M/1 Queues, Burkes and Jackson theorems. Traffic models, ISDN, ATM Networks, Quality of service and resource allocation, VPNs and MPLS, Cellular Telephone and Optical networks, VOIP and Multimedia networking. Mobile Adhoc Networks and Wireless Sensor Networks.

*Nader F. Mir, Computer and Communication Networks, Pearson Education, 2007*

*Garcia and Widjaja, Communication Networks, McGraw Hill, 2006*

*J.F. Hayes, Modelling and analysis of Computer Comm. Networks, Plenum, 1984.*

*Jean Walrand & Pravin Varaiya, High Performance Communication Networks, Morgan Kaufmann Publishers,*

*2002 Taub and Schilling, "Principles of Communication systems", Second Edition, Tata McGrawHill, 2006 Proakis and Salehi, "Fundamentals of Communication Systems", Second Edition, Pearson International, 2014.*

*Simon Haykin, "Communication Systems", Fourth Edition, Wiley, 2000.*

<b>EC390</b>	<b>SEMINAR</b>	<b>(0-0-2) 1</b>
<b>EC490</b>	<b>PRACTICAL TRAINING</b>	<b>(0-0-3) 2</b>
<b>EC498</b>	<b>MAJOR PROJECT</b>	<b>6</b>

**Department of Electrical and Electronics Engineering**

**EE110 ELEMENTS OF ELECTRICAL ENGINEERING**

**(2-0-0) 2**

Review of circuit elements, voltage sources, current sources, source transformation, mesh current and node voltage analysis of circuits. Network reduction techniques. Concept of the magnetic circuit. AC analysis of single-phase systems, wave forms, phasor representation, the j-operator, concepts of real and reactive power and power factor. Extension of AC analysis to symmetrical 3-phase systems, phase sequence, measurement of three-phase power under balanced condition. Introduction to transformers and Electro-mechanical energy conversion.

*Fitzgerald, D. E. Higginbotham, A. Grabel, Basic Electrical Engineering, 5th Edition, McGraw-Hill, 2009.*

*William H. Hayt Jr., Jack E. Kemmerly, Steven M. Durbin, Engineering Circuit Analysis, 6th Edition, TMH, 2002*

*Olle I. Elgerd, Basic Electric Power Engineering, Addison-Wesley, 1977. Edward Hughes, Electrical Technology, 7th Edition, Longman, 1995.*

**EE101 ANALYSIS OF ELECTRIC CIRCUITS**

**(3-1-0) 4**

Review of network geometry and network reduction techniques. Network theorems. Network variables, identification of the number of degrees of freedom, the concept of order of a system, establishing the equilibrium equations, network modeling based on energy-indicating (state) variables in the standard form, natural frequencies and natural response of a network. Introduction to system functions, inclusion of forcing functions, solution methodology to obtain complete solution in the time-domain – the vector-matrix approach. Analysis of network response (in the time-domain) for mathematically describable excitations. Solution strategy for periodic excitations. The phenomenon of resonance and its mathematical analysis. Sinusoidal steady state analysis. Introduction to three-phase systems. Magnetic circuit calculations.

*Ernst A. Guillemin, Introductory Circuit Theory, John Wiley and Sons, 1953.*

*Norman Balabanian and Theodore A. Bickart – Electrical Network Theory, John Wiley and Sons, Inc. 1969*

*Charles A. Desoer, Ernest S. Kuh, Basic Circuit Theory, McGraw-Hill, 1969.*

*Russell M. Kerchner, George F. Corcoran, Alternating Current Circuits, 4th Edition, Wiley Eastern, 1960.*

**EE207 ELECTROMAGNETIC THEORY**

**(3-1-0) 4**

Static electric and magnetic fields. E-fields, D-fields, potential fields & Laplace's equation. Time varying fields. Discussion of various laws like Ohm's, Kirchhoff's, Faraday's laws from the field theory point of view. Maxwell's equations. Concept of electromagnetic wave propagations, uniform plane wave. Introduction to computational methods in electromagnetics. Applications and analysis of few power engineering related problems.

*William Hayt Jr., Engineering electromagnetic, John A Buck, 8th Edtn. McGraw Hill Publication, 2012.*

*Mathew N O Sadiku, Elements of electromagnetic, 5th edtn, Oxford university press, 2010.*

*John D Kraus and Keith R Carver, Electromagnetics, 2nd Edtn, McGraw Hill Publication, 2012.*

*Julius Kdame Stratton, Electromagnetics, IEEE press, John Wiley and Sons inc publications, 1981.*

*Paul G Huray, Maxwell's equations, IEEE press, John Wiley and Sons inc publications, 2010*

**EE213 ELECTRICAL MACHINES-I**

**(3-1-3) 6**

Review of power network structures, principle of energy conversion. Transformers: Principle, construction (single-phase, three-phase), development of equivalent circuit through coupled circuit approach, phasor diagram, regulation, efficiency, autotransformers, vector groups and parallel operation of three-phase transformers, tap changers, phase conversion, energisation of transformer and harmonics. Induction machines: Principle, construction, classification, equivalent circuit, phasor diagram, characteristics, starting techniques, Introduction to Solid-state speed control, operation under unbalanced supply conditions and harmonics, effect of single-phasing, induction generator operation. Single-phase induction motor. Testing and diagnostic procedures for machines. Linear induction motor. Laboratory exercises and assignments to supplement the course.

*M. G. Say, Performance and design of A. C. Machines, CBS, 1983*

*D P Kothari, I J Nagrat, Electric Machines, 4th edition, TMH, 2010*

*A. E. Fitzgerald, Charles Kingsley, Jr., Stephan D. Umans, 6th edition, TMH, 2003 O I Elgerd, Patrick D, Electric Power Engineering, 2nd edition, Chapman & Hall, 1998.*

**EE224 ELECTRICAL MEASUREMENTS AND MEASURING INSTRUMENTS**

**(3-1-3) 6**

Review of units, standards, dimensional analysis. Measurement basics: significant figures, errors, calibration. Measuring instruments: Analog and digital-Concept of true rms, DVM, multimeter DMM, resolution, sensitivity. Oscilloscope: specifications, applications. Measurement of voltage, current, power, power factor, frequency and energy; Power analyzer. Extension of meter ranges: Shunts & multipliers, CTs and PTs. Measurement of low, high resistances and applications. Measurement of earth resistance, dissipation factor and dielectric strength. Basics of

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cable fault location. Transducers: Classification, strain gauge, RTD, pressure transducers, inductive LVDT, capacitive, thermocouple, piezo-electric. Photo-electric, Hall effect. Laboratory exercises and assignments to supplement the course.

*Golding and Widdis, Electrical Measurements and Measuring Instruments, Wheeler Publishing House, New Delhi 1979.*

*K. Sawhney, A Course in Electrical Measurement and Measuring Instruments, Dhanpat Rai and Sons, New Delhi 2007*

*M. B. Stout, Basic Electrical Measurements*

*C. T. Baldwin, Fundamentals of Electrical Measurement*

### EE226 ANALOG ELECTRONIC CIRCUITS

(3-1-3) 6

Terminal, switching and thermal characteristics of semiconductor devices, establishment of quiescent point, biasing considerations, load line concept, control of devices in switching and active zones, device cooling requirement. Introduction to usage of SPICE device models and simulation. Power amplifiers, feedback in amplifiers, filters, operational amplifiers: configurations, characteristics, applications. Sample and hold, A/D, D/A Converters. Multivibrators, voltage regulators, voltage controlled oscillators, phase locked loop. Laboratory exercises and assignments to supplement the course.

*Jacob Millman and A. Grabel, Microelectronics, Tata McGraw-Hill, 1999*

*Ramakant Gayakwad, Op-amps and Linear Integrated circuits, Pearson Education, 2007.*

*J. V. Wait, L. P. Huelsman and GA Korn, Introduction to Operational Amplifier theory and applications, 2nd Edition, McGraw Hill, New York, 1992.*

*P. Horowitz and W. Hill, The Art of Electronics, 2nd edition, Cambridge University Press, 1989.*

*A. S. Sedra and K. C. Smith, Microelectronic Circuits, Saunderson's College Publishing, 4th Edition.*

### EE229 POLYPHASE SYSTEMS AND COMPONENT-TRANSFORMATIONS

(3-1-0) 4

Balanced poly-phase circuits: Generation of poly-phase voltages, Phase sequence, three-phase 3-wire and 4-wire systems, wye and delta connections, n -phase star and mesh, power calculations in balanced systems, harmonics in wye- and delta-systems. Unbalanced poly-phase circuits: unbalanced loads, wye-wye system with and without neutral connections, neutral shift, wye-delta system, phase-sequence effects, extensions to non-sinusoidal behaviour. Introduction to symmetrical components: A brief historical review, application of the method. Calculation of unbalance faults. Multiphase systems: Resolution of multiphase systems into symmetrical components, 2-phase and 4-phase systems, Irregular systems.

*Edith Clarke, Circuit Analysis of AC Power Systems – Volumes I and II, John Wiley and Sons, 1950.*

*C. F. Wagner, R. D. Evans. Symmetrical Components, McGraw-Hill, 1933.*

*J. L. Blackburn, Symmetrical Components for Power System Engineering, Marcel-Dekker, 1993.*

### EE230 ELECTRIC CIRCUITS

(3-1-0) 4

Review of network geometry and network reduction techniques. Network theorems. Network variables, identification of the number of degrees of freedom, the concept of order of a system, establishing the equilibrium equations, network modeling based on energy-indicating (state) variables in the standard form, natural frequencies and natural response of a network. Introduction to system functions, inclusion of forcing functions, solution methodology to obtain complete solution in the time-domain - the vector-matrix approach. Analysis of network response (in the time-domain) for mathematically describable excitations. Solution strategy for periodic excitations. The phenomenon of resonance and its mathematical analysis. Sinusoidal steady state analysis. . Introduction to three-phase systems. Magnetic circuit calculations.

*Ernst A. Guillemin, Introductory Circuit Theory, John Wiley and Sons, 1953.*

*Charles A. Desoer, Ernest S. Kuh, Basic Circuit Theory, McGraw-Hill, 1969.*

*Russell M. Kerchner, George F. Corcoran, Alternating Current Circuits, 4 th Edition, Wiley Eastern, 1960.*

### EE143 MATHEMATICS FOR ELECTRICAL ENGINEERS

(3-1-0) 4

Linear Systems: Systems of linear equations and their solution sets. Matrix Algebra: Matrix Operations, Determinants, Properties of Determinants and Linear transformations. Vector Spaces; Linear Maps, Isomorphism and Norms on vector spaces. Eigen Functions: Eigen Values, Eigen Vectors. Orthogonality and Orthogonal spaces.

Integral Transforms: Laplace transforms of elementary functions, Inverse Laplace transforms and applications, Fourier series, Fourier transforms, Fourier cosine and sine integrals, Dirichlet integral, Inverse Fourier transforms

*David C. Lay, Linear Algebra and Its Applications, Third Edition, Pearson*

*Gilbert Strang, Linear Algebra and Its Applications, Fourth Edition, Academic Press, Cengage*

*Learning Kenneth Hoffmann and Ray Kunze, Linear Algebra,, Prentice Hall India*

*R. A. Horn and C. R. Johnson, Matrix Analysis, Cambridge University Press.*

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*Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Eastern.*

*Larry C. Andrews, Bhimsen K. Shivamoggi, Integral Transforms for Engineers, PHI*

*Ronald N Bracewell, The Fourier transform and its applications. McGraw-Hill;*

### EE253 COMMUTATOR MACHINES

(3-1-0) 4

Constructional details, commutator action analysis, windings, mmf production, limitations, special features, fields of application, fault detection and general maintenance, preliminary design.

*E. Openshaw Taylor, The Performance and Design of AC Commutator Machines.*

*Fitzgerald, Kingsley, Kusko. Electromechanical Energy Conversion.*

*Atkinson, Generalized Machine Theory.*

### EE255 INTRODUCTION TO ALGORITHMS AND DATA STRUCTURES

(3-1-0) 4

Mathematical basis and notions for algorithm analysis. Sorting, divide and conquer, linear time sorting, elementary data structures, priority queues, BST and RBT. Design and analysis. Paradigms – Dynamic programming, Greedy algorithms, Graph algorithms.

*T. H. Cormen, C. E. Leiserson, R. L. Rivest, C. Stein, Introduction to Algorithms, 2<sup>nd</sup> Edition, PHI, 2004.*

*D. E. Knuth, The Art of Computer Programming, Volumes I and III, Addison-Wesley, 1973.*

*Anany Levitin, Introduction to the Design and Analysis of Algorithms, Pearson Education, 2003.*

### EE256 SIGNALS AND SYSTEMS

(3-1-3) 6

Signals and Systems – Classification, time-domain analysis of continuous-time and discrete-time systems, continuous-time system analysis using the Laplace transform, discrete-time system analysis using the z-transform. Fourier series, Fourier transform, sampling, applications. Laboratory exercises and assignments to supplement the course.

*B. P. Lathi, Linear Systems and Signals, 2<sup>nd</sup> Edition, Oxford University Press, 2005.*

*Simon Haykin, Barry Van Veen, Signals and Systems, John Wiley Asia, 2003.*

*A. V. Oppenheim, A. S. Willsky, S. H. Nawab, Signals and Systems, 2<sup>nd</sup> Edition, Prentice-Hall Signal Processing Series, 1997.*

### EE258 ELECTRICAL MACHINES-II

(3-1-3) 6

Synchronous machines: Construction, prime-mover and excitation control systems. Steady state characteristics, handling of harmonics, voltage regulation calculations for salient and non salient pole machines, parallel operation, load sharing and associated capacity curves, load-generation balance. Dynamic characteristics, Park transformation, simplified generator models, electromechanical oscillations, concept of power system stability. Introduction to Synchronous motors and condensers, Permanent magnet synchronous motors, Switched reluctance motors. DC Machines: Construction, classification, emf and torque equations, characteristics of DC motors, speed control – Solid-state techniques. Introduction to brushless DC motor, stepper motor, servomotor. Laboratory exercises and assignments to supplement the course.

*M. G. Say, Performance and Design of Alternating Current Machines, CBS, 1983.*

*Fitzgerald, Kingsley, Umans, Electric Machinery, 5<sup>th</sup> Edition, McGraw-Hill, 1992*

*Arthur R. Bergen, and Vijay Vittal, Power System Analysis, 1st Edition, Pearson Education Asia, 2001.*

### EE260 DIGITAL COMPUTER ORGANIZATION AND ARCHITECTURE

(3-1-0) 4

Evolution of computers, instruction set design, processor design: functional unit design, micro-programmed and hardwired approaches, different architectures, control unit design, memory organization, input-output organization, introduction to system software, operating system basics.

*J. P. Hayes, Computer Architecture and Organisation, 2<sup>nd</sup> Edition, McGraw-Hill, 1988.*

*M. Rafiquzzaman, Rajan Chandra, Modern Computer Architecture, Galgotia, 1999.*

### EE261 BASIC ELECTRIC MACHINES

(3-1-0) 4

Review of power network structures, principle of energy conversion. Transformers: Principle, construction, development of equivalent circuit through coupled circuit approach, phasor diagram, regulation, efficiency, autotransformers. Induction machines: Principle, construction, classification, equivalent circuit, phasor diagram, characteristics, starting techniques, speed control, effect of single-phasing. Single-phase induction motor. DC Machines : Construction, classification, emf and torque equations, characteristics of DC motors, speed control, brushless DC motor. Stepper motor: Construction, principle of operation and control. Synchronous machines: Construction, prime-mover and excitation control systems. Steady state characteristics, voltage regulation calculations by synchronous impedance method. Synchronous motors and condensers, Permanent magnet synchronous motors, Switched reluctance motors.

*M. G. Say, Performance and Design of Alternating Current Machines, CBS, 1983.*

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*Fitzgerald, Kingsley, Umans, Electric Machinery, 5<sup>th</sup> Edition, McGraw-Hill, 1992*

*Arthur R. Bergen, and Vijay Vittal, Power System Analysis, 1<sup>st</sup> Edition, Pearson Education Asia, 2001.*

*N. N. Parker Smith, Problems in Electrical Engineering, CBS Publications*

### **EE265 POWER SYSTEM ENGINEERING – I**

**(3-1-0) 4**

Electrical energy sources, power network structure and its components. AC, AC-DC, and DG- based systems, forms of field energy, concepts of real and reactive powers and their conventions, per unit representation, single-line diagram representation, impedance diagram. Analysis of system transients: time-range of transients, traveling waves, low frequency transients. Transmission lines: Design, modeling and performance analysis. Cables, insulators, grounding and safety. power generation and demand management – load factor, diversity factor etc., tariff structure.

*Olle I. Elgerd, Electric Energy Systems Theory – An Introduction, TMH, 1982.*

*W. D. Stevenson Jr. , Elements of Power System Analysis, McGraw-Hill, 1968.*

*Arthur R. Bergen, and Vijay Vittal, Power System Analysis, Pearson Education Asia, 2001.*

*I. J. Nagrath, D. P. Kothari, Power System Engineering, TMH.*

### **EE276 DIGITAL ELECTRONIC CIRCUITS**

**(3-1-3) 6**

Logic families: TTL, ECL, NMOS, CMOS. Number systems, logic gates, boolean algebra, Karnaugh map. Combinational logic circuits: adders, subtractors, multiplexers, de-multiplexers, encoders, decoders, line drivers. Sequential logic circuits: latches and flip flops, registers and counters. Design of following finite state sequential machines using D flip-flops: Sequential code converters, sequence detectors, sequence generators and system controllers. Memories: read only and read/write memories, programming EPROM and flash. Laboratory exercises and assignments to supplement the course.

*M. Mano, "Digital Design", 3<sup>rd</sup> Ed. , Prentice Hall, India.*

*D. D. Givone, "Digital Principles and Design", Tata McGraw Hill.*

*J. F. Wakerly, "Digital Design Principles and Practices", Practice Hall.*

*R. J. Tocci, "Digital Systems Principles and Applications", Prentice Hall*

*Charles H Roth: Digital Systems Design using VHDL, Thomson Learning, 1998*

### **EE281 COMMUTATOR MACHINES LABORATORY**

**(0-0-3) 2**

Laboratory exercises and assignments to provide additional support to EE253.

### **EE295 ELECTRICAL MACHINE WINDING CALCULATIONS-I**

**(0-2-3)4**

An exposition of the magnetic and electric circuits of commutator-wound machines. Exercises involving: the geometrical layout of the armature windings, brush placement, interpoles, equalizing rings. Detailing of the process of commutation and of armature reaction. Calculations in respect of winding design and of estimation of machine parameters from design data.

*Clayton A. E. , Hancock N. N. , "The Performance and Design of Direct Current Machines", 3<sup>rd</sup> Edition, Oxford & IBH, 1986 (Indian Reprint).*

*Taylor O. E. , "The Performance and Design of AC Commutator Motors", A. H. Wheeler & Co. , 1988 (Indian Reprint).*

### **EE296 ELECTRICAL MACHINE WINDING CALCULATIONS-2**

**(0-2-3)4**

An exposition of the magnetic and electric circuits of open-wound (AC) machines. Salient- and non-salient-pole windings. Exercises involving: the geometrical layout of armature windings, armature reaction, harmonics and their quantification, cage rotor, and damper windings. Estimation of machine parameters from design data.

*Say M. G. , "The Performance and Design of Alternating Current Machines", 3<sup>rd</sup> Edition, CBS, 1983 (Indian Reprint).*

*Langsdorf A. S. , "Theory of Alternating Current Machinery", 2<sup>nd</sup> Edition, Tata McGraw-Hill, 1974.*

### **EE298 ELEMENTS OF ANALOG AND DIGITAL COMMUNICATION**

**(3-1-0) 4**

Introduction to analog and digital communication: Bandwidth and information capacity, transmission modes, signal analysis, noise considerations. Modulation and demodulation concepts: AM, FM, PM, TDM and FDM concepts. Classification of amplifiers (Class A, B, and C), tuned amplifiers, oscillators, amplitude modulation, demodulation circuits, mixer, TRF, superheterodyne and direct conversion receivers. Monochrome TV transmitter and receivers. Digital and data communication: Sampling theorem, coding and decoding, pulse modulation, FSK, PSK, Modem. Serial and parallel interface: Computer network configurations and protocols, OSI reference model, internet protocol, packet switching. Satellite communications, orbital patterns, geostationary satellites, frequency band allocation. Optical fibre communication: Mode of signal transmission, signal sources and detectors, attenuators and channel capacity. Digital telephony, PSTN and cellular telephony.

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Wayne Tomasi, *Electronic Communication Systems*, 4<sup>th</sup> Edition, Pearson Education, 2002.

Kennedy, *Communication Systems*, 4<sup>th</sup> edition.

Gary Miller, *Modern Electronic Communication*, 7<sup>th</sup> Edition.

Andrew S. Tanenbaum, *Computer Networks*, 3<sup>rd</sup> Edition.

William C. Y. Lee, *Mobile Cellular Telecommunication*, 2<sup>nd</sup> Edition.

### EE303 DISTRIBUTION SYSTEMS PLANNING AND CONTROL

(3-1-0) 4

Distribution systems, their importance in energy transfer, distribution loss minimization techniques, radial and ring system, voltage regulation, reconfiguration, capacitor placement, power flow analysis, sizing of conductors and transformers, fault analysis, data acquisition and control, remote reading of energy meter, role of computers in distribution system operation, state of the art.

T. M. Gonen, *Electrical Energy Distribution*. C.

L. Wadhwa, *Electrical Energy Distribution*.

Recent publication in reputed journals and conference proceedings of relevance.

### EE308 POWER ELECTRONICS

(3-1-0) 4

Devices: Characteristics- diode, BJT, IGBT, MOSFET, IPMs, Thyristor based devices: SCRs/TRIAC/GTOs. Reactive elements: capacitors, inductor, transformer, pulse transformer. Data sheets, switching and conduction losses, heat dissipation- heat sink, loss calculation. Drive circuit, current and voltage sensors, opto-couplers. Functional classification of converters: DC-DC converters - switched mode buck converter, switched mode boost converter: control circuit, snubber, applications. Inverters: H-Bridge, single-phase, three-phase inverters. Rectifiers: single-phase and three-phase rectifiers. AC power controllers. Simulations of power electronic converters.

Ned Mohan, Undeland, Robbins, *Power Electronics*, 3rd edition, John Wiley.

M H Rashid, *Power Electronics*, 3rd edition, PHI.

P C Sen, *Power Electronics*, Tata McGraw-Hill Publishing Company Ltd.

Bimal K Bose, *Modern power electronics and ac drives*, PHI.

L Umanand, *Power Electronics*, Wiley India Pvt Ltd

### EE310 ELECTRIC POWER SYSTEM

(3-1-0) 4

Electrical energy sources, power network structure and its components. per unit representation, single-line diagram representation. AC, AC-DC, and DG- based systems, forms of field energy, concepts of real and reactive powers and their conventions. Power system operation and control: State of operation of a power system, voltage and frequency control mechanisms, power generation, Introduction to tariff structure. Transmission lines: Design, modeling and performance analysis. Cables, insulators, grounding and safety. System modeling. Steady state analysis: power flow – NR Method. balanced and unbalanced short circuit analysis. Stability analysis: Classification, rotor angle stability of SMIB -- solution method using equal-area criteria.

Olle I. Elgerd, *Electric Energy Systems Theory – An Introduction*, TMH, 1982.

Arthur R. Bergen, and Vijay Vittal, *Power System Analysis*, Pearson Education Asia, 2001.

I. J. Nagrath, D. P. Kothari, *Power System Engineering*, TMH.

John J. Grainger and W. D. Stevenson, *Power Systems Analysis*, McGraw-Hill, 1994

### EE311 DIGITAL SYSTEM DESIGN

(3-1-0) 4

Review of combinational logic design using PLD, design of synchronous sequential logic systems, introduction to VHDL, design of system controllers, design of systems using PLD / FPGA, fundamentals of data converters.

C. H. Roth, *Digital System Design*, PWS, 1998.

J. F. Wakerly, *Digital Design*, PHI, 3rd Edition. , 2001

W. Fletcher, *An Engineering Approach to Digital Design*, PHI.

M. J. Sebastian Smith, *Application Specific Integrated Circuits*, Addison-Wesley, 1999.

### EE312 POWER SYSTEM HARMONICS

(3-1-0) 4

Harmonic Sources: Power electronic converters, transformers, rotating machines, arc furnaces, fluorescent lighting. Harmonic effects within power system- resonances, harmonic torques, static power plant, control systems, power system protection, consumer equipment, measurements, and on power factor. Harmonic effects related to communication interference: telephone circuit susceptibility, harmonic weights, I-T and kV-T products, shielding. Harmonic effects related to biological effects. Power theory, single and three-phase, non -sinusoidal conditions, Fryez and Budeno's methods. Power quality parameters. Transducers and data transmission, Hall effect voltage and current sensors. Harmonic mitigation techniques: passive filters, active filters. Algorithms for extraction of harmonic current in the line.

J. Arrillaga, *Power System Harmonics*, IEE Press.

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*G. T. Heydt, Power Quality, Stars in a Circle, 1991.*

*M. G. Say, Alternating Current Machines, ELBS.*

### EE313 DIGITAL SIGNAL PROCESSING

(3-1-0) 4

Review of FT, DTFT, DFT. Circular Convolution, DFT computation methods: Radix FFTs: Decimation in time and Decimation in frequency FFT, DCT. IIR Filters: Analog filters: properties and design of Butterworth, Chebychev and Elliptical filters. Frequency transformation. Review of Z-transform and its properties. Structure of digital filters. Methods of converting analog filters to digital filter (IIR): bilinear transformation, pole-zero mapping, Impulse invariant transformation. Methods of designing the FIR filters: window- based methods, frequency sampling method. Introduction to the programmed digital systems. General architecture of Digital Signal Processors, programming of the TMS320F243, application of DFT for linear filtering.

*John G. Proakis, D. G. Manolakis, Digital Signal Processing.*

*Ashok Ambardar, Analog and Digital Signal Processing.*

*L. R. Rabiner, B. Gold, Theory and Applications of Digital Signal Processing, PHI, 1975*

*Richard G. Lyons, Understanding Digital Signal Processing.*

*Roman Kuc, Introduction to Digital Signal Processing.*

### EE319 NEURAL NETWORKS AND APPLICATIONS

(3-1-0) 4

Introduction: Biological neuron, Mc-Culloch -Pitts neuron model. Various threshold functions, Feature vectors and feature space. Classification techniques – nearest neighbor classification. Distance metrics, linear classifiers, decision regions. The single layer and multilayer perception, multilayer perceptron algorithm, solution of the XOR problem, visualizing the network behaviour in terms of energy functions, Mexican hat function. Learning in neural networks, linearly non-separable pattern classification, delta learning rule. Error back-propagation training algorithms, Feedback networks - Hopfield network, energy landscape, storing patterns, recall phase, Boltzmann machine, traveling salesman problem. Associative memories, retrieval and storage algorithm, stability considerations. Application of neural systems - linear programming, modeling networks, character recognition, control system applications, robotic applications.

*R. Beale, T. Jackson, Neural Computing: An Introduction, IOP Publishing Ltd. , 1990.*

*Jack H. Zaruda, Introduction to Artificial Neural Systems, Jaico Publications.*

### EE320 ELECTRICAL SAFETY, OPERATIONS, REGULATIONS

(3-0-0) 3

Electrical safety: Safety of the self. Safety of the equipments, Safety of the public. PPE. General guidelines on earthing and protection. Operations: Sign boards, tagging system and procedures. Safe operating procedures, case studies and, safety audit basics. Regulations: IS, IEEE standards, Indian Electricity rules and regulations.

*HSC- A Practical guide VOL. 1 to 4, National Safety Council, India.*

*IS 5216 (Part I)- 1982, "Recommendations on safety procedures and practices in electric work".*

*SP 30 -1985 Special publication-National Electric Code, "Section-14: Electric Aspects of building services".*

*IEEE Standard 902.*

### EE321 LINEAR AND NONLINEAR SYSTEMS

(3-1-0) 4

Characteristics of linear systems, modeling and analysis of linear time-invariant systems using state-space approach, analysis of linear time-variant systems. Characteristics of nonlinear systems, common types of nonlinearities, phase-plane analysis, describing function analysis.

*Thomas Kailath, Linear Systems, Prentice-Hall, 1980.*

*K. Ogata, State-Space Analysis of Control Systems, Prentice-Hall, 1967. John E. Gibson, Non linear Automatic Control, McGraw-Hill, 1963.*

### EE324 ELECTRONIC MEASUREMENTS AND INSTRUMENTATION

(3-1-0) 4

Measurement systems, electromechanical instruments, bridges, electronic instrumentation, oscilloscopes, signal analysis, frequency, time interval measurements, physical parameter measurements, transducers, data acquisition systems.

*B. H. Oliver, J. M. Cage, Electronic Measurements and Instrumentation, McGraw-Hill, 1975*

*Albert D. Helfrick, William D. Cooper, Modern Electronic Instrumentation and Measurement Techniques, PHI.*

### EE326 LINEAR CONTROL THEORY

(3-1-0) 4

Introduction, classification, mathematical modeling of physical systems, transient response analysis, design specifications and performance indices, concept of stability and algebraic criteria, Root locus analysis, frequency response analysis, Bode diagrams, polar plots, Nyquist plots, stability in the frequency domain, basic control actions



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and response of control systems. Introduction to control system design using the root locus and frequency-domain approach. Introduction to state space approach to modeling of dynamic system, canonical forms, concept of controllability, observability, design by state-feedback.

*K. Ogata, Modern Control Engineering, 5<sup>th</sup> Edition, PHI.*

*Richard C Dorf, Modern Control Systems, 12<sup>th</sup> Edition, Pearson Education India.*

*I. J. Nagrath, M. Gopal, Control Systems Engineering, 6th Edition, New Age International.*

### EE328 NETWORK SYNTHESIS

(3-1-0) 4

Review of mathematics for network synthesis Partial -fraction expansion, Continued – fraction expansion, Bilinear transformation. The positive real concept - Hurwitz polynomials, analytic tests for positive real functions, positive -- definite and positive -- semi -- definite quadratic forms. Realizability conditions for networks with and without transformers (magnetic coupling) Realization of driving -- point functions -- Canonical forms – LC, RC, and RL driving -point functions.

*Louis Weinberg, Network Analysis and Synthesis, McGraw – Hill, New York, 1962 M. E.*

*Van Valkenburg, Modern Network Synthesis, Prentice – Hall, New Jersey*

### EE329 TRAVELING WAVES ON TRANSMISSION SYSTEMS

(3-1-0) 4

Introduction to the line equations. Attenuation and distortion of traveling waves. Reflection of traveling waves. Successive reflections: The reflection lattice, construction and use of the lattice-diagram, Charging of a line from various sources, Reflection between a capacitor and a resistor, effect of short lengths of cable, effect of insulator capacitance. Traveling waves on multi conductor systems. Theory of ground-wires: Direct stroke to a tower, effect of reflections up and down the tower, tower grounding. The counterpoise: Multi velocity waves on the counterpoise, tests on the counterpoise, successive reflections on the insulated counterpoise. Induced lightning surges: The field gradient, induced surges with ideal ground wires. Arcing grounds: Normal frequency arc extinction – single-phase and three-phase, oscillatory- frequency arc extinction, high-frequency effects, interruption of line-charging currents, cancellation waves, initiated waves, steady-state waves, recovery voltage, restriking phenomena.

*L. V. Bewley, Traveling Waves on Transmission Systems, John Wiley and Sons, 1951.*

*H. H. Skilling, Electric Transmission Lines, McGraw-Hill, 1951.*

*L. F. Woodruff, Principles of Electric Power Transmission, John Wiley and Sons, 1952 .*

### EE331 DISTRIBUTION SYSTEMS LABORATORY

(0-0-3) 2

Laboratory exercises and assignments to provide additional support to EE303.

### EE334 POWER ELECTRONICS LABORATORY

(0-0-3) 2

Laboratory exercises and assignments to provide additional support to EE308.

### EE335 DIGITAL SYSTEM DESIGN LABORATORY

(0-0-3) 2

VHDL / Verilog programming, design exercises on ECAD software, hardware realization on FPGA / CPLDs, to provide additional support to EE311.

### EE337 POWER SYSTEM HARMONICS LABORATORY

(0-0-3) 2

Laboratory Exercises and assignments to provide additional support to EE312. Experiments around MATLAB®, PSCAD®, OrCAD™ and laboratory measurement exercises.

### EE342 ELECTRONIC MEASUREMENTS LABORATORY

(0-0-3) 2

Laboratory exercises and assignments to additional support to EE324.

### EE343 STATISTICAL FOUNDATION FOR ELECTRICAL ENGINEERS

(3-1-0) 4

Probability: Axioms, Sample spaces (continuous & discrete), Density, Distribution and Mass functions and their applications. Random Variable: Single, Multiple, Continuous and Discrete, statistical operations and limit theorems. General Distributions and their practical significance. Functions of random variables: Probability distribution functions of functions of random variables. Random Process: Concept, Classification, Temporal and Spectral characterization, and Statistical Estimation: Estimation of variables, Estimation of parameters. Testing of hypothesis. Analysis of linear systems to Random signals and optimum linear systems, and Optimum Wiener Solutions.

*Davenport W. B Jr, Probability and Random Process, An Introduction for Applied Scientists and Engineers, McGraw-Hill.*

*Peyton Z. Peebles JR, Probability, Random Variables & Random Signal Principles, 4<sup>th</sup> Edition, McGraw-Hill.*

*Leon-Garcia, Probability and Random Process for Electrical Engineering, Addition-Wesley.*

*Viniotis Y, Probability and Random Process for Electrical Engineers, McGraw-Hill.*

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*Papoulis A, Probability, Random Variables and Stochastic Processes, McGraw-Hill.*

*Mayer P. L. , Introductory Probability and Statistical applications, Second Edition, Oxford and IBH publishing Co. Pvt. Ltd. , New Delhi.*

### **EE347 DESIGN AND DEVELOPMENT TASK IN CONTROL SYSTEMS**

**(0-0-3)2**

Analog and Digital controller design and implementation for specific problems. Stability analysis, performance comparison, and optimal controller. Simulation and implementation issues.

### **EE348 DESIGN & DEVELOPMENT TASK IN POWER ELECTRONICS AND DRIVES**

**(0-0-3)2**

Design of a specified power electronics converter. Simulation and implementation of some algorithms for power electronics controller applications.

### **EE350 POWER SYSTEM ENGINEERING – II**

**(3-1-0) 4**

Review of modeling of power system components: transmission lines, transformers, synchronous machines, loads etc.. System modeling. Steady state analysis: power flow methods. Balanced and unbalanced short circuit analysis. Stability analysis: Classification, rotor angle stability of SMIB -- solution method using equal-area criteria.

*John J. Grainger and W. D. Stevenson, Power Systems Analysis, McGraw-Hill, 1994*

*P. Kundur, Power System Stability and Control, McGraw-Hill, 1994.*

*Olle I. Elgerd, Electric Energy Systems Theory- An introduction, TMH, 1982*

*P. W. Sauer and M. A. Pai, Power System Dynamics and Stability, Prentice Hall, Upper Saddle River, New Jersey, 1998.*

### **EE359 ENERGY AUDITING**

**(3-1-0) 4**

Introduction to energy audit. Purpose, methodology, case studies of few selected industries, analysis of results and inference, standards, instruments used in energy auditing.

*Shirley J. Hansen, James W. Brown, Jim Hansen, Investment Grade Energy Audit, Marcel Dekker, 2003.*

*Donald R. Wulfinhoff, Energy Efficiency Manual, Energy Institute Press.*

### **EE360 MICROPROCESSORS**

**(3-1-0) 4**

Basics of finite state machines, Von Neumann Architecture, functional blocks of a microcomputer, architecture of 8-bit/16-bit Microprocessors/Microcontrollers [viz. Intel 8051 family, MOTOROLA 68HXX, ARM Core etc. ]. Programmers' model of any one microprocessor/microcontroller chosen for detailed study, instruction set, chip configuration and programming, use of development and debug tools, interface applications. Laboratory exercises.

*Intel Corporation, 8-bit Microcontroller Handbook, Intel Corporation, 1990.*

*ARM® Core Processor Hand book.*

*John B. Peatman, Design with Microcontrollers, McGraw-Hill, 1995.*

*Andrew N. Sloss, Dominic Symes, Chris Wright, John Rayfield, ARM System Developer's Guide, Designing and Optimizing System Software, Elsevier, 2004.*

### **EE361 POWER SYSTEM COMMUNICATIONS**

**(3-1-0) 4**

The Electric power supply and its properties, historic development of data communication over power lines, The European CENELEC standard EN50065, channel characteristics, coupling and measuring techniques at high frequencies for PLC, estimating power line channel capacity, EMC problems and solutions, modulation schemes for PLC, communication over the electric power distribution grid.

*Klaus Dostert, Franzis Verlag, Power Line Communications, PHI.*

### **EE362 OPERATION AND CONTROL OF POWER SYSTEMS**

**(3-1-0) 4**

Economic operation of power systems: Economic load dispatch, unit commitment. Load frequency control: Modeling of components of generating systems, concept of coherent units, operation of single area. Introduction to multi-area systems. Sources of reactive power. Introduction to contingency analysis. State estimation: Importance of state estimation, DC state estimation. Energy interchange evaluation.

*O. I. Elgerd, Electric Energy Systems Theory: An Introduction, McGraw-Hill, 1971.*

*I. J. Nagrath, D. P. Kothari, Modern Power System Analysis, TMH.*

*S. S. Rao, Optimisation Theory and Applications.*

*Allen J. Wood, Bruce F. Wollenberg, Power Generation Operation and Control, 2<sup>nd</sup> Edition, John Wiley and Sons, 1996.*

### **EE363 ADVANCED DIGITAL SIGNAL PROCESSING**

**(3-1-0) 4**

Time frequency analysis, time frequency distribution, short time Fourier transform. Multirate signal processing:

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Decimation interpolation, DFT filter banks, QMF filter banks. Multiresolution signal analysis. Wavelets theory of sub band decompositions, sub band coding and wavelet transforms, application of wavelet transforms. Homomorphic signal processing : Homomorphic system for convolution, properties of complex spectrum, applications of homomorphic deconvolution. Multi-dimensional signal processing : Review of convolution and correlation. 2-D signals. Linear estimation of signals and applications: Random signals, linear prediction and applications (deconvolution, least square filters). Recursive estimation and Kalman filters. Adaptive signal processing: Adaptive filters and applications.

*P. P. Vaidyanathan, Multirate Systems and Filter Banks, PH, 1993.*

*S. J. Orfanidis, Optimum Signal Processing, McGraw-Hill, 1989.*

*John G. Proakis, D. P. Manolakis, Introduction to DSP, Pearson, 2002.*

*E. C. Ifeachor, B. W. Jervis, Digital Signal Processing: A Practical Approach, Pearson Education.*

### EE366 SPECIAL MACHINES AND DRIVES

(3-1-0) 4

Method of control and application of brushless DC motor, PMSM, stepper motor, AC servomotor, universal motor. Electric drive, motor rating, heating effects, electric braking, modification of speed- torque characteristic of an induction motor by V/f control, starting and braking. Synchronous motor --Speed torque and torque angle characteristics by V/f control, braking.

*G. K. Dubey, Fundamentals of Electrical Drives, Narosa.*

*A . E. Fitzgerald, C. Kingsley, S. D Umans, Electric Machinery, McGraw-Hill.*

*S. K. Pillai, A First Course on Electric Drives, Wiley Eastern, 1990.*

### EE369 EMBEDDED SYSTEM DESIGN

(3-1-0) 4

Embedded controllers, basic requirements, design of embedded systems, system on chip concept. VLSI CAD application. Case study: DSP/microprocessor based or FPGA based system design.

*Charles H. Roth, Digital System Design using VHDL, PWS, 1998.*

*User manuals of Microprocessor /DSPs*

### EE370 ELECTRICAL AND ELECTRONICS MEASURING INSTRUMENTS AND TECHNIQUES (3 -1-0)4

Review of units, standards, dimensional analysis. Measurement basics: accuracy, precision, significant figures, errors (quantification and analysis), calibration. Measuring instruments: Analog and digital, Concept of true rms, DVM, multi-meter DMM, resolution, sensitivity. Oscilloscope: specifications, applications. Measurement of voltage, current, frequency, impedance, harmonics, power, power factor, and energy. Extension of meter ranges: Shunts & multipliers, CTs and PTs. Measurement of R, L, C and applications. Indicating, recording and integrating type of instruments. Measurement of non-electrical quantities (Displacement, Pressure, Temperature, Strain, Acoustic, flow and Photo measurement etc. ) and instrumentation. Basics of transducers.

*Golding and Widdis, 'Electrical Measurements and Measuring Instruments', Wheeler Publishing House, New Delhi 1979.*

*K. Sawhney, 'A Course in Electrical Measurement and Measuring Instruments', Dhanpat Rai and Sons, New Delhi 2007*

*M. B. Stout, 'Basic Electrical Measurements'*

*C. T. Baldwin, 'Fundamentals of Electrical Measurement'*

*B. S. Sonde, 'Transducers and Display Systems', Published by McGraw-Hill Inc. ,US, 1978.*

### EE371 POWER ELECTRONICS APPLICATIONS TO POWER SYSTEMS

(3-1-0) 4

HVDC systems: Classical HVDC systems, CCC systems, HVDC Light systems. Application of FACTS devices such as SVC, TCSC, SSS, UPFC to improve steady state and dynamic behaviour of power systems. Modeling of HVDC systems and FACTS devices to perform system studies.

*N. G. Hingorani, L. Gyugi, Understanding FACTS, IEEE Press, 2001.*

*P. Kundur, Power System Stability and Control, McGraw-Hill, 1994.*

### EE373 ELECTRIC POWER STATIONS

(3-1-0) 4

Choice of site for power plants. Thermal power plant: General layout, air and flue-gas circuit, fuel and ash handling circuit, cooling water circuit, steam and feed water circuit. Nuclear power plant: General layout, heat exchangers, moderators, coolants, control rods. Hydro power plant: Site selection, general layout, type of hydropower plants, hydrographs. Characteristics of hydro turbines. Electrical equipment in generating stations: General layout, excitation systems and voltage regulation. Substation layout, components of substation. bus-bar arrangements, current-limiting reactors and their location. Safety and coordination. Load forecasting and sharing: Load curve and load duration curves, load factor, diversity factor, plant factor and plant use factor, demand factor, load sharing between base and peak load stations.

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M. V. Deshpande, *Electrical Power Stations*.  
Tata Electric Co. , *Operator Training Manual*.

### EE374 ELECTRIC ENERGY SYSTEMS

(3-1-0) 4

Conventional and non- conventional energy sources and systems: Generation, transmission and distribution schemes, energy conservation systems, energy efficient equipment and controllers. Energy audit.

Olle I. Elgerd, *Electric Energy System Theory: An Introduction*, TMH, 1982.

I. J. Nagrath, D. P. Kothari, *Power System Engineering*, TMH.

### EE376 ADVANCED CONTROL SYSTEMS

(3-1-0) 4

Introduction, review of state space approach to modeling of dynamic system. Introduction to discrete time control system, Signal processing in digital control, models of digital control devices and systems, z -plane analysis of discrete time control system, transient response analysis, design specifications and performance indices, design of digital control algorithms, state variable analysis of digital control systems, Pole placement design and state observers, linear quadratic optimal control

K. Ogata, *Discrete Time Control Systems*, 2<sup>nd</sup> Edition, Pearson

Education. M. Gopal, *Digital Control and State Variable Methods*, TMH.

### EE377 MODELING AND SIMULATION TECHNIQUES FOR DYNAMIC SYSTEMS

(3-1-0) 4

Introduction to system dynamics, transfer function approach to modeling dynamic systems, modeling of electrical and electromechanical systems, mechanical systems, state-space approach to modeling dynamic systems, Bond graphs method, transient analysis of dynamic systems, frequency domain analysis of dynamic systems, numerical techniques applied to dynamic systems.

MathWorks Inc. , *MATLAB®/ SIMULINK™ Reference/User Manuals*, MathWorks Inc.

K. Ogata, *System Dynamics*, 4th Edition, Pearson Education.

K. Ogata, *Discrete Time Control Systems*, 2nd Edition, Pearson Education.

### EE378 SHELL SCRIPTING WITH BASH

(3-1-0) 4

The Linux environment: Files and file systems, directories, inodes and links, pipe and socket files, device files. Operating the shell, Bash keywords, command basics, command-line editing; files, users and shell customization, working with files. Script basics, creating a well-behaved script, basic redirection, standard output, error and input, built-in versus Linux commands. Variables: Basics and attributes, bash pre-defined variables, expressions, arithmetic and logical expressions, relational, bitwise and self-referential operations, substitutions. Compound commands, debugging and revision control, shell archives, parameters and subshells, job control and signals. Text file basics, text file processing, console scripting, functions and script execution. Shell security aspects and network programming. Related shells and the IEEE 1003. 2 POSIX shell standard.

Cameron Newham, Bill Rosenblatt, *Learning the Bash Shell*, O'Reilly Media, 2005.

Arnold Robbins, Nelson H. F. Beebe, *Classic Shell Scripting*, O'Reilly Media, 2005.

Ken O. Burtch, *Linux Shell Scripting with Bash*, Sams Publishing, 2004.

Stephen G. Kochan, Patrick Wood, *Unix Shell Programming*, 3<sup>rd</sup> Edition, Sams Publishing, 2003. Mendel

Cooper, *Advanced Bash-Scripting Guide*, 2005. (Available on-line in pdf at <http://www.tldp.org/>)

### EE379 INCREMENTAL MOTION CONTROL

(3-1-0) 4

Introduction to incremental motion systems, Principles of operation of various types of stepper motors, static and dynamic torque characteristics of stepper motors, open loop and closed loop controls, microprocessor based controllers for stepper motors.

P. P. Acarnley, *Stepping motors-A Guide to Modern Theory and Practice*, 3<sup>rd</sup> Edition, Peter Peregrinus, 1992.

Takashi Kenjo, Akira Sugawara, *Stepping Motors and their Microprocessor controls*, 3<sup>rd</sup> Edition, Oxford University Press, 2005.

### EE382 VIRTUAL INSTRUMENTATION LABORATORY

(0-0-3) 2

LabVIEW programming, data acquisition with LabVIEW™ DAQ VIs, interfacing with GPIB and RS232/RS485 .

### EE384 ENERGY AUDITING LABORATORY

(0-0-3) 2

Laboratory exercises and assignments to provide additional support to EE359.

### EE385 MICROPROCESSORS LABORATORY

(0-0-3) 2

Programming and interfacing experiments on the target processor / microcontroller discussed in EE360.

**EE386 DIGITAL SIGNAL PROCESSING LABORATORY**

**(0-0-3) 2**

Laboratory exercises and assignments to enhance learning of DSP.  
*MATHEMATICA®*, *LabVIEW™*, DSP programming. Exercises around  
*MATLAB®*, *S. Burrus et al, ComputerBased Exercises for Signal Processing, PH, 1994. S. K. Mitra, DSP: A Computer-Based Approach, TMH, 1998.*  
*TMS 320c54x Users Manual, Texas Instruments, 1997.*

**EE387 ADVANCED DIGITAL SIGNAL PROCESSING LABORATORY**

**(0-0-3) 2**

Laboratory exercises and assignments to provide enhance learning of advanced DSP techniques and algorithms.  
*MathWorks Inc. , MATLAB® Signal Processing Toolbox Users Guide, MathWorks Inc.*  
*C. S. Burrus et al, Computer-Based Exercises for Signal Processing, PH, 1994. S. K. Mitra, DSP: A Computer-Based Approach, TMH, 1998.*  
*TMS 320c54x Users Manual, Texas Instruments, 1997.*

**EE389 EMBEDDED SYSTEM DESIGN LABORATORY**

**(0-0-3) 2**

Laboratory exercises and assignments to provide additional support to EE369.

**EE392 POWER SYSTEM OPERATION LABORATORY**

**(0-0-3) 2**

Simulation exercises and assignments to provide additional support to EE362. Experiments around *MATLAB®*, *PSCAD®*, *PowerWorld™* and *SKM®* packages.

**EE393 DYNAMIC SYSTEM SIMULATION LABORATORY**

**(0-0-3) 2**

Laboratory exercises and assignments to provide additional support to EE377.

**EE397 DESIGN AND DEVELOPMENT TASK IN SIGNAL PROCESSING**

**(0-0-3)2**

Application of digital Signal processing techniques for power systems or any specific applications in communication, feature extraction, or data compressions. Simulation or DSP implementation.

**EE398 DESIGN AND DEVELOPMENT TASK IN POWER SYSTEMS**

**(0-0-3)2**

Problem solving in the area of power system dynamics, distribution systems and high voltage engineering.

**EE402 HVDC TRANSMISSION**

**(3-1-0) 4**

Need, Basic principle of conversion, economics of different configurations, The Graetz bridge circuit, analysis, overlap, firing delay, inversion, converter control, tap-changing control, power reversal, measuring devices, filters, circuit breaker, lightning arrester, DCCT, MRT. MTDC systems, interaction between AC and DC Systems, voltage stability, power modulation, Introduction to Voltage Source Converter based HVDC System, future of the HVDC transmission systems, research and development  
*E. W. Kimbark, Direct Current Transmission.*  
*K. R. Padiyar, Power Transmission by Direct Current, Wiley Eastern, 1990.*  
*Recent Publications of relevance.*

**EE404 SOFT COMPUTING AND APPLICATIONS**

**(3-1-0) 4**

Introduction to intelligent systems and soft computing, Intelligent systems, Knowledge-based systems, Knowledge representation and processing. Soft computing, Fundamentals of fuzzy logic systems, Fuzzy Sets, operations, relations, fuzzy logic, fuzzy control, Composition and inference, Considerations of fuzzy decision-making, neural networks – Single layer, multilayer networks, Features of artificial neural networks, learning, Fundamentals of connectionist modelling, BP algorithm, Major classes of neural networks, The multilayer perceptron, Radial basis function networks, Kohonen's self-organizing network, Industrial and commercial applications of ANN such as optimal control, manufacturing, power systems, robotics, etc. , neuro-fuzzy systems, Architectures of neuro-fuzzy systems, Neural network- driven fuzzy reasoning, Hybrid neuro-fuzzy systems, Construction of neuro-fuzzy systems, Evolutionary computing, Integration of genetic algorithms with neural networks, Integration of genetic algorithms with fuzzy logic, Known issues in GA and applications.  
*Karray, Fakhreddine O. , and Clarence W. De Silva. Soft computing and intelligent systems design: theory, tools, and applications. Pearson Education, 2004.*  
*J. S. R. Jang, C. T. Sun, E. Mizutani, Neuro-Fuzzy and Soft Computing – A Computational Approach to Learning and Machine Intelligence, PHI, 2002.*  
*M. Negnevitsky, Artificial Intelligence, A Guide to Intelligent Systems, Pearson Publishing, 2006*  
*C. T. Lin and C. S. Lee, Neural Fuzzy Systems, Prentice Hall Publishing, 1995*

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Timothy J. Ross, *Fuzzy Logic with Engineering Applications*, McGraw-Hill, 1997. Simon Haykin, *Neural Networks – A Comprehensive Foundation*, Prentice Hall, 1999.

David E. Goldberg, *Genetic Algorithms in Search, Optimization and Machine Learning*, Pearson Education, 2003.

### EE406 ELECTROMAGNETIC COMPATIBILITY

(3-1-0) 4

Review of EM theory. EMI from apparatus and circuits. EMI measurements. Shielding and grounding. EMI filters. Electrostatic discharge. EMC standards.

H. W. Ott, *Noise Reduction Techniques in Electronic Systems*.

V. Prasad Kodali, *Engineering Electromagnetic Compatibility*, S. Chand & Co.

### EE408 SOLID-STATE DRIVES

(3-1-0) 4

Separately excited dc motor drive: Operation and performance, single-phase fully controlled converter, operation on dual converter. Chopper drive: operation and performance calculation on class A, class C, and class E choppers. Induction motor drive: Stator voltage control with constant supply frequency, qualitative comparison of converter combinations, slip energy recovery scheme, VSI fed induction motor, CSI fed induction motor, synchronous motor drive, VSI drive, brushless excitation, true synchronous and self-controlled operation, performance with PMSM and synchronous reluctance motor.

S. B. Dewan, G. R. Slemon, A. Straughen, *Power Semiconductor Drives*, John Wiley and Sons, 1984.

W. Shepherd, L. N. Halley, D. T. W. Liang, *Power Electronics and Motor Control*, 2<sup>nd</sup> Edition, Cambridge University Press, 1998.

Vedam Subrahmanyam, *Electric Drives – Concepts and Applications*, TMH, 1994.

G. K. Dubey, *Power Semiconductor Controlled Drives*, Prentice Hall, 1989.

### EE410 POWER SYSTEM PROTECTION

(3-1-0) 4

Introduction to power system protection, Review of conventional power system protection schemes, power apparatus protection: viz. transformer, motor, generator, bus bar, transmission and distribution line protection schemes, Introduction to computer aided protection, numeric relay hardware design, digital protection algorithms, recent trends in power apparatus protection methodology, concepts of adaptive relaying and application of soft computing methods in numeric relaying.

Warrington, *Protective Relays – Their theory and practice*, Volumes. I, II, and III, Chapman and Hall.

Arun G. Phadke, J. S. Thorpe, *Computer Relaying for Power Systems*, Research Studies Press.

Gerhard Ziegler, *Numerical Distance Protection: Principles and Applications*.

A. T. Johns, S. K. Salman, *Digital Protection for Power Systems*, IEE, 1995.

M. S. Sachdev (Coordinator), *IEEE Tutorial Course on Advancement in Microprocessor-based Protection and Communication*, IEEE, 1979.

### EE411 OPERATION OF POWER SYSTEMS UNDER DEREGULATION

(3-1-0) 4

Fundamentals of deregulation, restructuring models and trading arrangements, different models of deregulation, operation and control, wheeling charges and pricing, Role of FACTS controllers and distributed generation in restructured environment, developments in India, IT applications in restructured markets.

K. Bhattacharya, M. H J Bollen and J. E Daalder, *“Operation of Restructured Power Systems”*, Kluwer Academic Publisher, USA, 2001.

L. Philipson and H. L. Willis, *“Understanding Electric Utilities and Deregulation”*, Marcel Dekkar Inc. 1999.

M. Shahidehpour and M. Alomoush, *“Restructured Electrical Power Systems, Operation, Trading and Volatility”*, Marcel Dekkar Inc. 2001.

Steven Stoft, *“Power System Economics: Designing Markets for Eligibility”*. John Wiley & Sons, 2002

### EE412 RANDOM SIGNAL PROCESSING

(3-1-0) 4

Random signal processing: Review of probability and random variables, Mathematical description of random signals, response of linear systems to random inputs, Wiener filtering, basic estimation theory, discrete Kalman filter, state-space modeling and simulation, nonlinear estimation.

Athanasios Papoulis, *Probability, Random variables, and Stochastic Processes*, McGraw-Hill, 1991.

R. G. Brown, P. Y. C. Hwang, *Introduction to Random Signals and Applied Kalman Filtering*, John Wiley and Sons, 1997.

A. P. Sage, James L. Melsa, *Estimation Theory with Applications to Communications and Control*, McGraw-Hill, 1971.

### EE414 NON-CONVENTIONAL ENERGY SYSTEMS

(3-1-0) 4

Solar energy, wind energy, chemical energy sources. Energy from the ocean and tides. MHD generation, thermo electric power. Geothermal energy. Energy from bio-mass.

G. D. Rai, *Non-conventional Energy Sources*. P.  
S. Sukhatme, *Solar Energy*.

#### EE415 POWER ELECTRONICS IN POWER CONTROL

(3-1-0) 4

Devices: Characteristics- diode, BJT, IGBT, MOSFET, IPMs, Thyristor based devices: SCRs/TRIAC/GTOs.  
Reactive elements: capacitors, inductor, transformer, pulse transformer. Data sheets, switching and conduction losses, heat dissipation- heat sink, loss calculation. Drive circuit, current and voltage sensors, opto-couplers. Functional classification of converters: DC-DC converters - switched mode buck converter, switched mode boost converter: control circuit, snubber, applications. Inverters: H-Bridge, single-phase, three-phase inverters. Rectifiers: single-phase and three-phase rectifiers. AC power controllers. Simulations of power electronic converters.

*Ned Mohan, Undeland, Robbins, Power Electronics, 3rd edition, John Wiley.*

*M H Rashid, Power Electronics, 3rd edition, PHI.*

*P C Sen, Power Electronics, Tata McGraw-Hill Publishing Company Ltd.*

*Bimal K Bose, Modern power electronics and ac drives, PHI.*

*L Umanand, Power Electronics, Wiley India Pvt Ltd*

#### EE418 ADVANCED POWER ELECTRONICS

(3-1-0) 4

Power devices, design of inductors, transformers, selection of core, design of capacitors, selection of capacitors for different applications. AC to DC converters, multilevel inverters, DC to DC converters, hard switch converters, design and analysis, isolated converters, resonant converters.

*Ned Mohan, Undeland, Robbins, Power Electronics.*

*M. H. Rashid, Power Electronic Circuits – Devices and Applications.*

#### EE420 POWER SYSTEM DYNAMICS

(3-1-0) 4

Power system component modeling for dynamic studies: Synchronous generator modeling, exciter and turbine modeling, load modeling. System stability analysis: Angle stability (small signal and large signal), voltage stability, frequency stability.

*K. R. Padiyar, Power System Stability and Control, Interline, 1996.*

*Prabha Kundur, Power System Stability and Control, McGraw-Hill, 1994.*

#### EE422 PRINCIPLES OF SWITCHGEAR AND PROTECTION

(3-1-0) 4

Fuses and switches, methods of earthing, Circuit breakers. circuit breaker ratings, auto reclosure. **Protective relaying**, fundamental characteristics. Relay classifications, differential protection schemes. **Transformer protection**. Buchholtz relay. **Alternator protection**: Negative phase sequence relay, loss of field protection. **Line protection**: Over current relays and schemes, distance relays and schemes, carrier current relaying. **Induction motor protection**: Abnormal operating conditions. **Solid state relays**: Comparators, duality between phase and amplitude comparators. Realization of directional, Ohm, reactance, impedance and Mho characteristics using the general characteristic equation, static distance relays. **Computer aided relaying**: Introduction to microcomputer based relays, General functional diagram of microcomputer-based relays.

*Ravindranath, Chander, Power System Protection and Switchgear, Wiley Eastern, 1994.*

*C. L. Wadhwa, Electrical Power Systems, 2<sup>nd</sup> Edition, PHI, 1993.*

*Arun G. Phadke, S H Horowitz, Power System Relaying, 2<sup>nd</sup> Edition, John Wiley, 1995.*

*Badriram, D. N. Vishwakarma, Power System Protection and Switchgear, TMH, 1995.*

#### EE423 SWITCHGEAR AND PROTECTION LABORATORY

(0-0-3) 2

Laboratory exercises and assignments to provide additional support to EE422. The course will have experiments related to: Fuses and fuse elements. Study of Induction motor starters. Study of MCCB and ELCB. Circuit breakers and their control circuits. Over current, Earth fault, Differential protection, Phase unbalance, Under frequency, Thermal and other relays and protective schemes

#### EE427 COMPUTER NETWORKS

(3-1-0) 4

Introduction, physical layer, data link, media Access, network layer, transport layer, ATM, applications.

*Andrew S. Tanenbaum, Computer Networks, Pearson Education.*

#### EE428 THE ARM CORE: ARCHITECTURE AND PROGRAMMING

(3-1-0) 4

The ARM design philosophy, ARM processor fundamentals – registers, current program status register, pipeline, exceptions, interrupts and the vector table, core extensions, architecture revisions, ARM processor families. The ARM instruction set: Data processing instructions, branch instructions, load-store instructions, software interrupt instructions, program status register instructions, conditional execution. The THUMB instruction set, THUMB register usage, ARM-

THUMB interworking. Writing assembly code, profiling and cycle counting, instruction scheduling, register allocation, looping constructs, bit manipulation, efficient switches, unaligned data handling. GNU assembler. Optimized primitives, exception and interrupt handling. Rudimentary aspects of embedded operating systems.

*David Seal (Ed. ), ARM Architecture Reference Manual, 2<sup>nd</sup> Edition, Addison-Wesley, 2001.*

*Steve Furber, ARM Sytem-on-Chip Architecture, 2<sup>nd</sup> Edition, Addison-Wesley, 2000.*

*Andrew N. Sloss, Dominic Symes, Chris Wright, ARM System Developer's Guide, Elsevier, 2004.*

*ARM Limited, ARM v7-M Architecture Application Level Reference Manual, ARM Limited, 2006.*

#### **EE430 ROBOT DYNAMICS AND CONTROL**

**(3-1-0) 4**

Introduction to robotics: History of robots, components and structures of robots, rigid motion and homogeneous transformations: representing position and rotation, rotational transformations, composition of rotations, parameterization of rotation, homogeneous transformations, Forward Kinematics, Inverse kinematics, velocity kinematics- the manipulator Jacobian, Dynamics: Euler-Lagrange equations, generalized expression for potential and kinetic energy, properties of robot dynamic equations, equation of motion, Independent joint control: set point tracking using classical PID control, force control, feedback linearization control. Computer vision: geometry of image formation, camera calibration, segmentation by thresholding, connected components, position and orientation of the object. Introduction to path planning and collision avoidance.

*M. W. Spong, S. Hutchinson and M. Vidyasagar, Robot Dynamics and Control by, John Wiley & Sons, 2008.*

*Craig, John J. Introduction to robotics: mechanics and control. Vol. 3. Upper Saddle River: Pearson Prentice Hall, 2005.*

*Sciavicco L, Siciliano B. Modelling and control of robot manipulators. Springer Science & Business Media; 2012*

#### **EE432 MACHINE LEARNING**

**(3-1-2) 5**

Introduction, linear classification, perceptron update rule; Perceptron convergence, generalization; Maximum margin classification; Classification errors, regularization, logistic regression; Linear regression, estimator bias and variance, active learning; Active learning, non-linear predictions, kernels; Support vector machine (SVM) and kernels, kernel optimization; Model selection, Model selection criteria; Description length, feature selection; Combining classifiers, boosting, Boosting, margin, and complexity; Margin and generalization, mixture models, Mixtures and the expectation maximization (EM) algorithm, regularization, clustering; Spectral clustering, Markov models, Hidden Markov models (HMMs), Bayesian networks, Learning Bayesian networks, Probabilistic inference. Simulation exercises covering the theory.

*Bishop, Christopher. Neural Networks for Pattern Recognition. New York, NY: Oxford University Press, 1995.*

*Duda, Richard, Peter Hart, and David Stork. Pattern Classification. 2nd ed. New York, NY: Wiley-Interscience, 2000.*

*MacKay, David. Information Theory, Inference, and Learning Algorithms. Cambridge, UK: Cambridge University Press, 2003.*

*Mitchell, Tom. Machine Learning. New York, NY: McGraw-Hill, 1997.*

*T. Hastie, R. Tibshirani, J. Friedman. The Elements of Statistical Learning, 2e, 2008.*

*Christopher Bishop. Pattern Recognition and Machine Learning. 2e.*

#### **EE439 ADVANCED POWER ELECTRONICS LABORATORY**

**(0-0-3) 2**

Laboratory exercises and assignments to provide additional support to EE418.

#### **EE443 MATHEMATICAL MORPHOLOGY AND APPLICATIONS TO SIGNAL PROCESSING (3-1-0) 4**

Introduction to Mathematical morphology: Minkowski addition and Minkowski subtraction, Introduction to the lattice theory, Structuring elements and its decomposition. Fundamental Morphological Operators: Erosion, Dilation, Opening, Closing, Binary vs Greyscale Morphological operations. Hit-or-Miss transform, Skeletons, Morphological reconstructions, Thinning, Thickening: Hit-or -Miss transformation, Skeletonization, Coding of binary image Via Skeletonization, Skeletonization by influence Zones(SKIZ), Weighted SKIZ, Medial Axis Transformation(MAT), Skeletonization Via Euclidean Distance Transformation, Partial Skeletons, Morphological Shape Decomposition(MSD), Morphology Thinning, Thinking, pruning, MSD Vs SKIZ. Morphological Filtering and Segmentation:Multi- scale Morphological Transformation, Top – Hat and Bottom Hat Transformation, Alternative Sequential filtering, Segmentation, Watershed Segmentation, Connected Operators for Segmentation, Hierarchical Segmentation Vs Watersheds, Markers, Hierarchical Segmentation, Geodesic active contours. Geodesic Transformation and Metrics: Geodesic Morphology, Graph – Based Morphology. Euclidean Metric, Geodesic Distance (Shortest path), Dilation distance, Hausdorff Dilation and Erosion distances. Applications of Mathematical Morphology

*J. Serra, Image Analysis and Mathematical Morphology, Academic Press London, 1982.*

*J. Serra, Image Analysis and Mathematical Morphology: Theoretical Advance, Academic Press, 1988.*



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*N. A. C. Cressie, Statistics for Spatial Data, John Wiley, 1991.*

*P. Soille, Morphological Image Analysis, Principles and Applications, 2<sup>nd</sup> Edition, Springer Verlag. 2003. L.*

*Najman and H. Talbot (Eds. ), Mathematical Morphology, Wiley, 2010.*

*B. Chanda and D. Dutta Majumdar, Digital Image Processing and Analysis, 2<sup>nd</sup> edition, New Delhi: PHI Learning Pvt. Ltd. , 2011,*

*B. S. Daya Sagar, Mathematical Morphology in Geomorphology and GISci, Chapman & Hall/CRC Press, FL. 2013,*

### **EE445 POWER SYSTEM SIMULATION LABORATORY-1**

**(0-0-3) 2**

Time-domain simulation of SMIB and multi-machine power systems in MATLAB®/SIMULINK™ to provide additional support to EE420.

### **EE448 SEMINAR**

**(0-0-2) 1**

This course is a 1 credit course to be completed during 7th semester. The student will make presentations on topics of academic interest.

### **EE449 MAJOR PROJECT-I**

**(0-1-3) 3**

### **EE454 FLEXIBLE AC TRANSMISSION SYSTEMS**

**(3-1-0) 4**

Transmission system performance, compensation approaches, static var systems, VSI based FACTS controllers – STATCOM, UPFC, TCSC, TCPAR, TCBR. Applications: Transient stability improvement. Introduction to custom power.

*K. R. Padiyar, Power System Dynamics, Stability and Control, 2<sup>nd</sup> Edition, B. S. Publishers.*

*Prabha Kundur, Power System Stability and Control, McGraw-Hill EPRI Power System Engineering Series, 1994.*

*Narain G. Hingorani, Laszlo Gyugyi, Understanding FACTS – Concepts and Technology of Flexible AC Transmission Systems, IEEE Press, 2001.*

### **EE456 HIGH-VOLTAGE ENGINEERING**

**(3-1-0) 4**

Electric breakdown in solid, liquid and gas dielectrics. Generation of high AC, DC and impulse voltages. Impulse current generators. Methods of measuring high AC, DC and impulse voltages and current. Partial discharge.

*E. Kuffel, Zengal, High Voltage Engineering.*

*D. Kind, An Introduction to High Voltage Experimental Techniques.*

*Kamaraju, Naidu, High Voltage Engineering.*

*C. L. Wadhwa, High Voltage Engineering.*

### **EE458 PHOTOVOLTAICS AND APPLICATIONS**

**(3-1-0) 4**

Overview of PV systems, relevance and adaptology, economics and efficiency, insolation and its measurement, types of cells. Elements of solar cell operation, light absorption and carrier generation in semiconductors, conversion efficiency and factors affecting it, Processing techniques. Concentrators, stand-alone inverters, grid operation, issue of energy storage, general applications, large PV power systems, rural power supply systems, Issues in developing countries, unconventional cell systems.

*Chenming Hu, R. M. White, Solar cells- From Basic to Advanced Systems, McGraw-Hill.*

### **EE464 POWER GENERATION AND ECONOMICS**

**(3-1-0) 4**

Hydro, thermal and nuclear power plants. Electrical equipments in generating stations. Load forecasting and sharing. Economic operation of power systems. Economic choice of transformers and electric motors.

*M. V. Deshpande, Elements of Power Station Design. G.*

*P Chalotra, Electrical Engineering Economics.*

*S. Domkundwar, S. C. Arora, A Course in Power Plant Engineering.*

### **EE466 UTILIZATION OF ELECTRICAL ENERGY**

**(3-1-0) 4**

Electric Traction: Requirements of an ideal traction system, requirements of ideal traction motors, comparison and control of traction motors, mechanics of train movement, tractive effort for acceleration, train resistance, gradient, coefficient of adhesion, speed time curves, specific energy consumption. Electric heating: methods of heat transfer, resistance heating, design of heating element, induction heating, eddy current heating, dielectric heating. Electric welding: resistance welding, arc welding. Electrolytic processes: Faraday's laws of electrolysis, Calculation of current required and related definitions, Factors governing the character of deposits, preparation of work for electroplating, electro-extraction. Illumination : Laws of illumination, lighting calculations, polar curves, Rousseau's construction.

*Partab, Art and Science of Utilization of Electrical Energy.*

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*E. O. Taylor, Utilization of Electric Energy.*

*C. L Wadhwa, Generation, Distribution and Utilization of Electrical Energy.*

### **EE467 INDUSTRIAL ELECTRICAL SYSTEMS**

**(3-0-0) 3**

Overview of electrical systems in manufacturing, chemical, metallurgical, process industries, electric traction, electric heating, electric welding, electroplating, illumination and case studies.

*Partab, Art and Science of Utilization of Electrical Energy.*

*E. O. Taylor, Utilization of Electric Energy.*

*C. L Wadhwa, Generation, Distribution and Utilization of Electrical Energy.*

### **EE468 ADVANCED ELECTRIC DRIVES**

**(3-1-0) 4**

Electric Drives: DC drives, modeling, analysis and simulation. Space phasors, modeling of brushless DC motor, modeling of induction motor, vector control of brushless DC motor. Induction motor drive: V/f control, vector control of induction motor, DT control of induction motor drives.

*W. Leonhard, Electric Drives, Springer Verlag.*

*B. K. Bose, Power Electronics and AC Drives.*

### **EE469 RENEWABLE ENERGY SYSTEMS**

**(3-0-0) 3**

Concept of renewable energy, design and implementation aspects of renewable energy systems employing solar energy, wind energy, chemical energy sources. Energy from the ocean and tides. MHD generation, thermo electric power. Geothermal energy. Energy from bio-mass.

*G. D. Rai, Non-conventional Energy Sources. P.*

*S. Sukhatme, Solar Energy.*

### **EE470 COMPUTATIONAL TECHNIQUES FOR LARGE SYSTEM ANALYSIS**

**(3-1-0) 4**

Solution of linear system of equations, solution of nonlinear system of equations, sparsity techniques, numerical integration techniques: explicit methods, implicit methods, fixed step methods, variable step methods, stability and accuracy-analysis of numerical methods, numerical calculation of eigenvalues, EMTP simulation techniques.

*Steven C. Chapra, R. P. Canale, Numerical Techniques for Engineers, TMH, 2000.*

*Mariessa Crow, Computer Techniques for Large Electric Power Systems, CRC Press, 2003.*

### **EE471 POWER SYSTEM SIMULATION LABORATORY-II**

**(0-0-3)2**

Developing computer programs related to some of the techniques/methods and its application to power system analysis to provide additional support to EE470.

### **EE472 INSULATION AND TESTING ENGINEERING**

**(3-1-0) 4**

Introduction, review of test sources and measurement associated with insulation studies. Insulation types: solids, liquids, gases and vacuum, properties and characteristics. Dielectric strength and permittivity, methods of measurements, theories of breakdown. Testing of transformer oil, Schering bridges for tan-delta measurement. Measurement of insulation resistance of solids: Bulk and surface. PD measurements. Testing of cables IR, PI, step test, tan delta, PD. Treeing tracking. Radio interference measurements, RI and RIV. Testing of insulators, power transformers, Impulse testing, testing of rotating machines. Accelerated ageing tests and life estimation. Testing of surge diverters, bushings, insulators. Testing of rubber mats. Testing of Gas Insulated Substations.

*Kamaraju, Naidu, High Voltage Engineering.*

*Kuffel, Zeangle, High Voltage Engineering.*

*Relevant Indian standards and Technical papers.*

### **EE476 OPTIMISATION TECHNIQUES**

**(3-1-0) 4**

Linear Programming: Simplex method and extensions. Network models: Shortest path, maximum flow and minimum cost problems. Dynamic programming: resource allocation, production scheduling and equipment replacement problem. Non-linear programming: selected unconstrained and constrained non-linear programming algorithms like quasi Newton, reduced gradient and gradient projection methods. Penalty function methods, quadratic programming.

*Lueneburger, Linear and Non linear Programming, McGraw-Hill.*

*Fletcher, Optimization techniques, John Wiley and Sons.*

### **EE478 AN INTRODUCTION TO THE INTEL IA-32 ARCHITECTURE**

**(3-1-0) 4**

A brief history of the IA-32 architecture, the Intel P6 family of processors – Intel Pentium®, Xeon®, Pentium® M, Pentium® Extreme, Core™ Duo and Core™ Solo. SIMD instructions, Hyper-threading technology, Multicore

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technology. Basic execution environment, memory organization, paging and virtual memory, address calculations in 64-bit mode. Basic program execution registers, instruction pointer, operand addressing, memory operands, segmentation, I/O port addressing. Data types. Implementation of the IEEE 754 floating point format. Overview of FP exceptions and FP exception handling. General purpose instructions, FPU instructions, MMX instructions, SSE instructions, SSE2 and SSE3 extensions. Programming with GP instructions, Programming with the x87 FPU. Programming the IA-32 in the GNU/Linux environment.

*Intel Corporation, IA-32 Intel Architecture Software Developer's Manual, Volume 1: Basic Architecture, Intel Corporation, 2006.*

*Intel Corporation, IA-32 Intel Architecture Software Developer's Manual, Volume 2A: Instruction Set Reference, A-M, Intel Corporation, 2006.*

*Intel Corporation, IA-32 Intel Architecture Software Developer's Manual, Volume 2B: Instruction Set Reference, N-Z, Intel Corporation, 2006.*

### **EE489 ADVANCED ELECTRIC DRIVES LABORATORY**

**(0-0-3) 2**

Laboratory exercises and assignments to provide additional support to EE468.

### **EE491 INSULATION AND TESTING ENGINEERING LABORATORY**

**(0-0-3) 2**

Laboratory exercises and assignments to provide additional support to EE472.

### **EE498 PRACTICAL TRAINING**

**(0-0-3) 2**

This course is a 2 credit course. A student may complete the practical training before the beginning of 8<sup>th</sup> semester (or as stipulated by DUGC) and register for it in 8<sup>th</sup> Semester. The duration and the details shall be decided by the faculty advisor, with approval from DUGC.

### **EE499 MAJOR PROJECT-II**

**(0-1-3) 3**

### **EE500 SYSTEM ANALYSIS IN DISCRETE TIME**

**(3-1-0) 4**

The calculus of finite differences; Operators and their properties; Inverse operators. Difference equations and their solutions. Linear difference equations with constant coefficients, general and particular solutions. Discretization of differential equations. Modeling and analysis of LTI lumped-parameter systems in discrete time.

*Kelley W. G. , Peterson A. C. , " Difference Equations: An Introduction with Applications", 2<sup>nd</sup> Edition, Elsevier, 2001.*

*Goldberg S. , "Introduction to Difference Equations", 2<sup>nd</sup> Edition, Dover, 1986.*

*Elaydi S. , "An Introduction to Difference Equations", 3<sup>rd</sup> Edition, Springer International Edition, 2008.*

### **EE501 ANALYSIS OF NONLINEAR CIRCUITS**

**(3-1-0)4**

Nonlinear circuit elements, v-i characteristics, energy and power considerations. Time-varying elements, multiterminal elements. Resistive nonlinear circuits, graphical analysis. Dynamic nonlinear networks, autonomous and non-autonomous networks. Analysis of memristive circuits.

*Chua L. O. , "Introduction to Nonlinear Network Theory", McGraw-Hill, 1969.*

*Chua L. O. , Desoer C. A. , Kuh E. S. , "Linear and Nonlinear Circuits", McGraw-Hill, 1987.*

**Department of Information Technology**

**IT110 DIGITAL SYSTEM DESIGN**

**(3-0-2) 4**

Introduction: Number Systems and Codes; Boolean Algebra and Logic Gates; Karnaugh Maps and Gate-Level Minimization; Combinational Logic Design: Adders, Subtractors, Comparators, Decoders, Encoders, Multiplexers; Sequential Logic Design: latches, Flip-Flops; Registers, Counters and Memory Unit: Shift Registers, Ripple and Synchronous Counters, Random Access Memory; Algorithmic State Machines; Design at the Register Transfer Level; Hardware Descriptive Language.

*M. Morris Mano, Digital Logic & Computer Design, 1st Edition, Pearson Education, 2016.*

*M. Morris Mano and Michael D. Ciletti, Digital Design with VERILOG HDL, 5th Ed., Pearson, 2012.*

*Mark Zwolinski, Digital System Design with VHDL, 2nd Edition, Pearson, 2004.*

*B. Holdsworth and R.C. Woods, Digital Logic Design, 4th Edition, Elsevier, 2003.*

**IT150 OBJECT ORIENTED PROGRAMMING**

**(3-0-2) 4**

Concepts of OOP – Introduction to OOP, Procedural Vs. Object Oriented Programming, Principles of OOP, Benefits and applications of OOP; Beginning with C++: Overview and Structure of C++ Program, Classes and Objects, Constructors and Destructors. Programming with JAVA – Overview of Java Language, Classes Objects and Methods, Method Overloading and Inheritance, Overriding Methods, Final Variables and Methods, Interfaces, Packages, Multithreaded programming, Exception Handling; Introduction to Android Programming : Setting up Development Environment, Basic Building blocks – Activities, Services, Broadcast Receivers & Content providers, UI Components –Views & notifications, Components for communication –Intents & Intent Filters; Introduction to Object-Oriented Design and Analysis, UML, Use Case Modeling. Introduction to Design Patterns (Observer, Strategy, Composite, Decorator, Iterator, Adaptor, Command, Factory Method, Proxy, Singleton, and Visitor).

*E. Gamma et al., Design Patterns: Elements of Reusable Object-Oriented Software, 1st Ed., Addison-Wesley, 1994. G.*

*Booch, J. Rumbaugh, and I. Jacobson, The Unified Modeling Language User Guide, Addison-Wesley, 1999. Bruce E.*

*Wampler, The Essence of Object Oriented Programming with Java and UML, Addison-Wesley, 2002. Danny Poo,*

*Derek Kiong and Swarnalatha Ashok, Object-Oriented Programming and Java, 2nd Ed., Springer, 2007.*

**IT200 COMPUTER COMMUNICATION AND NETWORKING**

**(4-0-0) 4**

Evolution of Data Communication and Networks, Transmission Fundamentals: Signaling Schemes, Encoding and Modulation, Data Transmission over Networks – Switching Techniques, Layered Architecture of Computer Networks, OSI & TCP/IP Architectures and Layers with protocols, Data Link Control and Protocols, Error Detection and Correction, Internetworking & Routing, Transport Layer Protocols, Applications: E-Mail, HTTP, WWW, Multimedia; Implementation of Signaling and Modulation, Bit, Byte & Character Stuffing and Error Detection/Correction Coding Techniques, TCP/IP Level Programming, Routing Algorithms, Exercises comprising simulation of various protocols.

*“Computer Networks”, Andrew S. Tanenbaum and David J Wetherall, 5<sup>th</sup> Edition, Pearson, 2013.*

*“Data Communications and Networking”, Behrouz A. Forouzan, 4th Edition, McGraw Hill, 2017.*

*“Data and Computer Communications”, William Stallings, 10<sup>th</sup> Edition, Pearson, 2013.*

*“Communication Networks”, Leon, Garcia and Widjaja, 2<sup>nd</sup> Edition, McGraw-Hill, 2003.*

*“Computer Networking: A Top-Down Approach”, James Kurose; Keith Ross, 7<sup>th</sup> Edition, Pearson, 2016.*

*“Computer Networks: A Systems Approach”, Larry Peterson and Bruce Davie, 5<sup>th</sup> Ed., Morgan Kaufmann, 2011.*

**IT201 COMPUTER ORGANIZATION AND ARCHITECTURE**

**(3-0-0) 3**

Introduction to computer organization and architecture, CPU Organization, Data Representation, Instruction Sets, Data path design, Fixed point and floating point arithmetic operations and hardware design, ALU design, Control unit : Hardwired control unit and Micro programmed control unit. Memory organization, Cache memory, Virtual memory. Input output Unit: Programmed Controlled I/O Transfer, Interrupt controlled I/O transfer, DMA controller. Secondary storage and type of storage devices. Pipelining. Performance evaluation.

*Carl Hamacher et al., Computer Organization and Embedded Systems, Sixth Edition, McGraw-Hill, 2014. Vincent P*

*Heuring, Harry F Jordan, T. G. Venkatesh, Computer Systems Design and Architecture, Pearson, 2008. Miles*

*Murdocca and Vincent Heuring, Computer Architecture & Organization An Integrated Approach, Wiley, 2007. J.*

*Hennesy and D. Patterson, Computer Architecture –A Quantitative Approach, 6th Ed., Morgan Kaufmann, 2017.*

**IT202 DATA STRUCTURES AND ALGORITHMS-I**

**(3-0-0) 3**

Elementary Data Types and Abstract Data Types. Computational model and complexity of algorithms (running time and space metrics), Introduction to Asymptotic notation: Big-O, Big-Omega, Big-Theta notations. Worst-case, Best-case, Average-case and amortized analysis. Arrays, Linear search and Binary search on sorted arrays. List ADT, implementing List ADT using arrays. Pointers, implementing List ADT using Linked Lists. Types of Linked Lists:

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Single, Double, Circular linked lists and their applications for e.g. in garbage collection. Stack ADT and Queue ADT implementation, applications for parenthesis matching, expression evaluation, implementing recursion, etc. Dynamic set ADT and Dictionary ADT. Hash tables: collisions, open and closed hashing, choosing good hash functions. Trees: Definitions and Representations; Tree traversals and their applications. Binary Search Trees. AVL trees, Red-black trees, Multi-way search trees, B- trees, splay trees; Priority Queue ADT and its implementations using Binary heaps. Applications of Priority Queues. Sorting algorithms: Bubble sort, Selection sort, Insertion sort, Merge sort and Quick sort. Randomized Quick sort and its analysis. Linear-time sorting algorithms like Radix and Counting sort. Lower bound for comparison based sorting.

*T H Cormen et al., Introduction to Algorithms, 3<sup>rd</sup> Edition, PHI Learning Ltd., 2010.*

*S. Horowitz. Fundamentals of Data Structures in C, Universities Press, 2<sup>nd</sup> Edition, 2008.*

*Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1st Edition, 2006.*

*Knuth D.E., Art of Computer Programming: Fundamental Algorithms, Addison Wesley, 3rd Ed., 1997.*

### IT203 DISCRETE MATHEMATICS

(3-0-0) 3

Mathematical Logic and Proofs: Propositional Logic and Applications, Operations on Propositions, Truth Tables, Tautologies & Logical Equivalence, Predicate Logic, Predicates & Quantifiers, Nested Quantifiers, Inference Rules, Proofs Methods; Set Theory: Sets/Operations, Sequences/Summations, Cardinality of Sets, Functions (Surjections, Injections); Induction and Recursion: Mathematical Induction, Strong Induction and Well-Ordering, Recursive Definitions, Structural Induction; Combinatorics: Counting, Pigeonhole Principle, Permutations/Combinations, Binomial Coefficients, Recurrence Relations, Generating Functions, Inclusion-Exclusion; Relations:  $n$ -ary Relations and Applications, Representing Relations, Closures of Relations, Equivalence Relations, Partial Orders; Group Theory: Groups, Semigroups, Monoids, Rings, Fields, Vector Spaces and Lattices; Graph Theory: Graphs and Models, Euler and Hamiltonian Paths, Trees, Tree Traversals, Spanning Trees, Graph Matching, Graph Coloring.

*C.L.Liu and D.P. Mahapatra, Elements of Discrete Mathematics, 4th Edition, McGraw-Hill, 2012.*

*K.H.Rosen, Discrete Mathematics and Its Applications, 7th Edition, McGraw-Hill, 2017.*

*John A. Dossey, Discrete Mathematics, 5th Edition, Pearson, 2011.*

*Jean-Paul Tremblay and R Manohar, Discrete Mathematical Structures with Apps., 1st Ed., McGraw-Hill, 2017.*

*J. L.Mott, A.Kandel, T.P. Baker, Discrete Mathematics for Computer Scientists, 2nd Ed., Prentice Hall of India, 1986.*

### IT204 SIGNALS AND SYSTEMS

(3-0-2) 4

Signals in Physical World: Continuous Time Signals & Spectra, Fourier Series, Fourier Transforms; Signals in Digital World: Sampling, Quantization, Interpolation, Discrete Time Signals & Spectra, Discrete Fourier Transforms (DFT); Fast Fourier Transforms (FFT), Discrete Cosine Transforms (DCT), Systems: Continuous Linear Time Invariant (LTI) and Time Variant (LTV) Systems, Discrete LTI & LTV Systems; Z-Transform; Convolution and Correlation; Filters: Feedforward and Feedback; Modulation: AM, FM, PAM, PCM, Multiplexing: FDM and TDM; Compression: Text (Huffman Coding, Run Length Coding); Audio (MP3); Image (JPEG); Video (MPEG4).

*Michael Stiber and Bilin Stiber, "Signal Computing: Digital Signals in the Software Domain", Published by University of Washington Bothell, 2016.*

*A.V. Oppenheim, A.S. Willsky and S. Hamid Nawab, Signals and Systems, 2nd Edition, Pearson, 2015.*

*Rodger E. Ziemer, W.H. Tranter and D.R. Fannin, Signals and Systems, 4th Edition, Pearson, 2014.*

*B.P. Lathi and Roger Green, Linear Systems and Signals, 3rd Edition, Oxford University Press, 2017.*

*M.J. Roberts, Signals and Systems - Analysis Using Transform Methods & MATLAB, McGraw-Hill, 2017.*

*Luis F. Chaparro, Signals and Systems Using MATLAB, 2nd Edition, Academic Press, 2014.*

### IT205 COMPUTER NETWORKING LAB

(0-0-3) 2

Implementation of Datalink Layer Protocols, Network Layer Protocols and Application Layer Protocols. Simulate different types of network topology, configure Router and Switches using open source tool such packet tracer. By writing a program/script measure incoming and outgoing network traffic, power consumption and storage status on networking device(s)/server.

### IT206 DATA STRUCTURES AND ALGORITHMS-I LAB

(0-0-3) 2

Implementation of List ADT operations using arrays and linked lists. Applications of Lists. Stacks, Queues, Circular Queues implementation and application. Implementing Hash Table with chaining and open addressing. AVL tree implementation, B- tree implementation, Application of trees. Array and pointer-based implementation of Binary heaps. Applications of Priority Queues. Searching and sorting. Applications to real world problems.

### IT210 DATA STRUCTURES AND ALGORITHMS

(3-0-2) 4

Elementary Data Types and Abstract data types. Computational model and complexity of algorithms (running time

and space metrics), Introduction to Asymptotic notation; Worst- case, Best -case, Average-case and amortized analysis. Arrays, Linear search and Binary search on sorted arrays. List ADT and its implementation using arrays and linked lists. Types of linked lists: Single, Double, circular linked lists and their applications. Stack ADT and Queue ADT implementations with applications. Dynamic set ADT and Dictionary ADT. Hash tables – collisions, open and closed hashing, choosing good hash functions. Trees: Definitions and Representations; Tree traversals and their applications. Binary Search Trees. AVL trees, Red-black trees, B-trees; Priority Queue ADT and its implementations using Binary heaps. Applications of Priority Queues. Sorting algorithms: Merge sort and Quick sort. Randomized Quick sort and its analysis. Linear-time sorting algorithms like Radix and Counting sort. Graphs: Definitions and representations. Depth-first and breadth-first search and their applications. Basic Graph algorithms like Dijkstra's shortest path algorithm and Kruskal's MST algorithm.

*T H Cormen, C E Leiserson, R L Rivest and C Stein, Introduction to Algorithms, 3<sup>rd</sup> Edition, PHI Learning, 2010.*

*S. Horowitz, Fundamentals of Data Structures in C, Universities Press, 2<sup>nd</sup> Edition, 2008.*

*Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1<sup>st</sup> Edition, 2006.*

*Knuth D.E., The Art of Computer Programming, Vol. I: Fundamental Algorithms, Addison Wesley, 3<sup>rd</sup> Ed., 1997.*

#### **IT250 AUTOMATA AND COMPILER DESIGN**

**(3-0-2) 4**

Introduction to Automata and Compiler Design, Regular Expressions, DFA, NFA, Minimization of states, Lexical analysis, usage of Lex, CFG, BNF notation, PDA, Parsing Techniques, Top-down and bottom-up parsing, Error Recovery strategies, Intermediate Code Generation, Runtime environment, Code Generation and introduction to code optimizations. Simple projects to demonstrate the usage of parsers for code generation for a simple C-like language.

*John E. Hopcroft et al., Introduction to Automata Theory, Languages and Computation, 3rd Ed., Pearson, 2007.*

*A.V. Aho et al., "Compilers: Principles, Techniques, Tools", 2nd Edition, Pearson, 2006.*

*Allen I. Holub, "Compiler Design in C", Prentice-Hall, 1990.*

#### **IT251 DATA STRUCTURES AND ALGORITHMS-II**

**(3-0-2) 4**

Graphs: Definitions and representations. Adjacency List and Adjacency Matrix representations and their relative advantages and disadvantages. Graph Algorithms: Depth-First Search (DFS) and Breadth-First Search (BFS). Applications of BFS and DFS. Topological Sorting and strongly connected components in directed graphs. Dijkstra's shortest path algorithm, and its analysis: runtime and correctness. Data Structure for Disjoint Sets: Union-by-rank and path-compression heuristics; applications to computing connected components and in Minimum Spanning Tree algorithms. Kruskal's and Prim's Minimal Spanning Tree algorithms. Network flows, max-flow min-cut theorem. Applications: network and internet examples. Tries, Suffix trees, Bloom filters and their applications. String Algorithms: Boyer-Moore, Rabin-Karp and Knuth-Morris-Pratt algorithms. Applications to Text Compression, Text similarity testing and Computational Biology. Topics in Computational Geometry: Range-trees, k-d trees, convex hull and other geometric algorithms.

*Jon Kleinberg and Eva Tardos, Algorithm Design, 1<sup>st</sup> Edition, Pearson Education India, 2013.*

*S Dasgupta, C Papadimitriou, U Vazirani, Algorithms, McGraw-Hill Education, 2006.*

*T H Cormen, C E Leiserson, R L Rivest, C Stein, Introduction to Algorithms, 3<sup>rd</sup> Edition, PHI Learning, 2010.*

*Horowitz and Sahni, Fundamentals of Computer Algorithms, Galgotia Publications, 2nd Ed., 2009.*

*Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1<sup>st</sup> Edition, 2006.*

#### **IT252 DATABASE SYSTEMS**

**(3-0-2) 4**

Basic Concepts, Data models: ER, EER; Languages: SQL as backend and PHP or equivalent as frontend; Logical Database Design: Normalization; Physical Database Design: Storage organization, Indexing; Query Languages – Procedural , Non-procedural; Logical and Physical Design, Query Processing, Transaction processing: Concurrency Control and Recovery. Current trends in database system, Design and Implementation of Database Systems for applications such as office automation, hotel management, hospital management; Normalization, Query Processing in the above said application projects; Implementation of few important functionalities of relational database management systems.

*Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-Hill, 2014 R.*

*Elmasri and S.B Navathe , Fundamentals of Database Systems, 7th Ed., Pearson, 2017*

*Silberschatz, Korth A.F., Sudarshan S., Database System Concepts, 6th Ed., McGraw-Hill, 2010.*

#### **IT253 OPERATING SYSTEMS**

**(3-0-2) 4**

Operating Systems Overview, Interrupt Sources and Priorities, Interrupt Service Routines; User and Kernel Threads, Synchronization, Critical Section Problem; Process Synchronization and Coordination, Semaphores, Monitors; Inter Process Communication; Deadlock Prevention, Avoidance, Detection, Recovery; CPU Scheduling Algorithms, Memory Management, Paging and Virtual Memory, Storage Hierarchy, File System Organization; Distributed Operating Systems: System Architectures, Design Issues, Communication Models, Clock Synchronization, Mutual Exclusion, Election Algorithms, Distributed Deadlock Detection; Mobile Operating Systems: ARM & Intel

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Architectures, Mobile OS Architectures, Runtime Issues, Approaches to Power Management; UNIX/LINUX OS as Case Studies; Configure, Compile, and Install a Linux Kernel/Kernel Module from Sources, Performance Analysis; Device Drivers: Building and Running Modules, Char Drivers, Concurrency and Race Conditions, Interrupt Handling, Data Types in the Kernel, PCI Drivers, USB Drivers, Block Drivers, Network Drivers, TTY Drivers.

*Andrew S. Tannenbaum and Herbert Bos, Modern Operating Systems, 4th Edition, Pearson, 2015*

*Abraham Silberschatz et al., Operating System Concepts, 9th Ed., John Wiley, 2012.*

*Harvey M. Deitel et al., Operating System, 3rd Edition, Pearson, 2007.*

*William Stallings, Operating Systems: Internals and Design Principles. 9th Ed., Pearson, 2017.*

*M. J. Bach. Design of the Unix Operating System, 1st Edition, Pearson, 2015.*

*Jonathan Corbet et al., Linux Device Drivers, 4th Edition, O'Reilly, 2013.*

### IT254 WEB TECHNOLOGIES AND APPLICATIONS

(3-0-2) 4

Internet and World Wide Web - Overview, Web System Architecture, Web Clients and Web Servers, Application Servers. Hypertext Transfer Protocol - primitives, methods, content transport, HTTP1.1 and HTTP2, HTTPS, SSL. Client side programming with XHTML, HTML5, CSS3, Event driven programming with JavaScript, Client-side validation; Server side programming, Sessions and Session Tracking techniques, jQuery and AJAX.; XML – Syntax and Semantics, DTD, Namespaces, XML Schemas, XPath and XSLT, Web Frameworks, Search Engines and Search Engine Optimization; The Next Generation Web - Social Web, Semantic Web, Internet/Web of Things, Applications and Research Trends.

*Jeffrey C Jackson, "Web Technologies – A Computer Science Perspective", Pearson Education, 2009*

*Robert W Sebesta, "Programming the World Wide Web", 7th Edition, Pearson Education, 2014*

*Dietel and Nieto, "Internet and World Wide Web — How to program", Pearson, 2010*

### IT290 SEMINAR

1

This seminar is a 1 credit mandatory learning course to be completed during 4th semester. Each student will make technical presentation on a topic of academic interest as per recommendations and evaluation criteria of the DUGC of IT department.

### IT300 DESIGN AND ANALYSIS OF ALGORITHMS

(3-0-2) 4

Models of computation, algorithm analysis and asymptotic notation, time and space complexity, average and worst case analysis, lower bounds. Amortized analysis. Algorithm design techniques: recursion, branch-and-bound, divide and conquer, greedy, dynamic programming, randomization. Applications of the above techniques to a variety of problems: Stable matching, linear- time selection, integer, polynomial and matrix multiplications, Fast Fourier Transforms (FFT): FFT Algorithms, computing shortest paths and minimum spanning trees, etc. Reductions and the theory of NP-Completeness, Approximation algorithms.

*Jon Kleinberg and Eva Tardos, Algorithm Design, 1<sup>st</sup> Edition, Pearson Education India, 2013.*

*S Dasgupta, C Papadimitriou, U Vazirani, Algorithms, McGraw-Hill Education, 2006.*

*T H Cormen, C E Leiserson, R L Rivest, C Stein, Introduction to Algorithms, 3<sup>rd</sup> Edition, PHI, 2010.*

*Steven S Skiena, The Algorithm Design Manual, 2nd Edition, Springer-Verlag, 2<sup>nd</sup> Edition, 2013.*

*Michael T. Goodrich and Roberto Tamassia. Algorithm Design, Wiley, 1<sup>st</sup> Edition, 2006.*

*Horowitz and Sahni, Fundamentals of Computer Algorithms, Galgotia Publications, 2<sup>nd</sup> Edition, 2009.*

### IT301 PARALLEL COMPUTING

(3-0-2) 4

Introduction to Parallel Computer Architectures, Shared memory and distributed memory programming techniques, Parallel Programming with OpenMP, MPI, Parallel Programming techniques like Task Parallelism using TBB, TL2, Cilk++ etc. and software transactional memory techniques. Introduction to accelerator programming using CUDA/OpenCL and Xeon-phi. Concepts of Heterogeneous programming techniques. Projects to implement a few of the techniques introduced in this course.

*J. Dongara, I. Foster, G. Fox, W. Cropp et al, "Sourcebook of Parallel Programming", Morgan Kaufmann, 2002.*

*Barbara Chapman et.al, "OpenMP: Portable Shared Memory Parallel Programming", Scientific & Engineering Computation, MIT 2008.*

*B. Wilkinson and M. Allen, "Parallel Programming: Techniques and Applications", 2nd ed., Pearson, 2004.*

*Benedict R. Gaster et al., Heterogeneous Computing with OpenCL, 2nd Edition, Morgan Kaufmann. 2012.*

*Rezaur Rahman, Intel Xeon-Phi Coprocessor Architecture/Tools - The Guide for App. Developers, Apress, 2013.*

*CUDA for Engineers by Duane Storti and Mete Yurgotlu, Addison-Wesley, 2016.*

### IT302 PROBABILITY AND STATISTICS

(3-0-2) 4

Introduction to Statistics and Data Analysis; Probability Theory: Non-deterministic models, Finite Probability Space and related concepts, Conditional Probability, Independent and mutually exclusive events, Bayes' Theorem, Random Variables – One and Two dimensional, Expectation, Variance, Correlation, Statistical Distributions – Uniform, Normal,

Binomial, Gamma, Exponential, Poisson, Chi-Square, Log-Normal, Weibull; Stochastic Processes: Markov Chains, Binomial & Poisson; Queuing Systems: M/M/1 and M/M/K; Sampling Theory: Random Sampling and Applications, Mean, Median, Mode, Variance, Standard Deviation; Hypothesis Testing: Formulation of hypotheses – null and alternate hypothesis, Parametric and non-parametric tests and their applicability, Criteria for acceptance of hypothesis, Level of Significance, *t*-test, *z*-test and Chi-Square Tests with applications.

*P. L. Meyer, Introductory Probability and Statistical Applications, Oxford & IBH Publishers, 2017.*

*S. M. Ross, Introduction to Probability & Statistics for Engineers and Scientists, 5th Ed., Academic Press, 2014.*

*Michael Baron, Probability and Statistics for Computer Scientists, 2nd Edition, CRC Press, 2014.*

*R. V. Hogg, J. W. McKean and A. T. Craig, Introduction to Mathematical Statistics, 7th Edition, Pearson, 2012.*

*R. E. Walpole et al., Probability and Statistics for Engineers and Scientists, 9th Edition, Pearson, 2010.*

*Jane M. Horgan, Probability with R with Computer Science Applications, 1st Edition, John Wiley, 2009.*

*John Verzani, Using R for Introductory Statistics, 2nd Edition, CRC Press, 2014.*

*G. Jay Kerns, Introduction to Probability and Statistics Using R, 1st Edition, G. Jay Kerns, 2010.*

*Maria Dolores Ugarte et al., Probability and Statistics with R, 2nd Edition, CRC Press, 2015.*

### **IT303 SOFTWARE ENGINEERING**

**(3-0-2) 4**

Software Requirements Fundamentals: Product and Process Requirements, Functional and Nonfunctional Requirements, Quantifiable Requirements, System Requirements and Software Requirements, Requirements Process Models, Process Actors, Requirements Elicitation, Requirements Classification, Architectural Design and Requirements Allocation, Formal Analysis, Requirements Specification, Software Requirements Specification Requirements Reviews, Prototyping, Key Issues in Software Design: Concurrency, Control and Handling of Events, Data Persistence, Distribution of Components, Error and Exception Handling and Fault Tolerance, Interaction and Presentation, Security, Software Structure and Architecture, Architectural Structures and Viewpoints, Architectural Styles, Architecture Design Decisions, Families of Programs and Frameworks, User Interface Design, General User Interface Design Principles, Software Design Quality Analysis and Evaluation, Quality Attributes, Quality Analysis and Evaluation Techniques, Measures. General Strategies: Function-Oriented (Structured) Design, Object-Oriented Design, Data Structure-Centered Design, Component-Based Design; Software Construction: Minimizing Complexity, Anticipating Change, Constructing for Verification, Reuse, Coding, Integration, Construction Technologies, API Design and Use, Object-Oriented Runtime Issues, Parameterization and Generics, Assertions, Design by Contract, and Defensive Programming, Performance Analysis and Tuning, Unit Testing Tools, Profiling, Performance Analysis, and Slicing Tools; Software Testing, Input Domain-Based Techniques, Code-Based Techniques, Fault-Based Techniques, Usage-Based Techniques, Model-Based Testing Techniques, Software Maintenance Fundamentals, Techniques for Maintenance, Program Comprehension, Reengineering, Reverse Engineering, Migration, Retirement; Software Configuration Management, Management of the SCM Process, Organizational Context for SCM, Constraints and Guidance for the SCM Process, Planning for SCM, Surveillance of Software Configuration Management, Software Configuration Identification, Identifying Items to Be Controlled, Requesting, Evaluating, and Approving Software Changes, Implementing Software Changes, Deviations and Waivers, Software Configuration Status Accounting, Software Configuration Auditing, In-Process Audits of a Software Baseline, Software Release Management and Delivery, Software Building Software Release Management, Software Configuration Management Tools.

*Axel van Lamsweerde, Requirements Engg: From System Goals to UML Models to Software Specs., Wiley, 2009.*

*Lenny Delligatti, SysML Distilled: A Brief Guide to the Systems Modeling Language, 1st Ed., Addison-Wesley, 2013.*

*J.H. Allen et al., Software Security Engineering: A Guide for Project Managers, Addison-Wesley, 2008.*

*R.S. Pressman, Software Engineering: A Practitioner's Approach, 7th ed., McGraw-Hill, 2010.*

*P. Clements et al., Documenting Software Architectures: Views and Beyond, 2nd ed., Pearson Education, 2010.*

*M. Utting and B. Legeard, Practical Model-Based Testing: A Tools Approach, Morgan Kaufmann, 2007.*

*J.W. Moore, The Road Map to Software Engg: A Standards-Based Guide, Wiley-IEEE Computer Society Press, 2006.*

*S.P. Berczuk and B. Appleton, Software Configuration Management Patterns: Effective Teamwork, Practical Integration, Addison-Wesley Professional, 2003.*

### **IT350 DATA ANALYTICS**

**(3-0-2) 4**

Introduction to Data analysis: statistical modelling, total information awareness, Bonferroni's Principle; Distributed File systems: MapReduce and Spark; Dimensionality Reduction: PCA, SVD; Finding Similar Items: Distance Measures, Near Neighbour Search; Mining Data Streams; Link Analysis, Mining Social-Network Graphs: graph centrality concepts, clustering, community detection, partitioning, overlapping community detection, SimRank; Applications of Large-scale Machine Learning, Neural Network Models like Multi-Layer Perceptron (MLP), Recurrent Neural Networks (RNN), Convolutional Neural Network (CNN), Long Short Term Memory (LSTM).

*Josh Patterson and Adam Gibson, "Deep learning: A Practitioner's Approach", O'Reilly, 2017*

*Ian Goodfellow, Y. Bengio and A. Courville, "Deep Learning", MIT Press, 2016.*

*Michael A. Nielsen, "Neural Networks and Deep Learning", Determination Press, 2015*



Li Deng and Dong Yu, "Deep Learning: Methods and Applications", 2013  
Koller, D. and Friedman, N. Probabilistic Graphical Models . MIT Press. 2009  
Hastie, Trevor, et al. The elements of statistical learning. Vol. 2. No. 1. New York: springer, 2009.  
Jure Leskovec et al., "Mining of Massive Datasets" Cambridge University Press, 2014  
Tom White " Hadoop: The Definitive Guide" Fourth Edition, O'reilly Media, 2015.

#### **IT351 HUMAN COMPUTER INTERACTION**

**(3-0-2) 4**

Foundations: The Human, The Computer, The Interaction and Paradigms; User Experience Design; The Process of Developing Interactive Systems: Models, Theories, Design Process and Evaluation; Interacting with Computers: Vision, Graphic Design, and Visual Displays - Touch, Gesture and Marking, Speech, Language and Audition; Human Factors in Design; Effective Interfaces; Application Domain Aspects; Affective User Experiences; Human Centered Evaluations; Assistive Technologies and Accessibility; User Advocacy; Research Trends.

Andrew Sears and Julie A. Jacko, *The Human-Computer Interaction Handbook: Fundamentals, Evolving Technologies and Emerging Applications*, 3rd Edition, CRC Press, New York 2012.

Philip Kortum, *HCI Beyond the GUI: Design for Haptic, Speech, Olfactory and other Nontraditional Interfaces*, Morgan Kaufmann Inc., Originally Published by Elsevier, 2008.

Alan Dix et al., *Human Computer Interaction*, 3rd Edition, Pearson, 2004.

Don Norman, *The Design of Everyday Things: Revised and Expanded Edition*, Basic Books, 2013.

Ben Shneiderman et al., *Designing the User Interface: Strategies for Effective HCI*, 6th Edition, Pearson, 2016.

J. Preece et al., *Interaction Design: Beyond Human Computer Interaction*, 4th Edition, Wiley, 2015.

Joel March, *UX for Beginners: A Crash Course in 100 Short Lessons*, O'Reilly Media, 2015

Jesse James Garrett, *The Elements of User Experience: UCD for the Web and Beyond*, New Riders, 2011.

Jeff Gothelf and Josh Seiden, *Lean UX: Designing Great Products with Agile Teams*, O'Reilly Media, 2016.

Constantine Stephanidis, *User Interfaces for All: Concepts, Methods and Tools*, LEA Inc., New Jersey, 2009.

Nicola Millard, *Designing Motivational User Interfaces: Balancing Effective and Affective User Interface Design to Motivate Call Centre Advisors*, VDM Verlag Dr. Müller, 2009.

Rex Hartson and Pardha S. Pyla, *UX Book: Process/Guidelines for Ensuring QUX*, Morgan Kaufmann, 2012.

#### **IT352 INFORMATION ASSURANCE AND SECURITY**

**(3-0-2) 4**

Cryptography: Private and Public Key Encryption, Uses of Encryption; Network Security: threats, controls – Encryption, Authentication, Network Security tools (Firewalls, Intrusion Detection); Program Security: non-malicious program errors such as buffer overflow, viruses, other malicious code, targeted malicious code, controls against program threats; Protection in Operating Systems: protected objects, methods of protection, access control, authentication; Web Security; Data security and privacy; Forensics and Incident response; Security Policies and Procedures.

"Network Security Essentials", William Stallings, 4<sup>th</sup> Edition, Pearson Education, 2008.

"Cryptography & Network Security", Atul Kahate, McGraw Hill, 2004.

"Information Assurance–Dependability & Security in Networked Systems", Yi Qian et al, Morgan Kaufmann, 2008.

"A. Abraham et al, Computational Intelligence in Information assurance and security", N.Nedjah, Springer

#### **IT360 INFORMATION SYSTEMS**

**(3-0-2) 4**

Introduction to Information Systems; Information Systems Development: Life Cycle, Management, Strategies, Construction Approaches; Systems Planning; Systems Analysis: Requirements, Tools for Business Process Modelling, Data Flow Diagram & Its Use, Data Modelling, Analysis Report; Systems Design: Acquisition Development, Construction Development, Systems Design Report; Systems Implementation; Systems Maintenance: Management, Post-Project Evaluation.

Shouhong Wang and Hai Wang, *Information Systems Analysis and Design*, Universal Publishers, 2012.

V. Rajaraman, *Analysis and Design of Information Systems*, 3rd Edition, PHI Learning, 2011.

Dennis, Wixom and Roth, *Systems Analysis & Design*, 5th Edition, John Wiley, 2012.

Langer A.M, *Analysis and Design of Information Systems*, 3rd Edition, Springer, 2008.

James A. Senn, *Analysis & Design of Information Systems*, 2nd Edition, McGraw-Hill, 2008.

Jeffrey L. Whitten and Lonnie D. Bentley, *System Analysis and Design Methods*, 7th Ed., McGraw-Hill, 2007.

Raul Sidnei Wazlawick, *Object Oriented Analysis and Design for Information Systems: Modelling with UML, OCL, and IFML*, Elsevier, 2014.

#### **IT361 PARADIGMS OF PROGRAMMING**

**(3-0-2) 4**

Programming domains; Language Evaluation; Programming Paradigms – Imperative, Functional, OOP and Logic

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programming; Formal methods: syntax and semantics - Backus Naur Form, Attribute grammars; Describing semantics - Denotational semantics; Data types, Names, Variables, Bindings, Scope and lifetime, Referencing Environments; Named Constants-Variable Initialization-Subprograms-Parameter Passing – Coroutines; Even Driven Programming; Fundamentals; Case studies from Desktop to Mobile applications, VB.NET, ANDRIOD Applications; Functional programming languages - Lambda calculus - LISP; Application of functional programming languages; Logic programming languages –introduction to predicate calculus - Horn clauses - Logic programming: Prolog, Applications; Asynchronous Programming Model with a Case Study (AJAX, C#...); Run-time Program Management; Virtual Machines: Java Virtual Machine, Common Language Infrastructure, Late Binding of Machine Code, Just-in-Time and Dynamic Compilation, Binary Translation, Binary Rewriting, Mobile Code and Sandboxing, Performance Analysis. Robert W. Sebesta, "Concepts of Programming Languages", 11<sup>th</sup> Edition, Pearson, 2016. Ravi Sethi, "Programming Languages - Concepts and Constructs", 2<sup>nd</sup> Edition, Pearson, 2002. Michael L. Scott, "Programming Language Pragmatics", 4th Edition, Morgan Kaufmann, 2015. Kenneth.C.Louden, "Programming Languages: Principles and Practices", 3rd Edition, Cengage Learning, 2011.

### IT362 COMPUTER GRAPHICS

(3- 0-2) 4

Computer Graphics Hardware; Scan Conversion: lines, circles, ellipses; Filling Algorithms, Clipping Algorithms, Viewing in 3D: Projections, 2D & 3D transformations, Visible surface determination, Animation of 2D images: Implementation of 2D packages which support graphics editor with classical input techniques and animation. Hearn and Backer, *Computer Graphics Principles and Practice-3rd Edition*, Addison Wesley, 2013. Van Dam, Foley, Feimer, *Hughes Computer Graphics Principles and Practice in C, 1st ed.*, Pearson, 2013.

### IT363 MICROPROCESSORS AND INTERFACING

(3-0-2) 4

Microprocessor history, Microprocessor architecture, 8086, instruction set, subroutines, Programming examples, software development systems, Interrupts, Polling, Daisy chain, RST instructions, Priority encoder, Programmable peripheral devices, 8255, 8253, 8259, 8257, Intel 80386, 80486 & Pentium Processors, Motorola 68000, 68020, 68030 processors, Mother boards, I/o bus, I/O channel, BIOS, DOS PC bus, Multibus I& II, VME and peripheral controllers. Douglas V. Hall, *Microprocessors and Interfacing*, 2<sup>nd</sup> Edition, Tata McGraw-Hill, 2006. Babby B.Brey, *The Intel Microprocessors – Architecture, Programming & Interfacing*, Pearson/Prentice Hall, 2008

### IT364 PERFORMANCE MODELING

(3-0-2) 4

Performance Evaluation methods. Analytical versus simulation modeling. Performance measurement and benchmarking. Workload modeling. Random variables. Commonly used distributions. Stochastic processes. Markov chain models of computer systems. Queuing models. Discrete event simulation. Simulation Languages. Confidence intervals. Variance reduction techniques. Case studies of analytical & simulation of computer systems. Raj Jain, *The Art of Computer Systems Performance Analysis*, Jon Wiley and Sons, New York, USA, 1991. KS Trivedi, *Probability and Statistics with Reliability, Queuing and computer science*, PHI 1982. Paul & Howard, *Computer systems performance Evaluation & Prediction*, Elsevier, 2005.

### IT365 ADVANCED COMPUTER NETWORKS

(3-0-2) 4

Review of TCP/IP Protocol suit with latest developments, Broadband networks, advanced concepts: ATM, Frame Relay, Fiber Optic Networks: SONET, VOIP, MIPv6 etc., Remote Access and Wireless Networking: Virtual Private Networks - L2 and L3 Switches, Tunneling; BGP and Adaptive Routing, MPLS: QoS, Network Recovery/Restoration; Security Issues in TCP/IP and BGP, DoS/DDoS attacks, Mitigation with recent trends, Cryptography, Intrusion Detection; Network Management issues and protocols, Internet Management, Common Management Information services/protocol (CMIS/CMIP), Network Trouble Shooting, QoS (Integrated/Differentiated Services), Port based Network Access control, Availability, Scalability, Load Balancing and Recent Trends. James F Kurose and Keith W Rose, *Computer Networking*, Pearson Education, 2003 Andrew. S. Tannenbaum, *Computer Networks*, Prentice Hall of India, 2nd Edition, 2002. M. Subramanian, *Network Management: Principles and Practice*, Addison- Wesley, 2000. William Stallings, *Data and Computer Communications and Networking*, 2nd Edition, TMH, 2002. Behrouz A Forouzan, *Data Communications and Networking*, 2nd edition, TMH, 2002. Leon, Garcia and Widjaja - *Communication Networks*, TMH 2002.

### IT366 OBJECT ORIENTED ANALYSIS AND DESIGN

(3-0-2) 4

Introduction to object technology and applications; object oriented decomposition vs. structured decomposition in software development, concepts and applications of object oriented analysis and design, object oriented databases, application development using programming language JAVA. Grady Booch, *Object Oriented Analysis and Design with Applications*, 3rd Edition, Addison Wesley, 2007. Michael R. Blaha and James Rumbaugh, *Object Oriented Modeling/Design with UML*, 2nd Ed., Pearson, 2004.

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Raul Sidnei Wazlawick, *Object Oriented Analysis and Design for Information Systems: Modelling with UML, OCL, and IFML*, Elsevier, 2014.

### IT400 PERCEPTUAL AUDIO PROCESSING

(3-0-2) 4

Fundamentals of Audio and Speech Processing; Speech and Audio Analysis: Transforms – STFT, DCT; Audio and Speech Compression Standards: MPEG and AAC; Human Auditory Perception; Perceptual Audio Quality Metrics, Perceptual Processing of Digital Speech; Speech and Audio Rendering; Speech and Audio Storage and Retrieval; Applications and Research Trends.

Jacob Benesty, M. Mohan Sondhi and Yiteng Huang, *Handbook of Speech Processing*, Springer-Verlag, 2008.

A Spanias, T Painter and Venkatraman A, “Audio Signal Processing and Coding”, Wiley-Interscience, 2007.

Hugo Fastl and Eberhard Zwicker, “Psychoacoustics: Facts and Models”, Springer, 3rd edition, 2006. Marina

Bosi and Richard E. Goldberg, “Introduction to Digital Audio Coding Standards”, Springer, 2002. Ben G,

Nelson M, “Speech & Audio Signal Processing: Processing/Perception of Speech/Music”, Wiley, 1999.

### IT401 PERCEPTUAL VIDEO PROCESSING

(3-0-2) 4

Fundamentals of Image and Video Processing; Image and Video Analysis: Image Transforms - DCT, Hadamard, Haar, KL and Wavelets; Image and Video Compression Standards: JPEG, JPEG2000, MPEG1, MPEG2, MPEG4 & MPEG7; Image and Video Rendering and Assessment; Human Visual Perception; Perceptual Video Quality Metrics, Perceptual Coding and Processing of Digital Pictures; Image and Video Storage, Retrieval; Applications and Research Trends.

*Perceptual Based Image Processing*, Morgan & Claypool, 2009

Al Bovik, “Handbook of Image and Video Processing”, Elsevier Academic Press, 2005

H. R. Wu and K. R. Rao, “Digital Video Image Quality and Perceptual Coding”, CRC Press, 2005

R. C. Gonzalez and R E Woods, “Digital Image Processing”, Pearson Education, 2002 William K

Pratt, “Digital Image Processing”, Wiley, 2001.

### IT402 SOFT COMPUTING

(3-0-2) 4

Optimization and Some Traditional Methods and issues, Introduction to Genetic Algorithms, Some Specialized Genetic Algorithms, Introduction to Fuzzy Sets, Fuzzy Reasoning and Clustering, Fundamentals of Neural Networks, Fundamentals biologically inspired computing, Hybrid soft computing methods, Swarm optimization techniques: Particle swarm optimization and Global swarm optimization, Applications and Recent Research Trends.

Vojislav Kecman, *Learning and Soft Computing*, Pearson Education ( Asia ) PTE, 2004

Ross T.J., *Fuzzy logic with engineering applications*-McGraw Hill, 1995

J. M. Zurada, *Introduction to artificial neural networks*, Jaico publishing, 1997.

Goldberg D., *Genetic algorithms*- Addison-Wesley, 1st edition, 1989.

S. N. Sivanandam, S. N. Deepa, *Principles of Soft Computing* 2nd edition, Wiley, 2011.

Shishir K. Shandilya, Smita Shandilya, Kusum Deep, Atulya K. Nagar, *Handbook of Research on Soft Computing and Nature-Inspired Algorithms*, IGI Global, 2017.

*Evolutionary Algorithm for Solving Multi-objective, Optimization Problems (2<sup>nd</sup> Edition)*, Collelo, Lament, Veldhnizer ( Springer)

J. Han and M. Kambar, *Data Mining: Concepts and Techniques*, Morgan Kaufmann Publishers Elsevier, 2008

### IT403 GENETIC ALGORITHMS

(3-0-2) 4

Robustness of traditional optimization and search techniques, Simple Genetic Algorithms, Similarity templates, goals of optimization, Schema Theorem of John Holland, Computer Implementation and Applications of genetic algorithms, advanced operators and techniques in genetic algorithms, Recent research Trends.

David Goldberg, *Genetic Algorithms in search, optimizations and machine learning*, Addison Wesley, 1999

Charles L Karr and L Michael Freeman, *Industrial applications of Genetic Algorithms*, CRC Press 1998.

### IT404 ARTIFICIAL NEURAL NETWORKS

(3-0-2) 4

Introduction to Artificial Neural Networks , Artificial Neuron Model and Linear Regression, Gradient Descent Algorithm, Nonlinear Activation Units and Learning Mechanisms, Learning Mechanisms, Associative Memory Model, Statistical Aspects of Learning, Single-Layer Perceptron, Least Mean Squares Algorithm, Perceptron Convergence Theorem, Bayes Classifier, Back Propagation Algorithm, Multi-Class Classification Using Multi-layered Perceptrons, Radial Basis Function Network, Introduction to Principal Component Analysis and Independent Component Analysis, Introduction to Self Organizing Maps, Applications and Recent Research Trends

Simon Haykin, “Neural Networks - A Comprehensive Foundations”, Pearson, 2004

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Laurene Fausett: "Fundamentals of Neural Networks: Architectures, Algorithms & Apps.", Pearson, 2004.

James A. Anderson, "An Introduction to Neural Networks", MIT press, 1995.

Yegnanarayana: "Artificial Neural Networks", Prentice Hall of India, 2004.

### IT405 FUZZY SYSTEM MODELS

(3-0-0) 3

Classical /crisp set, fuzzy sets, Fuzzy numbers, Fuzzy arithmetic, Fuzzy measures, Operations on Fuzzy sets, Fuzzy relations, Multi valued logic, Fuzzy logic, Uncertainty and information, Approximate reasoning, Fuzzy decision making, Fuzzy models, case studies.

Klir and Yuan, *Fuzzy Sets and Fuzzy Logic*, Prentice Hall of India 2001.

Li Xin Wang, *A Course in Fuzzy Systems and Control*, Prentice Hall, 1996.

J. Yen and R. Langari, *Fuzzy logic: Intelligence, Control and Information*, Pearson, 1998.

### IT406 DISTRIBUTED COMPUTING SYSTEMS

(3-0-2) 4

Basic concepts - Computer networks, Distributed systems and Computing, Design goals, Fundamental issues and transparencies in DCS, Ordering of events, Ordering of messages and concerned protocols, Global state detection Process synchronization, Process communications, Load balancing techniques. Mukesh Singhal and Niranjan G. Shivaratri, *Advanced Concepts in Operating System*, Tata McGraw Hill, 1994.

A.S Tanenbaum and M.V. Steen, *Distributed Systems – Principles and Paradigms*, Prentice-Hall, 2006.

Randy Chow, *Distributed Operating Systems and Algorithms*, Addison Wesley, 1997.

G.F. Coulouies, J.D. Dollimore and T. Kindberg, *Distributed Systems: Concepts & Design*, Addison Wesley, 1994.

### IT407 TECHNOLOGIES FOR INTERNET OF THINGS

(3-0-2) 4

Introduction, IPv6 packet: IPv6 base header, Hop by Hop extension Header, Source Routing, Structure of IPv6 packet: fragmentation, IPv6 packet processing in routers, IPv6 address architecture, Current IPv6 prefix allocation, IPv6 addressing. ICMPv6: functionalities, neighbor discovery, address auto configuration. Communication standards: IEEE 802.15.4, IEEE 802.11, 6LoWPAN. Routing in low power lossy networks: RPL. Introduction to service oriented architecture and Web services, RESTful web services and applications for networked embedded systems. The Constrained Application Protocol (CoAP): features, interaction model, messages and request and response sub layer

J. Biron and J. Follett, *Foundational Elements of an IoT Solution*, O'Reilly Media, 2016.

Keysight Technologies, *The Internet of Things: Enabling Technologies and Solutions for Design and Test*, Application Note, 2016.

Charles Bell, *Beginning Sensor Networks with Arduino and Raspberry Pi*, Apress, 2013

Arshdeep Bahga and Vijay Madisetti, *Internet of Things: A hands on approach*, VPT Publications 2014

Olivier Hersent, David Boswarthick, Omar Elloumi, *The IoT: Key Applications and Protocols*, Wiley, 2015.

### IT408 MOBILE COMPUTING

(3-0-0) 3

Evolution of Wireless and Cellular Systems; Wireless Propagation: Encoding, Modulation, Multiplexing, and Error Handling Techniques; MAC Layer: Channel Allocation Techniques; Study of Mobile Communication Systems: Infrastructure, Registration and basic Call Establishment and Termination, Handoff, Roaming Support; Threat, Logical Migration, Mobile agents, Security issues.

Kumkum Garg, *Mobile computing - Theory and Practice*, 2010

Raj Kamal, *Mobile computing*, Oxford University Press 2007. Joschen Schiller, *Mobile Commns*, Pearson, 2003.

Dharma Prakash Agarwal & Qing-An Zeng, *Wireless & Mobile Systems*, CENGAGE, 2nd Edition, 2006.

William Stallings, *Wireless Communication & Networks*, Prentice Hall of India, 2nd Edition, 2004.

### IT409 EMBEDDED SYSTEMS

(3-0-0) 3

Embedded System Design Process: Embedded Computing Platform, Program Design and Analysis, Real Time Operating Systems, Networks: Distributed Embedded Architecture, System on Chip (SOC) and the current trends. David E Silmon, *An Embedded Software Printer* Pearson Edition Asia, 2001 Wayne Wolf, *Computer as Components* – Harcourt India Pvt. Ltd. 2001

### IT410 BIOINFORMATICS

(3-0-0) 3

Introduction to Bioinformatics, Biological Databanks, Biological Sequence Analysis: Genome- Microarray, pairwise sequence alignment, Dynamic programming, global and local alignment, Progressive multiple sequence alignment, Iterative multiple sequence alignment. BLAST Scoring matrices, gap penalty, statistical significance of multiple sequence alignment, sum-of-pairs method, CLUSTAL W, searching motifs in sequence alignment. Structure Prediction – Protein Secondary Class prediction, Protein Folding.

Protein-Protein Interaction, Protein Subcellular Localization, Emerging Areas in Bioinformatics.

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

Durbin, R., Eddy, S., Krough, A. & Mitchison, G. (1998). *Biological sequence analysis: probabilistic models of proteins and nucleic acids*. Cambridge University Press.

Jones, N.C. & Pevzner, P.A. (2004). *An introduction to bioinformatics algorithms*. MIT Press.

Bioinformatics: *Sequence and Genome Analysis* by David W. Mount, Cold Spring Harbor Laboratory Press (2001)

Developing Bioinformatics Computer Skills by C. Gibas and P. Jambeck, O'Reilly (2001)

Biological Sequence Analysis: Probabilistic models of proteins and nucleic acids by R. Durbin, S.Eddy, A. Krogh and G. Mitchison, Cambridge University Press (1998)

### IT411 KNOWLEDGE MANAGEMENT

(3-0-0) 3

Introduction to knowledge management, Types of Knowledge within an organization. Intellectual capital. KM Architecture and Tools. ERP for KM. Knowledge sharing tools. Data warehousing, Knowledge strategy creation. KM practice. KM Process. Integrating knowledge sharing and learning, The chief knowledge Officer (CKO) and his/her job. Training programmes for organization. e-learning. Making KM work across various segments of industry and business firms. Case studies of KM practices in successful companies, Future challenges in KM Ratnaja Gogula, *Knowledge management: A New Dawn*, Institute of Chartered Financial Analysts of India, 2002.

### IT412 TIME SERIES ANALYSIS

(3-0-0) 3

Introduction, Stochastic Processes, Stationary Time Series Process (Time Domain), Univariate Analysis: Autoregressive (AR) Process. Moving Average (MA) Process, Autoregressive Moving Average (ARMA) Process, Causality, Multivariate Analysis: Autoregressive Distributed Lag (ARDL) Model, Vector Error Correction (VEC) Model, Vector Autoregressive (VAR) Model, Spectral Analysis (Frequency Domain), Non-Stationary Time Series Process, Unit Root Tests: Dickey-Fuller Test Phillips-Peron Test Elliott-Lothman-Stock Test, Schmidt-Phillips Test, Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test, Zivot-Andrews Test, Cointegration introduction and tests, ARCH GARCH Model, Generalized Method of Moments (GMM)

Shumway and D. S. Stoffer (2006), *Time Series Analysis and Its Applications (With R Examples)*, Springer.

Box, G. E. P. & Jenkins, G. M. (1976), *Time Series Analysis: Forecasting and Control*, Springer Series, Second Edition.

Box, G. E. P. & Jenkins, G. M. (1976), *Time Series Analysis: Forecasting and Control*, Chapman & Hall, Sixth Edition.

Box, G. E. P. & Jenkins, G. M. (1976), *Time Series Analysis: Forecasting and Control*, Springer-Verlag.

Box, G. E. P. & Jenkins, G. M. (1976), *Time Series Analysis: Forecasting and Control*, Princeton University Press.

### IT413 SYSTEM INTEGRATION

(3-0-0) 3

Enterprise Integration Drivers, Requirements and Strategies, The Business Imperative for Enterprise Integration. Business Drivers and Requirements. Enterprise Integration: Strategy, Architecture Overview. Current Integration Architecture Assessment. Technical Integration Architecture, Service Integration Architecture, Information Integration Architecture. Process Integration Architecture, Enterprise Integration Solutions: Application, Information, Composite Application and Process-Driven Integrations; Best Practices for Enterprise Integration.

B. G. Bernstein and W. Ruh. *Enterprise Integration: The Essential Guide to Integration Solutions*, Addison-Wesley.

C. Britton, P. Bye, *IT Architecture, Middleware: Strategies for Building Large Integrated Systems*, Addison-Wesley.

### IT414 DATA WAREHOUSING AND DATA MINING

(3-0-2) 4

Introduction to data mining: Motivation and significance of data mining, data mining functionalities, interestingness measures, classification of data mining system, major issues in data mining; Data pre-processing: Need, data summarization, data cleaning, data integration and transformation, data reduction techniques, data discretization and concept hierarchy generalization; Data warehouse and OLAP technology: multidimensional data model(s), data warehouse architecture, OLAP server types, data warehouse implementation, on-line analytical processing and mining; Data cube computation and data generalization: Efficient methods for data cube computation, discovery driven exploration of data cubes, complex aggregation, attribute oriented induction for data generalization; Mining frequent patterns, associations and correlations: Basic concepts, efficient and scalable frequent itemset mining algorithms, mining various kinds of association rules – multilevel and multidimensional, association rule mining versus correlation analysis, constraint based association mining; Classification and prediction: Definition, decision tree induction, Bayesian classification, rule based classification and support vector machines, associative classification, lazy learners, prediction, accuracy and error measures; Cluster analysis: Definition, clustering algorithms – partitioning, hierarchical, density based, grid based and model based; Clustering high dimensional data, constraint based cluster analysis; Data mining on complex data and applications: Algorithms for mining of spatial data, multimedia data, text data; Data mining applications, social impacts of data mining, trends in data mining.

Han, J. and Kamber, M., *"Data Mining - Concepts and Techniques"*, 3rd Ed., Morgan Kaufmann Series, 2008.

Alex Berson, S. J. Smith, *"Data Warehousing, Data Mining & OLAP"*, McGraw Hill

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Tan, P.N., Steinbach, M. and Kumar, V., "Introduction to Data Mining", Addison Wesley – Pearson, 2006  
Pujari, A. K., "Data Mining Techniques", 4<sup>th</sup> Ed., Sangam Books.  
Oded Maimon, Lior Rokach, *The Data Mining and Knowledge Discovery Handbook*, Springer, 2005.  
S. Weiss and N. Indurkha, *Predictive Data-Mining: A Practical Guide*, Morgan Kaufmann, 1998.  
S. Weiss, N. Indurkha, T. Zhang and F. Damerau, *Text Mining: Predictive Methods for Analyzing Unstructured Information*, Springer, 2004.

### IT415 MIDDLEWARE TECHNOLOGIES

(3-0-2) 4

Introduction to Middleware Technologies, General Middleware, Service Specific Middleware, Client/Server Building blocks: RPC, Messaging – P2P, Java RMI, Computing standards, OMG, Introduction to CORBA, EJB and .NET, XML Technologies - XML, DTD, XSD, XSLT, XQUERY, XPATH, Web Services and SOA.  
G. Sudha Sadasivam, *Distributed Component Architecture*, Wiley India Edition.  
Thomas Erl, *Service Oriented Architecture: Concepts, Technology & Design*, Prentice Hall  
G.Brose, A Vogel and K. Duddy, *Java programming with CORBA*, 3rd Edition, Wiley India  
Joha Wiley and Sons  
Ed Roman, *Mastering Enterprise Java Beans*, John Wiley & Sons Inc.

### IT416 COMPUTER VISION

(3-0-2) 4

Introduction to Computer Vision, Color + Math basics, Linear Algebra, Pixels and filters, Edge detection, Features and fitting, Feature descriptors, Resizing, Semantic segmentation, Clustering, Object recognition, Dimensionality reduction, Face identification, Visual Bag of Words, Detecting objects by parts, Image classification, Motion Tracking, Introduction to Deep Learning.  
Sonka M., Hlavac V., Boyle R., *Image Processing Analysis and Machine Design*. PWS Publishers  
Ballard D., Brown C., *Computer Vision*, Prentice Hall, 1982.  
R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, Addison Wesley, 1992.  
*Digital Image Processing and Computer Vision*;; John Wiley and Sons, 1989.  
Robert J. Schallkoff, *Pattern Recognition: Statistical. Structural & Neural Approaches*, John Wiley and Sons, 1992.  
D. A. Forsyth and J. Ponce, *Computer Vision: A Modern Approach*, Pearson Education, 2003.  
Richard Szeliski, *Computer Vision: Algorithms and Applications*, Springer-Verlag, 2011.

### IT417 PATTERN RECOGNITION

(3-0-2) 4

Patterns/features. Pattern recognition approaches. Discriminant functions. Statistical pattern recognition, Gaussian model. Parametric estimation. Bayesian parameter estimation, pattern classification by distance functions Cluster analysis, Syntactics pattern recognition. Features extraction and recent advances.  
Earl Gose, Richard Johnsonbaugh, Steve Jost, *Pattern Recognition and Image Analysis*, Prentice Hall 1999.  
Duda RO and Hart PE, *Pattern Classification and Scene Analysis*, Wiley 1973.

### IT418 CLOUD COMPUTING

(3-0-2) 4

Introduction to Cloud Computing, Cloud Computing Delivery Models, Open Source and Industry Case Studies of Cloud (Apache VCL, Amazon, IBM and Eucalyptus), Map/Reduce and Apache Hadoop Programming models for cloud computing and examples/applications, Virtualizations as an enabler for cloud computing infrastructure, Cloud Application Design & Development, Containers and Docker.  
George Reese, *Cloud Application Architectures*, O'Reilly Publications, 2009  
Tim Mather, Subra Kumaraswamy. *Cloud Security and Privacy*, O'Reilly, 2009  
Tom White, *The Hadoop – Definitive Guide*, O'Reilly, 2009.  
Arshdeep Bagha and Vijay Madisetti, *Cloud Computing: A Hands on Approach*, Universities Press, 2014.

### IT419 WIRELESS SENSOR NETWORKS

(3-0-2) 4

Introduction to wireless communication and wireless sensor networks, Network architecture and design principles, MAC and link layer protocols, Topology control in WSN, Routing protocols, Information Aggregation, Information Storage, Query, Localization, Security issues, Applications and recent trends: Wireless multimedia sensor networks.  
F. Zhao and L. Guibas, *Wireless sensor networks: An information Processing Approach*, Morgan-Kaufmann, 2004.  
Carlos de Moraes Ciordeiro nad Dharma Prakash Agrawal, *Adhoc and Sensor Networks: Theory and Applications*, World Scientific Publications, 2006.

### IT420 MOBILE ADHOC NETWORKS

(3-0-2) 4

Mobile ad hoc networking; imperatives, challenges and characteristics, Bluetooth networks, Routing approaches, Proactive and reactive protocols. Clustering and hierarchical routing, Multipath routing, Security aware routing, Energy efficient communication in Mobile ad hoc networks, Measuring energy consumption, Power save protocols, Maximum

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life time routing, Secure routing protocols, Intrusion detection, Security considerations in ad hoc sensor networks, Key management, Characterization of IP traffic, QOS classification, Self similar processes, Statistical analysis of both non – real time traffic and real – time services.

*C.S. Murthy & B.S. Manoj, AdHoc Wireless Networks, Pearson, 2006.*

*T.Janevski, Traffic Analysis and Design of Wireless IP Networks, Artech House, 2003.*

*Ozan K. Tonguz & Gianluigi, Adhoc Wireless Networks, Wiley, 2006.*

### IT421 SEMANTIC WEB TECHNOLOGIES

(3-0-2) 4

Introduction to the Semantic Web – What is Semantics; Syntax, Structure and Semantics, Layered Cake Architecture; Structured Web Documents and Resource Description Framework – Understanding content, Metadata, metadata standards, XML + metadata specification, RDF and metadata processing; Programming with RDF/XML; Web Ontology Language (OWL)- Domain Modeling, Logic, Inferencing, Context; Logic Reasoning for the Semantic Web- Classification and semantic metadata extraction techniques: statistical, statistical learning/AI, lexical and natural language, knowledge based; Programming with Ontologies; Semantic Applications- semantic technology for services, search, personalization, contextual/custom/ enterprise applications; Linked Open data and next generation semantic content management; Research trends and open issues.

*Pascal Hitzler et al, Foundations of Semantic Web Technologies, Chapman & Hall, 2009.*

*Karin Breitman et al, Semantic Web: Concepts, Technologies and Applications, Springer, 2010.*

*Grigoris Antoniou and Frank van Harmelen, A Semantic Web Primer, The MIT Press, 2nd Edition, 2008.*

*John Hebel, Matthew Fisher, Ryan Blace, Andrew Perez-Lopez, Semantic Web Programming, Wiley, 2009.*

### IT422 VIRTUAL REALITY

(3-0-2) 4

Introduction to Virtual Reality Technology and its effectiveness in Real -Time Applications, Scientific Visualization, Input Devices: Trackers, Navigation and Gesture Interfaces; Output Devices: Graphics, 3D Sound and Haptic Displays; Computing Architectures for Virtual Reality, Modeling, Virtual Reality Programming, Human Factors in Virtual Reality; Overview of Virtual Humans, Face Cloning & Face Motion Capture/Analysis and Research Trends.

*Gerard Jounghyun Kim, Designing Virtual Reality Systems – The Structured Approach, Springer-Verlag, 2005.*

*N Magnenat-Thalmann and D Thalmann, Handbook of Virtual Humans, Wiley, 2004.*

*L.J. Hettinger, M W. Haas, Virtual & Adaptive Environment: Apps, Human Performance, Lawrence Erlbaum, 2003.*

*Grigore C Burdea and Phillippe Coiffet, Virtual Reality Technology, John Wiley, 2003.*

### IT423 RICH INTERNET APPLICATIONS

(3-0-2) 4

Web2.0 concepts, SaaS model, Evolution of Web 2.0, Web Programming concepts, HTML, XHTML, CSS, Javascript. JS Execution Environment, Overview of XML, Web Services, Building Rich Internet Applications, AJAX, XML HTTP Object, ActionScript, Products from Industry like Flex (Adobe), Flash/AIR (Adobe), Silverlight (MS), JavaFX (SUN), OpenLazlo technologies, Recent Trends.

*Robert Sebesta, Programming the World wide web, Pearson Education, Third Edition*

*Nicholas C Zakas et al, Professional AJAX, Wrox publications, 2006*

*Chafic Kazoun, Programming Flex 2, O'Reilly publications, 2007*

*Colin Moock, Essential Action script 3.0, O'Reilly Publications, 2007*

*Steven Holzner, Ajax Bible, Wiley India Edition, 2007*

*Justin Gethland et al, A Web 2.0 primer Pragmatic Ajax, SPD Publications, 2006.*

### IT440 PRACTICAL TRAINING

2

The Student has to undergo a practical training programme or carrying out a research/practical oriented project or any equivalent training programme fixed by the DUGC of IT department. This practical training will be done during summer vacation (10-12 weeks) before the evaluation semester. Final evaluation is based on the report/seminar by the student.

### IT449 MAJOR PROJECT – I

The student has to select a project based on a topic of interest before starting of VII semester. This project work will be commencing in VII semester and continued in VIII semester, at the end of each semester, the project will be evaluated internally and externally as per the evaluation criteria decided by the DUGC.

### IT450 WEB SERVICES

(3-0-0) 3

IT Architecture, Distributed Information Systems, Middleware and Enterprise Application Integration, Introduction to Service Oriented Architecture, Web Services origins, standards, basic concepts, Web Service Technologies and Architecture; protocols for Web service Description, Discovery and Access (WSDL, UDDI and SOAP); Web Service



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Application Management: Co-ordination, Service Orchestration and Compositions; Web Service Application Development: developing Web services, exposing functions as web methods, accessing service endpoints, WCF Framework; RESTful Web Services - basics, concepts, Restful application development and deployment; Services for the Internet of Things - Constrained Application Protocol (CoAP), features, interaction model; Semantic Web Services - background, motivation, advantages, basic concepts; Research Trends and open problems.

*Alonso G, Casati F, "Web Services - Concepts, Architectures and Application Series: Data-Centric Systems and Applications", Springer, 2011*

*Robert Daignea, "Service Design Patterns: Fundamental Design Solutions for SOAP/WSDL and RESTful Web Services" 1st Edition, Addison Wesley Professional, 2011*

[Sam Newman, "Building Microservices: Designing Fine-Grained Systems", O-Reilly, 2015](#)

*Thomas Erl, "Service-Oriented Architecture: Concepts, Technology, and Design", Prentice Hall, 2005.*

### IT451 SOFTWARE ARCHITECTURE

(3-0-0) 3

Definition and overview of software architecture, The architecture business cycle: what influences software architects, Different Architectural styles, Architecture description language, Understanding and achieving quality attributes, Attribute-driven design, Documenting/Evaluating Software Architecture and its reuse, Case studies and Recent Trends.

*Mary Shaw, David Garlan, Software Architecture, Prentice Hall, India, 2000*

*Bass, Len; Paul Clements, Rick Kazman, Software Architecture In Practice, Second Edition. Addison-Wesley, 2003.*

*Clements, Paul et al, Documenting Software Architectures: Views and Beyond. Addison-Wesley, 2003.*

### IT452 ADVANCED COMPUTER ARCHITECTURE

(3-0-0) 3

Flynn's Classification, RISC Vs CISC, Data and control flow, Pipelining: Linear and non linear, pipeline hazards, instruction scheduling, Branch handling techniques, Arithmetic pipeline, VLIW architecture, Superscalar processors. Instruction level Data -Parallel architectures: SIMD architectures, Systolic and Vector architecture; MIMD architectures, Systems interconnect architecture: Network properties/routing, Static/dynamic interconnection networks. Multiprocessor architectures, models of memory consistency, cache coherence/directory protocols. Multicore architecture.

*J. Hennesy and D. Patterson, Computer Architecture –A Quantitative Approach, 6th Ed., Morgan Kaufmann, 2017*

*Yan Solihin, Fundamentals of Parallel Multicore Architecture, Chapman and Hall/CRC, 2015*

*Dezso Sima, Peter Karsuk, Advanced Computer Architectures: A Design Space Approach, Addison- Wesley, 2002*

### IT453 TRANSACTION PROCESSING

(3-0-0) 3

Introduction and need of transaction processing, online transaction process (OLTP), OLTP program design, OLTP and system Reliability, OLTP and CICS standards in OLTP, current trends.

*Gary McClain, OLTP handbook, McGraw Hill, 1997.*

### IT454 SOFTWARE QUALITY ASSURANCE

(3-0-0) 3

Overview of Software Engineering. Requirement Engineering Analysis, software reliability. Definition and concepts of software reliability, software quality. Introduction to software quality principles, total quality management, Quality Assurance Standards. ISO 9000 Tick-It method. Miscellaneous Issues: Software maintenance. Future OF SQA

*John J. Marciniak, Encyclopedia of Software Engineering. - Vol. I & II. John Wiley & Sons,*

*1994. Ince Darrel. ISO 9001 and Software Quality Assurance. McGraw Hill, 1994*

*Pankaj Jalote, An Integrated Approach to Software Engineering Narosh Publications, 1995*

*Isabel Evans, Achieving software Quality through team work, Allied publishers, 2004.*

### IT455 INFORMATION TECHNOLOGY FOR HEALTHCARE

(3-0-0)3

Evolution of IT Enhanced Healthcare, Internet Technologies in Telemedical Systems, Wireless Systems in E-Health, Decision Support Systems in Medicine, Health Telematics Networks, Computer Aided Diagnosis and Recent Trends.

*Krzysztof Zielinski, Mariusz Duplaga and David Ingram, IT Solutions For Healthcare, Springer, 2006*

*Robert E Hoyt, Nora Bailey, Ann Yoshihashi, Health Informatics, 5<sup>th</sup> Edition, Lulu Publishers, 2012*

*Kevin Beaver, Healthcare Information Systems, Auerbach Publications, 2<sup>nd</sup> Edition, 2002.*

### IT456 ENTERPRISE RESOURCE PLANNING AND SYSTEMS

(3-0-0) 3

ERP: Needs, Models, Commercial ERP Packages, Client Server and Open Technology Solutions, Supply Chain Management-Issues, Drivers and Obstacles, Coordinating SCM and ERP in E-Business

*Vinod Kumar G & N.K. Venkitakrishna, ERP- Concepts and Practice, PHI, 1998*

*Sunil C & Peter-SCM – Strategy and Planning and Operation, Pearson Education, LPE, 2002*



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Pete Loshin, Paul A. Murphy, *Electronic Commerce, A JAICO Book.*

### IT457 NATURAL LANGUAGE PROCESSING

(3-0-2) 4

Introduction and Overview, Language Modeling, History and Applications, Basic Text Processing - Word stemming, tokenization, normalization, Part of Speech tagging, Text Classification – basics and process, tools, Information Retrieval, TF/IDF, Ranked IR, Vector Space Models, Query analysis and processing, Basics of Information Extraction, Named Entity Recognition, Maximum Entropy models, Relation Extraction; Introduction to Semantics, word sense and word similarity, Basics of Wordnets, tools, Emerging trends, research issues, challenges, interesting applications in various domains.

Daniel Jurafsky and James H. Martin. *"Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition". Second Edition. Prentice Hall, 2008* Christopher D. Manning and Hinrich Schütze, *"Statistical Natural Language Processing"* MIT Press, 1999 [Tanveer Siddiqui, U. S Tiwary](#), *"Natural Language Processing/Information Retrieval"*, Oxford Univ. Press, 2008.

### IT458 INFORMATION RETRIEVAL

(3-0-2) 4

Introduction: Basic Concepts, Information need vs. Query, Modern Search Interface requirements, IR System Architecture, Classic IR Models for unstructured text, preprocessing techniques, Tokenizing, Indexing, and Implementation of IR models, Structured IR models, Multimedia IR, Experimental Evaluation of IR Systems, Implicit and Explicit Relevance Feedback techniques, Document/Query Properties and Representations, Web Search and Link analysis algorithms, Recommender Systems, Learning to Rank and Learning the ranking function based techniques, Machine learning in IR, Selected research papers on emerging trends and open problems in IR.

C. D. Manning et al., *"Introduction to Information Retrieval"*, Cambridge University Press, 2008.

Baeza-Yates & Ribeiro-Neto, *"Modern Information Retrieval"*, Pearson Education, 2010

Donald Metzler et al., *"Search Engines: Information Retrieval in Practice"*, Pearson Education, 2010

### IT459 SIMULATION AND MODELING

(3-0-2)4

System models and Role of Simulation, Types of Systems, Statistical Tools and Techniques, Discrete Event Simulation Languages, Modeling and Performance Evaluation of Computer Systems, Biological and Sociological System Simulation, Verification and Validation.

A. M. Law and W.D. Kelton, *Simulation Modeling and Analysis*, McGraw Hill, 2000

A. M. Law, *Simulation Modeling and Analysis*, McGraw Hill, 4th Edition, 2008

### IT460 E-COMMERCE

(3-0-0) 3

Infrastructure and Tools for E-Commerce, Current Trends in E-Commerce applications development, The Business of Internet Commerce, Enterprise level E-Commerce, Security and encryption, Electronic payment systems, Search engines, Intelligent agents in E-Commerce, On-line auctions, Data mining for e-commerce, Web metrics, Recommender systems, Knowledge management, Mobile e-commerce, Legal, ethical and social issues.

Henry Chan et al., *E-Commerce- Fundamental and applications*, John Wiley & Sons, 2002

G.Winfield Treese and Lawrence C.S, *Designing Systems for Internet Commerce*, Pearson Education, LPE, 2002

Fensel, Dieter, Brodie M. L., *Ontologies: A Silver Bullet for Knowledge Management and E-Commerce*, Allied Publishers, 2004.

Zimmermann, Olaf; Tomlinson, Mark R.; Peuser, Stefan, *Perspectives on Web Services*, Allied Publishers, 2004.

### IT461 ADVANCED DATABASE SYSTEMS

(3-0-2)4

Basic concepts, Buffer management, Query optimization, Selectivity estimation, Concurrency control, Recovery, Database tuning, Distributed databases– principles, architecture, design, query processing, transaction management, Replication, Web databases, Current trends in database system.

M. Tamer Özsu, *Principles of Distributed Database Systems*, Prentice Hall, 1999.

Ceri S and Pelagatti G, *Distributed databases: Principles and Systems*, McGraw Hill, 2000.

Thomas Connolly and Carolyn Begg, *Database Systems: A Practical Approach to Design, Implementation and Management*, Pearson Education, 2002.

### IT462 NUMBER THEORY AND CRYPTOGRAPHY

(3-0-2)4

Introduction to Number Theory: Prime Numbers, Fermat's Little Theorem and Euler's Theorem, Testing for Primality, Chinese Remainder Theorem, Discrete Logarithms. Euclidean Algorithm, Extended Euclidean Algorithm, Euler's Phi Function. Finite Fields: Groups, Rings, and Fields, Modular Arithmetic, Euclidean Algorithm, Finite Fields of The Form GF(p), Polynomial Arithmetic, Finite Fields Of the Form GF(2n); Introduction to Cryptography: Symmetric Cryptography, Substitution Cipher, Shift Cipher (or Caesar Cipher), Affine Cipher, Hill cipher. Stream Ciphers: Stream

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Ciphers vs. Block Ciphers, Encryption and Decryption with Stream Ciphers, Random Numbers and an Unbreakable Stream Cipher, Random Number Generators, One-Time Pad, Towards Practical Stream Ciphers, Shift Register-Based Stream Ciphers, Linear Feedback Shift Registers (LFSR), Known-Plaintext Attack Against

Single LFSRs. The Data Encryption Standard (DES) and Alternatives: Confusion and Diffusion, Double DES (2DES) and Triple DES (3DES). Advanced Encryption Standard (AES). Block Ciphers: Modes of Operation, Electronic Codebook Mode (ECB), Cipher Block Chaining Mode (CBC), Output Feedback Mode (OFB), Cipher Feedback Mode (CFB), Counter Mode (CTR), Galois Counter Mode (GCM). Introduction to Public-Key Cryptography: Practical Aspects of Public-Key Cryptography, RSA Cryptosystem, Elliptic Curve Cryptosystems. Digital Signatures: RSA Signature Scheme, Elgamal Digital Signature Scheme, Digital Signature Algorithm (DSA), Elliptic Curve Digital Signature Algorithm (ECDSA).

*"Cryptography and Network Security: Principles and Practices", 4<sup>th</sup> Edition, W. Stallings, Prentice Hall, 2005.*

*"Cryptography and Network Security", 6<sup>th</sup> Edition, William Stallings, Pearson, 2013.*

*"Understanding Cryptography A Textbook for Students and Practitioners", Christ of Paar, Jan Pelzl, Springer.*

*"Cryptography, Theory and Practice", 3<sup>rd</sup> Edition, Douglas R. Stinson, CRC Press, 2006.*

*"Network Security Private Communication in a Public World", C. Kaufman et al., Prentice Hall, 2002.*

*"Applied Cryptography", 2<sup>nd</sup> Edition, Bruce Schneier, Wiley, 1996.*

*"Handbook of Applied Cryptography", A. Menezes, P. Van Oorschot, S. Vanstone, CRC Press, Fifth Printing, 2001.*

*"Elementary Number Theory with Applications", Thomas Koshy, 2<sup>nd</sup> Edition, Academic Press, 2007.*

*"A Computational Intro. to Number Theory and Algebra", Victor Shoup, 2<sup>nd</sup> Ed., Cambridge Univ. Press, 2005.*

### IT463 LINUX KERNEL INTERNALS

(3-0-2) 4

Introduction to the Kernel: Important data structures, task structure, process table, files and inodes, dynamic memory management, queues and semaphores, system time and timers, main algorithms, signals, interrupts, booting the system, timer interrupt, scheduler, implementing system calls. Memory Management: LINUX, virtual address space for a process, block device caching, paging under LINUX. Inter- Process Communication: Synchronization in the kernel, Communication via files, pipes, debugging using ptrace, IPC with sockets. The LINUX File System: Basic principles, representation of file systems in the kernel, Proc file system, Ext2 file system. Device drivers under LINUX: Character and block devices, Polling and interrupts, Implementing a driver, Multi-processing: Intel multi-processor specification, problems with multi-processor systems, changes to the kernel, kernel initialization, scheduling, message exchange between processors, entering kernel mode, Interrupt handling, compiling LINUX SMP.

*"Linux Kernel Internals", Michael Beck et al., Second Edition, Addison-Wesley, 1998.*

*"Linux Kernel Programming", Michael Beck et al., Third Edition, Addison-Wesley, 2002.*

### IT464 FOUNDATIONS OF MACHINE LEARNING

(3-0-2) 4

Linear algebra and probability theory basics – Machine learning- Types- Classification- Regression- Multi-class classification. dimensionality reduction –Linear and Logistic Regression. Naive Bayes, Parameter Estimation, Sequential Pattern Classification. Neural Network Basics – Backpropagation –Support Vector Machines, Kernel methods – Bias-Variance tradeoff. Regularization and model/feature selection. Ensemble Methods: Boosting, Bagging, Random Forests. Unsupervised learning – K-Means clustering- EM Algorithm – Reinforcement learning – introduction to deep learning. Recent Applications and trends of Machine Learning.

*Understanding Machine Learning, Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press, 2017.*

*Tom M. Mitchell, -Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.*

*Stephen Marsland, - Machine Learning: An Algorithmic Perspective, Second Edition, 2014.*

*Pattern recognition and machine learning by Christopher Bishop, Springer Verlag, 2006.*

### IT465 CRYPTOCURRENCIES AND BLOCKCHAIN TECHNOLOGIES

(3-0-2) 4

Introduction to Crypto currency, peer-to-peer network, Abstract Models for BLOCKCHAIN – GARAY model – RLA Model, Hybrid models cryptographic basics for cryptocurrency – a short overview of Hashing, signature schemes, encryption schemes and elliptic curve cryptography, Bitcoin – Wallet – Blocks – Merkle Tree transaction verifiability – anonymity – forks – double spending, Ethereum, Wallets for Ethereum – Solidity – Smart Contracts – some attacks on smart contracts, Applications of smart contracts, Block chain Application in various areas- Health care, Insurance, IoT etc.

*Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder. Bitcoin and cryptocurrency technologies: a comprehensive introduction. Princeton University Press, 2016.*

*Joseph Bonneau et al, SoK: Research perspectives and challenges for Bitcoin and cryptocurrency, IEEE Symposium on security and privacy, 2015 (article available for free download) {curtain raiser kind of generic article, written by seasoned experts and pioneers}. 2. J. A. Garay et al, the bitcoin backbone protocol – analysis and applications*

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*EUROCRYPT 2015 LNCS Vol 9057. (VOLII), pp 281-310.. serious beginning of discussions related to formal models for bitcoin protocols. 3. R.Pass et al, Analysis of Blockchain Protocol in Asynchronous networks, EUROCRYPT 2017. A significant progress and consolidation of several principles. 4. R.Pass et al, Fruitchain, a fair blockchain, PODC 2017.*

### **IT499 MAJOR PROJECT – II**

**(0-0-6) 4**

The student has to select a project based on a topic of interest before starting of VII semester. This project work will be commencing in VII semester and continued in VIII semester, at the end of each semester, the project work will be evaluated internally and externally as per the evaluation criteria decided by the DUGC.

**Department of Chemical Engineering**

**CH150 Process Calculations**

**(2-2-0) 4**

Introduction to Engineering Calculations. Physical and chemical properties of compounds and Mixtures. Techniques of problem solving. Concepts of unsteady state processes and material balance equation. Steady State Material Balances. Material balances involving Recycle, By-pass and purge- calculations. Multiphase systems. Single component phase Equilibrium. Solutions of Solids in Liquids. Humidity charts and their uses. Energy balances.

*D.M.Himmelblau, Basic Principles and calculations in Chemical Engg. 5th Edition, Prentice Hall of India. 1992*

*R.M.Felder, R.W.Rlusseau, Elementary Principles of chemical processes 2nd Edition. John Wiley & Sons Inc. 1986*

**CH200 Momentum Transfer**

**(3-1-0)4**

Properties of fluids. Fluid statics. Introduction to fluid flow. Basic equations of fluid flow. Laminar Flow. Turbulent flow. Fluid flow around immersed bodies - Boundary layer and friction drag. Flow through packed bed or porous medium : Ergun's equation. Motion of particles through fluids. Fluidization principles. Similitude and Dimensional analysis. Mixing of liquids. Compressible flow. Flow measurement. Fluid transportation machinery.

*McCabe W.L. , Smith J.C., P Harriot ,Unit Operations in Chemical Engineering, McGraw Hill, New York, 7th edition.2014*

*J R Backhurst, J H Harker, J.F. Richardson, J.M. Coulson, R.P. Chhabra, Coulson and Richardson's Chemical Engineering Volume I Butterworth-Heinemann 6<sup>th</sup> Edition. 1999*

**CH201 Particulate Technology**

**(2-1-0)3**

Particle Size Analysis. Industrial Screening. Storage and Conveyance of Solids. Size Reduction. Size Enlargement. Classification. Centrifugal Separation. Gas cleaning. Solid - Liquid Separation. Thickening. Froth Flotation. Magnetic separation. Electrical separation. Sorting (Separation of solids). Mixing and Agitation. *Richardson J.F and Coulson J.M, Chemical Engineering (SI Units) Vol 2; 5th Edition*

*McCabe W.L. , Smith J.C., P Harriot ,Unit Operations in Chemical Engineering, McGraw Hill, New York, 7th edition.2014*

**CH202 Chemical Engineering Thermodynamics**

**(3-1-0) 4**

Basic Concepts of Thermodynamics. PVT relationships, First law of Thermodynamics for closed and open systems. Heat effects, Second Law of Thermodynamics and relationships involving entropy. Relations among thermodynamic properties. Thermodynamic properties of fluids. T-S diagrams and construction of thermodynamic charts. Third Law of thermodynamics. Refrigeration and Liquefaction Cycles. Solution Thermodynamics and principles of Phase Equilibria..

*Smith, J.M, and H.C. Van Ness -Introduction to Chemical Engineering Thermodynamics, 4th edition, McGraw - Hill. Hougen, A., K.M. Watson and R.A. Ragatz - Chemical Process Principles, Vol. 2 (Thermodynamics), Asia Publishing House, 1960.*

*Rao, Y.V.C. - Introduction to Chemical Engineering Thermodynamics, Wiley Eastern, 1994.*

*Narayanan, K.V. - A textbook of Chemical Engineering thermodynamics, Prentice Hall Eastern Economy Edition, 2004.*

**CH203 Transport Phenomena**

**(2-2-0) 4**

Shell balances for momentum, energy and mass transfer. Introduction to general transport equations for momentum, energy and mass transfer in Cartesian - cylindrical and spherical coordinates - simple solutions in one dimension. Simplification of general equations with time and spatial coordinates for momentum, energy, mass transport, boundary layer concepts of momentum energy and mass transport. Macroscopic balances for isothermal systems, non-isothermal systems and multi component systems.

*Robert S. Brodkey and Harey C. Hershey - Transport Phenomena - A Unified Approach, Brodkey Publishing., 2003*

*R.B.Bird, W.E.Stewart and E.W.Lightfoot - Transport Phenomena, John Wiley & Sons, 2007.*

*Beek W.J. andMutzall K.M.K., - Transport Phenomena, 2<sup>nd</sup> edition ,John Willey and Sons Ltd., 2000.*

**CH204 Computer Simulation Lab**

**(0-0-3) 2**

Numerical methods: Use of computational, plotting and programming abilities for solving problems relevant to chemical engineering: solving linear and nonlinear algebraic equations. Curve fitting and regression-linear and non-linear, Data analysis and handling, Solution of differential equations : initial value problems (IVP) and boundary value problems (BVP) .

*Finlayson, B. A., Introduction to Chemical Engineering Computing, John Wiley & Sons, New Jersey, 2006*

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Steven C. Chapra, *Applied numerical methods with MATLAB for Engineers and Scientists, Fourth Edition*, McGraw Hill Publishers, 2017

### CH250 Heat Transfer

(3-1-0) 4

Heat transfer fundamentals: Modes of heat transfer - conduction, convection, radiation Steady state conduction. Transient conduction. heat transfer with internal heat source; heat transfer from extended surfaces, Insulation - critical thickness of insulation. Heat transfer with heat generation. Heat Transfer by convection. analogies and correlations. Design of heat exchangers, Heat Transfer with packed and fluidized beds. Heat Transfer in Jacketted vessels. Cryogenic heat transfer. Heat transfer with change of phase: Boiling and Condensation, Radiation heat transfer, Evaporation: -Concept and applications.

*Incropera, F.D. and DeWitt, D.P., 5th edition, Fundamentals of Heat and Mass Transfer, Wiley, New York.2006*

*Holman, J.P. 1986. Heat Transfer, 6th Edition, McGraw Hill, New Delhi.*

*Krieth - Fundamentals of Heat Transfer, 4th Edition, Harper & Law, 1986.*

*Backhurst J R, Harker J H, Richardson J F, Coulson J.M , Chhabra R.P., Coulson and Richardson's Chemical Engineering Volume I Butterworth-Heinemann 6<sup>th</sup> Edition. 1999*

*McCabe W.L. , Smith J.C., P Harriot ,Unit Operations in Chemical Engineering, McGraw Hill, New York, 7th edition.2014*

### CH251 Mass Transfer-I

(3-1-0) 4

Introduction to Mass Transfer operations. Diffusion Mass Transfer. Unsteady state diffusion. Concept of Mass Transfer Coefficient, Convective mass transfer, mass transfer correlations, interphase mass transfer: Mass transfer theories, Equilibrium stages and transfer units: number and height of transfer units; stage efficiency. Gas –liquid operation : Gas absorption, plate and packed column design, Distillation fundamentals, Batch distillation, flash vaporization, Steam Distillation, Continuous distillation, Azeotropic distillation;. Introduction to multicomponent distillation.

*Treybal R .E- Mass-Transfer Operations, Third Edition, McGraw-Hill International Edition(1981).*

*Dutta B.K- Principles of Mass Transfer and Separation Processes, Prentice-Hall of India Private Ltd. (2007).*

*Geankoplis C J, Hersel A H,Lepek D H -Transport Processes and Separation Process Principles.Fifth Edition, Prentice Hall(2018)*

*McCabe W.L. , Smith J.C., Harriot P ,Unit Operations in Chemical Engineering, McGraw Hill, New York, 7th edition.2014*

### CH252 Chemical Reaction Engineering –I

(2-1-0) 3

Chemical Reaction Equilibrium. Kinetics of Homogeneous Reactions. Single Homogeneous Reactor Design. Reactor Sizing. Multiple Reactor Systems. Multiple Reaction Systems.

*Levenspiel, O. - Chemical Reaction Engineering, 3rd edition, Wiley Eastern Limited,2001*

*Fogler, H.S - Elements of Chemical Reaction Engineering, 2nd edition, Prentice Hall of India,2001*

### CH253 Momentum Transfer Lab

(0-0-3) 2

Experiments based on Momentum Transfer course

### CH254 Particulate Technology Lab

(0-0-3) 2

Experiments based on Particulate Technology course

### CH300 Chemical Reaction Engineering–II

(2-1-0) 3

Non-ideal Flow Reactors. Non-isothermal Homogeneous Reactions. Non-catalytic heterogeneous Reaction Kinetics. Catalytic Heterogeneous Reaction Kinetics.

*Smith J.M., "Chemical Engineering Kinetics", 3rd Edn. McGraw Hill International Editions,1981*

*Levenspiel O, Chemical Reaction Engineering, 3rd Ed, Wiley & Sons ,2001.*

*Fogler, H.S., Elements of Chemical Reaction Engineering, 2<sup>nd</sup> Ed., Prentice-Hall, Englewood Cliffs.2001*

### CH301 Mass Transfer-II

(3-1-0) 4

Mass Transfer Operations: Liquid-liquid Extraction: Ternary liquid-liquid equilibrium, cross-current extraction, continuous counter current extraction. Leaching: Equilibria, Stagewise and Counter current leaching. Adsorption: Physical and chemical adsorption, adsorbents, adsorption equilibrium and isotherms, Single and multi-stage cross-current operations, design principles for continuous fixed bed contactor, breakthrough curve. Humidification and Dehumidification: Basic concepts, Operations, design calculations, Mechanical Draft towers, Cooling towers.

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Drying: Equilibrium, Drying rate curve, rate and time of batch drying. Mechanisms of batch drying, continuous drying. Crystallization: delta L law, crystallizers

*Treybal R E- Mass-Transfer Operations, Third Edition, McGraw-Hill International Edition (1981).*

*Dutta B K- Principles of Mass Transfer and Separation Processes, Prentice-Hall of India Private Ltd. (2007).*

*Geankoplis C J, Hersel A H, Lepek D H-Transport Processes and Separation Process Principles. Fifth Edition, Prentice Hall (2018)*

*McCabe W.L. , Smith J.C., P Harriot , Unit Operations in Chemical Engineering, McGraw Hill, New York, 7th edition. 2014*

### CH 302 Process Dynamics & Control

(3-1-0) 4

Introduction .Transient analysis of open loop systems : First and second order systems, Interacting and non-interacting systems. Feed back control system, Modes of control action. Transient analysis of closed loop control systems, Stability analysis: Routh Stability Criteria, Root locus method, Frequency response analysis, Controller Tuning: Zeigler Nichols and Cohen Coon tuning method, Introduction to advanced control strategies.

*Coughanowr D R, Process Systems Analysis and Control, Second Edition, McGraw Hill, (1991).*

*Seborg D W, Edgar T F, Millichamp D A, Process Dynamics and Control, 3rd Edition, John Wiley & Sons (2010)*

*George Stephanopoulos, Chemical Process Control, Prentice Hall PTR (2001)*

### CH303 Heat Transfer Operations Lab.

(0-0-3) 2

Experiments based on Heat Transfer course.

### CH350 Chemical Process Industries

(3-0-0) 3

Inorganic chemical industries: Manufacture of sulfuric acid, nitric acid, ammonia, urea, different fertilizers, phosphoric acid and important phosphate salts. Chlor-alkali industries, Pulp and Paper, Fuel gases, organic chemical industries: C1, C2, C3, C4 compounds and their important derivatives, aromatic compounds, Synthetic fibers.

*Marshall Sittig, M. Gopala Rao, Dryden's Outlines of Chemical Technology for the 21st Century 3rd Edition 3rd Edition), 3rd edition, WEP East West Press, 2010*

*Austin G. T. - Shreve's Chemical Process Industries, McGraw Hill Book Co., 5th Edition, 1997.*

*Kirk-Othmer Encyclopedia of Chemical Technology 5th Edition, Kirk-Othmer Publishing,*

### CH351 Process Design of Chemical Equipment

(3-1-0) 4

Introduction to Chemical Equipment Design, Design Considerations of Heat Exchanges, Design methodology of Double pipe heat ex-changers, Design methodology of Shell and Tube Heat ex-changers (Kern method and Bell's method), Design Methodology of Calandria Evaporator. Design Considerations of Mass Transfer Equipment, Design Methodology of Packed and Tray towers for Absorption and distillation.. *Kern D Q - Process Heat Transfer, Tata McGraw Hill Publishing Co Ltd ,2013*

*.Coulson J M and Richardson J.F -Chemical Engineering, Vol.6, Design, Second Edition, Pergamon Press, 1993. Perry*

*R H and Don Green - Chemical Engineers' Hand Book, 6th Edition, McGraw Hill Book Co. Douglas J.M.,*

*Conceptual design of Chemical Processes McGraw Hill, New York, 1988. Seider J D Daniel R L, Product and Process Design Principles, Wiley, 2004.*

### CH352 Mass Transfer Operations Lab

(0-0-3) 2

Experiments based on Mass Transfer I & II.

### CH 353 Design and Simulation Lab

(0-0-2) 1

Simulation: Property evaluation using simulator, Thermodynamic and kinetic Models and its limitations, Rating Methodology for the equipment listed in Process Design of Chemical Equipment course, Dynamic and steady state simulations.

### CH400 Pollution Control & Safety in Process Industries

(3-0-0) 3

Importance of environment for human kind, flora and fauna, Types of pollution damages due to environmental pollution (industrial gas, liquid and solid effluents). Legislations to environmental pollution problems. Indian standards waste recycling. Noise pollution and its control. Waste water treatment. Air Pollution. Pollution control of effluents from different industries. Scientific and Engineering aspects of safety in industry. OSHAS.

*Mahajan S P - Pollution Control in Process Industries - Tata McGraw Hill, 1990.*

*Rao C S- Environmental Pollution Control Engineering, Wiley Eastern, 1992.*



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### CH401 Chemical Reaction Engg. and Process Control Lab

(0-0-3)2

Experiments based on Reaction Engg. I & II and Process Dynamics and Control courses.

### CH440 Practical Training

1

A student may complete the training before the beginning of 7<sup>th</sup> semester (or as stipulated by DUGC) and register for it in 7th semester. The duration and details shall be decided by the faculty advisor, with approval from DUGC.

### CH448 Seminar

2

This course to be completed during 7th semester. The student will make presentations on topics of academic interest.

### CH449 Major Project-I

(0-0-3)2

The Students jointly or individually will be assigned an experimental or a theoretical problem, to be carried out under the supervision of a guide. The project has to be completed in the VII & VIII semester. The students should complete the preliminary literature survey and a part of the work in the VII semester. Their work will be reviewed and evaluated.

### CH499 Major Project-II

(0-0-6)4

Extension and completion of Major project -I started in the previous semester (CH449). Their work will be reviewed and evaluated.

### CH450 Process Instrumentation

(3-0-0)3

Introduction: Temperature measurement, Pressure measurement, Flow measurement, Level measurements Viscosity measurement, Moisture and humidity measurements. Conductivity meter- pH meter, Analytical instruments – Liquid chromatography – HPLC – Mass spectroscopy - Computer aided analysis – process instruments and automatic analysis.

*Nakra B.C and Chaudhry K Instrumentation, Measurement and Analysis, , Tata McGraw Hill Co., New Delhi, 1985.*

*Liptak B.G ,Encyclopadia of Instrumentation,,Vol.I, and supplement Chelton Book Co., New York, 1969.*

*Willard, Merru, Dean and Settle, C.B.S, Instrumental Methods of Analysis,. publication, New Delhi,1986*

*R.K.Jain, , Mechanical and Industrial Measurements, Khanna Publishers, New Delhi, 1982.*

### CH451 Energy Technology

(3-0-0)3

Energy Scenario in India -Conventional/non-conventional renewable non renewable sources. Principles of efficient use of fuels, energy conservation and auditing. Solid liquid and Gaseous fuels. Combustion, Furnaces.Draught and chimney height. Nuclear Energy - Classification and Components. Unconventional fuels, renewable energy sources.

*Sharma S.P.andChander Mohan -Fuels and Combustions- Tata McGraw Hill Book Co., 1982.*

*Shaha A.K. - Combustion Engineering and Fuel Technology, Oxford Press.*

*Gilchrist J.D. - Fuels, Furnaces and Refractors, Pergamon Press, 1977.*

*Ronald F. Probstein and Hicks R.E. - Synthetic Fuels - McGraw Hill Book Co., 1982.*

*Manon L Smith and Keri W Stinson - Fuels and Combustion - McGraw Hill Book Co., 1952.*

### CH452 Petroleum Refining Processes

(3-0-0)3

Introduction.Composition and evaluation of properties of crude oil and refinery products. Refining of petroleum. Types of pipe still furnaces used in refineries and their design consideration. Cracking processes. Rebuilding processes. Product treatment processes.

*Robert A. Meyers, Hand Book of Petroleum Refining Processes, McGraw Hill Book Co., 1986.*

*BhaskerRao B.K.,Modern Petroleum Refining Processes, Oxford & IBM Publishing Co., 1984.*

### CH453 Biochemical Engineering

(3-0-0)3

Introduction to biochemical engineering and its applications, Role of microbes and microbiology in development of biochemical engineering. Types of organisms, their nomenclature. Introduction to medium formulation for microorganisms and types of media used. stoichiometry of biological reactions, Growth kinetics of microorganisms,Bioreactor configurations. yield coefficient and its importance in media development. Introduction to mass transfer in bioreactors, determination of transfer rates, Enzyme catalysed reactions and kinetics.

*Bailey J E, Ollis D.F. Biochemical Engineering Fundamentals, , 2nd Edn, McGraw-Hill, USA, 2010*

*Doran P M, Bioprocess Engineering Principles, Academic Press, 2008 Shuler M L, Kargi F,*

*Bioprocess Engineering, , Prentice Hall PTR, 2017*

**CH454 Introduction to Molecular Simulations**

**(2-0-2) 3**

Introduction and basics of molecular simulations – model systems, interaction potentials, periodic boundaries, minimum image convention, Equations of motion. Elementary statistical mechanics: ensembles, Boltzmann's distribution, and free energy. Measure and control of temperature and stress in molecular systems. Length and time scale limits of simulation methods. Molecular dynamics of simple model fluids such as hard spheres. Structure of a simulation program and introduction to programming methods. Applications in solids, liquids, and biomolecules. Demonstration using LAMMPS (Large-scale Atomic/Molecular Massively Parallel Simulator).

*Allen, M.P., Tildesley, D.J. Computer Simulation of Liquids, Oxford University Press*

*Frenkel, D., Smit, B., Understanding Molecular Simulations: From algorithm to applications, Academic Press.*

*Rapport, D.C., The Art of Molecular Dynamics Simulation, Cambridge University Press.*

*Donald Allan McQuarrie, Statistical Mechanics, University Science Books.*

**CH455 Energy Conservation and Management in Process industries**

**(3-0-0)3**

Energy Outlook, Energy conservation and its importance, Energy intensive industries, Global industrial energy efficiency benchmarking, Engineering fundamentals related to energy efficiency, Principles on energy management, Energy Audit, Detailed thermodynamic analyses of common unit operations, Opportunities and techniques/methods for energy conservation in equipment and utility systems in process industries, Process synthesis, Thermo-economics, Energy Management Information Systems (EMIS). Software tools for industrial energy efficiency and savings, Case studies on energy conservation and management in process industries

*Kenney W F, Energy Conservation in the Process Industries. Academic Press Inc., 1984.*

*Stepanov V S Analysis of Energy Efficiency of Industrial Processes. 1st Edition, Springer-Verlag, 1993. Jakob*

*de SwaanArans, Hedzer van der Kooi, Krishnan Sankaranarayanan, Efficiency and Sustainability in the Energy and Chemical Industries, 1st Edition, Marcel Dekker, Inc., 2004*

**CH456 Fuel Cell Engineering**

**(3-0-0)3**

Overview of Fuel Cells, Classification, Basic chemistry and thermodynamics. Fuels for Fuel Cells: Hydrogen, Hydrocarbon fuels. Fuel cell electrochemistry: electrode kinetics. Fuel cell process design: PEM fuel cell components. Fuel cell operating conditions: pressure, temperature, flow rates, humidity. Components of solid-oxide fuel cells. Fuel processing: Direct and indirect internal reforming, steam reformation, CO<sub>2</sub> and partial oxidation, Direct electro-catalytic oxidation of hydrocarbons, Impurity removal, renewable fuels for SOFCs

*Gregor Hoogers, Fuel Cell Technology Hand Book, CRC Press, 2003.*

*Karl Kordesch & Gunter Simader, Fuel Cells and Their Applications, VCH Publishers, NY, 2001.*

*Barbir F, PEM Fuel Cells: Theory and Practice (2nd Ed.) Elsevier/Academic Press, 2013.*

*Subhash C. S and Kevin Kendall, High Temperature Fuel Cells: Fundamentals, Design and Applications, 2003*

**CH457 Chemical Project Engineering**

**(3-0-0)3**

Introduction. Components of Techno-economic feasibility report. Site selection factors, prefeasibility analysis, Capital and operating costs, cashflow statement, project evaluation. project scheduling: Gantt charts, CPM, PERT, network formulation and scheduling, project handover and documentation. Project financing, annual report analysis.

*Chandra Prasanna, Projects: planning, analysis, selection, implementation and review, Tata McGrawHill, 8<sup>th</sup> edition, 2014.*

*Turton, R., Bailey, R.C., Whiting, W.B., and Shaewitz, J.A., Analysis, synthesis and design of chemical processes, 4<sup>th</sup> edition, Pearson 2012*

*Mahajani, V.V. and Mokashi, S.D., Chemical Project Economics, 1st edition, Macmillan India, New Delhi, 2005.*

**CH458 Biology for Chemical Engineers**

**(3-0-0) 3**

Science and Engineering: Differences in perspectives-Biological molecules-Chromosome structure-eukaryotic-bacterial- DNA replication-Replication errors-mutations-repair-homologous-non-homologous-recombination-bacterial gene expression-transcription-translation. Recombinant engineering-plasmids-restriction endonucleases-DNA cloning and assembly methods-site specific recombination-Genetics- Mendelian and non-Mendelian Inheritance-pedigree analysis-Gene-Interactions-Immunological reactions-innate immunity receptors- Systems biology-autoregulation-bistability-robustness-feed forward loops- Bacterial chemotaxis and kinetic proof reading-introduction to bioinformatics-enzyme as catalysts.

*Scott Freeman (2002). Biological Science. Prentice Hall, 1<sup>st</sup> edition*

*Craig et al., (2010) Molecular biology: principles of Genome function, Oxford university press, 1<sup>st</sup> edition*



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## Department of Mechanical Engineering

- ME110 ELEMENTS OF MECHANICAL ENGINEERING (3-0-0) 3**  
Introduction to Mechanical Engineering, Emerging trends & its role, Mechanics in Mechanical Engineering; Materials and Stresses: Mechanical design concept, Types of drives, Friction and wear; Prime movers, Introduction to refrigeration, centrifugal pumps and compressors. Sources of energies: conventional and renewable; Manufacturing Processes: Basic processes like machining, casting, forging etc. welding, brazing and soldering. Manufacturing Systems; Introduction to Mechatronics, electro-mechanical elements, working principles, construction and their applications (Sensors & actuators)  
*J.wickert, An introduction to Mechanical Engineering, Cengage learning, 2nd edn. 2006*  
*Gopalkrishna K.R., Mechanical Engineering Sciences. Subhas Publications, Bangalore 1999*  
*K P Roy, S K Hazra Choudhury and Nirjhar Roy, Elements of Mechanical Engineering, Media Promoters and Publishers Pvt Ltd, Mumbai, 2012.*  
*Gupta, P.N., and Poona, M.P., Elements of Mechanical Engineering. 4th Edition, Standard Publications Ltd, 2009*
- ME111 ENGINEERING GRAPHICS (1-0-3) 3**  
Orthographic Projections of points, Straight lines, Planes, Solids (Auxiliary Plane Method and Change of position method), Isometric Projections.  
*Gopalkrishna K. R, Engineering Graphics (1<sup>st</sup> angle projection), Subhas Publication, Bangalore, 1999.*  
*Bhat N. D., Engineering Drawing, Charotar Publication, 1991.*
- ME112 MATERIALS SCIENCE AND ENGINEERING (3-0-0) 3**  
Introduction and classification of Materials. Atomic bonding and interatomic forces, Crystal structures, Crystallographic Points, Directions and Planes, Imperfections in Solids, Diffusion, Mechanical Properties of Metals, Failure – Fracture, Fatigue and Creep, Phase Diagrams, The Iron- Carbon System, Solidification, Types of Metal Alloys, Ceramic Structures, Processing and Applications, Polymers – Types and Mechanical Behavior, Composite Materials, Biomaterials, Electronic Materials, Properties of Materials – Electrical, Thermal, Magnetic and Optical.  
*Callister W.D., Material Science and Engineering, John Wiley & Sons, Inc., 2010*  
*D. R. Askeland, P. P. Fulay W. Wright and K. Balani, The Science and Engineering of Materials, Cengage Learning, India, 2010.*  
*Smith and Hashemi, " Foundations of Materials Science and Engineering", Mcgraw Hill, 2009.*  
*Douglass, "Introduction to Materials Science and Engineering: A Guided Inquiry", Pearson 2013.*  
*Raghavan, "Materials Science and Engineering: A First Course", PHI, 6<sup>th</sup> edition, 2015.*
- ME113 MECHANICS OF DEFORMABLE BODIES (3-0-0) 3**  
Tension, Compression, and Shear, Mechanical properties of materials, Elasticity, Plasticity and Creep, Hooke's Law. Allowable stresses. Axially loaded members, Statically indeterminate structures, Thermal effects, misfits, and Pre-strains. Torsion of circular bar, Transmission of power by circular shafts. Shear forces and bending moments, Relationships between loads, shear forces and bending moments. Stresses in beams, Pure bending and Nonuniform bending, Design of beams for bending stresses, Shear stresses in beams of rectangular cross section. Plane stress, Principal stresses, Mohr's circle and Hooke's law for plane stresses. Spherical and Cylindrical pressure vessels. Deflection of beams, Column buckling.  
*Egor P Popov, Mechanics of Materials, Pearson, 2015.*  
*James M. Gere, Mechanics of Materials, Sixth Edition, Thomson Learning, 2004.*  
*Ferdinand Beer, E. Russell Johnston Jr., John Dewolf, David Mazurek, Mechanics of Materials, McGraw Hill Education, 2014.*  
*Russell C Hibbeler, Mechanics of Materials, Pearson, 2013.*  
*William F. Riley, Leroy D. Sturges, Don H. Morris, Mechanics of Materials, John Wiley & Sons, 1998.*
- ME200 WORKSHOP (0-0-2) 1**  
Fitting, Carpentry, Demonstration of Welding & Soldering.  
*Hajara H.K. and Choudhary Workshop Practice vol.I, Media Promoters and Publishers, Bombay, 2007.*  
*Workshop Technology, Choudhary and chapman, Viva publications, 1996.*
- ME201 BASIC ENGINEERING THERMODYNAMICS (3-1-0) 4**  
Fundamental Concepts, system, temperature, Heat and Work, I law and II law of Thermodynamics, applications, Pure substance, Entropy, Available and unavailable energy, Analysis of cycles, Helmholtz and Gibbs Functions and its applications, Ideal and Real gases, Non reactive mixtures, properties of air and water vapour.  
*Spalding and Cole, Engineering Thermodynamics, ELBS Edition Longmans, 1987.*  
*Arora C.P. Thermodynamics, TMH, 1998.*

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*Gordan J. Van Wylen and Richard E. Soutag, Fundamentals of Classical Thermodynamics, 4th Edition, Wiley, 1994.*  
*P. K. Nag, Basic and Applied Thermodynamics, Tata McGraw Hill. 3rd Edition, 2005.*  
*Yunus A Cengel and Michael A. Boles, Thermodynamics : An Engineering approach , Tata McGraw Hill, 7th Edition*

### **ME202 FLUID MECHANICS AND MACHINERY (3-1-0) 4**

Fundamentals of fluid properties, pressure measurement, hydrostatic forces on surfaces, Buoyancy and floatation, Kinematics of fluid flow, Fluid dynamics, Compressible flow, gas nozzles, Flow of real fluids, Boundary layer theory, Flow around immersed bodies, Flow through pipes, Impact of jets, Hydraulic Machines, pumps, Turbines, Hydraulic systems.

*Kumar K.L. Fluid Mechanics, Eurasia Publishing House, New Delhi, 1995.*

*Yahya S.M., Turbomachines, Satya Prakashan, New Delhi, 1972.*

*F.M. White, Fluid Mechanics, Springer-Verlag. New York. 1999.*

### **ME203 MECHANICS OF MACHINERY (3-1-0) 4**

Basics of Kinematics – Links, Kinematic pair, Kinematic diagram, Mobility, Basic mechanisms and its inversions. Position, Velocity and Acceleration analysis of Planar mechanisms, Inertia forces in machines, Kinematics of Gear, Kinematics of cam-follower mechanisms, Construction of disc-cam profile, Synthesis of Mechanisms: Type, number and dimensional synthesis.

*R.L. Norton, Kinematics & Dynamics of Machinery, McGraw Hill Education, 2017*

*H.H. Mabe and C.F. Rainbotten, Mechanism and Design, John Wiley, 1987.*

*Arthur G. Erdman, George N. Sandor, Mechanism Design –Analysis and Synthesis, Vol. I, Prentice Hall, New Jersey, 1996*

*David H Myzyska, Machines and Mechanisms, Applied Kinematic Analysis, 4<sup>th</sup> Edition, Prentice Hall, 2012.*

*V Ramamurti, Mechanics of Machines, Narosa, 2010*

### **ME204 BASIC MANUFACTURING PROCESSES (3-1-0) 4**

Introduction to materials and manufacturing, Manufacturability-Castability-Weldability-formability-forgeability-Green Manufacturing, Metal Casting Processes - Introduction to sand moulding, patterns: design and layout, testing of moulding sand. Use of core, other casting processes: shell moulding, precision investment casting, permanent mould casting, Die casting processes and its types - centrifugal casting, Continuous casting, squeeze casting, slush casting, vacuum casting, gating & risering design, Solidification of metal and alloys, directional solidification, Melting practices, cast iron foundry, aluminium foundry, Mechanisation, casting cleaning, casting defects.

Introduction to Metal joining processes - Welding types, Brazing & Soldering, Introduction to metal forming, High Energy Rate forming

*Amitabha Ghosh, Manufacturing Science, East-West Press, 2<sup>nd</sup> edition, 2010*

*Bhattacharya A, Metal Cutting: Theory and Practices, New Central Book Agency, 2012.*

*Jain P. L., "Principles of Foundry Technology", TMH, 5<sup>th</sup> edition, 2014.*

*Heine, R.W., Loper, C.R., and Rosenthal, P.C., "Principles of Metal Casting", TMH, 2<sup>nd</sup> edition, 2001*

*Serope Kalpakjian and Steven R Schmid, Manufacturing Engineering and Technology, (Fourth Edition), Pearson Education, Asia, 2000.*

### **ME205 WORKSHOP PRACTICE (0-0-3) 2**

Compressors, reciprocating and rotary, Steam nozzles and steam turbines, Air standard cycles, Vapour power cycles, Gas turbine cycles, performance testing of IC engines, Refrigeration cycles, vapour absorption system, Psychrometric processes.

*Holman J. P., Thermodynamics, McGraw Hill International Student Edition. Newyork, 1969.*

*Rajput R.K, Thermal Engineering, Laxmi Publications (Pvt) LTD., NewDelhi. 6th Edition , 2007.*

*Eastop and McConkey, Applied Engineering Thermodynamics, ELBS, 1995.*

### **ME211 THERMODYNAMICS AND FLUID MECHANICS (3-0-0) 3**

Laws of thermodynamics, Concept of entropy, Air standard efficiencies and MEP representation on P-V and T-S diagrams, Compressor. Reciprocating, Use of compressors in Mining equipment, Fluids: Definition and properties, Ideal and real fluids, Pressure and its measurement for liquids. Dynamics of fluid flow, Flow in pipes, Centrifugal and reciprocating pumps.

*Nag, P.K., Engineering Thermodynamics, 5<sup>th</sup> Edition, McGraw Hill Education, 2013.*

*Kumar, K.L, Engineering fluid mechanics, 8<sup>th</sup> Edition, Eurasia Publishing House Pvt. Ltd, 2009.*

*Eastop and McConkey, Applied Engineering Thermodynamics, ELBS, 1995.*

### **ME251 APPLIED THERMODYNAMICS (3-0-0) 3**

Compressors, reciprocating and rotary, Steam nozzles and steam turbines, Air standard cycles, Vapour power cycles, Gas turbine cycles, performance testing of IC engines, Refrigeration cycles, vapour absorption system, Psychrometric processes.

*Holman J. P., Thermodynamics, McGraw Hill International Student Edition. Newyork, 1969.*

*Rajput R.K, Thermal Engineering, Laxmi Publications (Pvt) LTD., NewDelhi. 6th Edition , 2007.*

*Eastop and McConkey, Applied Engineering Thermodynamics, ELBS, 1995.*

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

- ME252 ANALYSIS AND DESIGN OF MACHINE COMPONENTS (3-1-0) 4**  
Introduction to Design, Engineering Materials, Simple Stresses, Compound Stresses in machine parts, Review of Failure theories Design for static loading, Stress Concentration, Design for dynamic loading, Cotter and Knuckle Joint, Design of shafts, keys and coupling, Variable and Impact loading, Design of springs, Spring nomenclature, Design of helical spring for static and fatigue loads, Collar and Pivot friction, Design of power screws, Design of coupling and clutch, lubrication, selection of journal & roller Bearings.  
*R.L. Norton – Machine Design, An integrated approach, Pearson Education Asia, 2000.*  
*J.E. Shigley and Mische, Mech. Engineering Design, Tata Mc Graw Hill -2003.*  
*Jack A.Collins, Henry Busby, George Staab, Mechanical Design of Machine Elements and Machines, 2011.*  
*Richard G Budynas; J Keith Nisbett, Shigley's Mechanical Engineering Design, McGraw Hill Education, 2017.*  
*Ansel C. Ugural, Mechanical Design of Machine Components, Second Edition, CRC Press, 2015*
- ME253 COMPUTER AIDED ENGINEERING (3-0-0) 3**  
Fundamental of CAD- Hardware and software requirements, methods of modeling- wire frame, surface, solid modeling and feature based modeling, Analytic and synthetic curve entities, Parametric representation of curves and surfaces, NURBS, Computer graphics: display, transformation, visualization, animation, graphics standards, translators. Product Design : Mass property calculations, assembly modeling, Finite element methods. Product Manufacturing: Part programming, CNC machine tool and control system.  
*Ibrahim Zeid, Mastering CAD/CAM, TMH publishing company ltd, New Delhi, 2007.*  
*P. N. Rao, CAD/CAM Principles and Applications 2nd Edition, TMH education, 2007.*
- ME254 MANUFACTURING TECHNOLOGY (3-0-0) 3**  
Mechanics of metal removal process, force analysis, friction, economics, Heat Generation in machining, Tool Temperature, Failure of Cutting Tool and Tool Wear , Cutting Tool Materials, Tool Life and Machinability, Cutting Fluids, Machine tools and operations-Turning, Milling, shaping, planing, broaching, drilling, boring, Grinding and Micro-finishing, CNC & SPM, , Principles of Non Traditional Machining, Sheet Metal Forming, Dies, Jigs and Fixtures. GD&T
- ME255 ENGINEERING DRAWING (1-0-3) 3**  
Screw Thread forms and Threaded fasteners, Riveted joints, Section of Solids, Development of Surfaces. Orthographic views with sections, Intersection of Solids. Machine components done using conventional drawing board and AutoCAD, Assembly drawing from working drawing: Swivel bearing, Machine Swivel vice, Tool head of shaper, Tailstock, Fuel pump, Fuel Injector, Rams bottom safety valve, Stop valve, Blow- off cock, Screw Jack, Centrifugal pump. Part drawing from assembly drawing: Foot step bearing, Eccentric, connecting rod, square tool post, Drill jig, Feed check valve.  
*Gopalkrishna K. R., Engineering Graphics, Subhas Publications, Bangalore, 1999.*  
*Gopalkrishna K. R, Machine Drawing, Subhas Publications, Bangalore, 1985.*  
*Bhat N. D, Engineering Drawing, Charotar Publishing House, Anand, India, 1991.*  
*Bhat N. D, Machine Drawing, Charotar Publishing House, Anand, India, 1984.*
- ME301 METROLOGY AND INSTRUMENTATION (4-0-0) 4**  
Linear, angle measurement, Quality control fundamentals, Standard deviation, normal curve pattern of variations, control charts for variables, Comparators, Limits, Fits and Tolerances, statistical aspect of tolerances and setting tolerances, Surface finish terminology and measurement, Optical measuring instruments, Measurement of screw thread and Gear elements. Instrumentation: Fundamentals of Measurement, Static performance characteristics. Dynamic performance, instrument types, transfer function representation, system response to standard input signals. Treatment of uncertainties: error classification, statistical analysis of data, propagation and expression of uncertainties; Measurement of various physical quantities: Linear and angular displacement, velocity, force, torque, strain, pressure, flow rate and temperature; Transfer functions of standard measuring devices; Data Acquisition and processing, Surface finish and roughness in details  
*E.O. Doebelin, Measurement systems- Applications and Design, 4th Ed., TataMcGraw-Hill, 1990.*  
*T.G. Beckwith, R.D. Marangoni and J.H. Lienhard, Mechanical Measurements, 5th Ed., Addison Wesley, 1993.*  
*I.C. Gupta, Engineering Metrology, Dhanpat Rai Publications, New Delhi, 1994.*  
*R.K. Jain, Engineering Metrology, Khanna Publishers, New Delhi, 1997*
- ME302 HEAT TRANSFER (3-0-0) 3**  
Introduction - conduction, convection, radiation, heat conduction - Fourier law of heat conduction, general heat conduction equation, one dimensional steady state for plane wall, cylinder, sphere, steady state heat conduction with heat generation for plane wall, cylinder, sphere, critical radius thickness, Fin heat transfer, Transient heat conduction - Lumped analysis, one dimensional transient heat conduction - heisler chart, Convection heat transfer - Forced convection - external flow and internal flow, Boiling and condensation heat transfer, Heat exchangers, Radiation heat transfer (Non participating media), Introduction

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to mass transfer.

*Frauk P Incropera, Fundamentals of Heat and Mass transfer, John Wiley and sons, Fifth Edition, 2002.*

*Nicati M. Ozisik, Heat Transfer a Basic Approach, McGraw Hill Publication, 1985.*

*Holman J. P., Heat Transfer, McGraw Hill Publication, 8th Edition, 1996.*

*C. P. Arora, Engineering Heat Transfer, Khanna Publishers, India, 1996.*

### **ME303 DESIGN OF MECHANICAL DRIVES (3-0-0) 3**

Belt, rope and chain drives, Design of pulleys and sprockets, Design of spur and helical gears, Design of Bevel and worm gears, Design of Gear boxes, Cam design: undercutting, base circle determination, forces and surface stresses. Design of plate clutches, axial, cone, internal expanding rim clutches, Internal and external shoe brakes.

### **ME304 AUTOMOBILE ENGINEERING (3-0-0) 3**

Introduction, Automotive Chassis Layout, Frame and body Construction, I.C. Engine Construction and Components. Engine Cooling and Lubrication System, Fuel Supply System for petrol and diesel Engine, Ignition System, Clutches, Transmission System, Drive Line System, Steering System, Suspension and Shock Absorber System, Braking System, Automotive Electrical System, Maintenance, Engine Testing, Servicing and Repair.

*K.M. Gupta, Automobile Engineering, Umesh Publications. New Delhi, 2001.*

*Kirpal Singh, Automobile Engineering, Standard Pub, 8th Edition, 1999.*

*Heitner Joseph, Automotive Mechanics, East West Press, 2nd Edition, 1974.*

*Crouse, Automotive Mechanics, Mc Graw Hill, 6th Edition, 1970.*

*N.K. Giri, Automotive Mechanics, Khanna Pub. New Delhi, 2004.*

### **ME305 CONTROL ENGINEERING (3-0-0) 3**

Overview of feedback control, mathematical models of dynamical systems, linear time invariant systems, transfer function, time and frequency response of a system, stability analysis, Feedback systems, concept of root locus, dynamic compensation, PID control, state space representation of dynamical systems. Application of MATLAB

*Gene F. Franklin et.al., Feedback control of dynamic systems, Pearson Ed. Asia, 1998.*

*K. Ogata, Modern Control engineering, Pearson Ed, 2002.*

*Harison and Boiling, Introduction to Automatic Control System, John Wiley Publication, 1976.*

### **ME306 METROLOGY AND CAD LAB (0-0-3) 2**

Metrology Lab: Linear and angular measurement, measurement using slip gauges, Calibration, Screw thread and gear tooth parameter measurement, Tool makers microscope, surface measurement, comparators, acceptance test on lathe. CAD Lab: Graphics programming, drafting techniques, solid modeling practices.

*I.C. Gupta, Engineering Metrology, Dhanpat Rai Publications, New Delhi, 1994.*

*Ibrahim Zeid, Mastering CAD/CAM, TMH publishing company ltd, New Delhi, 2007.*

### **ME307 MACHINE SHOP – I (0-0-3) 2**

Study and Demonstration of different Lathes for various jobs, different cutting tools and different Lathe operations, Marking, Centre drilling, Facing, Taper turning, Grooving, knurling, Profile turning, Drilling, Boring, Thread cutting, Eccentric turning.

*Hajara and Choudhary, Workshop Technology Vol.I(2008) &II(2010), Median Promoters & publishers, Bombay.*

*Khanna O. P, Workshop Practice Vol.I, Dhanpat Rai & Co., 2000.*

### **ME308 MECHANICAL LAB – I**

Determination of Fuel properties, Calibration of pressure gauge, Performance of IC Engines.

*Mathur and Sharma, Internal Combustion Engines, Dhanpath Rai and Sons. New Delhi, 8th Edition, 1996.*

### **ME351 ENERGY ENGINEERING (3-0-0) 3**

Conventional Energy Sources: Hydel, Steam, Gas turbine, Diesel and Nuclear Power Plant, Layout, function of different components and types, Power plant Economics, Non-conventional or Renewable energy sources: Solar energy, application of solar energy, Wind, Ocean, Geothermal, Biomass Energies, Energy Conversion Principles and types. Carbon footprint.

*M.M.El.Wakil, Power Plant Techniques, McGraw Hill, New York, 1985.*

*PK Nag, Power Plant Engineering, Tata McGraw Hill, 5th Ed. 2012*

*Sukathme S.P., Solar Energy Principles of Thermal Collection and Storage, 2nd Ed., TMC New Delhi, 1984*

*G.D. Rai, Non-Conventional Energy, Dhanpat Rai & Sons, New Delhi, 1998*

*Houghton E.L., Carruthers, Aerodynamics for Engineering students, Butterworth-Hinemann Ltd., 2006*

### **ME352 MACHINE DYNAMICS AND VIBRATIONS (3-1-0) 4**

Introduction to dynamics, Derivation of GDE using Newton's laws of motion, D'Alembert's principle, Virtual work, Lagrangian

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Dynamics, Hamiltonian principle. Balancing of rotating and reciprocating masses, single plan, multi plane, rotating and reciprocating mass, V engines. Gyroscopic effect on two- wheel vehicle, four wheel vehicle, aero plane, and ship. Whirling of shafts with and without air damping, critical speeds. Dynamic analysis of cams and followers. Governor Mechanisms. Fundamentals of vibration, Free vibration of single degree of freedom systems, Types of damping, Harmonically excited vibration, Response under the Harmonic Motion of the Base. Response under Rotating Unbalance, Vibration Isolation, Transmissibility, Vibration measurement, Undamped Vibration Absorbers.

*John J. Dicker, Jr. , Gordon R. Pennock, Joseph E. Shigley, Theory of Machines and Mechanisms, Oxford University Press, 2003*

*Hamilton H Mabie and Charles F Reinholtz , Mechanisms & Dynamics of Machinery 4th Edition, John Wiley & Sons, 1998*

*W T Thamson, M D Dahleh, Chandramouli Padmanabhan, Theory of Vibrations with Applications, Pearson, 2008. Singiresu S Rao, Mechanical Vibrations, 6<sup>th</sup> Edition, Pearson, 2016.*

*Graham Kelly, Mechanical Vibrations: Theory and Applications, C L Engineering, 2011.*

### ME353 AUTOMATION SYSTEMS

(3-0-0) 3

Introduction to Digital Control Systems, CNC technology, Evolution of Automation, Microcontrollers, Programmable Logic Controllers, Automated Process Planning, Scheduling and Management systems, FMS Elements, Concepts of Agile Manufacturing, STEP-NC systems.

*Mikel P. Grover, Automation Production Systems and Computer Integrated Manufacturing, PHI, 2004.*

*P. Radha Krishna & S. Subramanian, CAD/CAM/CIM, New Age International Publishers, 2009.*

*Chris Mc Mohan & Browne. J, CAD CAM, Prentice Hall, 1998.*

*Jerome H. Fuchs, The Prentice Hall Illustrated Handbook of Advanced Manufacturing Methods, PrenticeHall, 1988.*

### ME354 OPERATIONS RESEARCH

(3-0-0) 3

Definition, Formulation of LPP, Graphical Solutions, Simplex Algorithms, Sensitivity Analysis, Maximization Application, Transportation, Travelling Salesman Problems, Dynamic Programming, Game Theory, Solution Methods, Dominance Concept, Approximation Method, Waiting Line Theory, Poisson Arrival Rate, Exponential Service Times, System Characterization and Economy, Simulation, Steps, Applications and Limitations, Monte Carlo Technique, Waiting Line Situations, Networks: CPM and PERT Analysis, Total, Free and Independent Float, Network Crashing, Non-Linear Programming.

*S.D. Sharma & H. Sharma, Operations Research- Theory, Methods & Applications- Kedarnath & Ramnath Publishers, 2002.*

*Taha H.A., Operations Research – An Introduction, 7th Edition, Prentice Hall Pub, 2002.*

*Shambling and Stevens, Operations Research – Fundamental Approach. McGraw-Hill Inc, US, 1974.*

### ME311 FINITE ELEMENT METHOD

(3-0-0) 3

Introduction, Variational formulation, Weighted-integral and weak formulations, Ritz Method, Weighted Residuals method, One-dimensional finite element formulation for structural problems (static, free vibration), heat transfer and fluid mechanics problems. Two-dimensional element formulation for structural problems, Computer implementation, Numerical integration, Iso-parametric formulations. Case studies.

*C Zienkiewics, R L Taylor, J Z Zhu, The Finite Element Method: Its Basis and Fundamentals, Butterworth-Heinemann, 2013.*

*J. N. Reddy, An Introduction to Finite Element method, 3rd Edition, McGraw- Hill, 2005.*

*T R Chandupatla, A D Belegundu, Introduction to Finite Elements in Engineering, 4<sup>th</sup> Edition, Pearson, 2011.*

*P Seshu, Textbook of Finite Element Analysis, PHI, 2004*

*Singiresu S. Rao, The Finite Element method in Engineering, 5<sup>th</sup> Edition, Elsevier, 2008.*

### ME312 THEORY OF ELASTICITY

(3-0-0) 3

Components of stresses, equations of equilibrium, principle stresses and Mohr 's diagram in three dimensions, boundary conditions, strain components, compatibility equations, stress-strain relation and the general equation of elasticity, formulation of elasticity problems, existence and uniqueness of solution, Saint-Venant's principle, principle of super - position and reciprocal theorem, Airy's stress function to solve two dimensional problem, torsion of prismatic bars, soap film analogy, membrane analogy and elastic stability.

*Wang C.T., Applied Elasticity, Mc-Graw Hill Book Company, New York, 1953*

*Timoshenko and Goodier, Theory of Elasticity, Mc-Graw Hill Book Company, 3rd Edition, 1969.*

*T.G. Sitharam, Applied Elasticity, Interline publishing, 2008.*

*L. S. Srinath, Advanced Mechanics of Solids, Tata Mc-Graw Hill Book Company, 3rd Edition, 2009.*

### ME313 MECHATRONIC SYSTEMS

(3-0-0) 3

Introduction to Mechatronic system, Sensors and transducers, Signals systems and control, Actuating devices, feedback and intelligent systems, Microprocessors and Microcontrollers, Mechatronic system design, Applications of Mechatronics

*Botton W., Mechatronics 3rd Ed, Pearson Education Ltd. Indian print, 2003.*

*N.P.Mahalik, Mechatronics, TMH publishing Co. Ltd, New Delhi India, 2003.*

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Bradley D. A, *Mechatronics*, Chapman & hall, London, 1997.

H. M. T Hand Book, *Mechatronics*, TMH Publication, 1997

### **ME314                      PRODUCT DESIGN AND DEVELOPMENT                      (3-0-0) 3**

Generic process of Product development, Concept Generation, TRIZ, Concept Selection and Testing, Computer applications in Product Development. Product Architecture, Design for Manufacture and Assembly. Prototyping, Virtual and Physical. Rapid Prototyping Technologies, Reverse Engineering. Product Life cycle Management

*K T Ulrich and S D Eppinger, Product Design and Development, McGraw Hill, 2000.*

*K Otto and K Wood, Product Design, Pearson Education, Inc. 2001*

*K G Cooper, Rapid Prototyping Technology, Marcel Dekker, Inc. 2001*

*D T Pham and S S Dimov, Rapid Manufacturing, Springer-Verlag, 2001*

### **ME315                      THEORY OF METAL FORMING                      (3-0-0) 3**

Brief introduction to the Theory of Elasticity, Elastic stress-strain, relations, Plasticity, Plastic stress-strain relations, Yield conditions, Graphical representations of yield criteria, Work hardening, Forming – fundamentals, classification, flow stress, flow curves, effect of parameters such as strain rate and temperature, workability, anisotropy.

Deformation zone geometry, uniform deformation energy method, and slab analysis, friction and lubrication, residual

stress. Forging: Classification of forging processes, Hammer or drop forging, Press forging, Open-die forging,

Closed- die forging, Calculation of forging loads, Effect of forging on microstructure, Residual stresses in forgings, Typical forging defects.

Extrusion: Introduction/objectives, Classification of extrusion processes, Extrusion equipment, Presses, dies and tools, Hot extrusion, Deformation, lubrication, and defects in extrusion, Analysis of the extrusion process, Cold extrusion and cold-forming, Hydrostatic extrusion, Extrusion of tubing, Production of seamless pipe and tubing.

Rolling: Introduction/objectives, Rolling mills, Classification of rolling processes, Hot rolling, Cold rolling, Forces and geometry relationships in rolling, Simplified analysis of rolling load: Rolling variables, Problems and defects in rolled products, Rolling-mill control, Theories of cold rolling, Theories of hot rolling, Torque and power.

Drawing of rods, wires and tubes: Introduction/objectives, Rod and wire drawing, Analysis of wire drawing, Tube drawing processes, Analysis of tube drawing, Residual stress in rod, wire and tubes.

*Mechanical Metallurgy, S.I. Metric edition, George E. Dieter, McGraw Hill Book Company.*

*Metal Forming: Mechanics and Metallurgy, William F. Hosford, and Robert M. Caddell, PTR Prentice-*

*Hall, USA Metal Forming Analysis, R.H. Wagoner and J.L. Chenot, Cambridge University Press, New York,*

*U.S.A. Metal Forming Practice, Heinz Tschaetsch, Springer-Verlag, Berlin Heidelberg.*

*Elementary Mechanics of Plastic Flow in Metal Forming, Samuel H. Talbert and Betzalel Avitzur, John Wiley and Sons, New York.*

*Fundamentals of Metal Forming Processes, B.L. Juneja, New Age International, Publishers, New Delhi.*

### **ME316                      WELDING TECHNOLOGY                      (3-0-0) 3**

Introduction, Classification, Sample preparation techniques, Gas Welding, Arc Welding, Resistance welding, Submerged Arc welding, Equipment details and working of Gas Metal Arc Welding (TIG & MIG), Carbon Arc Welding, Advanced Welding processes, Welding defects and inspection. Friction and friction stir welding, EBW, LBW, Dissimilar metal joining, Welding codes, Welding qualification, Fatigue of welded joints.

*IWA reference material*

*Parmar, R.S, Welding processes and Technology, Khanna Publishers, 1997.*

*Richard L. Little, Welding & Welding Technology, McGraw Hill, 1973.*

### **ME317                      BASICS OF COMPUTATIONAL FLUID DYNAMICS                      (3-0-0) 3**

Introduction to Computational Fluid Dynamics: historical review, applications. Derivation of the fluid flow and heat transfer governing equations based on various fluid flow models. Mathematical aspects of the fluid dynamic equations, classification methods. Implementation of the finite difference and finite volume methods for fundamental advection diffusion, advection-diffusion partial differential equations. Stability, consistency and convergence issues. Numerical schemes for two dimensional Navier– Stokes equations like Lax -Wendroff method, MacCormacks method, SIMPLE. Implementation of boundary conditions. Various meshing methods. Errors and Uncertainty in CFD.

*Versteeg, Henk Kaarle, and Weerattung eMalalasekera. An introduction to computational fluid dynamics: the finite volume method. Pearson Education, 2007.*

*Jiyan Tu, Guan Heng Yeoh and Chaoqn Liu. Computational fluid dynamics A Practical approach. Butterworth Heinemann An Imprint of Elsevier, 2008.*

*John D. Anderson Jr . Computational Fluid Dynamics The Basics with Applications. McGraw –Hill International Edition, 1995. Patankar S V. Numerical Heat Transfer and Fluid Flow. Hemisphere Publishing corporation, Taylor and Francis Group New York, 1980.*

**ME318 PRINCIPLES OF TURBOMACHINERY**

**(3-0-0) 3**

Introduction, Velocity triangles, Different turbomachinery and their operation, Classifications based on flow direction, type of fluid and energy transfer direction. axial, radial, mixed flow machines. Application of the equation of fluid motion: Conservation of mass, momentum and energy, Rothalpy in stators and rotors, Efficiency and reaction, Polytropic efficiency. Dimensional analysis and principle of similitude: Specific speed for turbine and pump. Model Laws. Axial flow machines: Reaction for repeating stage, Loading efficiency with reaction, Stage efficiency, Choice of reaction, Multistage axial compressor and turbines. Hydraulic turbines: Pelton wheel, Francis Turbine, Kaplan Turbine, Loss estimation, Draft tube analysis, Effect of draft tube. Centrifugal pump; Pump geometry and performance, pump diffuser analysis, pump losses, NPSH, application to real pumps.

**ME411 THEORY OF FATIGUE AND ANALYSIS**

**(3-0-0) 3**

Introduction to linear elastic fracture mechanics, fatigue design methods, application to fatigue crack growth, Stress-life and strain-life approaches, notches and their effects, fatigue from variable amplitude loading, spectrum loading, cumulative damage theories, cycle counting methods, statistical aspects of fatigue.

*Ralph I. Stephens, Ali Fatemi, Robert .R. Stephens and Henry O Fuchs, Metal Fatigue in engineering, John Wiley, New York, Second Edition, 2001.*

*Jack. A. Collins, Failure of Materials in Mechanical Design, Second Edition, John Wiley & Sons, New York, 1981.*

*Robert L. Norton, Machine Design- An Integrated Approach, Fourth Edition, Prentice Hall, 2010.*

*David Broek, Elementary Engineering Fracture Mechanics, Sijthoff & Noordhoff International Publishers, Netherlands, 1978*

**ME412 EXPERIMENTAL STRESS ANALYSIS**

**(3-0-0) 3**

Review of Elementary Elasticity and Fracture Mechanics, Strain measurement methods and related instrumentation, Optical methods of stress analysis, Brittle Coat methods, Applications of statistics to experimental data. Introduction to Thermal imaging

*J.W. Dally and W.F. Riley, Experimental Stress Analysis, Mc Hill International Editions, New York, 1991.*

*L.S. Srinath et al., Experimental Stress Analysis, Tata Mc Hill, NewDelhi, 1984.*

*A.W. Hendry, Elements of Experimental Stress Analysis, Pergamon Press, New York, 1977.*

*A. J. Durelli, Applied Stress Analysis, Prentice-Hall Inc., New Jersey, 1967.*

**ME413 SYNTHESIS OF MECHANISMS**

**(3-0-0) 3**

Introduction, tasks of Kinematics Synthesis, Type synthesis, Tools of dimensional synthesis, Function Generator: Three prescribed points, Introduction to Analytical synthesis, Standard Dyad form, three prescribed positions for motion, path and function generation, circle, point and center-point circles, Freudenstein's equations for three point function generation, order synthesis, coupler curves for four-link, slider- crank and inverted slider- crank mechanisms, Application of coupler curves in **design of six-link mechanism**, Coupler cognate mechanisms. Introduction to Compliant mechanism

*George N Sandor and Arthur G Erdman, Advanced mechanism design: analysis and synthesis, vol.2, pearson; Facsimile edition (8 March 1984)*

*A.H Soni, Mechanism Synthesis and Analysis, McGraw Hill, 1984.*

*Robert L. Norton, Design of Machinery- An Introduction to the Synthesis and Analysis of Mechanisms, WCB Mc Graw Hill, Boston, 1999.*

*Asok Kumar Mallik, Amitabha Ghosh, Gunter Ditttrich- Kinematic Analysis and Synthesis of Mechanisms, CRC Press; 1 edition (1994)*

**ME414 MICROSYSTEMS TECHNOLOGY**

**(3-0-0) 3**

Introduction to electromechanical systems and MEMS, Micro sensors and Micro actuators, Scaling and Material Issues, Micro fabrication techniques, Electro mechanics, Design of MEMS and Design realization tools. Packaging of MEMS, CAD Tools for MEMS

*J J Allen, MEMS Design, Taylor and Francis 2005*

*Tai Ran Hsu, MEMS and Microsystems-Design and Manufacture, TMH 2002*

*Nadim Maluf, An Introductionn to MEMS Engg, Artech House 2004*

*Stephen D Senturia, Microsystem Design, Springer 2001*

*Marc J Madou, Fundamentals of Microfabrication, CRC Press 2<sup>nd</sup> edition, 2002*

**ME415 HYDRAULICS AND PNEUMATICS CONTROL**

**(3-0-0) 3**

Introduction, Circuit Symbols, Fluid Pumps and Motors, Control Valves, Servo Systems, Single and Multi-Actuator Circuits, Design consideration of Circuits, Pumps and compressors - Working Principles, Hydro-Pneumatics, Fluidics, Principles of Pneumatic circuit design, Maintenance of Circuits, K-V Diagrams and Electrical Controls in Pneumatic Circuits, PLC control of hydraulic and pneumatic systems.

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

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Esposito A.P., *Fluid Power with applications*, Pearson Education Asia, 6<sup>th</sup> edition, 2005.

*Text Book of Hydraulics, Festo Didactic, 4th Edition, 2001.*

*Text Book of Pneumatics, Festo Didactic, 4th Edition, 2001*

Andrew Parr, *Hydraulics and Pneumatics*, Jaico Pub, 2000.

S.R. Majumder, *Pneumatic Systems – Principles and Maintenance*, Tata McGraw Hill Co. 15th Edition, 2006.

### ME416 ROBOTICS

(3-0-0) 3

Introduction, Classification and applications; manipulator – The industrial robotic arm; Kinematics of a serial-link robotic manipulator, dynamics and control of a serial-link manipulator; sensors and actuators for robotics.

J J Craig : *Introduction to robotics: Mechanics and Control*, 3rd edition, Pearson Ed, 2004

Asitava Ghosal, *Robotics: Fundamental concepts and Analysis*, oxford University Press, 2013

### ME417 NON DESTRUCTIVE EVALUATION

(3-0-0) 3

Liquid penetrate inspection: Post-emulsifiable penetrates, Solvent-soluble penetrates, Radiographic examination: X-Ray apparatus, X-Ray generation, Radiograph, safety hazards and Government control, Ultrasonic's Examination: Ultrasonic triangulation fault location acoustic emission technique, Instrumentation, Signals and processing, Magnetic testing Methods: current flow magnetization, Induction Magnetic Flow method, Induction threading bar method, Induction Magnetizing coil method, Induced current flow method, Magnetic particle Inspection, strippable Magnetic film, Industrial Computed Tomography, Thermal Inspection, Optical Holography, Quantitative Nondestructive Evaluation, Applications of NDE Reliability to Systems, NDE Reliability Data Analysis, Statistical Quality Design and Control, Eddy current testing methods

*Non destructive Evaluation and Quality Control, Volume 17, 9th Edition Metals Handbook, ASM Handbook, 1992*

L. F. Pau, *Failure Diagnosis and Performance Monitoring*. Marcel Dekker Inc, 1981.

Charles, J. Hellier, *Handbook of Non destructive evaluation*, McGraw Hill, New York 2001.

J Prasad, C G Krishnadas Nair, *Non-Destructive Testing and Evaluation of Material*, Tata McGraw-Hill

Education Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005

### ME418 PRODUCTION AND OPERATIONS MANAGEMENT

(3-0-0) 3

Introduction, Economic Analysis, Process Analysis, Work Study, Productivity, Value Analysis, Break Even Analysis, Layout and Location of Facilities, Line Balancing, Demand Forecasting, Inventory Control, MRP, Aggregate Planning, Scheduling. R. Panneerselvam, *Production and Operations Management*, PHI Learning Pvt Ltd, 2006 Samuel Eilon, *Elements of Production Planning and Control*, Mc Milan Company, 1962.

Joseph G. Monks, *Operations Management -Theory & Problems*, McGraw- Hill, 1987.

E.S. Buffa, *Modern Production / Operations Management*, John Wiley, New York, 1983

Seetharama L Narasimhan, Dennis W Mcleavey, Peter J Billington, *Production Planning and Inventory Control*, PHI, 2<sup>nd</sup> edition, 1997

### ME419 PROCESSING OF COMPOSITES

(3-0-0) 3

Basic concepts and characteristics: Definition and characteristics of composite materials, overview of advantages and limitations of composite materials, Significance and objectives, Sciences and technology, Types and classification of typical composite materials, current status and future prospects, Micromechanical and Macro mechanical Behavior of a Lamina, Macro mechanical behavior of a laminate, Processing of Polymer Matrix, Metal Matrix and Ceramic Matrix Composite Materials, Testing of Composite Materials.

F.L. Matthews and R.D. Rawlings, *Composite materials: Engineering and science*, Wood head publishing limited, 1999.

Robert M. Jones, *Mechanics of composite Materials*, McGraw Hill Kogakusha Ltd, 2nd Edition, 1998.

Krishnan K Chawla, *Composite material science and Engineering*, Springer Publishing, 3<sup>rd</sup> edition, 2012.

P.C. Mallik, *Fibre reinforced composites*, Marcel Decker, 2<sup>nd</sup> edition, 1993.

M M Schwartz, *Composite Materials Hand book*, McGraw Hill, 1983.

### ME 420 IC ENGINES

(3-0-0) 3

Fuel-air cycles, Actual cycles, Combustion in SI engines, Stages of combustion, Flame propagation, SI combustion chambers, Combustion in CI engines, Delay period, CI engine combustion chambers, Testing and Performance, Adiabatic flame temperature, Enthalpy of product, CRDI, MPFI, CDI, Supercharger, Turbocharger. Alternative fuels for IC engines

M.L Mathur & R.P Sharma, *A Course in Internal Combustion Engine*, Dhanpat Rai & Sons, New

Delhi, 2001 John. B. Heywood, *Internal combustion engine fundamentals*, McGraw Hill, 1st Edition, 1988.

E.F Obert, *Internal combustion engines*, Addison Wesley, 3rd edition, 1968,

V. Ganesan, *Internal Combustion Engines*, McGraw-Hill, 1995.



## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

### ME421 REFRIGERATION AND AIR CONDITIONING

(3-0-0) 3

Refrigerants, Refrigeration Cycles, Air cycle refrigeration, Vapour compression system, multi pressure system, Cascade refrigeration, Vapour absorption system, Dry ice manufacturing, Ejector refrigeration system, Decicant cooling system, Pollution by refrigerants. Use of solar energy, low grade energy to run the refrigeration system. Psychrometry, Air-conditioning processes, use of Psychrometric chart, air conditioning processes, Cooling load calculations. types of air conditioning systems, winter and Summer air conditioning, Applications of air conditioning. (Use of Refrigeration data handbook permitted in examination).

*Arora C. P., Refrigeration and Air Conditioning, Tata McGraw Hill Company Limited, New Delhi,*

*1981. Refrigeration/Thermodynamics/Heat transfer/Air conditioning data hand book*

*Manohar Prasad, Refrigeration and Air conditioning, Wiley Eastern Limited, New Delhi, 1983.*

*Parker, Spitler M, Heating, Ventilating and air conditioning, Wiley India, 2011.*

*Refrigeration/Thermodynamics/Heat transfer/Air conditioning data hand book.*

### ME422 MECHANICS OF COMPRESSIBLE FLOW

(3-0-0) 3

Fundamentals equations of the flow of compressible fluids: multi-dimensional continuity equation, momentum equation, energy equation. Non-dimensional quantities for compressible flow. Pressure equation. Propagation of motion in compressible fluids: Stationary wave, non- stationary wave and formation of shock. Isentropic flow relations in terms of the sonic velocity and the Mach number. Steady one- dimensional flow: Isentropic flow through tubes: without and with heat transfer. Wave phenomenon: Normal shock and Oblique shock. Application of shock expansion theory.

*S M Yuan, Foundation of Fluid Mechanics. Prentice Hall of India Pvt. Ltd., 1976.*

*I.Balachandran P., Fundamentals of Compressible Fluid Dynamics, Eastern Economy Edition, Prentice Hall of India. New Delhi, 2006.*

*S. M. Yahya, Fundamentals of Compressible Flow, Wiley Eastern Ltd, New Delhi, 1989.*

*Cambel and Jennings, Gas Dynamics, Mc Graw Hill. New York, 1958.*

*B.T. Nijaguna, Thermal Science/Engineering data Hand Book, 1st Edition, Allied Publishers Ltd, New Delhi, 1992.*

*White F.M., Fluid Mechanics, McGraw Hill, Singapore, 1999.*

### ME423 MULTI BODY DYNAMICS

(3-0-0)3

Kinematics of particles and rigid bodies, Euler angles, Generalized displacement, velocity and acceleration, Rigid body dynamics, D'Alembert's Principle, Virtual work application in dynamics and Lagrange's equation, Constraints formulation in Multi Body Systems, Formulation of joint constraints for various joints used in practice, Formulations of Constrained Dynamics Equations, Lagrange Multipliers,

Multi Body Dynamics Solution, Numerical Integration, Computer simulation of the dynamic behavior of multi-body systems using software tools. Treatment of holonomic and non-holonomic constraints through various elimination and augmentation methods, Application to Vehicle Dynamics, Engine Dynamics, Power Train Dynamics. Tyre models in Vehicle dynamics. Stability Analysis. Deformable Multi Body Dynamic Simulation.

*Ahmed A. Shabana, Dynamics of Multibody Systems, 3rd edition, Cambridge University Press, 2010.*

*Michael Blundell and Damian Harty., The Multibody Systems Approach to Vehicle Dynamics, Elsevier Limited, 2004*

*Farid Amirouche, Fundamentals of Multibody Dynamics: Theory and Applications, Birkhäuser, 2006 Ahmed A.*

*Shabana, Computational Dynamics”, Wiley InterScience, 2nd Edition. 2001*

### ME424 VEHICLE DYNAMICS

(3-0-0) 3

Introduction to Automotive vehicles and Vehicle dynamics, Fundamental approach to modeling, Dynamic axle loads, Automobile - Principle Components, Working Principles and Construction details, Forces and couples on the wheel, Tractive and braking effort, Vehicle drag, power for propulsion, Air resistance, rolling resistance, grade resistance, traction and tractive effort, distribution of effort, Stability of a vehicle on a slope, Front wheel drive, rear wheel drive and four wheel drive. Dynamics of a vehicle running on a banked and curved track, Vehicle Performance, Acceleration Performance, Braking Performance, Road Loads, Aerodynamics, Mechanics of air flow around a vehicle, Pressure distribution on a vehicle, Aerodynamic forces, Ride, Steady State Cornering, Roll Over, Electric Vehicles, Hybrid Electric Vehicles, Rail and off road vehicle dynamics.

*T.D. Gillespie, “Fundamentals of vehicle dynamics”, Society of Automotive Engineers, Warrendale, PA, 1992.*

*N. K. Giri, “Automotive Mechanics”, Khanna Publishers, Eighth edition*

*Ahmed A. Shabana, “Dynamics of Multibody Systems”, Cambridge University Press; 2<sup>nd</sup> edition, 1998.*

*Michael Blundell and Damian Harty, The Multibody Systems Approach to Vehicle Dynamics, Elsevier, 2004.*

*M.Ehsani, Y.Gao and A.Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles, Second edition, CRC Press, 2015.*

### ME425 CONTEMPORARY CONCEPTS IN PRODUCT DESIGN

(3-0-0) 3

Human -Product Interactions – Design for Aesthetics, Input-Output Human interface devices, Design thinking. Design for ease of use. Ergonomics and Human modeling-Definition and aspects in Product Design, Digital Human Modeling and Virtual

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Humans. Bio-inspired product design and biomechanics- Designs inspired by flora and fauna, fundamentals of biomechanics. Creative Design and Design research methodology- Definition of Novelty and creativity. Abstractize and Synthesize for creative design. Design for sustainability, twelve principles of green engineering.

*M S Sanders and E J McCormick, Human Factors in Engineering and Design, McGraw-Hill Education (India) Pvt. Ltd., 7ed, 2013*

*Don Norman, The Design of Everyday things, Basic Books, 2013*

*W Lidwell, K Holden and J Butler, Universal Principles of Design, Rockport Publishers, 2003.*

*Duane Knudson Fundamentals of Biomechanics, Springer, 2007 (Second Edition)*

### ME426 AUTOMOTIVE ELECTRONICS

(3-0-0) 3

Automotive Mechanical Systems, Vehicle Systems, Power Train System, Transmission System, Braking System, Steering System, Need for Electronics in Automotive Systems, Overview of Vehicle Electronic Systems, Embedded Systems, Hardware Module, Software Module, Debug Interfaces, BDM and JTAG, Introduction to Embedded RTOS, Embedded System in Automotive Applications, Embedded System Communication Protocols, Vehicle communication protocols.

*Lack Erjavec Automotive Technology A systems approach, , 4th edition, Thomson Delmar Learning, 2005, USA;*

*William B., Ribens Understanding Automotive Electronics, , 6 -th Edit., An Inprint of Elsevier Science, USA,*

*2004; Robert Bosch GmbH Diesel-Engine Management, 3th edition., Bentley Publishers, 2004;*

*Robert Bosch, GmbH Gasoline-Engine Management, 2nd edition., Bentley Publishers , 2004*

*Robert Bosch GmbH, Automotive Handbook, 6th edition. Bentley Publishers, 2004;*

### ME427 INTRODUCTION TO ADDITIVE MANUFACTURING

(3-0-0) 3

History, Process Chain, CAD Issues, Classification of Processes – Vat Photopolymerization, Powder Bed Fusion, Material Extrusion, Directed Energy Deposition, Binder Jetting, Sheet Lamination, Material Jetting Processes, Design for AM, Issues And Qualification of Powders, Process Control and Insitu Monitoring, Applications and Case Studies

*Ian Gibson, David W Rosen, Brent Stucker., “Additive Manufacturing Technologies: 3-D Printing, Rapid Prototyping and Direct Digital Manufacturing”, Springer, 2015.*

*Andreas Gebhardt, Jan-Steffen Hötter, “Additive Manufacturing: 3D Printing for Prototyping and Manufacturing”, Hanser Publications, 2016.*

*Chua Chee Kai, Leong Kah Fai, “3D Printing and Additive Manufacturing: Principles and Applications, World Scientific, 2014.*

*Hod Lipson, Melba Kurman, “Fabricated: The New World of 3-D Printing”, Wiley 2013.*

*Patri K. Venunod , Weiyin Ma, “Rapid Prototyping - Laser-based and Other Technologies”, Kluwer Academic Publishers, 2003*

### ME428 NON TRADITIONAL MACHINING PROCESSES

(3-0-0) 3

Modern Machining Processes: An Overview, Mechanical Processes - Ultrasonic Machining, Abrasive Jet Machining, Water Jet Machining; Electrochemical and Chemical Metal Removal Processes - Electrochemical Machining , Electrochemical Grinding, Electrochemical Deburring, Electrochemical Honing, Chemical Machining, Thermal Metal Removal Processes - Electric Discharge Machining, plasma Arc Machining, Electron Beam Machining, Neutral Particle Etching , Laser Beam Machining, Introduction to Micromachining

*Electrochemical machining, Debarr & Oliver, Elsevier, 1968.*

*Ghosh & Mallick, Manufacturing science, East-West Press, 2010.*

*P C Pandey and H S Shan, MODERN MACHINING PROCESSES, Tata McGraw-Hill Education Pvt. Ltd., 1980.*

*Modern Machining technology, J Pualo Davim, Elsevier, 2011.*

### ME429 ENERGY AUDITING AND MANAGEMENT

(3-0-0) 3

Energy sources, energy conservation and its importance, Energy Conservation Act, 2001 Energy management program, Objectives of Energy Management, Energy auditing, Need for energy audit, types of energy audit, instruments used, Energy economics, financial analysis techniques, Payback period, ROI, NPV, IRR, cash flow, sensitivity and risk analysis, Energy conservation in boilers, performance evaluation of boilers, direct and indirect methods, factors affecting boiler performance, types of furnaces, performance evaluation of furnaces, direct and indirect methods, steam and condensate system, steam distribution system, steam traps, cogeneration concepts, heat exchangers, waste heat recovery, compressed air system, Electrical energy conservation, power factor, electric motors, minimizing motor losses, space heating and cooling, case studies

*W R Murphy and G Murrey, Energy management Butterworth-Heinemann, 2007*

*Larry C Witte, Schmidt and Brown, Industrial energy management and utilization Hemisphere publishing Co. New York*

*1998 Wayne C Turner, Steve Doty, Energy management handbook, Sixth Edition, CRC Press 2006*

*D. A Reay , Industrial Energy Conservation, Pergamon press 1980*

*T L Boten Thermal energy Recovery Wiley 1980*

*Bureau of Energy Efficiency guide books*

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

### ME430 GAS TURBINES AND JET PROPULSION

(3-0-0) 3

Design point performance calculations, Intake and propelling nozzle efficiency, Meanline design: Turbofan, turbojet and turboprop engines, Reaction principles, Momentum theory applied to propulsive devices, Augmentation of thrust, Ramjet and Pulse jet engine, The concept of losses and efficiency, Types of combustion system, Combustion process, Compressibility effects, Vortex theory, Selection of blade profile, chord and pitch, Limiting factors in design.

### ME431 CONTINUUM MECHANICS

(3-0-0) 3

Mathematical Preliminaries – Vector and Tensor calculus

Deformation Kinematics – Deformation gradient, E & L formulations, Time dependent motion, material derivatives

Equilibrium of deformable bodies –Traction and stress, Equilibrium and balance principles. Different Stress Measures

Material models – Material frame indifferences, Thermodynamic considerations, Plasticity Boundary value problems and numerical solutions to BV problems

Structural mechanics of beams – Kinematic hypothesis, Planar beam: Timoshenko & Bernoulli-Euler formulations;

*J.E. Marsden and T.J.R. Hughes, Mathematical Foundations of Elasticity. Dover Publications, 1994.*

*G.A. Holzapfel, Nonlinear Solid Mechanics: A Continuum Approach for Engineering, John Wiley & Sons, 2000.*

*P. Chadwick, Continuum Mechanics: Concise Theory and Problems, Dover Publications, 1999.*

*L.E. Malvern, Introduction to the Mechanics of a Continuous Medium, Prentice Hall Series in Engineering of the Physical Sciences, 1969.*

*Y.C. Fung Foundations of Solid Mechanics, Prentice Hall, 1965.*

*P.G. Ciarlet, Mathematical Elasticity, Volume III: Theory of Shells, North Holland, 2000.*

### ME451 MECHANICAL LAB – II

(0-0-3) 2

Heat transfer experiments, Performance analysis of Compressors, Blowers, Boilers, Refrigerators and Air Conditioning equipments, Dynamics of Machinery experiments.

*C. P. Arora, Engineering Heat Transfer, Khanna Publishers, India, 1996.*

*J.E. Shigley and John Joseph Vicker, Theory of Machines and Mechanism, 3<sup>rd</sup> Ed. TMH, 1995.*

*Manohar Prasad, Refrigeration and Air conditioning, Wiley Eastern Limited, New Delhi, 1983.*

### ME452 MACHINE SHOP – II

(0-0-3) 2

Demonstration of Machine tools and Power tools, Practice on Shaper, Milling Machine, Cylindrical and Surface Grinding, Slotter, Drilling Machines, etc. Programming for CNC Machines,

*Hajara and Choudhary, Workshop Technology Vol.I(2008) &II(2010), Median Promoters & publishers, Bombay.*

*Khanna O. P, Workshop Practice Vol.I, Dhanpat Rai & Co., 2000.*

### ME490 SEMINAR

(0-0-2) 1

This course is an one credit course to be completed during 8<sup>th</sup> semester. The student will make presentation on topics of academic interest

### ME501 MANUFACTURING ENGINEERING

(3-1-0) 4

Metal casting processes: Introduction to sand moulding, patterns Use of core, other casting processes: shell moulding, precision investment casting, permanent mould casting, die casting, vacuum die casting, Low pressure die casting, centrifugal casting, gating and risering, casting defects.

Machining: Introduction, Mechanism of Chip Formation, Heat Generation and Cutting, Tool Temperature, Failure of Cutting Tool and Tool Wear, Cutting Tool Materials, Tool Life and Machinability, Machining processes: Shaping and Planning, Turning and Boring, Drilling.

Introduction to metal forming processes: Strain rates in metal forming, Development of metallurgical structure during deformation

Flow curves, Forging, Extrusion, Wire drawing, Deep drawing

Metal joining processes: Gas Welding, Arc Welding, Advanced Welding processes, Brazing

*Soldering Amitabha Ghosh, Manufacturing Science, East-West Press, 2<sup>nd</sup> edition, 2010*

*Serope Kalpakjian and Steven R Schmid, Manufacturing Engineering and Technology, (Fourth Edition), Pearson Education, Asia, 2000.*

*Metal Cutting: Theory and Practices, Bhattacharya A, New Central Book Agency, 2012.*

*Jain P. L., "Principles of Foundry Technology", TMH, 5<sup>th</sup> edition, 2014.*

*Heine, R.W., Loper, C.R., and Rosenthal, P.C., "Principles of Metal Casting", TMH, 2<sup>nd</sup> edition, 2001*

*Mechanical Metallurgy Si Metric Edition by George E. Dieter, McGraw Hill Book Company (UK), 1989.*

### ME502 THERMAL ENGINEERING

(3-1-0) 4

Thermodynamic Laws, Compressors, reciprocating and rotary, Steam nozzles and steam turbines, Air standard cycles, Vapour

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power cycles, Gas turbine cycles, performance testing of IC engines, Refrigeration cycles, vapour absorption system, Psychrometric processes. Flow of real fluids, Boundary layer theory, Flow around immersed bodies, Flow through pipes, Impact of jets, Hydraulic Machines, pumps, Turbines, Hydraulic systems. Fin heat transfer, Transient heat conduction - Lumped analysis, one dimensional transient heat conduction - Heisler chart, Convection heat transfer - Forced convection - external flow and internal flow, Boiling and condensation heat transfer, Heat exchangers, Radiation heat transfer

*Holman J. P., Thermodynamics, McGraw Hill International Student Edition. Newyork, 1969.*

*Rajput R.K, Thermal Engineering, Laxmi Publications (Pvt) LTD., NewDelhi. 6th Edition, 2007.*

*Eastop and McConkey, Applied Engineering Thermodynamics, ELBS, 1995.*

*Frauk P Incropera, Fundamentals of Heat and Mass tranfer, John Wiley and sons, Fifth Edition, 2002.*

*Nicati M. Ozisik, Heat Transfer a Basic Approach, McGraw Hill Publication,1985.*

*Holman J. P., Heat Transfer, McGraw Hill Publication, 8th Edition, 1996.*

*Kumar K.L. Fluid Mechanics, Eurasis Publishing House, New Delhi, 1995.*

*F .M. White, Fluid Mechanics, Springer-Verlag. New York. 1999.*

### ME503 MECHANICAL DESIGN

(3-1-0) 4

Introduction to elasticity, plane stress and plane strain problems, Shear force and bending moment diagram, Bending equation, Beam deflection, Compound stresses and Mohr's circle, working stresses, modes of mechanical failure, theories of failure, stress concentration, fatigue loading, Soderberg criteria, members subjected to steady and alternating loads. ASME design of transmission shafts and keys. Springs: stresses in coil springs, deflection of coil springs, Design of transmission drives: Flat-and V-belt drives, Gear drives. Kinematics of Machine elements, balancing of rotating and reciprocating systems, gyroscopic effect on two-wheeler, single Degree-of free and forced vibratory systems with and without damper.

*RL Norton – Machine Design, An integrated approach, Pearson Education Asia,*

*2000 J.E. Shigley and Mische Mech. Engineering Design , Tata McGraw Hill – 2003*

*Hall, Holowenko, Laughlin- Machine Design, Schaum's Outline Series, 1981.*

*Robert L. Mott- Machine Elements in Mechanical Design, Pearson Prentice Hall 4<sup>th</sup> Edition, 2003.*

*V.B. Bhandary - Design of Machine Elements, Tata McGraw Hill, 2010.*

*K. Mahadevan and K. Balaveera Reddy- Design data Hand Book , (SI Units), 2013*

### ME504 PRODUCTION MANAGEMENT

(3-1-0) 4

Introduction, Economic Analysis, Break Even Analysis, Layout and Location of Facilities, Line Balancing, Demand Forecasting, Inventory Control, MRP and ERP, Supply Chain Management, Aggregate Planning, Scheduling, Project Management, JIT, TPS and Lean operations. Product Life cycle management

*Jay Heizer, Barry Render, Operations Management, Pearson, 11<sup>th</sup> Edition, 2015*

*R. Panneerselvam, Production and Operations Management, PHI Learning Pvt Ltd, 2006*

*Joseph G. Monks, Operations Management -Theory & Problems, McGraw- Hill, 1987.*

*E.S. Buffa, Modern Production / Operations Management, John Wiley, New York, 1983*

*Seetharama L Narasimhan, Dennis W Mcleavey, Peter J Billington, Production Planning and Inventory Control, PHI, 2<sup>nd</sup> edition,1997*

*K Aswathappa, K Shridhar Bhat, Production and Operations Management, Himalaya Publishing, second revised edition,2018*

### ME505 INDUSTRIAL AUTOMATION

(3-1-0) 4

Evolution of Automation, Automation Principles and Strategies, CNC technology, Microcontrollers, Programmable Logic Controllers, Automated Process Planning, Robotics & Flexible Manufacturing Systems. Automation in Production Systems, Industrial Control Systems, Applications of Sensors and Actuators, Material Handling and Transport Systems, Storage Systems, Manufacturing Cells, Group Technology and Cellular Manufacturing, Automated Assembly and Inspection

*Mikel P. Grover, Automation Production Systems and Computer Integrated Manufacturing, PHI, 2004.*

*P. Radha Krishna & S. Subramanian, CAD/CAM/CIM, New Age International Publishers, 2009.*

*Chris Mc Mohan & Browne. J, CAD CAM, Prentice Hall, 1998.*

*Jerome H. Fuchs, The Prentice Hall Illustrated Handbook of Advanced Manufacturing Methods, Prentice Hall, 1988.*

**Department of Metallurgical and Materials Engineering**

**MT 160 INTRODUCTION TO MATERIALS SCIENCE AND TECHNOLOGY**

**(3-1-0) 4**

The electronic structure of atoms, Types of atomic and molecular bonds; ionic bonding; covalent bonding; metallic bonding; secondary bonding; mixed bonding; hybridization. Energy bands in metals, insulators and semiconductors. Basic crystallography. Defects and dislocations. Types of Materials: Polymers, metals and alloys, semiconductors, ceramics, composites. Diffusion. Phase rule and phase diagrams. Properties: optical, magnetic, mechanical, electrical, thermal. Corrosion and material degradation. Selected topics and case studies.

*W.D. Callister Jr, Materials Science and Engineering, Wiley, 2006.*

*W.F.Smith et al, Materials Science and Engineering, Tata McGraw Hill, 2008.*

*D.R. Askeland, W. J. Wright, Essentials of Materials Science and Engineering, Cengage, 2013.*

*V. Raghavan, Materials Science and Engineering: a First Course, PHI, 2011.*

**MT 200 TESTING OF MATERIALS**

**(2-0-1) 3**

Definitions and physical interpretations of various mechanical properties of metals and alloys. Structures & Properties of engineering materials. Comparison of physical, thermal, and mechanical properties of metallic, ceramic, and polymeric materials, and composites. Scientific rationale for mechanical properties; cohesion between atoms, interatomic bonds, different levels of structures: atomic, crystal, micro, macro and mega structures. Methodology, equipment, acquisition-processing-presentation of engineering data of: Tension, Compression, Hardness, Torsion, Impact, Fatigue, and Creep Tests. Introduction to Non-Destructive Testing; DPI, MPI, UTI, Eddy Current Inspection and Radiography.

Lab component: Mechanical Testing: Brinell, Rockwell, Vicker's and Rebound Hardness Tests, Tensile Test using Hounsfield Tensometer/UTM, Charpy Impact Test, Creep Test, Spark Test. Non-Destructive Testing: Dye Penetrant and Magnetic Particle Tests.

*W.D. Callister Jr, Materials Science and Engineering, Wiley, 2006.*

*G.E. Dieter, Mechanical Metallurgy, McGraw Hill 1988.*

*Barry Hull, Vernon John, Non-Destructive Testing, ELBS/Macmillan, 1988.*

**MT 201 METALLURGICAL THERMODYNAMICS & KINETICS**

**(3-1-0) 4**

Review of first and second laws of thermodynamics, Maxwell's relations; free energy concept and applications, general strategy of deriving thermodynamic relations; third law of thermodynamics; related problems from Dube & Upadhyaya. Solutions, partial molar properties, Gibbs-Duhem equation, fugacity, activity, equilibrium constant; regular solutions, integration of G-D equation, dilute solutions, interaction parameter; equilibrium in thermodynamic systems, structure of unary phase diagrams in (P,T) space, Clausius -Clapeyron equation, triple point, alternative representation of unary diagrams; Gibbs phase rule, Free energy-composition diagrams, Ellingham diagrams; activation energy, effect of activation energy on reaction rate, chemically controlled reactions (both ideal and non-ideal systems).

*Robert T. DeHoff, Thermodynamics in Materials Science, McGraw Hill International, 1993 D.R Gaskell,*

*Introduction to Metallurgical Thermodynamics, McGraw Hill International, 1973 G.S.Upadhyaya and*

*R.S.Dube, Problems in Metallurgical Thermodynamics and Kinetics, Pergamon, 1977 A.Ghosh, Textbook*

*of Materials & Metallurgical Thermodynamics, PHI, 2003. H.S. Roy, Kinetics of Metallurgical Reactions, Oxford, BH, 1993.*

**MT202 PHYSICAL METALLURGY**

**(3-1-0) 4**

Structure of metals, space lattice, unit cells, crystal systems, metallic crystal structures, packing efficiencies, planes and directions, voids, imperfections in crystalline solids, dislocations and plastic deformation, theoretical shear strength, concept of dislocations, types of dislocations, Burgers vector, strain field associated with dislocations, dissociation of dislocations, climb and cross slip, dislocation interactions, plastic deformation by twin, yield point phenomenon, strain ageing, work hardening in single and polycrystalline materials, effect of temperature, composition and grain size on strain hardening, recovery, recrystallisation and grain growth, high temperature deformation of crystalline materials, diffusion in solids, applications of diffusion concepts, solidification of metals, freezing of alloys, Scheil equation, dendritic freezing in alloys, freezing of ingots, segregation, homogenization, porosity, eutectic freezing, growth of single crystals.

*E.Reed-Hill and R. Abbaschian, Physical Metallurgy Principles, PWS Publishing Co., 1994.*

*G.E. Dieter, Mechanical Metallurgy, McGraw-Hill Book Co., 1988.*

*W.G.Moffat, G.W.Pearsall & I.Wulff, The Structure & Properties of Materials, Vol. I Structure, Wiley Eastern,*

*1968. G. W. Hayden, W.G.Moffat and I.Wulff, The Structure & Properties of Materials, Vol.III Mechanical Behaviour, Wiley Eastern Pvt. Ltd, 1968.*

**MT203 POLYMER SCIENCE AND TECHNOLOGY**

**(3-0-0) 3**

Fundamentals of polymer science: Introduction, different types of polymerization and their mechanism, nomenclature of polymers, polymer molecular architecture, polymerization technology, molecular weight and molecular weight distribution, polymer crystallinity, thermal transitions in polymers. Industrial polymers: property Requirements and polymer utilization, thermoplastics: commodity and engineering plastics, thermosets, elastomers, natural rubber and synthetic rubbers, thermoplastic elastomers, blends & reinforced polymers. Polymer Reactions: polymer modification, polymer degradation. Properties of polymers: viscoelastic behavior, time – temperature superposition, stress-strain behavior, fracture, creep, hardness, impact behaviour, methods to improve mechanical properties, basics of polymer rheology, permeability, electrical, optical and flammability properties. Compounding and processing of polymers: plastics Technology, fiber Technology, elastomer technology.

*R. O. Ebewele, Polymer Science and Technology, 1e, CRC Press, Boca Raton, 2000.*

*V. R. Gowariker, N.V. Viswanathan, J. Sreedhar, Polymer Science, 1e, New Age International, New Delhi, 2011.*

*C.S. Brazel, S. L. Rosen, Fundamental Principles of Polymeric Materials, 3e, John Wiley, New York, 2012.*

*F. W. Billmeyer Jr., Textbook of polymer science, John Wiley, New York, 1996.*

*J. R. Fried, Polymer Science and Technology, 3e, PHI, 2014.*

*M.P. Stevens, Polymer Chemistry-an Introduction, 3e, Oxford University Press, New York, 1999.*

**MT204 MINERAL PROCESSING AND BENEFICIATION**

**(3-0-1) 4**

General theory of Mineral Crystallography: Crystal Symmetry, Space Group, Crystal Structure Packed Spheres. Scope of Mineral Dressing in Metallurgy. Economics of the Minerals Industry, Mineral Liberation process: crushing and grinding, milling. Sampling and Particle size analysis. Materials and Energy Balance in Mineral Processing, Mineral Beneficiation process: Gravity concentration methods. Froth floatation. Magnetic and electrical separation. Advance Magnetic and Electrical separator for beneficiation of low grade minerals. Recycling process and methods for electronic waste.

Lab component: Identification of ore under polarized microscope such as iron ore, copper ore, practical on size distribution, Forth floatation experiment, gravitation concentration on iron ore, and Magnetic separation.

*W. D. Nesse, Introduction to Minerology, Oxford Press 2000.*

*C. W. Correns, Introduction to Minerology, Crystallography, and Petrology, Second Edition, Springer, 1969*

*Maurice C. Fuerstenau and Kenneth N. Han, Principles of Mineral Processing, Society of Mining, Metallurgy, and Exploration, 2003*

*B. A Wills, Mineral Processing Technology, 7e, Elsevier, 2006.*

*H. M. Veit, A. M. Bernardes, Electronic waste recycling Technology, Springer, 2015.*

**MT 251 TRANSPORT PHENOMENA**

**(3-1-0) 4**

Units & Dimensions, applications of transport phenomena in materials processing, properties of fluids, Newton's law of viscosity, momentum diffusivity, Newtonian and Non-Newtonian Fluids, Laminar flow, simple cases of flow along an inclined plane, flow between parallel plates, flow through a circular pipe, Equation of Continuity and Navier- Stokes Equation, Creeping flow around a sphere, Stokes law, Turbulent and complex flows, Concept of friction factor, dimensional analysis for friction factor, flow over a flat plate, flow past submerged bodies, applications, Packed beds, Darcy's law, Tube Bundle Theory and Ergun's Equation, Fluidized beds, Bernoulli's Equation, friction loss in pipes, concept of friction loss factor and entrance loss coefficient, flow through ladles, Pitot tubes, head meters, pumps, flow of compressible fluids, isentropic flow, convergent-divergent nozzles, vacuum pumps, conductance and throughput, Diffusion Pumps, Ion pumps.

Fourier law of heat conduction, thermal properties of solids, gases and liquids, steady state heat transfer, steady state heat transfer across a composite wall and a cylinder, concept of thermal resistance, critical thickness of insulation, Newtonian heat transfer, Biot Number. Unsteady state heat conduction, Semi-infinite and finite systems, error functions for solving heat conduction problems, Chart solutions, Finite Difference techniques, Modelling of latent heat, Natural and Forced Convection, Dimensional analysis for the heat transfer coefficient, correlations in convective heat transfer, heat exchangers, Significance of LMTD. Solidification heat transfer, Derivation of Chvorinov's rule, Radiation heat transfer, concept of black body, radiation resistance, radiation shields, radiation in gases, Similarity Criteria in heat transfer.

Steady state diffusion, molar diffusivity, Fick's 1<sup>st</sup> law of Diffusion, bulk flow, logarithmic mean of concentration difference, Ordinary and Knudsen Diffusion, Unsteady state diffusion, applications in microelectronic materials processing and homogenization heat treatment. Mass Transfer coefficient, mass transfer correlations, Models of Mass Transfer coefficient, Staged operations, counter current cascade, determination of number of stages .

*D. R. Poirier and G. H. Geiger, Transport Phenomena in Materials Processing, TMS Warrendale, 2016, eBook.*

*N.J. Themelis, Transport and Chemical Rate Phenomena, Gordon Breach, 1995.*

*R. B. Bird, W.E. Stewart and E.N. Lightfoot, Transport Phenomena, John Wiley, 2007.*

*R.I.L. Guthrie, Engineering in Process Metallurgy, Clarendon Press, 1992.*

#### **MT252 PHASE DIAGRAMS**

**(3-1-0) 4**

Introduction: types of solid solutions, Hume Rothery rules, intermediate phases, binary isomorphous system; phase rule and lever rule, miscibility gaps, eutectic systems, phase diagrams with intermetallic compounds; monotectics, syntectic, eutectoid, peritectic and peritectoid reactions in binary systems and solidification behaviour of typical alloys in these systems; ternary phase diagrams: isothermal sections and isopleths; ternary systems involving binary reactions, ternary reaction, experimental techniques of phase diagram determination: Fe-Fe<sub>3</sub>C phase diagram, introduction to steels and cast irons, other commercially important binary systems.

*A. Prince, Alloy Phase Equilibria, Elsevier, Amsterdam, 1966.*

*D.R.F West, Ternary equilibrium diagrams, 3rd Edn., CRC Press, 2002*

*Shant P Gupta, Phase equilibria in Materials, Allied Publishers Pvt Ltd, 2003*

*F.N.Rhines, Phase Diagrams in Metallurgy, McGraw Hill, N.Y.1956. S.H.Avner,*

*Introduction to Physical Metallurgy, 2nd Ed (Indian edition) 1997.*

#### **MT253 PRINCIPLES OF EXTRACTIVE METALLURGY**

**(3-1-0) 4**

Sources of metals, unit processes, pyrometallurgical processes, halides in extractive metallurgy, refining processes, stoichiometric calculations, hydrometallurgical processes, recovery of metal values from leach solution, electrometallurgical processes, electrorefining and electrowinning, nickel: sources, extraction from sulphide ores, carboxyl and electrolytic refining of nickel, extraction of nickel from oxide ores; copper: sources of copper, extraction from sulphide ores, refining, newer processes for copper extraction, hydrometallurgy of copper; zinc: sources, pyrometallurgical extraction, hydrometallurgical extraction, recovery of byproducts (cadmium); Imperial Smelting Process (ISP); lead: sources, extraction of lead, lead blast furnace, refining, modern developments in lead smelting, aluminium and magnesium extraction.

*Ray, Sridhar and Abraham - Extraction of nonferrous metals, EWP., New Delhi 1985.*

*R.D.Pehlke - Unit Processes of extractive metallurgy, 1975, American Elsevier, New York.*

*Sevmkov N. - Nonferrous Metallurgy, 1975, Mir, Moscow.*

#### **MT254 X-RAY DIFFRACTION AND ELECTRON MICROSCOPY**

**(3-1-0) 4**

Stereographic projections, generation, absorption and detection of X-rays; intensity of diffracted beam, Scherrer formula; Laue, rotating, powder methods, Debye-Scherrer technique, focusing technique, pin hole technique, diffractometer, crystal structure, indexing cubic and non-cubic patterns, precise lattice parameter, single crystal orientation; order-disorder transformation, grain size, texture, solvus line, chemical analysis: qualitative, quantitative; TEM Vs optical microscope, electron - matter interaction, image formation, specimen preparation, reciprocal lattice, indexing SAD patterns; SEM: modes, magnification, contrast, EPMA, FIM, STM, EDAX.

*B D.Cullity, Elements of X-Ray Diffraction, Addison Wesley, 1977. R. E. Smallman & K. M.B. Ashbee, Modern Metallography, 1966.*

#### **MT255 INSTRUMENTAL METHODS OF ANALYSIS**

**(3-0-1) 4**

Spectroanalytical methods: Introduction, Beers law, selection rules, IR spectroscopy, UV-visible spectroscopy, atomic absorption spectrometry. Thermal Analysis: Thermogravimetry, differential thermal analysis, differential scanning calorimetry, temperature modulated DSC, dynamic mechanical thermal analysis, hyphenated techniques. Surface Characterization: X-ray photoelectron spectroscopy, scanning tunnelling microscopy, atomic force microscopy, comparison between electron microscopy and scanning probe microscopy, sample preparation techniques for electron microscopy.

Lab component: Experiments on FTIR spectroscopy, DSC, SEM, and TEM of materials.

*J.W.Robinson, E.M.S Frame, and G.M Frame II, Undergraduate Instrumental Analysis, 6e, Marcel Dekker, 2005.*

*D.A.Skoog, F.J.Holler and T.A Nieman, Principles of Instrumental Analysis, 4e. Harcourt, 2001.*

*J.D Menczel, R.B Prime, Thermal Analysis of Polymers, Wiley, 2009.*

*G.H Michler, Electron Microscopy of Polymers, 1e, Springer – Verlag, 2008.*

#### **MT 256 MEASUREMENTS AND CONTROL**

**(3-0-0) 3**

Measurement and Instrumentation: Introduction, Measurement, Instrument, Measurement methods, Generalized measurement system and its functional elements, Classification of instruments, Basic standards and units

Instrument Characteristics: Introduction, Static terms and characteristics, Dynamic terms and characteristics, standard test-inputs, Zero, first and second order instruments, First order system responses, Second order system responses.

Measurement Errors and Statistical Analysis: Introduction, Classification of errors, Statistical analysis of test data,

Curve fitting by least squares, selecting an instrument.

Pressure Measurement: Introduction, Terminology, Pressure units and measuring instruments

Flow Measurement: Introduction, Nature of flow, Classification of fluid flow measurement techniques, Variable head-meters, Pitot tubes, Variable area flow meters, Quantity meters.

Temperature Measurement: Introduction, Temperature scales, Temperature measuring instruments, Liquid-in-glass thermometers, Bimetallic thermometers, Filled-system thermometers, Thermocouples, Resistance thermometers and thermistors, Radiation and optical pyrometers, Pyrometric cones, crayons, paints and pellets.

Strain Gauges and Strain Measurement: Introduction, Strain measuring techniques, Requirements of a strain gauge, Resistance strain gauge, Strain gauge alloys and materials, Metal resistance strain gauges, Unbonded versus bonded gauges.

Force and Torque Measurements: Introduction, Force measurement, Torque measurement.

Miscellaneous Measurements: Density and specific gravity, Liquid level, Viscosity.

Control Systems and their Classification: Introduction, Examples of control systems, Classification of control systems, Control systems terminology, Servomechanism, process control and regulators, Manual and automatic control systems.

*Kumar, D.S., Mechanical Measurements and Control, Metropolitan, New Delhi, 2015.*

*Instrumentation for engineering measurements: J W Dally, W.F. Riley, K.G. McConnel, John Wiley, 1995.*

*Industrial Instrumentation-Al Sutko, J.D. Faulk, Cengage Learning, 1996.*

*Principles of Industrial Instrumentation- D. Patranabis, McGraw Hill, 1996.*

*Industrial Instrumentation, D.P. Eckman, John Wiley, 1951.*

### **MT300 PRODUCTION OF IRON AND FERRO ALLOYS**

**(3-0-0)-3**

History of Iron Making, Traditional Iron Making, Evolution of Blast Furnace, Iron Making in India. Iron ores of the world: Distribution; Indian iron ores, limestones and coking coal deposits, problems associated with Indian raw materials. Iron ore beneficiation and agglomeration, theory and practice of sintering and pelletising, Testing of burden materials, Blast Furnace Reactions, Thermodynamics and Kinetics, Fundamental studies, Blast furnace design, other auxiliary units, plant layout, recent developments in the design & operation of blast furnace, irregularities in operation and their remedies, Blast furnace refractories and instrumentation; Blast furnace slag & gas: importance, formation and use. Direct reduction methods, Details of some commercial processes like Rotary Kiln, Electric Pig Iron Furnace, HYL, Midrex, Fluidised Bed, Corex Process, Pyrophoricity of DRI, Ferroalloy Furnaces, Production of FeSi, FeMn and FeCr, Nitrided Ferroalloys.

*Making, Shopping and Treating of Steel, 10<sup>th</sup> Edition, Edited by United States Steel, 1985; or 11<sup>th</sup> Edition Edited by the Association of Iron and Steel Engineers, 1999.*

*Ghosh and A. Chatterjee, Ironmaking and Steelmaking: Theory and Practice, PHI Learning (P) Ltd., New Delhi, 2008*

*A. K. Biswas, Principle of Blast Furnace iron making, SBA Publications, Calcutta, 1981.*

*Kurt Meyer, Pelletizing of Iron Ores Springer Verlag, Berlin, Heidelberg, Newyork, 1980.*

*Strasburger, Brown, Stephenson & Dancy, B.F. Theory and Practice, Vol.I & II, 1969, Gordon & Reach, New York.*

*K.K.Prasad& H.S. Ray, Advances in Rotary Kiln Sponge Iron Plant.*

*Robert L. Stephenson, Direct reduced iron – Technology & Economics of production and use, 1980, Iron & Steel Society of AMIE.*

*C.K.Gupta and A.K.Suri, Ferroalloys Technology in India, C.K. 1982, Milind Pub., New Delhi.*

### **MT301 HEAT TREATMENT**

**(3-1-0) 4**

Nucleation and growth of austenite, pearlitic transformation, TTT diagrams, formation of martensite, annealing, normalizing, hardening and tempering, hardenability, heat treatment furnaces, austempering, martempering, ausforming; thermomechanical treatments; surface hardening of steels; effect of alloying elements on Fe-C diagram, structure and properties of steels; carbon and alloy tool steels, stainless steels, HSLA steels, maraging steels, dual phase steels; cast irons and their heat treatment, alloy cast irons, aluminium and its alloys.

*R.E. Reed Hill, Physical Metallurgy Principles, Van Nostrand, East West Press, Newyork, New Delhi, 1973.*

*S.H.Avner, Introduction to Physical Metallurgy, McGraw Hill, 1974.*

*D.S.Clark& W.R Varney, Physical Metallurgy for engineers, East West Press, New Delhi, 1962.*

*T.V.Rajan and G.P.Sharma, Heat treatment (Principles & Techniques), Prentice Hall of India, 1995.*

### **MT302 MACHINE DESIGN**

**(3-1-0) 4**

Fundamentals of machine design, Engineering materials and their properties, Manufacturing Considerations in Machine Design, modes of mechanical failure, Shear force and bending moment diagram, Bending equation, Beam deflection, Simple and compound stresses in machine parts, variable stresses in machine parts, stress concentration,



welded joints, strength and efficiency of the joint, Springs: stresses in coil springs of round and square, deflection of coil springs, design of compression and tension springs. Flexible machine elements: Flat belt, V belt drives rope drives, Gears: spur, helical, bevel, worm gear, nomenclature, Lewis equation, Lewis form factor, design based on strength dynamic and wear loads, design of flywheels, pressure vessels and pipe joints.

*K. Mahadevan and K. Balaveera Reddy, Design and data book (SI Units) 2e, CBS publishers & distributors, 1984.*

*V. B. Bhandary, Design of Machine Elements, Tata Mc Graw Hill, New Delhi, 2e, 2007.*

*Robert. L. Norton, Design of Machinery, Mc Graw- Hill International, 1992.*

### **MT303 ELECTRONIC PROPERTIES OF MATERIALS**

**(3-0-0) 3**

Free electron theory, Fermi-Dirac statistics; density of energy states, Fermi energy, electrons in a periodic field of a crystal, Kronig Penny model, Brillouin zone theory, classical theory of specific heat, thermal conductivity, photon conductivity, phonon conductivity, thermal expansion of metals, polymers and ceramics, resistivity variation, intrinsic & extrinsic semiconductors, semiconducting compounds, production of transistors, integrated circuits, zone refining and single crystal growth, dielectric materials, ferroelectric materials, superconductors, magnetic materials, applications, ferrites, zone theory, opacity, luminescence, translucency, laser modulation and amplification, LED, optical storage and optical computer, optical fibres; Lasers.

*W. H. Rothery and B R Coles, Atomic Theory for Students of Metallurgy, Institute of Materials, London, 1988.*

*G.V. Raynor, An Introduction to Electron Theory of Metals, Institute of Materials, London, 1988.*

*Rolf E Hummel, Electronic Properties of Materials, 2<sup>nd</sup> Edition, Narosha Publishing House, 1995.*

*Manas Chanda, Science of Engineering Materials, Vol. 3, Engineering Properties, McMillan, 1980.*

*S. O. Pillai, Solid State Physics, New Age International Pvt. Ltd., India 2002.*

*B. M. Srivatsava and C. Srinivasan, Science of Engineering Materials New Age International Pvt. Ltd. 1999.*

*John Wulff et al. Electronic Properties, Vol. IV John Wiley and Sons, 1964.*

### **MT304 PHYSICAL METALLURGY LAB**

**(0-0-3) 2**

Temperature measurement: calibration of thermocouples, use of optical and radiation pyrometer, metallography, study of metallurgical microscope, specimen preparation for metallography, etching technique, image analyzer, quantitative metallography, phase diagram by cooling curve, phase transformation study by dilatometer, diffusion studies of solidification structure.

### **MT305 EXTRACTIVE METALLURGY LAB**

**(0-0-3) 2**

Study of temperature distribution in a tubular furnace, oxidation and reduction roasting, pelletisation and sintering of iron ore fines, leaching studies, flotation of sulphide ores, oxidation of metals and alloys, cementation of copper, reducibility of ores, proximate analysis of coal, calorific value of solid fuels and gaseous fuels, flash and fire point determination using Cleveland's open cup and Pensky Marten's closed cup testers, determination of viscosity of liquids using Redwood viscometer and Brookfield viscometer, Orsat apparatus for gas analysis.

### **MT306 FATIGUE, FRACTURE AND CREEP**

**(3-0-0) 3**

Fatigue test: S-N curve, statistical nature, effect of mean stress, Goodman diagram, effect of surface finish, size, residual stress and temperature; effect of metallurgical variables, suppression of fatigue, fracture mechanics: type of fracture in metals, theoretical cohesion strength, Griffith theory, dislocation theory of fracture, plane strain fracture toughness and its evaluation, instrumented impact testing, comparison of fracture toughness of various materials,

embrittlement of steels, creep and stress rupture, creep curve, stress rupture test, determination of fracture at higher temperature, presentation of engineering creep data, prediction of long time practices, theories of creep, effect of metallurgical variables.

*Dieter G.E., Mechanical Metallurgy, McGraw Hill, 1988.*

*T. H. Courtney, Mech. Behaviour of Metals, McGraw Hill 1990.*

### **MT307 FUELS AND FURNACES**

**(2-1-0) 3**

Classification of fuels, properties and tests, coal origins, carbonization and gasification. Other solid fuels; Liquid fuels -Types, testing, properties; Gaseous fuels, Hydrates. Introduction to nuclear fuels; Indian fuel deposits. Heat balance, principles of theory of combustion, Combustion calculations, evolution of heat, flame temperature, waste heat utilization. Basic concept of temperature measurement and control. Thermocouples: Principal, calibration, types and advantages Classification of furnaces; Construction and working principles of furnaces like Cupola, Induction furnace, Microwave furnace, Spark Plasma Sintering furnaces, Arc furnace, Resistance furnace, Pit furnace, Rotary furnace, Muffle furnace etc. Designing of laboratory furnaces.

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*O.P.Gupta, Elements of fuels, furnaces and refractories, 2011.*  
*J. D. Gilchrist, Fuels, Furnaces and Refractories, 1977.*  
*V. A. Krivandin, B. L. Markov, Metallurgical Furnaces, 1980.*  
*W Trinks, Industrial Furnaces, W. Trinks, John Wiley & Sons Inc, 2003.*

### MT350 PRODUCTION OF STEEL

(3-0-0) 3

History of steel making, major steel making processes, principles of steel making, physical chemistry of steel making, deoxidation, tapping and teeming, slags in steel making. Basic oxygen steelmaking processes, top and bottom blown processes, combined blowing/Hybrid processes, LD/BOF, Q-BOP/ OBM, LD-AC/OLP, Kaldor Rotor; Requirement of Metallic Coolant, Energy Optimizing furnace (EOF), Inputs required in oxygen steel making, yields from metallic inputs. Alloy and stainless steel making, continuous steel making, steelmaking in electric arc furnace, steel making in induction furnace, conarc process. Secondary steel making processes, steel degassing processes, casting pit practice, continuous casting of steel, moulds used for continuous casting; use of casting powder, Electromagnetic stirring, defects in continuous cast product.

*Making, Shaping and Treating of Steel, 11e, Edited by the Association of Iron and Steel Engineers, 1999.*

*A. Ghosh and A. Chatterjee, Ironmaking and Steelmaking: Theory and Practice, PHI, 2008.*

*A.K. Chakravarty, Steelmaking, PHI (P) Ltd., New Delhi, 2007.*

*R. H. Tupkary, Modern Steel Making, Khanna Pub, 2008.*

*C. Bodsworth, Physical Chemistry of Iron and Steelmaking*

*T. Rosenqvist, Principles of Extractive Metallurgy.*

*R.G. Ward, An Introduction to the Physical Chemistry of Iron and Steel making, ELBS, London.*

### MT351 CERAMICS AND REFRACTORIES

(3-0-0) 3

Structure of ceramics: bonding, Pauling's rules, oxide structures, silicate structures, structure of glasses; Defects in ceramics, Kroger-Vink notation; Processing of ceramics: powder processing, forming, calcination, sintering; Sintering – solid state and liquid phase sintering, grain growth; Microstructure of ceramics; Properties and testing of ceramics: physical, mechanical, thermal; Brittle Fracture, Toughening mechanisms; Formation and properties of glasses; Cement; Advanced ceramics; Definition of refractory, Classification, Properties and testing of refractories; General Production method of refractories, Selection of refractories for metallurgical applications, Special types of refractories.

*Michel Baersoum, Fundamentals of ceramics, McGraw Hill, 1997.*

*W.D.Kingery, Introduction to Ceramics, Wiley Interscience, 1976.*

*D.W.Richerson, Modern Ceramic Engg., Marcel Decker Inc. New York and Basel, 1984.*

*F. H. Norton, Refractories, McGraw-Hill; 4 Reprint edition, 1992.*

*A. R. Chetti, Refractories, Manufacture, properties & applications refractories.*

*A.O Surendranathan, An introduction to ceramics and refractories, CRC Press NY 2015.*

### MT352 METALLOGRAPHY LAB

(0-0-3) 2

Microstructure of cast iron, plain carbon steel, brasses, bronze and babbitts, aluminum silicon alloys, aluminum copper alloys, image analysis, inclusion studies, macro-microstructure of forged, rolled, cast and welded structures.

### MT353 CERAMICS AND POLYMERS LAB (0-0-3) 2

Molecular weight determination of polymer by viscometry, Melt flow Index of thermoplastics, Apparent density and specific gravity of a ceramics, physically bound water in a ceramic material, interfacial polycondensation, wet spinning, synthesis of conducting polymer, molding and measuring hardness of a thermoplastics material, synthesis of nanoceramics, identification of polymers, FTIR spectroscopy and scanning electron microscopy of polymer and ceramics, characterization of rubber latex.

### MT354 HEAT TREATMENT LAB

(0-0-3) 2

Full annealing, normalizing, hardening and tempering of plain carbon steels, Jominy end quench test, pack carburizing, precipitation hardening, diffusion studies, recrystallisation and grain growth, heat treatment of high speed steel and stainless steels.

### MT355 POWDER METALLURGY

(3-0-0) 3

Historical Development of Powder Metallurgy, Reasons for Using Powder Metallurgy, Advantages of Powder Metallurgy (P/M), Limitations, Applications, Metal Powder Production Methods, Production of Ceramic Powders, Microstructure Control In Powders, Powder Treatments And Handling, Pyrophoricity and Toxicity of Metal Powders, Powder Characteristics, Consolidation of Metal and Ceramic Powders, Classification of P/M Parts,

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Compaction Characterization, Sintering, Types of Sintering, Sintering Theory, Sintering Mechanisms, Solid State Sintering, Sintering of Multicomponent Systems, Sintering Variables, Effects of Sintering, Sintering Atmospheres and Equipment, Metallography of P/M Parts, Postsintering Operations, Testing, P/M Products: Porous P/M Parts, Sintered Carbides, Cermets, Sintered Friction Materials, Refractory Metals, Cemented Carbides or Hard Metals, Dispersion Strengthened Materials, Electrical Applications of P/M, Magnetic Materials, Structural P/M Parts; Mechanical Alloying, Metal Injection Molding (MIM) Testing, Standards and Quality Controls

*Powder Metallurgy- Science, Technology and Applications, 3<sup>rd</sup> Edition, P. C. Angelo and R. Subramanian, PHI Learning Private Limited, Delhi, 2012.*

*Powder Metallurgy- Advanced technique of processing engineering materials, 2<sup>nd</sup> Edition, B. K. Dutta, PHI Learning Private Limited, Delhi, 2014.*

*Powder Metallurgy Science, 2<sup>nd</sup> edition, Randall M. German, Metal Powder Industries Federation, USA, 1994.*

*An Introduction to Powder Metallurgy, F. Thummler and R. Oberacker, The Institute of Materials, 1993.*

*ASM Handbook, Powder Metallurgy Technologies and Applications, Vol. 7, ASM International, 1998.*

*Powder Metallurgy, Anil Kumar Sinha.*

### MT356 JOINING OF METALS

(3-0-0) 3

Classification of Welding Methods; Types of Welded Joints, Electrodes, Electrode Codes and Their Critical Evaluation, Welding Fluxes and Coatings - Type and Classification; Coated Electrodes, Hardfacing Electrodes, Stainless Steel and Cast Iron Electrodes, Inconel Electrode, Fluxes, Filler Materials, Solid State Welding Processes: Forge Welding, Friction Welding, Explosive Welding, Ultrasonic Welding, Cold Pressure Welding, Hot Pressure Welding, Thermo-Compression Bonding, Diffusion Bonding; Induction Welding, Resistance Welding Processes: Resistance Spot Welding, Resistance Seam Welding, Projection Welding, Resistance Butt Welding, Flash Butt Welding, Percussion Welding, High Frequency Resistance Welding, High Frequency Induction Welding; Production of Tubes; Essential Parameters and Principles in Fusion Welding, Heat Sources for Fusion Welding, Introduction to Weld Metal and Solidification, Gas-Metal Reaction, Liquid-Metal Reaction, Solid State Reactions; Gas Welding, Arc Welding: Gas Tungsten Arc Welding Torch, Materials and Shielding Gas, GTAW Circuit and Set-Up, GTAW Operation, Joint Design, Variants of GTAW; Shielded Metal Arc Welding (SMAW/MMAW): Equipment & Material, Operation, Metal Fusion And Weld Penetration, Electrode Motions, Welding Positions, Variants Of SMAW Process; Submerged Arc Welding (SAW): Equipment, Process Variables, Variants off SAW; Gas Metal Arc Welding (GMAW): Equipment and Material, Operations and Technique, GMAW Variables Variants of GMAW; Electroslag Welding (ESW): Equipment and Material, Electrical Set-Up , Operations and Technique, Process Variables, Variant of ESW; Plasma Arc Welding [PAW]; Plasma-MIG Welding, Radiant Energy Welding Processes: Electron Beam Welding [EBW], Laser Beam Welding [LBW]; Thermit Welding; Underwater Welding; Welding In Vacuum, Welding at Low Temperature (Cryogenic Welding), Welding in Space, Robotic Welding, Welding of Wrought Iron, Copper, Aluminium, Magnesium, Titanium and Super Alloys, Welding of Dissimilar Metals, Heat Treatment of Welds, Micro and Macrostructure, Residual Stresses, Shrinkage and Distortion in Welds, Inspection and Testing of Welds, Weldability, Weld Quality and Strength, Checking and controlling weld quality, Design of Weldments, Allied Processes: Brazing & Soldering, Braze Welding, Adhesive Bonding, Surfacing, Thermal Spraying; Flame Cutting, Powder Cutting, Plasma Cutting, Laser Cutting, Electron Beam Cutting,

*Principles of welding technology, 1st Edition, L. M. Gourd, Viva Books Private Limited, India,*

*2004 Welding Science and Technology, Ibrahim Khan, New Age International Publishers, India,*

*2009 Welding Processes and Technology, 3rd Edition, R. S. Parmer, Khanna Publishers, 2015*

*Welding Technology, 4<sup>th</sup> Edition, N. K. Srinivasan, Khanna Publishers, 2016*

*Metallurgy of welding, 6<sup>th</sup> Edition, J.F.Lancaster, Woodhead Publishing Limited,, Cambridge, London, 1999.*

*Welding & Welding Technology, Richard Little, Tata McGraw Hill, 1998.*

*Welding, A. C. Davies, Cambridge University Press 1996.*

*ASM Handbook, Volume 6.*

### MT357 AEROSPACE MATERIALS

(3-0-0) 3

Carbon-carbon composites, production, properties and applications, intermetallic matrix composites, ablative composites based on polymers, ceramic matrix, metal matrix composites based on aluminium, magnesium, titanium and nickel based composites for engines, superalloys, aluminum alloys, magnesium alloys and titanium alloys, materials for plasma engines, intermetallic aluminides, ceramics and polymeric materials.

*H. Buhl, Advanced Aerospace Materials, Springer Verlag, Berlin 1992.*

*Balram Gupta et.al Aerospace Materials Vol 1, 2, 3, ARDB, S. Chand & Co. 1996.*

### MT 400 CORROSION ENGINEERING

(3-0-1) 4

Definition of corrosion, Classification of corrosion, role of microstructures on corrosion, thermodynamic and electrochemical kinetics aspects, details of Mixed Potential Theory. Effect of Galvanic Coupling Using Mixed

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Potential Theory. Polarization, Details of metallic Passivity, role of passivity on corrosion, role of alloying elements, Types of corrosion, Tribo-corrosion, Environmental Effects, Effect of oxygen and oxidizers, Effect of Temperature, Effects of Corrosive Concentration.

High Temperature Corrosion: Oxidation of metal and alloy, hot corrosion and Mechanisms and Kinetics, High-Temperature Materials, Corrosion problems in selected industry.

Corrosion Protections: Materials Selection, Alteration of Environment and Design, Cathodic and Anodic Protection, Coatings (paints and electro-deposition) and inhibitors.

Corrosion Testing: Corrosion Rate measurement, Galvanic corrosion, Intergranular Corrosion, Pitting, Stress Corrosion, Erosion Corrosion, Tafel and Linear Polarization, AC Impedance, Mott-Schottky test, Paint Tests, Interpretation of Results, ASTM and NACE standard for corrosion testing.

Laboratory: examination of corrosion rate using weight loss and Tafel plot. Pitting corrosion test, Intergranular corrosion test (electrochemical etching techniques). Surface preparation method and Electro-deposition of metals.

Mars G. Fontana, *Corrosion Engineering*, 3<sup>rd</sup> edition, McGraw-Hill Book Company, 1986

David Talbot and James Talbot, *Corrosion Science and Technology*, CRC Press, New York,

1998 H. H. Uhlig and R. W. Revie, *Corrosion and Corrosion Control*, Wiley (NY) (1985)

K.E. Perumal and V.S. Raja, *Corrosion Failures: Theory, Case Studies, and Solutions* 1<sup>st</sup> edition, John Wiley & Sons, USA

ASM Handbook Vol-13 (A, B & C)

R. G. Kelly, John R. Scully, D. W. Shoesmith, and R. G. Buchheit "Electrochemical Techniques in Corrosion Science and Engineering" 1<sup>st</sup> edition, CRC Press

Nasser Kanani "Electroplating: Basic Principles, Processes and Practice" Elsevier publications (2004)

YD. Gamburg, G Zangari "Theory and Practice of Metal Electro deposition" Springer publications (2011).

### MT401 METAL FORMING

(2-0-1) 3

Elasticity and plasticity, yield criterion theories of metal forming, hot, warm and cold working, ring compression test, temperature rise in deformation zone, superplasticity and explosive forming, force-stroke diagrams in forming, friction and lubrication in metal working processes, forging, CAD & CAM in forging, extrusion, Mannesmann mill, rolling, drawing of rods, wire and tubes, dies, optimum die angle, bulk forming and sheet metal forming, deep drawing, redrawing, limiting draw ratio, forming limit diagram, role of texture defects in sheet metal working, bending, shearing, rubber pad forming, stretch forming, electro hydraulic forming, electromagnetic forming and high energy rate forming, numerical problems and design aspects in forming.

G. E. Dieter and David Bacon, *Mechanical Metallurgy*, McGraw-Hill, 1988, 3e.

Kurt Lange, *Handbook of Metal Forming* McGraw-Hill, 1985.

W. F. Harsford & R M Caddell, *Metal Forming Mechanics & Metallurgy*, Prentice Hall, USA, 1993, Second

Edition. B. Avitzur, *Handbook of Metal Forming Processes*, John Wiley, New York, 1983 *Metals Handbook Vol. 14, Forming and Forging*, ASM Metals Park, Ohio, 1988.

T Altan, *Metal Forming-Fundamentals and Applications*, ASM Metals Park, Ohio, 1983.

### MT402 FOUNDRY TECHNOLOGY

(2-0-1) 3

Patterns, sand moulding, cores and core materials, sand compaction, sand reclamation, moulding equipment, foundry layouts, furnaces and mechanization of foundries. Melting and pouring practices. Gating Systems; design of sprue, risers, and runners. Metallurgy of cast irons; White, Grey, Malleable, Ductile irons, ADI.

Demonstration of sand testing; moisture content, clay content, permeability, sieve analysis, compressive and shear strengths of moulding sand, shatter index, mould hardness.

Demonstration of green sand moulding process, Melting and pouring of aluminium alloy, Study of casting defects. J. Campbell, *Castings*, Butterworth, 1991

Heine and Rosenthal, *Principles of Metal Casting*, McGraw Hill, 1955

H.W. Taylor, M.C. Flemings, J. Wulff, *Foundry Engineering*, Wiley, 1959

### MT403 PHASE TRANSFORMATIONS

(3-0-0) 3

Thermodynamic concepts, homogeneous and heterogeneous transformation, nucleation and growth, growth kinetics, Johnson-Mehl and Avrami models, precipitation hardening, modern theories of precipitation hardening, crystallography and morphology of precipitates, typical age hardening alloys, martensitic transformation, morphological features, crystallographic features, kinetic features, phenomenological theories of martensitic transformation, martensitic transformation in-Ti, Fe-Ni and Fe- C alloys, pearlitic transformation, order-disorder transformation, short range order, long range order, degree of order, experimental methods to study ordering,

dependence of order parameter on temperature, change of property with ordering, recovery, recrystallisation and grain growth, secondary recrystallisation, anelasticity and internal friction, thermo-elastic effect, interstitial diffusion, Snoek effect, Kahn's torsion pendulum, relaxation time, measurement of damping capacity.

*R.E.Reed-Hill and R. Abbaschian, L Abbaschian, Physical Metallurgy Principles, 4th Ed., PWS Publishing Co., 2008.*

*V. Raghavan, Solid State Phase Transformations, Prentice Hall of India Pvt. Ltd, 1987. D.A.Porter and K.E.Easterling, Phase Transformation in Metals and Alloys, Chapman & Hall, 1992. Anil Sinha, Physical Metallurgy Handbook, McGraw Hill, 2002*

*D E Laughlin & K Hono, Physical metallurgy, 5th ed, Kindle Ed, 2014.*

*H Bhadeshia & R Honeycombe, Steels: Microstructure and Properties, 4th ed., Kindled, 2016.*

#### **MT404 EXTRACTION OF NON-FERROUS METALS**

**(3-0-0) 3**

Silver: sources, extraction by cyanidation, refining; gold: sources, concentration methods, gold recovery, refining; chromium: occurrence, production; cadmium: sources, extraction, recovery from secondary sources; mercury: sources, extraction from cinnabar; uranium: ores, processing of uranium ores, solvent extraction, reduction, production in India; thorium - sources, extraction and its purification; beryllium: types of ore, production, zirconium: sources, extraction and its refining, separation of Zr and Hf, fabrication of zirconium, production of zirconium in India; titanium: sources, beneficiation methods of ilmenite, production of titanium tetrachloride, the Kroll process; molybdenum: production of powder and ductile Mo; tungsten: ores, concentration methods, production of tungsten trioxide; production of tungsten powder and ductile tungsten; tin: types, smelting of tin concentrates, refining of tin.

*H.S.Ray A.SridharandK.P.Abraham, Extraction of Nonferrous Metals, 1985, EWP, New Delhi.*

*Sevryukov N., Nonferrous Metallurgy, 1975, Mir, Moscow.*

*W.H.Dennis - Metallurgy of the Non-Ferrous Metals, Ed.2, 1966, Pitman, London.*

#### **MT405 SECONDARY REFINING OF STEELS**

**(3-0-0) 3**

Introduction, unit processes in secondary steelmaking viz stirring, slag control, refractories and atmosphere control: ladle furnace method; ladle injection metallurgy, vacuum treatment of liquid steel: principles, processes viz ladle, stream and circulation degassing methods, stainless steel making technology - VOD, AOD and CLII processes, remelting, refining processes - ESR and VAR processes.

*R.H.Tupkary, Modern Steelmaking, Khanna Publishers, New Delhi, 1996*

*R.G.Ward, An Introduction to the Physical Chemistry of Iron and Steel making, ELBS, London, 1962 V.Kudrin, Steel Making, Mir Publication, Moscow, 1985*

#### **MT406 PROCESS PLANT MATERIALS**

**(3-0-0) 3**

Selection of process materials, fabrication, mechanical properties and strength of materials, effect of temperature on mechanical properties, testing and inspection of materials, properties and uses of ferrous metals, cast iron, plain carbon steels, thermal and electrical insulating materials, non-ferrous metals and alloys, general properties and fields of application of non-ferrous metals, plastics as materials of construction for chemical plant, corrosion resistance, uniform corrosion, galvanic corrosion, pitting, intergranular corrosion, effect of stress, erosion corrosion, high temperature oxidation, hydrogen embrittlement, selection for corrosion resistance, corrosion charts, design for corrosion resistance.

*William F. Smith, Principles of Material Science and Engineering, McGraw Hill Book Co, 1990.*

*Vernon John, Engg Materials, 3<sup>rd</sup> Edition, Macmillan, 1992.*

*William D. Callister, Materials Science & Engg., 4<sup>th</sup> Edition, John Wiley, 1997.*

#### **MT407 ADVANCED ENGINEERING MATERIALS**

**(3-0-0) 3**

Metals for high temperature service, Ti and Zr alloys, Ni and Co based super alloys, rapid solidification, metallic glasses, production, properties and applications, liquid crystals: production, properties and applications, composite materials, mechanics of composite materials, dispersion strengthening, metal matrix composites, special steels, maraging steels, trip steels, patenting, interstitial free steels, smart materials, shape memory effect, principles, pseudoelasticity, applications, nano technology, nano materials.

*R. E. Reed Hill & Reza Abbaschian, Physical Metallurgy Principles, 3<sup>rd</sup> Edition, 1994 PWS Publishers USA.*

*W. E. Smith Structure & Properties of Engineering Alloys McGraw Hill, 1993 F.L. Matthews & R. D. Rawlings, Composite Materials Engg. & Science, 1994 K. K. Chawla, Composite Materials, 2<sup>nd</sup> Edition, Springer - Verlag 2001*

#### **MT408 THIN FILMS, COATINGS AND APPLICATIONS**

**(3-0-0) 3**

Need for miniaturization, Basics of thin film, Brief review of kinetic theory of adsorption, desorption, film growth: nucleation and growth kinetics. Vacuum science and technology, vacuum pumps, surface: role of substrate surface, substrate cleaning. Epitaxy, thin film growth control, physical vapor deposition (PVD) processes, evaporation:

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thermal and e-beam. Principles of glow discharge and various sputtering processes. Fundamentals of Chemical Vapor Deposition (CVD) processes. Pulsed laser deposition (PLD), other techniques: electro-deposition, spin coating, sol-gel, Langmuir Blodgett (LB) techniques, SILAR technique, Doctor blade technique, printing. Hard coating: physical, mechanical and protective properties, basic thin film thickness measurement, microstructural characterization of films/coating. Thin film devices: optoelectronic devices, photo-detectors, solar cells. Applications: high hardness, corrosion resistance, biocompatibility and high temperature stability.

*Milton Ohring, Materials Science of Thin Films, 2nd Edition, Academic Press, 2001 Hartmut Frey and Hamid R Khan, Handbook of Thin Film Technology, Springer, 2016*

*K. L. Chopra & L. K. Malhotra, Thin film Technology and Application, Tata McGraw-Hill, 1985 Peter M. Martin, Handbook of Deposition Technologies for Films and Coatings, Elsevier, 1994 Sam Zhang, Nanostructured Thin Films and Coating, CRC Press, 2010*

*Narendra B. Dahotre and T.S. Sudarshan, Intermetallic and Ceramics Coatings, Mercel Dekker Inc., 1999 L. Tushinsky, I. Kovensky, A. Plokhov, V. Sindeyev, P. Reshedko, Coated Metal, Springer, 2002.*

### MT409 NUCLEAR MATERIALS

(3-0-0) 3

Structure of a nuclear power plant, requirements of reactor materials, fuel materials, plutonium uranium and thorium and their alloys & compounds, core materials: beryllium, graphite, control and shielding materials, magnesium & its alloys, aluminium & its alloys, zirconium & its alloys, austenitic stainless steel; materials for reactor vessel and other components, pearlitic steels, ferritic, chromium stainless steels, copper alloys, titanium and its alloys, coolants used in reactors: radiation embrittlement, corrosion of reactor materials, mechanical properties of materials.

*V.Gerasimov& A. Monakhov, Nuclear Engineering Materials, Mir Publishers, Moskow, 1983.*

*D.S.Clark& W.R Varney, Physical Metallurgy for engineers, East West Press, New Delhi,*

*1987 C.M.Srivatsava&C.Srinivasan, Science of engineering Materials, 1997, New Age International.*

### MT410 FRACTURE OF ENGINEERING MATERIALS

(3-0-0) 3

Failure and their causes - techniques of failure analysis, conventional design concepts, inadequacies of conventional design, mechanics of fracture, theoretical cohesive strength, Griffith theory of fracture, Irwin-Orowan modification, concepts of G and R, relation between G and rate of change of compliance, crack tip stress fields, stress intensity factors, relation between G and K, fracture toughness: determination of fracture toughness, ASTM standards; crack tip plasticity, plastic enclaves and their effect on energy release rate, concept of plastic zone criterion, R curve concept, J Integral, COD criterion, brittle and ductile fractures, fatigue crack growth and fracture mechanics, stress corrosion cracking, liquid metal embrittlement, hydrogen embrittlement, microscopic aspects of cleavage crack propagation, plastic relaxation at crack tip, nucleation of cleavage cracks by plastic deformation, crystallographic mechanism, initial growth and propagation, ductile - brittle transition; designing and testing for fracture resistance, principles of fracture safe design, testing procedure, designing steels for fracture resistance, improved toughness in ceramics, composites, case studies in failure analysis.

*D. Broek, Elementary Engineering Fracture Mechanics, Springer, 2012.*

*J.F.Knott, Fundamentals of Fracture Mechanics, Butterworths, 1973.*

*S.Tetelman&A.J.McEvily, Fracture of Structural Materials, John Wiley and Sons, 1967.*

### MT440 PRACTICAL TRAINING

2

This course is a 2 credit course. A student may complete the training before the beginning of 7<sup>th</sup> semester (or as stipulated by DUGC) and register for it in 7<sup>th</sup> Semester. The duration and the details shall be decided by the faculty advisor, with approval from DUGC.

### MT441 SEMINAR

(0-0-2) 1

This course is a 1 credit course to be completed during 7<sup>th</sup> / 8<sup>th</sup> semester. The student will make presentations on topics of academic interest.

### MT442 MAJOR PROJECT - I

(0-0-2) 1

### MT451 COMPOSITE MATERIALS

(3-0-0) 3

Reinforcements, whiskers, matrix materials, polymers, metals, ceramics, interfaces: wettability, crystallographic nature, interactions, types of bonding: processing, thermoset matrix composites, thermoplastic matrix composites, structure and properties, structural defects, mechanical properties applications, processing: liquid-state processes, solid state processes, properties, thermal characteristics, aging, fatigue and creep applications, electronic-grade MMCs, ceramic matrix composites: processing, infiltration, directed oxidation properties, toughness, thermal shock

resistance, applications- cutting tool inserts, ceramic composite filters.

*K. K. Chawla, Composite Materials, Springer, New York, 1998*

*Mallick, P.K, Composite Materials Technology: Process and Properties, Hanser, New York, 1990*

*D. Hull and T.W.Clyne, An Introduction to Composite Materials, Cambridge University Press, 1996.*

#### **MT452 ADVANCED WELDING TECHNOLOGY**

**(3-0-0) 3**

Arc Characteristics: Cathode Spot, Cathode Drop Zone, Arc Column; Arc Efficiency; Arc Blow; Types of Welding Arcs, Arc Initiation; Arc Maintenance, Electrode Polarity, Arc Stability, Arc Temperature, Metal Transfer, Welding Machine Characteristics - Conventional and Pulsed Power Sources, Inverter Type, Power Sources for Resistance Welding, Fusion Welding Process Variables, Gases in Weld Metal, Weld Thermal Cycle, Heat flow in welding - Significance, Theory of Heat Flow, Cooling Rate Determination, Selection of Welding Parameters Based on Heat Flow Analysis, Heat Flow Equations, Characteristics of Weld Solidification, Thermal Gradients and Turbulence in the Melt, Geometry of Weld Melt, Epitaxial Solidification, Crystal Growth and Segregation, Cellular and Dendritic Solidification in Welds, Refining of Weld Structure, Phase Transformation During Weld Metal Cooling, Role of Alloying and Slag Inclusions, Weld Metal Toughness, Heat Affected Zone: The Base Material, Carbon Equivalent, Heating Cycle, Recrystallization, Phase Transformation, Precipitate Stability, Coarsening, Dissolution During Weld Thermal Cycle, Grain Growth; Reactions at The Fusion Line, Hardness Measurements, Multi Run Welds, Cracking and Fracture in Welds, Special Welding Techniques: Electron Beam Welding, Laser Welding, Ultrasonic Welding, Numerical Problems in Welding, Residual Stresses in Welds and Their Measurements, Weld Defects, Fracture and Failure of Welds, Welding codes, Fracture Toughness Testing and Its Application to Welded joints, Determination of Preheat temperature, Use of Schaefflers Diagram, Weldability Tests, Weldability of Plain Carbon Steels, Low Alloy Steels, Stainless Steels, Tool Steels, Cast Iron.

*Welding Processes and Technology, 3rd Edition, R. S. Parmer, Khanna Publishers, 2015*

*Metallurgy of welding, 6th Edition, J.F.Lancaster, Woodhead Publishing Limited,, Cambridge, London, 1999*

*Introduction to the Physical Metallurgy of Welding, 2nd Edition, Kenneth Easterling, Butterworth Heinemann, 1992*

*Principles of welding technology, 1st Edition, L. M. Gourd, Viva Books Private Limited, India, 2004*

*Welding Science and Technology, Ibrahim Khan, New Age International Publishers, India,*

*2009 Welding and Welding Technology, Richard L. Little, Tata McGraw Hill, 2004.*

#### **MT453 SURFACE ENGINEERING**

**(3-0-0) 3**

Current status of surface engineering, fundamentals of electrode position, electroless plating, metallizing, hard anodizing, carburizing, nitriding, carbonitriding, flame hardening, induction hardening, thermal evaporation, sputter coating, ion plating electron-beam surface treatments, electron- beam hardening, laser hardening, ion implantation, hardfacing processes: shielded metal arc welding, gas tungsten arc welding, gas metal arc welding, flux cored arc welding, submerged arc welding, plasma arc welding, oxyacetylene welding, furnace fusing, thermal spray processes. *Kenneth G.Budinsk, Surface.Engineering for Wear Resistance, Prentice Hall, New Jersey, 1988 P.K.Datta&I.S.Gray, Surface Engineering, Vol. I, II, & III, Royal Society of Chemistry; 1993 J.S.Burnell -Grayand, P.K.Datta, Surface Engineering Casebook- Solutions to Corrosion and Wear- related Failures, Woodhead Pub., 1996.*

#### **MT454 MODELLING AND SIMULATION IN MATERIALS PROCESSES**

**(3-0-0) 3**

Introduction to modelling, simulation models, Casting process: modelling of heat transfer, direct heat conduction modelling, one- dimensional and multidimensional inverse modelling, fluid flow and heat transfer model, thermodynamics of solidification, metal/mold interfacial heat transfer, deformation and stresses in castings, thermo-mechanical modelling in casting, determination of heat transfer coefficient and air gap width in permanent mould castings, continuous casting and DC casting process, Welding process: weld heat -source models, thermal analysis with-microstructure, transient fluid flow, residual stresses in welds, Heat treatment: metal quenchant, interfacial heat transfer, diffusion model, microstructure model, carburization model, quench crack simulation, creep simulation, Modeling of rolling, forming and extrusion processes, Artificial Neural Networks in materials processing, Phase-field modeling and Monte-Carlo simulations, introduction to commercially available softwares - Solid Cast, FlowCast, OptiCast, Deform HT, ProCast, MagmaSoft, Design of experiments and factorial designs.

*Modeling in Welding, Hot Powder Forming and Casting (Eds. L. Koarlsson), ASM, MaterialsPark,OH, 1997. Szekey,J.,Evans, J.E.and Brinacombe, J.K., The Mathematical and Physical Modelling of Primary Metal processing Operations, Wiley, 1988.*

*Numerical Recipes: The Art of Scientific Computing, Cambridge Univ. Press, N.Y., 1988.*

*D.R. Poirier and G.H. Geiger: Transport Phenomena in Materials Processing, TMS, warrendale 1994.*

R.I. L. Guthrie: *Engineering in Process Metallurgy*, Oxford Science Publications (1989).

**MT455 SCIENCE & TECHNOLOGY OF NANOMATERIALS**

**(3-0-0) 3**

Introduction: Definitions, Classification, Fundamental principles, Fullerenes, nanoparticles, nanoclusters, nanowires, nanotubes, nanolayers, nanopores, supramolecules.

Synthesis: Top-down and bottom-up approaches, Plasma arcing, Chemical vapor deposition, Electro-deposition, Sol-gel synthesis, High energy ball milling, Nanolithography, Self-assembly, Langmuir-Blodgett films, Electrospinning. Characterization: Particle size and surface area determination, IR and Raman Spectroscopy, X-ray photoelectron spectroscopy, scanningtunnelling Microscopy, Atomic force microscopy.

Properties : Size dependence of properties, such as Electrical, Physical, Optical, Chemical.

Applications: Nanomachines and nanodevices, nanocomposites, Impact of nanomaterials in the areas of materials manufacturing, health care, data storage, clean energy, etc .

Society and nanotechnology: Challenges and fears, Impact on health and environment.

D. L. Schodek, P. Ferreira and M. F. Ashby, *Nanomaterials, Nanotechnologies and Design*, Butterworth-Heinemann, Oxford, 2009.

M. Wilson, K. Kannangara, G. Smith, M. Simmons and B. Raguse, *Nanotechnology: basic science and emerging technologies*, CRC press, Boca Raton, 2002.

C. P. Poole, Jr., and F. J. Owens, *Introduction to Nanotechnology*, Wiley-Interscience, New Jersey, 2003.

**MT456 ADVANCED MICROSCOPIC TECHNIQUES**

**(3-0-0) 3**

SEM-Review of electron optics, Electron specimen interactions, image formation and interpretation, High resolution imaging, WDS and EDS, Quantitative x-ray analysis, compositional mapping, Sample preparation for inorganic, organic, hydrated and biological materials.

TEM-Review of electron optics, reciprocal space and electron diffraction, sample preparation, diffraction from crystals and small volumes, diffraction patterns and their indexing, Kikuchi diffraction, CBED, Amplitude contrast and phase contrast, Thickness and bending effects, defects and their visualisation, High resolution TEM, Quantitative analysis using TEM. Concept of EELS, STEM, XPS, Auger microscopy, SIMS, etc.

*Scanning electron microscopy and X-ray analysis: J.I Goldstein et al. Plenum press, (Second or higher ed), 1992*

*Transmission electron microscopy: D.B. Williams & C B Carter, Springer,*

*2009 Electron microscopy- S. Amelinckx et al. VCH publ., 1997.*

**MT457 SMART MATERIALS AND SENSORS**

**(3-0-0) 3**

Inorganic: solid electrolyte sensor, oxygen sensors, hydrogen sensors, sulfur and sulfur containing gas sensors, humidity sensors, gas sensitive resistors, surface acoustic wave sensors, catalytic gas detectors, semiconductor junction devices, organic: semiconductor gas sensors, surface Plasmon resonance sensors, mass-sensitive sensors optical chemical sensors, electro chemical sensors, future prospects, automotive sensors: ceramic sensors, silicon sensors, chemical sensors for hostile environments, Piezoelectric sensors, actuator materials, micromechanics, chiral materials, conducting and chiral polymers, electrochromic materials, liquid crystals, molecular level smart materials, bio materials, composites, ceramics processing and fabrication, interface science, optical fibers, optical mirrors, smart skins for drag and turbulence control, other applications in aerospace/hydrospace structures, transportation vehicles, manufacturing equipment.

*J. of Smart, Materials and Structures, Back volumes, Institute of Physics, Polishing Bristol, U.K.*

*L.Dai, Intelligent Macromolecules for Smart Devices, Springer, 2002.*

**MT492 MAJOR PROJECT – II**

**(0-0-6) 3**



**Department of Chemistry**

**CY 110 CHEMISTRY**

**(3-0-0) 3**

Electrochemical Cells: Nernst equation, electrochemical series, types of electrodes, Polarization, Decomposition potential, Overvoltage, factors effecting electroplating, Electroless plating – PCB preparation. Corrosion: Types, Theory and factors affecting, Corrosion control, Galvanic series, Measurement of corrosion rate. Water Technology: Hardness of water, Boiler troubles, Internal and external treatments, Desalination. Energy: Fuels, Classification, Calorific value and its determination, Coal and its analysis, Petroleum, Catalytic cracking, Synthetic petrol, Power alcohol, Biodiesel, Hydrogen as a source of energy. High Polymers: Addition, Condensation and Coordination polymerization, Copolymerization, Molecular weights and their determinations, Methods of polymerization, T<sub>g</sub> & T<sub>m</sub> and factors affecting them; Elastomers - Compounding, SBR and Silicone rubbers, Conducting, biodegradable polymers. Chemistry of Nano-materials - Nano-carbons, ZnO, TiO<sub>2</sub>. Green chemistry, Semiconductor chemistry.

*P. C. Jain and Monika Jain, Engineering Chemistry, Dhanpat Rai & Sons, Delhi, Revised 14th Edn. 2004.*

*Gowariker et al., Polymer Science and Technology, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.*

*C. N. R. Rao, Chemistry of Nanomaterials, Volume I and II, Wiley Publication, 2004.*

*Industrial Organic Chemicals (3rd Ed.) by Harold A. Wittcoff, Bryan G. Reuben, and Jeffrey S. Plotkin, Wiley, ISBN 978-0-470-53743-5*

**CY 111 CHEMISTRY LABORATORY**

**(0-0-3) 2**

Volumetric estimations involving metal-ion, redox, self and precipitation type indicators - analysis of water (hardness and chlorides), ores (haematite and pyrolusite); Instrumental methods of analysis - potentiometry, colorimetry, conductometry and refractometry; Analysis of polymers, metals, alloys, and related engineering materials.

*Engineering Chemistry Lab Manual, written by Faculty, Dept of Chemistry, NITK, Surathkal. Furnis et al (ed.), Pearson, Vogel's Text book of 'Quantitative Chemical Analysis', Pearson, 2006*

**CY201 PRINCIPLES OF ORGANIC SYNTHESIS**

**(3-0-0) 3**

Formation of C-C bonds: Organometallic reagents. Formation of aliphatic C-C bonds, base/acid catalyzed. Formation of aliphatic C-N bonds. Pericyclic reactions. Electrophilic aromatic substitution. Nucleophilic aromatic substitution reactions. Molecular rearrangements: Rearrangement to electron-deficient carbon, nitrogen and oxygen. Aromatic rearrangements. Photochemical reactions. Free radical reactions. Oxidation & reduction reactions.

*J. March, Advanced Organic Chemistry, 4<sup>th</sup> edition, McGraw Hill, New York, 1994.*

*R. O. C. Norman and J. M. Coxon, Principles of Organic Synthesis, Blackie Academic and Professional, Glasgow, New York, 1993.*

**CY202 UNIT PROCESSES IN ORGANIC SYNTHESIS**

**(3-0-0) 3**

Bond breaking, bond forming, synchronous bond breakage and formation, intramolecular migration, electron transfer, types of reactions. Electrophilic addition. Nucleophilic addition. Radical addition. Elimination. Substitution reactions. Intramolecular rearrangements and intermolecular rearrangements. Oxidation and reduction reactions.

*P. H. Gorggins, Unit Processes in Organic Synthesis, 5<sup>th</sup> edition, McGraw-Hill, 1958.*

*J. March, Advanced Organic Chemistry, 3<sup>rd</sup> edition, McGraw Hill, New York, 1985.*

**CY205 ORGANIC CHEMISTRY**

**(3-0-0) 3**

Strengths of organic acids and bases: Various Acid-base concepts, HSAB theory & its applications. Heterocyclic compounds: synthesis, reactions, reactivity of some five and six member heterocyclic compounds & their industrial importance. Reagents of synthetic importance: synthesis, uses, mechanism, applications of some important reagents.

Named organic reactions: mechanism and applications of some industrially important organic reactions.

Stereochemistry: types of stereo-isomers, Optical activity, Enantiomers, Diastereomers, conformations & conformational analysis of some cyclic derivatives. Dyes: Colour and constitution, different classification of dyes, synthesis and applications of some important dyes of different types. Photochemistry and photochemical organic reactions.

*M. K. Jain and S. C. Sharma, Organic Chemistry, Shoban Lal Chand. & Co., 2000.*

*K. Venkataraman, The chemistry of synthetic dyes, Academic Press Inc. 1980.*

*I. L. Finar, Organic Chemistry volume I & II by I. L. Finar, Pearson publishers R.*

*T. Morrison and R. N. Boyd, Organic chemistry, Prentice-Hall India, New Delhi*

**CY206 INSTRUMENTAL ANALYSIS LAB.**

**(0-0-4) 2**

Potentiometry. Conductometry. Colorimetry. Refractometry. Gravimetric estimations. Demonstration of UV and IR spectrophotometer.

## NATIONAL INSTITUTE OF TECHNOLOGY KARNATAKA, SURATHKAL

A. I. Vogel, *A Text Book of Quantitative Inorganic Analysis Including Elementary Instrumental Analysis*, ELBS, Longman Group, UK, III Edition, 1962.

J. Basset, R. C. Denny, CH Jaffery and J. Mendhan, *Vogel's Text Book of Quantitative Inorganic Analysis, including elementary analysis*, ELBS, London, 5<sup>th</sup> Edition, 1989.

### **CY251 POLYMER SCIENCE AND TECHNOLOGY**

**(3-0-0) 3**

Basic concepts, configuration and conformation. Thermoplastic and thermosetting polymers. Condensation, addition, coordination, ring opening, metathesis polymerization. Copolymerization. Chemical reactions of polymers and polymer degradation. Analysis and testing of polymers. Rheology and mechanical properties: Kinetic theory of rubber elasticity, glassy state and glass transition, mechanical properties, crystalline melting point, property requirements and polymer utilization. Polymer processing: Molding, extrusion, calendaring, casting, coating, thermoforming, foaming. Multipolymer systems and composites. Additives and Compounding. Fibre and elastomer technology.

F. W. Billmeyer, *Textbook of Polymer Science*, Wiley Interscience Publication, 1984.

Joel R. Fried, *Polymer Science and Technology*, Prentice Hall, NJ, 1995.

### **CY252 INDUSTRIAL CHEMISTRY**

**(3-0-0) 3**

Synthetic Organic Chemical Industries: Petrochemicals – Chemicals from C<sub>1</sub>, C<sub>2</sub>, C<sub>3</sub>, C<sub>4</sub> compounds. Chemicals from aromatics. Phenols and alkyl phenols. Isomerization, Dehydrogenation. Oxidation of paraffins. Pesticides and Pharmaceutical Industries. Polymer Industries: PE, PVC, Teflon, SBR, NBR, Neoprene, Silicone rubber, Nylon, Dacron. Starch and cellulose derivatives. Natural product industries: Oils. Soaps. Detergents. Essential oils. Paints and Varnishes. Food industries. Fermentation industries. Explosives and propellants.

E. Riegel, *Industrial Chemistry*, 6<sup>th</sup> ed., J. A. End, Reinhold Publishing Corp., 1962.

R. N. Shreve, *Chemical Process Industries*, 3<sup>rd</sup> ed., McGraw-Hill Book, 1967.

### **CY 255 TECHNICAL ANALYSIS LAB.**

**(0-0-4) 2**

Demonstration about laboratory safety and First aid, Experiments involving Organic estimations, organic preparations, Electroanalytical methods: Conductometric and potentiometric titrations, Beer-Lambert's law and its deviations, Viscometry, Gravimetric analysis

Willard, Merritt, Dean & Settle, *Instrumental methods of analysis*, 6th Ed., CBS Publishers & Distributors, Delhi, 1986.

G. Chatwal and S. Anand, *Instrumental Methods of Chemical Analysis*, S. D. Himalaya Publishing House, 2000. B.S. Furniss, A.J. Hannaford, P.W.G. Smith, A.R. Tachell Vogel's text book of Practical organic Chemistry, Longman group, UK, 1989.

### **CY 300 INSTRUMENTAL METHODS OF ANALYSIS**

**(3-0-0) 3**

Electroanalytical methods: Conductometric and potentiometric titrations. Polarography - theory and applications. Amperometric titrations. Spectroanalytical methods: Molecular spectra, Microwave, IR, UV-visible spectroscopy – theory, instrumentation and applications. Beer-Lambert's law and its deviations. Atomic absorption spectroscopy: Thermal methods of analysis: TGA, DTA, DTG, instrumentation and applications. Solvent extraction: Principle, distribution coefficient, separation factor and efficiency, applications. Chromatography: Paper chromatography, TLC, GC, HPLC – theory, instrumentation, experimental techniques and applications.

Willard, Merritt, Dean & Settle, *Instrumental methods of analysis*, 6th Ed., CBS Publishers & Distributors, Delhi, 1986.

D.A. Skoog, F.J. Holler, S.R. Crouch, *Instrumental Analysis*, 2008.

G.H. Jeffery, J. Bassett, J. Mendhem, R.C. Denney, Vogel's Textbook of quantitative Chemical analysis, ELBS, 5<sup>th</sup> Edn, 1989.

G. Chatwal and S. Anand, *Instrumental Methods of Chemical Analysis*, S. D. Himalaya Publishing House, 2000.

### **CY301 ADVANCED ELECTRO CHEMISTRY**

**(3-0-0) 3**

Introduction. Theory of electrolytic conductance: Debye-Huckel theory, transport numbers, Faradays laws and ionic velocities, Hittorff's methods of determination. Ion-solvent interaction: Born model and expression for free energy of ion-solvent interaction, Fick's law of diffusion. Polarography: DME, Ilkovic equation, half-wave potential, theory and applications. Special polarographic techniques: Chronopotentiometry, Chronoamperometry, Linear sweep voltammetry, like Cyclic voltammetry, Oscillographic polarography, Amperometry.

Samuel Glasstone, *An Introduction to Electrochemistry*, Affiliated East West Press, New Delhi.

J. O. M. Bockris and A. K. N. Reddy, *Modern Electrochemistry*, Plenum Press, 1970.

**CY302 BIOCHEMISTRY**

**(3-0-0) 3**

Chemistry of biomolecules: Basic aspects of carbohydrates, lipids, amino acids, proteins, nucleic acids and biological membranes. Enzymes: structure, functions, mechanism of action, specificity, kinetic considerations, multi enzyme systems and immobilized enzymes. Bioenergetics: ETS, ATP. Biochemistry of nutrition and digestion: Metabolism of carbohydrates, lipids, and amino acids. Interrelation. Flow of genetic information: Genetic code, replication of DNA, transcription and translation. Biosynthesis of proteins.

*Albert L. Lehninger, David L. Nelson, Michael M. Cox, Principles of Biochemistry, CBS Publishers and Distributors, Indian Edition, 1993.*

*Eric E. Conn. Paul K. Stumpf, George Breining & H. Roy Doi, Outlines of Biochemistry, 5<sup>th</sup> Edition, John Wiley and Sons, 1987.*

**CY305 INORGANIC AND PHYSICAL CHEMISTRY**

**(3-0-0) 3**

Chemistry of d-block elements: Periodic properties. Coordination compounds: Theory of complexes, VBT, CFT, LFT and MOT for complexes, optical and magnetic properties, factors affecting stability and isomerism. Surface Chemistry: Adsorption -Freundlich and Langmuir's adsorption isotherms, applications. Catalysis – Types, mechanism, kinetics of surface reactions, autocatalysis. Solutions: Raoult's law, ideal and nonideal solutions, Gibb's-Dichem Margules equation, thermodynamics of ideal solution, binary solutions, fractional distillation, Henry's law.

*J.E. Huhey, Inorganic Chemistry – Principles of structure and reactivity, Harper & Row Publishers, Singapore.*

*B. R. Puri, L. R. Sharma and M. S. Pathania, Principles of Physical Chemistry, S. N. Chand & Co., Jalandhar, 31<sup>st</sup> edition, 1990.*

**CY350 ENVIRONMENTAL CHEMISTRY**

**(3-0-0) 3**

Introduction, Environmental segments, Natural cycles of the environment. Atmosphere: Composition, structure, evolution. Chemical and photochemical reactions. Green house effect, Ozone hole, E1-Ninophenomena. Water resources: Complexation in natural waste water. Microbially mediated aquatic chemical reactions. Composition of Lithosphere, water, air, and inorganic components in soil. Nitrogen pathways. Wastes and pollutants in soils. Toxic chemicals in the environment. Air and water pollution, causes, bad effects and control.

*C. N. Sawyer, P. L. McCarty and G. F. Parkin, Chemistry for Environmental Engineering, McGraw-Hill, 1990.*

*A. K. De, Environmental Chemistry, New Age Intl. (Pvt)Ltd., 1998.*

**CY351 PHYSICAL CHEMISTRY OF POLYMERS**

**(3-0-0) 3**

Kinetics of free radical, ionic, coordination and step polymerization, copolymerization. Phase transitions: Kinetics and mechanism of polymer crystallization. Amorphous polymers. Thermodynamics and theory of polymer solutions, Flory Huggins theory, UCST and LCST. Determination of molecular weights of polymers –osmometry, viscometry, light scattering methods. Rheological properties of solutions and polymer melt. Liquid crystalline state. Electrical properties of polymers. Elastomers – theory of elasticity.

*A. Tager, Physical Chemistry of Polymers, MIR Publishers, 1972.*

*Anil Kumar and Santhosh K Gupta, Fundamental of Polymer Science and Engineering, Tata Mcgraw-Hill Publishing Co. Ltd. India, New Delhi, 1970.*

**CY352 PHARMACEUTICAL CHEMISTRY**

**(3-0-0) 3**

Introduction, classification and nomenclature of drugs. Theories of drug action and factors affecting. Assay of drugs and their metabolism. Sedatives. Analgesics. Antihistamins. Antiinflammatory, Antimalarial. Antifungal, Antiviral agents. Steroids. Sulphonamides and Antibiotics. Organic pharmaceutical aids. Chemical models and mimics for enzymes, receptors, carbohydrate and other bioactive molecules, catalytic antibodies. Molecular modeling, conformational analysis, qualitative and quantitative structure and activity relationships.

*Ed. Manfred E. Wulf, Burger's Medicinal Chemistry and Drug Discovery, Vol. 1-6, John Wiley, New York, 1995.*

*G. R. Chatwal, Pharmaceutical Chemistry, Vol. I and II, Himalaya Publishing House, Delhi, 2<sup>nd</sup> edition, 1997.*

**CY353 FOOD CHEMISTRY**

**(3-0-0) 3**

Components of food: Carbohydrates, Fats and oils, Proteins, Vitamins, Minerals. Food Microbiology: Interaction between microorganism and food, mechanism of spoilage, food borne illness and fermentation. Cryogenic food preservation. Water activity and storage stability. Drying techniques. Food and food by-products processing industries. Food preservatives, Fragrances. Flavours. Food additives. Interesterification of oils. Food packing, materials, and methods. Analysis of food proteins, fats, carbohydrates, vitamins, etc.

*T. P. Coultate, Food – The Chemistry of Components, RSC, 2002; C. W. Hall, Encyclopedia of Food Engineering, AVI publishing, 1971. M. Karel and D. B. Lund, Principles of Food Science, M. Decker, New York, 1975.*

**CY356 CERAMIC AND POLYMER LAB.**

**(0-0-3) 2**

Experiments involving evaluation of thermal, electrical, mechanical, optical, and miscellaneous properties of

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polymeric materials and ceramics. Chemical analysis of polymers and ceramics. Molecular weights, MFI, Strength, hardness, Specific gravity, Particle size distribution, T<sub>g</sub> and Softening point, Refractive index, Haze, Water permeability, Spalling resistance, Refractoriness, Chemical characterization, Identification of plastics.

*Cyus Klings, Physics & Chemistry of Ceramics & Refractories, Ed. Breach Science, 1963*

*Vishu Shah, Hand Book of Plastic Testing Technology, Wiley-Interscience Publication, New York, 1984.*

### **CY400 BIO-INORGANIC CHEMISTRY**

**(3-0-0) 3**

Introduction. Transport and storage of metal ions. Elements of Biology and Medicine. Energy of biological systems. Hydrogen Biochemistry. The functional value of the chemical elements in Biological systems. Sodium, Potassium, Chlorine, Magnesium, Cadmium, Zinc, Iron, Manganese, Copper, Cobalt, Molybdenum, Vanadium, Tungsten, Phosphorus, Sulphur, Sele-nium, Halogen. Metal based drugs. Environmental application and toxic effects of metal ions.

*M. Satake & Y. Mido, Bioinorganic Chemistry, Discovery Publ House, New Delhi, 2001.*

*H. Siegel & T. G. Spiro, Metalions of Biological Systems, Mercel-Dekker, 1980 to present.*

### **CY401 CHEMISTRY OF DYES AND PIGMENTS**

**(3-0-0) 3**

Dyes – Color and constitution, chromophores and auxochromes, insulating groups, Classification based on chemical constitution and applications. Preparation, properties and uses of dye intermediates and dyes. Photochemistry – Principles, photo induced reactions, oxidation, reduction, isomerization, addition reactions. Woodward Hoffmann's rule. Inks – composition, pigments, vehicles, ink additives, Ink manufacture, printing methods and screen printing. Inorganic pigments.

*The chemistry of synthetic dyes and pigments, American Chemical Society Monograph Series, Hagger Pub. Co., 1970.*

*K. Venkataraman, The chemistry of synthetic dyes, Academic Press Inc. 1980.*

*D. E. Bissett, Printing Ink Technology, Northwood, 1978.*

### **CY402 SURFACE MODIFICATIONS**

**(3-0-0) 3**

Introduction. Plating and Coating Processes: Basic principles and methods. Hardfacing. Anodising. PVD. CVD. Thermal spraying. Electrodeposition. Electroless deposition. Hot dipping. Composite coating. Surface alloying. Alloy plating. Thermal processes: Laser -hardening, glazing, surface alloying, cladding. Electron beam hardening. Implantation and special processes: Ion implantation. CMM coating. Applications and recent developments.

*T. S. Sudarshan (Ed), Surface Modification Technologies, Marcel Dekker, 1989.*

*V. Vasantasree and P. S. Sidky, Metallic and Ceramic Coatings, Longman Scientific and Technical, UK, 1989.*

### **CY403 WATER AND SOIL CHEMISTRY**

**(3-0-0) 3**

Water resources. Physical chemistry of sea water. Complexation in natural water and waste water. Microbially mediated redox reactions. Ion-water interactions. Water Pollution: Water pollutants, waste water treatment, trace elements in water, water quality parameters and standards, sampling, preservation and monitoring techniques. Soil-ion interactions and chemical cycles. Solute-solute interactions. Weathering and soil development processes. Soil organic matter. Soil and microorganism. Cation, anion and molecular interactions in soils. Acid soils and salt affected soils. Soil pollution. Radiation effect.

*K. H. Tan, Principles of Soil Chemistry, Dekker, New York, 1982.*

*R. A. Home, Chemistry of our Environment, Plenum, New York, 1975.*

### **CY450 ADVANCED INSTRUMENTAL METHODS OF ANALYSIS**

**(3-0-0) 3**

Magnetic Resonance Spectroscopy: NMR. FTNMR. ESR. NQR. X-ray methods: Absorption, Fluorescence, Diffraction. Radiochemical methods. Electron and Ion Spectroscopy. XPS. UPS. EIS. AES. ISS. Photoacoustic Spectroscopy. Basic principles and applications.

*G. W. Ewing, Instrumental Methods of Analysis, McGraw-Hill, New Delhi, 1990.*

*Willard, Merritt, Dean & Settle, Instrumental methods of analysis, 6<sup>th</sup> Ed., CBS Publishers & Distributors, Delhi, 1986.*

### **CY451 CHEMISTRY OF NATURAL PRODUCTS**

**(3-0-0) 3**

Alkaloids: Introduction, occurrence, functions, nomenclature, classification, isolation, properties, determination of molecular structure. Terpenoids: occurrence, isolation, classification, general characteristics, structural features, isoprene rule. Steroids and hormones. Natural Pigments. Biosynthesis of some natural products: Biosynthesis of carbohydrates and photosynthesis, biosynthesis of terpenoids and steroids.

*I. L. Finar, Organic Chemistry, Volume 1: The Fundamental Principles, and Volume 2, Stereochemistry and Chemistry of Natural Products, VI Edition, ELBS, 1989.*

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O..P. Agarwal, *Chemistry of organic natural products, (volumes 1 & 2)*, Goel Publishing house, Meerut, 1993.

### **CY452 BIO-PHYSICAL CHEMISTRY**

**(3-0-0) 3**

Molecular species in solution. Energy and equilibria. Enzyme and Enzymatic catalysis – Kinetics and mechanism of enzymatic reactions and their specificity. Bioenergetics – Notions of TD, application to chemical reactions in living organisms. ATP energetics.

*C. R. Canter and P. R. Sehimell, Biophysical Chemistry, Freeman, Sanfransisco.*

*G. M. Barrow, Physical Chemistry of Life Sciences, McGraw-Hill, New Delhi.*

### **CY453 POLYMERS FOR ELECTRONICS AND OPTOELECTRONICS**

**(3-0-0) 3**

Conducting polymers. Electrodepositable resists: Electrodepositable resins formulation. Thermotropic liquid crystal polymers: fundamentals, processing. Photoconductive polymers: charge-carrier generation, charge injection, charge transport and charge trapping; electron-transporting and bipolar polymers. Polymers for optical data storage: Principles of optical storage, polymers in recording layer. Nonlinear materials: NLO properties, NLO effects, wave guide devices and through-plane modulators.

*A. B. Kaiser (Eds. H. Kuzmany, M. Mehring and S. Roth), Electronic properties of conjugated polymers – basic models and applications, Springer-Verlag, Berlin, 1989.*

*Ed. J. A. Chilton & M. T. Goosy, Special polymers for electronics and optoelectronics, Chapman & Hall, 1995.*

### **Courses for B.Tech. with Chemistry Minor ( Refer M.Sc Chemistry curriculum for details)**

**CY804 Spectroscopy, Applications in Chemistry (3-0-0) 3**

**CY703 Organic Chemistry-I (3-0-0) 3**

**CY704 Physical Chemistry – I (3-0-0) 3**

**CY751 Inorganic Chemistry – II (3-0-0) 3**

**CY754 Spectroscopy (3-0-0) 3**

**Department of Physics**

**PH110 PHYSICS**

**(3-1-0) 4**

Brief review of Newton's laws and vector notation, Conservation laws: energy, momentum, angular momentum, torque, moment of inertia as a matrix, diagonalization to obtain principle moments of inertia, Non-inertial frames of reference. Coriolis force. Pseudo-forces, Solution of damped and forced harmonic oscillator. Resonance, q-factor. Electric flux, Gauss' Law, divergence operator and divergence theorem, Dielectrics, bound and free charges, electric susceptibility, relative permittivity, dielectric constant, Curl, Stokes' theorem, Faraday's law, displacement current, Maxwell's equations in differential (point) and integral (volume) form, Electromagnetic wave propagation in free space, speed of light, Swimmers in a river, Michelson-Morley experiment, Lack of invariance of Maxwell's wave equation under Galilean transformation, Einstein's postulates, Consequences of Einstein's postulates - length contraction, time dilation, velocity addition, Relativistic energy, momentum, Mass-energy relationship, relativistic system of units, Photoelectric effect, Compton effect, de Broglie hypothesis, Davisson-Germer experiment, uncertainty relationship for classical waves, Heisenberg uncertainty principle, wave packets, phase and group velocity, properties of waves at boundaries, Schrodinger's equations, particle in infinite and finite potential wells, tunneling.

*Kleppner & Kolenkow, An Introduction to Mechanics, 2nd edition, 2010*

*Hayt & Buck, Engineering Electromagnetics, 8th (intl) edition, 2012*

*Kenneth Krane, Modern Physics, 3rd edition, 2012*

*Arthur Beiser, Concepts of Modern Physics,*

*MIT OpenCourseWare, freely available online*

**PH111 PHYSICS LABORATORY**

**(0-0-2) 1**

Error analysis and graph drawing, photoelectric effect, laser diffraction, slinky spring experiments, Newton's rings, Pendulum experiment, Helmholtz resonator, Hall Effect.

*Kenneth Krane, Modern Physics, 3rd edition, 2012*

*Arthur Beiser, Concepts of Modern Physics.*

**PH201 QUANTUM MECHANICS FOR ENGINEERS**

**(3-0-0) 3**

Basic principles of quantum mechanics. Probabilities and probability amplitudes. Linear vector spaces. Bra and ket vectors. Completeness, orthonormality, basis sets. Change of basis. Eigenstates and eigenvalues. Position and momentum representations. Wavefunctions, probability densities, probability current. Schrodinger equation. Expectation values. Generalized uncertainty relation. One dimensional potential problems Particle in a box. Potential barriers. Tunnelling. Linear harmonic oscillator: wavefunction approach and operator approach. Motion in three dimensions. Central potential problem. Orbital angular momentum operators. Spherical harmonics. Eigenvalues of orbital angular momentum operators. The hydrogen atom and its energy eigenvalues. Charged particle in a uniform constant magnetic field, energy eigenvalues and eigenfunctions. Schrodinger and Heisenberg pictures Heisenberg equation of motion. Interaction picture.

*V.K. Thankappan, Quantum Mechanics. Wiley Eastern (1985)*

*A.K Ghatak, S.Lokanathan Quantum Mechanics Theory and applications, Macmillan India Ltd ( 1984)*

**PH202 CLASSICAL MECHANICS**

**(3-0-0) 3**

Review of Newton's Laws of motion; Conservation principles; Harmonic oscillator; Two particle systems; Time dependent forces; Variational Principle; Lagrange's equation of motion; Charged particles in EM fields; Planetary motion; Rutherford scattering; Small Oscillations; CO<sub>2</sub> Molecule; Beads on a stretched string; Euler's equation for rotating bodies; Hamilton's equations of motion; Charged particle dynamics; Virial theorem; Hamilton – Jacobi equations; Action angle variables; Poisson Brackets; Integral invariants; Stretched elastic string; Energy momentum relations.

**PH251 ELECTRICAL PROPERTIES OF MATERIALS**

**(3-0-0) 3**

Conductivity of metals-classical free electron theory and quantum free electron theory, Semiconductors -pure and impure semiconductors, band model, conductivity and its temperature dependence, Hall effect, Direct and indirect bandgap semiconductors, p-n junction and diode equation, Dielectric properties of insulators-dielectric behaviour in static and alternating fields, dipolar relaxation and dielectric loss, ferroelectric and piezoelectric materials.

*Electrical Engineering Materials – A.J.Dekkar, Prentice Hall India Publ.*

*Solid state Electronic Devices – B.G. Streetman, Prentice Hall India Publ.*

**PH252 ELECTROMAGNETIC THEORY**

**(3-0-0) 3**

Electrostatics: electrostatic field, Divergence and Curl of electric field, Electric potential. Laplace's equation in three

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dimetians. Separation of variables. Electrostatic field in Matter Electric displacement. Magnetostatic, Lorentz force law, Biot-Savarts law, Divergence and Curl of Magnetic field, Ampere's law. Electromotive force Faraday's law, Maxwell's Equations plane wave solutions of Maxwell's equations, Poynting vector, wave propagation through a boundary, reflection, refraction, absorption and skin depth.

*D. Griffiths, Introduction to Electrodynamics, 2<sup>nd</sup> ed., Prentice Hall, 1989.*

*William H. Hayt . Engineering Electromagnetics, 5<sup>th</sup> ed. Tata Mc Graw Hill Publishing Company Ltd.*

### PH351 PHYSICS OF SEMICONDUCTOR DEVICES

(3-0-0) 3

The PN Junction Diode, basic device technology, current-voltage characteristics, Transient behaviour and noise. Heterojunction. Bipolar transistor- static characteristics. Microwave and power transistor and related devices. Metal-semiconductor contacts. Energy band relation, transport processes, barrier height JFET and MESFET basic device characteristics. Microwave performance. MOSFET-Device structure and characteristics, Nonvolatile memory devices Tunnel Diode, IMPATT and related transit-time diodes. Transferred-electron devices- Gunn effect. Principles of photonic devices: LEDs, semiconductor lasers; photodetectors – photodiodes and APDs. Solar Cells.

*S.M. Sze, Physics of Semiconductor Devices.*

*Donald A Neamen, Semiconductor Physics and Devices-Basic Principles*

*M.S. Thyagi, Semiconductor Materials and Devices. David H Ferray,*

*Electronic materials and Devices*

*Jaspri Singh, Semiconductor Optoelectronics and Technology.*

### PH352 VACUUM TECHNOLOGY AND THIN FILMS

(3-0-0) 3

Production of vacuum – mechanical pumps, sorption pumps and cryogenic pumps. Measurement of vacuum – thermal conductivity gauges and ionization gauges. Behaviour of gases at low pressure. Thin films – methods of preparation – vacuum evaporation, sputtering, electro-deposition, chemical deposition. Properties of thin films. Measurement of film thickness, Applications of thin films.

*Handbook of thin film technology – L. I. Maissel and R. Glang, McGraw Hill publ.*

### PH401 OPTOELECTRONICS

(3-0-0) 3

Light Propagation in material media. Maxwell's equations, Wave equations for dielectrics, Polarization., reflection and refraction of light from dielectric interfaces, total internal reflection, light propagation in uniaxial crystals. Nonlinear polarizability of material media, second harmonic generation of light, optical rectification, frequency conversion by 3- wave mixing, parametric oscillators. Optical wave guides- Types of optical wave guides, guided modes in planar wave guides, guided modes in step-index optical fibers. Attenuation and dispersion. Directional couplers, prism couplers. Mach-Zehnder interferometer, Optical sources and detectors - light absorption and emission in semiconductors, structure, working and operating characteristics of heterojunction LED's laser diodes, photodiodes and APDs. Noise in photodiodes, Electro-optic effect, longitudinal and transverse electro-optic modulators. Acousto-optic effect, Bragg diffraction. Photonic switching and optical bistability.

*B E Saleh & M.C. Teich, Fundamentals of Photonics.*

*J Wilson & J F B Hawkes, Optoelectronics - an Introduction*

*Jaspri Singh, Optoelectronics: An introduction to Materials & Devices*

*P. Bhattacharya, Semiconductor Optoelectronics.*

**Courses for B.Tech. with Physics Minor ( Refer M.Sc Physics curriculum for details): Student may select any five courses from the following:**

**PH701 Mathematical Methods-1 (3-1-0)4**

**PH 702 Classical Mechanics (3-1-0)4**

**PH 703 QuantumMechanics-1 (3-1-0)4**

**PH751 Mathematical Methods-2 (3-1-0)4**

**PH-752 Quantum Mechanics-2 (3-1-0)4**

**PH754 Electromagnetic Theory (3-1-0)4**

**Department of Mathematical and Computational Sciences**

**MA110 ENGINEERING MATHEMATICS - I**

**(3-0-0) 3**

Functions of two or more variables: Definition, Region in a plane, Level curves, Level surfaces, Limits, Continuity, Partial derivatives, Differentiability, Gradients, Directional derivatives, Normals to level curves and tangents, Extreme values and saddle points, Lagrange multipliers.

Integral calculus: Double integral and iterated integrals - Cartesian and polar coordinates, Volume of solids of revolution, Triple integral, Change of variables, Multiple integrals in cylindrical and spherical coordinates.

Vector calculus: Line Integrals, Vector Fields, Work, Circulation and flux, Path independence, Potential functions, and Conservative fields, Green's theorem in the plane, Surface area and surface integrals, Surface area of solid of revolution, Parametrized surfaces, Stokes' theorem, The Divergence theorem.

*References:*

*G.B. Thomas Jr., M.D. Weir and J.R. Hass, Thomas Calculus, Pearson Education, 2009.*

*N. Piskunov, Differential and Integral Calculus Vol. 1, Mir Publishers, 1974.*

*E. Kreyszig, Advanced Engineering Mathematics, 10th Ed., John Wiley & Sons, 2010.*

*J.E. Marsden, A.J. Tromba, A. Weinstein, Basic Multivariable Calculus, Springer Verlag, 1993.*

*J. Stewart, Calculus (5th Edition), Thomson (2003).*

*S. R. Ghorpade, B. V. Limaye, A Course in Multivariable Calculus and Analysis.*

**MA111 ENGINEERING MATHEMATICS - II**

**(3-0-0) 3**

Series: Sequences of real numbers and their convergence criteria, Infinite series, Sequence of partial sums, Tests for convergence/divergence -  $n^{\text{th}}$  term test, Boundedness and monotonicity, Integral, Condensation, Comparison, Ratio and root tests, Alternating series, Absolute and conditional convergence, Rearrangement theorem, Power series, Taylor and Maclaurin series (one and two variables), Fourier series.

Ordinary differential equations: First order ODE - various methods, Initial value problems - Picard's iteration, Conditions for existence and uniqueness of solution to an IVP, Second and higher order linear DEs with constant coefficients - general solution for homogeneous equations (characteristic equations), Super-position principle, Euler-Cauchy equation, Particular integrals, Second order linear ODEs with variable coefficients, Existence and uniqueness - Wronskian, Method of variation of parameters, Method of reduction of order, Series solutions. *References:*

*G.B. Thomas Jr., M.D. Weir and J.R. Hass, Thomas Calculus, Pearson Education, 2009.*

*G.F. Simmons, Differential Equations with Applications and Historical Notes, 2nd Ed., McGraw-Hill, 1991.*

*N. Piskunov, Differential and Integral Calculus Vol. 2, Mir Publishers, 1974.*

*E. Kreyszig, Advanced Engineering Mathematics, 11th Ed., John Wiley & Sons, 2010.*

*E.A. Coddington, An Introduction to Ordinary Differential Equations, PHI Learning 1999.*

**MA201 CONCRETE MATHEMATICS**

**(3-0-0) 3**

Sums and Recurrences, General methods. Finite and infinite calculus. Floors and ceilings, Applications, Number theory, Congruences, Chinese remainder Theorem, Generating functions, Solving recurrences, Special generating functions, Convolutions and Exponential generating functions.

*References:*

*G. Knuth, and Patashnik, Concrete Mathematics: A foundation for Computer Science, Pearson, 2000.*

**MA202 DISCRETE MATHEMATICAL STRUCTURES**

**(3-0-0) 3**

Propositional & Predicate Calculus: Introduction to Propositional Logic, Well-formed formulas - Tautology, Contingency, Contradiction, Normal forms, Predicates and Quantifiers, Types of proof techniques, Validity of logical arguments.

Graph Theory: Graph Representations, Directed and Undirected graphs - Introduction and basic properties, Subgraphs, Isomorphism, Trees, Spanning Trees, Eulerian and Hamiltonian graphs, Connectivity, Planar graphs, Euler's formula, Applications of Kuratowski's theorem.

Groups: Cosets, Normal Subgroups, Permutation groups, Burnside's Theorem and simple applications.

Lattice Theory: Equivalence relations, Partial order relations, Linear order relations, Hasse diagrams, Lattices, Lattices as algebraic systems, Special classes of Lattices, Boolean algebra and its properties, Boolean expressions and their canonical forms.

*References:*

*K. H. Rosen, Discrete Mathematics and its applications with Combinatorics and Graph Theory, 7th Edition, 2012.*

*D. B. West, Introduction to Graph Theory, Eastern Economy Edition published by PHI Learning Pvt Ltd, 2nd Edition.*



*N. L. Biggs, Discrete Mathematics, 2nd Edition (Indian Edition published by Oxford University Press).*

**MA203 GRAPH THEORY**

**(3-0-0) 3**

Introduction to Graphs, Digraphs, Multipartite graphs, Connectivity and Flows, Trees, Traversability, Matching, Covering and Independence, Planarity, Coloring, Operations on Graphs, Domination in graphs – Basic concepts, Graphs and Matrices, Enumeration of graphs.

*References:*

*Douglas B. West, Introduction to Graph Theory, Second Edition, Pearson Education, India, 2001.*

*R. Diestel, Graph Theory, Fifth Edition, Springer-Verlag, Germany, 2017.*

*T.W. Haynes, S. Hedetniemi and P. Slater, Fundamentals of Domination in Graphs, New York: Marcel Dekker, Inc., 1998.*

*B. Bollobás, Modern Graph Theory, Springer-Verlag, New York, 1998.*

**MA204 LINEAR ALGEBRA AND MATRICES**

**(3-0-0) 3**

Vector spaces, subspaces, span, linear dependence, basis, dimension. Linear transformations, rank and nullity, matrix Representation, change of bases. Rank-nullity theorem.

Inner products, Orthogonal and orthonormal sets, Gram-Schmidt orthogonalization, Orthogonal Complement, QR-factorization, Best approximation and least squares.

System of linear equations, echelon matrices, LU-factorization, similarity, determinant, inverse of a matrix. eigenvalues and eigenvectors, symmetric matrices, spectral mapping theorem, characteristic polynomial, Cayley-Hamilton Theorem, quadratic forms, orthogonal transformations, singular value decomposition.

*References:*

*G. Strang, Linear Algebra and its applications, Thomson Learning, 2003.*

2. *S. H. Friedberg, A. J. Insel, L.E. Spence, Linear Algebra, 4th Edition, Pearson. 2015.*

3. *S. Lang, Linear Algebra, 3rd Edition, Springer, 2004*

4. *G. Hadley, Linear Algebra, Narosa 2000.*

5. *W. Cheney, D. Kincaid, Linear Algebra Theory and Applications, Jones & Bartlett, Student Edition. 2010*

**MA205 MODERN COMPUTER ALGEBRA**

**(3-0-0) 3**

Fundamental algorithms. Extended Euclidean algorithm and applications. Modular inverses, repeated squaring continued fractions and Diophantine approximation. Modular algorithms and interpolation Chinese Remainder Algorithm. Resultant and GCD computation. Applications to decoding BCH codes.

*References:*

*J.V Zur Gathen and Jurgen Gerhard, Modern Computer Algebra, Cambridge University Press, 1999.*

**MA206 NUMBER THEORY AND CRYPTOGRAPHY**

**(3-0-0) 3**

Elementary Number Theory. Congruences, applications to Factoring. Finite fields, Quadratic residues and reciprocity. Simple cryptosystems, public key cryptography, RSA, Discrete logs. Primality and Factoring, the rho method, Fermat factorization, continued fraction and Quadratic Sieve methods.

*References:*

*N. Koblitz, A course in Number Theory and Cryptography, Springer, 1994.*

**MA207 NUMERICAL METHODS**

**(3-0-0) 3**

Computer arithmetic - Floating point errors, Round-off errors, Absolute and relative errors.

Polynomial interpolation: Newton's and Lagrange interpolation methods, Hermite interpolation, Curve fitting using least-square principle.

Numerical differentiation: Through polynomial interpolation, Deduction of first and second order formulae.

Numerical integration: Newton-Cotes formula, Trapezoidal and Simpson's 1/3rd and 3/8th rules, Method of undetermined coefficients.

Solution of linear system: Basic iterative methods: a) Jacobi, b) Gauss-Siedel, c) Successive over relaxation methods.

Finding root of an equation: (polynomial and transcendental) - Bisection and Regula-falsi methods (bracketing roots), Newton-Raphson (Newton) method, fixed point iterations, Muller's method. Extension of Newton's method to nonlinear system of equations.

Numerical solution of ODEs (IVPs): Euler's and higher order Taylor series methods, Runge-Kutta methods,

Predictor-Corrector methods: a) Modified Euler method, b) Linear multi-step methods.

*References:*

*R L Burden and J Douglas Faires, Numerical Analysis, 9<sup>th</sup> Edn, Brooks/Cole.*

*K E Atkinson, An Introduction to Numerical Analysis, 2<sup>nd</sup> Edn, John-Wiley and Sons.*

*D. Kincaid, W. Cheney, Numerical Analysis Mathematics of Scientific Computing, 3rd Edition, 2009.*

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*S. D. Conte, C. De Boor, Elementary Numerical Analysis, Tata McGraw-Hill, 2006.*

*W. H. Press, S A Teukolsky, W T Vetterling, B P Flannery, Numerical Recipes in C/Fortran - The Art of Scientific Computing, Cambridge University Press, 2007.*

*M.K. Jain, S.R.K Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computation.*

### MA208 PROBABILITY THEORY AND APPLICATIONS

(3-0-0) 3

Introduction to probability, Sample space, Definitions of probability, Conditional probability, Bayes' theorem, Random variables, pmf, pdf, cdf, Marginal and Conditional Distributions, Mean and Variance, Covariance and Correlation, Standard probability distributions: Bernoulli, Binomial, Geometric, Poisson, Uniform, Exponential, Normal, Gamma, Moment Generating Functions.

*References:*

*S.M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Academic Press.*

*S.M. Ross, Introduction to Probability Models, Academic Press.*

*P.L. Meyer, Introductory Probability and Statistical Applications, Oxford & IBH Publishing Co.*

### MA209 THEORY OF COMPLEX VARIABLES

(3-0-0) 3

Functions of complex variables. Cauchy Riemann equations. Properties of analytic functions. Conformal mapping. Line integrals in complex plane. Cauchy's theorems. Power series. Residues. Evaluation of standard real integrals using contour integration.

*References:*

*J.B. Conway, Functions of one complex variable, 2nd edition, Springer-Verlag, New York, 1978.*

*L. V. Ahlfors, Complex analysis, 3rd edition, McGraw-Hill 1979.*

*E. Stein, R. Shakarchi. Complex Analysis, Princeton Univ. Press 2003.*

*D. G. Zill, P. D. Shanahan, A First Course in Complex Analysis with Applications, Jones and Bartlett, 2003.*

### MA210 EXTREMAL COMBINATORICS AND ALGEBRAIC GRAPH THEORY

(3-0-0) 3

Basic techniques: Counting, Pigeon hole principle and resolution refutation lower bound, Matching and Hall theorem. The probabilistic method: Basic method, Lovaz local lemma and its constructive proof, Linearity of expectation, The deletion method, The entropy functions Random walks and randomised algorithm for CNF formulae.

Spectral graph theory: Basic properties of graph spectrum, Cheeger's inequality and approximation of graph extension, Expander graphs and applications to super concentrators and pseudo randomness, Error correcting codes and expander codes, Small set expansion, Unique games conjecture and hardness of approximation.

Additive Combinatorics: Sum product theorem, Szemerédi-Trotter theorem, Kakeya set problem and applications to randomness extractors.

*References:*

*S. Jukna, Extremal Combinatorics: With Applications in Computer Science, 2nd Edition, Springer.*

*N. Alon, J. H. Spencer, The probabilistic Method, 4th Edition, Wiley.*

### MA211 LAPLACE AND Z TRANSFORMS

(1-0-0) 1

Laplace Transforms: Solutions of boundary value problem using Laplace transforms, Applications of Laplace Transforms to the solutions of ordinary differential equations. Z-transforms, Solution of difference equations using z-transforms.

*References:*

*I.N. Sneddon; Integral Transforms, Tata McGraw-Hill, 1974.*

*P.P. Gupta; Integral Transforms, 2nd Edition, Meerut Publishers, 1989.*

### MA301 ADVANCED GRAPH THEORY

(3-0-0) 3 (PREREQ: Exposure to MA203)

Representations of Graphs, Trees, Enumeration, Spanning Trees, Planar and Dual Graphs, Detection of planarity, Geometric and Combinatorial Duals, Covering and Independence, Coloring, Structure of k-chromatic graphs, Perfect graphs, properties.

*References:*

*D.B. West, Introduction to Graph Theory, PHI*

### MA302 DATA ANALYSIS, TIME SERIES ANALYSIS AND NON-PARAMETRIC METHODS (3- 0-0) 3

(PREREQ: Exposure to MA208)

Data analysis: Correlation and Regression of data, simple linear regression, Time series analysis: definitions, characteristic movements, measurement of trend, secular trend, seasonal movements, cyclical movements. Non – parametric methods, Wald – Wolfowitz test, sign test, Mann – Whitney U test, signed rank test, Kolmogorov – Smirnov tests, Kruskal – Wallis test.

*References:*

W.W.Hines and D.C. Montgomery, *Probability and Statistics in Engineering and Management Science*, John Wiley. J. Medhi, *Statistical Methods*, Wiley Eastern.

**MA303 INTEGRAL TRANSFORMS APPLICATIONS**

**(3-0-0) 3**

Laplace Transforms: solutions of boundary value problem using Laplace transforms, Applications of Laplace Transforms to the solutions of partial differential equations.

Fourier Transforms: Fourier sine and cosine transforms, Applications of Fourier Transforms to the solutions of ordinary differential equations and partial differential equations.

Hankel and Mellin and z – Transforms: solution of difference equations using z – transforms.

*References:*

I.N. Sneddon; *Integral Transforms*, Tata McGraw-Hill, 1974.

P.P. Gupta; *Integral Transforms*, 2nd Edition, Meerut Publishers, 1989.

**MA304 LINEAR PROGRAMMING AND APPLICATIONS**

**(3-0-0) 3 (PREREQ: Exposure to MA204)**

Linear programming theory of simplex method, Duality, Dual sensitivity analysis. Integer linear programming,

Transportation problem, assignment problem, solution by the Hungarian method, transshipment model. Game theory – 2 persons zero sum

game. *References:*

G. Hadley, *Linear Programming*, Narosa Publish, 1987.

H. A. Taha, *Operations Research*, Fifth edition, Mc Millan Publishing company, 1992.

K. Swarup, Gupta and Manmohan, *Operations Research*, Sultan Chand Publications, 1995,.

**MA305 NETWORK OPTIMIZATION**

**(3-0-0) 3 (PREREQ: Exposure to MA203)**

Network Models, Minimal Spanning Tree, Shortest Route Problem (viewed as transshipment model), Matching and Covering Problems. Max-Flow Min-Cut Theorem, Capacitated Network Model and Network Simplex Method. PERT and CPM, Resource analysis in Network Scheduling: LP formulation, Precedence Planning Updating, Resource Allocation and Scheduling.

*References:*

C.H. Papadimitriou and K. Steiglitz, *Combinatorial Optimization: Algorithms & Complexity*, PHI

H. Taha, *Operations Research*, McMillan

**MA306 OPERATIONS RESEARCH**

**(3-0-0) 3 (PREREQ: Exposure to MA204)**

Introduction, Linear Programming, Duality Theory, Transportation and Assignment problem., Integer Programming: Branch and bound method for IPP, Dynamic Programming: Introduction to Non- linear programming.

*References:*

G. Hadley, *Linear Programming*, Narosa Publishers, 1987.

H. A. Taha, *Operations Research*, Fifth Edition Mc. Millan publishing company, 1992.

F. Hiller and G.J. Leibermann, *Operations Research*, Holden Day Inc., 1974.

**MA307 OPTIMIZATION TECHNIQUES AND STATISTICAL METHODS**

**(3-0-0) 3**

**(PREREQ: Exposure to MA208)**

Linear programming, simplex method, duality, transportation and assignment problems, Reliability, definitions, concept of hazard, bath- tub curve, system reliability for various configurations, data analysis: correlation and regression of data, simple linear regression, time series analysis: definitions, characteristic movements, measurement of trend, secular trend, seasonal movements, cyclical movements.

*References:*

H.A. Taha, *Operations Research*, Prentice Hall India.

J. Medhi, *Statistical Methods*, Wiley Eastern.

**MA308 STATISTICAL ANALYSIS AND APPLICATIONS**

**(3-0-0) 3**

**(PREREQ: Exposure to MA208)**

Sampling theory: random samples, statistic, sampling distribution, x t and F distributions, central limit theorem, statistical inference, point estimation, unbiasedness, MLEs, interval estimation of mean and variances, hypothesis testing, types of errors, one – sided, two – sided tests, tests concerning means and variances, goodness of fit tests, data analysis: correlation and regression of data, simple linear regression.

*References:*

P. L. Meyer, *Introductory Probability and Statistical Applications*, Oxford & IBH Publishing Co.

S. M. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, John Wiley.

**MA401 COMPUTATIONL FLUID DYNAMICS (3–0–0) 3**

**(PREREQ: Exposure to MA207)**

CFD applications in Engineering, Overview of CFD, Governing equations of fluid dynamics, Introduction to finite differences, Explicit and implicit approaches, Advances in CFD, Upwind schemes, High – resolution schemes.

*References:*

*Hanif Chaudhry, Open – channel Flow.*

*J.D. Anderson, Computational Fluid Dynamics.*

**MA402 FINITE ELEMENT METHODS (3–0–0) 3**

**(PREREQ: Exposure to MA207)**

Introduction to calculus of variations, Approximate methods, Finite Elements, nodes classifications, approximate functions, Solution of Boundary value problems of second order differential equations, Finite element equations for the heat conduction equation, vibration equation, elliptic problems using Galerkin and Ritz methods.

*References:*

*M.K. Jain, Numerical Solution of Differential Equations, PHI Ltd.*

*A.R. Mitchell and R. Wait, Finite Element methods in partial Differential Equations, Edn. John Wiley, 1977.*

**MA403 MATHEMATICAL MODELING (3–0–0) 3**

**(PREREQ: Exposure to MA110 & MA111)**

Introduction: Mathematical modeling through ordinary differential equations and systems of ordinary differential equations of first order, Mathematical modeling through difference equations, Modeling using partial differential equations, Mathematical modeling through graphs.

*References:*

*J. N. Kapoor Mathematical Modeling, 1988, Wiley Eastern.*

*R. Aris, Mathematical Modeling Techniques 1978, Pitman.*

**MA404 NON – LINEAR OPTIMIZATION (3–0–0) 3**

**(PREREQ: Exposure to MA304)**

Classical optimization techniques: Unconstrained optimization –constrained optimization, Quadratic Programming, Construction of Kuhn- Tucker conditions, Wolfe’ s method and Beale’s method; separable programming, Geometric Programming: unconstrained and constrained geometric programming problems Dynamic Programming: Deterministic dynamic programming, probabilistic dynamic programming.

*References:*

*H. A.Taha, Operations Research, fifth edition, 1992, Mc Millan.*

*F. S. Hillier, Gerald J. Libermann, Operations Research, 1974, Holden Day Inc.*

*K. Swarup, Gupta and Manmohan, Operations Research, 1995, Sultan Chand Publications.*

**MA405 RELIABILITY THEORY AND APPLICATIONS (3-0-0) 3**

**(PREREQ: Exposure to MA208)**

Reliability, concepts and definitions, causes of failure, concept of hazard, failure models, bath tub curve, MTTF, MTBF, system reliability for various configurations, reliability improvement, redundancy, reliability-cost trade – off, maintainability and availability concepts, system safety analysis, FTA, FMEA.

*References:*

*E.E. Lewis, Introduction to Reliability Engineering, John Wiley.*

*K S. Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, PHI.*

**MA406 STATISTICAL DESIGN AND ANALYSIS OF EXPERIMENTS**

**(3-0-0) 3**

**(PREREQ: Exposure to MA208)**

Sampling theory: random samples, statistics, sampling distributions, central limit theorem, statistical inference: point estimation, unbiased ness, interval estimation of means and variance, hypothesis testing, types of errors, one – sided, two – sided tests, tests concerning means and variances, goodness of fit tests, Analysis of variance of one – way, two – way classified data, experimental designs: CRD, RBD, LSD, factorial

experiments *References:*

*D.C. Montgomery, Design and Analysis of Experiments, John Wiley.*

*R. V. Hogg and A.T. Craig, Introduction to Mathematical Statistics, McMillan.*

**MA407 STASTICAL QUALITY CONTROL (3-0-0) 3**

**(PREREQ: Exposure to MA208)**

Sampling theory: random samples, statistic sampling distributions, central limit theorem, concept of Quality, types of variations, process control and product control, control charts for variables and attributes, concept of acceptance sampling, by attributes, O.C., AQL, LTPD, AOQL, ATI etc, types of sampling plans, Reliability, definitions, concept of hazard, bath-tub curve, system reliability for various configurations.

*References:*

*E.L. Grant, Statistical Quality Control, Mc Graw Hill.*

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*D C Montgomery, Introduction to Statistical Quality Control, John Wiley.*

### **MA408 STOCHASTIC ANALYSIS AND APPLICATIONS (3-0-0) 3 (PREREQ: Exposure to MA208)**

Stochastic processes, basic concepts, classifications, Markov chains, C–K equations, ergodic chains, steady state behaviour, Poisson process, derivations, birth and death process. Queuing systems, basic concepts, M/M/1 and M/M/s queues, Reliability, definitions, concept of hazard, bath-tub curve, system reliability for various configurations.

*References:*

*J. Medhi, Stochastic Processes, New Age International Publishers.*

*K S. Trivedi, Probability and Statistics with Reliability, Queuing and Computer Science Applications, PHI.*

### **MA 409 ADVANCED LINEAR ALGEBRA (3-0-0) 3 (PREREQ : MA204 / EC224 / EC388 / EE243)**

Vector spaces, subspaces, quotient spaces, basis, change of basis, linear functional, dual space, projection, eigenvalues and eigenvectors, Cayley-Hamilton theorem, elementary canonical forms, annihilating polynomials, invariant subspaces, simultaneous diagonalization, direct sum decomposition, invariant direct sum, the primary decomposition theorem, Jordan form, inner product spaces, orthonormal basis, Gram-Schmidt process; adjoint operators, normal and unitary operators, self adjoint operators, spectral theorem for self adjoint operators.

Linear systems; Gaussian elimination, iterative methods - Gauss-Jordan, Gauss-Seidel and successive over relaxation method; LU decomposition, positive definite system, Cholesky decomposition, condition numbers; orthogonal matrices, Householder transformation, Givens rotations, QR factorization, stability of QR factorization, singular value decomposition, sensitivity analysis of singular values and singular vectors, least square problems.

*References:*

*K. Hoffman and R. Kunze, Linear Algebra, 2nd edition, Pearson Education, New Delhi, 2006.*

*C.D. Meyer, Matrix Analysis and Applied Linear Algebra, SIAM, 2001.*

*L.N Trefethen and David Bau, Numerical Linear Algebra, SIAM , 1997.*

*S. Axler, Linear Algebra Done Right, Springer, 1997.*

### **Courses for B Tech Minor in Mathematics**

#### **MA501 Real Analysis (3-0-0) 3**

#### **MA502 Algebra (3-0-0) 3**

#### **MA503 Complex Analysis (3-0-0) 3**

#### **MA504 Partial Differential Equations (3-0-0) 3**

#### **MA504 Topology (3-0-0) 3 PREREQ: MA501**

### **MA501 REAL ANALYSIS (3-0-0) 3**

Review of basic concepts of real numbers: Archimedean property, Completeness. Metric spaces, compactness, connectedness. Continuity and uniform continuity. Monotonic functions, Functions of bounded variation; Absolutely continuous functions. Derivatives of functions and Taylor's theorem. Riemann integral and its properties, Characterization of Riemann integrable functions. Improper integrals, Gamma functions. Sequences and series of functions, Uniform convergence and its relation to continuity, differentiation and integration. Fourier series, Pointwise convergence, Fejer's theorem, Weierstrass approximation theorem.

*References:*

*T. Apostol, Mathematical analysis, 2nd Edition, Narosa, 2002.*

*W. Rudin, Principles of mathematical analysis, 3rd Edition, McGraw-Hill, 1983.*

*K. Ross, Elementary analysis: The theory of calculus, Springer Int. Edition, 2004.*

*G. F. Simmons, Topology and modern analysis, Kreiger, 2003.*

### **MA502 ALGEBRA (3-0-0) 3**

Group Theory: Definitions, Group Actions, Kernel and Stabilizer of Group actions, Transitive group action, Cayley's theorem, The Class equation, Sylow's theorems, Direct products, Structure theorem for Finite Abelian Groups, Existence and universal Properties of free Groups, Examples of Groups specified by Generators and Relations.

Ring Theory: Definitions, Properties of Ideals, Prime and Maximal Ideals, Two-sided ideals and Quotient Rings, Chinese Remainder Theorem, Euclidean Domain, Euclidean Algorithm, Principal Ideal Domain, Euclidean Domain is a Principal Ideal Domain, UFD, PID implies UFD, Universal Property of a Polynomial Ring, Criteria for Irreducibility. Definition and simple examples of modules over commutative and non-commutative rings.

Field Theory: Finite and Algebraic Extensions, Existence and Cardinality of Algebraic Closure, Finite Fields, Galois

Theory of Polynomial in characteristic zero and simple examples.

*References:*

*M. Artin, Algebra, Prentice Hall inc 1994.*

*I.N. Herstein, Topics in Algebra, John-Wiley, 1995.*

*D. S. Dummit and R. M. Foote, Abstract Algebra, 2nd Edition, John-Wiley,*

*1999. S. Lang, Algebra, 3rd Edition, Addison-Wesley, 1999.*

### **MA503 COMPLEX ANALYSIS**

**(3-0-0) 3**

Topology of the complex plane, Riemann sphere, limits, continuity and differentiability, Analytic functions, harmonic functions and multi-valued functions; Convergence of series of complex numbers, Radius of convergence of power series, and power series as an analytic function, Laurent series; Cauchy's integral theorem, Cauchy integral formula, Morera's theorem, Taylor's theorem, Laurent's theorem, Liouville's theorem, Schwarz lemma; Maximum Modulus Principle, Argument Principle, Rouché's theorem; Conformal mappings, linear fractional transformations, Classification of singularities, Cauchy's residue theory and evaluation of real integrals.

*References:*

*L. Ahlfors, Complex analysis, 2nd ed., McGraw-Hill, New York, 1966.*

*J.W. Brown and R.V. Churchill, Complex variables and applications, McGraw Hill, 2008.*

*T.W. Gamelin, Complex analysis, Springer-Verlag, 2001.*

*J.B. Conway, Functions of one complex variables, 2nd edition, Springer, 1978.*

*S. Ponnusamy: Foundations of complex analysis, Second Edition, Narosa, 2005*

### **MA504 PARTIAL DIFFERENTIAL EQUATIONS (3-0-0) 3**

Origins of first order partial differential equations, Cauchy problem, Linear equations of first order, Integral surfaces passing through a given curve, Surfaces orthogonal to a given system of surfaces, Nonlinear equations of first order, Cauchy's method of characteristics, Compatible systems, Charpit's method, Jacobi's method, Linear second order partial differential equations with constant and also with variable coefficients, Characteristic curves of second order equations, Separation of variables, Greens functions for Laplace equation, wave equation and heat equation, Properties of Laplace equation, wave equation and heat equation.

*References:*

*I. N. Sneddon, Elements of Partial Differential Equations, Dover Pub Inc., 2006.*

*F. John, Partial Differential Equations, Springer Int Edn, 2009.*

*G. B. Folland, Introduction to Partial Differential Equations, Princeton Uty Press, 1995.*

### **MA505 TOPOLOGY**

**(3-0-0) 3 PREREQ: MA501**

Topological Spaces, Basis for a topology, Subspace topology, Closed sets and Limit points, Nets and convergence, Continuous Functions and homeomorphisms, Product Topology, Quotient Topology; Connected spaces, Components and Local Connectedness, Path connectedness, Compact spaces, Local compactness, Compactifications; The Countability and Separation axioms, The Urysohn Lemma, The Urysohn Metrization Theorem, The Tietze Extension Theorem, Tychonoff Theorem.

*References:*

*J.R. Munkres, Topology, 2nd Ed., Pearson Education India, 2001.*

*K.D. Joshi, Introduction to General Topology, New Age International, 2000.*

*G. F. Simmons, Introduction to topology and modern analysis, Kreiger, 2003.*

*M. A. Armstrong, Basic Topology, Springer (India), 2004.*

**School of Management**

**SM110 PROFESSIONAL COMMUNICATION**

**(3-0-0) 3**

Organization Communication : Attempts to acquaint students with the process and requirements of Communication in organization. It includes the Objectives of Communication, Channels of Communication, Barriers in Communication, Cross Cultural Communication.

Written Communication : Focuses on improving the Writing Skills. A Review of Grammar, Transformation of Sentences; Reading Comprehension; Precis Writing; Skills to Express ideas through various kinds of Essays; Business Letters, Application Letters, Email and Internet; Report Writing, CVs/Resumes.

Oral Communication : Aims at improving the Oral Communication Skills, Public Speaking Skills, Features of Effective Speech-Verbal and Non-Verbal, Presentation Skills, Audio and Visual Aids; Group Discussion, Mock Interviews and Meetings.

*Meenakshi Raman and Sangeeta Sharma, Technical Communication; Principles and Practice, Oxford University Press, 2011.*

*Mattukutty M. Monippally, Business Communication Strategies, Tata Mcgraw-Hill Publishing Co. Ltd, 2001.*

*Shirley Taylor, Model Business Letters, E-Mails and other Business Documents (VI Edition), Pearson Education /Prentice Hall, 2012.*

*Michael Swan, Practical English Usage, Oxford University Press, 2005.*

**SM111 PROFESSIONAL ETHICS AND HUMAN VALUES (1-0-0) 1 Professional Ethics:Engineering as a**

Profession, Aim of Engineering, Responsibilities of Engineers, Rights of Engineers, Impediments to Responsibilities, Honesty, Integrity, Reliability, Risk, Safety and Liability, Global Issues. Personal Ethics: Value of Self, others and Society, Compliance with Law, Social Norms, Service to Community, Engineer's Responsibilities to Economically Deprived Peoples and Environment, Corruption, Indian and Western Culture, Simple Living and High Thinking, Science and Spirituality.

*Charles E. Harris et al., Engineering Ethics, Cengage Learning,*

*2009 Govindarajan M, Engineering Ethics: PHI 2004.*

*Fleddermann, Charles D. Engineering Ethics: Pearson Education*

*2004 Baura Gail D. Engineering Ethics: Academic Press 2006*

**SM300 ENGINEERING ECONOMICS**

**(3-0-0) 3**

Basic economic concepts and problems – Theories of demand, supply and Market equilibrium. Elasticity, demand forecasting, cost terminology. Methods of economic analysis in Engineering– Bases for Comparison of alternatives. Selection among alternatives, replacement analysis - Evaluating public activities - depreciation accounting - Estimating economic elements.

*Samuelson P.A. and Nordhans W.D., Economics, 15th ed., McGraw Hill, New York, 1995.*

*Thuesen G.J. and Fabrycky W.J. Engineering Economy, 9<sup>th</sup> ed., Prentice Hall of India, New Delhi 2002.*

*Sullivan W.G., Bontadelli J.A. and Wicks E.M., Engineering Economy, 11th ed., Pearson Education Asia, New Delhi 2001*

*Leland Blank P.E and Anthony Tarquin P.E., Engineering Economy, 4<sup>th</sup> ed., McGraw Hill, Singapore, 1998.*

**SM302 PRINCIPLES OF MANAGEMENT**

**(3-0-0) 3**

Management: science, Theory and Practice. Management and Society: External Environment, Social Responsibility and Ethics. Global, Comparative and Quality Management. Planning: Principles, Process, MBO, Strategies, Policies, Planning Premises, Strategic Management, Decision Making. Organizing: Nature, Entrepreneurship, Reengineering, Organisation Structure, Departmentation, Line Staff Authority, Power, Empowerment, Decentralisation, Effective Organizing and Organization Culture, Staffing: Human Resource Management, Recruitment and Selection, Performance Appraisal. Career Strategy, Managing Change and Organization Development, Leading: Human Factors and Motivation, Leadership, Committees, Teams, Group Decision Making and Communication. Controlling: System and Process of Controlling, Controlled Techniques, Productivity, Operations Management and Total Quality Management.

*Harold Koontz and Heinz Weihrich, Essentials of Management, Tata Mc Graw Hill, 2012.*

*Heinz Weihrich, Mark V, Cannice and Harold Koontz, Management, Tata Mc Graw Hill,*

*2012. Evans, Pucik, Barsoux, The Global Challenge, Tata Mc Graw Hill, 2010*

**SM400 MANAGERIAL ECONOMICS**

**(3-0-0) 3**

Introduction, Business Objectives and business decisions, Entrepreneurship Demand Analysis and forecasting, Market Structure, Perfect and imperfect competition, Production Theory, Pricing and Profit Management,

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Decision techniques and capital budgeting, National Income, Money System, Case Studies.

*Mote V.L. Paul Samuel and Gupta G.S., Managerial Economics, McGraw-Hill,*

*Craig Petersen H. and Cris Lewis W., Managerial Economics Prentice-Hall of India, 2000.*

*Dwivedy D. N., Managerial economics, Vikas Publishing House, 1995.*

### **SM401 MARKETING MANAGEMENT**

**(3-0-0) 3**

Concept of Market, Marketing Management Process, Marketing Environment, Organisational Market and Buyer behaviour, Market Segmentation, targeting and positioning, Planning marketing tactics, Product, price distribution and promotion decisions, Concepts of Market Research, Product Development and Re-Engineering- E-commerce, Marketing Information System and Research, Customer Relations Management (CRM), Business Process Outsourcing (BPO), Case Studies.

*P. Kotler: Marketing Management, Prentice Hall of India, 1984.*

*D.J. Dalrymple and L.J. Parsons, Marketing Management, John Wiley, 1982.*

*R. W. Haas: Industrial Marketing Management, Petrocelli / Charter, 1974.*

### **SM402 MANAGEMENT INFORMATION SYSTEM**

**(3-0-0) 3**

Functions of Management, Organization Environment, Organization Structure, System Concepts, Stakeholders Analysis, Framework for Information Systems (IS), Decision making process, Problem solving Process, Definition of Management Information System (MIS), EIS, DSS, Artificial Intelligence, Expert Systems, Computer hardware, Hardware standards, Computer Software File and Database Management, Communication Systems, Common Network components, Distributed systems, Design of MIS, Applications of MIS to business, Case studies.

*Kenneth C. Laudon and Jane Price Laudon, Management Information Systems, Managing the Digital firm, Pearson Education, Asia, 2002.*

*Gordon B. Davis, Management Information System: Conceptual Foundations, Structure & Development, McGraw Hill, 1974.*

*Joyce J Elam, Case series for Management Information Systems', Simon and Schuster Custom Publishing, 1996.*

### **SM403 HUMAN RESOURCE MANAGEMENT**

**(3-0-0) 3**

HRM functions, role each plays in the overall HRM process. HRM integration into strategic planning of the organizations - Key issues facing global HRM today and their impact on its successful practice in the 21st Century, including the critical issues of technology, workplace stability, workforce diversity or pluralism, globalization and ethics - Job analysis, job design, and job description in relation to job evaluation, job enrichment, and job enlargement. Effective recruiting plan and selection process for hiring qualified employees. Design of training program focused on needs assessment and evaluation of the effectiveness of training in relation to job performance – Development of practical system for evaluating employee performance and managing performance on a continuous basis - Analysis and evaluation of various approaches to compensation and benefit programs designed to meet the needs of the organizations and its employees - Integrating the human resource and organizations development aspects of the overall HRM responsibility. Evaluation of relationship between labour unions and management in relation to collective bargaining and contract negotiation. Approaches to respecting employees rights and protecting the health and safety of workers. Concept of planned, managed organizational change through proven organization development techniques.

*Drucker, Peter F. (1992). Managing for the Future: The 1990s and Beyond. Truman Talley Books/Dutton. New York.*

*Gary Dessler, Human Resource Management.*

### **SM450 FINANCIAL MANAGEMENT**

**(3-0-0) 3**

Financial Management, Accounting concepts. Financial statement analysis. Financial Investment Analysis.

Financial Decisions. Managing Components of Working Capital. Capital Investment & Financing Decisions .

*Pandey I.M., Financial Management, Vikas Publishing House, 1999.*

*Prasanna Chandra, Financial Management, Tata McGraw Hill Publication, 1998.*

*Kuchhal S.C., Financial Management an Analytical & Conceptual Approach, Chaitanya Publ. house, Allahabad 15th Ed, 2001.*

### **SM451 FOUNDATION COURSE ON ENTREPRENEURSHIP**

**(3-0-0) 3**

Self Discovery; Opportunity discovery, Customer and Solution – understanding who is the customer, identify job, pains, gains and early adopters, Establish your venture's unique value proposition and competitive advantage; Basics of business models and lean canvas; Validation – refine value proposition with blue ocean strategy, build solution demo, prototype development; Understanding cost structures, bootstrapping and initial financing;



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Positioning and branding, Sales plan using funnel approach; Support – Project management, operating a business. Mariotti, Steve. *The Young Entrepreneur's Guide to Starting and Running a Business.*, New York NY: Random House, Inc.2000.

Osterwalder Alexander, *Business Model Generation*, Wiley India Pvt. Ltd., 2017

*Entrepreneurship Development and Management – EDI Ahmedabad.*

Vasant Desai, *Dynamics of Entrepreneurial Development and Management*, Himalaya Publishing House. 2000.

### SM452 INTELLECTUAL PROPERTY RIGHTS

(3-0-0) 3

Introduction to intellectual property. Copyright. Related Rights. Trademarks. Geographical indications(GI). Industrial Design. Patents. International Registration Systems. Unfair Competition. Protecting New Varieties Plants. Overall Summary. Glossary

*WIPO handbook/ notes*

Wadehra B.L, *Law Relating to Patents, Trademarks, Copyright Designs & Geographical Indications*, Universal Law Pub., 2000.

Sullivan & Patrick H., *Profiting from Intellectual Capital: extracting value from Innovation*, John Wiley, 1998.

Correa, Carlos M., *Intellectual Property Rights, the WTO and Developing Countries: the TRIPS Agreement and Policy Options*, Zed books, New York, 2000.

### SM453 YOGA SUTRAS OF PATANJALI

(3-0-0) 3

Bases and relevance of yoga. Elements of Sankhya philosophy. Some ancient texts on yoga. Sri Krishna and Gita. Patanjali and his Yoga Darshana. Commentaries (Bhashyas) and notes (Teekas) to Yoga aphorisms. The nature of asthanga yoga or raja yoga. A brief introduction to Patanjala Yoga Sutras on contemplation, yogic practices, attainments and the nature of freedom and realization.

Maharsi Patanjali, *Yoga Sutram (shattikopetham)* Edited with notes by Nyayacharya, Kavyathirtha Pandit Dhundhiraj Sastri, Chaukhamba Sanskrit Sansthan, Varanasi.

Bangali Baba, *The Yogasutra of Patanjali with the commentary of Vyasa.*

Swami Vivekananda, *Raja Yoga.*

### SM454 INTRODUCTION TO INDIAN CLASSICAL MUSIC

(3-0-0) 3

A brief history of Indian classical music and musical culture – Specificities of Indian classical music- Hindustani and Carnatic traditions of music – Musical notes in Indian classical music – Raga and Tala – Difference between Indian and Western musical traditions – vocal and instrumental music – Classification of Indian musical instruments – Some doyens of Indian music and their music – Classical and non- classical music – folk and film music – Dialectical relation between the classical and the non-classical music – Music criticism – certain key terms – Indian classical music in print media – Indian classical music I (India) English literature – Some novels

Raghava R Menon, *Indian Classical Music: An Initiation*, New Delhi: Vision Books, 1996

Ram Avtar Vir, *Theory of Indian Music*, New Delhi: Pankaj Publications, 1999

Sumati Mutatkar, *Aspects of Indian Music*, New Delhi: Sangit Natak Academy, 2006

### SM 455 PHILOSOPHY

(3-0-0)3

The difference between knowledge (Vidya) and Ignorance (Avidya): Upanishads; Six systems orthodox and Heterodox Schools of Indian Philosophy. Greek Philosophy; Origin of the Universe: Nasidiya Sukta: “Who really knows?” Brhadaranyaka Upanishad; Chandogya Upanishad; Non-self, Self, real and unreal. Taittiriya, Upanishd; Siksha Valli. Plato's Symposium: Lack as the source of desire and knowledge. Socratic method of knowledge as discovery. Language: Word as root of knowledge (Bhartrahari's Vakyapadiyam) Fourteen Knowledge basis as a sources of Vidya; Four Vedas; Six auxiliary sciences (Vedangas); Purana, Nyaya, Mimamsa and Dharama Sastras. Knowledge as Power: Francis Bacon. Knowledge as both power and self –realization in Bagavad Gita. Knowledge as oppression: M. Foucault. Discrimination between *Rtam* and *Satyam* in Indian Philosophy. Knowledge as invention: Modern definition of creativity, scientific activity in the claim that science invents new things at least through technology. Knowledge about the self, transcendental self; knowledge about society, polity and nature. Knowledge

about moral and ethics codes. Tools of acquiring knowledge: Tantrayuktis, as system of inquiry (charaka, Sushruta, Kautilya, Vyasa)

Copleston, Frederick, *History of Philosophy*, Vol. 1. Great Britain : Continuum.

Hiriyanna, *M Outlines of Indian Philosophy*, Motilal Banarsidass Publishers; Fifth Reprint edition(2009) Sathaye, Avinash, *Translation of Nasadiya Sukta*

Ralph T. H. Griffith. *The Hymns of the gveda*. Motilal Banarsidass ; Delhi:1973.

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Raju, P.T. *Structural Depths of Indian Thought*, Albany; State University of New York Press.

Plato, *Symposium*, Hamilton Press.

Kautilya Artha Sastra, Penguin Books, New Delhi.

### SM456 FINANCIAL MARKETS AND INSTITUTIONS

(3-0-0)3

Financial System: Significance and Structure of the Financial System, Banks and Other Financial Institutions - Financial Innovation - Function of Financial Markets. Banking Institutions: Institutional structure in India- Implication for the economy - Asset and Liability Management by Banks. Non-Bank Financial Intermediaries: Institutional structure in India - Types and comparison of asset liability structures of various NBFCs. Money Market: Money and Call Money Market - Institutions constituents. The money markets - The discount market - The 'parallel' markets - The interbank market. Capital Market: The importance of capital markets - Characteristics of bonds and equities. The trading of bonds and equities. Foreign Exchange Markets: The nature of foreign exchange markets - Interest rate parity - Other foreign exchange market rules. The determinants of spot exchange rates - Purchasing power parity. International Capital Markets: The world capital market - Eurocurrencies. Central Banking and the Conduct of Monetary Policy: Reserve Bank - Assets liabilities and implications for the financial sector - Conduct of Monetary Policy: Tools, Goals, Strategy, and Tactics - Autonomy of the central bank.

Fabozzi, [Frank](#), Modigliani, Franco, Jones, Frank (Feb 2009), [Foundations of Financial Markets and Institutions](#), International Edition, 4th Edition, Pearson.

Mishkin, Frederic S. and Eakins, [Stanley G.](#) (2005), *Financial Markets and Institutions* (6th Edition), Pearson. Howells, Peter, Bain, Keith (2007), *Financial Markets and Institutions*, 5th Edition. Madura, Jeff (2008), *Financial Markets and Institutions*, 8<sup>th</sup> edition, Thomson Publications.

Kidwell, David, Blackwell, David W., Whidbee, David A. et.al. (2008) *Financial Institutions, Markets, and Money*, 10th Ed., John Wiley & sons. Bhole, L. M., and Jitendra Mahakud (2010), *Financial Institutions And Markets: Structure, Growth And Innovations*, 5th Edition, Tata McGraw Hill.

### SM457 CREATIVE WRITING

(3-0-0)3

Introduction to creative writing, challenges involved in writing, process of writing, modes of writing, introducing fiction, non-fiction, poetry, and academic writing, important literary terms, defining literary terms, basics of story writing, characteristics of stories, structure, variations in the style of writing stories, writing fiction, types of fiction, form and structure, character sketch, writing non-fiction, features of writing non-fiction, structure, choice of topic, relevance of non-fiction, writing poems, procedure involved in writing poems, variations in style, rhythm, travel writing, essentials and relevance of travel writing, writing in community and academy, cross-over discipline, academy as open space, analysis of various forms of writings, discussions on style.

Morley, David. *The Cambridge Introduction to Creative Writing*. New Delhi: Cambridge University Press, 2010.

Rao, N. Meera Raghavendra. *Feature Writing*. New Delhi: PHI Learning Private Limited, 2009.

Bulman, Colin. *Creative Writing: A Guide & Glossary to Fiction Writing*. London: Polity Press. 2007.

Mills, Paul. *Creative Writing Course Book*. London: Routledge, 2006.

Rao, Cheryl, Gita Iyengar and Meena Murdeshwar. Ed. *Anyone Can Write*. New Delhi: Cambridge University Press, 2009.

### SM458 INTRODUCTION TO INDUSTRIAL ECONOMICS AND ORGANIZATION

(3-0-0)3

Introduction to economics of industry- review of relevant microeconomic concepts; Theory of the Firm; Structure-Conduct -Performance paradigm; Market structure concepts including concentration and vertical integration; Market conduct concepts including pricing behaviour; Performance aspects including growth and profitability; Transaction cost analysis; Economics of information technology; Introduction to Game Theory- Basic elements, Prisoner's Dilemma, Nash equilibrium; Overview of latest industrial and competition policies in India.

Belleflamme, P. and Peitz M., *Industrial Organization: Markets and Strategies*, Second Edition, Cambridge University Press, 2015.

Carlton D.W. and Perloff, J. M., *Modern Industrial Organization*, Fourth Edition, Pearson, 2005.

Hay, D.A. and Morris, D.J., *Industrial Economics and Organization: Theory and Evidence*, Oxford University Press, Revised Edition, 1991.

Varian, H.R., Farrell, J. and Shapiro, C., *The Economics of Information Technology: An Introduction*, Cambridge University Press, 2004.

Osborne, M.J. and Rubinstein, A., *A Course in Game Theory*, Cambridge, MIT Press, 1994.

**SM459 ADVANCED COURSE ON ENTREPRENEURSHIP**

**(3-0-0)3**

Pivoting – evaluating different business models, analyze competitors, product management.

Business planning – yearly sales, people and financial plan; Growth strategy – scaling customers, revenue and sources of funding; Team building; Branding and channel strategy – Understand and examine different channels; Leveraging technology – Identifying technology needs and choosing key technologies, technology as a competitive advantage; Measuring progress establishing key metrics and measuring; Legal – Incorporating, regulations.

*John R. Bessant, Joe Tidd, Entrepreneurship, Wiley, 2018*

*Beverly Rudkin Ingle Design Thinking for Entrepreneurs and Small Businesses: Putting the Power of Design to Work 1<sup>st</sup> ed. Edition, Wiley, 2018*

*Value Proposition Design, Osterwalder Alex, Wiley India Pvt. Ltd.*

**Courses for B.Tech. with Minor in Management (Refer M.B.A. curriculum for details)**

**SM722 Marketing Management (3-0-0) 3**

**SM723 Entrepreneurship (3-0-0) 3**

**SM725 Financial Management (3-0-0) 3**

**SM726 Human Resource Management (3-0-0) 3**

**SM727 Business Analytics and Decision Making (3-0-0) 3**

## STUDENT DECLARATION ON THE NITK HONOUR CODE

I do hereby undertake that as a student at NITK-Surathkal, I shall be bound by the NITK Academic Regulations & Curriculum, and all the applicable Rules governing the academic programmes; and also specifically that :

- (1) I will not give or receive aid in examinations; that I will not give or receive un-permitted aid in class work, in preparation of reports, or in any other work that is to be used by the instructor as the basis of evaluation/grading; and
- (2) I will do my share and take an active part in seeing to it that others as well as myself uphold the spirit and letter of the *NITK Honour Code*.

I realize that some examples of misconduct which are regarded as being in violation of the *Honour Code* include (but is not limited to) what is listed here below:

- Copying in examination, from another's paper or from any other source;
- Allowing another to copy from one's own examination paper;
- Un-permitted collaboration in any form whatsoever;
- Plagiarism of any form or extent;
- Revising and resubmitting a marked quiz or examination paper for re-grading without the instructor's knowledge and consent;
- Giving or receiving un-permitted aid on take-home examinations, etc.;
- Representing as one's own work the work of another, including information available on the Internet, etc.;
- Giving or receiving aid on an academic assignment under circumstances in which a reasonable person should have known that such aid was not permitted;
- Committing a cyber offence, such as, breaking passwords and accounts, sharing passwords, electronic copying, planting viruses, etc.;
- Engaging in any act of indiscipline whatsoever, directly or indirectly, whether in the Institute premises or in the Hostels/Campus/etc, or even outside the Institute, that would reflect or project an undesirable image on the Institute;

I understand and accept that any act of mine that can be considered to be a violation of the *NITK Honour Code* will invite disciplinary action as decided by the Institute Authorities.

Student's Full Signature : \_\_\_\_\_

FULL NAME IN BLOCK LETTERS : \_\_\_\_\_

Semester Fee Payment Receipt Number & Date : \_\_\_\_\_

Student Register Number :

Admission Number (if assigned)	Roll Number (if assigned)

Date : \_\_\_\_\_

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**Declaration to be duly filled-in by the student, and signed in presence of the Faculty-Advisor or the HOD.**

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Date : \_\_\_\_\_

- copy to be retained by the student, as a Reference -

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