B.E

Electronics and Communication Engineering Degree Programme

Regulations & Syllabi (under CBCS)

2023

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Government Aided Autonomous College Affiliated to Anna University, Chennai
Accredited by NAAC with 'A' Grade
ISO 9001:2015 Certified

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PSG COLLEGE OF TECHNOLOGY, COIMBATORE - 641 004

(Autonomous college affiliated to Anna University, Chennai)

2023 REGULATIONS FOR FOUR YEAR BE / BTech DEGREE PROGRAMMES*

(for the batches of students admitted in 2023 - 2024 and subsequently, under Choice Based Credit System)*

NOTE: The regulations hereunder are subject to amendments as may be made by the Academic Council of the College from time to time. Any or all such amendments will be effective from such date and to such batches of students (including those already undergoing the programme) as may be decided by the Academic Council.

1. (a)PRELIMINARY DEFINITIONS AND NOMENCLATURE

In the following Regulations, unless the context otherwise requires

i) **"Programme"** means Degree Programme,that is **BE / BTech Degree Programme.**

ii) **"Branch"** means specialization or discipline of BE / BTech Degree Programme, like Civil Engineering, Textile Technology, etc.

iii) **"Course"** means a theory or practical course that is normally studied in a semester, like Mathematics, Physics, etc.

iv) **"University"** means **Anna University.**

(b)CONDITIONS FOR ADMISSION

Students for admission to the BE / BTech degree programme will be required to satisfy the conditions of admission thereto prescribed by the University and Government of Tamil Nadu.

2. DURATION OF THE PROGRAMME

i) **Minimum Duration:** The programme will extend over a period of four years* leading to the Degree of Bachelor of Engineering (BE)/Bachelor of Technology (BTech) of the Anna University. The four academic years will be divided into eight semesters with two semesters per academic year. Each semester shall normally consist of 90 working days including examination days.

ii) **Maximum Duration:** The student shall complete all the passing requirements of the BE / BTech degree programme within a maximum period of 7 years (6 years for lateral entry); these periods reckoned from the commencement of the semester to which the student was first admitted to the programme.

3. BE / BTech PROGRAMMES OFFERED

The following are the branches of study under BE / BTech degree programme.

BE

Automobile Engineering
Biomedical Engineering
Civil Engineering
Computer Science and Engineering
Computer Science and Engineering (AI & ML)
Electrical and Electronics Engineering
Electronics and Communication Engineering
Instrumentation and Control Engineering

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* Provision is made for lateral entry of students in the third semester of the programme in all branches of study (except part time progarmme) and they will be required to satisfy the conditions of admissions thereto prescribed by the University and Government of Tamil Nadu.

Mechanical Engineering
Metallurgical Engineering
Production Engineering
Robotics and Automation

BTech Biotechnology
Fashion Technology
Information Technology
Textile Technology

4. STRUCTURE OF PROGRAMMES

(i) The course work of the odd semesters will normally be conducted in odd semesters and that of the even semesters in even semesters.

(ii) **Curriculum:** The curriculum will comprise courses of study as given in section 13 infra in accordance with the prescribed syllabi. The hours / week listed in section 13 infra for each of the course refer to periods/week. The curriculum consists of (a) Basic Sciences, (b) Humanities and Social sciences (c) Engineering Sciences (d) Professional cores (e) Professional electives (f) Open electives (g) Employability Enhancement courses (h) Mandatory courses (i) Induction programme and (j) Activity point programme as per AICTE guidelines.

(iii) **Electives:** Every student shall opt for electives from the list of electives of the respective degree programme as given in section 13 in consultation with the Tutor, Programme Co-ordinator and the HoD. A student shall undergo two open elective courses and six professional elective courses. Professional electives will be offered from5th semester to 8th semester. **Minimum number of credits to be earned for open elective courses is 6. Minimum number of credits to be earned for professional elective courses is 18.** Open electives are the elective courses offered by a department for students of other branches and professional electives are courses offered by a department to the students of their own branches only.

(iv) **Project Work:** Every student shall be required to undertake a suitable project in industry / research organization / department in consultation with the Head of the Department and the faculty guide and submit the project report thereon at the end of the semesters in which the student registered, on dates announced by the College/Department. A student shall register for the Project Work I in the7th semester and for Project Work II in the 8th semester.

(v) **Online Courses (SWAYAM based NPTEL, GIAN, Coursera, Edx):** Students can register and earn credits for online courses approved by department committee consisting of HoD, Programme Coordinator, Tutor and Subject Expert. Students who complete relevant online courses (having 3 credits only) successfully to a maximum of 9 credits may obtain exemption from studying three Professional Electives. Similarly, students who complete relevant online courses (having 3 credits only) successfully to a maximum of 6 credits may obtain exemption from studying two Open Electives. The list of online courses is to be approved by Chairman Academic Council on the recommendation of HoD at the beginning of the semester if necessary, subject to ratification in the subsequent Academic Council meeting. For earning credits through online courses, students will be evaluated within the institute and will be recommended grades based on the scheme of evaluation given in Section 8, vii) m and grading system given in Section 8, iii) b. Students may do online courses from fifth to seventh semester for getting exemption from professional electives and from third to seventh semesters for getting exemption from open electives. Any online course undergone by a student during break of study period shall not be considered for exempting a professional elective/open elective course.

(vi) (a)**Self Study Courses:** A student without current reappearance courses and /or redo courses can opt for one course as a Self Study course, which may be either an Open Elective or a Professional Elective by getting prior approval from the HoD who will nominate a faculty for the periodic monitoring and evaluation of the course.

(b) **"Self Directed Learning Courses:** These courses are not text book based courses but are based on various attempts made by researchers to solve a specific problem as available in quality journals. These courses will not have specific course titles. These courses will have 3 credits.

Individual students who are motivated, aspire to acquire additional knowledge through self direction and are willing to experience a new way of problem solving are permitted to opt for these courses. Individual students can opt for self-directed courses based on the recommendation by department committee consisting of HoD, Programme Coordinator, Tutor and Subject Expert and approval by the Head of the Institution. Students should choose a specific problem addressed by an author or authors having good citations and published in a peer reviewed journals having a good impact factor for this course. Students can solve the problem using the framework used by the author or by using a new approach. The proposed work by the student should have adequate scientific content, scope for further exploration and should involve good mathematical modeling and solution using programming/software. The adequacy of this proposed work is to be ensured by the department committee before recommending the same for the approval of the Head of the Institution. The students will be mentored by a faculty who have successfully guided PhD scholars and have published papers or completed sponsored projects involving unstructured problems. Students will be evaluated for evidence of this learning experience as per the scheme of evaluation given in section 8 (vii) n"

If a student wishes to avail exemption of professional electives, he/she can do so by exercising his/her option in writing to the respective Head of the Department and Head of the Institution during the beginning of the prefinal year / final year (i.e., semester 5, 6, 7 or 8) by following the equivalence norm that one professional elective is equivalent to one self-directed learning course completed by the student.

(vii) (a) **Induction Programme:** All students shall undergo induction program in the first semester for a duration of three weeks as per the guidelines of All India Council for Technical Education (AICTE).A student completing the induction programme will be awarded **completed** grade and only the students who complete the induction programme shall be considered as eligible for award of degree subject to satisfying other conditions. A student who does not complete the induction program in the first semester shall Redo the same in the subsequent semester.

(b) **Internship**

Every student has to earn minimum 12credits (Recommended credit range 12-20) of Internship/ Entrepreneurial activities / Project work/ Seminar and Inter/ Intra Institutional Training as a part of his BE/BTech degree programme. It should be noted that for these activities, one credit is equivalent to minimum 40 hours of work. Various activities as per AICTE guidelines under internship is provided in the scheme under the category of Employability Enhancement Courses.

(c) **ACTIVITY POINT PROGRAMME (ADDITIONAL REQUIREMENT FOR EARNING BE/BTech Degree**

Every student shall have to earn prescribed number of activity points detailed below relating to entrepreneurial capabilities and societal commitment from 2nd semester to 6th semester.

Level of entry in degree course	**Total years for points**	**Minimum points**
1st Year	1st to 4th Year	100
2nd Year (3rd Sem.) through lateral entry or transfer from other University	2nd to 4th Year	80

A student shall earn 20 points in each semester from 2nd semester (3rd semester for later entry) to 6th semester the activities shall consists of participation of the student in NSS/NCC/Sports/Sansad Adarsh Gram Yojna (SAGY). These activities will be coordinated by the student department and 3 hours of participation in activity will be taken as 1 activity point these points will not be accounted for CGPA calculation.

A student completing the minimum number of activity points in a semester will be awarded **completed** grade and only the student who secure **completed** grade in all specified semesters shall be considered as eligible for award of degree subject to satisfying other conditions. A student who fails to secure the specified number of activity points in a semester shall Redo the same in the subsequent semester

The Details of implementation (semester wise) is provided. One activity point is considered equivalent to 3 hours of activity.

Semesters	Responsibility	Supporting agency / Activity	points
2	Respective department	NSS/NCC/TRAINING & PLACEMENT/TECHNICAL ASSOCIATIONS/SPORTS/ ENTREPRENEURSHIP/APPROVED EXTRA CURRICULAR ACTIVITIES	20
3			20
4			20
5			20
6			20

These activities will be coordinated by the respective department with the support of NSS / NCC / Sports / Sansad Adarsh Gram Yojna (SAGY) Coordinator or Training and Placement Officer (TPO) of the Institute. The student will be provided with a certificate from the concerned coordinator and Institutional Head. These points will not be accounted for CGPA calculation. The student may choose any relevant (techno-economic-societal) activity as per their liking in order to earn the Activity points.

(viii) **One-Credit Courses**: Students can also opt for industry oriented one credit courses of 15 hours duration which will be offered by experts from industry / other institution on specialized topics related to their branches of study. Students can complete such one credit courses during the semesters 3 to 7 as and when these courses are offered by different departments. A student will also be permitted to register for the one credit courses offered by other departments provided the student has fulfilled the necessary pre-requisites of the course subject to approval by both the Heads of Departments. There is no limit on the number of one credit courses a student can register and successfully complete during the above period. If a student wishes to avail exemption of professional electives, he/she can do so by exercising his/her option in writing to the respective Head of the Department during the beginning of the prefinal / final semester (i.e., semester 7/8) by following the equivalence norm that one professional elective is equivalent to three one credit courses completed by the student. The grades of the students completing the one credit courses will be finalized based on absolute grading system listed in 8(iii) (b) infra. The grades earned by the students for the one-credit courses which are not opted for conversion into an elective, will not be included in the computation of CGPA.

However number of professional electives for which the student seeks exemption in having studied online courses and/or one credit courses shall not exceed three under any circumstance.

(ix)**Entrepreneurship and Innovation Start-ups:**

Student entrepreneurs may earn academic credits for their efforts in working on innovative prototypes/business models with an intent of setting up a start-up from the beginning of their 6th semester onwards. Students are free to dedicate any time outside their regular academic hours and duties towards their companies. They will be allowed to earn credits by opting for startup related activities in place of the courses under the category of Employability Enhancement Courses (EEC). It is recommended that such teams are to be formed from various disciplines rather than a single discipline.

The Innovation & Entrepreneurship expert committee constituted by the Principal will review the startup/ innovation proposals submitted by students and give approval for credit conversion. At the end of the designated semester, the student teams are expected to make a presentation on the progress to the I& E expert committee which will then recommend grades based on the level of attainment of the stated objectives. Students will be evaluated for evidence of this learning experience as per the scheme of evaluation given in section 8 (vii) j" and will be awarded grades based on absolute grading system listed in 8(iii)(j) infra.

Students can avail exemption from joining the courses at the beginning of 5th, 6th and 7th semesters for a maximum duration of 15 days in each semester. This exemption period can be used for entrepreneurship related activities like attending entrepreneurship/innovation training programmes conducted by premier institutes, working with startups etc. The exemption can be availed by getting prior approval before the beginning of the semester from a committee constituted by the Head of the Department/Institute and the students should demonstrate their utilization of this exemption through a presentation/viva voce to the committee after the end of the exemption period.

(x) **Course Enrollment and Registration**

a) Each student, on admission shall be assigned to a Tutor who shall advise and counsel the student about the details of the academic programme and the choice of courses considering the student's academic background and career objectives.

b) Each student on admission shall register for all the courses prescribed in the curriculum in the student's first and second semester of study. In the case of lateral entry students, they shall register for all the courses prescribed in the curriculum in the third semester of study.

c) From third semester onwards, (fourth semester in the case of lateral entry students) a student has the option to drop a maximum of two theory courses except Professional Core Courses in a semester. A student has the option to study two additional theory courses in a semester from third semester onwards. These courses can be open electives in third and fourth semesters and/ or professional electives from fifth semester onwards. The maximum number of credits the student can register in a particular semester cannot exceed 30 credits including courses for which the student has registered for redoing (section 5, iii (a)).

d) In case of a student dropping a course of study (other than professional core courses)in one semester, he/she shall register for that course in the next given opportunity and earn necessary attendance in that course exclusively to become eligible to appear for the semester examination in that course.

e) The courses to be offered in a semester for candidates who need to reappear (as per 5 (iii) infra) or having attendance shortage etc., will be decided by HoD.

f) After registering for a course, a student shall attend the classes, satisfy the attendance requirements, earn Continuous Assessment marks and appear for the semester end examinations.

The enrollment for all the courses of the Semester II will commence 10 working days prior to the last working day of Semester I. The student shall confirm the enrollment by registering for the courses within the first five working days after the commencement of the Semester II.

The enrollment for the courses of the Semesters III to VIII will commence 10 working days prior to the last working day of the preceding semester. The student shall enroll for the courses with the guidance of the Tutor. If the student wishes, the student may drop or add courses subject to eligibility within five working days after the commencement of the concerned semester and complete the registration process duly authorized by the Tutor.

(xi) **Credit assignment:** Each course is assigned certain number of credits based on the following:

Contact Period per week	**Credits**
One Lecture Period	1
One Tutorial Period	1
TwoPractical Periods (Laboratory / Project Work/ etc.)	1

The Contact Periods per week for Practical shall be in multiples of 2.The exact number of credits assigned to the different courses is shown in section 13.

(xii) **Minimum credits:** The minimum number of credits to be earned through successful completion of the courses of study in the respective branch listed in section 13 infra, by a student to qualify for the award of degree is provided below.

Branch of Study	Minimum number of credits to be earned through successful completion of the courses of study of the respective branch listed in section 13 infra, for the award of degree	
	for entry at first semester	**for *lateral entry* at third semester**
BE Programmes		
Automobile Engineering	166	125
Biomedical Engineering	166	122
Civil Engineering	166	128
Computer Science Engineering	166	124
Computer Science and Engineering (AI & ML)	166	125
Electronics and Communication Engineering	166	120
Electrical and Electronics Engineering	166	123
Instrumentation and Control Engineering	166	126
Mechanical Engineering	166	127
Metallurgical Engineering	166	124
Production Engineering	166	125
Robotics and Automation	166	123
BTech Programmes		
Biotechnology	166	127
Fashion Technology	166	123
Information Technology	166	122
Textile Technology	166	122

(xiii) **B.E. / B.Tech. (Honours) specialization in the same discipline, B.E. / B.Tech. (Honours) and B.E. / B.Tech. minor in other specialization course enrolment:**

a. These degrees are optional for students. The students who opt for any one of these degrees have to earn extra 18 credits. For BE/BTech (Hons in same specialization), BE/BTech (Hons) and BE/BTech (minor) the students will be permitted to register the courses from 5th Semester onwards for BE regular and 7th semester onwards for BE Sandwich provided the marks earned by the students until 3rd semester for BE Regular and 5th Semester for BE Sandwich should be of CGPA 8.0 and above and cleared all the courses in the first attempt.

b. If a student decides not to opt for Honours specialization in the same discipline and Honours, after completing certain number of additional courses, the additional courses studied shall NOT be considered instead of the Professional Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of Professional Elective courses required as per the curriculum, the courses with higher grades shall be considered for the calculation of CGPA at the end of the final semester while calculating final CGPA. Remaining courses shall be printed in the mark sheet, however, they will not be considered for calculation of CGPA.

c. If a student decides not to opt for Minor, after completing certain number of courses, the additional courses studied shall NOT be considered instead of Open Elective courses which are part of the curriculum. If the student has studied more number of such courses than the number of open electives required as per the curriculum, the courses with higher grades shall be considered for calculation of CGPA at the end of the final semester while calculating final CGPA. Remaining courses shall be printed in the mark sheet, however, they will not be considered for calculation of CGPA.

(xiv) **Medium of instruction:** English is the medium of instruction for examinations, project report etc. other than elective language courses.

5. REQUIREMENTS OF ATTENDANCE AND PROGRESS

i. A student will be qualified to appear for semester end examinations in a particular course of a semester only if

a) he / she has satisfied the attendance requirements as per the norms given below:

- Shall secure not less than 75% attendance in that course
- If a student secures attendance 65% or more but less than 75% in any course in the current semester due to medical reasons (hospitalization / accident / specific illness) or due to participation in the College / University / State / National / International level Sports events with prior permission from the Chairman, Sports Board and Head of the Department concerned, the student shall be given exemption from the prescribed attendance requirement and the student shall be permitted to appear for the semester end examinations of that course.

b) his / her progress has been satisfactory and
c) his / her conduct has been satisfactory.

ii. A student shall normally be permitted to appear for Semester end examinations of the course if the student has satisfied the attendance requirements (vide Clause 5(i) supra) and has registered for examination in those courses of that semester by paying the prescribed fee.

iii. a) Students who do not satisfy clause 5(i) supra will not be permitted to appear for the Semester End Examinations / Evaluation of that course. The student has to register and redo

that course in a subsequent semester when it is offered next, earn necessary attendance and CA mark and appear for semester end examinations.

b) If the total number of "Redo" courses (except mandatory courses) at the end of any semester is more than TWO, the student will not be eligible to register for next immediate semester courses.

Such students will be permitted to register for those courses only when offered next, subject to fulfillment of the above condition.

c) If a student with more than TWO "Redo" courses (except mandatory courses) is in the last batch of his/her current regulations, then he/she has to redo two equivalent courses from the next regulations when it is offered. If such equivalent courses are not available in the next regulations, he/she has to complete the redo courses in a self study mode following the guidelines given in 4 (vi) supra.

iv. A student who has already appeared for a course in a semester and passed the examination is not entitled to reappear in the same course for improvement of letter grades / marks.

v. In respect of students who complete a part of the academic programme either one or two semesters under the student exchange scheme in approved foreign Universities, the transfer of credits of equivalent courses completed by them in the foreign university will be approved; and in the case of the remaining courses of the respective semester(s) which they have not studied in the respective regulation, they shall register for those courses within the next two or subsequent semesters on a self-study basis. Such an appearance of the student in those courses will be treated as first appearance for the purpose of classification. (Vide sections infra 10 (A,B,C &D))

6. DISCIPLINE

i) Every student is required to observe disciplined and decorous behavior both inside and outside the college and not to indulge in any activity which will tend to bring down the prestige of the college. The Head of the Institution shall constitute a disciplinary committee to enquire into acts of indiscipline and notify the punishment

ii) If a student indulges in malpractice in any of the examinations, he / she shall be liable for punitive action as decided by the Board of Examiners.

7. PROCEDURE FOR REJOINING THE PROGRAMME

A student who desires to rejoin the programme after a period of discontinuance or who upon his/her own request is permitted by the authorities to repeat the study of any semester, may join the semester which he/she is eligible or permitted to join, only at the time of its normal commencement for a regular batch of students and after obtaining the approval from the Commissioner of Technical Education and the University. No student will however be enrolled in more than one semester at any time.

8. ASSESSMENT AND PASSING REQUIREMENTS

i) **Assessment:** The assessment will comprise of either Final Examination (FE) for 50 marks and Continuous Assessment (CA) for 50 marks OR Continuous Assessment for 100 marks as specified in the scheme in section 13 infra. The Continuous Assessment (CA) marks will be awarded on assessing the student continuously during the semester as per guidelines 8(vii) infra. For Theory courses, the CA marks will be scaled down from 50 to 40 marks and the Final Examination (FE), which will be conducted for 100 marks, will be scaled down to 60 marks and the total being 100 marks (CA 40 + FE 60). For Laboratory courses including Project work, Summer Term Courses, Industry Visit and Lecture / Industry Visit, In plant Training, Industrial Training, Innovation Practices the Continuous Assessment (CA) marks will be scaled up from 50 to 60 marks and the Final Examination (FE) marks which will be conducted for 50 marks will be scaled down to 40 marks. The award of grades for theory

courses will be done on Relative Grading System and for the other courses on Absolute Grading System as specified in the corresponding section.

ii) **Semester End Examinations:** Semester end examinations will normally be conducted during October / November and during March / April of each year. Reappearance examinations may be conducted at such times as may be decided by the college.

A student will be permitted to appear for the final semester examination in a course only if he/she has completed the study of that course.

iii) **Grade and Grade Point:** Each student, based on his / her performance, will be awarded a final grade and grade point as given below for each course at the end of each semester by following relative grading system and absolute grading system.

a. Relative Grading System

In this system, the grades are awarded to the students based on their performance relative to others in Theory courses having Continuous Assessment (CA) and Final Examination (FE) components.

For each theory course, the total mark M [ie., the sum of Continuous Assessment marks (CA) and Final examination marks (FE)] is computed for every candidate.

The students who secure a mark as detailed below are declared as fail (RA) in a theory course.

Marks scored in FE is less than 45% (or) M less than 50% of total marks	Grade : RA

Note:

- "RA" denotes reappearance in a course

After omitting the marks (M) of all failed students, if the number of students who have passed the course is more than 30, the marks obtained by all the students in that course (having the same course code) will be normalized using the BOX-COX transformation method. The grade range for each course will be computed based on the procedure given by Anna University, Chennai and the grades will be awarded for each student in a particular course. This procedure will be followed for all the courses offered under this regulation.

Then letter grade and grade point to each student are awarded as given in the table below.

Letter Grade	Grade Points
O (Outstanding)	**10**
A +(Excellent)	**9**
A (Very Good)	**8**
B +(Good)	**7**
B (Average)	**6**
C (Satisfactory)	**5**
RA (Re-appearance)	**0**
SA (Shortage of Attendance)	**0**
W(Withdrawal)	**0**

b. Absolute Grading System

If the number of students registered for a particular course or if the number of students who have passed a particular course is less than or equal to 30, absolute grading system will be followed. The letter grade and mark range are given in table below.

Letter Grade	Mark Range	Grade Point, g
O	91 - 100	10
A+	81 - 90	9
A	71 - 80	8
B+	61 - 70	7
B	56 - 60	6
C	50 – 55	5
RA	< 50	0
W(Withdrawal)	0	0
SA (Shortage of Attendance)	0	0

- "RA" denotes Reappearance in a course.

The grades RA and SA will not figure in the grade sheet.

c. For online courses the following grading pattern is applicable in case of credit transfer and CGPA calculations.

Range of percentage of total marks	Letter grade	Grade Point g
O	91 - 100	10
A+	81 - 90	9
A	71 - 80	8
B+	61 - 70	7
B	56 - 60	6
C	50 – 55	5
RA	< 50	0
W (Withdrawal)	0	0
SA (Shortage of Attendance)	0	0

iv) **Cumulative Grade Point Average :**

After the completion of the programme, the Cumulative Grade Point Average (CGPA) from the semester in which the student has joined first (first semester for regular & third semester for lateral entry students) to the final semester is calculated using the relationship:

$$CGPA = \frac{\sum g_i * C_i}{\sum C_i}$$

where, g_i is Grade point secured for i^{th} course.

C_i is Credit allotted for the i^{th}course.

v) **Passing a course:**

a. A student shall be deemed to have passed a theory course with CA and FE components. if

i) he/she secures at least 45% of the total marks in the final examination and
ii) he/she secures not less than 50% of total marks [CA and FE put together] prescribed for the course shall be declared to have passed the course and acquired the relevant number of credits.

A student is deemed to have passed in any other course like Laboratory Course, Summer term Course, Industry Visit, Inplant Training, Mini Project and Project Work I & II etc. with CA and FE components (except theory course with CA and FE components) or in any course carrying only Continuous Assessment marks if the total mark secured by him/her is at least 50% of total marks.

b. A student who is absent or has failed in the semester end examinations in any theory course has to register for the subsequent examination in that theory course when it is offered next time, either by retaining or by not retaining the CA marks already earned.

I. A student who chooses to register as retaining CA may continue to appear for further appearances in that option or at any time can switch over to the option not retaining CA.

II. A student who chooses the option as not retaining CA shall have to continue to register for further appearances in that option only till he/she obtains a pass. In such case, the maximum grade that will be awarded to the students who appear in the Reappearance Examination will be capped at "A".

(ii) For students who chooses the option of not retaining CA, the following grading pattern is applicable

Range of percentage of total marks	Letter grade
71 to 100	A
61 to 70	B+
56 to 60	B
50 to 55	C
0 to 49 or less than 45% in final examination	RA

c. A student who after having earned necessary attendance, is absent for semester end examination or has failed in any other course like Laboratory Course, Summer term Course, Industry Visit, Inplant Training, Mini Project and Project Work I etc. with CA and FE components (except theory course with CA and FE components) or in any course carrying only Continuous Assessment marks will register for the examinations when it is conducted next time and will be solely assessed in the final examinations carrying the entire marks of that course.

d. A student who has earned necessary attendance in the course Project work II but does not submit the report on Project Work II on or before the date specified by the college / department, he/she shall be deemed to have failed in the Project work II and awarded grade RA and will have to register for the same at the beginning of the subsequent semester, redo and submit the project report at the end of that semester and appear for the final examination, the CA mark earned afresh.

e. A student who has earned necessary attendance in the course Project work II but whose project report is not accepted for reasons of incompleteness or other serious deficiencies will be treated as 'absent' and will have to register for the same at the beginning of the

subsequent semester, redo and submit the project report at the end of that semester and appear for the final examination, the CA mark earned afresh.

f. A student who has submitted the report on Project Work II, but could not appear for the semester end examination on the scheduled date, shall be deemed to have failed in the Project work II and awarded grade RA and will have to register for the same at the beginning of the subsequent semester, Redo and submit the project report at the end of that semester and appear for the final examinations, the CA mark earned afresh. The same shall be applicable also to candidates who fail in the Project work.

g. If a student is absent or has failed in an elective course, he/she may register for the same course as detailed in v (b) above or for any other elective in the subsequent semester by registering afresh.

h. A student who is not eligible to write the semester end examination in any course due to lack of attendance, will be awarded grade SA and the student has to register for that course again, when offered next, attend the classes and fulfill the attendance requirements as per section 5 supra. If the course, in which the student has lack of attendance, is a Professional Elective or an Open Elective, the student may register for the same or any other Professional Elective or Open Elective course respectively in the subsequent semesters.

i. A student after registering for a course may withdraw his / her registration between first & second CA Test on valid reasons.

j. Out of the required six Professional Electives to be studied, a student has to study a minimum of three Professional Electives from the list of Professional electives prescribed in their scheme of courses of study / those courses approved by the department committee with the Head of the Department as the Chairman (in case of credit transfer while undergoing programme in other Universities/Institutions as approved by the head of the Institution). The remaining three Professional electives can be studied either from the list of electives prescribed in the scheme of study of the department of the student/other departments or as online courses / special courses (vide clause 4.(v) supra) by obtaining equivalence or by studying required number of One / Two Credit Courses etc.

   If a student has studied more than six professional electives totally, three Professional Electives with highest grade among all Professional Electives prescribed in the scheme and the three courses with next highest grade among all remaining courses will be considered for calculation of CGPA; however the grades obtained in all other remaining courses will also appear in the grade sheet.

k. If a student has studied more than two open elective courses, then two open elective courses with higher grades alone will be considered for CGPA calculation. The grades obtained in other elective courses will also appear in the grade sheet.

l. If a student does not clear an one credit course it will be treated as a course ‘withdrawn’ by a student; One credit courses will be evaluated by the course instructor / department faculty concerned and will carry a total of 100 marks for continuous assessment; out of which 75 marks will be for final test to be scheduled by the course instructor / department faculty concerned.

m. A student who is absent in the semester end examination of a course after registering for the same will be considered to have appeared and failed in that examination and awarded grade RA.

vi) Reappearance Examinations:

For Reappearance Examinations/ Examinations in any course under REDO category, absolute grading will be followed irrespective of whether the grading was originally under Relative Grading System or Absolute Grading System

vii) **Scheme of Evaluation**

a. <u>Theory Courses with Tutorial Component (CA: 40% + FE: 60%)</u> Total: 100 Marks

CA Distribution:

(i)	Assignment Presentation	**10 Marks**
(ii)	Assessment Tutorial I	**05 Marks**
(iii)	Assessment Tutorial II	**05 Marks**
(iv)	Internal Tests (Average of 2 test):	**30 Marks**
	• Test I (conducted for 50 marks)	30 Marks
	• Test II (conducted for 50 marks)	30 Marks
	Total:	**50 Marks**

(50 Marks scaled down to 40 Marks)

Final Examination (FE) **100 Marks**

(100 Marks scaled down to 60 Marks)

Note:

1. a) Theory courses with tutorial component- Separate tutorial note books/files are to be maintained by the students for regular class room tutorials and two assessment tutorials have to be conducted and marks entered in e-assessment.

b) Assessment Tutorial I is of open book type, to be conducted as per schedule in the allotted halls.

c) Assessment Tutorial II is of surprise type. The 5 marks allotted must be the best out of a minimum of two surprise Tutorials to be conducted by the faculty concerned.

d) During tutorial sessions, if requested the students may be guided by faculty to solve problems.

2. Assignment Presentation for the first and final year students shall be conducted by the faculty concerned as per his/her own schedule. For others it shall be conducted by the faculty concerned as per the schedule prescribed in academic calendar.

b. <u>Theory Courses with no Tutorial Component (CA: 40% + FE: 60%)</u> Total: 100 Marks

CA Distribution:

(i)	Assignment Presentation	**10 Marks**
(ii)	Objective Tests I (Surprise type)	**05 Marks**
(iii)	Objective Tests II (Surprise type)	**05 Marks**
(iv)	Internal Tests (Average of 2 test):	**30 Marks**
	• Test I (conducted for 50 marks)	30 Marks
	• Test II (conducted for 50 marks)	30 Marks
	Total :	**50 Marks**

(50 Marks scaled down to 40 Marks)

Final Examination (FE) **100 Marks**

(100 Marks scaled down to 60 Marks)

Note:

1. Theory courses with no tutorial component- Objective Type Tests I and II- The 5 marks allotted for Objective Type Test I must be the best out of a minimum of two surprise tests to be conducted by the faculty concerned. A similar procedure is to be adopted for the award of the 5 marks allotted for the objective Type Test II.

2. Assignment Presentation for the first and final year students shall be conducted by the faculty concerned as per his/her own schedule. For others it shall be conducted by the faculty concerned as per the schedule prescribed in academic calendar.

c. Summer Term Courses (CA: 60% + FE: 40%)* **Total : 100 Marks**

- **CA Distribution**
  - (i) Presentation - I (At the middle of II week) — 25 Marks
  - (ii) Presentation - II (At the end of III week) — 25 Marks
- **Final Examination**
  - a) Report — 30 Marks
  - b) Viva voce — 20 Marks

d. Laboratory Courses (CA: 60% + FE: 40%)* **Total : 100 Marks**

- **CA Distribution:**
  - (i) I Cycle
    - Pre-laboratory Reports & Observations — 10 Marks
    - Individual Report — 15 Marks
  - (ii) II Cycle
    - Pre-laboratory Reports & Observations — 10 Marks
    - Individual Report — 15 Marks
- **Final Examination**
  - a) Lab examination — 30 Marks
  - b) Viva Voce** — 20 Marks

e. Industry Visit and Lecture / Industry Visit (CA : 100%) **Total: 100 Marks**

- **CA Distribution:**
  - (i) Presentation / Report — 80 Marks
    - Presentation I /Report I — 25 Marks
    - Viva Voce I — 15 Marks
    - Presentation II /Report II — 25 Marks
    - Viva Voce II — 15 Marks
  - (ii) Viva Voce** — 20 Marks

- Minimum of 2 Industry Visits, at least one shall be associated with PSG II / PSG Foundry Division
- Minimum of 2 Lectures by External Experts

f. Inplant Training (CA: 60% + FE: 40%)* **Total: 100 Marks**

- **CA Distribution:**

(i) Record / Report	50 Marks
(ii) Final Examination / Presentation	30 Marks
(iii) Viva Voce**	20 Marks

g. Industrial Training (CA: 60% + FE: 40%)* **Total: 100 Marks**

- **CA Distribution:**

(i) Test / Viva Voce	50 Marks
▪ Test I	10 Marks
▪ Viva Voce I	
▪ (based on daily observation)	15 Marks
▪ Test II	10 Marks
▪ Viva Voce II	
▪ (based on daily observation)	15 Marks
• **Final Examination**	50 Marks
▪ Final Examination / Mini Project	25 Marks
▪ Viva Voce#	25 Marks

h. Mini Project (CA: 60% + FE: 40%)* **Total: 100 Marks**

- **CA Distribution:**

(i) Presentation - I	20 Marks
(ii) Guide	10 Marks
▪ Committee	10 Marks
(iii) Presentation – II	30 Marks
▪ Guide	15 Marks
▪ Committee	15 Marks

- **Final Examination** 50 Marks

  Project Report Evaluation & Viva Voce

▪ Guide	25 Marks
▪ Committee	25 Marks

i.Project Work I (CA: 60% + FE: 40%)* **Total : 100 Marks**

- **CA Distribution:**

(i) Review - I	20 Marks
▪ Guide	10 Marks
▪ Committee$	10 Marks
(ii) Review – II	30 Marks
• Guide	15 Marks
▪ Committee$	15 Marks
(iii) **Final Examination**	
Project Report Evaluation & Viva Voce	50 Marks
▪ Guide	25 Marks
▪ Committee$	25 Marks

j. Project Work II (CA : 60% + FE : 40%)* **Total : 100 Marks**

- **CA Distribution:**
  - (i) Review - I — 20 Marks
    - Guide — 10 Marks
    - Committee$ — 10 Marks
  - (ii) Review - II — 30 Marks
    - Guide — 15 Marks
    - Committee$ — 15 Marks
- **Final Examination (FE)** — 50 Marks
  - External — 25 Marks
    - Thesis Evaluation — 10 Marks
    - Presentation & Viva Voce — 15 Marks
  - Internal — 25 Marks
    - Thesis Evaluation — 10 Marks
    - Presentation & Viva Voce — 15 Marks

k. Mandatory Course/AICTE Activity Point Programme (CA: 100%) **Total: 100 Marks**

(i) Assessment - I — 50 Marks

(ii) Assessment – II — 50 Marks

l. Soft Skills Development/Business and Managerial Communications / Quantitative and Reasoning Skills (CA: 100%) **Total: 100 Marks**

(i) Basic Test — 50 Marks
(ii) Advanced Test — 50 Marks

m. Online courses (CA: 40% + FE: 60%) **Total: 100 Marks**

CA Distribution:

For courses with one credit

(i) Internal Tests (to be conducted within the institute)
Test 1 (to be conducted at the end of the course) — 50 Marks

For courses with two/three credits

(i) Internal Tests (to be conducted within the institute)
(ii) Average of two tests — 50 Marks
Test I (conducted for 50 marks) — 50 marks
Test II (conducted for 50 marks) — 50 Marks

(50 Marks scaled down to 40 Marks)

Final Examination (FE)
(to be conducted within the institute) — 50 Marks

(50 Marks will be scaled up to 60 Marks)

n. Self Directed Learning Courses (CA: 40% + FE: 60%) **Total: 100 Marks**

CA Distribution:

(i) Internal Tests

Average of two tests	20 Marks
• Test I	20 Marks
• Test II	20 Marks

(ii) Three presentations scheduled periodically to check for evidence of learning, each carrying 10 marks — 30 Marks

(50 Marks scaled down to 40 Marks)

Final Examination (FE)

Final presentation	50 Marks
(i) Report	15 Marks
(ii) Viva voce examination	25 Marks
(iii) New inferences/interpretations	10 Marks

(50 Marks will be scaled up to 60 Marks)

o. Innovation Practices (CA: 60% + FE: 40%)* **Total: 100 Marks**

- **CA Distribution**

i) **Identification of Innovative idea / problem & justification (IPR status on this idea) 20 Marks**

- Presentation and Viva Voce I — 10 Marks
- Report — 10 Marks

ii) **Development of the idea & the resulting process / product / solution 30 Marks**

- Presentation and Viva Voce II — 15 Marks
- Report — 15 Marks

iii) **Final Examination 50 Marks**

- Final Presentation & Viva Voce — 30 Marks
- Report including preparation of IPR documents as prescribed by Indian Patent Office — 20 Marks

p. Tamil Courses (CA: 100%)

Continuous assessment test — 100 Marks

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* CA 50 marks scaled up to 60 marks, FE 50 marks scaled down to 40 marks

**- by external examiner

#- by internal & external examiner

$ - In respect of Project Work I & II carried out and reviewed in the departments, the review committee shall comprise of at least three senior faculty nominated by the HoD.

However, in respect of Project Work II carried out in industry, the committee nominated for the second review at industry includes one faculty deputed by the department and one mentor from respective industry.

9. QUALIFYING FOR THE AWARD OF DEGREE

A student shall be declared to have qualified for the award of the BE/BTech Degree provided

i) the student has successfully completed the course requirements and has passed all the prescribed courses of study of the respective programme listed in section13 within the duration specified in section 2 and

ii) no disciplinary action is pending against the student.

10. CLASSIFICATION OF DEGREE

Classification of a student while awarding the degree will not be affected if the student has to REDO courses which are Mandatory in nature (i.e. having no credit but whose completion is compulsory for the award of degree)

A) FIRST CLASS WITH DISTINCTION:

A student who satisfies the following conditions shall be declared to have passed the examination in First class with Distinction.

* Should have passed the semester end examination in all the courses of all the eight semesters (6 semesters in the case of lateral entry) in his/her First appearance within 5 years (four years in the case of lateral entry), which includes authorized break of study of one year. Withdrawal from examination (vide clause 11) will not be considered as an appearance.

* Should have secured a CGPA of not less than 8.50.

* One year authorized break of study (if availed of) is included in the five years (four years in the case of lateral entry) for award of First class with Distinction.

* Should not have been prevented from writing semester end examination due to lack of attendance in any of the courses.

B) FIRST CLASS:

A student who satisfies the following condition shall be declared to have passed the examination in First Class.

* Should have passed the examination in all the courses of all eight semesters (6 semesters in the case of Lateral Entry) within five years. (Four years in the case of Lateral Entry).

* One year authorized break of study (if availed of) or prevention from writing the End Semester examination due to lack of attendance (if applicable) is included in the duration of five years (Six years in case of Sandwich and four years in the case of lateral entry) for award of First class.

* Should have secured a CGPA of not less than 6.5.

C) SECOND CLASS:

All other students (not covered in clauses A and B) who qualify for the award of the degree shall be declared to have passed the examination in Second class.

D) RANK:

A student shall be eligible for award of ranking only if he/she has passed the examination in first class with distinction or first class in having passed all the courses in first attempt. Those who have availed the provision of break of study / withdrawal will not be eligible for rank.

E) B.E. / B.Tech. (Honours) specialization in the same discipline, B.E. / B.Tech. (Honours) and B.E. / B.Tech. minor in other specialization:

a. For BE/BTech Honours in the same discipline, the students should have earned additionally a minimum of 18 credits from a vertical of the same programme. He / She should have passed all the courses in the first attempt and should have earned a minimum of 8.50 CGPA for the award of degree in First class with distinction and 7.50 CGPA for the award of degree in First class

b. For B.E. / B.Tech. Honours the students should have earned additionally a minimum of 18 credits from more than one vertical of the same programme. He / She should have passed all the courses in the first attempt and should have earned a minimum of 8.50 CGPA for the award of degree in First class with distinction and 7.50 CGPA for the award of degree is First class

c. Student who have earned additional 18 credits but does not satisfy the conditions mentioned above shall not be awarded B.E./B.Tech. Honours. In such cases the grade sheet will show the additional courses studied and those courses shall not be considered for CGPA computation. Also, if the student becomes eligible for First Class, while computing CGPA without taking into account the additional courses studied, the student shall be awarded B.E. / B.Tech. in First Class only.

d. For BE/BTech minor in other specialization, the student should have earned additionally a minimum of 18 credits in any one of the verticals of other B.E./B.Tech programmes. He / She should have earned a minimum of 8.50 CGPA in the first attempt for the award of degree with First class with distinction and 6.50 CGPA for the award of degree with First class. If he / she is just qualified for the award of the degree he / she shall be declared to have passed the examination in Second Class.

11. WITHDRAWAL FROM EXAMINATION

i) A student may, for valid reasons, be granted permission to withdraw from appearing for the examination in any course or courses of only one semester if he/she does not have any history of reappearance courses at the time of request for withdrawal. Prior permission for withdrawal from semester examinations is to be obtained from Principal. Also, only one application for withdrawal is permitted for that semester examination in which withdrawal is sought. Withdrawal may be granted only once during one semester examination throughout the period of study what so ever the reasons may be.

ii) Withdrawal application shall be valid only if the student is otherwise eligible to write the examination and if it is made prior to the commencement of the examination in that course or courses and also recommended by the Head of the Department.

12. TEMPORARY BREAK OF STUDY FROM THE PROGRAMME

i) A student is not normally permitted to temporarily break the study. However, if a student intends to temporarily discontinue the programme in the middle for valid reasons (such as accident or hospitalization due to prolonged ill health) and to rejoin the programme in a later respective semester, he/she shall apply to the Principal through the Head of the Department and stating the reasons therefore.

ii) A student is permitted to rejoin the programme at the respective semester as and when it is offered after the break subject to the approval of Commissioner of Technical Education and Anna University, Chennai, and shall be governed by rules and regulations in force at the time of rejoining.

iii) The duration specified for passing all the courses for the purpose of classification (vide sections 10 supra) shall be increased by the period of such break of study permitted.

iv) The total period for completion of the programme reckoned from the commencement of the semester to which the student was first admitted shall not exceed the maximum period specified in section2 (ii) supra irrespective of the period of break of study in order that he/she may be qualified for the award of the degree.

v) If any student is detained for want of requisite attendance, progress and conduct, the period spent in that semester shall not be considered as permitted 'Break of Study' and section 12 (iii) supra is not applicable for such cases.

13. Courses of Study and Scheme of Assessment

BE ELECTRONICS AND COMMUNICTION ENGINEERING (2023 REGULATIONS)

(Minimum No. of credits to be earned: 166)

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
		Lecture	Tutorial	Practical		CA	FE	Total	
SEMESTER I									
THEORY									
23L101	Calculus and its Applications	3	1	0	4	40	60	100	BS
23L102	Electrical Engineering Materials	3	0	0	3	40	60	100	BS
23L103	Applied Chemistry	3	1	0	4	40	60	100	BS
23L104	Problem Solving and C Programming	3	2	0	5	40	60	100	ES
23G105	English Language Proficiency	3	1	0	4	40	60	100	HS
PRACTICALS									
23L110	Engineering Graphics	0	0	4	2	60	40	100	ES
23L111	Basic Science Laboratory	0	0	4	2	60	40	100	BS
MANDATORY COURSES									
23IP15	Induction Programme**	0	0	0	0	-	-	-	MC
	Total 28 hrs	**15**	**5**	**8**	**24**	**320**	**380**	**700**	

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
		Lecture	Tutorial	Practical		CA	FE	Total	
SEMESTER II									
THEORY									
23L201	Complex Variables and Transforms	3	1	0	4	40	60	100	BS
23L202	Sensors for Engineering Applications	3	1	0	4	40	60	100	BS
23L203	Electron Devices	3	1	0	4	40	60	100	ES
23L204	Circuit Theory	3	1	0	4	40	60	100	ES
23L205	Object Oriented Programming with Python	2	2	0	4	40	60	100	ES
PRACTICALS									
23G___	Language Elective	0	0	4	2	60	40	100	HS
23L211	Devices and Circuits Laboratory	0	0	4	2	60	40	100	ES
MANDATORY COURSES									
23L215	Activity Point Programme*	0	0	0	Grade	-	-	-	MC
23Q213	Foundations of Problem Solving	0	0	2	0	60	40	100	MC
	Total 30 hrs	**14**	**6**	**10**	**24**	**380**	**420**	**800**	

CAT - Category; BS - Basic Science; HS - Humanities and Social Sciences; ES - Engineering Sciences; PC - Professional Core; PE - Professional Elective; OE - Open Elective; EEC - Employability Enhancement Course; MC – Mandatory Course

****As per AICTE norms;**

*** As per AICTE norms; Grade: Completed / Not Completed, Not counted for CGPA**

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
		Lecture	Tutorial	Practical		CA	FE	Total	
SEMESTER III									
THEORY									
23L301	Matrix Theory and Numerical Methods	3	1	0	4	40	60	100	BS
23L302	Analog Electronics	3	0	0	3	40	60	100	PC
23L303	Digital Electronics	3	0	0	3	40	60	100	PC
23L304	Electromagnetic Fields and Waves	3	1	0	4	40	60	100	PC
23O305	Engineering Economics	3	1	0	4	40	60	100	HS
PRACTICALS									
23L310	Analog Electronics Laboratory	0	0	2	1	60	40	100	PC
23L311	Digital Electronics Laboratory	0	0	2	1	60	40	100	PC
23Q313	Building Communication Skills	0	0	2	1	60	40	100	EEC
MANDATORY COURSES									
23K312	Environmental Science	2	0	0	0	-	-	-	MC
23L315	Activity Point Programme*	-	-	-	Grade	-	-	-	MC
23TC01	Heritage of Tamils / **தமிழர் மரபு**	1	0	0	1	100	0	100	HS
	Total 27 hrs	**18**	**3**	**6**	**22**	**480**	**420**	**900**	

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
		Lecture	Tutorial	Practical		CA	FE	Total	
SEMESTER IV									
THEORY									
23L401	Probability and Random Processes	3	1	0	4	40	60	100	BS
23L402	Linear Integrated Circuits	3	0	0	3	40	60	100	PC
23L403	Signals and Systems	3	0	0	3	40	60	100	PC
23L404	Computer Architecture	3	2	0	5	40	60	100	PC
23L405	Data Structures and Algorithms	3	2	0	5	40	60	100	ES
PRACTICALS									
23L410	Linear Integrated Circuits Laboratory	0	0	2	1	60	40	100	PC
23L411	Signals and Systems Laboratory	0	0	2	1	60	40	100	PC
23Q413	Problem Solving	0	0	2	1	60	40	100	EEC
MANDATORY COURSES									
23O412	Indian Constitution	2	0	0	0	-	-	-	MC
23L415	Activity Point Programme*	-	-	-	Grade	-	-	-	MC
23TC02	Tamils and Technology / தமிழரும் தொழில்நுட்பமும்	1	0	0	1	100	0	100	HS
	Total 29 hrs	**18**	**5**	**6**	**24**	**480**	**420**	**900**	

CAT - Category; BS - Basic Science; HS - Humanities and Social Sciences; ES - Engineering Sciences; PC - Professional Core; PE - Professional Elective; OE - Open Elective; EEC - Employability Enhancement Course; MC – Mandatory Course
* As per AICTE norms; Grade: Completed / Not Completed, Not counted for CGPA

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
		Lecture	Tutorial	Practical		CA	FE	Total	
SEMESTER V									
THEORY									
23L501	Communication Engineering	3	0	0	3	40	60	100	PC
23L502	Embedded Systems	3	0	0	3	40	60	100	PC
23L503	Control Systems	3	1	0	4	40	60	100	PC
23L504	Computer Networks	3	2	0	5	40	60	100	PC
23L505	Antennas and Wave Propagation	3	1	0	4	40	60	100	PC
PRACTICALS									
23L510	Communication Engineering Laboratory	0	0	2	1	60	40	100	PC
23L511	Embedded Systems Design Laboratory	0	0	4	2	60	40	100	EEC
23Q513	Aptitude Skills	0	0	2	1	60	40	100	EEC
MANDATORY COURSES									
23L515	Activity Point Programme*	-	-	-	Grade	-	-	-	MC
	Total 27 hrs	**15**	**4**	**8**	**23**	**380**	**420**	**800**	

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
		Lecture	Tutorial	Practical		CA	FE	Total	
SEMESTER VI									
THEORY									
23L601	Digital Signal Processing	3	0	0	3	40	60	100	PC
23L602	Digital Communication	3	0	0	3	40	60	100	PC
23L603	VLSI Design	3	0	0	3	40	60	100	PC
23L___	Professional Elective I	3	0	0	3	40	60	100	PE
23L___	Open Elective I	3	0	0	3	40	60	100	OE
PRACTICALS									
23L610	Digital Signal Processing Laboratory	0	0	2	1	60	40	100	PC
23L611	VLSI Design Laboratory	0	0	4	2	60	40	100	EEC
23L620	Innovation Practices	0	0	2	1	60	40	100	EEC
23Q613	Enhancing Problem Solving Ability with Code	0	0	2	1	60	40	100	EEC
MANDATORY COURSES									
23L615	Activity Point Programme	-	-	-	Grade	-	-	-	MC
	Total 25 hrs	**15**	**0**	**10**	**20**	**440**	**460**	**900**	

CAT - Category; BS - Basic Science; HS - Humanities and Social Sciences; ES - Engineering Sciences; PC - Professional Core; PE - Professional Elective; OE - Open Elective; EEC - Employability Enhancement Course; MC – Mandatory Course
*** As per AICTE norms; Grade: Completed / Not Completed, Not counted for CGPA**

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
		Lecture	Tutorial	Practical		CA	FE	Total	
SEMESTER VII									
THEORY									
23L701	RF Passive and Active Circuits	3	0	0	3	40	60	100	PC
23L___	Professional Elective II	3	0	0	3	40	60	100	PE
23L___	Professional Elective III	3	0	0	3	40	60	100	PE
23L___	Professional Elective IV	3	0	0	3	40	60	100	PE
23LH_	Open Elective II	3	0	0	3	40	60	100	OE
PRACTICALS									
23L711	RF and Microwave Engineering Laboratory	0	0	2	1	60	40	100	PC
23L712	Digital Communication Engineering Laboratory	0	0	2	1	60	40	100	PC
23L720	Project Work I	0	0	4	2	60	40	100	EEC
	Total 23 hrs	**15**	**0**	**8**	**19**	**380**	**420**	**800**	

Course Code	Course Title	Hours / Week			Credits	Maximum Marks			CAT
		Lecture	Tutorial	Practical		CA	FE	Total	
SEMESTER VIII									
THEORY									
23L__	Professional Elective V	3	0	0	3	40	60	100	PE
23L__	Professional Elective VI	3	0	0	3	40	60	100	PE
PRACTICALS									
23L820	Project Work II	0	0	8	4	60	40	100	EEC
	Total 14 hrs	**6**	**0**	**8**	**10**	**140**	**160**	**300**	

CAT - Category; BS - Basic Science; HS - Humanities and Social Sciences; ES - Engineering Sciences; PC - Professional Core; PE - Professional Elective; OE - Open Elective; EEC - Employability Enhancement Course; MC – Mandatory Course

PROFESSIONAL ELECTIVES (Regular, PE I to PE VI)

23L001 FPGA Based System Design
23L002 Low Power VLSI Design
23L003 System on Chip Design
23L004 Multimedia Compression Techniques
23L005 Advanced Digital Signal Processing
23L006 Digital Signal Processing System Design
23L007 Digital Image Processing
23L008 Wireless Communication
23L009 Long Term Evolution Technologies
23L010 Vehicular Systems and Networks
23L011 Cryptography and Network Security
23L012 Satellite Communication
23L013 Wireless Sensor Networks
23L014 Radar Communication
23L015 EMC Test and Measurements
23L016 Computational Electromagnetics
23L017 Smart Antennas
23L018 Wireless Systems and Standards
23L019 RFID System Design and Testing
23L020 Digital Switching Systems
23L021 Pattern Recognition and Machine Learning
23L022 Computer and Machine Vision
23L023 Nano Electronics
23L024 Embedded Linux
23L025 Operating Systems
23L026 Advanced Computer Architecture
23L027 Real time systems
23L028 Advanced Embedded Systems
23L029 Relational Database Management Systems
23L030 Soft Computing Techniques
23L031 Deep Learning
23L032 Industrial Internet of Things and Industry 4.0

PROFESSIONAL ELECTIVE VERTICALS FOR HONORS

SEMICONDUCTOR CHIP DESIGN AND TESTING

23L051 Analog VLSI Circuits
23L052 Device Modeling
23L053 VLSI Physical Design
23L054 Testing and Testability of VLSI Circuits
23L055 Mixed Signal IC Design
23L056 Hardware Verification Techniques

SIGNAL PROCESSING

23L061 Speech Signal Processing
23L062 Wavelets and its Applications
23L063 Biomedical Signal Processing
23L064 Statistical Signal Processing
23L065 VLSI Signal Processing
23L066 Detection and Estimation

HIGH SPEED COMMUNICATION

23L071 Fiber Optic Communication
23L072 Digital Communication receivers
23L073 Wireless Networking
23L074 5G and 6G Wireless Technologies
23L075 Quantum Communication
23L076 Software Defined Networking
23L077 Radio Frequency Integrated Circuits
23L078 Modern Antenna Systems
23L079 RF Transceiver Design

LANGUAGE ELECTIVES

23G001 Communication Skills for Engineers
23G002 Basic German
23G003 Basic French
23G004 Basic Japanese

OPEN ELECTIVES

23LO01 Nano Technology and its applications
23LO02 Internet of things
23LO03 Virtual Reality
23LO04 Systems Engineering
23LO05 Universal Human Values 2: Understanding Harmony
23LO06 Artificial Intelligence and Machine Learning
23LO07 Measurements and Instrumentation

Summary of Credit Distribution

BE ELECTRONICS AND COMMUNICATION ENGINEERING										
S. No	**Course Category**	**Credit per Semester**								**Total Credits**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
1	HS	4	2	5	1	0	0	0	0	12
2	BS	13	8	4	4	0	0	0	0	29
3	ES	7	14	0	5	0	0	0	0	26
4	PC	0	0	12	13	20	10	5	0	60
5	PE	0	0	0	0	0	3	9	6	18
6	OE	0	0	0	0	0	3	3	0	6
7	EEC	0	0	1	1	3	4	2	4	15
8	MC	-	-	-	-	-	-	-	-	-
	Total	**24**	**24**	**22**	**24**	**23**	**20**	**19**	**10**	**166**

CAT - Category; BS - Basic Science; HS - Humanities and Social Sciences; ES - Engineering Sciences; PC - Professional Core; PE - Professional Elective; OE - Open Elective; EEC - Employability Enhancement Course; MC – Mandatory Course

SEMESTER I

23L101 CALCULUS AND ITS APPLICATIONS

3 1 0 4

DIFFERENTIAL CALCULUS: Functions of two variables, limits and continuity, partial derivatives, chain rule, extreme values and saddle points, Lagrange multipliers, Taylor's formula for two variables. (9+3)

INTEGRAL CALCULUS: Double and iterated integrals over rectangles, double integrals over general regions, Fubini's theorem, area and volume by double integration, reversing the order of integration, double integrals in polar form. (9+3)

FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS: Basic concepts, separable differential equations, exact differential equations, integrating factors, linear differential equations, modeling - mixing problems, Newton's law of cooling, decay and growth problems. (9+3)

SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS: Homogeneous linear equations of second order, homogeneous linear ODEs with constant coefficients, Euler–Cauchy equations, solution by variation of parameters, free oscillations mass spring systems, electric circuits. (9+3)

VECTOR CALCULUS: Gradient and directional derivative of a scalar field, divergence and curl of a vector field. Integration in vector field – line integrals, path independence of line integrals, Green's theorem in the plane, divergence theorem of Gauss and Stokes' theorem. (9+3)

Total L: 45 +T: 15 = 60

TEXT BOOKS

1. J. Hass, C. Heil, Maurice D.W "'Thomas' Calculus", Pearson Education, New Delhi, 2018.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India, New Delhi, 2018.

REFERENCES

1. H. Anton, I. Bivens, S. Davis, "Calculus", John Wiley and Sons, USA, 2016.
2. Wylie C. R and Barrett L. C, "Advanced Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2019.
3. Michael D. G, "Foundations of Applied Mathematics", Dover Publications, INC, New York, 2013.
4. Gilbert Strang, "Calculus", Wellesley Cambridge Press, USA, 2017.

23L102 ELECTRICAL ENGINEERING MATERIALS

3 0 0 3

ELECTROMAGNETISM: Review of definitions of fundamental terms. Permeability. Forces due to currents. Uniform and non-uniform magnetic fields. Static and time-varying magnetic fields. Electromagnetic induction. Expression for induced emf. Electric fields definition of fundamental terms. Dielectric constant, Permittivity. Dielectric displacement. Gauss theorem. Electromagnetic waves. Propagation of electromagnetic waves through isotropic media. Maxwell's equations and interpretation of Maxwell's equations. (9)

QUANTUM MECHANICS: Wave particle duality, de Broglie waves- Heisenberg's uncertainty principle. Wave function-normalization. The wave equation. Schrodinger's equation of motion: Time dependent form, steady-state form. Particle in a box. Quantum Tunneling and applications: Zener diode and Tunnel diode. (9)

ELECTRICAL PROPERTIES: Conducting materials-quantum free electron theory -Fermi Dirac Statistics-Band theory of solids-the density of states. Dielectrics-types of polarization-measurement of dielectric permittivity-Loss Factor-Dielectric loss mechanisms. (9)

PHYSICS OF SEMICONDUCTORS: P type and N type semiconductors-the effective mass. Electrical conductivity in P type and N type semiconductors. P-N junction, rectifier equation. Hall effect and its applications. Hetero junction-Quantum well, wire, dots- Optical properties of Semiconductors: LD, LED, Photo diode. Introduction to MEMS (9)

MAGNETIC PROPERTIES: Types of magnetic materials-domain theory-hysteresis- hard and soft magnetic materials-Applications-eddy current brakes, regenerative braking. Magnetic lenses, Magnetostriction. Superconductivity –Meissner's effect- Josephson junction, SQUID magnetometer, applications. (9)

Total L: 45

TEXTBOOKS:

1. William D CallisterJr, "Materials Science and Engineering-An Introduction", John Wiley and Sons Inc., 10th Edition, NewYork, 2018.
2. Arthur Beiser, "Concepts of Modern Physics" Tata McgrawHill,India , 7th Edition, 2017

REFERENCES:

1. Richard Wolfson, "Essential University Physics".,Vols 1 and 2. Pearson Education, Singapore, 2021
2. Rolf E. Hummel, Electronic Properties of Materials, Springer, 4th Edition, 2013

3. Van Vlack, “Elements of Material Science and Engineering”, Pearson Education India, 2008.
4. Sze S.M, Physics of Semiconductor Devices, John Wiley and Sons,USA, 4th Edition, 2021.

23L103 APPLIED CHEMISTRY

3 1 0 4

ELECTRONIC MATERIALS: Inorganic semiconductors – Elemental – Si and Ge - band theory, doping, compound semiconductors – band gap engineering – applications. Organic semiconductors – conjugated polymers – mechanism of charge transport, doping, states of aggregation, material properties – thermal, mechanical, electrical, chemical, electrochemical. Applications – OLED, OPV – working principle. Liquid crystalline materials – display application. (9+3)

PROCESSES IN ELECTRONICS MANUFACTURE: Microchip fabrication – overview, photoresists – chemistry, types. Fabrication facilities – clean rooms - maintenance, ultrapure water– specification, production processes – ion exchange, reverse osmosis, continuous electrodeionisation. PCB fabrication – electroless and electroplating of copper – principle, bath chemistries and process parameters, formation of copper track on plastic board. (9+3)

ELECTRONICS PACKAGING AND PROTECTION: Packaging materials-encapsulants and underfills - adhesives – chemical types, application methods, factors influencing adhesion, soldering alloys – phase diagrams, lead free alloys, phase change materials for cooling. Conducting inks for printed electronics - metal and carbon based – graphene, CNT– synthesis, structure, electrical properties. Corrosion in electronics – types, protection – vapour phase inhibitors. (9+3)

ELECTROCHEMICAL POWER SOURCES: Electrochemical cells – emf, electrode potential, dependence of emf on electrolyte concentration – Nernst equation. Batteries**–**performance characteristics. Materials, construction, reactions, characteristics of lechlanche cell, primary lithium batteries, lead - acid battery and lithium-ion batteries. Supercapacitors – EDLC – fundamentals, electrode materials, electrolytes, pseudocapacitors– materials. (9+3)

CHEMICAL SENSORS: Sensors – basic components. Electrochemical sensors- potentiometric transducers – principle, ion-selective electrodes – configurations, response functions and selectivity, applications –potentiometric titrations, water quality monitoring - pH, Hardness, fluoride ion sensors Amperometric transducers – principle, application - glucose biosensors, conductivity sensors – principle – application in conductometric titrations. Colorimetric sensors - Beer-Lambert’s law, components, application - determination of ferric ion in water sample. Chemiresistive sensors - principle, application – environmental monitoring – CO_2 sensor. Microelectrodes for sensors – fabrication. (9+3)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Shashi Chawla, “A Textbook of Engineering Chemistry”, 1st Edition, New Delhi: Dhanpat Rai and Co. , 2005.
2. Cowie J.M.G, Valeria Arrighi "Polymers: Chemistry and Physics of modern materials", CRC Press, 2007.

REFERENCES:

1. Bansi D. Malhotra "Handbook of Polymers in Electronics", Rapra Technology Ltd., 2002.
2. Peter Van Zant "Microchip Fabrication: A Practical Guide to Semiconductor Processing", Mc Graw Hill, 2014.
3. Derek Pletcher and Frank C. Walsh. “Industrial Electrochemistry”, Chapman and Hall , 1993.
4. Florinel-Gabriel Banica, “Chemical Sensors and Biosensors – Fundamentals and Applications”, John Wiley & Sons Ltd, 2012.

23L104 PROBLEM SOLVING AND C PROGRAMMING

3 2 0 5

INTRODUCTION TO PROBLEM SOLVING: Analyzing and Defining the Problem - Algorithm - Flow Chart – Program development steps -Types of programming language. **C:** The C character set - Identifiers and keywords - Data types – Constants - Variables - Declarations -input and output functions-preprocessor directives. (6+3)

OPERATORS AND EXPRESSIONS: Arithmetic operators - Unary operators - Relational operators - logical operators - Assignment operators - Conditional operators- bitwise operators - comma operator - sizeof operator -precedence and associativity- Library functions. **CONTROL STATEMENTS**:simple if, if..else, nested if .. else ,elseifladder , switch case - while - do while - for - nested loops - break – continue – goto statements. (12+9)

ARRAYS: Defining an array - Processing an array - Multi dimensional arrays–strings-string operations. (10+6)

FUNCTIONS: Function prototype - Defining a function – function call - Passing arguments to a function –nested function – recursive function- Storage classes - auto - static - extern and register variables. (7+4)

STRUCTURES: Definitions - Processing a structure – Array and structures – Nested structures - Structures and functions. Pointers: Definition - Pointer Arithmetic – types of pointer - const pointer, pointer to a constant, void pointer, null pointer. (10+8)

Total L+T: 45+30: 75

TEXT BOOKS:

1. Paul Deitel and Harvey Deitel, “C How to Program: With an Introduction to C++”, Eighth edition, Pearson Education, 2018.

2. Ajay Mittal, ”Programming in C - A Practical approach”.Pearson,New Delhi, 2010

REFERENCES:

1. Gottfried B., “Programming with C”, McGraw Hill Education, New Delhi, 2018.
2. Herbert Schildt, “C: The Complete Reference”, McGraw Hill, New Delhi, 2017.
3. Kernighan B. W. and Ritchie D. M., “C Programming Language (ANSI C)”, Prentice Hall of India, New Delhi, 2013.

23G105 ENGLISH LANGUAGE PROFICIENCY

3 1 0 4

VOCABULARY: Etymology-Prefixes and suffixes–Synonyms–Antonyms–Guessing meanings from context–Word formation-Single-word substitutes- Different forms of a word–Phrasal verbs–Collocations. (9+3)

LISTENING AND SPEAKING: Understanding listening – Listening techniques - Introducing oneself and others –Seeking and sharing information– Description-Conversation skills– Extempore speaking– Speech practice in varied formal contexts. (9+3)

GRAMMAR: Wh-questions – Yes/no questions– Parts of speech – Articles– Prepositions–Gerunds–Conjunctions-Degrees of comparison– Tenses– Modal verbs – Adverbs - Direct and indirect questions. (9+3)

READING: Reading strategies: Skimming and scanning, Predicting– Reading comprehension: techniques –Practice reading. (9+3)

WRITING: Discourse markers – Dialogue writing - Completing sentences – Jumbled sentences – Paragraph writing –Writing compare & contrast paragraphs – Letter writing. (9+3)

Total: 45 +15 = 60

TEXTBOOKS:

1. Shoba K.N.and Lourdes Joavani Rayen, Communicative English, Cambridge University press, Cambridge, 2021.
2. Raymond Murphy, Intermediate English Grammar, Cambridge University Press, New Delhi, 2020.

REFERENCES:

1. Raymond Murphy, English Grammar in Use, Cambridge University Press, New Delhi, 2020.
2. Sudharshana N P and Savitha C, English for Engineers, Cambridge University Press, New York, 2018.
3. Anne Laws, Writing Skills, Orient Black Swan, Hyderabad, 2011.
4. Helen Naylor with Raymond Murphy, Essential English Grammar, Cambridge University Press, New Delhi, 2019.

23L110 ENGINEERING GRAPHICS

0 0 4 2

INTRODUCTION: (14)
1) Lettering practice
2) Dimensioning practice as per BIS conventions
3) Types of projection and concepts of orthographic projection

ORTHOGRAPHIC PROJECTION: (18)
1) Projection of points and lines
2) Projection of planes
3) Projection of solids

SECTIONS AND DEVELOPMENT: (14)
1) Sectional views of regular solids
2) Development of lateral surfaces of regular solids
3) Projection of truncated solids and simple engineering sheet metal components

PICTORIAL PROJECTIONS: (14)
1) Isometric view of simple engineering components
2) Conversion of isometric views to orthographic views
3) Perspective projection methods

Total P: 60

REFERENCES:

1. Venugopal K, Prabhu Raja V "Engineering Graphics", New Age International Publishers, 16th edition, 2021.
2. John K.C "Engineering Graphics for Degree", PHI Learning Private Limited, 2009.
3. Bureau of Indian Standards "Engineering Drawing Practices for Schools and Colleges SP 46-2003", BIS, 2003.
4. Shaw M.B, Rana B.C "Engineering Drawing", Pearson Education India, 2009.

23L111 BASIC SCIENCE LABORATORY

0 0 4 2

List of Experiments:

1. Determination of thermal conductivity of bad conductor using Lee's Disc method
2. Determination of fibre thickness – air wedge method
3. Determination of wavelength of mercury spectrum using transmission grating
4. Measurement of vibration frequency of electrically maintained tuning fork using Melde's apparatus
5. Determination of velocity of sound – Helmholtz resonator
6. Determination of Hysteresis loss of a ferromagnetic material
7. Study of reverse bias characteristics of Germanium diode and determination of its band gap
8. Thermistor: Measurement of temperature and band gap
9. Find the finesse and free spectral region of the Etalon.
10. Determine the charge of an electron by Millikan's oil drop method.

Demonstration:

1. Determine the excitation potential of Argon using the Franck Hertz method.
2. Determine the number of turns & radius of the coil and magnetic field of 'Helmholtz' coil using Biot-Savart's Law – apparatus
3. Find the Hall voltage, Hall coefficient, mobility & charge density of the given 'Ge' crystal using Hall apparatus.
4. Determine e/m (charge to mass ratio) of the electron by Thomson's method.
5. Determine the Planck's constant using Photo Electric method.
6. Determine the wavelength of the laser source by Michelson Interferometer.
7. Determine the thickness of the film by Mach Zehnder Interferometer.
8. Analyze the mercury spectrum and find wavelength using polynomial equation.
9. Determine the refractive index of given specimen using Brewster's angle apparatus.

Total P : 30

REFERENCES:

1. Department of Physics," Physics laboratory observation", 2022.
2. Jerry D Wilson; Cecilia A Hernandez Hall, "Physics laboratory experiments", Boston, MA : Cengage Learning, 2016.

CHEMISTRY (Any eight experiments)

1. Determination of total hardness of water by EDTA method.
2. Demineralisation of water using ion-exchange resins and determination of water quality - pH, TDS and conductivity.
3. Electroplating of copper and Nickel and determination of cathode efficiency of electroplating.
4. Construction of phase diagram for a simple eutectic system.
5. Demonstration of different forms of metallic corrosion using ferroxyl indicator test and determination of rate of galvanic corrosion using zero-resistance ammeter.
6. Designing a battery and determination of its characteristics.
7. Potentiometric estimation of ferrous iron.
8. Preparation of a chloride ion sensor and ascertaining Nernstian response by construction of calibration curve.
9. Conductometric estimation of a mixture of strong and weak acids.
10. Photocolorimetric estimation of Ferric ion in a water sample.

Total P : 30

REFERENCE:

1. Laboratory Manual Prepared by the Department.

23IP15 INDUCTION PROGRAMME

0 0 0 0

AS PER AICTE GUIDELINES

SEMESTER II

23L201 COMPLEX VARIABLES AND TRANSFORMS

3 1 0 4

COMPLEX DIFFERENTIATION: Derivative, analytic function, Cauchy-Riemann equations, Laplace's equation, linear fractional transformations. (9+3)

COMPLEX INTEGRATION: Cauchy's integral theorem, Cauchy's integral formula, derivatives of analytic functions, Laurent series, singularities and zeros, residue integration method (Residue integration of complex integrals only). (9+3)

LAPLACE TRANSFORMS: Laplace transform, linearity, first shifting theorem, transforms of derivatives and integrals, unit step function, second shifting theorem, Dirac's delta function, periodic functions, differentiation and integration of transforms, solving ODEs with constant coefficients and initial value problems. (9+3)

FOURIER ANALYSIS: Fourier series – arbitrary period, even and odd functions, half range expansions. Fourier transforms, Fourier cosine and sine transforms. (9+3)

PARTIAL DIFFERENTIAL EQUATIONS: Basic concepts of PDEs, wave equation, heat equation, steady state two-dimensional heat problems, solution by Fourier series. (9+3)

Total L: 45 + T:15 = 60

TEXT BOOKS

1. Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley India, New Delhi, 2018.
2. Dennis G. Z, "Advanced Engineering Mathematics", Jones and Bartlett Pvt Ltd, New Delhi, 2017.

REFERENCES

1. Dennis G. Z and Patrick D. S, "A first course in Complex Analysis with applications", Jones and Bartlett Pvt Ltd, New Delhi, 2015.
2. Wylie C. R and Barret L. C, "Advanced Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2019.
3. Peter V.O Neil, "Advanced Engineering Mathematics", Cengage, New Delhi, 2018.
4. Dean G. D, "Advanced Engineering Mathematics with MATLAB", CRC Press, USA, 2017.

23L202 SENSORS FOR ENGINEERING APPLICATIONS

3 1 0 4

STRAIN AND PRESSURE MEASUREMENT: Resistance strain gauge, piezoelectric pressure sensor, characteristics. Electronic circuits for strain gauge, load cells. Interferometer, Fibre-optic pressure sensor. capacitance pressure sensor. (9+3)

ELECTRONIC SENSORS: Inductive,capacitive and ultrasonic based proximity sensors Reed switch, Hall-effect switching sensors, capacitive based humidity sensor, liquid level detectors, flow sensors, smoke sensors. (9+3)

MOTION SENSORS: Capacitor plate sensor, Inductive sensors, LVDT Accelerometer systems, rotation sensors, piezoelectric devices for motion sensing, Hall effect-based speed sensor. (9+3)

LIGHT SENSORS: Color temperature, light flux, photo sensors, photo resistor and photoconductors, photodiodes, phototransistors, photovoltaic devices, fiber-optic sensors and their applications. LIDAR working principle and automotive applications. (9+3)

THERMAL SENSORS: Bimetallic strip, semiconductor based temperature sensor, thermocouples, Resistance thermometers, thermistors, PTC and NTC thermistors and their applications. Infrared sensors: bolometer, Pyroelectric detector, photodiodes and phototransistor. (9+3)

Total L: 45 + T:15 = 60

TEXTBOOKS:

1. Ian R Sinclair, Sensors and Transducers, Third Edition, Newnes publishers, 2011.
2. Krzysztof Iniewski, Smart sensors for industrial applications, CRC Press Taylor and Francis, 2019.

.

REFERENCES:

1. Doebelin E O, Measurement Systems, Application and Design, McGraw Hill, seventh Edition, 2019
2. Jack P Holman, —Experimental Methods for Engineers, Eighth Edition, McGraw Hill, USA, 2011.
3. Jacob Fraden, Handbook of modern sensors: Physics,design,and applications, Springer, 5th Edition, 2016.

23L203 ELECTRON DEVICES

3 1 0 4

SEMICONDUCTOR PHYSICS: Energy bands in intrinsic and extrinsic semiconductors, equilibrium carrier concentration, direct and indirect band-gap semiconductors. Carrier transport: diffusion current, drift current, mobility and resistivity, Poisson and continuity equations, generation and recombination of carriers. (6+3)

SEMICONDUCTOR DIODE: Theory of PN Junction Diode and Zener diode – Characteristics, Temperature dependence- Break down mechanisms- Diode Resistance- Diode Capacitance- Diode Models- Rectifiers- Clipper- Clamper- Voltage regulator- Tunnel Diode, Varactor Diodes. (10+3)

BIPOLAR JUNCTION TRANSISTOR : Transistor types - Transistor Action - Current Components –Configurations - Transistor as a Switch and Amplifier - Small Signal Low Frequency Hybrid and π Model - Ebers Moll Model - DC and AC Load Lines - Operating Point - Bias stability, Bias Methods, Bias Compensation. (9+3)

FIELD EFFECT TRANSISTORS:JFET – Operation and Characteristics, MOSFET: Physical Operation,Current—Voltage Characteristics, Threshold voltage equations – MOS device equations, MOSFET as an Amplifier and Switch, MOS Capacitor ,Small-Signal Operation and Models , MOSFET Configurations and Biasing- Second order effects. (10+4)

SPECIAL SEMICONDUCTOR DEVICES : Thyristor Family, UJT- Operation, Characteristics and Applications - Opto Electronic Devices and applications- Laser diode - Photo diodes - Photo Transistors - Light emitters – Organic LED – Liquid Crystal Displays – FINFETs, MESFETs, HEMT. (10+2)

Total: L: 45 + T: 15 = 60

TEXT BOOKS:

1. MillmanJ., Halkias C. C., Satyabrata J, "Electronic Devices and Circuits", Mcgraw Hill Education (I) P Ltd, Chennai 2019.
2. Floyd T. L, "Electronic Devices and Circuits",Pearson, Chennai, 2021.

REFERENCES:

1. Boylestad, R. L. and Nashelsky, L., "Electronic Devices and Circuit Theory", Pearson, Chennai, 2021.
2. David A.Bell , "Electronic Devices and Circuits", Oxford University Press , New Delhi, 2021.
3. Sedra and Smith, "Microelectronic Circuits", Seventh Edition, Oxford University Press, New Delhi, 2022.
4. Neil.H.E.Weste, Kamran Eshranghian , "Principles of CMOS VLSI Design- A system perspective", Pearson, Noida, 2017.

23L204 CIRCUIT THEORY

3 1 0 4

DC CIRCUIT ANALYSIS: Charge and Current, Voltage, Power and Energy, Network Elements - Current and Voltage sources. Ohm's Law - Resistive circuits - Series and Parallel reduction method and analysis. Voltage and Current division. Source Transformation. Wye-Delta transformation. AC circuit analysis: Average and RMS values - Phasor representation of variables - Power triangle and average power - Resonance, Magnetically coupled circuits. (10+3)

NETWORKS THEOREMS: Kirchoff"s Laws -Source Transformation - Duality - Mesh and Nodal analysis- Superposition, Thevenin's and Norton's, Maximum power transfer, Reciprocity theorem, Tellegen"s theorem. (8+3)

TIME DOMAIN ANALYSIS: Source free RL and RC circuits, Transient Response of RL and RC circuits for DC excitation and Sinusoidal excitation. Frequency Domain Analysis: Transient Response of RL, RC, RLC circuits for DC and Sinusoidal excitation using Laplace transform. (9+4)

ANALYSIS OF TWO PORT NETWORK: Network functions of single-port network, Driving point and transfer function of Two-port networks, Poles and Zeros of network functionsNetwork parameters-Impedance, admittance, transmission and hybrid, Conversion formulae. Properties – reciprocity and symmetry - Equivalents of T, Π, Ladder, bridged T and Lattice networks. (10+3)

FILTERS AND ATTENUATORS: Passive Filters - Low Pass, High Pass, Band Pass and Band Stop filters – Constant K and m-derived filter – Attenuators – T type, Π type, Lattice Attenuator. (8+2)

Total L+T: 45+15: 60

TEXT BOOKS:

1. Singh, Ravish R, "Network Analysis and Synthesis", McGraw-Hill Education, New Delhi, 2019.
2. Alexander C. and Sadiku M. N. O., "Fundamentals of Electric Circuits ", Tata McGraw Hill, New Delhi, 2020.

REFERENCES:

1. Sudhakar A. and Shyammohan S. Pillai, "Circuits and Networks Analysis and Synthesis", McGraw Hill, New Delhi, 2020.
2. AbhijitChakrabarthy, "Circuit Theory Analysis & Synthesis", DhanpathRai& Sons, New Delhi, 2019.
3. Nahvi M. and Edminister J. A., "Theory and Problems Electric circuits", Tata McGraw Hill, New Delhi, 2017.

23L205 OBJECT ORIENTED PROGRAMMING WITH PYTHON

2 2 0 4

BASICS : Python - Variables – Executing Python from the Command Line - Editing Python Files - Python Reserved Words - Comments – Simple Input and Output—Indenting. Data types: Numeric, Boolean Data Types. Conditional Statements: if Statements – Loops: while Loop – break and continue – for Loop -String data type –methods. (6+6)

COLLECTIONS: Lists, Tuples - Sets – frozen sets-Mapping types: Dictionaries-Standard Modules: math- sys-time – dir Function. (6+6)

FUNCTIONS: Definition – Passing parameters to a Function - recursive functions –Scope – Passing Functions to a Function – Lambda functions- Modules: Creating modules. Introduction to numpy –matplotlib. (6+6)

FILE ORGANIZATION- Access Modes : Writing data to a File –Reading data From a file – seek –tell- Error Handling: Run Time Errors – Exception Model - Exception Hierarchy - Handling Multiple Exceptions – raise exceptions. (6+6)

OBJECT ORIENTED FEATURES: Principles of Object Orientation – Creating Classes, objects – Instance Methods –Special Methods – Class Variables – Inheritance – Polymorphism – Type Identification. (6+6)

Total L+T: 30+30: 60

TEXTBOOKS:

1. Mark Summerfield. "Programming in Python 3: A Complete introduction to the Python Language", Addison-Wesley Professional, 2009.
2. Reema Thareja ,"Python Programming : Using Problem Solving Approach", Oxford university Press 2017

REFERENCES:

1. Wesley J Chun, "Core Python Applications Programming", Prentice Hall, 2012.
2. Allen B Downey, "Think Python", O'Reilly, 2012.
3. Martin C. Brown, "PYTHON: The Complete Reference", McGraw-Hill, 2018.

23G___ LANGUAGE ELECTIVE

0 0 4 2

23L211 DEVICES AND CIRCUITS LABORATORY

0 0 4 2

Hardware Experiments (40)

1. Verification of Kirchhoff's Voltage and Current laws
2. Verification of Thevenin's theorem and Maximum Power Transfer Theorem
3. PN Junction Diodes and Rectifier circuits
4. Wave shaping circuits: Clippers and clampers
5. Zener Voltage Regulator
6. Evaluation of BJT Hybrid parameters
7. BJT Biasing Techniques
8. MOSFET Characteristics and its application as a switch

Software Experiments (20)

1. Verification of theorems – Superposition, Reciprocity
2. BJT and FET Characteristics
3. Characteristics of Thyristor Family Devices

AUGMENTED EXPERIMENTS*

1. Application circuits based on BJT.
2. Application circuits based on FET.
3. Application based on optoelectronic devices.
4. Design of Relaxation oscillator using UJT.

Total P: 60

REFERENCES:

1. ECE Department "Laboratory Manual"2019

* Augmented experiments will be evaluated at the end of the semester.

23Q213 FOUNDATIONS OF PROBLEM SOLVING

0 0 2 0

PROBLEM SOLVING:

1.Speed Mathematics (SAW, Oz, Mirror methods)
2. Speed Mathematics (High5, Minion, Butterfly methods)
3. Speed Mathematics (Inception, Goldeneye methods)
4. Thinking with Numbers
5. Problem Solving with Visual information
6. Words Puzzles
7. Resume Writing Essentials

Total P: 30

REFERENCES:

1. R.S. Aggarwal, "Quantitative Aptitude for Competitive Examination", S Chand Publishing, New Delhi, 2017.

SEMESTER III

23L301 MATRIX THEORY AND NUMERICAL METHODS

3 1 0 4

EIGENVALUES AND EIGENVECTORS: Eigenvalues and eigenvectors of a real matrix – characteristic equation, properties - diagonalization - quadratic forms, reduction to canonical form by orthogonal reduction - Errors and approximations in numerical methods, power method for dominant eigenvalue. (10 + 3)

LINEAR ALGEBRIAC SYSTEM OF EQUATIONS AND NONLINEAR EQUATIONS: System of linear equations – Gauss elimination method, Crouts method, Gauss Seidal iterative method, Roots of equations - false-position method, Newton-Raphson method, Graeffe's root squaring method. (8 + 3)

INTERPOLATION, DIFFERENTIATION AND INTEGRATION: Newton's forward and backward interpolating polynomials, Lagrange and Newton's divided difference interpolating polynomials. Numerical differentiation, numerical integration - Newton-Cotes formulae, Trapezoidal rule, Simpson's 1/3 rule. (12 + 4)

ORDINARY DIFFERENTIAL EQUATIONS: Taylor-series method, Euler method, 4th order Runge-Kutta method, multi-step method – Milne's method. (6 + 2)

PARTIAL DIFFERENTIAL EQUATIONS: Finite difference: elliptic equations – Laplace equation, Poisson equation – Liebmann method, parabolic equations – heat conduction equation – Crank Nicolson's method, hyperbolic equations – vibrating string. (9 + 3)

Total L: 45 + T: 15 = 60

TEXT BOOKS:
1. David C Lay, Judi J McDonald, Steven R Lay "Linear Algebra and its Applications", Pearson Education, New Delhi, 2021.
2. Steven C Chapra and Raymond P Canale, "Numerical Methods for Engineers", Tata McGraw Hill, New Delhi, 2021.

REFERENCES:
1. Curtis F Gerald and Patrick O Wheatly, "Applied Numerical Analysis", Pearson Education, New Delhi, 2017.
2. Rizwan B, "Introduction to Numerical Analysis Using MATLAB", Infinity Science Press, Hingham, 2010.
3. Richard L. B and Douglas J. F, "Numerical Analysis", Thomas Learning, NewYork, 2017.
4. Howard Anton, Chris Rorres, Anton Haul "Elementary Linear Algebra", Wiley India, New Delhi, 2019.

23L302 ANALOG ELECTRONICS

3 0 0 3

POWER SUPPLIES : Half wave and Full wave Rectifiers - Calculation of Ripple factor, Regulation, Rectification efficiency and TUF - Filters - L, C , L-Section and Pi - Voltage Regulators - Series and Shunt - Current limiting and protection circuits. (9)

SINGLE STAGE AMPLIFIERS AND TUNED AMPLIFIERS: BJT and MOSFET amplifiers - calculation of input and output impedance, voltage gain – Low and High Frequency Response of BJT and MOSFET Amplifier - Analysis of single tuned amplifiers. (9)

DIFFERENTIAL AMPLIFIERS : BJT and MOSFET Current Mirrors- Simple, Widlar, Wilson - Differential amplifier- Differential and common mode gain - CMRR - Circuits for improving CMRR using active load - Cascode and Darlington amplifiers. (9)

POWER AMPLIFIERS AND FEEDBACK AMPLIFIERS: Classification of Power Amplifiers-Class A/B/AB/C/D - Single ended and Push-pull configuration - Feedback Concepts - Effect of negative feedback on voltage and current feedback amplifier circuits. (9)

OSCILLATORS AND MULTIVIBRATORS : RC and RL integrator and differentiator circuits- Barkhausen criteria - Sinusoidal oscillators - RC, LC and Quartz – Frequency stability of oscillators - Non-sinusoidal oscillators - Multivibrators - Bistable, Monostable and Astable -Schmitt Trigger. (9)

Total: L: 45

TEXT BOOKS:
1. Jacob Millman, Christos C Halkias, SatyabrataJit , "Electronic Devices and Circuits", Fourth Edition, McGraw Hill Education,2015.
2. Sedra and Smith , "Micro electronic Circuits", Seventh Edition, Oxford University Press, NY,USA, 2017.

REFERENCES:
1. MillmanJ ,Taub H. , "Pulse, Digital and Switching waveforms", Third, McGraw Hill International, 2011.
2. Donald L Schilling , Charles Belove , "Electronic Circuits", 3rd Edition, Tata McGraw-Hill, 2002.
3. Allen Mottershed , "Electronic Devices and Circuits", Prentice Hall of India, 2009.
4. David A Bell, "Electronic Devices and Circuits", Prentice Hall of India, New Delhi, 2008.

23L303 DIGITAL ELECTRONICS

3 0 0 3

NUMBER SYSTEMS AND BOOLEAN ALGEBRA : Number systems - Arithmetic operations-computer codes – Boolean algebra – basic postulates and theorems - canonical forms- Standard representation of logic functions- K-maps and Quine McClusky method- Introduction to Verilog. (9)

COMBINATIONAL LOGIC DESIGN : Binary / BCD adders, Subtractors, encoders, decoders, multiplexers and demultiplexers - Carry look ahead adder – Multiplier - magnitude comparator – ALU - Verilog implementation of Combinational logic circuits. (9)

SYNCHRONOUS SEQUENTIAL CIRCUITS : Flip-flops- latches - Shift registers- Design and analysis of clocked sequential circuits- synchronous counters- Sequence detector - state reduction techniques- Verilog implementation of Synchronous Sequential circuits. (9)

ASYNCHRONOUS SEQUENTIAL CIRCUITS : Fundamental and pulse mode circuits-Binary / BCD Ripple counter – Races - Hazards. Verilog implementation of Asynchronous sequential circuits. (8)

PROGRAMMABLE LOGIC DEVICES AND LOGIC FAMILIES: Classification of memories, Read/write operations- Memory decoding and expansion, Static and Dynamic RAM- PLDs- Architecture and implementation - Digital logic families - Characteristics - TTL, ECL and CMOS logic – Applications of PLDs. (10)

Total: L: 45

TEXT BOOKS:

1. Morris Mano, and M.D. Ciletti , "Digital Design: with an introduction to Verilog HDL, VHDL and system verilog", 6th Edition, Pearson, New Delhi, 2018.
2. Joseph Cavanagh , "Digital Design and Verilog HDL Fundamentals", CRC Press, 2017.

REFERENCES:

1. Charles Roth, Lizykurian john , "Digital Systems Design using Verilog", 1st Edition, cengage India private limited, 2016.
2. Floyd T L , "Digital Fundamentals", 11th Edition, Pearson education, New Delhi, 2017.
3. AAnandkumar , "Fundamentals of Digital circuits", 4th Edition, Prentice Hall of India, New Delhi, 2016.
4. B.SSonde, "Introduction to System Design using Integrated circuits", New Age international Publishers, Second edition,1992.

23L304 ELECTROMAGNETIC FIELDS AND WAVES

3 1 0 4

ELECTROSTATIC FIELDS : Review of vector calculus and Co-ordinate systems - Electrostatic fields - Coulomb's Law and field intensity - Electric flux density - Gauss's law and its application - Electric potential - Relationship between E and V-Flux lines - Dipole- Energy density - Conductors -Boundary conditions in electrostatic fields - Boundary value problems. (12+4)

MAGNETOSTATIC FIELDS : Biot-Savart's Law - Ampere's circuital law - Magnetic flux density and Maxwell's equations – Magnetic forces due to magnetic fields - Magnetic -Scalar and Vector potential - Magnetic Boundary conditions – Boundary value problems - Magnetic energy. (12+4)

TIME VARYING FIELDS: Faraday's Law – Equation of continuity - Inconsistency of Ampere's law - Maxwell's equations and their interpretation – Time varying Potentials. (6+2)

ELECTROMAGNETIC WAVES: Uniform plane waves- Wave equation - Wave propagation in different media - Poynting Vector and Theorem – wave Polarization - Reflection of a plane wave at Normal and Oblique incidence - EMI / EMC Interference. (8+3)

TRANSMISSION LINES AND WAVEGUIDES : Transmission line-parameters-VSWR- reflection coefficient - stub matching using Smith chart - Rectangular waveguide – TE and TM modes and propagation characteristics – Impossibility of TEM waves. (7+2)

Total L: 45 +T: 15 = 60

TEXT BOOKS:

1. Sadiku M H . Principles of Electromagnetics , New Delhi: Oxford University Press Inc, 2015.
2. William H Hayt . Engineering Electromagnetics, 8th Edition, New Delhi: McGraw Hill international Edition, 2012.

REFERENCES:

1. David K Cheng . Fields and Wave Electromagnetics ,2nd Edition , Pearson Education, 2013.
2. Umran S. Inan, Aziz Inan, Ryan Said. Engineering Electromagnetics and Waves ,2nd Edition , Pearson, 2015

23O305 ENGINEERING ECONOMICS

3 1 0 4

Fundamentals of Economic Analysis: Introduction – Scope of Engineering Economics – Circular Flow in an Economy – Demand and Supply– Types of Efficiency. (7+2)

Cost and Inventory Control: Cost Concepts – Types of Cost – Short-run and Long-run - Cost-Output Relationship - Make or Buy Decision – Criteria – Approaches - Inventory Models – Purchase Model – Manufacturing Model - With or Without Shortages- Depreciation Methods – Problems in Straight Line and Diminishing Balance Method. (9+4)

Pricing, Revenue and Value Engineering: Pricing Practices and Strategies -Revenue Concepts – CVP Analysis- Problems in Break-Even Analysis – Value Analysis - Value Engineering. (9+2)

Project Management: Capital Budgeting – Decisions – Steps Involved in Capital Budgeting – Methods of Project Appraisal – Pay-back Period – Net Present Value and Internal Rate of Return - Project Management - Techniques – PERT – CPM Models – Case Analysis. (10+5)

Economic Growth and Development: Concepts of Macro Economics – National Income – Inflation – Control Measures - Monetary Policy – Fiscal Policy – Technological Innovation in Banking and Economic Development - Sustainable Development Goals – Circular Economy. (10+2)

Total L: 45 + T: 15 =60

Text Books

1. Panneerselvam. R., “Engineering Economics”, PHI Learning Private Limited, 2012.
2. Metha P.L, “Managerial Economics – Analysis, Problems and Cases”, Sultan Chand & Sons, 2016.

References

1. Zahid A. Khan., Arshad N. Siddiquee, Brajesh Kumar, Mustufa H. Abidi, “Principles of Engineering Economics with Applications”, Cambridge University Press, 2018.
2. Varshney, R.L and K.L. Maheshwari, “Managerial Economics”, Sultan Chand & Sons, 2014.
3. McEachern and Indira., “Macro ECON”, Cengage India Private Limited, 2017.

1.Shalini Goyal Bhalla, “Circular Economy (Re) Emerging Movement”, Invincible Publishers, 2020.

23L310 ANALOG ELECTRONICS LABORATORY

0 0 2 1

Hardware Experiments (20)

1. Full Wave Rectifiers with and without filters.
2. Series voltage regulators.
3. BJT amplifiers.
4. MOSFET amplifiers.
5. RC phase shift and Colpitt’s oscillators.
6. Class B and Class AB amplifiers.
7. Astable and MonostableMultivibrators.
8. Schmitt Trigger.

Software Experiments (10)

1. Current mirrors and Differential amplifiers
2. MOS CS amplifier with resistive load and current source load
3. Feedback Amplifiers
4. RC Integrator and Differentiator Circuits.

AUGMENTED EXPERIMENTS*

1. Design of a regulated power supply.
2. Design of an audio power amplifier.
3. Design of an Automatic gain control circuit using differential amplifier.
4. Application using multivibrator circuits.

Total P: 30

REFERENCES:

1. Laboratory Manual Prepared by ECE Department, 2019.
2. David A Bell, Electronic Devices and Circuits, Prentice Hall of India, New Delhi, 2008.

* Augmented experiments will be evaluated at the end of the semester.

23L311 DIGITAL ELECTRONICS LABORATORY

0 0 2 1

HARDWARE EXPERIMENTS:

1. Half adder and Full adder
2. Code Conversion: BCD to Gray and Seven segment conversion
3. Multiplexers/Demultiplexers
4. Encoders/Decoders
5. Flip-flops
6. Shift Registers

7. Ring Counter and Johnson Counter
8. Asynchronous Counters

(20)

SOFTWARE EXPERIMENTS (FPGA Implementation):
1. Adder / Subtractor Circuits and BCD adder using verilog code
2. Magnitude Comparator and ALU using verilog code
3. Synchronous Counters using verilog code
4. Sequence Detector using verilog code

(10)

AUGMENTED EXPERIMENTS*
1. Design of Hamming code generator for 8-bit data
2. Design of Digital Clock
3. Develop Verilog code for 4-bit Universal Shift Register
4. Develop Verilog code for Arithmetic Logic Unit

Total P: 30

TEXT BOOKS:
1.Morris Mano, and M.D. Ciletti , "Digital Design: with an introduction to Verilog HDL, VHDL and system verilog", 6th Edition, Pearson Education, New Delhi, 2018.
*Augmented experiments will be evaluated at the end of the semester.

23Q313 BUILDING COMMUNICATION SKILLS

0 0 2 1

BUILDING COMMUNICATION SKILLS:
1. Introduction to Workplace Communication
2. Profile Building for Internships
3. English in the Workplace (Grammar & Vocabulary)
4. Professional Communication (Speaking & Writing)
5. Workplace Communication Tools
6. Career Exploration
7. Resume Update

Total P: 30

REFERENCES:
1. P.C.Wren and H.Martin, "High school English grammar & composition ", S Chand Publishing, New Delhi, 2017.
2. Norman Lewis, "Word Power Made Easy", Goyal Publisher, New Delhi, 2011.

23K312 ENVIRONMENTAL SCIENCE

2 0 0 0

INTRODUCTION TO ENVIRONMENT: Environment - Definition, scope and importance. Types and composition of atmosphere – particles, ions and radicals. Ozone layer- significance, formation and depletion. Ecosystems- Structure and functions, components, energy flow, food chains, food web, Biodiversity-levels, values and threats – India as a mega- diversity nation – hotspots of biodiversity – endangered and endemic species of India – conservation of biodiversity. (6)

ENERGY RESOURCES: Introduction – National and International status- exploitation - sustainable strategies- Fossil fuels- classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas; solar energy - introduction, harnessing strategies. Wind energy - availability, wind power plants, wind energy conversion systems, site characteristics, and types of wind turbines. Supporting renewable energy resources - tidal –geothermal -hydroelectric. (6)

ENVIRONMENTAL POLLUTION: Definition – Sources, causes, impacts and control measures of (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards (h) RF hazards - Role of an individual in prevention of pollution. Disaster Management: Floods, earthquake, cyclone and landslides – Case studies, consequences and rescue measures. (6)

WASTE MANAGEMENT: Wastewater - Characteristics of domestic and industrial wastewater - COD and BOD – Various stages of treatment – primary, secondary, tertiary treatment- Biological and advanced oxidation processes. Solid waste management – Characteristics of municipal solid waste(MSW), biomedical, automobile and e-wastes and their management – landfills, incineration, pyrolysis, gasification and composting. (6)

SOCIAL ISSUES AND THE ENVIRONMENT: Environmentally Sustainable work practices- Rain water harvesting – Role of non-governmental organizations. Human ethics and rights- impact on environment and human health – role of information technology on environment and human kind. Green IT policies, Process of EIA - ISO 14000. Legislation- Environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act. (6)

Total L: 30

TEXT BOOKS:
1. Gilbert M.Masters , "Introduction to Environmental Engineering and Science", Pearson Education, New Delhi, 2004.

2. De A K , "Environmental Chemistry", New Age International P Ltd, New Delhi, 2006.

REFERENCES:

1. Benny Joseph , "Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006.
2. KoteswaraRao MVR , "Energy Resources: Conventional & Non-Conventional", BSP Publications, New Delhi, 2006.
3. Deswal S and Deswal A , "A Basic Course in Environmental Studies", Dhanpat Rai and Co, New Delhi, 2004.

23TC01 தமிழர் மரபு / HERITAGE OF TAMILS

1 0 0 1

அலகு – I மொழி மற்றும் இலக்கியம்: 3

இந்திய மொழிக் குடும்பங்கள் – திராவிட மொழிகள் – தமிழ் ஒரு செம்மொழி – தமிழ் செவ்விலக்கியங்கள் – சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை – சங்க இலக்கியத்தில் பகிர்தல் அறம் – திருக்குறளில் மேலாண்மைக் கருத்துக்கள் – தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் – பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் – சிற்றிலக்கியங்கள் – தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி – தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு – II மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக்கலை: 3

நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள் – பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வியல் கோவில்களின் பங்கு.

அலகு – III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்: 3

தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு - IV தமிழர்களின் திணைக் கோட்பாடுகள்: 3

தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு – சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் – சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு - V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு: 3

இந்தி விடுதலைப்போரில் தமிழர்களின பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் – தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS

1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை (வெளியீடு – தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல.சுந்தரம். (விகடன் பிரசுரம்)
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருனை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)
5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.)
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D.Thirunavukkarasu) (Published by : International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies).
9. Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by : The Author)

11. Porunai Civilization (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigal (R.Balakrishnan) (Published by : RMRL) – Reference Book.

SEMESTER IV

23L401 PROBABILITY AND RANDOM PROCESSES

3 1 0 4

RANDOM VARIABLES: Probability: Review of basic concepts, discrete random variables: probability mass function, cumulative distribution function, binomial, Poisson and geometric random variables, expected values. Continuous random variables: cumulative distribution function, probability density function, uniform, exponential and Gaussian random variables, expected values. (11+3)

MULTIPLE RANDOM VARIABLES: Joint cumulative distribution function, joint probability mass function, marginal probability mass function, joint probability density function, marginal probability density function, independent random variables, expected values, covariance, correlation and independence. (10+3)

SUMS OF RANDOM VARIABLES AND ESTIMATION: Expectations of sums, moment generating functions, mgf of sums of independent random variables, central limit theorem, laws of large numbers. Estimation of a random variable: linear estimation of X given Y, MAP and ML estimation. (8+3)

RANDOM PROCESSES: Definition, classifications of random processes, Poisson process, Brownian motion process, expected value and correlation, stationary processes, strict sense and wide sense stationary processes, cross covariance, cross correlation. (8+3)

POWER SPECTRAL DENSITY AND LINEAR SYSTEMS: Linear filtering of a continuous-time random process, linear filtering of a random sequence, power spectral density of a continuous-time process, Wiener-Khintchine theorem (statement), power spectral density of a random sequence. (8+3)

Total L: 45 + T: 15 = 60

TEXT BOOKS:

1. Roy D Yates and David J Goodman, “Probability and Stochastic Processes”, Wiley India, New Delhi, 2021.
2. Athanasios P and Unnikrishna P S, “Probability, Random Variables and Stochastic Processes”, Tata McGraw Hill, New Delhi, 2017.

REFERENCES:

1. Saeed Ghahramani, “Fundamentals of Probability with Stochastic Processes”, CRC Press, USA, 2018.
2. Douglas C Montgomery and George C Runger, “Applied Statistics and Probability for Engineers”, Wiley India, New Delhi, 2018.
3. Oliver C Ibe, “Fundamentals of Applied Probability and Random Processes”, Elsevier Academic Press, USA, 2005.
4. Scott Miller and Donald Childers, “Probability and Random Processes: With applications to Signal Processing and Communications”, Academic Press, USA, 2012.

23L402 LINEAR INTEGRATED CIRCUITS

3 0 0 3

OPERATIONAL AMPLIFIERS: Block diagram - Ideal Operational Amplifier Characteristics - DC and AC characteristics - frequency response - Stability. (9)

APPLICATION OF OPERATIONAL AMPLIFIERS: Linear applications- DC & AC amplifiers- summing differential amplifier-instrumentation amplifier-Log and antilog amplifiers-V to I and I to V converters-Integrator-Differentiator-Active filters. Nonlinear applications - Op-Amp circuits using diodes-Comparators-Schmitt Trigger- Oscillators-Waveform generators-Sample and hold circuits. (9)

TIMER AND PHASE LOCKED LOOP: 555 Timer - modes of operation and applications- Voltage Controlled Oscillator - Phase Locked Loop and applications. (9)

A-D AND D-A CONVERTERS : Digital to Analog converters: Binary weighted and R-2R Ladder types - Analog to digital converters: Flash, Counter, Successive approximation and Dual slope - DAC / ADC performance characteristics and comparison. (9)

VOLTAGE REGULATORS: Fixed voltage regulators - adjustable voltage regulators - IC Voltage regulators - Buck & Boost regulators - Switching regulators. (9)

Total L: 45

TEXTBOOKS:

1. D. RoyChoudhury&ShailBala Jain, "Linear IntegratedCircuits",6thEdition, New Age International Publishers, NewDelhi, 2022.
2. James.M.Fiore , "OP- AMPS and Linear Integrated Circuits-concepts and applications", 3rd Edition, cenage learning india, New Delhi,2019.

REFERENCES:

1. Ramakant A. Gayakwad, “Op-Amps and Linear Integrated Circuits”, 4th Edition, Pearson Noida, 2016.
2. Michael Jacob J,"Analog Integrated Circuits and Applications", 1st Edition, Prentice Hall of India, New Delhi,2019.
3. Robert F Coughlin and Fedrick F Driscoll. , "Operational amplifiers and linear Integrated Circuits", Pearson, Noida, 2016.

23L403 SIGNALS AND SYSTEMS

3 0 0 3

INTRODUCTION & LTI SYSTEMS: Continuous Time (CT) and Discrete Time (DT) signals: Operations - Basic signals - Classification - Properties of CT & DT systems – Analysis of LTI systems - Convolution Sum - Convolution Integral – Properties. (16)

FOURIER SERIES ANALYSIS FOR CT & DT SIGNALS AND SYSTEMS: Representation of CT periodic signals by Continuous Time Fourier Series (CTFS) - Convergence - Properties - Representation of DT periodic signals by Discrete Time Fourier Series (DTFS) – Properties**.** (7)

FOURIER TRANSFORM ANALYSIS FOR CT & DT SIGNALS AND SYSTEMS: Representation of CT aperiodic and periodic signals by Continuous Time Fourier Transform (CTFT) - Convergence - Properties - Frequency response of CT systems - Representation of DT aperiodic and periodic signals by Discrete Time Fourier Transform (DTFT) – Convergence - Properties - Frequency response of DT systems. (9)

SAMPLING: Representation of CT signals by samples - Impulse train sampling - Effect of under sampling - Reconstruction of CT signal from samples using interpolation - Zero-order hold Sampling. (4)

Z TRANSFORM ANALYSIS OF DT SIGNALS AND SYSTEMS: z- transform - Properties - Inverse z-transform - Partial fraction and Cauchy Residue methods - Analysis of LTI systems using z transform - Solution of difference equations - Stability and causality in z-plane. (9)

Total L: 45

TEXT BOOKS:

1. Alan V Oppenheim, Alan S Willsky, Hamid NawabS , "Signals and Systems", Second Edition, Pearson, 2021.
2. V Krishnaveni, A Rajeswari , "Signals and Systems", First Edition, Wiley India, 2019.

REFERENCES:

1. Simon Haykin, Barry Van Veen, "Signals and Systems" Second Edition, Wiley India, 2018..
2. HP Hsu, R Ranjan , "Signals and Systems Schaums‘s Outlines, Second Edition,, Tata McGraw Hill, 2010.
3. Samir S. Soliman, MandyamDhatiSrinath , "Continuous and Discrete Signals and Systems", Second Edition, Prentice Hall International, 2011.
4. Luis F. Chaparro , "Signals and Systems Using MATLAB", 1st Edition, Academic Press, An Imprint of Elsevier, 2011.

MIT open courseware

https://ocw.mit.edu/resources/res-6-007-signals-and-systems-spring-2011/

23L404 COMPUTER ARCHITECTURE

3 2 0 5

INTRODUCTION: Generations of computer system - Elements of computer - CPU organization - Instruction formats - Addressing modes - Instruction types - CISC and RISC architectures. (9+6)

DATA PATH DESIGN: Fixed point arithmetic - adder / subtractor - Signed magnitude multiplication algorithm - Robertson multiplication algorithm - Booth's and modified Booth's multiplication algorithm - non-restoring division algorithm - restoring division algorithm - floating point arithmetic - addition, subtraction, multiplication and division - ALU - Verilog implementation of datapath components (9+6)

CONTROL LOGIC DESIGN: Control organization - Hardwired Control - one flip flop per state - sequence register and decoder - PLA control - Micro programmed control - performance enhancement techniques - parallel processing - arithmetic pipeline, instruction pipeline - Amdhal's law - Measuring CPU performance – Verilog implementation of control logic components. (9+6)

MEMORY ORGANIZATION: Basic Concepts - Memory Hierarchy - Main Memory - Auxiliary Memory – Associative Memory - Cache and Virtual Memory - SDRAM, DDRAM, QDRAM - Flash memories. (9+6)

INPUT / OUTPUT AND SYSTEM ORGANIZATION: Input / Output Interface - Modes of data transfer - I/O Processor - Interrupts - Communication methods - Buses - Bus control - Bus interfacing - Bus arbitration - Multicore architectures - Introduction to RISC V. (9+6)

Total L: 45 +T: 30 = 75

TEXT BOOKS:

1. Morris Mano M , "Digital Logic and computer design", Pearson Education, New Delhi, 2016.

2. Hayes J P , "Computer architecture and Organization", McGraw Hill, New Delhi, 2012.

REFERENCES:

1. Stallings W, "Computer Organization and Architecture: Designing for performance, Pearson Education, New Delhi, Tenth Edition", 2016.
2. Patterson D, Hennessy J, "Computer Organization and Design RISC-V Edition: The Hardware Software Interface", Second Edition, Morgan Kaufmann Publishers, 2021.
3. Joseph Cavanagh, "Computer Arithmetic and Verilog HDL Fundamentals", CRC Press, 2020.

23L405 DATA STRUCTURES AND ALGORITHMS

3 2 0 5

INTRODUCTION: Data types – Abstract data types – Types of Data structures- Algorithms- properties – Design and development of algorithm-Recursive Algorithms- Analysis of Algorithms-Best case, Average case, Worst case – Asymptotic Notations. (9+6)

LINEAR DATA STRUCTURES: Arrays-operations – Memory Representation- Row Major and Column Major – Multi Dimensional Arrays – Sparse Matrix, Dense Matrix. Stack: Array implementation – operations-Applications – Checking of well-formedness Parenthesis Infix to Postfix –Conversions. (9+6)

QUEUES: Queue Operations-Circular Queue - Priority Queues - Array Implementation of Queue.Linked List:. Types-Singly Linked List – Circularly Linked List – Doubly Linked List–List operations-linked stack-linked queue. (9+6)

NONLINEAR DATA STRUCTURES: Trees-Terminologies - Binary trees – Representations – Operations – Traversals- Inorder, Preorder and Postorder- Binary Search Trees – Insertion and deletion. Graph: Terminologies -Breadth First Search algorithm-Depth First Search Algorithm. (9+6)

SORTING AND SEARCHING: Bubble Sort – Insertion Sort – Radix Sort- Quick sort- Algorithms and Time Complexity. Linear Search – Binary Search – Hashing: Hash functions – Separate Chaining – Open Addressing – Linear Probing. (9+6)

Total L: 45 +T: 30 = 75

TEXT BOOKS:

1. Thomas H Cormen, Charles E Leiserson,Ronald L Rivest,CliffordStein,"Introduction to Algorithms" ,The MIT Press , 2022.
2. Mark Allen Weiss," Data Structures and Algorithm Analysis in C++", Pearson Education , 2012.

REFERENCES:

1. Ellis Horowitz,SartajSahni,SanguthevarRajasekaran. "Fundamentals of Computer Algorithms" Second Universities Press , 2011.
2. SahniSartaj. "Data Structures, Algorithms and Applications in C++",Silicon Press , 2009.
3. Aaron M Tanenbaum,Moshe J Augenstein,YedidyahLangsam. "Data structures using C and C++" ,PHI Learning , 2009.
4. G A V VijayalakshmiPai. "DataStructures and Algorithms Concepts, Techniques and Allocations", New Delhi: McGraw Hill Education(India) Private Limited , 2015.

23L410 LINEAR INTEGRATED CIRCUITS LABORATORY

0 0 2 1

HARDWARE EXPERIMENTS:

1) Design and testing of Inverting, Non-Inverting, Differential amplifiers,Integrator and Differentiator
2) Design and testing of Rectifiers using precision diodes
3) Design and testing of Comparators and Schmitt Trigger using op-amp
4) Design and testing of Phase shift and Wien bridge oscillators using op-amp
5) Frequency response analysis of Second order High pass and wide Band pass filters
6) Design and testing of Astable and monostable multivibrators using Timer.
7) Design and testing of Digital to Analog Converters and Analog to Digital converters
8) Design and testing of Low dropout voltage regulators

(20)

SOFTWARE EXPERIMENTS:

1) Design and testing of Instrumentation amplifier
2) Design and testing of Log and Antilog amplifiers
3) Design and testing of Universal Filters
4) Design and testing of Voltage Controlled Oscillator (10)

AUGMENTED EXPERIMENTS*

1) Design of a function generator to generate sine/square/Triangular waveforms.
2) Design a circuit to reduce the power supply noise.
3) Design of a frequency synthesizer using PLL.
4) Application using 555 timer circuits.

Total P: 30

TEXT BOOKS:

1. D. RoyChoudhury&ShailBala Jain, "Linear IntegratedCircuits",6thEdition,New Age International Publishers, NewDelhi, 2022.
2. Ramakant A. Gayakwad, “Op-Amps and Linear Integrated Circuits”, 4th Edition, PEARSON 2016 NOIDA, 2016.

* Augmented experiments will be evaluated at the end of the semester.

23L411 SIGNALS AND SYSTEMS LABORATORY

0 0 2 1

SIMULATION EXPERIMENTS

1. Generation of Continuous -time (CT) and Discrete-time (DT) signals
2. Signal operations on CT and DT signals
3. Verification of CT and DT System properties
4. Computation of Linear Convolution
5. Analyze and Synthesize the continuous time periodic signals using Fourier Series and study of Gibbs phenomenon
6. Analyze and Synthesize the continuous time aperiodic signals using Fourier Transform
7. Analyze and Synthesize the discrete time periodic signals using Fourier Series
8. Analyze and Synthesize the discrete time aperiodic signals using Fourier Transform
9. Sampling and Reconstruction
10. Analysis of DT systems using z-transform

Total P: 30

REFERENCES:

1. “Signals and Systems Lab Manual”, Department of ECE, PSG college of Technology, 2019.
2. Krishnaveni.V, Rajeswari.A, "Signals and Systems", First Edition, Wiley India Pvt.Ltd, 2019 (Reprint).
3. Luis F. Chaparro, “Signals and Systems Using MATLAB” 1st Edition, Academic Press, An Imprint of Elsevier, 2018.

23Q413 PROBLEM SOLVING

0 0 2 1

PROBLEM SOLVING:

1. Algorithmic Thinking, Branching & Repetition Problems
2. Logical Reasoning - Data Arrangements & Relations
3. Solving problems based on Coding & decoding, Series, Analogy, Odd man out and Visual reasoning
4. Problems based on Ages, Logical Connectives, Syllogisms, Data Interpretation & Data Sufficiency
5. Solving problems on Clocks Calendars, Direction Sense & Cubes
6. Problems based on Number system, Percentages, Simple & Compound Interest
7. Resume Update

Total P: 30

REFERENCES:

1. R.S. Aggarwal, "Quantitative Aptitude for Competitive Examination", S Chand Publishing, New Delhi, 2017.

23O412 INDIAN CONSTITUTION

2 0 0 0

INTRODUCTION: Evolution of Indian Constitution; significance of constitution; Composition; Preamble and its Philosophy. (4)

RIGHTS, DUTIES AND DIRECTIVE PRINCIPLES: Fundamental Rights- Writs and Duties, Directive Principles of State Policy (5)

UNION GOVERNMENT: Union Government, President and Vice President, Houses of the Parliament and their functions; Types of Bills, Stages of passing of Bill into an Act, Veto Power, Constitution Amendment Procedure, Various Amendments made and their significance for India. (6)

STATE GOVERNMENT AND FEDERALISM: Composition of State Legislature; Powers, Functions and Position of Governor, Function of Chief Ministers, Council of Ministers; The Indian Federal System, Administrative Relationship between Union and States (8)

JUDICIARY: Supreme Court, High Court; District Court and Lower Courts - Functions and Powers – Judges – Qualifications and Powers - Judicial Review. (7)

Total L:30

TEXT BOOKS:

1. Subash C. Kashyap, “Our Political System”, National Book Trust, 2011.
2. Praveenkumar Mellalli, E., “Constitution of India, Professional Ethics and Human Rights”, Sage Publications India Pvt. Ltd., 2015.

REFERENCES:

1. Briji Kishore Sharma, “Introduction to the Constitution of India”, Prentice Hall of India, 2010.

2. Basu D.D., “Introduction to the Constitution of India”, Prentice Hall of India, 2016.
3. Jain. M. C., “The Constitution of India”, Law House, New Delhi, 2001.
4. Shukla. V. N., “Constitution of India”, Eastern Book Company Ltd., New Delhi, 2011.

23Q413 PROBLEM SOLVING

0 0 2 1

PROBLEM SOLVING:
1. Algorithmic Thinking, Branching & Repetition Problems
2. Logical Reasoning - Data Arrangements & Relations
3. Solving problems based on Coding & decoding, Series, Analogy, Odd man out and Visual reasoning
4. Problems based on Ages, Logical Connectives, Syllogisms, Data Interpretation & Data Sufficiency
5. Solving problems on Clocks Calendars, Direction Sense & Cubes
6. Problems based on Number system, Percentages, Simple & Compound Interest
7. Resume Update

Total P: 30

REFERENCES:
1. R.S. Aggarwal, "Quantitative Aptitude for Competitive Examination", S Chand Publishing, New Delhi, 2017.

23TC02 தமிழரும் தொழில்நுட்பமும் / TAMILS AND TECHNOLOGY

1 0 0 1

அலகு – I நெசவு மற்றும் பானைத் தொழில்நுட்பம்: **3**
சங்க காலத்தில் நெசவுத் தொழில் – பானைத் தொழில்நுட்பம் – கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு – II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்: **3**
சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள், சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு – சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் – சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும் – சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள் – மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு – III உற்பத்தித் தொழில் நுட்பம்: **3**
கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணங்கள் – நாணயங்கள் அச்சடித்தல்- மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத் துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

அலகு – IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்: **3**
அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

அலகு V – அறிவியல் தமிழ் மற்றும் கணித்தமிழ்: **3**
அறிவியல் தமிழின் வளர்ச்சி – கணித்தமிழ் வளர்ச்சி – தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

TOTAL : 15 PERIODS

TEXT-CUM-REFERENCE BOOKS
1. தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே.பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முனைவர் இல.சுந்தரம் (விகடன் பிரசுரம்).
3. கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4. பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

5. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
6. Social Life of the Tamils – The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.)
7. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D.Thirunavukkarasu) (Published by : International Institute of Tamil Studies).
8. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies).
9. Keeladi – 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
10. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by : The Author)
11. Porunai Civilization (Jointly Published by : Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
12. Journey of Civilization Indus to Vaigal (R.Balakrishnan) (Published by : RMRL) – Reference Book.

SEMESTER V

23L501 COMMUNICATION ENGINEERING

3 0 0 3

AMPLITUDE MODULATION SYSTEMS : Communication system model – Amplitude Modulation – DSBFC, DSBSC, SSB - Generation and detection of DSB-FC, DSB-SC, SSB waves, Vestigial Sideband Modulation, Independent Sideband Modulation - Comparison of AM systems – FDM. (9)

ANGLE MODULATION SYSTEMS : FM and PM - Narrow band FM and Wideband FM - Bandwidth requirements- Carson's Rule - Pre emphasis, De-emphasis - Generation and demodulation of FM waves – FM Stereo Multiplexing. (9)

TRANSMITTERS AND RECEIVERS : Transmitter characteristics & Classification - Low Level and High Level transmitters – AM broadcasting transmitters - Pilot carrier technique- FM transmitters. Receiver -characteristics and Classification- Tuned radio frequency receiver - Super heterodyne receiver – AM and FM receivers – Introduction to Software Defined Radio. (9)

NOISE IN COMMUNICATION SYSTEMS : Types of Noise – Noise Calculations – Equivalent Noise Bandwidth – Noise Figure – Effective Noise Temperature – Narrowband Noise representation- Noise in CW Modulation systems, Noise in Linear Receiver using coherent detection, Noise in AM receivers using envelope Detection – Noise in FM receivers. (9)

PULSE MODULATION SCHEMES : Sampling Theorem - Pulse Amplitude Modulation – TDM - Pulse Width Modulation – Pulse Position Modulation – Pulse Frequency Modulation –Quantization - PCM – Noise Performance of PPM and PCM - Delta Modulation – Adaptive Delta Modulation – Delta Sigma Modulation – DPCM. (9)

Total L:45

TEXT BOOKS:

1. Simon Haykin , "Communication Systems", Wiley, 2014.
2. Kennedy G , "Electronic Communication systems", Tata McGraw Hill, 2017.

REFERENCES:

1. HerbutTaub, Donald L. Schilling, GoutamSaha , "Principles of Communication Systems", McGraw Hill, 2017.
2. Carlson A B , "Communication systems: An Introduction to signals and noise in electrical communication", McGraw Hill,2010.
3. Dennis Roddy, John Coolen , "Electronic Communications", Prentice Hall of India, 2013.
4. Lathi B P , "Modern Digital and Analog communication Systems", Oxford University Press, 2017.

23L502 EMBEDDED SYSTEMS

3 0 0 3

MICROCONTROLLER ARCHITECTURE AND PROGRAMMING: Introduction - Product Design Life Cycle of Embedded Systems-Functional block diagram of 8051- Program and Data memory Organization-Addressing Modes and Instruction Set – Assembly language Programming. (9)

ON-CHIP PERIPHERALS INITIALIZATION AND PROGRAMMING TECHNIQUES: Parallel Ports, Timer/Counter, Capture/Compare, WDT, RTC, PWM, QEI, Interrupts, EEPROM, ADC and DAC. (9)

OFF-CHIP PERIPHERALS INTERFACING AND PROGRAMMING TECHNIQUES: LED, 7-segment, LCD, Push-to-On switch, Matrix keyboard, DC Motor, Servo Motor & Stepper Motor. (9)

WIRED & WIRELESS PROTOCOLS: UART, I2C, CAN, USB, SPI and Ethernet - LoRa, Bluetooth and WiFi. (9)

RTOS: Device Drivers - Tasks and Task States, Context Switching - Intertask Communication: Shared Data, Semaphores, Message Queues, Mailbox, Pipe - Timer Functions - Events - Memory Management Functions - Interrupt handling in RTOS. (9)

Total L:45

TEXT BOOKS:
1. Kenneth J Ayala, “The 8051 Microcontroller: Architecture, Programming & Applications”, West Publishing Company, 3rd Edition, 2007.
2. David. E. Simon, “An Embedded Software Primer” Pearson Education, 2015.

REFERENCES:
1. Muhammad Ali Mazidi, J.G. Mazidi, R.D. McKinlay , "The 8051 Microcontroller and Embedded Systems", Second Edition, Pearson Education Limited, 2014.
2. Arnold S. Berger, “Embedded Systems Design: An Introduction to Processes, Tools, and Techniques” CMP Books, 2002.
3. Bai Y, “Practical Micro Controller Engineering with ARM Technology”, John Wiley and Sons, 2015.

23L503 CONTROL SYSTEMS

3 1 0 4

INTRODUCTION : Modeling of Electrical and Mechanical systems - Translational and Rotational systems – Block diagram – Signal flow graph - Mason's gain formula. (9+2)

TIME AND FREQUENCY DOMAIN ANALYSIS : Standard Test signals – Time response of second order systems - Performance specifications on system time response - Types of systems - Steady state error - Generalized error series - Introduction to PID Controllers –Performance specifications on system Frequency response – Correlation between time and frequency response. (10+3)

STABILITY ANALYSIS : Concepts of Stability - Routh Stability Criterion - Root locus technique. (6+2)

FREQUENCY RESPONSE PLOTS AND SYSTEM STABILITY: Polar plot - Nyquist stability Criterion - Bode plot - Compensator design using Bode Plot. (10+4)

STATE VARIABLE ANALYSIS : Introduction –State space representation of continuous time systems using Physical and Phase Variables – Solution of state equations–Concepts of Controllability and Observability. (10 +4)

Total L:45 + T:15=60

TEXTBOOKS:
1. Nagrath I J, and Gopal, M, “Control Systems Engineering”, New Age International P Ltd, 7th Edition, 2022, New Delhi
2. C.Norman, SNise, “Nise's Control Systems Engineering”,5thEdition, Wiley ,2022, New Delhi.

REFERENCES:
1. Katsuhiko Ogata, “Modern Control Engineering”, 5thEdition, Pearson, 2021, New Delhi.
2. Kuo B C, “Automatic Control Systems”, 10thEdition, McGraw Hill Education (I) P Ltd, 2018, Chennai.
3. Katsuhiko Ogata, “DiscreteTime Control SystemsII”,2ndEdition, Pearson Education Asia, New Delhi,2016.
4. Smarajit Ghosh, “Control Systems Theory and Applications”, 2ndEdition, Pearson Education Asia, Chennai, 2022.

23L504 COMPUTER NETWORKS

3 2 0 5

INTRODUCTION AND QUEUING PRINCIPLES : Network Criteria - Network Types - Transmission modes - Network Models: OSI Model, TCP/IP model - Digital to Digital Conversion – Digital Data Transmission - Transmission Media – Multiplexing – Switching - Connecting devices - Queuing Models: M/M/n and M/G/1-Queues with blocking and priority queues. (12+6)

DATA LINK LAYER: Error Detection and Correction - Data Link Control - Media Access Control- Wired LANs: Ethernet, Token bus,Token ring, FDDI - Virtual LAN. (9+6)

NETWORK LAYER: IPv4 addressing- Class ful and Classless addressing, Subnetting–NAT–DHCP–ICMP–IGMP– Routing Algorithms:Distance Vector and Link State -Progression to IPv6- Network Layer Performance. (9+6)

TRANSPORT LAYER: Process to process delivery–UDP–TCP–SCTP–Congestion control–Quality of Service. (8+6)

APPLICATION LAYER: ClientServerProgramming–WWW–HTTP - FTP–Email–Telnet–DNS–SNMP –VoIP (7+6)

Total: L: 45 + T: 30 = 75

TEXT BOOKS:
1. Behrouz A Forouzan , "Data Communication and Networking", 5th Edition, Tata McGraw-Hill, New Delhi, 2017.
2. Kurose James F, Keith W. Ross , "Computer Networking: A Top-Down Approach", 7th Edition, Pearson Education, New Delhi, 2016.

REFERENCES:
1. J.F. Shortle, J.M. Thompson, D. Gross and C.M. Harris, “Fundamentals of Queueing Theory”, 5th Edition, Wiley, 2018.
2. AndrewS Tanenbaum, "Computer Networks",PrenticeHallofIndia,NewDelhi,2011.

3. William Stallings,"Data and Computer Communication",PrenticeHallofIndia,NewDelhi, 2014.
4. Keizer G.E , "Local Area Networks", 2nd Edition, McGraw Hill, New Delhi, 2001.

23L505 ANTENNAS AND WAVE PROPAGATION

3 1 0 4

ANTENNA PARAMETERS: Introduction **-** Types of antennas-Radiation mechanism-current distribution-Parameters: Radiation Pattern, Beam solid angle, Radiation intensity, Radiation Power density, Directivity, Gain, Effective aperture, Polarization, Bandwidth, Beamwidth, antenna impedance - Poynting vector- Friis Transmission formula - Duality theorem. (9+3)

SMALL ANTENNAS: Transmission line as an antenna - Radiation from a dipole antenna - Radiation fields of point source - infinitesimal dipole and half wave dipole-Radiation resistance-Directivity and Design procedure. (9+3)

ANTENNA ARRAYS: Introduction, Array of two point sources - Power patterns – Pattern multiplication-Broadside array-End fire array-N-element linear array, Evaluation of null directions and maxima, amplitude distributions, Binomial arrays, Dolph – Chebychev arrays**.** (9+3)

SPECIAL ANTENNAS: Construction, Features and applications of Yagi-Uda , Turnstile, Log periodic, Loop, Helical: normal mode and axial mode - Rhombic- Horn-Reflector and their feed systems- Micro strip-Rectangular patch antennas - Phased array. (9+3)

ANTENNA MEASUREMENTS AND WAVE PROPAGATION: Antenna ranges-Measurement of radiation pattern, Gain, directivity and impedance measurements-Polarization measurements-scale model measurements. Propagation in free space-Surface wave-structure of the ionosphere-determination of critical frequencies - maximum usable frequency - effect of the earth‘s magnetic field –ionospheric variations – fading – tropospheric propagation - space wave propagation- super refraction - refractive index of troposphere. (9+3)

TotalL:45+T: 15=60

TEXT BOOKS:

1. Balanis E S, "Antenna Theory Analysis and Design", 5th Edition, John Wiley and Sons Inc, Singapore, 2016.
2. Prasad K D," Antennas and Wave Propagation",12th Edition, Satya Prakash, Tech India Publications, New Delhi, 2019.

REFERENCES:

1. Harish A R, and ScahidanandaM,"Antennas and Wave Propagation" ,3rdEdition,Oxford University Press, Chennai, 2018.
2. Edward C Jordan, Keith G Balmain,"Electromagnetic waves and Radiating systems", 5th Edition, Prentice Hall of India, New Delhi, 2018.

23L510 COMMUNICATION ENGINEERING LABORATORY

0 0 2 1

HARDWARE EXPERIMENTS : (20)

1) Amplitude Modulation and Demodulation
2) DSB-SC Modulation and Demodulation
3) Pre emphasis and De emphasis circuits
4) Frequency Modulation and Demodulation
5) Single tuned amplifier
6) FM Reception using Universal Software Radio Peripheral
7) Pulse Modulation Schemes
8) TDM and FDM systems

SOFTWARE EXPERIMENTS : (10)

1) Automatic Gain Control circuits
2) Figure of Merit Analysis of AM and FM
3) PCM and DPCM
4) Delta Modulation and Adaptive Delta Modulation

AUGMENTED EXPERIMENTS*

1) Audio Amplifier
2) Superheterodyne Receiver
3) Application of Pulse Modulation Schemes
4) Application of PCM and DPCM

Total P: 30

REFERENCES:

1. Laboratory Manual Prepared by ECE Department, 2019.
2. Simon Haykin , "Communication Systems", Wiley, 2014.

* Augmented experiments will be evaluated at the end of the semester.

23L511 EMBEDDED SYSTEMS DESIGN LABORATORY

0 0 4 2

HARDWARE (8051) EXPERIMENTS (40)
1) Display Interface
2) Keyboard Interface
3) Timer/Counter Applications
4) RTC and WDT Interface
5) Hardware & Software Interrupts
6) Serial Communication Protocols
7) ADC Applications
8) Motor Control Applications

SOFTWARE EXPERIMENTS (KEIL IDE) (20)
1) Arithmetic and Logical Operations
2) Searching & Sorting
3) Code Conversion Techniques
4) Multi-tasking using tiny RTOS

AUGMENTED EXPERIMENTS*
1) Temperature monitoring and control
2) Speed measurement and calculation
3) Object recognition using camera interface
4) Attendance monitoring system with display interface

Total P: 60

REFERENCES:

1. Laboratory Manual Prepared by ECE Department, 2019.
2. Muhammad Ali Mazidi, J.G.Mazidi, R.D. McKinlay, “The 8051 Microcontroller and Embedded Systems: Using Assembly & C”, Pearson, 2008.

* Augmented experiments will be evaluated at the end of the semester.

23Q513 APTITUDE SKILLS

0 0 2 1

APTITUDE SKILLS:
1. Reading comprehension
2. Sentence correction, Sentence completion and Para-jumbles
3. Vocabulary, Articles, Prepositions and Interrogatives
4. Critical reasoning
5. Ratio and Proportion, Profit and loss, Partnerships and averages
6. Permutation, Combination and Probability
7. Time, Speed and Distance
8. Resume progress check

Total P: 30

REFERENCES:

1. R.S. Aggarwal, "Quantitative Aptitude for Competitive Examination", S Chand Publishing, New Delhi, 2017.
2. P.C.Wren and H.Martin, "High school English grammar & composition ", S Chand Publishing, New Delhi, 2017.
3. Norman Lewis, "Word Power Made Easy", Goyal Publisher, New Delhi, 2011.

SEMESTER VI

23L601 DIGITAL SIGNAL PROCESSING

3 0 0 3

DISCRETE FOURIER TRANSFORM (DFT) : Review of CTFT & DTFT - DFT – Properties - Radix 2 FFT algorithms - Decimation in time - Decimation in frequency - Use of FFT in Linear filtering - Filtering of long data sequences. (8)

DESIGN AND REALIZATION OF IIR FILTERS : Review of design techniques for analog low pass filters - Design of IIR filters - Approximation of derivatives - Impulse Invariance - Bilinear transformation - Butterworth and Chebychev Type 1 filters - Realization of IIR filters. (10)

DESIGN AND REALIZATION OF FIR FILTERS : FIR filters - Symmetric and anti-symmetric FIR filters - Design of linear phase FIR filters using windows - Realization of FIR filters. (10)

ANALYSIS OF FINITE WORD LENGTH EFFECTS : Representation of Numbers - Quantization of filter coefficients in IIR and FIR filters - Round Off effects in Digital filters - Quantization effects in computation of DFT. (10)

PROGRAMMABLE DIGITAL SIGNAL PROCESSORS: Introduction to Digital Signal Processors - Architecture of TMS320C6748 - Device characteristics - Memory mapping – Peripherals. (7)

Total L:45

TEXTBOOKS:

1. Lonnie C Ludeman , "Fundamentals of Digital Signal Processing", Wiley India, New Delhi, 2011.
2. John G Proakis and Dimitris G Manolakis , "Digital Signal Processing", Prentice Hall India, New Delhi, 2010.

REFERENCES:

1. Mitra S K , "Digital Signal Processing – A Computer based Approach", Tata McGraw Hill, New Delhi,2012.
2. Vinay K Ingle, John G Proakis , "Digital signal processing using MATLAB", Brooks / Cole, California,United States, 2011.
3. B.Venkatramani,M.Bhaskar, "Digital Signal Processor Architecture, Programming and Application", McGraw hill, Second edition 2002.
4. TI Team, "TMS320C6748 Technica; Reference Manual", September 2016.

23L602 DIGITAL COMMUNICATION

3 0 0 3

INFORMATION THEORY : Review of Probability theory and random process - Self information measure - Entropy function - Conditional Entropies - Mutual information - Redundancy - Efficiency – Source Coding - channel capacity - capacities of channels with symmetric noise structure Shannon's Hartley Law. (8)

BASEBAND SIGNALLING : Power Spectral Density - Concept of base band signaling - Signaling formats – Line coding - Optimum Filtering - Error due to Noise – ISI - Pulse Shaping - Scrambling and unscrambling - channel equalization, tapped delay line and Transversal filters (9)

ERROR CONTROL CODING : Parity check codes - Linear block codes – Decoding of linear Block codes – Polynomial representation of code structures - cyclic codes - convolution codes –The Generating function-Viterbi Decoding algorithms - turbo codes. (9)

PASSBAND SIGNALLING : Signal Space Analysis - Detection using matched filters for signals via AWGN channels – Analysis of coherent and non coherent detection Schemes for ASK, FSK, PSK, DPSK - M-arysignaling – MSK – GMSK – QAM - Probability of error for each scheme - Multicarrier modulation – OFDM. (10)

SPREAD SPECTRUM AND SYNCHRONIZATION : PN sequences - Direct Sequence Spread spectrum – Frequency Hop Spread Spectrum - Need for Synchronization - Bit, word, frame and Carrier synchronization. (9)

Total L: 45

TEXT BOOKS:

1. Simon Haykin , "Digital Communications", John Wiley & Sons, Inc, Singapore, 2017
2. Lathi B P , "Modern Digital and Analog communication Systems", Oxford University Press, 2020

REFERENCES:

1. Proakis J G, SalehiM , "Digital Communications", Tata McGraw Hill, New Delhi, 2016.
2. Bernard Sklar , "Digital Communications- Fundamentals and applications", Pearson Education, New Delhi, 2019.
3. Reza F M , "An Introduction to information theory", McGraw Hill, New Delhi, 2010.
4.Sam ShanmugamK , "Digital and Analog communication systems", John Wiley Inc, Singapore, 2008.

23L603 VLSI DESIGN

3 0 0 3

INVERTERS : Review of MOS transistor equations -Passive load inverter- CMOS inverter – Transfer Characteristics, Power dissipation- Depletion mode and enhancement mode pull ups – Pseudo nMOS Inverter - Sheet resistance - Area Capacitance - Inverter delay and Logical Effort. (9)

LOGIC DESIGN : Combinational logic circuits - Static CMOS logic- Complementary CMOS, Ratioed logic, Pass- Transistor, Transmission gate - Dynamic CMOS logic – Performance, Noise considerations, domino, npCMOS logic - Sequential logic circuits - static and dynamic flip-flops (10)

SUBSYSTEM DESIGN : Design of adders-Static adder, Mirror adder, Carry Look Ahead adder, Binary adder – Multipliers-Array multiplier, Carry Save multiplier, Booths and Modified Booths multiplier - Barrel shifter, Logarithmic shifter. (10)

MEMORY DESIGN : 6T SRAM Cell**,** CAM memory,4x4 -OR ROM, NOR ROM, NAND ROM cell array,6-T SRAM cell,3-T DRAM cell, Memory peripheral circuitry-Address Decoders-Sense amplifiers-Power dissipation in memories. (9)

VLSI LAYOUT DESIGN AND FABRICATION TECHNIQUES : Layout styles – Full custom and Semi custom approaches - Layout Design Rules – CMOS nwell process rules - Stick diagram - Layout examples – Fabrication techniques – Wafer processing - Oxidation - Patterning - Diffusion - Ion implantation - Deposition - CMOS processes : nWell, Twin tub, Silicon on Insulator. (7)

Total L: 45

TEXT BOOKS:

1. Neil H E Weste, David Money Harris, “CMOS VLSI Design: A Circuits and System Perspective, Pearson, 2017.
2. Jan M Rabaey, AnanthaChandrakasan, "Digital Integrated Circuits- A Design Perspective", Prentice hall of India, 2016.

REFERENCES:

1. Caver Mead, Lynn Conway , "Introduction to VLSI Systems", Addison-Wesley, 2017.
2. Douglas A Pucknell , Kamran Eshranghian , "Basic VLSI Design", Prentice Hall of India, 3rd edition, 2011.
3. Amar Mukherjee , "Introduction to nMOS and CMOS VLSI System Design", Prentice Hall, 1986.
4. Sung-Mo Kang , Yusuf Leblebici “CMOS Digital Integrated Circuits, Analysis and Design”, McGraw Hill Education; Fourth edition, 2019.

23L610 DIGITAL SIGNAL PROCESSING LABORATORY

0 0 2 1

SOFTWARE EXPERIMENTS: (15)

1) Compute DFT
2) FFT Algorithms
3) Linear filtering using FFT
4) Filtering of long data sequences
5) IIR filter design using BLT
6) IIR filter design using IIT
7) FIR filter design using windows
8) Analysis of Finite word length effects

HARDWARE EXPERIMENTS: (15)

1) Signal generation
2) Linear convolution
3) FIR filter
4) IIR filter

Total P: 30

TEXT BOOKS:

1.Vinay K Ingle and John G Proakis , "Digital signal processing using MATLAB", , Brooks / Cole, California, United States,2011.

REFERENCES:

1. Mitra S K , "Digital Signal Processing – A Computer based Approach", Tata McGraw Hill, New Delhi, 2010.
2. Vinay K Ingle, John G Proakis , "Digital signal processing using MATLAB", United States, Brooks / Cole, California, 2011.
3. B.Venkatramani,M.Bhaskar, ”Digital Signal Processor Architecture, Programming and Application”,McGrawhill,Second edition 2002.

23L611 VLSI DESIGN LABORATORY

0 0 4 2

SOFTWARE EXPERIMENTS:

1) Characteristics of NMOS and PMOS transistors
2) Design and Simulation of nMOS inverter, CMOS inverter, Pseudo nMOS inverter and obtaining its Transfer characteristics, Noise Margin
3) Power analysis of nMOS inverter, CMOS inverter and Pseudo NMOS inverter
4) Design of combinational Static CMOS circuits - Complementary CMOS, Pass transistors, Transmission gates
5) Design of combinational Dynamic CMOS circuits –Domino, npCMOS logic
6) Design and Simulation of simple combinational and sequential circuits using CMOS gates (Encoder, Multiplexer, Code Converters, Counters, Registers)
7) Design and Simulation of static and dynamic flip flops – C2MOS, Pseudo static, NORA CMOS
8) Design and Simulation of subsystem modules-Adders, Multipliers
9) Design and simulation of 6-T SRAM memory cell
10) Layout design of Digital logic circuits

Total P: 60

23L620 INNOVATION PRACTICES

0 0 2 1

- **Preparing a project – brief proposal including**
  - Problem Identification
  - A Statement of system / process specifications proposed to be developed (Block diagram / concept tree)
  - List of possible solutions including alternatives and constraints
  - Cost benefit analysis
  - Time line of activities

- **A report highlighting the design finalization (based on functional requirements & standards (if any))**

- **A Presentation including the following**
  - Implementation Phase (Hardware / Software / both)
  - Testing and validation of the developed system
  - Learning in the project
- **Consolidated report preparation**

Total P: 30

23Q613 ENHANCING PROBLEM SOLVING ABILITY WITH CODE

0 0 2 1

ENHANCING PROBLEM SOLVING ABILITY WITH CODE:
1. Compilation, Namespace, Header file, Data types, Variables, Declaration, Scope of variables
2. Input / Output, Type Conversion, Operators
3. For, While, Do-while, break, continue,.
4. Decision Making
5. Problem solving Pattern Programming
6. Arrays
7. Call by value & Call by reference, with and without arguments
8. Functions, Recursion & Strings
9. Structures & Union
10. Command Line Argument
11. Structure using Pointers
12. Handling Stress
13. Handling Peer pressure
14.Resume progress check

Total P: 30

REFERENCES:

1. GayleLaakmann McDowell, "Cracking the Coding Interview: 150 Programming Questions and Solutions", 5th Edition, S Chand Publishing, New Delhi, 2015.
2. John Mongan, Noah Kindler and Eric Giguère, “Programming Interviews Exposed: Secrets to Landing Your Next Job", 5th Edition, Wrox, New Delhi, 2018.

SEMESTER VII

23L701 RF PASSIVE AND ACTIVE CIRCUITS

3 0 0 3

MICROWAVE SOURCES: Introduction to Microwave frequencies and systems - RF behaviour of passive components- High frequency limitations of conventional tubes- Two cavity Klystron and Reflex klystron - Magnetron oscillator- Microwave solid state devices: Microwave Transistors - Gunn diode oscillators-Microwave network analysis-Scattering matrix. (9)

RF PASSIVE CIRCUITS: Basic properties of ferrite material - Ferrite based isolator-Phase Shifters-Circulator - Series and Parallel Resonant Circuits - Transmission Line Resonators- Microwave Resonators. (9)

COUPLERS AND FILTERS: Directional Couplers- Quadrature Hybrid Couplers - T-Junction Power Divider - Microwave Filters: Design by the Insertion Loss Methods- Implementation. (9)

RF ACTIVE CIRCUITS: Characteristics of RF Transistors- Gain and Stability - Single- Stage Transistor Amplifier Design - Oscillator Design - Detectors and Mixers. (9)

APPLICATIONS: Microwave radio stations –Diversity- system gain- Radio receiver architectures- RF section in cellular phone- Radar systems-Microwave heating-Biological effects and safety. (9)

Total: L: 45

TEXT BOOKS:

1.David M Pozar , "Microwave Engineering", Fourth Edition, John Wiley and Sons, 2017.
2. Liao Y.S , "Microwave devices and circuits", New Delhi, 2013, .

REFERENCES:

1. Reinhold Ludwig ,PavelBretchko , " RF Circuit Design: Theory and Applications", Asia Publication, 2012.
2.TomasiW , "Advanced Electronics communication System", Prentice Hall Inc, 2014.

23L711 RF AND MICROWAVE ENGINEERING LABORATORY

0 0 2 1

HARDWARE EXPERIMENTS :

1) Study of Klystron oscillator characteristics.
2) Study of GUNN diode characteristics
3) Determination of Directional Coupler characteristics
4) Determination of VSWR and reflection coefficient.
5) Determination of radiation pattern of horn antenna
6) Determination of radiation pattern and return loss of planar antenna.
7) Determination of characteristics of Directional Coupler and Filter using MIC Kit
8) Study of measurement of S-parameters of micro strip components using vector network analyzer

(15)

SOFTWARE EXPERIMENTS :

1) Design and Simulation of RF lumped element filters.
2) Design and Simulation of Filter using Microstrip line
3) Design and Simulation of Branch line coupler
4) Design and simulation of RF amplifier.

(15)

Total P: 30

REFERENCES:

1. David M Pozar , "Microwave Engineering", John Wiley and Sons, 2011.

23L712 DIGITAL COMMUNICATION ENGINEERING LABORATORY

0 0 2 1

HARDWARE EXPERIMENTS:

1) Scrambler and Descrambler
2) Linear Block Coder and decoder
3) Cyclic Coder and decoder
4) Convolutional Coder
5) Line Encoder and Decoder
6) Error performance of ASK, FSK and PSK schemes
7) Signal Transmission and Reception using Software Defined Radios
8) Spread Spectrum Systems - DSSS, FHSS (15)

SOFTWARE EXPERIMENTS:

1) Viterbi decoder for decoding Convolutional codes
2) Simulation of Synchronization & Equalization techniques
3) Modeling wireless fading channels
4) Simulation of OFDM with MIMO (15)

Total P: 30

REFERENCES:

1. Lathi B P , "Modern Digital and Analog communication Systems", Oxford University Press, 2017
2. Proakis J G, SalehiM , "Contemporary communication systems using MATLAB", PWS Publishing company, 2013.
3. Dennis Silage , "Digital Communication Systems Using MATLAB and Simulink", Bookstand Publishing, 2016.

23L720 PROJECT WORK I

0 0 4 2

Identification of a real time problem in thrust areas
Developing a mathematical model for solving the above problem
Finalization of system requirements and specification
Simulation / Implementation of different solutions for the problem based on literature survey
Future trends in providing alternate solutions
Consolidated report preparation of the above

Total P: 60

SEMESTER VIII

23L820 PROJECT WORK II

0 0 8 4

Identification of a real time problem in thrust areas
Developing a mathematical model for solving the above problem Finalization of system requirements and specification

Simulation / Implementation of different solutions for the problem based on literature survey
Future trends in providing alternate solutions
Consolidated report preparation of the above

Total P: 120

PROFESSIONAL ELECTIVES

23L001 FPGA BASED SYSTEM DESIGN

3 0 0 3

FPGA DESIGN FLOW AND ARCHITECTURES: Digital IC design flow-The role of FPGAs in digital design–Goals and techniques–Hierarchical design-CAD Tools. FPGA architectures–Configurable logic blocks-configurable I/O blocks–Programmable interconnect–clock circuitry–Xilinx FPGA architecture–Programming Technologies: Antifuse, SRAM, EPROM, EEPROM. (9)

VERILOG HDL: HDL overview-Modules and ports-compiler directives-data types-operands and operators-gate level modeling-data flow modeling-behavioral modeling-structural modeling–primitives-Tasks and functions- Writing test bench. (9)

ARCHITECTING SPEED AND TIMING ISSUES: High Throughput - Low Latency - Timing - Add Register Layers, Parallel Structures, Flatten Logic Structures, Register Balancing, reorder Paths. CLOCKING AND METASTABILITY: Set up time hold time–setup time hold time violations-critical path-calculation of maximum clock frequency– metastability - synchronizers-design examples. (9)

ARCHITECTING AREA AND POWER: Architecting Area - Rolling Up the Pipeline - Control-Based Logic Reuse - Resource Sharing - Impact of Reset on Area - Resources Without Reset, Resources Without Set, Resources Without Asynchronous Reset, Resetting RAM, Utilizing Set/Reset Flip-Flop Pins. Architecting Power - Clock Control, Clock Skew, Managing Skew, Input Control, Reducing the Voltage Supply, Dual-Edge Triggered Flip- Flops, Modifying Terminations. (9)

EMBEDDED SYSTEM DESIGN WITH FPGA : Processors - Interfaces - Zynq System-on-chip Development - IP based Design Hardware-Software Co-design for Zynq - Software Development Tools - Real-time Applications. (9)

Total L: 45

TEXT BOOKS:
1. Michael D. Ciletti, "Advanced Digital Design with the Verilog HDL", Second Edition, Pearson, 2011.
2. Steve Kilts, "Advanced FPGA Design Architecture, Implementation, and Optimization", First Edition, John Wiley & Sons, Inc.,Hoboken, New Jersey, 2007.

REFERENCES:
1. Crockett H. Louise, Ross A. Elliot, Martin A. Enderwitz, "The Zynq Book Embedded Processing with the ARM Cortex-A9 on the Xilinx Zynq-7000 All Programmable SoC", First Edition, Strathclyde Academic Media, 2014.
2. Charlet H. Roth, Lizy Kurian John, Byeong Kil Lee , "Digital Systems Design using Verilog", Cengage Learning, 2016.
3. Zainalabedin Navabi, "Verilog Digital System Design", Second Edition, McGraw-Hill Education, 2005.
4. Ming-Bo Lin, "Digital System Designs and Practices: Using Verilog HDL and FPGAs", First Edition, Wiley, 2008.

23L002 LOW POWER VLSI DESIGN

3 0 0 3

PRINCIPLES OF LOW POWER VLSI DESIGN: Need for Low power VLSI chips - Sources of Power Dissipation – Dynamic Power Dissipation - Charging and Discharging of Capacitance – Short Circuit Current in CMOS Circuits - CMOS Leakage current – Static Current - Basic Principles of Low Power VLSI Design. (9)

POWER ANALYSIS: Simulation power Analysis - Gate-Level Analysis - Architecture level Analysis – Data Correlation Analysis – Monte Carlo Simulation - Probabilistic Power Analysis Techniques. (9)

POWER REDUCTION AT THE CIRCUIT LEVEL: Transistor and Gate Sizing – Equivalent Pin Ordering – Network Restructuring and Reorganization – Special Latches and Flip Flops – Low Power Digital Cell Library – Adjustable Device Threshold Voltage. (9)

POWER REDUCTION AT THE LOGIC LEVEL: Gate Reorganization – Signal Gating – Logic Encoding – State Machine Encoding – Precomputation Logic. (7)

POWER REDUCTION AT THE ARCHITECTURE AND SYSTEM LEVEL: Power and Performance management – Switching Activity Reduction – Parallel Architecture with Voltage Reduction – Flow Graph Transformation - Advanced Techniques: Adiabatic Computation - Pass Transistor Logic Synthesis - Power Reduction in Clock Networks - CMOS Floating Node – Low Power Bus-Software power estimation and optimization techniques. (11)

Total L: 45

TEXT BOOKS:
1. Gary K Yeap, "Practical Low Power Digital VLSI Design", Kluwer academic publishers, 2012.
2. Kaushik Roy, Sharat C. Prasad, "Low Power CMOS VLSI circuit Design", John Wiley & Sons, 2009.

REFERENCES:

1. Kuo J B , Lou J H , "Low Voltage CMOS VLSI Circuits", John Wiley & Sons, 2001.
2. AP Chandrakasan, RW Brodersen, "Low Power Digital CMOS Design", Kluwer Academic Publishers, 1995
3. Abdelatif Belaouar, Mohamed I Elmasry, "Low-Power Digital VLSI Design: Circuits and Systems, Kluwer Academic Press, 1995.
4. Sasan Iman, Massoud Pedram, "Logic Synthesis for Low Power VLSI Designs" Kluwer Academic publishers, 1998.

23L003 SYSTEM ON CHIP DESIGN

3 0 0 3

SOC INTRODUCTION: Driving Forces for SoC- Components - Generic template- Design flow- Hardware/Software nature-Design Trade-Offs-Major Applications-SYSTEM-LEVEL DESIGN: Processor selection-Concepts in Processor Architecture: Instruction set architecture (ISA) -Robust processors: Vector processor, VLIW, Superscalar, CISC, RISC Processor Evolution: Soft and Firm processors, Custom-Designed processors-IP based design- on-chip memory. (10)

SYSTEM-LEVEL INTERCONNECTION: On-chip Buses: basic architecture, topologies, arbitration and protocols, Bus standards: AMBA, Core Connect, Wishbone, Avalon-Network-on-chip: Architecture-topologies-switching strategies- routing algorithms-flow control, quality-of-service-Reconfigurability in communication architectures. (9)

CO-DESIGN CONCEPTS : Nature of hardware & software- quest for energy efficiency- driving factors for hardware- software codesign- Codesign space-Dualism of Hardware design and Software design-Modeling Abstraction Level-Concurrency and Parallelism- Hardware Software tradeoffs- Introducing Dataflow modelling. (9)

SOC IMPLEMENTATION : Study of Microblaze RISC processor - Real-time operating system, peripheral interface and components, High-density FPGAs-Introduction to tools used for SOC design: Xilinx SoC based development kit. (12)

SOC TESTING : Manufacturing test of SoC: Core layer, system layer, application layer-P1500 Wrapper Standardization-SoC Test Automation. (5)

Total L: 45

TEXT BOOKS:

1. Michael J.Flynn, Wayne Luk , "Computer system Design: System-on-Chip", Wiley-India, 2012.
2. Sudeep Pasricha, Nikil Dutt , "On Chip Communication Architectures: System on Chip Interconnect", Morghan Kaufmann Publishers, 2008.

REFERENCES:

1. W.H.Wolf , "Computers as Components: Principles of Embedded Computing System Design", Elsevier, 2008.
2. Patrick Schaumont , "A Practical Introduction to Hardware/Software Co-design", 2nd Edition, Springer, 2012.
3. Lin, Youn-Long Steve , "Essential issues in SOC design: designing complex systems-on-chip", Springer, 2006.
4. William Hohl, " ARM Assembly Language: Fundamentals and Techniques" 2nd Edition, 2014.

23L004 MULTIMEDIA COMPRESSION TECHNIQUES

3 0 0 3

INTRODUCTION: Compression Techniques - Overview of information theory - lossless and lossy coding– Multimedia components and their characteristics -Text, sound, images, graphics, animation, video- Huffman coding – Non-Binary Huffman codes – adaptive Huffman coding. (8)

ARITHMETIC CODING AND DICTIONARY TECHNIQUES: Introduction- coding a sequence – generating deciphering the tag-Generating a binary code –Static and Adaptive dictionary – LZ77, LZ78, LZW approach – Applications - Facsimile encoding – run length coding – MH, MR, MMR and JBIG. Scalar and Vector Quantization. (10)

AUDIO COMPRESSION : Audio compression techniques - frequency domain and filtering - basic sub-band coding - application to speech coding - G.722 - application to audio coding - MPEG audio - silence suppression – speech compression techniques – Vocoders. (10)

IMAGE COMPRESSION : Predictive techniques - DPCM, DM - DCT,JPEG, Wavelet based compression: quad-trees, EZW, SPIHT, JPEG-2000. (9)

VIDEO COMPRESSION : Video signal representation –Motion compensation – MPEG standards - Motion estimation techniques - H.261 family of standards - VP9 standards-Motion video compression. (8)

Total L: 45

TEXT BOOKS:

1. Sayood Khaleed , "Introduction to data compression", 5th Edition, Morgan Kauffman, 2017.
2. Yun Q. Shi, Huifang Sun , "Image and Video Compression for Multimedia Engineering: Fundamentals, Algorithms, and Standards", third Edition, CRC Press, 2019.

REFERENCES:

1. Salomon D, "Data Compression The Complete Reference", Springer, 2014.
2. SalomonD, "A Guide to Data Compression Methods", Springer, 2012.
3. Ralf steinmetz and Klara Nahrstedt,"Multimedia Computing, Communications & Applications",1st Edition,Pearson,2002.
4. Iain E. Richardson,"The H.264 Video Compression Standard", Second Edition,wiley,2010.

23L005 ADVANCED DIGITAL SIGNAL PROCESSING

3 0 0 3

INTRODUCTION : DT signals and DT systems - DTFT - Random variables and random process – Autocorrelation function - Power spectral density. (5)

MULTIRATE SIGNAL PROCESSING : Down sampling - Up sampling - Noble identities - cascading sampling rate convertors - Decimation with transversal filters - interpolation with transversal filters - decimation with polyphase filters – interpolation with polyphase filters - decimation and interpolation with rational sampling factors - multistage implementation of sampling rate convertors. (10)

POWER SPECTRUM ESTIMATION : Non parametric methods - Periodogram - Modified Periodogram - Bartlett - Welch & Blackman Tukey methods - Performance comparison - Parametric methods - Auto Regressive spectrum estimation - Relationship between autocorrelation and model parameters - Moving Average and Auto Regressive Moving Average spectrum estimation. (10)

ADAPTIVE FILTERS : Introduction to Wiener Filter - Adaptive Filter Applications - System identification - Inverse modeling - Prediction - Interference Cancellation - Adaptive linear combiner - Performance function - Gradient and Minimum Mean Square error - Gradient search by steepest descent method - LMS algorithm - Convergence of LMS algorithm – Learning curve - Introduction to RLS algorithm. (10)

WAVELET TRANSFORMS : Need for Time Frequency Analysis - Short time Fourier transform - short comings of STFT – Need for Wavelets - Continuous time Wavelet Transform - Multi Resolution Analysis - Haar and Daubechies wavelet functions - Introduction to Discrete Wavelet Transform. (10)

Total L: 45

TEXT BOOKS:

1. Monson H.Hayes , "Statistical Digital Signal Processing and Modeling", John Wiley and Sons, 2015.
2. Ifeachor E C, Jervis B. W. , "Digital Signal Processing: A Practical Approach", Prentice Hall, 2015.

REFERENCES:

1. K.P.Soman, K.I.Ramach, N.G.Resmi , "Insight into Wavelets from Theory to Practice", Third Edition, PHI, 2015.
2. Jaideva C Goswami , Andrew K Chan , "Fundamentals of Wavelets – Theory, Algorithms and Applications", John Wiley and Sons, 2015.
3. Vaidyanathan P P, "Multirate Systems and Filter banks", Prentice Hall, 2008.
4. Bernard Widrow and Samuel D Stearns, "Adaptive Signal Processing", Prentice Hall, 2008.

23L006 DIGITAL SIGNAL PROCESSING SYSTEM DESIGN

3 0 0 3

COMPUTATIONAL ACCURACY IN DSP IMPLEMENTATIONS: Number Formats for Signals and Coefficients in DSP systems: Fixed Point Format, Double Precision Fixed Point Format, Floating Point Format, Block Floating Point Format. Dynamic Range and Precision - Sources of Error in DSP Implementations - A/D Conversion Errors – DSP Computational Errors - D/A Conversion Errors. (9)

ARCHITECTURES FOR PROGRAMMABLE DSP DEVICES: Basic Architectural Features-DSP Computational Building Blocks: Hardware Multiplier, Barrel Shifter, MAC Unit-Bus Architecture and Memory-Data Addressing Capabilities- Address Generation Unit- Speed Issues: Hardware Architecture - Parallelism – Pipelining – System level Parallelism and Pipelining- Architecture of TMS320C6748 Processors. (9)

DEVELOPMENT TOOLS FOR DSP IMPLEMENTATIONS: Introduction to Code Composer Studio (CCS) – DSP Software Development using CCS- Implementation of Basic DSP Algorithms: Q-notation, Convolution, FIR Filters, IIR Filters, Decimation Filters, PID Controller, Adaptive Filters –2D Signal Processing: Matrix Multiplication. (9)

IMPLEMENTATION OF FFT ALGORITHMS: FFT Algorithm for DFT Computation- Butterfly Computation – Overflow & Scaling – Bit Reversed Index Generation-8-point FFT Implementation on DSP processor- Computation of the Signal Spectrum. (9)

INTERFACING SERIAL CONVERTERS TO A PROGRAMMABLE DSP DEVICE: Synchronous Serial Interface-Multichannel Buffered Serial Port (McBSP)-McBSP Programming-CODEC Interface-CODEC Programming- CODEC, DSP Interface. (9)

Total L: 45

TEXT BOOKS:
1. Julien Osmalskyj, Jean-Jacques Embrechts, "Digital Signal Processing Application on the Texas Instrument C6748 Processor", Texas Instruments, 2014.
2. John G Proakis, Dimitris G Manolakis, "Digital Signal Processing", Prentice Hall India, 2013.

REFERENCES:
1. Venkataramani B, Bhaskar M, "Digital Signal Processors: Architecture, Programming & Applications", Tata McGraw Hill,2015.
2. TI , "Technical Reference Manuals for TMS320C6748", Texas Instruments, 2016.
3. Oppenheim A V , "Discrete Time Signal Processing", Prentice Hall India, 2014.
4. Mitra S K , "Digital Signal Processing – A Computer based Approach", Tata McGraw Hill, 2013.

23L007 DIGITAL IMAGE PROCESSING

3 0 0 3

DIGITAL IMAGE FUNDAMENTALS: Two dimensional signals and systems - Mathematical preliminaries, Image sensing and acquisition-CCD, CMOS, X-Ray, CT, MRI, Ultrasound, SAR, IR, Thermal-Imaging, Image processing system- Image formation-Sampling and Quantization - Neighbours of pixel – Distance measures, Color models. (8)

IMAGE TRANSFORMS: Discrete Fourier transform - properties – Discrete Cosine Transform - Properties - KL Transform and SVD. (8)

IMAGE ENHANCEMENT: Point Operations - Histogram Equalization technique - Spatial Filtering – Low pass filtering, Median filtering, Sharpening Filters - frequency domain – Homomorphic filtering, Color Image enhancement. Case Study: Image enhancement, noise removal operations in an image. (10)

IMAGE COMPRESSION: Image Compressions models - Variable length coding - Bit plane coding –- Predictive coding – JPEG, MPEG-2 Case Study: JPEG image compression using DCT coding. (9)

IMAGE SEGMENTATION AND REPRESENTATION: Discontinuity detection: Point, Line and Edge , Gradient operators ,combined detection - Thresholding – Region based segmentation - Representation schemes: chain codes – Boundary descriptors: Simple, Shapes , Texture – Morphology : dilation and erosion, opening and closing. Case Study: Image Analysis: License plate detection, CT image analysis, crack detection, Missing component detection. (10)

Total L: 45

TEXT BOOKS:
1. Rafael C Gonzalez, Richard E Woods, "Digital Image Processing", 4th Edition, Pearson, India, 2018.
2. Anil K Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India Pvt Ltd, New Delhi, 1995.

REFERENCES:
1. Jayaraman S, Esakkirajan S, Veerakumar T, "Digital Image Processing", 1st Edition, Tata McGraw Hill, New Delhi, 2020.
2. Rafael C Gonzalez, Richard E.woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Tata McGraw Hill, New Delhi, 2010.
3. Al.Bovik , "The Essential Guide to Image Processing", Academic Press, India, 2009.
4. Kenneth R Castleman, “Digital Image Processing”, Prentice Hall, New Delhi, 2008.

23L008 WIRELESS COMMUNICATION

3 0 0 3

INTRODUCTION: Cellular concept- system design fundamentals Handoff Strategies- Interference and system capacity, Improving Coverage and Capacity. (9)

WIRELESS CHANNEL MODELING : Free space propagation model, Reflection- Diffraction – Scattering - Log-normal shadowing. Small-scale multipath propagation, Types of small scale fading, Rayleigh and Ricean distribution, Input /output model of the wireless channel - Time and frequency coherence - Statistical channel models. (9)

MULTIPLE ACCESS SCHEMES AND DIVERSITY : FDMA, TDMA, CDMA, SDMA and CSMA, OFDMA. Diversity Techniques – Frequency diversity, Time diversity, Code diversity, Antenna diversity –RAKE Receiver - SIMO, MISO, MIMO, MIMO-OFDM Technique. (9)

CAPACITY OF WIRELESS CHANNELS : AWGN channel capacity – capacity of flat fading channels , Frequency- selective fading channels, Multiuser capacity, Downlink channel capacity, Uplink channel capacity, Outage capacity. (9)

EVOLUTION OF WIRELESS TECHNOLOGIES : Mobile Technologies – GSM- 3G-4G (LTE)- 5G NR AND 5G CORE NETWORK (5GCN)- 6G Technologies, Wireless LAN Technologies. (9)

Total L: 45

TEXT BOOKS:
1. Theodore S. Rappaport , "Wireless Communications", Pearson Education, 2017.

2. Andrea Goldsmith , "Wireless Communications", Cambridge University Press, 2012.

REFERENCES:

1. David Tse, Pramod Viswanath , "Fundamentals of Wireless Communication", Cambridge University Press, 2015.
2. Jonathan Rodriguez," Fundamentals of 5G Mobile Networks" John Wiley & Sons, Ltd, 2015.
3. Kamilo Feher , "Wireless Digital Communications, Modulation & Spread Spectrum Applications", PHI, 2015.
4. Andreas F. Molisch , "Wireless Communications", Wiley, 2011.

23L009 LONG TERM EVOLUTION TECHNOLOGIES

3 0 0 3

LTE INTRODUCTION AND NETWORK ARCHITECTURE: Motivation to LTE - Evolution of Architecture – Standardization process in 3GPP - Technologies for LTE - Network Architecture - Core Network - Access Network - Roaming Architecture - Protocol Architecture - Quality of service and EPS Bearers - S1 and X2 E-UTRAN Network Interfaces. (9)

CONTROL PLANE AND USER PLANE PROTOCOLS: Radio Resource Control - PLMN and Cell Selection - Paging – User Plane Protocol Stack - Packet Data Convergence Protocol - Radio Link Control - Medium Access Control. (8)

ORTHOGONAL FREQUENCY DIVISION MULTIPLE ACCESS & MIMO TECHNIQUES: History of OFDM Development - OFDM- OFDMA - Parameter Dimensioning. Fundamentals of Multiple antenna theory - MIMO Signal Model – Single User MIMO - Multi User MIMO - MIMO Schemes in LTE. (9)

PHYSICAL LAYER FOR DOWNLINK: Transmission Resource Structure - Signal Structure - Downlink operation. Synchronization and Cell Search - Synchronization sequences and cell search in LTE - Coherent versus Non-Coherent Detection. (9)

PHYSICAL LAYER FOR UPLINK : Uplink Physical Layer Design - SC- FDMA Principle - SC-FDMA Design in LTE. Uplink Physical channel structure - Physical uplink shared Data channel Structure - Uplink control channel Design - Multiplexing of control signaling - ACK/NACK Reception - Uplink transmission procedures- Timing Control - Power control. (10)

Total L: 45

TEXT BOOKS:

1. Stefania Sesia, Issam Toufik , Matthew Baker, "LTE – The UMTS Long Term Evolution: From Theory to Practice", John Wiley & Sons, 2011.
2. Christopher Cox, "An introduction to LTE – LTE, LTE-Advanced, SAE, VoLTE and 4G Mobile Communications", John Wiley & Sons, 2014.

REFERENCES:

1. Moray Rumney, "LTE and Evolution to 4G Wireless: Design and Measurement Challenges", Agilent Technologies, 2013.
2. Arunabha Ghosh, Jun Zhang, Jeffrey G. Andrews, Rias Muhamed, "Fundamentals of LTE", Prentice Hall Communications Engineering and Emerging Technologies, 2010
3. Erik Dahlman, Stefan Parkvall, Johan Skold, "4G: LTE/LTE-Advanced for Mobile Broadband", 2nd Edition, Academic Press, 2013.
4. Martin Sauter, "From GSM to LTE-Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", 3rd edition Wiley, 2017.

23L010 VEHICULAR SYSTEMS AND NETWORKS

3 0 0 3

BODY AND CONVENIENCE ELECTRONICS: Electronics in automotive , central body control module system - Lighting and Indicators - external lights, head light reflectors, lighting circuits - Gas discharge and LED lighting - Advanced lighting technology, new developments - Body electrical and electronics systems - washers, wipers, horns - Obstacle avoidance - Cruise control, seats, mirrors - Passenger compartment climate control - Ac unit design and operation - Climate control systems - Comfort and convenience system in door and roof. (12)

VEHICLE SAFETY SYSTEMS: Basic security - Top of the range security - Security coded ECU - Air bags and belt tensioners - Other security and control systems - Obstacle avoidance RADAR - Tire Pressure warning - Noise control. (6)

POWER TRAIN SYSTEM: Engine Management system - Combined ignition and fuel management — Exhaust emission control for diesel emissions - complete vehicle control system - Electric vehicles - Hybrid vehicles. (9)

AUTOMOTIVE NETWORKING: Bus systems - Technical principles - Buses for motor vehicles: CAN, FLEXRAY, LIN, MOST, ETHERNET, PS15 - Introduction to AUTOSAR. (8)

VEHICULAR ADHOC NETWORKS: Special Characteristics, Technical Challenges - DSRC spectrum and applications for VANET - IEEE Standards for MAC Protocols - Cluster based and Distributed MAC Protocols - Requirements for routing protocols and classifications - Network Mobility problems - NEMO basic support protocol. (10)

Total L: 45

TEXT BOOKS:
1. Tom Denton, "Automobile Electrical and Electronic Systems", 3rd Edition, Routledge Taylor and Francis Group, Newyork, 2000.
2. Bosch, "Automotive Handbook", 8th Edition, Wiley Eastern, Germany, 2011.

REFERENCES:
1. Nicholas Navet, Francois Simonot-Lion, "Automotive Embedded Systems Handbook", New York, 2009.
2. Dominique Paret, "Multiplexed Networks for Embedded Systems CAN, LIN, FlexRay, Safe", England, 2008.
3. Tom Denton, "Automobile Mechanical and Electrical systems", 2nd Edition, Routledge Taylor and Francis Group, Newyork, 2018.
4. Hassnaa Moustafa, Yan Zhang, "Vehicular Networks - Techniques, Standards and applications", CRC Press, 2009.

23L011 CRYPTOGRAPHY AND NETWORK SECURITY

3 0 0 3

SECURITY PROBLEM: Security Problem in Computing-Security services - Attacks-Mechanisms-Points of security vulnerability- Methods of defense-Controls-Effectiveness of control -Introduction to cryptography and steganography - Plan of attack on encryption – Security Standards. (9)

SYMMETRIC CRYPTOGRAPHY: Encryption and Decryption-substitution-transposition - Block ciphers-Data Encryption Standard- -advance Encryption Standard-Triple DES-RC5,Stream cipher- RC4 - Block Cipher modes - Differential & Linear Cryptanalysis. (9)

PUBLIC KEY ENCRYPTION: Number Theory basics - RSA-key management-Diffie-Hellman key exchange - Elliptic curve cryptography. (9)

MESSAGE AUTHENTICATION: Requirements of authentication - HASH functions –SHA algorithm-MD5 - HMAC- Digital signature standards. (9)

NETWORK AND SYSTEM SECURITY: Secure Socket layer- Transport Layer Security-E-mail Security - IP Security–Worms-Viruses-Intrusion detection system-Firewalls. (9)

Total L: 45

TEXT BOOKS:
1. William Stallings, "Cryptography & Network Security: Principles & Practices", Eighth Edition, Pearson Education Limited, 2022.
2. Behrouz A.Forouzan, Debdeep Mukhopadhyay, "Cryptography & Network Security", Tata McGraw Hill, 2018.

REFERENCES:
1. Charles P Pfleeger, Shari Lawrence Pfleeger, Jonathan Margulies, "Security in Computing", Pearson, 2018.
2. Eric Maiwald, ”Network Security A Beginner’s Guide”, Tata McGraw-Hill, 2013.
3. Charlie Kaufman, Radia Perlman, Mike Speciner, ”Network Security: PRIVATE Communication in a PUBLIC World”, PHI Learning Private Limited, 2012.
4. Tyler Wrightson ,”Wireless network security: A beginner's guide”, Tata McGraw-Hill, 2012.

23L012 SATELLITE COMMUNICATION

3 0 0 3

ELEMENTS OF SATELLITE COMMUNICATIONS AND ORBITAL ASPECTS: Brief history and current state of Satellite Communications - Satellite systems, Types of satellites, Transmission and Multiplexing-Modulation-Multiple access-advent of Digital satellite communications. The Equations of the Orbit - Locating the Satellite in the Orbit - Orbital elements - Look angle - Elevation and Azimuth calculations - Geostationary orbit - Visibility - Orbital perturbations - Orbital effects in Communication system performance. (12)

EXPANDABLE LAUNCH VEHICLE: Space Transportation System (STS) - The mechanics of Launching a Synchronous satellite - The rocket equation - Powered flight - Injection into final orbit and orbital manoeuvres - Mission possibilities - Low thrust variations. (8)

SPACE CRAFT: Space craft subsystems - Altitude and Orbit Control System - Telemetry, Tracking and Command (TT&C) - Power systems - Description of communication system - Transponder - Implementations – Transmission Impairments - Space Craft Antennas - Equipment reliability. (8)

SATELLITE LINK: Basic Transmission Theory - System noise temperature and G/T ratio - Calculation of system noise temperature - Noise figure - Downlinks and Uplinks - Limits on link performance - Design of Satellite links for specified (C/N) - Rain attenuation model, Modulation and Multiplexing techniques. (8)

SATELLITE SERVICES AND EARTH STATION: MSAT service, BSAT service, RADARSAT service, SAR SAT service, INTELSAT service, INMART SAT service, VSAT service, Satellite Navigation and the Global positioning system, Chandrayaan, Mangalyan, Earth station design for Low system noise temperature. (9)

Total L: 45

TEXT BOOKS:
1. Tri T Ha, "Digital Satellite Communications", Tata McGraw Hill, 2014.
2. Timothy Pratt, Charles W Bostian, Jeremy Allnutt, "Satellite Communications", John Wiley and Sons, 2015.

REFERENCES:
1. Richaria M, "Satellite Communication Systems Design Principles", McGraw Hill, 2012.
2. Coolen M, "Satellite Communication", IEEE Publication, 2010.
3. Dennis Roddy, "Satellite Communications", Fourth, McGraw Hill, 2017.
4. Varsha Agrawal, Anil K. Maini "Satellite Communications" Wiley, 2010.

23L013 WIRELESS SENSOR NETWORKS

3 0 0 3

INTRODUCTION: Challenges and constraints - Comparison of sensor network with Adhoc network - WSN Applications - case studies related to Structural monitoring - Healthcare, Precision Agriculture - Underground mining. (9)

ARCHITECTURE: Single node architecture - sensing subsystem - processing subsystem - communication interfaces - Operating systems - Network architecture - Sensor network scenarios - Design principles – Gateway Concepts. (9)

MEDIUM ACCESS CONTROL: MAC protocols - MAC low duty cycle protocols and wake up concepts - contention-based protocols - SMAC, IEEE 802.15.4 MAC. (9)

ROUTING IN WIRELESS SENSOR NETWORKS: Energy-efficient unicast - Broadcast and multicast - Data centric Routing protocols in WSNs - Data Aggregation, Hierarchical Routing protocols Location based routing protocols. (9)

NODE AND NETWORK MANAGEMENT: Power Management - Local Power Management Aspects - Time Synchronization in Wireless Sensor Networks - Ranging techniques - Range based Localization - range free localization. (9)

Total L: 45

TEXT BOOKS:
1. HolgerKarl, Andreas willig, "Protocol and Architecture for Wireless Sensor Networks", John wiley publication, 2007.
2. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", Wiley, 2010.

REFERENCES:
1. **FeiHu, Xiaojun Cao, "Wireless Sensor Networks, Principles and Practice", CRC Press, 2010.**
2. Sudip Misra, Isaac Woungang, Subhas Chandra Misra, "Guide to Wireless Sensor Networks", Springer, 2009.
3. KazemSohraby, Daniel Minoli, TaiebZnati, "Wireless Sensor Networks: Technology, Protocols, and Applications", John Wiley & Sons, 2007.
4. Ian Akyildiz, Mehmet Can Vuran, "Wireless Sensor Networks", John Wiley & Sons, USA, 2010.

23L014 RADAR COMMUNICATION

3 0 0 3

INTRODUCTION TO RADAR: Basics of radar, EM Waves & properties- applications of radar, radar frequencies- radar block diagram, Radar Coordinates, Radar equation for hard targets and the SNR-radar cross section of targets, Radar Resolution Elements, Pulse, CW and FMCW Radars–configurations, transmitter power- pulse repetition frequency, Duty Ratio, Pulse Compression, Coding. (9)

DETECTION OF SIGNALS IN NOISE AND RADAR WAVEFORMS: probability density functions – probabilities of detection and false alarm-matched filter receiver-detection criteria – integration of radar pulses - constant-false alarm rate receivers - Radar Waveforms, Pulse Compression, Ambiguity Diagram. (9)

RADAR TRANSMITTER AND RECEIVER: Introduction- Types of Transmitters - linear-beam power tubes- solid-state RF power sources- magnetron- Klystron, crossed-filed amplifier- radar receiver- receiver noise figure- super heterodyne receiver, Digital Receivers, duplexers and receiver protectors- radar displays-Human Machine Interface(HMI). (9)

RADAR ANTENNA: Functions of radar antenna- antenna parameters- antenna radiation pattern and aperture illumination - reflector antennas- electronically steered phased array antennas- phase shifters – frequency - scan arrays-- architectures for phased arrays , radiators for phased arrays- mechanically steered planar array antennas- radiation pattern synthesis -effect of errors on radiation patterns - low side lobes antennas. (9)

MTI AND PULSE DOPPLER RADAR: Introduction to Doppler and MTI radar- delay –line cancellers- staggered pulse repetition frequencies- doppler filter banks- digital MTI processing - Moving target detector- limitations to MTI performance- pulse Doppler radar-MTD, Tracking radar- monopulse tracking- conical scan and sequential lobing- comparison of trackers. tracking accuracy-low-angle tracking- Atmospheric & Weather Radars: Precipitation Radars, Doppler Weather Radar, Polarimetric Radar, Clear Air Radars. (9)

Total L: 45

TEXT BOOKS:
1. Merril I Skolnik, "Introduction to Radar Systems", Mc Graw-Hill, 2017.
2. Peebles P Z, "Radar Principles", Wiley, 2016.

REFERENCES:
1. Richard J Doviak, Dusan S Zrnic , "Doppler Radar and Weather Observations", Academic Press, 2014.
2. Bringi V N, Chandrasekar V , "Polarimetric Doppler Weather Radar", Cambridge University Press, 2012.
3. Richards M A, Scheer J A and Holm W A , "Principles of Modern Radar", Scitech Publishing, 2014.
4. Levanon N, "Radar Signals", Wiley-IEEE Press, 2012.

23L015 EMC TEST AND MEASUREMENTS

3 0 0 3

NATURE AND ORIGINS OF ELECTROMAGNETIC COMPATIBILITY: Introduction – Visualising the EMI problem - Source of EMI – EMI coupling to victim equipments - Intersystem and Intrasystem EMI – Historical background - Technical disciplines and Knowledge areas within EMC - Electrical engineering – Physics –Mathematical modeling – Limited chemical knowledge – - System engineering – Legal aspects of EMC. (9)

EMC STANDARDS AND SPECIFICATIONS: The need for standards and specifications – The need to meet EMC standards - Derivation of military standards – Derivation of commercial standards– - Outline of EMC testing - Types of EMC testing – Preconformance test measurements - Implication of repeatability of EMC measurements - Introduction to EMC test sensor - Conduction and Induction couplers – Radiative coupling - EMC antennas. (9)

MEASUREMENT DEVICES FOR CONDUCTED EMI : Introduction – Measurement by direct connection - Inductively coupled devices - EMC antennas – Basic antenna parameters - Antennas for radiated emission testing – Wideband antennas - Magnetic field antennas – Use of antennas for radiated susceptibility testing - Type of antennas used in susceptibility testing – Standards requiring immunity tests. (9)

RECEIVERS, ANALYSERS AND MEASUREMENT EQUIPMENT: EMI receiver - Spectrum Analyzers - RF power meter Frequency meters - Instrumentation for susceptibility testing – Automatic EMC tests - Electromagnetic transient testing – Transient types – Continuous and transient signal – - ESD-electrostatic discharge. (9)

DESIGNING TO AVOID EMC PROBLEMS: Intrasystem and Intrasystem EMC – - Design for formal EMC compliance Achieving product EMC :checklists for product development and testing - Introduction – Developing an approach to EMC design - Process flow chart, - EMC strategy – Self certification. (9)

Total L: 45

TEXT BOOKS:
1. David Morgan , "A Handbook for EMC Testing and Measurement", IET Electrical Measurement, 2012.
2. Tim Williams , "EMC for Product Designers", 5th Edition, Newnes Elsevier, 2017.

REFERENCES:
1. Clayton R. Paul , "Introduction to Electromagnetic Compatibility", Wiley Press, 2014.
2. C.Christopoulos, Principles and techniques of electromagnetic compatibility, 2nd ed. Boca Raton, Fla.: CRC Press, 2018.
3. Prasad V K, Engineering Electromagnetic Compatibility – Principles, Technologies and Computer Models, 2nd ed. BSP Books, 2010.
4. Dr Kenneth L Kaiser, “The Electromagnetic Compatibility Handbook”, CRC Press 2005.

23L016 COMPUTATIONAL ELECTROMAGNETICS

3 0 0 3

FINITE DIFFERENCE METHODS: Finite difference schemes; Forward difference - backward difference - central difference. Laplace Equation- Poisson Equation. Accuracy and stability analysis examples. (9)

FINITE DIFFERENCE TIME AND FREQUENCY DOMAIN: Maxwell's Partial derivative equation system - Maxwell's finite difference time domain system- Maxwell's finite difference frequency domain system- Introduction to boundary conditions- Absorbing boundary conditions. (9)

VARIATIONAL METHODS: Operators in linear space- calculus of variations- Rayleigh-Ritz method - method of weighted residuals-Collocation method- Galerkin method. (9)

FINITE ELEMENT METHOD: Motivation and background- Finite element method from weighted residuals. Formulation- basis function- mapping. Poisson equation - time domain finite element method- Analysis of examples. (9)

METHOD OF MOMENTS: Galerkin method integral equation - Integral equation to matrix form. Pocklington integral - Hallen integral convergence comparison - Antenna example-Simulation exercises. (9)

Total L: 45

TEXT BOOKS:
1. Mathew. N.O. Sadiku, "Computational Electromagnetics with Matlab", CRC Press, 2019.
2. David B. Davidson, "Computational Electromagnetics for RF and Microwave Engineering", Cambridge university press, 2014.

REFERENCES:
1. Walton C Gibson, "The Method of Moments in Electromagnetics", CRC Press, 2014.
2. Peterson, Scott L Ray and Raj Mittra, "Computational Methods for Electromagnetics", IEEE Press Series on Electromagnetic Wave Theory, 1998.
3. Roger F Harrington, "Field Computation by Moment Methods", IEEE Press, 1993.
4. Mathew. N.O. Sadiku, "Numerical Techniques in Electromagnetics with Matlab", CRC Press, 2009.

23L017 SMART ANTENNAS

3 0 0 3

INTRODUCTION: Antenna gain, Phased array antenna, Power pattern, Beam steering, Degree of freedom, Optimal antenna, Adaptive antennas, Smart antenna - Key benefits of smart antenna technology, Wide band smart antennas. (9)

NARROW BAND PROCESSING: Signal model, Conventional beamformer, Null steering beamformer, Optimal beamformer, Optimization using reference signal, Beam space processing. (8)

ADAPTIVE PROCESSING: Sample matrix inversion algorithm, Least Mean Square(LMS) algorithm, Perturbation algorithms, Neural network approach, Adaptive beam space processing. (9)

BROADBAND PROCESSING: Tapped delay line structure, Partitioned realization, Derivative constrained processor, Digital beam forming, Broad band processing using DFT method. (9)

DIRECTION OF ARRIVAL(DOA) ESTIMATION METHODS: Spectral estimation methods, linear prediction method, Maximum entropy method, Maximum likelihood method, Eigen structure methods, MUSIC algorithm, ESPRIT algorithm. diversity combining: Spatial diversity selection combiner, Switched diversity combiner, Equal gain combiner, Maximum ratio combiner, Optimal combiner. (10)

Total L: 45

TEXT BOOKS:
1. Lal Chand Godara, Smart Antennas, CRC press, 2018.
2. Constantine A. Balanis, Panayiotis I. Ioannides, Introduction to Smart Antennas, Morgan & Claypool, 2014.

REFERENCES:
1. Frank Gross, Smart Antennas with MATLAB, McGraw-Hill Education, 2015.
2. Robert A Monzingo, Introduction to Adaptive Arrays: 2nd Edition, Yesdee, 2012.
3. Joseph C Liberti.Jr and Theodore S Rappaport, Smart Antennas for Wireless Communication: IS- 95 and Third Generation CDMA Applications, Prentice Hall, 1999.
4. Paul R.P. Hoole,"Smart Antennas and Electromagnetic Signal Processing in Advanced Wireless Technology", CRC Press, 2020.

23L018 WIRELESS SYSTEMS AND STANDARDS

3 0 0 3

CELLULAR STANDARDS AND WIRELESS SYSTEMS: Introduction to 2G GSM - Advanced Mobile Phone Systems (AMPS) - Global System for Mobile Communication - Universal Mobile Telecommunications Systems (UMTS).and 3G - Standardization process in 3GPP-Technologies for LTE - Network Architecture - Core Network- Access Network – EPS bearers- Network Interfaces- Control Plane and User Plane Protocols – LTE Advanced – Performance of LTE and LTE Advanced. (10)

5G: Building blocks for 5G – 5G Use Cases and System Concept – 5G Architecture – 5G Radio Access Technologies - Simulation Methodology. (8)

THE IEEE 802.11 WLAN STANDARD: Introduction to IEEE 802.11 - General Description - Medium Access Control (MAC) - Physical Layer for IEEE 802.11 Wireless LANs; Radio systems - IR Systems Applications. (9)

THE IEEE 802.16 WIMAX STANDARD: Introduction to IEEE 802.16 - General Description - Medium Access Control (MAC) - Radio systems - Physical Layer- Evolution to 802.16m - Bluetooth – Zigbee. (9)

WIFI6: PPDU Formats – Single user and multiuser operation – Security – WiFi 6E - Deployment – Beyond WiFi 6. (9)

Total L: 45

TEXT BOOKS:
1. Assuncion Santamaria, Francisco Lopez-Hern, "Wireless LAN Standards and Applications", Artech House, 2001.

2. Afif Osseiran, Jose F. Monserrat and Patrick Marsch, “5G Mobile and Wireless Communication Technology”, Cambridge University Press, 2016.

REFERENCES:

1. Wei Xiang, Kan Zheng, Xuemin Shen, - 5G Mobile Communications, Springer, 2017.
2. Tamal Chakraborty, Iti Saha Misra , Ramjee Prasad, “VoIP Technology: Applications and Challenges”, Springer, 2019
3. Susinder R. Gulasckaran, Sundar G. Sankaran, “WI-FI 6: Protocol and Network”, Artech House, 2021.
4. Christopher Cox, “An Introduction To LTE: LTE, LTE-Advanced, SAE VoLTE and 4G Mobile Communications”, 2nd Edition, Wiley, 2014.

23L019 RFID SYSTEM DESIGN AND TESTING

3 0 0 3

RFID PRINCIPLES AND SYSTEMS: RFID Principles-Near-field based RFID – Properties of Magnetic field – Far-field based RFID – Properties of Backscatter RF Systems – Modulation techniques – Frequency based property comparison of RFID Systems. (9)

RFID STANDARDS AND PROTOCOLS: RFID Industry standards: EPC global – ISO15693 Vicinity cards and RFID – ISO14443 Proximity cards and RFID – The NFC forum – Reading collocated RFID tags: Query Tree protocol – Query Slot protocol. (9)

RFID OPERATING PRINCIPLES: RFID Tag components: RFID tag types – the 1-Bit Transponder and Chipless Tags – RFID readers and middleware component – Communication fundamentals: Coupling, Data encoding, multi-path effect – Tag, Reader and sensor communication. (9)

RFID DATA INTEGRITY AND SECURITY: The checksum procedure – Multiaccess procedures – Attacks on RFID Systems – Protection by Cryptographic measures. (9)

RFID ENABLED SENSORS AND APPLICATIONS: RFID enabled Sensors: Antenna design challenges – IC design – Integration of sensors and RFID – Power consumption and Link budget. Applications: Contactless smart cards – Access control – Electronic passport – Industrial Automation – Medical applications – Challenges and opportunities. (9)

Total L: 45

TEXTBOOKS:

1. Roy Want, “RFID Explained”, Springer, 2022.
2. Amin Rida, Li Yang, Manos M. Tentzeris, “RFID Enabled Sensor Design and Applications”, Artech House, 2010

REFERENCES:

1. Klaus Finkenzeller, “RFID Handbook”, 3rd Edition, Wiley, 2010
2. Syed Ahson, Mohammad Ilyas, “RFID Handbook”, CRC Press, 2008
3. Paris Kitsos, “Security in RFID and Sensor Networks”, CRC Press, 2016.

23L020 DIGITAL SWITCHING SYSTEMS

3 0 0 3

DIGITAL SWITCHING : Functions of a switching system- Classification-Message, packet and circuit switching – Electronic switching-Reed electronic systems - Switching networks- Single stage networks - cross point switches - gradings- forms of grading - Link systems-2, 3 and 4 stage networks -Space and Time switching - time division switching networks – PBX switches. (13)

SWITCHING SYSTEMS CONTROL AND SIGNALLING METHODS : Introduction-digital switching system fundamentals and evolution - call processing functions-common control-stored program control - Processor- Distributed processing - software-The 5ESS switching system - Review of dc signaling over audio frequency lines FDM carrier systems-Out-band and in –band signaling-PCM signaling - Inter register signaling- common channel signaling- Digital customer line signaling. (13)

TRAFFIC ENGINEERING : Introduction to traffic and queuing Theory - Network Traffic Load and Parameters – Grade of Service Blocking Probability - Incoming traffic and service time characterization. (7)

TELEPHONE NETWORK ORGANISATION : Analog and Digital networks - Subscriber Loop System – Switching Hierarchy and Routing - Transmission Plan and Transmission Systems - Numbering, Charging. (6)

MOBILE SWITCHING : The cellular concept - analog and digital network elements - channels-initialization- signaling - channel assignment-handoff digital cells.-fading and path loss - digital cells-fading and path loss. (6)

Total L: 45

TEXT BOOKS:

1. Flood J E , "Telecommunications switching, Traffic and Networks", Pearson Education Ltd., 2011.
2. Viswanathan T , "Telecommunication Switching Systems and Networks ", Prentice Hall of India, 2015.

REFERENCES:

1. Syed R. Ali, “Digital Switching Systems: System Reliability and Analysis”, McGraw Hill Education; 1st edition, 2017.
2. StephenW Gibson , "Cellular Mobile Radio Telephones", Prentice Hall of India, 2015.
3. John Ronayne , "An Introduction to Digital Communications switching", Wheeler publishing, 2012.
4. David J Goodman , "Wireless Personal Communication Systems", Addison Wesley Inc, 2010.

23L021 PATTERN RECOGNITION AND MACHINE LEARNING

3 0 0 3

PATTERN CLASSIFIER : Pattern recognition overview-Feature extraction-Statistical Pattern Recognition-Supervised &Unsupervised Learning; Bayes decision Theory, Linear discriminant functions, Pattern classification by distance functions – Minimum distance pattern classifier. (9)

STRUCTURAL PATTERN RECOGNITION: Elements of formal grammars –String generation as pattern description – Recognition of syntactic description –Parsing –Stochastic grammars and applications –Graph based structural representation. (8)

COMPUTATIONAL LEARNING THEORY: Basics , Types of Learning - Designing a learning system – concept learning -Find-s – Candidate Elimination - PAC Learnabilty- Sample complexity for finite and Infinite hypothesis spaces-VC Dimension. (9)

LINEAR MODELS: Linear Models For Regression – Linear Regression Models, Maximum Likelihood Estimation – Least Squares, The Bias-Variance Decomposition, Bayesian Linear Regression, Linear Models for Classification, Linear Discriminant Analysis. (9)

NEURAL NETWORKS AND KERNEL METHODS: Neural Networks - Feed-forward Networks - Network Training – Delta Rule-Gradient Descent - Error Backpropagation - Constructing Kernels - Radial Basis Function Networks- Gaussian Processes - Maximum Margin Classifiers – SVM. (10)

Total L: 45

TEXT BOOKS:

1. Christopher Bishop, "Pattern Recognition and Machine Learning", Springer-Verlag, New York, 2016.
2. Narasimha Murty, Susheela Devi V, "Pattern Recognition: An Algorithmic Approach", Pattern Recognition: An Algorithmic Approach, India, 2011.

REFERENCES:

1. Friedman, Menahem, and Abraham Kandel. Introduction to pattern recognition: statistical, structural, neural and fuzzy logic approaches. Vol. 32. World Scientific Publishing Company, 2022.
2. Singh, Himanshu. Practical Machine Learning and Image Processing: For Facial Recognition, Object Detection, and Pattern Recognition Using Python. Apress, 2019.
3. Yin, Peng-Yeng, ed. Pattern Recognition: Techniques, Technology and Applications. BoD–Books on Demand, 2017.
4. Sergios T, Konstantinos K, "Pattern Recognition", 4th Edition, Academic Press, 2008.

23L022 COMPUTER AND MACHINE VISION

3 0 0 3

IMAGE ACQUISITION: Introduction – Illumination – Lenses – Cameras – Camera-Computer interfaces – 3D Image Acquisition Devices. (7)

MACHINE VISION ALGORITHMS: Fundamentals Data Structures – Image Enhancement – Geometric Transformations – image Segmentation – Feature Extraction – Morphology Edge Extraction – Segmentation and Fitting of Geometric primitives – Camera calibration – Stereo Reconstruction – Template matching – Optical Character Recognition. (12)

MACHINE VISION APPLICATIONS: Reading of Serial numbers – Inspection of Ball Grid Arrays – Pose verification of resistors – 3D Pick and Place. (10)

COMPUTER VISION IMPLEMENTATION: Setting up OpenCV – Handling files, Cameras and GUIs – Processing Images with OpenCV – Depth Estimation and Segmentation. (7)

HARDWARE IMPLEMENTATION: Working with images using OpenCV – Drawing geometric shapes with OpenCv and Numpy – Working with a USB webcam - Capturing images and videos using Rpi camera – Arithmetic operations on images – Creating a negative of an image. (9)

Total L: 45

TEXT BOOKS:

1. Steger, Carsten, Markus Ulrich, and Christian Wiedemann. Machine vision algorithms and applications. John Wiley & Sons, 2018.
2. Bradski, Gary, and Adrian Kaehler. Learning OpenCV: Computer vision with the OpenCV library. " O'Reilly Media, Inc.", 2008.

REFERENCES:
1. Howse, Joseph, and Joe Minichino. Learning OpenCV 4 Computer Vision with Python 3: Get to grips with tools, techniques, and algorithms for computer vision and machine learning. Packt Publishing Ltd, 2020.
2. Solem, Jan Erik. Programming Computer Vision with Python: Tools and algorithms for analyzing images. " O'Reilly Media, Inc.", 2018.
3. Pajankar, Ashwin. Raspberry Pi Computer Vision Programming: Design and implement computer vision applications with Raspberry Pi, OpenCV, and Python 3. Packt Publishing Ltd, 2020.
4. Davies, E. R, "Machine vision: theory, algorithms and practicalities", Elsevier, 2006.

23L023 NANO ELECTRONICS

3 0 0 3

NANO ELECTRONICS AND SCALING: Introduction to Nanoelectronics – Classical and quantum systems – Current CMOS device technology- International Technology Roadmap for Semiconductor projections – Scaling principles – General scaling, Characteristic scale length – Limits to scaling – Quantum mechanics, Atomistic effects, Thermodynamic Effects, Practical considerations – Power constrained scaling limits. (9)

PHYSICAL PROPERTIES OF NANO SCALE STRUCTURES: Energy subbands and Density of States in nanoscale structures – Electron transport in a Two Dimensional electron gas – Resistance of a ballistic semiconductor – Landauer formula – Transmission probability calculation – Resonant tunnelling effect – Coulomb blockade – Quantization of thermal conductance in ballistic nanostructures. (9)

SINGLE ELECTRON, SESO AND CNT DEVICES: Introduction – Quantum Dot transistor – structure and fabrication – Quantum Cellular Automata – Single Electron and Single Hole Quantum Dot transistor – Artificial atom – Single Electron MOS Memory – structure and fabrication - SESO Transistor – SESO Memory – CNT transistor – CNT based Field Emission devices. (9)

SPINTRONICS AND MOLECULAR NANODEVICES: Introduction – Spin filters – Spin diodes – Spin transistors – Spin based optoelectronic devices – Electrical conduction of molecules – Manipulation of single molecules – Molecular motors – Molecular nanoactuators – Molecular electronic devices – Molecular based optic devices. (9)

FABRICATION TECHNIQUES: Optical lithography – Electron beam lithography – X –Ray lithography - Focussed Ion beam lithography – Nanoimprint lithography – Pulsed laser deposition – Sputter deposition – Chemical Vapour Deposition – Wet and dry etching techniques – Chemical Mechanical Polishing. (9)

Total L:45

TEXT BOOKS:
1. Mircea Dragoman and Daniela Dragoman, "Nanoelectronics Principles and Devices", Artech house, Boston, 2008.
2. Shunri Oda and David Ferry, "Silicon Nanoelectronics", CRC Press, Taylor & Francis Group, USA, 2019.

REFERENCES:
1. Karl Goser, Peter Glosekotter, Jan Dienstuhl, "Nanoelectronics and Nanosystems: From Transistors to Molecular Quantum Devices", Springer, New York, 2004.
2. W.R.Fahrner, "Nanotechnology and Nanoelectronics: Materials, Devices, Measurement Techniques", Springer (India), New Delhi, 2011.
3. Rainer Waser,"Nanoelectronics and Information Technology: Advanced Electronic Materials and Novel Devices", Wiley – VCH, Germany, 2012.
4. George W. Hanson, "Fundamentals of Nanoelectronics", Pearson, New Delhi, 2012.

23L024 EMBEDDED LINUX

3 0 0 3

INTRODUCTION: Embedded Linux - Real Time Linux - Types of Embedded Linux - Reason for choosing Linux - Design and Implementation methodology - Types of Host/Target Development setup - Types of hosts/Target Debug setup. (9)

ARCHITECTURE OF EMBEDDED LINUX: Generic architecture of an Embedded Linux System - System Startup - Types of Boot configuration - Selecting the kernel - Configuring the kernel - Compiling the kernel - Installing the kernel. (9)

DEVELOPMENT TOOLS: GNU Cross-platform development tool chain - debugging - tracing & profiling tools - binary utilities - kernel debugging - debugging in Embedded Linux applications. (9)

REALTIME LINUX: Real-Time Operating System - Interrupt latency - ISR duration - Scheduler latency - Scheduler duration - User space Real Time - Real-Time programming in Linux. (9)

PORTING APPLICATIONS: Introduction to Beagle bone - Porting of Embedded Linux prebuilt images - Communicating with boards – Controlling the Beagle board – Bone script. (9)

Total L: 45

TEXT BOOKS:
1. Karim Yaghmour, Jon Masters, Gilad Ben-Yossef and Philippe Gerum. “Building Embedded Linux Systems”, O’Reilly Media Inc, 2008.
2. P. Raghavan, Amol Lad , Sriram Neelak, “Embedded Linux System Design and Development”, Auerbach Publications , 2019.

REFERENCES:
1. Christopher Hallinan, “Embedded Linux Primer”, New Delhi 2006.
2. Derek Molloy, “Exploring BeagleBone: Tools and Techniques for Building with Embedded Linux”, John Wiley & Sons , 2019.
3. Holt A, Huang CY. Embedded operating systems. Springer-Verlag, London; 2018.
4. Steven Barrett, Jason Kridner, “Bad to the Bone: Crafting Electronic Systems with BeagleBone Black”, Springer International Publishing, 2022.

23L025 OPERATING SYSTEMS

3 0 0 3

INTRODUCTION: Operating system - Functions - Evolution of Operating Systems - Structure of operating system - Monolithic and Micro Kernel structures – System Calls – Types of System Calls – System programs – System boot. (8)

PROCESS MANAGEMENT: Introduction to processes - Scheduling objectives - Scheduling Criteria - Types of scheduling algorithms - Performance comparison - Inter-process communications - Synchronization - Semaphores - Deadlock - Prevention, Recovery, Detection and Avoidance - Classical problems in concurrency - Threads, Thread models - Multithreading. (12)

MEMORY MANAGEMENT: Introduction - Contiguous allocation - Buddy System - Paging - Structure of Page Table - Swapping - Segmentation - Segmentation with paging - Virtual Memory concepts - Demand Paging - Page Replacement Algorithms. (8)

FILE MANAGEMENT: File Systems - Files - Directories - File System Implementation - Allocation methods - Free Space management - Security - Protection mechanisms, Disk structure - Disk Scheduling Algorithms - RAID Levels. (8)

LINUX: Linux Architecture - Kernel - Shell Programming - Process Management - Memory Management - File Systems - Input and Output - Inter-process Communication. (9)

Total L: 45

TEXT BOOKS:
1. Silberschatz A, Galvin P and Gagne G, “Operating System Concepts”, John Wiley & Sons, Singapore, 2018.
2. William Stallings, “Operating Systems: Internals and Design Principles”, Pearson, New Delhi, 2019.

REFERENCES:
1. Ann Mclver, McHoes and Ida M Flynn, ”Understanding Operating Systems,” Cengage Learning India Pvt Ltd, USA, 2017.
2. Mukesh Singhal and Niranjan G Shivaratis, “Advanced Concepts in Operating Systems”, Tata McGraw-Hill, New Delhi, 2008.
3. Deitel H M,” An Introduction to Operating Systems”, Pearson Education, New Delhi, 2011.
4. Crowley Charles, “Operating systems: a design-oriented approach”, McGraw-Hill Professional, 2018.

23L026 ADVANCED COMPUTER ARCHITECTURE

3 0 0 3

COMPUTER ABSTRACTIONS AND TECHNOLOGY: Introduction - Concepts in Computer Architecture - Hardware and Software Interface - Components of Computer Organization - Technologies for Building Processors and Memory - Performance - The Power Wall - The Switch from Uniprocessors to Multiprocessors - Case study : Benchmarking the Intel Core i7. (8)

THE RISC-V INSTRUCTIONS: Operations of the Computer Hardware - Operands of the Computer Hardware - Signed and Unsigned Numbers - Representing Instructions in the Computer - Logical Operations - Instructions for Making Decisions - RISC-V Addressing for Wide Immediates and Addresses - Parallelism and Instructions: Synchronization - Translating and Starting a Program - MIPS Instructions - RISC-V Instruction Set. (8)

THE RISC-V PROCESSOR: Introduction - Logic Design Conventions - Building a Datapath - A Simple Implementation Scheme - An Overview of Pipelining - Pipelined Datapath and Control - Data Hazards: Forwarding versus Stalling - Control Hazards - Exceptions - Parallelism via Instructions - Case study : The ARM Cortex-A53 and Intel Core i7 Pipelines. (9)

MEMORY HIERARCHY: Memory Technologies - The Basics of Caches - Measuring and Improving Cache Performance - Dependable Memory Hierarchy - Virtual Machines - Virtual Memory - A Common Framework for Memory Hierarchy - Using a Finite-State Machine to Control a Simple Cache - Parallelism and Memory Hierarchy: Cache Coherence, Redundant Arrays of Inexpensive Disks - Case study: The ARM Cortex-A53 and Intel Core i7 Memory Hierarchies. (10)

PARALLEL PROCESSORS: The Difficulty of Creating Parallel Processing Programs - SISD, MIMD, SIMD, SPMD, and Vector - Hardware Multithreading - Multicore and Other Shared Memory Multiprocessors - Introduction to Graphics Processing Units -

Clusters, Warehouse Scale Computers, and Other Message Passing Multiprocessors - Introduction to Multiprocessor Network Topologies - Communicating to the Outside World: Cluster Networking - Multiprocessor Benchmarks and Performance Models - Case study: Benchmarking and Rooflines of the Intel Core i7 960 and the NVIDIA Tesla GPU 540. (10)

Total L: 45

TEXT BOOKS:
1. David A. Patterson and John L. Hennessy, "Computer Organization and Design The Hardware/Software Interface: RISC-V Edition", Morgan Kaufmann / Elsevier, 2018.
2. Kai Hwang, Naresh Jotwani, "Advanced Computer Architecture - Parallelism, Scalability, Programmability", Tata McGraw Hill, 2020.

REFERENCES:
1. John P. Hayes, “Computer Architecture and Organization”, Tata McGraw Hill, 2017.
2. William Stallings, “Computer Organisation and Architecture – Designing for performance”, Pearson Publishers, 2014.
3. Smruti Ranjan Sarangi,"Computer Organisation and Architecture", McGraw Hill Education, 2015.
4. Mano M.M, "Computer System Architecture", Pearson Publishers, 2017.

23L027 REAL TIME SYSTEMS

3 0 0 3

HARDWARE FOR REAL TIME SYSTEMS: Basic Real-Time system concepts – Design challenges – Basic Processor Architecture – Memory Technologies – Architectural Advancements – Peripheral Interfacing – Distributed Real-Time Architectures. (9)

REALTIME OPERATING SYSTEMS: Foundations of Scheduling – System services for Application Programs – Memory Management issues – Selecting Real-Time Operating Systems. (8)

PROGRAMMING REAL TIME SYSTEMS: Coding of Real-Time Software - Assembly Language – Procedural Languages – Object-Oriented Languages – Overview of Programming Languages – Automatic Code Generation – Compiler Optimizations of code. (7)

ENGINEERING AND SOFTWARE DESIGN REQUIREMENTS: Formats methods and Semi-Formal methods in Software specification – Requirements Document – Software Engineering Principles – Procedural Design Approach – Object-Oriented Design Approach – Life Cycle models. (11)

PERFORMANCE ANALYSIS AND OPTIMIZATION: Application of Queuing Theory - I/O Performance –Analysis of Memory Requirements **–**Metrics in Software – Design for Fault Tolerance – Performance Optimization Techniques. (10)

Total L : 45

TEXT BOOKS:
1. Philip A. Laplante, "Real Time Systems Design and Analysis-An Engineers Handbook", II Edition, IEEE Computer Society Press, 2008.
2. Krishna C M and Kang G Shin, “Real-Time System”, Tata McGraw Hill, New Delhi, 2017.

REFERENCES:
1. Rajib Mall, “Real-Time Systems - Theory and Practice”, Pearson, New Delhi, 2008.
2. Herman Kopetz, “Real-Time Systems”, Kluwer Academic Press, New York, 2011.
3. Xiaocong Fan, "Real-Time Embedded Systems Design Principles and Engineering Practices", Elsevier Science, 2015.
4. Arnold S. Berger, "Debugging Embedded and Real-Time Systems" Elsevier Science, 2020.

23L028 ADVANCED EMBEDDED SYSTEMS

3 0 0 3

INTRODUCTION: Hardware Components of Embedded Systems-ARM Architecture: Basic Architecture of ARM7core-Registers-CPSR-Operating States-Operating Modes-Programming Model-Interrupt and Exception Handling-ARM Instruction Set-Migration to Cortex Series-ARM Architecture v7 Profile-ARMv7-M Architecture-CMSIS. TIVA Microcontroller. (9)

MICROCONTROLLER FUNDAMENTALS FOR BASIC PROGRAMMING: Host and Target Machines-Linker/Locators for Embedded Software-Getting Embedded Software into the Target System-Programming Tiva C Series-System Peripheral and Memory Address-Programming GPIO in Tiva Launch pad-DMA-Timers-Interrupts-WDT-Low Power Modes-ADC-PWM-QEI. (9)

COMMUNICATION PROTOCOLS AND INTERFACING WITH EXTERNAL DEVICES: Synchronous and Asynchronous Protocols: UART-Programming UART on TIVA Platform-I2C,SPI,CAN & USB. (9)

REAL TIME OPERATING SYSTEMS: Introduction-Task States-Semaphores and Shared Data-Message Queues-Mail Boxes-Pipes-Timer Functions-Events-Memory Management Functions-Interrupt Routines in RTOS Environment-Basic Design using RTOS. (9)

EMBEDDED NETWORKING AND INTERNET OF THINGS: Embedded Networking Fundamentals and Ethernet-TCP/IP Introduction-IoT Architecture & Overview-IPV6-Architecture of IoT-Applications of IoT-Challenges of IoT. Wireless Sensor Network: Wireless Connectivity in Embedded Networks-Wireless Protocols and Applications: NFC, Zigbee, Bluetooth & WiFi. (9)

Total L: 45

TEXT BOOKS:
1. David E. Simon, "An Embedded Software Primer", Pearson Education, 2005.
2. Bahga A, Madisetti V, "Internet of Things: A Hands-on Approach", Universities Press, 2021.

REFERENCES:
1. Rajkamal, "Embedded Systems: Architecture, Programming and Design", Tata McGraw Hill, 2015.
2. Marwedel P, "Embedded System Design", Springer, New York, 2006.
3. Bai Y, "Practical Microcontroller Engineering with ARM technology", John Wiley and Sons, 2016.
4. Web Reference: Embedded System Design using TIVA https://www.ti.com/seclit/ ml/ssqu017/ssqu017.pdf

23L029 RELATIONAL DATABASE MANAGEMENT SYSTEMS

3 0 0 3

BASIC CONCEPTS: Introduction to databases – Characteristics of database approach – Advantages of using DBMS – Database concept and architecture – Data Abstraction – Data Models – Instances and Schema – Data Independence – Schema Architecture – The Database System Environment: Components of a DBMS – Database Languages – Database Administrator – Database Users. (8)

DATA MODELING: Introduction – Conceptual modeling: Entities, attributes, relationships –associations- roles and structural constraints – Weak and Strong entity types – Design of Entity Relationship data models (ERD) – Enhanced ER model: Specialization and Generalization – constraints-Aggregation –– Applications. (9)

RELATIONAL MODEL: Introduction to Relational Data Model – Basic concepts – Enforcing data Integrity constraints – Relational Algebra: Unary Relational Operations, S e t theory Operations – Binary relational operations-additional operations-Queries using relational algebra. File organization: Storage device characteristics – Operations on file – Serial files – Sequential files – Index sequential files – Direct files – Indexing . (8)

SQL PROGRAMMING: Introduction to Structured Query Language (SQL) – datatypes- Data definition Language- , Constructing database, Manipulations on database – Basic data retrieval operations – Advanced Queries in SQL – Functions in SQL – Aggregation – Categorization – Updates in SQL – Views in SQL. (10)

DATA BASE DESIGN THEORY: Data base design process – Relational Database Design – Relation Schema – Anomalies in a database – Functional dependencies – Axioms – Normal forms based on primary keys – Second Normal form, Third Normal form, Boyce – Codd Normal form – Examples – Conversion of ERD into tables. Database Security, Integrity Control: Security and Integrity threats – Defense mechanisms – Transaction and concurrency control mechanisms. (10)

Total L: 45

TEXT BOOKS:
1. Silberschatz A, Korth H , Sudarshan S , "Database System Concepts", 6th Edition, Tata McGraw Hill, 2013.
2. Elmasri R , Navathe S B , "Fundamentals of Database Systems", 7th Edition, Pearson Education, 2016.

REFERENCES:
1. Date C J, Kannan A, Swamynathan S , "An Introduction to Database Systems", 8th Edition, Pearson Education, 2006.
2. Raghu Ramakrishnan , Johannes Gehrke , "Database Management System", 3rd Edition, Tata McGraw Hill, 2007.
3. Bob bryla, Kevin Loney , "Oracle 12c: The Complete Reference", Oracle press, 2014.
4. Shefali Naik, "Concepts of Database Management Systems", Pearson India, 2014.

23L030 SOFT COMPUTING TECHNIQUES

3 0 0 3

NEURAL NETWORKS: Basic concepts - Neural Network Architectures - Characteristics - Learning methods -Linear Separability -Hebb network - Perceptron networks -Adaptive Linear Neuron- Multiple adaptive linear neuron- Back Propagation Networks - Radial Basis Function Networks, -Associative memory networks - Hopfield networks- Kohonen self-organizing feature maps. (10)

FUZZY SYSTEMS: Features - Fuzzy sets - Fuzzy relations - Fuzzification and its methods - Defuzzification and its methods - Fuzzy arithmetic and Fuzzy measure- Fuzzy integrals -Fuzzy rule base and approximate reasoning - Fuzzy propositions - formation of rules - decomposition of rules - aggregation of fuzzy rules- fuzzy reasoning-fuzzy inference systems- fuzzy expert system-fuzzy decision making. (10)

GENETIC ALGORITHMS: Survival of the fittest - Search space – Operators - Crossover and its types - Mutation and its types - Selection methods - Fitness Computation - Generational cycle -stopping condition –constraints – Real time problem solving using Genetic Algorithms. (8)

HYBRID SOFT COMPUTING TECHNIQUES: Neuro-fuzzy hybrid systems -Genetic neuro hybrid systems - Genetic fuzzy hybrid, Fuzzy genetic hybrid systems -Simplified fuzzy ARTMAP – Applications of Soft Computing. (8)

MACHINE LEARNING BASICS: Learning algorithms - Capacity, Overfitting and Underfitting -Hyperparameters and Validation Sets - Estimators, Bias and Variance - Supervised and Unsupervised Machine Learning Algorithms - Building a Machine Learning Algorithm - Challenges in Machine Learning. (9)

Total L: 45

TEXT BOOKS:
1. Timothy J Ross , "Fuzzy Logic with Engineering Applications", John Wiley & Sons Ltd, 2010.
2. Sivanandam S N, Deepa S , "Principles of Soft Computing", 3rd Edition, Wiley India Pvt Ltd, 2018.

REFERENCES:
1. Rajasekaran S , Vijayalakshmi Pai G A , "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications", 2nd Edition, Prentice Hall of India , 2017.
2. Jang J.S.R, Sun C T, Mizutani E, "Neuro-Fuzzy and Soft computing", Prentice Hall, New Jersey, 2004.
3. Laurene V Fausett , "Fundamentals of Neural Networks: Architectures, Algorithms and Applications", Prentice Hall, 2008.
4. Ian Goodfellow, Yoshua Bengio and Aaron Courville, "Deep Learning", MIT Press, USA, 2016.

23L031 DEEP LEARNING

3 0 0 3

INTRODUCTION: Motivation for deep learning - Machine learning Basics: Learning algorithms - Overfitting - Underfitting - Hyper parameters Estimators - Validation - Maximum Likelihood estimation - Bayesian Statistics - Challenges in Machine Learning. (6)

DEEP LEARNING NETWORKS: Gradient based learning - Hidden Units - Architectural design - Back - propagation for MLP - Regularization - Parameter Regularization - Data Augmentation - Dropout - Optimization algorithms - Adaptive learning rates. (8)

CONVOLUTIONAL NEURAL NETWORK: Architecture - Pooling - Convolution and its variants - CNN for Image Recognition. (9)

SEQUENCE MODELING: Recurrent Neural Networks(RNN) - Bi - directional RNN, Encoder Decoder Architecture - Recursive Nets - LSTM - Gated RNN - RNN for Sentiment Analysis. (11)

DEEP LEARNING MODELS: Autoencoders - Deep Boltzmann Machine - Deep Belief Networks - Architecture - Greedy Learning – Speech Processing and Recognition using DBN-predefined models-ResNet. (11)

Total L: 45

TEXT BOOKS:
1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, USA, 2016.
2. Adam Gibson, Josh Patterson, "Deep Learning A practitioner's approach", O'Reilly, USA, 2016.

REFERENCES:
1. Yusuke Sugomori, "Deep Learning: Practical Neural Networks with Java", Packt Publisher, New York, 2016.
2. Jeff Heaton, "Artificial Intelligence for Humans: Deep Learning and Neural Networks", Lightning Source Inc, Tennessee, 2015.
3. David Foster, "Generative Deep Learning", O'Reilly Media, Inc., 2019.
4. Eugene Charniak, "Introduction to Deep Learning", MIT Press, London, 2018.

23L032 INDUSTRIAL INTERNET OF THINGS AND INDUSTRY 4.0

3 0 0 3

OVERIVEW OF INDUSTRY 4.0 & IIOT: Industrial Revolution: Phases of Development-Evolution of Industry 4.0-Environmental impacts of Industrial Revolution-Industrial Internet-Applications of Industrial Internet and Industry 4.0. IIoT: Prerequisites of IIoT- Basics of Cyber Physical Systems (CPS)-CPS and IIoT-Applications of IIoT. (9)

TECHNOLOGICAL ASPECTS OF INDUSTRY 4.0 AND IIOT: Cloud Computing and IIoT-Industrial Cloud Platform Providers-Requirements of Industry 4.0 and its solution. Fog Computing for IIoT- Applications of fog and their solutions. Big Data and advanced analytics-Smart factories: Characteristics fo Smart Factory-Technologies used in Smart Factories. (9)

INDUSTRIAL DATA TRANSMISSION: Field Bus – Profibus – HART – Interbus – Butbus –CCLink – Modbus – Batibus - Digital STROM – CAN – DeviceNet – LonWorks - Wireless HART - LoRa and LoRa WAN - NB-IoT - IEEE 802.11AH. (9)

IIOT ANALYTICS, PLANT SAFETY & SECURITY: Necessity-Categorization of Analytics-Usefulness of IIoT Analytics-Challenges of Analytics in Industries-Mapping of Analytics with the IIRA Architecture-Deployment of Analytics-Application of analytics across value chain. IIoT applications for undertaking safety measures in Plant-Plant.Software Security - Network Security - Mobile Device Security. (9)

CASE STUDY: Operational Management Tool for Factory IoT- Configuration and Dashboard Visualization-Monitoring the operational status of the whole factory: Equipment Monitoring-Group Alarm and Signal Monitoring-Operational Results-Group

Results and Production Results. Connecting Legacy equipments: OPC UA Configuration, data back-up – SRAM Data Utility-Machine Data Archive Management-Web API. (9)

Total L: 45

TEXT BOOKS:
1. Sudip Misra, Chandana Roy, Anandarup Mukherjee, “Introduction to Industrial Internet of Things and Industry 4.0”, CRC Press, Taylor &Francis Group, 2021.
2. Arshdeep Bahga and Vijay Madisetti, “Internet of Things A Hands-on Approach”, Universities Press (India), 2015.

REFERENCES:
1. Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, John Wiley & Sons, 2014
2. Francis Dacosta, “Rethinking the Internet of Things”, Apress Open, 2013.
3. Gater, A., Ryu, S.H."Process Analytics Concepts and Techniques for Querying and Analyzing Process Data" Springer International Publishing Switzerland, 2016.
4. MT Link-i Reference Manual from FANUC.

PROFESSIONAL ELECTIVE VERTICALS FOR HONORS

23L051 ANALOG VLSI CIRCUITS

3 0 0 3

ANALOG CIRCUIT BUILDING BLOCKS: Switches - Active resistors - Current sources and sinks - Current mirrors – Simple Cascode and Wilson Current Mirrors - Voltage and current references - Analog multiplier. (9)

AMPLIFIERS: MOS amplifiers – Common Source, Common Drain, Common Gate, MOS inverting amplifier - Improving performance of inverting amplifier - CMOS differential amplifiers – Qualitative and Quantitative Analysis. (9)

CMOS OPERATIONAL AMPLIFIERS: Characterization of Op-Amp - Design of two stage op-amp – Feedback and opamp Compensation– Folded Cascode op-amp, Transconductance Amplifier-Noise and Distortion in Amplifiers. (9)

D/A AND A/D CONVERTERS: Analog signal processing -Parallel D/A converter: Current scaling , Voltage scaling and Charge scaling - Serial D/A converters - A/D converters: Serial A/D converters, Parallel A/D converters - Oversampling Converters. (9)

PHASE LOCKED LOOPS: Phase Detector-Voltage Controlled Oscillator-Loop Filter. Non-linear analog blocks: Comparators, Charge-pump circuits, and Multipliers, Analog Testing methods. FILTERS: Active RC Filters - Low pass filters - High pass filters - Bandpass filters - Switched capacitor filters. (9)

Total L: 45

TEXT BOOKS:
1. Jacob Baker Lee H W and Boyce D E , "CMOS Circuit Design, Layout and Simulation", Fourth, John Wiley & Sons, New Jersey, 2019.
2. David A Johns and Ken Martin, "Analog Integrated Circuit Design", Second, John Wiley & Sons, USA, 2013.

REFERENCES:
1. Phillip Allen and Douglas R Holberg, "CMOS Analog Circuit Design", Third, Oxford University Press, New York, 2013.
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Second-Indain, Tata McGraw Hill, New Delhi, 2017.
3. Randall L Geiger Phillip E Allen and Noel R. Strader , "VLSI Design techniques for Analog and Digital Circuits", McGraw Hill, New Delhi, 2010.
4. Sedra and Smith, "Microelectronic Circuits", Seventh Edition, Oxford University Press, NY,USA, 2017.

23L052 DEVICE MODELING

3 0 0 3

INTRODUCTION TO SEMICONDUCTOR PHYSICS AND DIODE MODELING : Quantum Mechanics – Density of states-Fermi Dirac Distribution-Carrier Concentration –Energy band Modelling - Continuity equation - Poisson equation, Junction and Schottky diodes in monolithic technologies- static and dynamic behaviour - small and large signal models - SPICE models. (10)

INTEGRATED MOS CAPACITANCE : Band diagram – flat band condition and flat band voltage - surface accumulation, surface depletion - threshold condition and threshold voltage, charge versus gate voltage,MOS C - Characteristics, PolySi gate depletion – effective Increase In Tox. (6)

INTEGRATED MOS TRANSISTOR : Review of MOSFETs- MOS models SPICE model, EKV Model, BSIM Model. Technology scaling for cost, speed and power consumption, Substhershold Current –Subthreshold Swing, Threshold voltage Roll Off - Short Channel Leakage, reducing gate insulator electrical thickness And Tunneling Leakage, Short Channel Effects. (10)

INTEGRATED THIN BODY AND MULTIGATE TRANSISTOR : Ultra Thin body and Multi-Gate MOSFET - FINFET. MOSFET Compact Model for Circuit Simulation using Verilog. (8)

SPINTRONICS: Electron Spins in Quantum Dots as Qubits- Quantum Computing - Quantum Communication - Requirements for Quantum Computing - Coupled Quantum Dots as Quantum Gates - Single-Spin Rotations - Read-Out of a Single Spin.Quantum Computing wth spins- The quantum inverter - NAND without energy dissipation - Universal reversible gate: Toffoli-Fredkin gate - Universal quantum gates. (11)

Total L: 45

TEXT BOOKS:
1. Chenming C.Hu , "Modern Semiconductors for Integrated Circuits Prentice Hall", First Edition, Prentice Hall, 2010.
2. Tyagi M S , "Introduction to Semiconductor Materials and Devices", John Wiley, 2014.

REFERENCES:
1. Richard S. Muller, Theodore I. Kamins , "Device Electronics for Integrated circuits", John Wiley, Third Edition, 2018.
2. Neil Weste and David Harris , "CMOS VLSI DESIGN: A Circuits and Systems Perspective", Pearson, Edition 4, 2015.
3. Ben G. Streetman and Sanjay Kumar Banerjee, “Solid State Electronic Devices”, Pearson Education India, Edition 7, 2018.
4. Bandyopadhyay S, Cahay M, “Introduction to Spintronics”, CRC press; 2015

23L053 VLSI PHYSICAL DESIGN

3 0 0 3

INTRODUCTION TO VLSI DESIGN AUTOMATION: Algorithmic Graph Theory, Computational Complexity and ROBDD; Partitioning and Placement: KL algorithm, FM algorithm, Group-migration algorithm, Simulated Annealing and Evolution, use of VLSI CAD tools (Open source). (9)

FLOOR PLANNING AND PIN ASSIGNMENT, PLACEMENT, LAYOUT STYLES: Discrete methods in global placement, Timing driven placement, Routing: Global Routing, detailed routing, Graph models, Line Search, Maze Routing, Channel Routing, Steiner Tree based Algorithms, ILP base approaches, DRC methods. (9)

PERFORMANCE ISSUES IN CIRCUIT LAYOUT: delay models, timing driven placements, timing driven routing, Via Minimization, Over the Cell Routing – Single layer and two layer routing, Clock and Power Routing. (9)

COMPACTION: Problem formulation, One Dimension compaction, Two Dimension compaction, Hierarchical Compaction, Compaction Algorithms. Physical Design Automation in FPGAs. (9)

SCHEDULING: constrained and unconstrained scheduling, ASAP, ALAP, List scheduling, Force directed Scheduling, operator binding, Static Timing Analyses: Delay models, setup time, hold time, cycle time, critical paths, Topological mvs. Logical timing analysis, False paths, Arrival time (AT), Required arrival Time (RAT), Slacks. (9)

Total L:45

TEXT BOOKS:
1. Sherwani, N., Algorithms for VLSI Physicsl Design Automation, Springer, 3rd edition, 2007.
2. Gerez S.H., Algorithms for VLSI Design Automation, John Wiley, 2008.

REFERENCES:
1. Sarrafzadeh, M. and Wong, C. K., An Introduction to VLSI Physical Design, McGraw Hill, 2015.
2. Trimberger, S. M., An Introduction to CAD for VLSI, Kluwer, 1987.
3. Sait, S. M. and Youssef, Habib, VLSI Physical Design Automation – Theory and Practice, World Scientific, 2004.
4. Andrew B. Kahng, Jens Lienig, Igor L. Markov, Jin Hu “VLSI Physical Design: From Graph Partitioning to Timing Closure”, Springer,2011.

23L054 TESTING AND TESTABILITY OF VLSI CIRCUITS

3 0 0 3

FAULT SIMULATION:Need for testing-Fault models-Fault equivalence, Fault Dominance, Fault collapsing-logic level simulation-Event driven simulation-Fault simulation techniques-Serial, Deductive, Parallel and Concurrent Simulation. (9)

COMBINTIONAL CIRCUIT TESTING: Test generation algorithms for combinational circuits - Fault Table, Boolean difference, Path sensitization, D – algorithm, PODEM, FAN algorithms. (9)

SEQUENTIAL CIRCUIT TESTING: Functional testing – State table verification-Designing checking experiments-Homing sequence-Distinguishing sequence-Transfer sequence- Fault model based testing- Time frame expansion. (9)

DESIGN FOR TESTABILITY:DFT basics,Ad Hoc design for testability ,Scan cell Design-Scan path technique- LSSD-Design rules, Single and Double latch Design-Random access scan designs. (9)

BIST ARCHITECTURES: Test pattern generation- Exhaustive Testing, Pseudo exhaustive testing, LFSR-Response analysis-One’s count, transition count, Signature analysis-BIST Architectures-BILBO, Circular BIST, Boundary scan architecture. (9)

Total L: 45

TEXT BOOKS:
1. Vishwani D Agarwal, “Essential of Electronic Testing for Digital, Memory and Mixed Signal Circuits”, Springer, 2005.
2. Keshab K Parhi, “VLSI Digital Signal Processing Systems Design and Implementation”, Wiley - Inter science, 2007.

REFERENCES:
1. Abramovici M, Breuer M A and Friedman A D, “Digital Systems Testing and Testable Design”, Wiley, 1994.
2. Parag K Lala, “Digital Circuit Testing and Testability”, Academic Press, 1997.
3. Wang, Wu and Wen, “VLSI Test Principles and Architectures”, Morgan Kaufmann, 2006.
4. N.K,Jha, S.Gupta, “Testing of Digital systems”, Cambridge university press, 2003.

23L055 MIXED SIGNAL IC DESIGN

3 0 0 3

SWITCHED CAPACITOR C FILTERS: Switched capacitor filters: Switched capacitor resistors - Integrator-amplifiers – comparators - sample & hold circuits –- Biquad. (9)

CONTINUOUS TIME FILTERS: Introduction to Gm - C filters - CMOS Transconductors using Triode transistors, active transistors – BiCMOS transconductors – MOSFET C Filters – Tuning Circuitry - Dynamic range performance - First and Second order filters. (9)

DIGITAL TO ANALOG & ANALOG TO DIGITAL CONVERTERS: Non-idealities in the DAC - Nyquist rate DAC’s: Cyclic, Pipelined, Hybrid, segmented DAC’s - Non-idealities in the ADC, High Speed ADC’s: Flash, pipelined, folding ADC’s. (9)

SIGMA DELTA CONVERTERS: Over sampled converters - over sampling without noise & with noise – implementation imperfections - first order modulator - decimation filters - second order modulator - sigma delta DAC & ADC’s. ADC and DAC testing methods. (9)

ANALOG AND MIXED SIGNAL EXTENSIONS TO HDL: Introduction - Language design objectives - Tolerance groups-Conservative systems - Time and the simulation cycle - A/D and D/A Interaction - Quiescent Point - Frequency domain modeling and examples. Analog extensions to Verilog: Introduction - data types –Expressions – Signals - Analog behaviour – Hierarchical Structures – Mixed signal Interaction. (9)

Total L: 45

TEXT BOOKS:
1. David A Johns and Ken Martin, "Analog Integrated Circuit Design", Second, John Wiley & Sons, USA, 2013.
2. Kenneth S Kundert and Olaf Zinke, “The Designers Guide to Verilog AMS”, Springer Publishing Company, 2013.

REFERENCES:
1. Phillip Allen and Douglas R Holberg, "CMOS Analog Circuit Design",Third, Oxford University Press, New York, 2013
2. R. Jacob Baker, “CMOS, Circuit Design Layout and Simulation”,4th Edition,Wiley- IEEE Press, 2019.
3. R. Jacob Baker, “CMOS, Mixed Signal Circuit Design”, Wiley- IEEE Press, 2008.
4. Shanthi Pavan, Richard Schreier, Gabor C. Temes “Understanding Delta-Sigma Data Converters” IEEE Press, 2017.

23L056 HARDWARE VERIFICATION TECHNIQUES

3 0 0 3

INTRODUCTION TO SYSTEM VERILOG: Data Types, Arrays, Queues, Structures, Union, Packages, Class, System verilog Module, Program, Interface, Operators, Constrained Random Test Generation and Verification. (7)

VERIFICATION TECHNOLOGIES AND TOOLS: Importance of Verification - Reconvergence Model - The Human Factor - Formal and Functional Verification Approaches - Formal Verification - Boolean Functions, Approaches Based on Finite State Machines, Propositional Temporal Logics - Timing Verification - Testing Versus Verification - Design and Verification Reuse - Linting - Simulation - Third Party Models - Verification Intellectual Property - Waveform Viewers - Issue Tracking – Metrics - Role of the Verification Plan - Levels of Verification - Verification strategies - High-level modeling. (10)

SYSTEMVERILOG ASSERTIONS AND FUNCTIONAL COVERAGE: Immediate Assertions - Concurrent Assertions - Sampled Value Functions - System Functions and Tasks - Asynchronous Assertions - Multiple Clocks - Functional Coverage - Gathering Coverage Data - Coverage Types - Functional Coverage Strategies - Anatomy and Triggering of a Cover Group - Data Sampling - Cross Coverage - Generic Cover Groups - Coverage Options - Analyzing Coverage Data - Performance Implications of Coverage Methodology. (10)

TEST CASE GENERATION AND ARCHITECTING TESTBENCHES: Simple Stimulus - Simple Output - Complex Stimulus - Bus-Functional Models - Response Monitors - Transaction Level Interface - Verification Harness - Design Configuration - Self-Checking Test benches - Directed Stimulus - Random Stimulus - System Level Verification Harnesses - Transaction Level Models - Managing Simulations - Regression. (9)

VERIFICATION METHODOLOGY: Universal Verification Methodology (UVM) – Packages – Components – Environmental Structure – Factory Registration – Reporting. (9)

Total L: 45

TEXT BOOKS:
1. Janick Bergeron, “Writing Test Benches Using System Verilog”, Springer 1st Edition, 2009.
2. Chris Spear, Greg Tumbush, "System Verilog for Verification - A Guide to Learning the Test bench Language Features" Springer 3rd edition, 2012.

REFERENCES:
1. Ashok B. Mehta, "System Verilog Assertions and Functional Coverage Guide to Language, Methodology and Applications", Springer, 2014.
2. Kropf T, “Introduction to Formal Hardware Verification”, Springer Verlag, 2010.
3. UVM Golden Reference Guide, Doulos, 2013.

23L061 SPEECH SIGNAL PROCESSING

3 0 0 3

SPEECH SIGNAL MODELLING: Speech signal characteristics and classifications - Speech production mechanism - Acoustic Theory of speech production - Source - Filter model - Lossless Tube Models - Digital Model of speech signals. (9)

SPEECH SIGNAL ANALYSIS: Time domain Analysis for speech processing - Short time energy and magnitude - short time average zero crossing - Speech vs silence discrimination - Pitch period estimation using autocorrelation function - Short time Fourier analysis- Definition and properties - Design of digital filter banks - Pitch detection - Analysis and synthesis-Machine Learning Methods for Speech Signal Processing. (12)

SPEECH CODING IN TIME DOMAIN: Linear predictive coding (LPC) - principle - solution of LPC equation – Cholesky decomposition method - Durbin's method - Lattice formulation. (6)

SPEECH CODING IN FREQUENCY DOMAIN: Frequency domain interpretation of LPC - LPC Applications - CELP - Subband coding - Transform coding - Vocoders and cepstral vocoders - Vector quantiser coders. (6)

SPEECH RECOGNITION: Problems in ASR - Dynamic Time warping - Isolated word recognition - pattern matching – Speaker independent recognition- Pattern classification – Connected word recognition – Speaker identification/Verification - Hidden Markov model. (12)

Total L: 45

TEXT BOOKS:
1. Rabiner L R , Schaffer R W , "Digital Processing of Speech Signals", Pearson Education - India, 2015.
2. Thomas F Quatieri , "Discrete –Time Speech Signal Processing", Pearson Education - India, 2015.

REFERENCES:
1. Owens FJ , "Signal Processing of Speech", Macmillan, 2015.
2. Rabiner L R , K Juang B H , "Fundamentals of speech Recognition", Pearson Education - India, 2015.
3. John R Deller Jr, John H L Hansen, John G Proakis , "Discrete Time Processing of Speech Signal", IEEE press, 2015.
4. Ben Gold, Nelson Morgan, Dan Ellis, “Speech and Audio Signal Processing: Processing and Perception of Speech and Music, Wiley, 2016.

23L062 WAVELETS AND ITS APPLICATIONS

3 0 0 3

FOURIER ANALYSIS : Fourier basis & Fourier Transform – failure of Fourier Transform – Need for Time-Frequency Analysis – Heisenberg‘s Uncertainty principle – Short time Fourier transform (STFT)- short comings of STFT- Need for Wavelets. (9)

CWT AND MRA: Wavelet basis – Continuous time Wavelet Transform (CWT) – need for scaling function – Multi- Resolution Analysis (MRA) – important wavelets: Haar, Mexican hat, Meyer, Shannon, Daubachies. (9)

INTRODUCTION TO MULTIRATE SYSTEMS : Decimation and Interpolation in Time domain - Decimation and Interpolation in Frequency domain – Multi rate systems for a rational factor. (9)

FILTER BANKS AND DWT : Two channel filter bank – Perfect Reconstruction (PR) condition – relationship between filter banks and wavelet basis – DWT – Filter banks for Daubachies wavelet function. (9)

ADVANCED TOPICS AND APPLICATIONS: Introduction to Multiwavelets, Multidimensional wavelets – wavelet packet transform, wavelet frame transform- Feature extraction using wavelet coefficients, Image compression, Wavelet based denoising. (9)

Total L: 45

TEXT BOOKS:
1. Jaideva C Goswami, Andrew K Chan, "Fundamentals of Wavelets – Theory, Algorithms and Applications", John Wiley & Sons, Singapore, 2011.
2. Soman K P, Ramachandran K I , "Insight into wavelets from Theory to practice", Prentice Hall, New Delhi, 2010.

REFERENCES:

1. Sidney Burrus C, "Introduction to Wavelets and Wavelets Transforms", Prentice Hall, New Delhi, 2002.
2. Stephane G Mallat, "A Wavelet Tour of Signal Processing", Academic Press, India, 2009.
3. Raghuveer M Rao, Ajit S Bopardikar, "Wavelet Transforms: Introduction to Theory & Applications", New Delhi, 2003.
4. Mani Mehra, "Wavelets Theory and Its Applications: A First Course", Springer, 1st edition, 2018.

23L063 BIOMEDICAL SIGNAL PROCESSING

3 0 0 3

INTRODUCTION TO BIOMEDICAL SIGNALS: Nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in Biomedical analysis. Basic electrocardiography, ECG lead systems, ECG signal characteristics. Simple signal conversion systems, Conversion requirements for biomedical signals, Signal conversion circuits. (9)

SIGNAL AVERAGING: Basics of signal averaging, signal averaging as a digital filter, a typical averager, software for signal averaging, limitations of signal averaging. Adaptive Noise Cancelling: Principal noise canceller model, 60-Hzadaptive cancelling using a sine wave model, other applications of adaptive filtering. (9)

DATA COMPRESSION TECHNIQUES: Turning point algorithm, AZTEC algorithm, Fan algorithm, Huffman coding, data reduction algorithms The Fourier transform, Correlation, Convolution, Power spectrum estimation, Frequency domain analysis of the ECG. (9)

CARDIOLOGICAL SIGNAL PROCESSING: Basic Electrocardiography, ECG data acquisition, ECG lead system, ECG signal characteristics (parameters and their estimation), Analog filters, ECG amplifier, and QRS detector, Power spectrum of the ECG, Bandpass filtering techniques, Differentiation techniques, Template matching techniques, A QRS detection algorithm, Realtime ECG processing algorithm, ECG interpretation, ST segment analyzer, Portable arrhythmia monitor. (9)

NEUROLOGICAL SIGNAL PROCESSING: The brain and its potentials, The electrophysiological origin of brain waves, The EEG signal and its characteristics (EEG rhythms, waves, and transients), Correlation. Analysis of EEG channels: Detection of EEG rhythms, Template matching for EEG, spike and wave detection, Electromyography,EMG Signal Analysis. (9)

Total L:45

TEXT BOOKS:

1. Willis J. Tompkins, "Biomedical Digital Signal Processing", PHI, 2006.
2. Naik, Ganesh, "Biomedical Signal Processing", Springer, Singapore, 2020.

REFERENCES:

1. D C Reddy, "Biomedical Signal Processing Principles and Techniques", McGrawHill Publications, 2005.
2. Blinowska, Katarzyna J, and Jarosław Żygierewicz, "Practical biomedical signal analysis using MATLAB", CRC Press, 2021.
3. Rangaraj M. Rangayyan, "Biomedical Signal Analysis", John Wiley & Sons, 2002.

23L064 STATISTICAL SIGNAL PROCESSING

3 0 0 3

DISCRETE RANDOM SIGNAL PROCESSING: Discrete random processes - Ensemble averages - Wide sense stationary process - Ergodic process - Sample mean & variance - Autocorrelation - Auto covariance and Cross covariance - White noise process - Power spectral density - Filtering random process. (9)

SIGNAL MODELING: Least squares method - Pade approximation - Prony's method - Linear Prediction – Stochastic models – Auto Regressive(AR), Moving Average(MA), ARMA model. (9)

SPECTRUM ESTIMATION: Non Parametric methods - Periodogram, Modified Periodogram, Bartlett, Welch and Blackman-Tukey methods, Parametric Methods: AR, MA and ARMA spectrum estimation – frequency estimation. (9)

PARAMETER ESTIMATION THEORY: Properties of estimates - unbiased and consistent estimators, Minimum Variance Unbiased Estimates - Cramer Rao bound -Efficient estimators - Methods of maximum likelihood - Bayesian estimation. (9)

ADAPTIVE FILTERS: Wiener filter - Newton's steepest descent method – Least mean square (LMS) algorithm- Convergence – Normalized LMS – Applications - Adaptive Recursive Filters - Recursive least square (RLS) algorithm -Exponentially weighted RLS - sliding window RLS. (9)'

Total L: 45

TEXT BOOKS:

1. Monson. H. Hayes, "Statistical Digital Signal Processing and Modeling", John Willey and Sons, 2017.
2. Steven M Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory", Pearson India, 2019.

REFERENCES:

1. D.G. Manolakis, V.K. Ingle and S.M. Kogon, "Statistical and Adaptive Signal Processing", Artech House Publishers, 2018.
2. S Nandi, D Kundu, "Statistical Signal Processing- Frequency Estimation", Springer Nature, 2020.

3. Bruce Hajek, "Random Processes for Engineers", Cambridge University Press, 2015.
4. Steven Kay, "Intuitive Probability and Random Processes Using MATLAB", Springer, 2017.

23L065 VLSI SIGNAL PROCESSING

3 0 0 3

ITERATION BOUND: Introduction, Data flow graph representations, loop bound and iteration bound, Algorithms for computing Iteration bound, iteration Bound of multirate Data - Flow Graphs. (7)

PIPELINING AND PARALLEL PROCESSING: Introduction - Pipelining of FIR Digital filters - Parallel processing - Pipelining and parallel processing for Low power. (10)

RETIMING TRANSFORMATIONS: RETIMING**:** Introduction - Definitions and Properties - Solving system of Inequalities - Retiming Techniques. (7)

UNFOLDING AND FOLDING TRANSFORMATION: Introduction - An algorithm for unfolding - Properties of unfolding - Critical path, unfolding and retiming - Application of unfolding. FOLDING: Introduction - folding Transformation - Register Minimization Techniques - Register Minimization in folded Architectures. (11)

FAST CONVOLUTION: Cook-Toom algorithm – modified Cook-Toom algorithm Winograd algorithm- modified Winograd algorithm, Algorithmic strength reduction in filters and transforms-parallel FIR filters, Parallel architectures for Rank-order filter. (10)

Total L: 45

TEXT BOOKS:
1. Keshab K Parhi, “VLSI Digital Signal Processing Systems Design and Implementation”, Wiley - Inter science, 2007.
2. John G Proakis and Dimitris G Manolakis, “Digital signal processing –Principles, Algorithms and Applications” Pearson, 2014.

REFERENCES:
1. Uwe Meyer Baese, “Digital Signal Processing with Field Programmable Gate Arrays”, Springer, 2014.
2. Lonnie C Ludeman, “Fundamentals of Digital Signal Processing”, Wiley India Pvt Ltd., 2010.
3. Peter Pirsch“Architectures for Digital Signal Processing”, Wiley India Pvt Ltd., 2009.
4. Lars Wanhammar, "DSP Integrated Circuits", Academic Press, 1999.

23L066 DETECTION AND ESTIMATION

3 0 0 3

DETECTION THEORY: Bayesian Hypothesis Testing - Likelihood Ratio Tests -Minimax Hypothesis Testing - Neyman Pearson Hypothesis Testing - Composite Hypothesis Testing - M’ary Hypothesis Testing. (8)

SIGNAL DETECTION IN DISCRETE TIME: Deterministic Signals - Stochastic Signals – Models and Detector Structures – Performance Evaluation - Chernoff Bounds - Applications of Detection in Signal Processing . (8)

PARAMETER ESTIMATION: Fundamentals of Estimation Theory - Minimum Variance Unbiased Estimation – Cramer Rao Lower bound – Best Linear Unbiased Estimators - Linear Least Squares Estimation –Nonlinear Least Squares Estimation - Maximum Likelihood Estimation. (10)

BAYESIAN ESTIMATION: Bayesian philosophy – General Bayesian Estimators - Minimum Mean Square Error Estimators – Maximum A Posteriori Estimators – Linear MMSE Estimation. (9)

DISTRIBUTION-FREE ESTIMATION: Orthogonality Principle – Autoregressive Techniques - Discrete Wiener Filter, Continuous Wiener Filter, Generalization of Discrete and Continuous Filter Representations, Kalman Filter, Extended Kalman Filter - Applications of Estimation in Signal Processing. (10)

Total L: 45

TEXT BOOKS:
1. Kay S M, “Fundamentals of Statistical Signal Processing, Volume 1: Estimation Theory”, Prentice Hall, 2010.
2. Kay S M, “Fundamentals of Statistical Signal Processing, Volume 2: Detection Theory”, Prentice Hall, 2009.

REFERENCES:
1. Thomas Schonhoff and Arthur A. Giordano, “Detection and Estimation Theory", Prentice Hall, 2007.
2. Poor H V, “An Introduction to Signal Detection and Estimation”, Springer-Verlang, 2013.
3. ScharfL L, “Statistical Signal Processing”, Addison Wesley, 1991.

23L071 FIBER OPTIC COMMUNICATION

3 0 0 3

INTRODUCTION: Evolution of fiber optical system -Elements of optical Fiber Systems - Optical Fiber structure and parameters – classification of fibers- ray and mode theory of light propagation in optical fibers-Fiber manufacturing. (9)

FIBER PROPERTIES: Optical signal attenuation- Optical signal distortion – Dispersion - Principles of fiber nonlinearities. (8)

OPTICAL SOURCES- Light-Emitting Diodes (LEDs)- Laser Diodes – types - Light Source, Linearity – Reliability, noise, direct and external modulation. (8)

OPTICAL RECEIVER: Photo detectors-Photodiodes - Avalanche photo diodes- Comparisons of photo detector- Receiver Noise and sensitivity-Digital Receiver Performance-BER Calculation-Eye Diagrams. (10)

SYSTEM CONFIGURATIONS AND FSO: Optical link design - System Design considerations - Optical amplifiers - EDFA - Multiplexing strategies - Wavelength division multiplexing. Free space optics - Overview of FSO Optical Transmitters – Receivers – Subsystems. (10)

Total L: 45

TEXT BOOKS:

1. Keiser G , "Optical Fiber Communications", McGraw Hill, 2016.
2. Hemani Kaushal, V.K. Jain, SubratKar, "Free Space Optical Communication", Springer India, New Delhi, 2017.

REFERENCES:

1. Rajiv Ramasami Kumar and Sivarajan N, "Optical Networks A Practical Perspective", Morgan Kaufmann Publishers, 2011.
2. John M. Senior, "Optical Fiber Communications Principles and Practice", PHI, 2016.
3. G.P. Agrawa, "Fiber optic Communication Systems", John Wiley and sons, 2012.
4. K. Mynbaev and Lowell L Scheiner, "Fiber Optic Communication Technology", Prentice Hall, 2001.

23L072 DIGITAL COMMUNICATION RECEIVERS

3 0 0 3

BASEBAND COMMUNICATION: Baseband PAM, Clock Synchronizers - Error tracking and spectral line generating synchronizers, Squaring synchronizers, Mueller and Muller synchronizers. (9)

OPTIMUM RECEIVERS FOR AWGN CHANNEL: Correlation demodulator, matched filter , maximum likelihood sequence detector, optimum receiver for CPM signals, M-ary orthogonal signals, envelope detectors for M-ary and correlated binary signals. (9)

RECEIVERS FOR FADING CHANNELS: Characterization of fading multiple channels, statistical models, flat and frequency selective fading, diversity technique, Optimal receivers for data detection and synchronization parameter estimation, coded waveform for fading channel. (9)

SYNCHRONIZATION TECHNIQUES: Carrier and signal synchronization, carrier phase estimation-PLL, Decision directed loops, symbol timing estimation, maximum likelihood and non-decision directed timing estimation, joint estimation. (9)

ADAPTIVE EQUALIZATION: Zero forcing algorithm, LMS algorithm, adaptive decision-feedback equalizer and Equalization of Trellis-coded signals, Kalman algorithm, blind equalizers and stochastic gradient algorithm. (9)

Total L: 45

TEXT BOOKS:

1. H.Meyer, M. Moeneclaey, S. A. Fechtel , "Digital Communication Receivers", Wiley, 2015.
2. Proakis J G, Salehi M , "Digital communications", Tata McGraw Hill, New York, 2018.

REFERENCES:

1. U.Mengali, A.N.D.Andrea , "Synchronization Techniques for Digital Receivers", Kluwer, 2014
2. Rohde U L, Whitaker J C, Zahnd H , "Communications Receivers", McGraw-Hill, 2017.
3. Bernard Sklar , "Digital Communications- Fundamentals and applications", Prentice Hall, 2017.
4. Michael Rice,Digital Communications: A Discrete-Time Approach" Pearson Education, New Delhi, 2009.

23L073 WIRELESS NETWORKING

3 0 0 3

WIRELESS LOCAL AREA NETWORK: Introduction to Wireless LAN s – Topologies, IEEE 802.11 WLAN – Architecture and Services, Physical Layer- MAC SubLayer –MAC Management Sub Layer, Other IEEE 802.11 Standards - HIPERLAN, WiMAX. (9)

ADHOC WIRELESS NETWORKS: Characteristics of Adhoc Networks, MAC Protocols — Routing Protocol - TCP Over Ad Hoc Wireless Networks. (9)

WIRELESS PERSONAL AREA NETWORKS: Introduction to Bluetooth - Architecture, Protocol Stack, Topology, Application. Wireless Sensor Network — Architecture, Data Dissemination and Gathering. Zigbee Technology — Components, Network topologies and architecture. (9)

MOBILE NETWORK AND TRANSPORT LAYER: TCP Enhancements for Wireless Networks — Implementation of Wireless TCP – Mobile IP and Session Initiation Protocol. (8)

6G NETWORKS: Beyond 5G – 6G Requirements – 6G Performance Metrics – 6G Usecases – 6G Enabling Technologies – 6G CloudNet - Role of Open-Source in 6G Wireless Networks. (10)

Total L: 45

TEXT BOOKS:

1. Vijay.K. Garg, "Wireless Communication and Networking", Morgan Kaufmann Publishers, 2017.
2. Siva Ram Murthy C, Manoj B S , "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall, 2017.

REFERENCES:

1. T L singal , "Wireless communciations ", Mcgraw Hill Education, 2016.
2. PahalavanK, Krishnamurthy P, "Principles of Wireless Networks - A Unified Approach", Prentice Hall, 2002.
3. William Stallings, "Wireless Communications and Networks", 2nd Edition, Pearson/ Prentice Hall India, 2007.
4. Yulei Wu, Sukhdeep Singh, Tarik Taleb, Abhishek Roy, Harpreet S. Dhillon, Madhan Raj Kanagarathinam, Aloknath De, “6G Mobile Wireless Networks”, 1st Edition, Springer, 2021.

23L074 5G AND 6G WIRELESS TECHNOLOGIES

3 0 0 3

INTRODUCTION AND ROADMAP TO 5G: Historical trend and evolution of major cellular communication standards (1G/2G/3G/4G/5G/6G systems)-LTE technology to beyond 4G – Key building blocks of 5G – 5G use cases and System Concepts – The 5G Architecture – IoT: relation to 5G. (8)

5G ARCHITECTURE: E2E Architecture: Enablers and Design Principles- Physical Network Architecture – QoS Architecture – Spectrum Sharing Architecture – Architecture modularization for the core network – RRC States – Control/User Plane Split. RAN Architecture: Requirements –Protocol Stack Architecture and Network Functions-Multi-Connectivity. (10)

5G WAVEFORMS AND CHANNEL MODELS: 5G Radio Access Technologies: Design principles - Multi-carrier with filtering - Non-orthogonal Multiple Access - Radio access for dense deployments – Radio Access for V2X Communication - Radio access for massive machine-type communication - 5G wireless propagation channel models: Modeling requirements and scenarios - The METIS channel models. (9)

NETWORKING IN 5G: Coordinated multi-point transmission in 5G: Joint Transmission CoMP enablers - Distributed cooperative transmission - JT CoMP with advanced receivers - Relaying and network coding in 5G: Multi-flow wireless backhauling - Buffer Aided relaying. (9)

6G KEY ENABLERS: Key building blocks of 6G – 6G use cases Wireless energy harvesting, machine learning, Terahertz Communication, Optical Wireless Communication, Intelligent reflecting surface (IRS), Extremely Large Aperture Massive MIMO, Wireless powered communication networks, Space-Air-Ground Integrated Networks. (9)

Total L: 45

TEXT BOOKS:

1. Afif Osseiran, Jose F. Monserrat and Patrick Marsch, “5G Mobile and Wireless Communications Technology”, Cambridge University Press, 2016.
2. Patrick Marsch, “5G System Design – Architectural and Functional Considerations and Long Term Research", Wiley Publications, 2018.

REFERENCES:

1. Manish, M., Devendra, G., Pattanayak, P., Ha, N., 5G and Beyond Wireless Systems PHY Layer Perspective, Springer Series in Wireless Technology.
2. Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen, - 5G Mobile Communications, Springer, 2017.
3. Fei Hu” Opportunities in 5G Networks A Research and Development Perspective”, CRC Press Taylor & Francies Group, 2016
4. Jonathan Rodriguez, “Fundamentals of 5G mobile networks”, John Wiley and Sons, Ltd, 2015.

23L075 QUANTUM COMMUNICATION

3 0 0 3

QUANTUM MECHANICS FUNDAMENTALS: Matrix Representation, Photons, pin-1/2 Systems,adamard Gate,Uncertainty Principle, Density Operators , Change of Basis , Photon Polarization ,Diagonalization and Unitary Equivalent Observables, Time Evolution, Harmonic Oscillator. (9)

QUANTUM INFORMATION THEORY: Shannon Entropy, Von Neumann Entropy, Composite Systems, Holevo Information, Accessible Information, and Holevo Bound, Data Compression Shannon's Noiseless Channel Coding Theorem Schumacher's Noiseless Quantum Channel Coding Theorem. (9)

QUANTUM CIRCUITS AND INFORMATION PROCESSING: Single-Qubit Operations, Two-Qubit Operations, Generalization to N-Qubit Gates and Quantum Computation Fundamentals,Quantum Teleportation, Superposition Principle and Quantum Parallelism No-Cloning Theorem, Distinguishing Quantum States ,Quantum Entanglement. (9)

QUANTUM MODULATION AND ERROR CORRECTION: Noise in quantum channels, QAM/PSK/OOK in quantum links, bit/sign flips in quantum channels, quantum error correction, Shor code.BB84, E91 and SARG04 protocols. Post processing in quantum key distribution. (9)

CASE-STUDY: Multi-photon protocols, quantum networks and applications Fibre-based, satellite and drone-based quantum communication. (9)

Total L: 45

TEXT BOOKS:
1. Ivan Djordjevic, "Quantum Information Processing and Quantum error Correction" Elsevier Inc., UK, 2012.
2. Mark M. Wilde, "Quantum Information Theory", Cambridge University Press, 2013.

REFERENCES:
1. G. Cariolaro, "Quantum communications". Vol. 2. Springer, 2015.
2. S. Loepp, W. K. Wooters, "Protecting Information: From Classical Error Correction to Quantum Cryptography", Cambridge Press, 2006.
3. M. Nielsen and I. L. Chuang, "Quantum Computation and Quantum Information", Cambridge Press, 2006.

23L076 SOFTWARE DEFINED NETWORKING

3 0 0 3

EVOLUTION AND SOFTWARE DEFINED NETWORKING (SDN) CHARACTERISTICS: Introduction - Centralized/Distributed Control and Data Planes – Fundamental Characteristics of SDN - SDN Operation, Devices Network Virtualization: Concepts, Applications, Existing Network Virtualization Frameworks. (9)

SDN IMPLEMENTATION AND OPENFLOW: SDN design - Separation of the control and data planes - Edge- oriented networking - Telecommunication SDN attributes – Telecommunication services – Realisation of SDN using software – OpenFlow: Overview, Channel, Controller Modes, Configuration and management protocol. (9)

SDN CONTROLLERS: Introduction - General Concepts — Different controllers: NOX, POX, Ryu, Trema, Floodlight and OpenDaylight - Realisation of Controllers using software. (9)

SDN DEVELOPMENT: Existing network limitations - Programmable networks – Network and application information - Legacy to SDN – Protocols in the context of SDN – Additional SDN Protocol Models - Additional SDN Controller Models - AdditionalApplication Models. (9)

SDN APPLICATIONS AND OTHER ENVIRONMENTS: Application Types: Reactive and Proactive applications, Internal and External applications - Wide Area Networks - Service Provider and Carrier Networks — Campus Networks - Mobile Networks - Optical Networks. (9)

Total L: 45

TEXT BOOKS:
1. Patricia A. Morreale, James M. Anderson, "Software Defined Networking: Design and Deployment", 1st Edition, CRCPress, 2014.
2. Paul Goransson, Chuck Black, Timothy Culve, "Software Defined Networks: A Comprehensive Approach", 2nd Edition, Morgan Kaufmann, 2016.

REFERENCES:
1. Larry L. Peterson, Carmelo Cascone, Brian O'Connor, Thomas Vachuska, Bruce Davie, "Software Defined Networks: A Systems Approach", Systems Approach LLC, 2021
2. Rajesh Kumar , "Software Defined Networking – a definitive guide", Smash words Edition, 2013.
3. Thomas D. Nadeau, Ken Gray , "SDN: Software Defined Networks: An Authoritative Review of Network Programmability Technologies", 1st Edition, O'Reilly Media, 2013.
4. Siamak Azodolmolky, "Software Defined Networking with Open Flow", Packt Publishing, 2013.

23L077 RADIO FREQUENCY INTEGRATED CIRCUITS

3 0 0 3

BASIC OF RF ELECTRONICS AND ISSUES IN RFIC DESIGN: Lumped element concept at RF - lumped and distributed regions lower frequency analog design - microwave design versus radio frequency integrated circuit design - Impedance levels for microwave and low-frequency analog design - noise - linearity and distortion in RF Circuits. (7)

SEMICONDUCTOR DEVICE MODELING OF TECHNOLOGY: Basic operation and characteristic of bipolar junction transistor - Small -signal model of bipolar transistor - high frequency effects - noise in bipolar transistors - base shot noise-noise sources in the transistor model - bipolar transistor design considerations-CMOS transistor. (8)

DESIGN OF PASSIVE CIRCUIT ELEMENTS IN IC TECHNOLOGIES: Technology backend and metallization in IC technologies - sheet resistance and skin effect -parasitic capacitance and inductance - current handling in metal lines – design of inductors and transformers - characterization of inductor-layout of spiral inductors. (8)

LOW NOISE AMPLIFIER: Basic amplifiers - amplifiers with feedback - noise in amplifiers - linearity in amplifiers – differential amplifiers - low-voltage topologies for LNAs and the use of on-chip transformers - DC bias networks - temperature effects - broad band LNA design. (11)

MIXERS AND VOLTAGE-CONTROLLED OSCILLATORS: Nonlinearity -controlled transconductance mixer - double- balanced mixer - mixer with switching of upper quad - analysis of switching modulator - mixer noise - linearity - improving isolation - image reject - single -sideband mixers -Analysis of an oscillator as a feedback system - phase noise - VCO automatic - amplitude control circuits. (11)

Total L: 45

TEXT BOOKS:

1. John Rogers , Calvin Plett , "Radio Frequency Integrated Circuit Design", Artech House, 2011.
2. Radmanesh M M , " Radio Frequency and Microwave Electronics", Asia, 2011.

REFERENCES:

1. Less Besser , Rowan Gllmore , " Practical RF Circuit Design for Modern Wireless Systems", Artech House, 2011.
2. Stephan A Mass , "Non-Linear Microwave and RF circuits", Artech House, 2008.
3. Ferri Losee , "RF Systems, Components and Circuits handbook", Artech house, 2018.
4. Larson L E , "RF and Microwave Circuit for Wireless Applications", Artech House, 2015.

23L078 MODERN ANTENNA SYSTEMS

3 0 0 3

RADIATION FROM APERTURES : Field equivalence principle - Radiation from Rectangular and Circular apertures - Uniform aperture distribution on an infinite ground plane- Babinet's principle and complementary antennas- Slot antenna- Biconical antenna- Discone and conical skirt monopole antennas. (9)

ARRAY ANTENNAS : Uniform array-Phased array - beam scanning - grating lobes - feed network - Linear array synthesis techniques - Super Directivity - Planar array- stacked array -Circular array - Design problems. (9)

FREQUENCY INDEPENDENT ANTENNAS: Condition for frequency independence - general analysis-equiangular spiral antennas-planar-conical-lens antennas-types-non metallic dielectric lens-Feed systems. (9)

RADIO DIRECTION FINDING ANTENNA: Loop antenna - Transmitting loop antenna-equivalence to loop antenna- Far fields-radiation resistance, directivity- square loop-ferrite rod antenna-whip antenna. (9)

RFID TAG ANTENNAS: UHF RFID Tags- RFID back scatter. Passive, active and semi passive RFID Tags-Types of Antennas for RFID Tags-Regulation and standards- Chipless RFID Tags-active antennas. (9)

Total L: 45

TEXT BOOKS:

1. K.D. Prasad, "Antenna and Wave propagation" 4th edition, Satya Prakashan publication, 2020.
2. Balanis A , "Antenna Theory Analysis and Design", Second, John Wiley and Sons, New Delhi, Reprint 2018.

REFERENCES:

1. John D krauss , "Antennas", 3rd Edition, Mc Graw-Hill, Inc, New York, 2018.
2. Stutzman W L , Thiele G A , "Antenna Theory and Design", 2nd Edition, John Wiley and Sons Inc., Singapore, 2014.
3. S. Drabowitch, A. Papiernik, J. Encinas, H. Griffiths, "Modern Antennas", Springer US, 2013.
4. Mohammod Ali, "Reconfigurable Antenna Design and Analysis" Artech House, 2021.

23L079 RF TRANSCEIVER DESIGN

3 0 0 3

RF PASSIVE NETWORK AND ANALYSIS: High frequency passive components – Transmission Lines, Micro strip line, Voltage Reflection Co-efficient, propagation constant phase velocity and special termination – Definition –properties of networks and parameters-microwave filter design-couplers and dividers- design of two component Impedance matching – discrete component matching. (9)

PASSIVE COMPONENT MODELING: Modeling of Resistor, Inductor and capacitor- planar transmission line for RF/ MW applications and design using CAD tools. (9)

RF AMPLIFIERS: Introduction power gain – DC Bias – maximum small signal gain – multistage amplifiers- operating gain design for maximum linear output power -noise in RF circuits- available gain design technique- comparison of the various amplifier designs –Low noise amplifier - smith chart based graphical design aids- broadband amplifiers. (9)

RF POWER AMPLIFIER AND OSCILLATOR DESIGN: Diode model- Nonlinear concept- power amplifier design- categories of amplifiers - bias considerations - oscillators – principles of design – oscillator design examples. (9)

MIXER AND FREQUENCY MULTIPLIERS: Overview of mixers and their applications in systems- diode mixers and their topologies- transistor mixer design - frequency multipliers-an overview- doublers. (9)

Total L: 45

TEXTBOOKS:
1. David M Pozar, "Microwave Engineering", John Wiley and Sons, 2012.
2. Reinhold Ludwig and Pavel Bretchko, "RF Circuit Design: Theory and Applications", Pearson Education, 2011.

REFERENCES:
1. Rowan Gilmore and Les Besser, "Practical RF Circuit Design for Modern Wireless Systems", Vol I, Passive Circuit and Systems, Artech House, London, Reprint 2021.
2. Rowan Gilmore and Les Besser, "Practical RF Circuit Design for Modern Wireless Systems", Vol II, Active Circuit and Systems, Artech House, London, Reprint 2021.
3. Collin R E,"Foundations of Microwave Engineering, McGraw Hill, Reprint 2012.

LANGUAGE ELECTIVES

23G001 COMMUNICATION SKILLS FOR ENGINEERS

0 0 4 2

COMMUNICATION CONCEPTS: Process of Communication – Inter and Intrapersonal Communication – Essentials for effectiveness (9)

ORAL COMMUNICATION: Oral presentations with visual aids and Group discussions. (16)

FOCUS ON SOFT SKILLS: Etiquette – Work Place etiquette – Telephone etiquette- Body Language – Critical Reasoning and Conflict Management based on Case Studies – Group Communication- Meetings -Interview Techniques (14)

TECHNICAL WRITING: Technical Writing Principles - Style and Mechanics - Technical Definitions – Physical, Functional and Process Descriptions –- Technical Report Writing – Preparing Instructions – Interpretation of Technical Data (14)

BUSINESS CORRESPONDENCE: Writing Emails, Preparing Resumes. (7)

Total: 60

TEXTBOOKS:
1. Course materials prepared by the Faculty, Department of English.

REFERENCES:
1. Jeff Butterfield, "Soft Skills for Everyone", Cengage Learning, New Delhi, 2020.
2. Sabina Pillai and Agna Fernandez, "Soft skills and Employability Skills", Cambridge University Press, New Delhi, 2019.
3. Prashant Sharma, "Soft Skills Personality Development for Life Success", BPB Publications, New Delhi, 2021.
4. Shoba K N and Praveen Sam D, "Technical English", Cambridge University Press, New York, 2020

23G002 BASIC GERMAN

0 0 4 2

Guten Tag! - Learning: To greet, learn numbers till 20, practice telephone numbers & e mail address, learn alphabet, speak about countries & languages ; **Vocabulary:** related to the topic; **Grammar:** W – Questions, Verbs & Personal pronouns I. (10)

Freunde, Kollegen und ich - Learning: To speak about hobbies, jobs, learn numbers from 20; **Vocabulary:** related to the topic; **Grammar:** Articles, Verbs & Personal pronouns II, sein & haben verbs, ja/nein Frage, singular/plural. (10)

In der Stadt – **Learning**: To know places, buildings, question, know transport systems, understand international words; **Vocabulary:** related to the topic; **Grammar:** Definite & indefinite articles, Negotiation, Imperative with Sie. (12)

Guten Appetit! – Learning: To speak about food, shop, converse; **Vocabulary:** related to the topic; **Grammar:** Sentence position, Accusative, Accusative with verbs. (13)

Tag für Tag and Zeit mit Freunden – Learning: To learn time related expressions, speak about family, ask excuse, fix appointments on phone, birthdays, understand & write invitations, converse in the restaurant ; **Vocabulary:** related to the topic; **Grammar: Preposition –** am, im, um, von…bis, Possessive articles, Modalverbs. (15)

TOTAL : (60)

TEXT BOOK:
1. Dengler, Stefanie et al.,, *Netzwerk A1.1*, Klett-Langenscheidt Gmbh, München, 2013.

REFERENCES:
1. Dengler, Stefanie et al., *Netzwerk A1*,Klett-Langenscheidt Gmbh, München, 2013.
2. Sandra Evans,Angela Pude, Franz Specht-Menschen A1–Hueber Verlag ,2012.
3. Hermann Funk, Christina Kuhn, Silke Demme, Studio d A1 , Goyal Publishers & Distributors Pvt. Ltd ,2009.
4. Rosa-Maria Dallapiazza, Eduard von Jan, Til Schönherr, *Tangram Aktuell 1 (Deutsch als Fremdsprache)* , Max Hueber Verlag ,2004.

23G003 BASIC FRENCH

0 0 4 2

Unité 1: inviter et répondre à une invitation, Pronoms sujets, L'article définis, l'article indéfinis, Conjugation : présent, adjectifs possessifs, interrogation, décrire les personnes. La vie de quatre parisiens de profession différentes (15)

Unité 2: Exprimer l'ordre et l'obligation demander et commander, l'adjectif possessifs, l'articles partitif, l'article démonstratif, négation ne....pas, l'article contracté, verbe pronominaux, prépositions. (15)

Unité 3: Raconter et reporter-donner son avis, Futur simple, pronom complètement d'objet direct, passé composé, plusieurs région de France, imparfait, pronom y/en, imparfait (15)

Unité 4: Demander l'autorisation-passé récent, futur proche,La vie administrativé et régionale, Pluriel des noms, moyens de transport (15)

Total : 60

TEXT BOOK :
1. Christine Andant étal, À propos (livre de l'élève), LANGER, NEW DELHI, 2012.

REFERENCES:
1. Dondo Modern French Course ---Mathurin Dondo
2. Modern French Grammar---Margaret Lang and Isabelle Perez.

23G004 BASIC JAPANESE

0 0 4 2

Orientation Session, Geographic & Socio, economic perspective to Japan, Japanese people and culture and Basic greetings and responses (3)

Basic script, Method of writing hiragana and katakana, and Combination sounds and simple words (3)

Topic marker “wa”, Desu / dewa arimasen cupolas, Interrogative particle “ka”, Grammar particles “mo”, “no”, ‘’ Introducing some one: “Kochira wa ~“ and Self introductions: Hajimemashite” (3)

Demonstratives “Kore”, “Sore”, “Are”, Demonstrative “Kono”, “Sono”, “Ano” , Possessive noun particle “no” and Japanese apartments: Greeting your neighbour (3)

Place marakers “Koko”, “Soko”, “Asoko”, Direction markers “Kochira”, “Sochira”, “Achira” and Japanese department stores: Asking for and buying something (3)

Asking for and telling the time, Paticle “ni (at)” for time, kara (from) ~ made (until), Particle “to (and)”, Time periods: Days of the week, months, time of day, Verbs (Present / future and past tense) and Telephone enquiry: Asking for a phone no. And business hours (3)

Destination particle “e”, Particles “de (mode of transportation)” and “to (with) and Japanese train station: Asking for Fare and track no. / types of trains (3)

Direct object particle “o”, Particle “de (place of action)” , Verbs (“~masen ka”, “~mashou”) and “Ohanami” Cherry blossom viewing (3)

Particle “de (by means of)” , Particle “ni (to)”, ,Aaemasu (give) and Moraimasu (receive) and Visiting a Japanese house (3)

Adjectives (“i” and “na” type), Adjectives (Positive and negative useage), Particle “ga (however, but), “Dore which?)” and Leaving a room, thanking someone for hospitality (3)

Likes and dislikes, Potential verbs (wakarimasu and dekimasu), “Kara (~ because)”, Adverbs and Asking someone out over the phone (3)

Verbs denoting presence: “Imasu” and “arimasu”, Particle “ni (in)”, “Dare (who?)” , Adverbs (“Chikaku ni ~“), Particle “dare mo (negative ~ no one)” , Dare ka (anyone), dare ga (who) , Nani ka (anything) , nani ga (what) - ~ya (and) ~ nado (etc.) and Asking for directions (3)

Counters and Counting suffixes (3)

Introduction to Adjectives (na and ii type), Different usages of adjectives, Comparison, Likes and dislikes and Going to a trip (3)

Need and desire (ga hoshii), Wanting to … (Tabeti desu), Going for a certain purpose (mi –ni ikimasu) and Choosing from a menu (3)

Verb groups, I, II and III and Exercises to group verbs (3)

Please do (te kudasai), Present continuous tenses (te imasu), Shall I? (~ mashou ka) and Describing a natural phenomenon (It is raining) (3)

To grant permission (~te mo ii desu), Asking for permission (~ te mo ii desu ka) and Should not do (~ te wa ikemasen) (3)

Describing a continuing state and Describing a habitual action (2)

Roleplays in Japanese (2)

A demonstration on usage of chopsticks and Japanese tea party (2)

Total: 60

TEXT BOOK:
1. Minna no nohongo – Romaji ban (first 10 lessons of this book)

REFERENCE:
1. Minna no Nihongo I Honsatsu Roma – ji ban (Main Textbook Romanized Version). International publisher – 3A Corporation,
2. Tokyo, Indian distributor – Goyal Publishers & Distributors, New Delhi.

OPEN ELECTIVES

23LO01 NANOTECHNOLOGY AND ITS APPLICATIONS

3 0 0 3

NANO CONCEPTS AND MATERIALS: Scientific Revolution -Feynman's Vision –Nanosized Effects –Surface to Volume Ratio –Size Dependent Properties of Nanomaterials. Quantum Confinement Effects –Classifications of nanosystems-0D, 1D, & 2D. Challenges and future prospects of Nanoscience. (9)

PREPARATION AND CHARACTERIZATION: Top down approach-bottom up approach. Mechanical alloying and Milling, Self assembly, biomimmetic approach. Characterization: electron microscopy, atomic force microscopy, scanning tunneling microscopy, particle size analyzer. (9)

NANOTECHNOLOGY IN HEALTHCARE: Material characteristics for healthcare industry, Drug delivery, molecular imaging, diagnostic tools, implant coatings, implantable medical devices, nanosensors for point of care diagnostic devices. **(**9)

ENVIRONMENTAL NANOTECHNOLOGY: Air purification, water purification, nano biosensors for pesticide detection, nano biosensor for plant pathogen detection, pesticide degradation, soil structure and remediation, metal and CNT based adsorbents for waste water treatment. (9)

NANO IN TEXTILE AND FOOD INDUSTRY: Self cleaning textiles-superhydrophobicity, smart textiles-wearable electronics, shape memory polymers. Food packaging, beverage industry, milk and derivative processing using nanotechnology. (9)

Total L:45

TEXTBOOKS
1. Pradeep T, "Nano: The essentials, Understanding Nanoscience and Nanotechnology", Tata Mc Graw Hill, New Delhi, 2007.
2. Yasir Beeran Pottathara,et.al., "Nanomaterials Synthesis, Design, Fabrication and Applications", Elseiver, USA, 2019.

REFERENCES
1. Ratna Tantra, "Nanomaterial Characterization An Introduction", Wiley, 2016
2. M. H. Fulekar, Bhawana Pathak, Environmental Nanotechnology, Taylor & Francis, CRC Press, 2017
3. Mangala Joshi, "Nanotechnology in Textiles Advances and Developments in Polymer Nanocomposites", Jenny Stanford Publishing, Singapore, 2020
4. Abdullah Mohamed Asiri et.al, Food Applications of Nanotechnology, CRC Press, 2019

23LO02 INTERNET OF THINGS

3 0 0 3

SYSTEM ARCHITECTURE: Characteristics – IoT Stack – Enabling Technologies – Challenges – IoT Architecture - M2M Communication – Network Layers and Design Standards – Communication Technologies: Wired and Wireless. (9)

PROTOCOLS: Application Layer Protocols: HTTP – CoAP – MQTT – XMPP – AMQP – Transport Layer: TCP – UDP – Network Layer: IPv6 – 6LoWPAN – Link Layer: Bluetooth – BLE- ZigBee – WiFi – LoRaWAN. (10)

CLOUD COMPUTING: Internet Connectivity: IP and Non IP based – Data Acquisition – Need for cloud computing - Models of Cloud computing – Cloud Services: Thing Speak – AdaFruit IO. (10)

APPLICATION BUILDING: IFTTT- Programming Raspberry Pi for IoT System – WiFi based IoT system – Bluetooth based IoT system – LoRa Communication based IoT System. (10)

CASE STUDY: Home Automation, Connected Cars, Agriculture – Education System. (6)

Total: 45

TEXT BOOKS:

1. Raj Kamal, Internet of Things: Architecture and Design Principles, McGraw Hill Education (India) Private Limited, 2017.
2. Milenkovic, Milan, “Internet of Things: Concepts and System Design”, Springer Nature, 2020.

REFERENCES:

1. James, Alice, Avishkar Seth, and Subhas Chandra Mukhopadhyay. "IoT System Design—A Project Based Approach." In IoT System Design, pp. 9-33. Springer, Cham, 2022.
2. Lea, Perry. IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security. Packt Publishing Ltd, 2020.
3. Cirani, Simone, Gianluigi Ferrari, Marco Picone, and Luca Veltri. Internet of Things: Architectures, Protocols and Standards. John Wiley & Sons, 2018.
4. Tsiatsis, Vlasios, Stamatis Karnouskos, Jan Holler, David Boyle, and Catherine Mulligan. Internet of Things: technologies and applications for a new age of intelligence. Academic Press, 2018.

23LO03 VIRTUAL REALITY

3 0 0 3

INTRODUCTION TO VIRTUAL REALITY: Virtual reality – Hardware and software – VR Input Devices – Game Engines-VR Applications- Sports- News and Documentary Films- Scientific Data Visualization- Medical Training- Physical Rehabilitation and Psychotherapy-Human physiology-Challenges in Virtual Reality. (9)

3D MODELS FOR VIRTUAL REALITY: Geometric models–Changing position and orientation-viewing and chaining transformations - 3DGraphics–VRGraphics–Introduction to OpenGL programming. (9)

VISUAL PERCEPTION AND AUDIO: Perception of depth, motion and color, Visual Rendering -Ray Tracing and Shading Models, Improving Latency and Frame Rates, Auditory Perception, Auditory Rendering. (9)

3D INTERACTION DESIGN: VR Interaction Theory – Locomotion, Manipulation – Moving around in VR –Virtual Navigation– Interacting with objects in VR-User Interfaces in VR. (9)

BEYOND VR: Augmented Reality – Differences between VR and AR - Content Creation in VR and AR - Mixed Reality – Extended Reality - Social VR– Virtual characters – Body animation- Case studies. (9)

TotaL:45

TEXT BOOKS:

1. StevenM.LaValle, “Virtual Reality”, Cambridge Universitypress,2020.
2. Grigore C Burdea and Philippe Coiffet, “Virtual Reality Technology”, Wiley Interscience, 2016

REFERENCES:

1. Rajesh k. Maurya, “Computer Graphics with Virtual Reality Systems, John willey &sons, Second Edition ,2014.
2. Alan B Craig, William R Sherman and Jeffrey D Will,” Developing Virtual Reality Applications: Foundations of Effective Design”, Morgan Kaufmann, 2009
3. Paul Mealy,” Virtual & Augmented Reality for dummies “, John Wiley & Sons, Inc ,2018.

23LO04 SYSTEMS ENGINEERING

3 0 0 3

INTRODUCTION TO SYSTEMS ENGINEERING AND COMPLEX SYSTEMS: Systems engineering – what is, origin, and examples; Systems engg as a profession Power of systems engineering and examples; Systems engineering viewpoint, perspectives, domains; Systems engineering fields, approaches, activities, and products- Complex system structure-building blocks, hierarchy, interfaces; Complex system structure-environment, interfaces and interactions, complexity in modern systems. (9)

DEVELOPMENT PROCESS AND SYSTEMS ENGINEERING MANAGEMENT: System development process–life cycle, evolutionary characteristics; Systems engineering method; Systems testing throughout development- Managing systems development, risks, work breakdown structure , systems engineering management plan - Systems risk management, organizing for systems engineering- Need analysis – originating, operations, functional, and feasibility Need validation, systems operations requirement; System requirements development, performance requirements. (9)

CONCEPT DEVELOPMENT AND DECISION ANALYSIS : Implementing concept exploration, validating requirements; Concept definition – selection and validation, functional analysis and allocation ; Systems architecture, system modeling languages, Model-Based Systems engineering- Decision making, modeling for decisions; Simulation, Trade-off analysis engineering development stage – program risk reduction, prototype development for risk mitigation. (9)

ENGINEERING DEVELOPMENT AND SOFTWARE SYTEMS ENGINEERING: Engineering development stage – program risk reduction, prototype development for risk mitigation - Development testing, risk reduction- functional analysis and design- Engineering design – implementing system building blocks, component design; Design validation, change management- coping with complexity and abstraction -nature of software development - life cycle models- concept development: analysis and design - coding and unit test - Integration and Test – software engineering management. (9)

INTEGRATION, EVALUATION AND SUPPORT: Integration, testing and evaluating total system; Test planning and preparation, system integration -Developmental and operational test and evaluation; Engineering for production, transition from development to production -Production operations - Production operations - Installation, maintenance and upgrading; Installation testing; In-service support Upgrades and modernization. (9)

Total: 45

TEXT BOOKS:

1. Alexander Kossiakoff, William N. Sweet, Samuel J. Seymour, Steven M. Biemer, “Systems Engineering Principles and Practice”, Wiley, New Jersey, 2011.
2. Robert J. Cloutier, “Guide to the Systems Engineering Body of Knowledge”, version 2.2, The InternationalCouncil on Systems Engineering (INCOSE) IEEE, Systems Engineering Research Center (SERC), Computer Society (IEEE CS), South Alabama, 2019.

REFERENCES:

1. Haberfellner, R., de Weck, O., Fricke, E., Vössner, S, “Systems Engineering Fundamentals and Applications”, Birkhauser Basel Publishers, Basel, Switzerland, 2019.
2. Charles S. Wasson, “System Engineering Analysis, Design, and Development: Concepts, Principles, and Practices”, Wiley, New Jersey, 2015.
3. INCOSE, “INCOSE Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities”, Wiley, New Jersey, 2015.

23LO05 UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY

2 1 0 3

NEED FOR VALUE EDUCATION: Self-Exploration–; ‘Natural Acceptance’ and Experiential Validation as the process for self-exploration, Continuous Happiness and Prosperity- basic Human Aspirations, . Right understanding, Relationship and Physical Facility - the basic requirements for fulfillment of aspirations, understanding and living in harmony. (6+3)

UNDERSTANDING HARMONY IN THE HUMAN BEING: Understanding human being as a co-existence of the sentient ‘I’ and the material ‘Body’, Understanding the needs of Self (‘I’) and ‘Body’ - happiness and physical facility, Understanding the Body as an instrument of ‘I’ (I being the doer, seer and enjoyer), Understanding the characteristics and activities of ‘I’ and harmony in ‘I’, Understanding the harmony of I with the Body; correct appraisal of Physical needs . (6+3)

UNDERSTANDING HARMONY IN THE FAMILY AND SOCIETY: Understanding values in human-human relationship; Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship Understanding the harmony in the society Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals, Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. Gratitude as a universal value in relationships. (6+3)

UNDERSTANDING HARMONY IN THE NATURE: Understanding the harmony in the Nature, Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature, Understanding Existence as Co-existence of mutually interacting units in all- Holistic perception of harmony at all levels of existence. (4+2)

HOLISTIC UNDERSTANDING OF HARMONY ON PROFESSIONAL ETHICS: Definitiveness of Ethical Human Conduct, Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order, Competence in professional ethics-. Ability to utilize the professional competence for augmenting universal human order-. Ability to identify the scope and characteristics of people - friendly and eco-friendly production systems- Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems, Strategy for transition from the present state to Universal Human Order:- At the level of individual: as socially and ecologically responsible engineers, technologists and managers-. At the level of society: as mutually enriching institutions and organizations. (8+4)

Total L: 30 + T:15=45

TEXT BOOKS:

1. R R Gaur, R Sangal, G P Bagaria ,”Human Values and Professional Ethics”, Excel Books, New Delhi, 2010 .
2. A.N. Tripathi, “Human Values”, New Age International Publishers, New Delhi, 2004.

REFERENCES:

1. Tanu Shukla , Anupam Yadav ,Gajendra Singh Chauhan, “ Human Values and Professional Ethics**”,** Cengage India, 2017
2. Jayasree Suresh, B.S.Raghavan, “ Human Values and Professional Ethics**”,** S.Chand & company, 2010.
3. Dubrien,A.J.,“Human Relations for Career and Personal Success: Concepts, Applications, and Skills”, Pearson, 2017.
4. William, K Frankena, “ Ethics” ,Prentice Hall of India, 1988.

23LO06 ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

3 0 0 3

KNOWLEDGE IN AI: History of AI – Representing Knowledge – Metrics for accessing knowledge representations – Logic representations – Procedural representations – Network representations – Structural representations – General Knowledge.(7)

REASONING AND SEARCH: Overview – Forward and Backward reasoning – Reasoning with uncertainty – Exhaustive search and simple pruning – Heuristic search – Knowledge rich search. (7)

SUPERVISED AND UNSUPERVISED LEARNING: Linear regression – Logical regression – Multilayer perceptron – KL divergence – Generalized linear models – Nonlinear ensembles – Evaluation metrics – k-means clustering – EM algorithm. (11)

REGRESSION ANALYSIS: Linear regression – Cost functions – Gradient descent – Polynomial regression – Regularization – Evaluating a machine learning model. (9)

EDGE AI AND IMPLEMENTATION: Embedded ML and Edge AI – Technology of Edge AI – Understand and Framing problems - Building an AI expert system using PyTorch in Raspberry PI. (11)

Total: 45

TEXT BOOKS:

1. Finlay, Janet, and Alan Dix. An introduction to artificial intelligence. Crc Press, 2020.
2. Pandey, Rajiv, Sunil Kumar Khatri, Neeraj Kumar Singh, and Parul Verma, eds. Artificial Intelligence and Machine Learning for EDGE Computing. Elsevier, 2022.

REFERENCES:

1. Norris, Donald J. Beginning artificial intelligence with the Raspberry Pi. Apress, 2017.
2. Daniel Situnayake, Jenny Plunkett, AI at the Edge. O'Reilly, 2022.
3. Ertel, Wolfgang. Introduction to artificial intelligence. Springer, 2018.
4. Tang, Jeff. Intelligent Mobile Projects with TensorFlow: Build 10+ Artificial Intelligence Apps Using TensorFlow Mobile and Lite for IOS, Android, and Raspberry Pi. Packt Publishing Ltd, 2018.

23LO07 MEASUREMENTS AND INSTRUMENTATION

3 0 0 3

MEASUREMENTS : Significance and methods of measurements – Standards and their classification. calibration – functional elements of a measurement system - errors in measurements Types of errors- statistical analysis of errors –probability of errors-limiting errors– Introduction to VI software. (6)

INDICATING INSTRUMENTS : PMMC Mechanism - D'Arsonal Galvanometer - DC Ammeters and voltmeters -Measurement of resistance, inductance and capacitance using dc and ac bridges –Wheatstone, Kelvin, Maxwell, Hay and Schering Bridges- AC voltmeters using rectifiers - digital voltmeters – Multimeter - VSWR meter - Frequency meter. (9)

SIGNAL SOURCES AND ANALYSERS : Function generator and pulse generators-functions and applications- Oscilloscopes – DSO and MSO, Harmonic Distortion and spectrum Analyzers-Applications- Digital Recorders and printers, 3D printing - Realization of signal sources and analyzers. (10)

TRANSDUCERS : Classification and selection of Transducers - Resistive, capacitive and inductive Transducers — Piezoelectric, Hall effect, optical and digital transducers – Microphone and speakers - Smart sensors and MEMS - Interfacing of transducers. (10)

DATA ACQUISITION SYSTEMS : Block Diagram – Specifications, various components and Applications of DAS -Realization of DAS. (10)

Total L : 45

TEXT BOOKS:

1. Albert D Helfrick, Cooper. W.D , "Electronic Instrumentation and Measurement Techniques", Prentice Hall of India, New Delhi, 2012.
2. Sawhney A K , "A course in Electrical and Electronic Measurement and Instrumentation", 19th Edition, Dhanpat Rai and Co. (P) Ltd, New Delhi, Reprint 2019.

REFERENCES:

1. Joseph J Carr , "Elements of Electronic Instrumentation and Measurement", Pearson Education, New Delhi, 2008.
2. Nakra B C, Choudhury K.K , "Instrumentation Measurement and Analysis", Tata McGraw Hill, New Delhi, 2004.
3. Jovitha Jerome , "Virtual Instrumentation Using LabView", Prentice Hall of India, New Delhi, 2010.
4. D.V.S. Murthy, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, 2015.