PONDICHERRY UNIVERSITY

B.Tech.

Electronics and Communication Engineering (ECE)

REGULATIONS, CURRICULUM AND SYLLABUS

(for Affiliated Colleges)

(2023- 24)

PONDICHERRY UNIVERSITY

BACHELOR OF TECHNOLOGY PROGRAMMES

(EIGHT SEMESTERS)

REGULATIONS 2023-24

1. Conditions for Admission:

a) Candidates for admission to the first semester of the 8 semester B.Tech. degree programme should be required to have passed:

The Higher Secondary Examination of the (10+2) curriculum (Academic Stream) prescribed by the different State Boards/ Central Boards or any other examination equivalent there to with minimum of 45% marks (mere pass for OBC and SC/ST candidates) in aggregate of subjects – Mathematics, Physics and any one of the following optional subjects: Chemistry / Biotechnology/ Computer Science / IT and equivalent/ Biology (Botany & Zoology) or an Examination of any University or Authority recognized by the Executive Council of the Pondicherry University as equivalent thereto.

b) For Lateral entry into second year (third semester) of the 8 semester B.Tech. degree programme :

The minimum qualification for admission is a pass in three year diploma or four year sandwich diploma course in Engineering / Technology with a minimum of 60 % marks (50% marks for OBC and a mere pass for SC/ST candidates) in aggregate in the subjects covered from third to final semester or a pass in any B.Sc. course with Mathematics as one of the subjects of study with a minimum of 60 % marks (50% marks for OBC and a mere pass for SC/ST candidates) in aggregate in main and ancillary subjects excluding language subjects. As per AICTE guidelines, Diploma candidates of any branch can join any B.Tech. Degree programme in the second year.

2. Age Limit :

As per applicable AICTE norms.

3. Duration of Programme:

The Bachelor of Technology degree programme shall extend over a period of 8 semesters spread over 4 academic years – two semesters constituting one academic year. The duration of each semester shall normally be 15 weeks excluding examinations.

4. Program Structure

The medium of instruction is English.

A student admitted to the B.Tech. programme in a particular branch of engineering will earn the degree in that branch by fulfilling all the requirements prescribed in the regulations during the course of study. The student is also permitted to opt for earning an **Honors degree in the same discipline of Engineering or a Minor degree** in another discipline of Engineering in addition to the degree in his

own discipline of engineering. The student will be allowed to exercise this option at the end of first year based on his academic performance in the first year. The students admitted through lateral entry can exercise this option at the end of third semester, based on the GPA scored in the third semester examination.

The student opting for B.Tech. degree with **Honors or B.Tech. degree with Minor** is required to earn additional 20 credits starting from the third semester. The students admitted in the second year through lateral entry and opting for Honors / Minor degree will earn the additional 20 credits starting from the fourth semester.

5. Eligibility for the award of B.Tech. Degree:

No candidate shall be eligible for the award of the degree of Bachelor of Technology, unless he/she has undergone the course for a period of 8 semesters (4 academic years) / 6 semesters (3 academic years for Lateral Entry candidates) in the Faculty of Engineering and has passed the prescribed examinations in all the semesters. Details regarding the possible exits for a B.Tech. student – in line with one of the goals of the National Education Policy (NEP) 2020 are provided in section 13.

6. Branches of Study:

Branch I - Civil Engineering
Branch II – Mechanical Engineering
Branch III - Electronics & Communication Engineering
Branch IV - Computer Science & Engineering
Branch V – Electrical & Electronics Engineering
Branch VI – Chemical Engineering
Branch VII - Electronics & Instrumentation Engineering
Branch VIII – Information Technology
Branch IX - Instrumentation & Control Engineering
Branch X – Biomedical Engineering
Branch XI - Robotics and Automation
Branch XII – Food Technology
Branch XIII- CSE (Internet of Things & Cyber security including Block chain Technology)
Branch XIV – Artificial Intelligence and Machine Learning
Branch XV - Artificial Intelligence and Data Science
or any other branch of study as and when offered. The branch allocation shall be ordinarily done at the time of admission of the candidate to the first semester.

7. Course Structure and Subjects of Study:

Definition of Credit:

1 Hour Lecture (L) per week	1 Credit
1 Hour Tutorial (T) per week	1 Credit
2 Hours Practical (P) per week	1 Credit

Range of Credits: The total credits of all the branches for the four-year B. Tech. degree Programme shall be in the range of 160 to 172 (Minor variation is allowed as per AICTE guidelines)

The subjects of study shall include theory, practical courses and project work/internships as given in the curriculum and shall be in accordance with the prescribed syllabus.

The curriculum of every programme will have courses that are categorized as follows:

(i) Humanities, Social Sciences and Management Courses (HSM)
(ii) Basic Science Courses (BSC)
(iii) Engineering Science Courses (ESC)
(iv) Professional Core Courses (PCC)
(v) Professional Elective Courses (PEC)
(vi) Open Elective Courses (OEC)
(vii) Professional Activity Courses (PAC)
(viii) Mandatory non-Credit Courses (MCC)

Each course will have either one or more of three components namely Lecture (L), Tutorial (T) and Practice (P). Each course is assigned credits as detailed below:

(i) Theory courses will carry either 3 or 4 credits - 3 credits for courses with 3 lecture periods per week and 4 credits for courses with 3 lecture periods and 1 tutorial period per week.

(ii) All Elective courses including online courses will carry maximum 3 credits. The student can earn the credits towards the Open Elective Courses (OEC) by completing the online courses offered in NPTEL anytime between third and seventh semester on prior approval of the courses by the Academic Courses Committee of the Institute. Credits earned through the NPTEL courses will be confined to 2 or 3 credits and subject to a maximum of 9 credits during the entire programme of study.

(iii) Practical courses will normally carry either 1 or 1.5 credits – 1.5 credits for courses with 3 practice periods per week and 1 credit for courses with 2 practice periods per week.

(iv) Out of total credits required for successful completion of the degree, 14 to 22 credits can be assigned for Project work and/or Internship.

(v) Mandatory non-credit courses carry zero credit.

8. Examinations:

The theory and practical examinations shall comprise continuous internal assessment throughout the semester in all subjects as well as university examinations conducted by Pondicherry University at the end of the semester (November / December or April / May).

Evaluation Scheme

All Credit courses are evaluated for 100 marks comprising of Internal assessment and end-semester exam.

For Theory Course, the weightage of internal assessment is 40% and end semester examination is 60%

For Practical course, the weightage of internal assessment is 60% and end semester examination is 40%

For Project, the weightage of internal assessment is 60% and end semester examination is 40%

Internal Assessment (Theory)

Total Internal Assessment mark for a theory course is 40 marks. The breakup is as follows:

Criteria	Maximum Marks
a) Internal Assessment Tests	30
b) Percentage of Attendance	5
c) Assignment(s)	5
Total	**40**

Marks for Attendance is as follows:

Below 75%	0
75% - 80%	1
81% - 85%	2
86% - 90%	3
91% - 95%	4
96% - 100%	5

The Principal of the College/Institute schedules the Internal Assessment tests for all courses. All faculty members are expected to conduct this Internal Assessment tests for 1.30 hours duration and evaluate and required to upload the marks to the Controller of Examinations of University. Colleges are also requested to preserve the answer sheets of Internal Assessment tests until declaration of results by the University.

Internal Assessment (Practical's)

Faculty in-charge of Lab courses shall evaluate the practical course for 60 marks. The break up is as follows:

Criteria	Maximum Marks
a) Laboratory exercises and Record	30
c) Mid Semester exam (Average of 2 exams)	15
c) Internal Viva voce	5
d) Percentage of Attendance	10
Total	**60**

Marks for Attendance is as follows:

Below 75%	0
75% - 80%	2
81% - 85%	4
86% - 90%	6
91% - 95%	8
96% - 100%	10

Internal Assessment (Project)

The Project work carried out in the eighth semester shall be assessed as follows:

Criteria	Marks
a) Continuous assessment (Guide)	25
b) Project Evaluation Committee	35
Total	**60**

Requirement for appearing for University Examination

The Controller of Examinations (COE) of Pondicherry University schedules the End-Semester exams for all theory and practical courses based on the University academic calendar.

A detailed Exam Time Table shall be circulated to all Colleges at least 15 days before the start of exams. Question Papers shall be set externally based on BOS approved syllabus.

A candidate shall be permitted to appear for university examinations at the end of any semester only if:

i) He / She secures not less than 75% overall attendance arrived at by taking into account the total number of periods in all subjects put together offered by the institution for the semester under consideration.
(*Candidates who secure overall attendance greater than 60% and less than 75% have to pay a condonation fee as prescribed by University along with a medical certificate obtained from a medicalofficer not below the rank of Assistant Director*)

ii) He / She earns a progress certificate from the Head of the institution for having satisfactorily completed the course of study in all the subjects pertaining to that semester

iii) His / Her conduct is found to be satisfactory as certified by the Head of the institution.
A candidate who has satisfied the requirement (i) to (iii) shall be deemed to have satisfied the course requirements for the semester.

End Semester Exam Evaluation Pattern

Course	**Maximum marks**
a) Theory course (Sec A, Sec B and Sec C) Questions from all units of syllabus	60 marks
b) Practical course (Based on Lab exercises/Record/ Practical's /Viva)	40 marks
c) Internship /Project Work (Based on Seminar/Project Work/Project report/Presentation and viva voce)	40 marks

Consolidation of Marks and Passing Minimum

The Controller of Examinations of the University consolidates the Internal Assessment marks uploaded by the Colleges and marks secured by students in the end-semester examination.

A student shall be declared to have passed the examination in a subject of study only if he/she secures not less than **40% marks individually both in internal assessment and end-semester examination or an aggregate of 40%.**

A candidate who has been declared "Fail" in a particular subject may reappear for that subject during the subsequent semesters and secure pass marks. However, there is a provision for revaluation of failed or passed subjects provided he/she fulfills the following norms for revaluation.

a) Applications for revaluation should be filed within 15 days from the date of declaration of results or 7 days from the date of receipt of grade sheet whichever is earlier.
b) The candidate should have attended all the internal assessments conducted by the college as well as all the end semester examinations conducted by the University.
c) If a candidate has failed in more than two papers in the end semester examinations, his/her representation for revaluation will not be considered.
d) The request for revaluation must be made in the prescribed format duly recommended by the Head of the Institution along with the revaluation fee prescribed by the University.

A student shall be declared to have passed the examination in a subject of study only **if he/she secures not less than 40% marks in the end-semester examination and secures an overall aggregate of 40%.**

Arrear Exams

A student who failed to secure 40% marks in aggregate is declared as "Fail" and he is eligible to take up a supplementary examination by registering to the said course in the following semester. All other candidates who failed due to shortage of attendance those who are seeking to improve the grade shall repeat the course.

Letter Grades and Calculation of CGPA

Total Marks Secured by a student in each course shall be converted into a letter grade. The following Table shows the seven letter grades and corresponding meaning and the grade points for the calculation of Cumulative Grade Point Average (CGPA).

Each course (Theory/Practical) is to be assigned 100 marks, irrespective of the number of credits, and the mapping of marks to grades may be done as per the following table:

Range of Marks	Assigned Grade	Grade Points
91-100	A^+	10
81-90	A	9
71-80	B^+	8
61-70	B	7
51-60	C^+	6
46-50	C	5
40-45	D	4
<40	F	0
-	F^R (Fail due to shortage of attendance and therefore, to repeat the course)	

Note: -F- denotes failure in the course; - F^R - denotes absent / detained as per AICTE norms.

After the results are declared, grade sheets will be issued to the students. The grade sheets will contain the following details:

a) The college in which the candidate has studied.

b) The list of courses enrolled during the semester and the grades scored.

c) The Grade Point Average (GPA) for the semester and t he Cumulative Grade PointAverage (CGPA) of all enrolled subjects from first semester onwards.

d) GPA is the ratio of sum of the products of the number of credits (C) of courses registeredand the corresponding Grades Points (GP) scored in those courses, taken for all the courses and sum of the number of credits of all the courses.

$$\mathbf{GPA = \sum(C \times GP)/ \sum C}$$

CGPA will be calculated in a similar manner, considering all the courses enrolled from first semester. F^R grades are to be excluded for calculating GPA and CGPA.

e) The conversion of CGPA into percentage marks is as follows

$$\% \text{ Mark} = (\text{CGPA} - 0.5) \times 10$$

9. Procedure for completing the B.Tech. course:

A candidate can join/rejoin the course of study of any semester only at the time of its normal commencement and only if he/she has satisfied the course requirements for the previous semester and further has registered for the university examinations of the previous semester in all the subjects as well as all arrear subjects if any.

However, the entire B.Tech. course should be completed within 7 years (14 semesters) and six years (12 semesters) for students admitted under lateral entry.

10. Award of Class and Rank in B.Tech. degree:

i) A candidate who satisfies the course requirements for all semesters and who passes all the examinations prescribed for all the eight semesters (six semesters for lateral entry candidates) within a maximum period of 7 years (6 years for lateral entry candidates) reckoned from the commencement of the first semester to which the candidate was admitted shall be declared to have qualified for the award of B.Tech. degree.

ii) A candidate who qualifies for the award of the B.Tech. degree passing in all subjects pertaining to the semesters 3 to 8 in his/her first appearance within 6 consecutive semesters (3 academic years) and in addition secures a CGPA of 8.50 and above for the semesters 3 to 8 shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION**.

iii) A candidate who qualifies for the award of the B.Tech. degree by passing in all subjects relating to semesters 3 to 8 within a maximum period of eight semesters after his/her commencement of study in the third semester and in addition secures CGPA not less than 6.5 shall declared to have passed the examination in **FIRST CLASS**.

iv) All other candidates who qualify for the award of B.Tech. degree shall be declared to have passed the examination in **SECOND CLASS**.

v) For the Award of University ranks and Gold Medal for each branch of study, the CGPA secured from the 1^{st} to 8^{th} semester alone should be considered and it is mandatory that the candidate should have passed all the subjects from the 1^{st} to 8^{th} semester in the first attempt. Rank certificates would be issued to the first ten candidates in each branch of study.

11. Provisions for Honors/Minor degree along with B.Tech. degree:

1. B.Tech. with Honors Degree in the same Engineering discipline

a. The student shall be given an option to earn a honors degree in the same discipline of engineering at the end of first year based on his academic performance in the first year.

b. A student is eligible to exercise this option if he has passed all the subjects offered in the first year in the first attempt itself and has earned a CGPA of not less than 7.5.

c. Honors degree in a particular discipline of engineering shall be offered for a batch of students if and only if a minimum of 5 eligible students opt for it.

d. The student is required to earn an additional 20 credits (over and above the prescribed maximum credits in the curriculum) starting from the third semester onwards to become eligible for the award of Honors degree. 20 credits shall be earned by the student by completing 5 additional courses of 4 credits each, one in each of the 5 semesters starting from the third to seventh semester. The syllabus of these 5 courses are framed so as to cover advanced topics in that discipline of engineering.

e. The students admitted in the second year through Lateral Entry Scheme will also be given a chance to opt for Honors degree. Eligibility to avail this option is CGPA of 7.5 and above with no arrears in the third Semester. The student will join the existing batch of students in the fourth semester and earn 16 credits by registering the prescribed courses offered up to the seventh semester. The respective BoS will decide on a suitable course in lieu of the course offered in the third semester to facilitate the student to earn the remaining 4 credits.

f. A student is eligible to get the Honors degree only on completing the programme in 'First Class with Distinction' class.

g. A student can exercise the option to withdraw from the Honors degree at any time after entry.

h. Details about the courses completed and credits earned for Honors degree will appear only in the 'Eighth Semester Grade Sheet' and 'Consolidated Grade Sheet'. These details will be listed under the heading 'Credits Earned for Honors degree'. In the case of students who have either withdrawn from Honors degree or become ineligible for Honors degree by not securing 'First Class with Distinction', the credits earned for the courses registered and successfully completed for Honors degree will be listed under the heading 'Additional Credits Earned'.

i. The CGPA will be calculated for all the courses credited by the students inclusive of major and honors courses

j. Nomenclature of Honors Degree is 'B.Tech.(Honors) in XXX ', where XXX is Discipline in which the student has enrolled.

2. B.Tech. with Minor degree in another Engineering discipline

a) The student shall be given an option to earn a minor degree in another discipline of engineering of his choice at the end of first year based on his academic performance in the first year.

b) A student is eligible to exercise this option if he has passed all the subjects offered in the first year in the first attempt itself and has earned a CGPA of not less than 7.5.

c) Minor degree in a particular discipline of engineering shall be offered for a batch of students if and only if a minimum of 5 eligible students opt for it.

d) The student is required to earn an additional 20 credits (over and above the prescribed maximum credits in the curriculum) starting from the third semester onwards to become eligible for the award of minor degree. 20 credits shall be earned by the student by completing 5 additional courses of 4 credits each, one in each of the 5 semesters starting from the third to seventh semester. The curricular content of these 5 courses are framed in such a way that that these courses will essentially cover the core minimum knowledge required to be fulfilled for award of degree in the discipline of engineering in which the student chooses to earn the minor degree.

e) The students admitted in the second year through Lateral Entry Scheme will also be given a chance to opt for Minor degree. Students with a CGPA of 7.5 and with no arrears in the third semester are eligible to avail this option. The student will join the existing batch of students in the fourth semester and earn 16 credits by registering for prescribed courses offered up to seventh semester. The respective BoS will decide on a suitable course in lieu of the course offered in the third semester to facilitate the student to earn the remaining 4 credits.

f) A student can exercise the option to withdraw from the Minor degree at any time after entry.

g) Details about the courses completed and credits earned for Minor degree will appear only in the 'Eighth Semester Grade Sheet' and 'Consolidated Grade Sheet'. These details will be listed under the heading 'Credits Earned for Minor degree'. In the case of students who have withdrawn from Minor degree, the credits earned for the courses registered and successfully completed for Minor degree will be listed under the heading 'Additional Credits Earned'.

h) Nomenclature of Minor Degree is 'B.Tech. in XXX with Minor in YYY', where XXX is Discipline in which the student is enrolled and YYY is Discipline which the student has opted as Minor.

i) The CGPA will be calculated for all the courses credited by the students inclusive of major and minor courses.

12. Provision for withdrawal:

Based on the recommendation of the Head of the Institution, a candidate with valid reasons may be granted permission by the University to withdraw from writing the entire semester examination as one Unit. The withdrawal application shall be valid only if it is made earlier than the commencement of the last theory examination pertaining to that semester. Withdrawal shall be permitted only once during the entire course. A candidate who has withdrawn is also eligible to be awarded DISTINCTION provided he/she satisfies the other necessary conditions. But, they are not eligible to be awarded a rank.

13. Provisions for exit in B.Tech. course:

(For courses where AICTE specifies multiple exits in the model curriculum)

The curriculum and the syllabus for all B.Tech programmes have been planned in compliance with the NEP guidelines proposed by AICTE. Accordingly, students joining B.Tech programmes shall have all benefits NEP offers in terms of exercising exit options at different stages during the course of study. Every B.Tech programme governed under this school board shall adopt the NEP guidelines, as and when proposed/amended by AICTE, and the following scheme will be applied for all such B.Tech programmes.

NEP 2020 suggests that a student can exercise exits at multiple stages of the course of study. As per AICTE norms, a student can have two possible exits before the completion of the Full Engineering degree and may get a UG Diploma or B.Sc. degree in the relevant discipline if he/she fulfils the following conditions:

1. **UG Diploma/Certificate in the relevant branch of study**

   A student should be able to get a UG Diploma if he/she completes:

   a. 50% of the credits for B.Tech. (80-85 credits)

   b. 50% of the program core courses

   c. Students exiting the program after earning 50% credit requirements will be awarded a UG Diploma provided they secure an additional 6 credits through summer internships/apprenticeship of 2 months duration.

   d. Students admitted through lateral entry cannot exercise the exit option as he will not be able to meet out the 50% Credits for B.Tech. degree.

2. **B.Sc. in the relevant branch of study**

   A student should be able to get a B.Sc. degree if he/she completes:

   (i) 75% of the credits for B.Tech. (120 -122 credits) and at least 3 years in the program

   (ii) 100% of the core program courses

(iii) Students exiting the program after earning 75% credit requirements will be awarded a B.Sc. provided they secure an additional 6 credits through 2 summer internships/apprenticeship for 2 months each.

(iv) With B.Sc. degree, the student is eligible for entry into programs which take B.Sc. degree as eligibility criteria.

Award of Class in B.Sc. degree

A candidate who satisfies the course requirements for all semesters and who passes all the examinations within a maximum period of 6 years (5 years for lateral entry candidates) reckoned from the commencement of the first semester to which the candidate was admitted shall be declared to have qualified for the award of B.Sc. degree in the relevant discipline.

i) A candidate who qualifies for the award of the B.Sc. degree passing in all subjects pertaining to semesters the 3 to 6 in his/her first appearance within 4 consecutive semesters (2 academic years) and in addition secures a CGPA of 8.50 and above for the semesters 3 to 6 shall be declared to have passed the examination in **FIRST CLASS** with **DISTINCTION**.

ii) A candidate who qualifies for the award of the B.Sc. degree by passing in all subjects relating to semesters 3 to 6 within a maximum period of six semesters after his/her commencement of study in the third semester and in addition secures CGPA not less than 6.5 shall declared to have passed the examination in **FIRST CLASS.**

iii) All other candidates who qualify for the award of B.Sc. degree shall be declared to have passed the examination in **SECOND CLASS**.

3. Re-entry to complete the program

A student exiting with a UG Diploma or B.Sc. should be entitled to re-enrol in the programme of the same Engineering discipline. Only students admitted to the B.Tech. programme and exercised an exit option are eligible for readmission to the B.Tech. programme under the same discipline. It is suggested that all credits will be transferred, if the student enrols back within a limited period (3 years) of exiting. In case a student enrols after that, then the decision on the transfer of credits should be based on the changes in the curriculum the student studied. A candidate after exit may rejoin the course only at the commencement of the semester at which he/she discontinued, provided he/she pays the prescribed fees to the University. The total period of completion of the B.Tech. course reckoned from the commencement of the first semester to which the candidate was admitted shall not in any case exceed 7 years, including of the period of discontinuance.

4. Completion Possibility in other Institutions

A student can earn a UG Diploma/B.Sc. in one institution (Engineering) and complete the degree program in another institution (same Engineering discipline only).

(Note: If these exit options are accepted for multiple B.Tech. programs, it is suggested that AICTE actively communicate these to the industry and other bodies, so they recognize these and accept them as bona-fide credentials for the purposes of recruitment and/or eligibility for admission to programs, appearing in competitive examinations, etc.)

14. Revision of Regulations and Curriculum:

The University may from time to time revise, amend or change the regulations of curriculum and syllabus as and when found necessary.

GENERAL COURSE STRUCTURE

&

CREDIT DISTRIBUTION

GENERAL COURSE STRUCTURE & THEME

A. Definition of Credit:

1 Hr. Lecture (L)	1 Credit
1 Hr. Tutorial (T)	1 Credit
2 Hours Practical (P)	1 Credit

B. Range of Credits: In the light of the fact that a typical Model Four-year Under Graduate degree program in Engineering has about 160 credits, the total number of credits proposed for the four-year B. Tech in Electronics and Communication Engineering is kept as 160.

C. Structure of UG Program in ECE: The structure of UG program in Electronics and Communication Engineering shall have essentially the following categories of courses with the breakup of credits as given:

S. No	Category	Credit Breakup	Percentage of Credit Breakup
1	Humanities and Social Sciences including Management courses	15	9%
2	Basic Science courses	23	14%
3	Engineering Science courses including workshop, drawing, basics of electronics/ electrical/ mechanical/ computer etc.	17	10%
4	Professional core courses	64	40%
5	Professional Elective courses relevant to chosen specialization/branch	12	8%
6	Open subjects – Electives from other technical and /or emerging subjects	12	8%
7	Project work	17	10%
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition]	(non-credit)	-
	Total	**160**	**100%**

D. Course code and definition:

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses

PCC	Professional core courses
PEC	Professional Elective courses
OEC	Open Elective courses
MC	Mandatory courses

- **Course level coding scheme:** Three-digit number (odd numbers are for the odd semester courses and even numbers are for even semester courses) used as suffix with the Course Code for identifying the level of the course. Digit at hundred‟s place signifies the year in which course is offered. e.g.

  101, 102 … etc. for first

  year. 201, 202 …. Etc.

  for second year. 301,

  302 … for third year.

- Category-wise Courses

HUMANITIES & SOCIAL SCIENCES COURSES [HS]

(i) Number of Humanities & Social Science Courses: 6

(ii) Credits: 15

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	HSMC-101	English	I	2	0	2	3
2	HSMC-102	Universal Human Values	II	2	1	0	3
3	HSMC-201	Life Skills/ Languages	III	2	0	0	0
4	HSMC-202	Management (Organizational Behavior / Finance & Accounting)	IV	3	0	0	3
5	HSMC-301	Humanities – 1	V	3	0	0	3
6	HSMC-302	Humanities – II	VII	3	0	0	3
						Total Credits	**15**

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BASIC SCIENCE COURSE [BSC]

(i) Number of Basic Science Courses:7

(ii) Credits: 23

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	BSC-101	Physics	I	3	1	2	5
2	BSC-102	Mathematics-I	I	3	1	0	4
3	BSC-103	Chemistry	II	3	0	2	4
4	BSC-104	Mathematics-II	II	3	1	0	4
5	BSC-105	Biology for Engineers	II	2	0	2	3
6	BSC-201	Nano Science	III	2	1	0	3
Total Credits							**23**

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ENGINEERING SCIENCE COURSE [ESC]

(i) Number of Engineering Science Courses:5
(ii) Credits: 17

S. No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	ESC-101	Basic Electrical Engineering	I	2	1	2	4
2	ESC-102	Engineering Graphics & Design	I	1	0	4	3
3	ESC-103	Design Thinking	I	0	0	2	1
4	ESC-104	Programming for Problem Solving	II	2	0	4	4
5	ESC-105	Digital Fabrication	II	0	0	4	2
6	ESC-206	Numerical Techniques	IV	2	0	2	3
Total Credits							**17**

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PROFESSIONAL CORE COURSES [PCC]

(i) Number of Professional Core Courses: 28

(ii) Credits: 64

Sr. No.	Course Code	Course Title	Preferred Semester	Hrs /Week L: T: P	Credits
1	EC01	Electronic Devices	III	3:0:0	3
2	EC02	Electronics Devices Lab	III	0:0:2	1
3	EC03	Digital System Design	III	3:0:0	3
4	EC04	Digital System Design Lab	III	0:0:2	1
5	EC05	Signals and Systems	III	3:0:0	3
6	EC06	Network Theory	III	3:0:0	3
7	EC07	Probability Theory and Stochastic Processes	III	2:1:0	3
8	EC08	Analog and Digital Communication	IV	3:0:0	3
9	EC09	Analog and Digital Communication Lab	IV	0:0:2	1
10	EC10	Analog Circuits	IV	3:0:0	3
11	EC11	Analog Circuits Lab	IV	0:0:2	1
12	EC12	Microcontrollers	IV	3:0:0	3
13	EC13	Microcontrollers Lab	IV	0:0:2	1
14	EC14	Digital Signal Processing	V	3:1:0	4
15	EC15	Digital Signal Processing Lab	V	0:0:2	1
16	EC16	Electromagnetic Waves	V	3:1:0	4
17	EC17	Electromagnetic Waves Lab	V	0:0:2	1
18	EC18	Computer Architecture	V	3:0:0	3
19	EC19	Control Systems	V	3:0:0	3
20	EC20	Embedded Systems	V	3:0:0	3
21	EC-21	Embedded Systems Lab	V	0:0:2	1
22	EC-22	Computer Networks	VI	3:0:0	3
23	EC-23	Computer Networks Lab	VI	0:0:2	1
24	EC-24	VLSI Design	VI	3:0:0	3
25	EC-25	VLSI Design Lab	VI	0:0:2	1
26	EC-26	Mobile Communication and Networks	VI	3:1:0	4
27	EC-27	Seminar	VII	0:0:2	1
28	EC-28	Internship /Project Phase-I	VII	6 weeks	2
				Total Credits	**64**

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PROFESSIONAL ELECTIVE [PEC]

(i) Number of Professional Elective Courses: 4

(ii) Credits: 12

S.No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	PEC	Professional Elective-I	VI	3	0	0	3
2	PEC	Professional Elective-II	VII	3	0	0	3
3	PEC	Professional Elective-III	VII	3	0	0	3
4	PEC	Professional Elective- IV	VIII	3	0	0	3
						Total Credits	**12**

PROGRAM ELECTIVE COURSES

Sr. No.	Course Code	Course Title	Hrs /Week L: T: P	Credits
1	ECEL1	Microwave Theory and Techniques	3:0:0	3
2	ECEL2	Fiber Optic Communications	3:0:0	3
3	ECEL3	Information Theory and Coding	3:0:0	3
4	ECEL4	Digital Audio Processing	3:0:0	3
5	ECEL5	Introduction to MEMS	3:0:0	3
6	ECEL6	Adaptive Signal Processing	3:0:0	3
7	ECEL7	Antennas and Propagation	3:0:0	3
8	ECEL8	Bio-Medical Electronics	3:0:0	3
9	ECEL9	5G Communications	3:0:0	3
10	ECEL10	Digital Image Processing	3:0:0	3
11	ECEL11	Mixed Signal Design	3:0:0	3
12	ECEL12	Wireless Sensor Networks	3:0:0	3
13	ECEL13	Power Electronics	3:0:0	3
14	ECEL14	Satellite Communication	3:0:0	3
15	ECEL15	High Speed Systems	3:0:0	3
16	ECEL16	Nanoelectronics	3:0:0	3
17	ECEL17	Problem Solving using Python	3:0:0	3
18	ECEL18	Internet of Things and Applications	3:0:0	3
19	ECEL19	Cyber Security	3:0:0	3
20	ECEL20	Machine Learning for wireless Applications	3:0:0	3
21	ECEL21	AI For Image Processing	3:0:0	3

22	ECEL22	Underwater Communication	3:0:0	3
23	ECEL23	AI for Wireless Communication	3:0:0	3
24	ECEL24	Sequential Circuit Design	3:0:0	3
25	ECEL25	FSO and Light wave Communication	3:0:0	3

OPEN ELECTIVE COURSES [OEC]

(i) Number of Open Elective Courses: 4
(ii) Credits: 12

S.No	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	OEC	Open Elective-I	VI	3	0	0	3
2	OEC	Open Elective-II	VII	3	0	0	3
3	OEC	Open Elective-III	VII	3	0	0	3
4	OEC	Open Elective-IV	VIII	3	0	0	3
Total Credits							**12**

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PROJECT

Number of Courses: 5

(i) Credits: 20

S. No	Course Code	Cours Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	PRJ EC 201	Micro project	IV	0	0	4	2
2	PRJ EC -301	Mini project	VI	0	0	6	3
3	PRJ EC -402	Project Phase -II	VIII	0	0	24	12
Total Credits							**17**

SEMESTER WISE STRUCTURE

Semester I									
3-Weeks Induction Programme (UHV-I)									
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1.	BSCT101	Chemistry	3	0	0	3	40	60	100
2.	BSCP101	Chemistry laboratory	0	0	2	1	60	40	100
3.	BSCT102	Mathematics-I	3	1	0	4	40	60	100
4.	ESCP101	Engineering Graphics & Design	1	0	4	3	60	40	100
5.	ESCT102	Programming for Problem Solving	3	0	0	3	40	60	100
6.	ESCP102	Programming for Problem Solving Laboratory	0	0	2	1	60	40	100
7.	BSCT103	Biology for Engineers	3	0	0	3	40	60	100
8.	ESCP103	Design Thinking	0	0	2	1	60	40	100
9.	AU-101^	IDEA Lab Workshop	2	0	4	0	-	-	-
Total						**19**	400	400	800
Note: ^ represents “Audit Course”.									

Semester II									
S.No	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1.	BSCT104	Physics	3	1	0	4	40	60	100
2.	BSCP104	Physics Laboratory	0	0	2	1	60	40	100
3.	BSCT105	Mathematics-II	3	1	0	4	40	60	100
4.	ESCT104	Basic Electrical Engineering	2	1	0	3	40	60	100
5.	ESCP104	Basic Electrical Engineering Laboratory	0	0	2	1	60	40	100
6.	ESCP105	Digital Fabrication	0	0	4	2	60	40	100
7.	HSMC101	English for Technical Writing	2	0	2	3	60	40	100
8.	HSMC 102	Universal Human Values -II	2	1	0	3	60	40	100
9.	AU-102^	Sports and Yoga	1	0	1	0	-	-	-
Total						**21**	420	380	800
Note: ^ represents “Audit Course”.									

Semester-III									
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1	ECT-201	Electronic Devices	3	0	0	3	40	60	100
2	ECP-202	Electronic Devices Lab	0	0	2	1	60	40	100
3	ECT-203	Digital System Design	3	0	0	3	40	60	100
4	ECP2-04	Digital System Design Lab	0	0	2	1	60	40	100
5	ECT-205	Signals and Systems	3	0	0	3	40	60	100
6	ECT-206	Network Theory	3	0	0	3	40	60	100
7	ECT-207	Probability Theory and StochasticProcesses	2	1	0	3	40	60	100
8	BST-206	Nano-science Technology	2	1	0	3	40	60	100
9	AU-203	Indian constitution & knowledge systems	0	1	0	0	-	-	-
TOTAL						**20**	360	440	800

Semester-IV									
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1	ECT-208	Analog Circuits	3	0	0	3	40	60	100
2	ECP-209	Analog Circuits Lab	0	0	2	1	60	40	100
3	ECT-210	Microcontrollers	3	0	0	3	40	60	100
4	ECP-211	Microcontrollers Lab	0	0	2	1	60	40	100
5	ECT-212	Analog and Digital Communication	3	0	0	3	40	60	100
6	ECP-213	Analog and Digital Communication Lab	0	0	2	1	60	40	100
7	PRJ EC-201	Micro Project	0	0	4	2	60	40	100
8	ESCT-206	Numerical Techniques	2	0	2	3	40	60	100
9	HSMC-203	Life Skills	3	0	0	3	40	60	100
10	AU-204	Environmental Science	1	0	1	0	-	-	-
TOTAL						**20**	440	460	900

Semester-V									
S.No.	Course Code	Course Title	L	T	P	Credit	Marks		
							IA	UE	TM
1	ECT-314	Digital Signal Processing	3	1	0	4	40	60	100
2	ECP-315	Digital Signal Processing Lab	0	0	2	1	60	40	100
3	ECT-316	Electromagnetic Waves	3	1	0	4	40	60	100
4	ECP-317	Electromagnetic Waves Lab	0	0	2	1	60	40	100
5	ECT-318	Computer Architecture	3	0	0	3	40	60	100
6	ECT-319	Control Systems	3	0	0	3	60	40	100
7	ECT-320	Embedded Systems	3	0	0	3	60	40	100
8	ECP-321	Embedded Systems Lab	0	0	2	1	60	40	100
9	HSMC-304	Total Quality Management	3	0	0	3	40	60	100
10	AU-305	Professional Ethics	1	0	0	0	-	-	-
TOTAL						23	440	460	900

Semester-VI									
S. No.	Course Code	Course Title	L	T	P	Credit	Marks		
							IA	UE	TM
1	ECT-22	Computer Networks	3	0	0	3	40	60	100
2	ECP-23	Computer Networks Lab	0	0	2	1	60	40	100
3	ECT-24	VLSI Design	3	0	0	3	40	60	100
4	ECP-25	VLSI Design Lab	0	0	2	1	60	40	100
5	ECT-26	Mobile Communication and Networks	3	1	0	4	40	60	100
6	PECT-1	Program Elective-1	3	0	0	3	40	60	100
7	OECT-1	Open Elective-1	3	0	0	3	40	60	100
8	PRJ EC-302	Mini Project	0	0	6	3	60	40	100
TOTAL						21	380	420	800

Semester-VII									
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1	PECT-2	Program Elective-2	3	0	0	3	40	60	100
2	PECT-3	Program Elective-3	3	0	0	3	40	60	100
3	OECT-2	Open Elective-2	3	0	0	3	40	60	100
4	OECT-3	Open Elective-3	3	0	0	3	40	60	100
5	HSMC-405	Entrepreneurship Development	3	0	0	3	40	60	100
6	SEM EC-27	Seminar	0	0	2	1	100	-	100
7	INT EC-28	Internship	0	0	4	2	100	-	100
TOTAL						**18**	400	300	700

Semester-VIII									
S. No.	**Course Code**	**Course Title**	**L**	**T**	**P**	**Credit**	**Marks**		
							IA	**UE**	**TM**
1	PECT-04	Program Elective-4	3	0	0	3	40	60	100
2	OECT-04	Open Elective-4	3	0	0	3	40	60	100
3	PRJ EC-403	Project	0	0	24	12	60	40	100
TOTAL						**18**	140	160	300

SEMESTER – I

SEMESTER I

Induction program (UHV-I)	Three-week duration(mandatory)

Objective:

The induction program for students offered at the start of the first year aims to provide a holistic and enriching experience to new students, fostering their personal growth, academic preparedness, and a strong sense of belonging to the institution.

The program is designed to achieve the following objectives:

1. To help students smoothly transition from school to college life.
2. To facilitate opportunities for students to interact with their peers, faculty, and staff.
3. To enhance Physical Well-being: and encouraging Creative Expression.
4. To instill Universal Human Values.
5. To develop Communication and Literary Skills, Visit Local areas and get inspiration from Eminent Personalities and thus gain Confidence to nurture a Positive Learning Environment.

The Induction program contains.

- Physical activity
- Creative Arts
- Universal Human Values
- Literary
- Proficiency Modules
- Lectures by Eminent People
- Visits to local Areas
- Familiarization to Dept./Branch & Innovations

The Essence and Details of Induction program can also be understood from the "Detailed Guide on Student Induction program", as available on AICTE Portal,

(Link:https://www.aicteindia.org/sites/default/files/Detailed%20Guide%20on%20Student%20I nduction%20program.pdf).

BSCT101	Chemistry	3L:0T:0P	3 Credits

Course Objectives:

- *To acquaint the students with basic concepts of chemistry in understanding the atomic & molecular structure and its nanoscale applications.*
- *To understand the fundamental concepts of various spectroscopic techniques and applications.*
- *To understand the basic electrochemical properties such as thermodynamic functions, cell potentials, lead storage batteries, corrosion and phase rule.*
- *To describe and explain the observed trends in atomic size, ionization energy, and electron affinity of the elements.*
- *To identify the various types, preparation and applications of polymer used in the industrial processes.*

Course Contents:

MODULE I - ATOMIC AND MOLECULAR STRUCTURE: 9 Hours

Atomic and Molecular Structure: Molecular orbital‟s of diatomic molecules. Band theory of solids. Liquid crystal and its applications. Point defects in solids. Structure and applications of Graphite and Fullerenes. Concepts of Nanomaterials and its application

MODULE II - SPECTROSCOPIC TECHNIQUES AND APPLICATIONS: 9 Hours

Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Elementary idea and simple applications of Rotational, Vibrational, Ultravoilet & Visible and Raman spectroscopy.

MODULE III – ELECTRO CHEMISTRY: 9 Hours

Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and EMF. Cell potentials, Nernst Equation and application, Lead storage battery. Corrosion; causes, effects and its prevention. Phase Rule and its application to water system.

MODULE IV - PERIODIC PROPERTIES 9 Hours

Effective nuclear charge, penetration of orbital‟s, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electro-negativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.

MODULE V – POLYMER: 9 Hours

Basic concepts of polymer-Blend and composites, Conducting and biodegradable polymers. Preparation and application of some industrially important polymers (BunaS, Buna-N, Neoprene, Nylon-6, nylon-6,6 and Terylene). General methods of synthesis of organometallic compounds (Grignard reagent) and their applications.

Total No. of Hours: 45

Text Books:

1. B. H. Mahan, "University chemistry" Pearson Education, 2009.
2. C.N.R. Rao, "University Chemistry" World Scientific PublishingCompany, 2009
3. M. J. Sienko and R. A. Plane, "Chemistry: Principles and Applications" McGraw-Hill, 3rd edition 1980.

Reference Books:

1. C. N. Banwell, "Fundamentals of Molecular Spectroscopy" McGraw-Hill Book Company, 1983.
2. B. L. Tembe, Kamaluddin and M. S. Krishnan, "Engineering Chemistry (NPTELWeb-book).
3. P. W. Atkins, Julio de Paula, "Physical Chemistry" Oxford University Press, 2018

Course Outcomes:

On successful completion of this course, the students will be able to,

- Get an understanding of the theoretical principles understanding molecular structure, bonding and properties
- Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energylevels in various spectroscopic techniques
- Understand and explain the thermodynamic functions and cell potentials for different applications.
- Rationalize specific models and processes for better understanding of material properties and applications.
- Learn the synthesis of various industrially important polymer and its applications.

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BSCP101	Chemistry Laboratory	0L:0T:2P	1 Credits

Course Objectives:

The Chemistry laboratory course will enable students to get a hands-on experience of determining various analysis parameters learnt in the theory course using different methods/techniques prevalent in analytical chemistry.

List of Experiments:

1. Determination of surface tension and viscosity.
2. Determination of chloride content of water.
3. Determination of cell constant and conductance of solutions.
4. Potentiometry - determination of redox potentials and emfs
5. Synthesis of a polymer/drug.
6. Determination of the partition coefficient of a substance between two immiscible liquids.
7. Saponification/acid value of oil.
8. Chemical analysis of a salt.
9. Lattice structures and packing of spheres.
10. Spectrophotometry: Beer-Lambert‟s law verification and determination of strength of unknown solution.
11. Thin layer chromatography.
12. Ion exchange column for removal of hardness of water.
13. The pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

REFERENCES:

Virtual Labs

SL. No.	Experiment Name	Experiment Link(s)
1	Determination of surface tension and viscosity.	http://pcv-au.vlabs.ac.in/physical-chemistry/Determination_of_Viscosity_of_Organic_Solvents/
2	Ion exchange column for removal of hardness of water.	http://icv-au.vlabs.ac.in/inorganic-chemistry/Water_Analysis_Determination_of_Chemical_Parameters/
3	Determination of chloride content of water.	http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/Environmental_Engineering_1/experiments/determination-of-chloride-nitk/simulation.html
4	Colligative properties using freezing point depression.	http://pcv-au.vlabs.ac.in/physical-chemistry/Cryoscopy/
5	Determination of the rate constant of are action.	http://pcv-au.vlabs.ac.in/physical-chemistry/EMF_Measurement/
6	Determination of cell constant	http://icv-au.vlabs.ac.in/inorganic-chemistry/Water_Analysis_Determination_of_Physical_Parameters/

7	Potentiometry - determination of redoxpotentials and EMFs.	http://pcv-au.vlabs.ac.in/physical-chemistry/EMF_Measurement/
8	Saponification/acid value of an oil.	http://biotech01.vlabs.ac.in/bio-chemistry/Estimation_of_Saponification_Value_of_Fats_or_Oils/
9	Lattice structures and packing ofspheres.	https://vlab.amrita.edu/?sub=1&brch=282&sim=370&cnt=1

Text Books:

1. B. H.Mahan, & Rollie J Meyers , "University chemistry" Pearson Education India; 4th edition (1 January 2009).
2. M.J.Sienkoand R.A.Plane,Ann Arbor, "Principles and Applications" Mich: Edwards Bros., 1955.

Reference Books:

1. B. L. Tembe, Kamaluddin and M. S. Krishnan, "Engineering Chemistry (NPTEL Web-book).
2. P. W. Atkins, Julio de Paula, "Physical Chemistry" Oxford University Press, International Eleventh edition, 2018.
3. K. Peter C. Vollhardt & Neil E. Schore, "Organic Chemistry: Structure and Function" 5th Edition December 28, 2005

Course Outcome*:*

The Chemistry laboratory course aims at developing abilities in combining chemical principles alongside handling instruments/techniques and synthesis methodologies to facilitate good understanding of the subject.

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BSCT102	Mathematics-I	3L:1T:0P	4 Credits

Course Objective:

- *To comprehend the mathematical concepts of matrices, ordinary differential equations, multivariable calculusand problem-solving.*

Course Contents:

MODULE I LINEAR ALGEBRA(MATRICES) (12 Hrs)

Rank of a matrix - Consistency of a system of linear equations - Characteristic equation of a matrix - Eigen values and Eigen vectors - Properties of Eigen values and Eigen vectors - Cayley-Hamiltontheorem (excluding proof)- Verification- Application (Finding Inverse and Power of a matrix)- Diagonalization of a matrix by orthogonal and similarity transformation- Quadratic form – Nature of Quadratic Form- Orthogonal reduction of quadratic form to canonical form.

MODULE II ORDINARY DIFFERENTIAL EQUATIONS (12 Hrs)

Differential Equations of First Order- Exact equations- Leibnitz's linear equations- Bernoulli's equation- Equations solvable for p- Clairaut's equation- Differential equations of Higher order- Linear differential equations of higher order with constant coefficients- Euler's linear equation of higher order with variable coefficients- Method of variation of parameters.

MODULE III MULTIVARIABLE CALCULUS (DIFFERENTIATION) (12 Hrs)

Partial differentiation- Partial derivatives of first order and higher order- Partial differentiation of implicit functions- Euler's theorem on homogeneous functions - Total derivative - Jacobian Properties - Taylor's series for functions of two variables- Maxima and minima of functions of two variables.

MODULE IV MULTIVARIABLE CALCULUS (MULTIPLE INTEGRALS) (12 Hrs)

Double integration (Cartesian form and Polar form)-constant limits- variable limits- over the region R- Change of variables in double integrals (Cartesian to polar)- Appli- cation of double integral- Area by double integration- Change of Order of Integration- Triple Integration (Cartesian- Spherical and Cylindrical)- constant limits- variable limits- over the region R- Application of triple integral- Volume by triple integration.

MODULE V MULTIVARIABLE CALCULUS (VECTOR CALCULUS) (12 Hrs)

Vector Differential Operator- Gradient - Properties - Directional derivative - Divergence and curl Properties and relations- Solenoidal and Irrotational vector fields - Line integral and Surface integrals - Integral Theorems (excluding Proof) - Green's theorem - Stoke's theorem - Gauss divergence theorem.

Text Books:

1. Veerarajan T., "Engineering Mathematics - I & II ", Tata McGraw-Hill, New Delhi, 2014 &; 2015.
2. Dr. M.K. Venkataraman, "Engineering Mathematics – Volume I and Volume II", The National PublishingCompany, Chennai 2008.

References:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Bali N.P and Manish Goyal., “A Text Book of Engineering Mathematics”, Laxmi Publications(P) Ltd, 2011.
3. Erwin Kreyszig, “Advanced Engineering Mathematics”, John Wiley & Sons, New Delhi, 9th Edition, 2011
4. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw-Hill, New Delhi, 2010.

ONLINE / NPTEL Courses:

1. Differential equations for engineers: https://nptel.ac.in/courses/111106100
2. Calculus of Several Real Variables: https://nptel.ac.in/courses/111104125
3. Engineering Mathematics - I: https://nptel.ac.in/courses/111105121
4. Matrix Analysis with Applications: https://nptel.ac.in/courses/111107112

Course Outcomes:

- To solve practical problems using Matrix algebra.
- To solve various types of ordinary differential equations, including higher-order linear equation.
- To compute partial derivatives, determine total derivatives, Jacobians, employ Taylor series, and find extremesof functions of two variables.
- To demonstrate proficiency in evaluating double integration and triple integration and using them to computearea and volume.
- To apply Green’s theorem, Stoke’s theorem and Gauss divergence theorem.

ESCP101	Engineering Graphics & Design	1L:0T:4P	3 Credits

Course Objectives:

- *To provide the basic knowledgeabout Engineering Drawing.*
- *To learn the concepts of projections, technical drawing, dimensioning and specifications*
- *To understand the engineering graphics standards and solid modeling.*
- *To learn the analysis of Isometric views*
- *To understand the basic concepts of computer aided drafting hardware and its importance in the field of engineering and design.*

Course Contents:

MODULE I- INTRODUCTION:
Introduction, Conics and Special Curves

MODULE II- PROJECTIONS:
Projection of points, lines and planes

MODULE III- SOLIDS:
Projection of solids, section of solids, development of surface

MODULE IV- ISOMETRIC PROJECTIONS:
Isometric and Orthographic projections

MODULE V- AUTOCAD:
Introduction to computer Aided Drafting hardware overview of application software – 2D drafting commands (Auto CAD) for simple shapes – Dimensioning

Text Books:

1. Bhatt N.D., Panchal V.M. & Ingle P.R., "Engineering Drawing" Charotar Publishing House (2014).
2. Shah, M.B. & Rana B.C., "Engineering Drawing and Computer Graphics" Pearson Education (2008).
3. Agrawal B. & Agrawal C. M., "Engineering Graphics" TMH Publication,2012.
4. K. Venugopal, "Engineering Drawing and Graphics + Auto CAD" 4th edition, New Age International Publication Ltd., 2004

Reference Books:

1. Narayana, K.L. & P Kannaiah, "Text book on Engineering Drawing" Scitech Publishers, 2008.
2. CAD Software Theory and User Manuals.

Course Outcomes:

On successful completion of this course, the students will be able to

- Describe engineering design and its place insociety.
- Discuss the visual aspects ofengineering design.
- Use engineering graphics standards.
- Illustrate solid modelling.
- Use computer-aided geometric design.
- Design creating working drawings.

ESCT102	Programming For Problem Solving	3L:0T:0P	3 Credits

Course Objectives:

- *To learn the fundamentals of computers.*
- *To understand the various steps in program development.*
- *To learn the syntax and semantics of any programming language.*
- *To learn the usage of structured programming approach in solving problems.*
- *To understated and formulate algorithm for programming script*
- *To analyze the output based on the given input variables*

Course Contents:

MODULE I - INTRODUCTION TO PROGRAMMING: 6 Hours

Introduction to components of a computer system: - disks, memory, processor, where a program is stored and executed, operating system, compilers etc. Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithms Flowchart/Pseudocode with examples.

MODULE II- ALGORITHMS TO PROGRAMS: 6 Hours

Source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code. Arithmetic expressions and precedence. Conditional Branching and Loops. Writing and evaluation of conditionals and consequent branching. Iteration and loops.

MODULE III - INTRODUCTION TO ARRAYS AND APPLICATIONS: 6 Hours

Arrays, Arrays (1-D, 2-D), Character arrays and Strings, Basic Algorithms, Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexitythrough example programs (no formal definition required)

MODULE IV – FUNCTIONS: 6 Hours

Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference. Recursion as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc.Quick sort or Merge sort.

MODULE V – STRUCTURES AND POINTERS: 6 Hours

Defining structures and Array of Structures. Pointers, Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list (no implementation), File handling.

Total No. of Hours: 30

Text Books:

1. Byron Gottfried, Schaum's, "Outline of Programming with C", McGraw-Hill. 1996
2. E. Balaguruswamy, "Programming in ANSI C" Tata McGraw-Hill. 2019

Reference Books:

1. Brian W. Kernighan and Dennis M. Ritchie, " The C Programming Language" Prentice Hall of India. Second Edition 2015.

Course Outcomes:

Upon successful completion of the course, students should be able to:

- Formulate simple algorithms for arithmetic and logical problems and translate the algorithms to programs and execute the programs and correct syntax and logical errors.
- Discuss the use of arrays for to work with arrays, strings, and basic data structures like linked lists, queues, and stacks.
- Understand the use of functions in the programming language.
- Discuss the arrays and its significance in the programming language with involving arrayconcepts.
- Implement the use of pointers and implementation of memory and handling of files in any programming.

ESCP102	Programming For Problem Solving Laboratory	0L:0T:2P	1 Credit

Course Objectives:

- *Introduce students to the fundamental concepts of the any programming language,including variables, data types, operators, and control structures.*
- *Introduce problem-solving techniques and algorithms to approach and solve programming challenges efficiently.*
- *Develop proficiency in writing any programs to implement algorithms and solvecomputational problems.*
- *Introduce students to basic data structures in any, such as arrays, strings, and pointers,and guide them in applying these structures to solve problems effectively.*

List of Experiments:

1. Familiarization with programming environment
2. Simple computational problems using arithmetic expressions
3. Problems involving if-then-else structures
4. Iterative problems e.g., sum of series
5. 1D Array manipulation
6. Matrix problems, String operations
7. Simple functions
8. Programming for solving Numerical methods problems
9. Recursive functions
10. Pointers and structures
11. File operations

Course Outcomes:

Upon successful completion of the course, students should be able to:

- Demonstrate the problem solving skills through programming simple logics.
- Demonstrate the array concepts and memory management through programming.
- Illustrate the pointers and file operations through programming.

References:

Virtual Labs

S. No	Experiment Name	Experiment Link(s)
1	Simple computational problems using arithmetic expressions.	http://ps-iiith.vlabs.ac.in/exp7/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

2	Iterative problems e.g., sum of series.	http://ps-iiith.vlabs.ac.in/exp4/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
3	1D Array manipulation.	http://cse02- iiith.vlabs.ac.in/exp4/index.html
4	Matrix problems, String operations.	http://ps-iiith.vlabs.ac.in/exp5/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
5	Simple functions.	http://cse02- iiith.vlabs.ac.in/exp2/index.html
6	Programming for solving Numerical methods problems.	http://ps-iiith.vlabs.ac.in/exp1/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab
7	Recursive functions.	http://ps-iiith.vlabs.ac.in/exp6/Introduction.html?domain=Computer%20Science&lab=Problem%20Solving%20Lab

BSCT103	Biology For Engineers	3L:0T:0P	3 Credits

Course Objectives:

- *To familiarize the students with the basic biological concepts and their engineering applications.*
- *To develop the interdisciplinary vision of biological engineering.*
- *Familiarize engineering students with the principles of microbiology, including the structure and function of microorganisms, their significance in various engineering applications, and techniques for microbial analysis and identification.*

Course Contents:

MODULE I - INTRODUCTION AND CLASSIFICATION OF BIOLOGICAL SCIENCE: 9 Hours

Bring out the fundamental differences between science and engineering by drawing a comparison between eye and camera, Bird flying and aircraft. Biological observations of 18th Century that lead to major discoveries. Examples from Brownian motion and the origin of thermodynamics by referring to the original observation of Robert Brown and Julius Mayor. Classification based on (a) energy and carbon utilization-Autotrophs, heterotrophs, lithotropes (b) Ammonia excretion – aminotelic, uricoteliec, ureotelic (c) Habitata- acquatic or terrestrial (d) Molecular taxonomy- three major kingdoms of life.

MODULE II – GENETICS: 9 Hours

Mendel‟s laws, Concept of segregation and independent assortment. Concepts of excessiveness and dominance. Concept of mapping of phenotype to genes. Discuss about the single gene disorders in humans. Discuss the concept of complementation using human genetics.

MODULE III - BIOMOLECULES AND ENZYMES: 9 Hours

Discuss - monomeric units, polymeric structures, sugars, starch and cellulose, amino acids and proteins. Enzyme classification. Mechanism of enzyme action. Enzyme kinetics and kinetic parameters.

MODULE IV - INFORMATION TRANSFER: 9 Hours

DNA as a genetic material. Hierarchy of DNA structure- from single stranded to double helix to nucleosomes. Concept of genetic code. Universality and degeneracy of genetic code. Define gene in terms of complementation and recombination. DICOM Image formats, The DNA Technology (Use and Application)Regulation Bill, 2019

MODULE V - MICROBIOLOGY ANALYSIS: 9 Hours

Proteins- structure and function. Hierarch in protein structure. Primary secondary, tertiary and quaternary structure. Proteins as enzymes, transporters, receptors and structural elements. Exothermic and endothermic versus endergonic and xergonic reactions. Synthesis of glucose from CO_2 and H_2O (Photosynthesis). Energy yielding and energy consuming reactions. Identification and classification of single celled organisms.

Total No. of Hours: 45

Text Books:

1. Conn,E.E; Stumpf,P.K; Bruening,G; Doi,R.H., "Outlines of Biochemistry" John Wiley and Sons, 2009.
2. Prescott, L.M J.P. Harley and C.A. Klein, "Microbiology" Wm C. Brown Publishers , 2nd edition 1995.

Reference Books:

1. Uma Devi Koduru, "General Biology" Khanna Book Publishing Company. 2022
2. Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. "Biology: A global approach" Pearson Education Ltd. 12th Edition, 2020.
3. E.E; Stumpf, P.K; Bruening, G; Doi, R.H., "Outlines of Biochemistry" John Wiley and Sons. 2006.

Course Outcomes:

Upon successful completion of the course, students should be able to:

- Describe how biological observations of 18th Centurythat lead to major discoveries.
- Highlight the concepts of recessiveness and dominance during the passage of genetic material from parent to offspring
- Classifyenzymes and distinguish between different mechanisms of enzyme action.
- IdentifyDNA as a genetic material in the molecular basis of information transfer.
- Identifyand classify single celled microorganisms

ESCP103	DESIGN THINKING	0L:0T:2P	1 Credit

Course Objectives:

- *To provide the new ways of creative thinking*
- *To learn the innovation cycle of Design Thinking process*
- *To develop innovative products*

Course Contents:

MODULE I - LEARNING, MEMORY AND EMOTIONS: 9 Hours

Understanding the learning process, kolb‟s learning styles, assessing and interpreting, understanding the memory process, problems in retention, memory enhancement techniques, understanding emotions: experience & expression, assessing empathy, application with peers

MODULE II - DESIGN THINKING, BEING INGENIOUS & FIXING PROBLEM: 9 Hours

Definition of design thinking, need for design thinking, objectives of design thinking, concepts& brainstorming, stages of design thinking process (explain with examples) – empathize, define, ideate, prototype, test, understanding creative thinking process, understanding problem solving, testing creative problem solving.

MODULE III: PRODUCT DESIGN, PROTOTYPING & TESTING: 9 Hours

Process of engineering product design, design thinking approach, stages of product design, examples of best product designs and functions, assignment – engineering product design, What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing

MODULE IV: CELEBRATING THE DIFFERENCE AND CUSTOMER CENTRICITY: 9 Hours

Understanding of individual differences & uniqueness, group discussion and activities to encourage the understanding, acceptance and appreciation of individual difference. Practical examples of customer challenges, use of design thinking to enhance customer experience, parameters of product experience, alignment of customer expectations with product design.

MODULE V: FEEDBACK, RE-DESIGN & RE-CREATE: 9 Hours

Feedback loop, Focus on User Experience, Address “ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – “Solving Practical Engineering Problem through Innovative Product Design & Creative Solution”.

Total no. of Hours: 45

Course Outcomes:

On successful completion of the module students will be able to:

- Compare and classify the various learning styles and memory techniques and Applythem in their engineering education
- Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products
- Develop new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products
- Propose real-time innovative engineering product designs and Choose appropriate frame works, strategies, techniques during prototype development
- Perceive individual differences and its impact on everyday decisions and further Create a better customer experience

AU-101	IDEA LAB WORKSHOP	2L:0T:4P	0 CREDIT

Course Objectives:

- *To learn all the skills associated with the tools and inventory associated with theIDEA Lab.*
- *Learn useful mechanical and electronic fabricationprocesses.*
- *Learn necessary skills to build useful and standalone system/ project with enclosures.*
- *Learn necessary skills to create print and electronic documentation for the system /project.*

MODULE	Topics
1.	Electronic component familiarization, Understanding electronic system design flow. Schematic design and PCB layout and Gerber creation using Eagle CAD. Documentation using Doxygen, Google Docs, Overleaf. Version control tools - GIT and Git Hub. Basic 2D and 3D designing using CAD tools such as Free CAD, Sketchup, Prusa Slicer, Flat CAM, Ink space, Open BSP and Veri CUT.
2.	Familiarization and use of basic measurement instruments - DSO including various triggering modes, DSO probes, DMM, LCR bridge, Signal and function generator. Logic analyzer and MSO. Bench power supply (with 4-wire output) Circuit prototyping using (a) breadboard, (b) Zero PCB (c) „Manhattan" style and (d) custom PCB. Single, double and multilayer PCBs. Single and double-sided PCB prototype fabrication in the lab. Soldering using soldering iron/station. Soldering using a temperature controlled reflow oven. Automated circuit assembly and soldering using pick and place machines.
3.	Electronic circuit building blocks including common sensors. Arduino and Raspberry Pi-programming and use. Digital Input and output. Measuring time and events. PWM. Serial communication. Analog input. Interrupts programming. Power Supply design (Linear and Switching types),Wireless power supply, USB PD, Solar panels, Battery types and charging.
4.	Discussion and implementation of a mini project.
5.	Documentation ofthe mini project (Report and video).

LABORATORY ACTIVITIES:

S. No.	List of Lab activities and experiments
1.	Schematic and PCB layout design of a suitable circuit, fabrication and testing of the circuit.
2.	Machining of 3D geometry on soft material such as soft wood or modeling wax.
3.	3D scanning of computer mouse geometry surface. 3D printing of scanned geometry using FDM or SLA printer.
4.	2D profile cutting of press fit box/casing in acrylic (3 or 6 mm thickness)/cardboard, MDF(2 mm) board using laser cutter & engraver.
5.	2D profile cutting on plywood /MDF (6-12 mm) for press fit designs.
6.	Familiarity and use of welding equipment.
7.	Familiarity and use of normal and wood lathe.
8.	Embedded programming using Arduino and/or Raspberry Pi.
9.	Design and implementation of a capstone project involving embedded hardware, software and machined or 3D printed enclosure.

Reference Books:

1. Chris Hackett. Weldon Owen, "The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects". 2018.
2. Sean Michael Ragan, Weldon Owen; "The Total Inventors Manual (Popular Science): Transform Your Idea into a Top-Selling Product", 2017.
3. Paul Horowitz and Winfield Hill, "The Art of Electronics". Cambridge University Press. 3rd edition. 1995.
4. Simon Monk, "Programming Arduino: Getting Started with Sketches" McGraw Hill. 2nd edition.2012.
5. Ian Gibson, David W Rosen, Brent Stucker., "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.
6. Chapman W.A.J, "Workshop Technology", Volume I, II, III, CBS Publishers and distributors, 5th Edition,2002.

SEMESTER – II

BSCT104	Physics	3L:1T:0P	4 Credits

Course Objectives:

- *To understand the physics of simple harmonic motion (SHM) and its applications in various fields.*
- *To understand the characteristics and behavior of non-dispersive transverse and longitudinal waves in one dimension and to introduce the concept of dispersion in waves and its implications.*
- *To understand the behavior and propagation of light and to study the principles of geometric optics and their applications.*
- *To understand the wave nature of light and its interactions with matter and study the principles of wave optics and their applications.*
- *To understand the principles and applications of lasers and study the properties and behavior of laser light.*

Course Contents:

MODULE I - SIMPLE HARMONIC MOTION AND OSCILLATOR: 12 Hours

Mechanical and electrical simple harmonic oscillators, complex number notation and phasor representation of simple harmonic motion, damped harmonic oscillator – heavy, critical and light damping, energy decay in a damped harmonic oscillator, quality factor, forced mechanical and electrical oscillators, electrical and mechanical impedance, steady state motion of forced damped harmonic oscillator, power absorbed byoscillator.

MODULE II -WAVES AND INTRODUCTION TO DISPERSION: 12 Hours

Transverse wave on a string, the wave equation on a string, Harmonic waves, reflection and transmission of waves at a boundary, impedance matching, standing waves and their Eigen frequencies, longitudinal waves and the wave equation for them, acoustics waves and speed of sound, standing sound waves. Waves with dispersion, water waves, superposition of waves and Fourier method, wave groups and group velocity.

MODULE III - PROPAGATION AND GEOMETRIC OPTICS: 12 Hours

Fermat‟s principle of stationary time and its applications e.g. in explaining mirage effect, laws of reflection and refraction, Light as an electromagnetic wave and Fresnel equations, reflectance and transmittance, Brewster‟s angle, total internal reflection, and evanescent wave. Mirrors and lenses and optical instruments based on them, transfer formula and the matrix method.

MODULE IV - WAVE OPTICS: 12 Hours

Huygens‟ principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young‟s double slit experiment, Newton‟s rings, Michelson interferometer, Mach- Zehnder interferometer. Farunhofer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power.

MODULE V – LASERS: **12 Hours**

Einstein‟s theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO2), solid-state lasers (ruby, Neodymium), dye lasers; Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in science, engineering and medicine.

Total No. of Hours: 60

Course Outcomes:

On successful completion of the module students will be able to:

- Solve engineering problems dealing with simple, damped, or forced harmonic oscillation and perform Fourier analysis of wave phenomena.
- Differentiate between transverse and longitudinal waves and explain their properties.
- Understand the generation and propagation of light and explain the principles of geometric optics, including reflection and refraction.
- Understand the wave nature of light and its properties, such as interference and diffraction.
- Understand the basic principles of laser operation, including population inversion and stimulated emission

Text Books:

1. Ian G. Main, “Vibrations and Waves” Physics Cambridge University Press; 3rd edition (1993).
2. H.J. Pain, “The physics of vibrations and waves” John Wiley & Sons, Ltd. Sixth Edition 2005.

Reference Books:

1. E. Hecht, “Optics” addison wesley(2001)
2. O. Svelto, “Principles of Lasers” Springer books, 2010.
3. R.N.Chaudhuri, “Waves and Oscillations” New Age International (P) Limited, 2010.

BSCP104	Physics Laboratory	0L:0T:2P	1 Credit

Course Objectives:

- *To observe and study the diffraction pattern produced by a single slit.*
- *To observe and study the interference pattern produced by double slits.*
- *To verify the wave nature of light and measure the wavelength of light.*
- *To measure the speed of light using a Michelson interferometer setup.*
- *To measure the speed of light on a tabletop using the modulation technique.*

List of Experiments

1. **Single-Slit Diffraction Experiment:** A laser pointer or a beam of ordinary light is passed through a single narrow slit, and the resulting diffraction pattern is observed on a screen or a wall. The pattern will show a central maximum and alternating dark and bright fringes on both sides of the central maximum.
2. **Double-Slit Interference Experiment:** A laser or a light source is directed through two closely spaced slits. The resulting pattern on a screen or wall will show a series of alternating bright and dark fringes. This is known as an interference pattern, demonstrating the wave nature of light.
3. **Young's Double-Slit Experiment:** This is an extension of the double-slit interference experiment. By measuring the interference pattern and knowing the distance between the slits and the screen, one can determine the wavelength of light used.
4. **Michelson Interferometer (Measurement of Speed of Light):** In this experiment, a Michelson interferometer is set up, and the speed of light is measured by observing the fringe shift produced when one of the arms of the interferometer is moved.
5. **Measurement of Speed of Light using Modulation:** This experiment involves using a laser, a rotating mirror, and a photosensitive detector to measure the time taken for light to travel a known distance, allowing the speed of light to be calculated.
6. **Minimum Deviation from a Prism:** A prism is placed in a beam of light, and the angle of minimum deviation (where the emergent ray is parallel to the incident ray) is measured. Using this angle, along with the known refractive index of the surrounding medium, the refractive index of the prism material can be calculated.
7. **Lloyd's Mirror Interferometer:** In this experiment, a light source is directed towards a half-silvered mirror (Lloyd's mirror configuration), creating interference fringes by the combination of direct and reflected light.
8. Experiments to study Lasers.

Course Outcomes:

i. Comprehend the concept of interference and how waves combineconstructively and destructively to produce varying amplitudes.
ii. Understand the single-slit diffraction pattern and calculate the angles ofdiffraction for different wavelengths and slit sizes.
iii. Understand the double-slit interference pattern and calculate fringe spacingand angles of interference for various setups.

iv. Develop skills to analyze and interpret interference patterns resulting from different light sources and experimental configurations.

v. Develop a comprehensive understanding of the fundamental principlesof laser operation, including stimulated emission, population inversion, and optical gain.

References:

Virtual Labs

S. No.	Experiment Name	Experiment Link(s)
1	Diffraction and interference experiments (from ordinary light or laser pointers).	http://ov-au.vlabs.ac.in/optics/Diffraction_Grating/
2	Minimum deviation from a prism.	http://ov-au.vlabs.ac.in/optics/Spectrometer_i_d_C u rve/

BSCT105	Mathematics- II	3L:1T:0P	4 Credits

Course Objective:

- *To formulate and solve partial differential equations, Laplace, Fourier transforms within the engineering domain.*

Course Contents:

MODULE I PARTIAL DIFFERENTIAL EQUATIONS (12 Hrs)

Formation of partial differential equations, Solutions of standard types of first order partial differential equations, Lagrange s linear equation, Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

MODULE II LAPLACE TRANSFORM (12 Hrs)

Existence conditions, Transforms of elementary functions , Properties, Transform of unit step function and unit impulse function , Transforms of derivatives and integrals , Transforms of Periodic Functions , Initial and final value theorems.

MODULE III INVERSE LAPLACE TRANSFORM (12 Hrs)

Inverse Laplace Transforms Properties, Convolution theorem, Application - Solution of ordinary differential equations with constant coefficients - Solution of simultaneous ordinary differentialequations.

MODULE IV FOURIER TRANSFORM (12 Hrs)

Fourier Integral theorem (statement only) , Fourier transform and its inverse, Properties: Fourier sine and cosine transforms, Properties, Convolution and Parseval s identity.

MODULE V FOURIER SERIES (12 Hrs)

Dirichlet s conditions , Expansion of periodic functions into Fourier series- Change of interval, Half-range Fourier series, Root mean square value - Parseval s theorem on Fourier coefficients, Harmonic analysis.

Text Books:

1. Grewal B.S, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2015.
2. Veerarajan T, "Transforms and Partial Differential Equations", Tata McGraw-Hill, New Delhi, 2012.

References:

1. Bali N.P and Manish Goyal., "A Text Book of Engineering Mathematics", Laxmi Publications(P) Ltd, 2011.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, New Delhi, 9th Edition, 2011.
3. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw-Hill, New Delhi, 2010.

ONLINE / NPTEL Courses:

1. Laplace Transform: https://nptel.ac.in/courses/111106139
2. Partial Differential Equations: https://nptel.ac.in/courses/111101153
3. Advanced Engineering Mathematics: https://nptel.ac.in/courses/111107119

Course Outcomes:

- To formulate and solve various types of partial differential equations.
- To understand the Laplace transform and its properties.
- To apply Laplace transforms to solve ordinary differential equations with constant coefficients and simultaneousordinary differential equations.
- To understand and apply Fourier transform techniques, including Fourier integral theorem, properties of Fouriertransforms, convolution, and Parseval's identity.
- To apply Fourier series and harmonic analysis, enabling them to analyze and synthesize periodic signals andfunctions in various engineering and mathematical applications.

ESCT104	Basic Electrical Engineering	2L: 1T:0 P	3 Credits

Course Objectives:

- *To understand and gain basic knowledge about DC and AC circuits.*
- *To learn the concept of single phase and three phase circuit with power measurement.*
- *To study the operating principles of Transformers.*
- *To explore the working of the DC Machines and motors.*
- *To study the three phase induction motors.*

Course Contents:

MODULE I - D. C. CIRCUITS: 9 Hours

Ohm's Law and Kirchhoff‟s Laws; Analysis of series, parallel and series-parallel circuits excited by independent voltage sources; Power and energy; Electromagnetism covering, Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy stored in magnetic fields;

MODULE II - A.C. CIRCUITS: 9 Hours

Generation of sinusoidal voltage- definition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series-parallel circuits; Three Phase A.C. Circuits - Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method;

MODULE III – TRANSFORMERS: 9 Hours

Principle of operation and construction of single-phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation

MODULE IV - DC MACHINES: 9 Hours

Working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, relation between EMF induced and terminal voltage enumerating the brush drop and drop due to armature reaction; DC motor working principle; Back EMF and its significance, torque equation; Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor;

MODULEV- THREE PHASE INDUCTION MOTORS: 9 Hours

Concept of rotating magnetic field; Principle of operation, types and constructional features; Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter.

Total No. of Hours: 45

Text Books:

1. Nagrath I.J. and D. P. Kothari, " Basic Electrical Engineering" Tata McGraw Hill (2001).
2. Hayt and Kimberly, "Engineering Circuit Analysis" Tata McGraw Hill, 8th Edition, 2013.

References Books:

1. Kulshreshtha D.C., "Basic Electrical Engineering" Tata McGraw Hill (2009).
2. Rajendra Prasad, "Fundamentals of Electrical Engineering" Prentice Hall, India Hughes, 2009.

Course Outcomes:

On successful completion of the module students will be able to:

1. Understand the concept of DC circuits and Electromagnetic principles over inductors,
2. Explain the concepts of AC circuits over RLC circuits and with knowledge of power andload performance and Obtain the power measurement using single phase and three phase circuit
3. Discuss the principles of operation and construction ofsingle-phase transformers
4. Explain the operation and characterizes of DC machines and motors.
5. Illustrate the principle of the three phase induction motors.

ESCP104	Basic Electrical Engineering Laboratory	0L:0T:2 P	1 Credit

Course Objectives:

- *Understand the importance of electrical safety in handling electrical equipment and wiring.*
- *Understand the techniques for making secure and reliable electrical joints.*
- *Understand the principles of series and parallel circuits and their applications in lamp circuits.*
- *Learn the concept and purpose of staircase, wiring in residential andcommercial settings.*
- *Learn the concept of load tests in motors and transformers.*

List of Experiments

1. Electrical Safety, Precautions, studyof tools and accessories.
2. Practices ofdifferent joints. Wiring and testing of series and parallel lamp circuits.
3. Staircase wiring, Doctor‟s room wiring.
4. Bed room and godown wiring
5. Wiring and testing a ceiling fan and fluorescent lamp circuit.
6. Studyof different types of fuses, circuit breakers and A.C and D.C meters.
7. OC and SC test on single phase transformer.
8. Load test on single phase transformer.
9. Load test on DC shunt motor.
10. Two wattmeter method of power measurement.
11. Load test on single phase induction . and 3 phase induction motor.
12. Speed control methods of DC motor

Course Outcomes:

On successful completion of the experiment students will be able to:

1. Demonstrate a thorough understanding of electrical safety practices, including the use of personal protective equipment (PPE) and safety guidelines.
2. Design and execute wiring layouts for series and parallel lamp circuits,understanding their applications and advantages.
3. Plan and execute a staircase/ n wiring system, incorporating appropriate switching mechanisms for efficient and convenient lighting control.
4. Evaluate the performance of Transformers and motors for different loads.
5. Discuss the power measurements in DC machines.

ESCP105	Digital Fabrication	0L:0T:4P	2 Credits

Course Objectives:

The course is designed to impart knowledge and skills related to 3D printing technologies, selection of material and equipment and develop a product using this technique in Industry environment.

Course Contents:

1. **3D Printing (Additive Manufacturing)**
   Introduction, Process, Classification, Advantages, Additive V/s Conventional Manufacturing processes, Applications.

2. **CAD for Additive Manufacturing**
   CAD Data formats, Data translation, Data loss, STL format.

3. **Additive Manufacturing Techniques**

   Stereo- Lithography, LOM, FDM, SLS, SLM, Binder Jet technology.
   Process, Process parameter, Process Selection for various applications.
   Additive Manufacturing Application Domains: Aerospace, Electronics, Health Care, Defence, Automotive, Construction, Food Processing, Machine Tools

4. **Materials**
   Polymers, Metals, Non-Metals, Ceramics.
   Various forms of raw material- Liquid, Solid, Wire, Powder; Powder Preparation and their desired properties, Polymers and their properties.
   Support Materials.

5. **Additive Manufacturing Equipment**
   Process Equipment- Design and process parameters
   Governing Bonding Mechanism
   Common faults and troubleshooting
   Process Design

6. **Post Processing: Requirement and Techniques**

7. **Product Quality**
   Inspection and testing
   Defects and their causes

List of Experiments

1. 3D Modelling of a single component.
2. Assemblyof CAD modelled Components.
3. Exercise on CAD Data Exchange.
4. Generation of .stlfiles.
5. Identification of a product for Additive Manufacturing and its AM process plan.
6. Printing of identified product on an available AM machine.
7. Post processing of additivelymanufactured product.
8. Inspection and defect analysis of the additivelymanufactured product.
9. Comparison of Additively manufactured product with conventional manufactured counterpart.

Text Books:

1. AICTE"s Prescribed Textbook: Workshop / Manufacturing Practices (with Lab Manual), Khanna Book Publishing Co.

2. Lan Gibson, David W. Rosen and Brent Stucker, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2010.

3. Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Tooling, Rapid Manufacturing", Hanser Publisher, 2011.

4. Sabrie Soloman, "3D Printing and Design", Khanna Publishing House, Delhi.

Reference Books:

1. CK Chua, Kah Fai Leong, "3D Printing and Rapid Prototyping- Principles and Applications", World Scientific, 2017.
2. J.D. Majumdar and I. Manna, "Laser-Assisted Fabrication of Materials", Springer Series in Material Science, 2013.
3. L. Lu, J. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Kulwer Academic Press, 2001.
4. Zhiqiang Fan And Frank Liou, "Numerical Modelling of the Additive Manufacturing (AM) Processes of Titanium Alloy", InTech, 2012.

Course Outcomes:

After completion of this course, the students will be able to:

1. Develop CAD models for 3D printing.
2. Import and Export CAD data and generate. stl file.
3. Select a specific material for the given application.
4. Select a 3D printing process for an application.
5. Produce a product using 3D Printing or Additive Manufacturing (AM).

HSMC101	English For Technical Writing	2L:0T:2P	3 Credit

Course Objectives:

- *To provide learning environment to practice listening, speaking, reading and writing skills and assist the students to carry on the tasks and activities through guided instructions and materials.*
- *To effectively integrate English language learning with employability skills and training, by providing hands-on experience through case-studies, mini-projects, group and individual presentations.*

Course Contents:

MODULE I - VOCABULARY BUILDING: 9 Hours

The concept of Word Formation, Root words from foreign languages and their use in English. Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations.

MODULEII - BASIC WRITING SKILLS: 9 Hours

Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents, Techniques for writing precisely.

MODULE III - IDENTIFYING COMMON ERRORS IN WRITING: 9 Hours

Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies and Clichés.

MODULE IV - NATURE, STYLE OFSENSIBLE WRITING: 9 Hours

Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion

MODULE V - WRITING PRACTICES AND ORAL COMMUNICATION: 9 Hours

Comprehension, Précis Writing, Essay Writing, Listening Comprehension, Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues, Communication at Workplace, Interviews, Formal Presentations.

Total No. of Hours: 45

Text Books:

1. Effective Communication Skills. Kul Bhushan Kumar, Khanna Book Publishing, 2022.
2. Practical English Usage. Michael Swan. OUP. 1995.
3. Remedial English Grammar. F.T. Wood. Macmillan,2007.

Reference Books:

1. On Writing Well. William Zinsser. Harper Resource Book. 2001.
2. StudyWriting. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

Course Outcomes

Upon successful completion of the course, students should be able to:

1. Aware of correct usage of English grammar in writing and speaking
2. Increase their reading speed and comprehension of academic articles
3. Improve their reading fluency skills through extensive reading
4. Speaking ability in English both in terms of fluency and comprehensibility
5. Oral presentations and receive feedback on their performance

HSMC-102	Universal Human Values - II	2L:1T:0P	3 Credits

PRE-REQUISITES: None. Universal Human Values 1 (Desirable)

Course Objectives:

During the Induction Program, students would get an initial exposure to human values through Universal Human Values-I. This exposure is to be augmented by this compulsory full semester foundation course. This introductory course input is intended:

- *To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.*
- *To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value- based living in a natural way.*
- *To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.*
- *Thus, this course is intended to provide a much-needed orientational input in value education to the young enquiring minds.*

Course Contents:

MODULE I – INTRODUCTION TO VALUE EDUCATION: 9 Hours

Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education) ; Understanding Value Education; Self-exploration as the Process for Value Education; Continuous Happiness and Prosperity – the Basic Human Aspirations; Happiness and Prosperity – Current Scenario; Method to Fulfill the Basic Human Aspirations: Exploring Natural Acceptance.

MODULE II – HARMONY IN THE HUMAN BEING: 9 Hours

Understanding Human being as the Co-existence of the Self and the Body; Distinguishing between the Needs of the Self and the Body; Exploring the difference of Needs of Self and Body; The Body as an Instrument of the Self; Understanding Harmony in the Self ; Harmony of the Self with the Body ; Programme to ensure self-regulation and Health; Exploring Harmonyof Self with the Body.

MODULE III – HARMONY IN THE FAMILY AND SOCIETY: 9 Hours

Harmony in the Family – the Basic Unit of Human Interaction; „Trust' – the Foundational Value in Relationship; 'Respect' – as the Right Evaluation; Other Feelings, Justice in Human- to-Human Relationship; Understanding Harmony in the Society; Vision for the Universal Human Order.

MODULE4 – HARMONY IN THE NATURE/EXISTENCE: 9 Hours

Understanding Harmony in the Nature; Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature: - Exploring the Four Orders of Nature; Realizing Existence as Co-existence at All Levels; The Holistic Perception of Harmony in Existence: - Exploring Co-existence in Existence.

MODULE5 – IMPLICATIONS OF THE HOLISTIC UNDERSTANDING – A LOOK AT PROFESSIONAL ETHICS: 9 Hours

Natural Acceptance of Human Values; Definitiveness of (Ethical) Human Conduct: - Exploring Ethical Human Conduct; A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order; Competence in Professional Ethics:- Exploring Humanistic Models in Education; Holistic Technologies, Production Systems and Management Models-Typical Case Studies; Strategies for Transition towards Value-based Life and Profession.

Total No. of Lectures: 45

Text Book and Teachers Manual

1. R R Gaur, R Asthana, G P Bagaria, "A Foundation Course in Human Values and Professional Ethic",Excel Books, 2nd Revised Edition, New Delhi, 2019.
2. RR Gaur, R Asthana, G P Bagaria, "Teachers" Manual for A Foundation Course in Human Values and Professional Ethics", Excel Books, 2nd Revised Edition New Delhi, 2019.ISBN 978-93-87034-53.

Reference Books:

1. Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak," Jeevan Vidya" 1999.
2. A.N. Tripathi, "Human Values" New Age Intl. Publishers, New Delhi, 2004.
3. The Storyof Stuff (Book).
4. Mohandas Karamchand Gandhi "The Story of My Experiments with Truth".

Course Outcomes

1. Discuss the Right understanding about the human aspirations.
2. Explore the harmony in the human being with the right understanding about the body and self.
3. Develop effective communication skills for promoting understanding and resolving conflicts within the family and society with Trust and Respect.
4. Develop a comprehensive understanding of the concept of harmony and its significance in nature and human life.
5. Recognize the Natural Acceptance of Human Values and Strategies for Transition towards Value-based Life and Profession.

AU-102	Sports and Yoga	1L:0T:1P	0 Credit

Course Objectives:

- *To make the students understand the importance of sound health and fitness principles as they relate to better health.*
- *To expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness.*
- *To create a safe, progressive, methodical and efficient activity based plan to enhance improvement and minimize risk of injury.*
- *To develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health.*

Course Contents:

MODULE I - INTRODUCTION TO PHYSICAL EDUCATION: 9 Hours

Meaning & definition of Physical Education; Aims & OBJECTIVESs of Physical Education; Changing trends in Physical Education; Ancient & Modern Olympics (Summer & Winter); Olympic Symbols, Ideals, OBJECTIVESs & Values; Awards and Honours in the field of Sports in India (Dronacharya Award, Arjuna Award, Dhayanch and Award, Rajiv Gandhi Khel Ratna Award etc.)

MODULE II - PHYSICAL FITNESS, WELLNESS AND LIFE STYLE: 9 Hours

Meaning & Importance of Physical Fitness & Wellness. Components of Physical fitness Components of Health related fitness. -Components of wellness. - Preventing Health Threats through Lifestyle Change; Concept of Positive Lifestyle; Nutritional practices for good Health.

MODULE III - FUNDAMENTALS OF ANATOMY AND PHYSIOLOGY IN PHYSICALEDUCATION, SPORTS AND YOGA: 9 Hours

Define Anatomy, Physiology & Its Importance; Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc.)

MODULE IV - YOGA AND LIFESTYLE: 9 Hours

Meaning & Importance of Yoga, Elements of Yoga; Introduction - Asanas, Pranayama, Meditation & Yogic Kriyas; Yoga for concentration & related Asanas (Sukhasana; Tadasana; Padmasana &Shashakasana); Relaxation Techniques for improving concentration

- Yog-nidra

Asanas as preventive measures.

Hypertension: Tadasana, Vajrasana, Pavan Muktasana, Ardha Chakrasana Bhujangasana, Sharasana.

Obesity: Procedure, Benefits & contraindications for Vajrasana, Hastasana, Trikonasana,

Ardh Matsyendrasana.

Back Pain: Tadasana, Ardh Matsyendrasana, Vakrasana, Shalabhasana, Bhujangasana. *Diabetes:* Bhujangasana, Paschimottasana,Pavan Muktasana, Ardh Matsyendrasana. *Asthema:* Sukhasana, Chakrasana, Gomukhasana, Parvatasana, Bhujangasana, Paschimottasana, Matsyasana.

MODULE V - PSYCHOLOGY & SPORTS: 9 Hours

Definition & Importance of Psychology in Physical Edu. & Sports; Define & Differentiate Between Growth & Development; Adolescent Problems & Their Management; Emotion: Concept, Type & Controlling of emotions; Meaning, Concept & Types of Aggressions in Sports. Psychological benefits of exercise. Anxiety & Fear and its effects on Sports Performance. Motivation, its type & techniques. Understanding Stress & Coping Strategies. Meaning and Concept of Doping ; Prohibited Substances & Methods :- Side Effects of Prohibited Substances.

Total No. of Lectures: 45

Text Books:

1. Ajmer Singh, Jagdish Bains , Jagtar Singh Gill and Rachpar SinghBrar, "Essentials of Physical Education" by Kalyani publications, 2022.
2. B.K.S. Iyengar, "Light On Yoga: The Classic Guide to Yoga bythe World'sForemost Authority"2006.
3. Health and Physical Education – NCERT (11th and 12th Classes).

Course Outcomes:

On successful completion of the course the students will be able to:

1. Discuss the physical education needs and history with reference to awards given in promotion of the sports in India.
2. Practice Physical activities and Hatha Yoga and Breathing techniques focusing on yoga for strength, flexibility, and relaxation, including strength and flexibility, balance and coordination.
3. Learn techniques for increasing concentration and decreasing anxiety which leads to stronger academic performance.
4. Develop understanding of health-related fitness components: cardio respiratory endurance, flexibility and bodycomposition etc.
5. Develop understanding of psychological problems associated with the age and lifestyle.
6. Demonstrate an understanding of sound nutritional practices as related to health and physical performance.

SEMESTER – III

ECT-201	Electronic Devices	3L:0T:0P	3 Credits

Course Objective:

- *To introduce the concepts of semiconductor physics.*
- *To understand in detail the operation, characteristics and various parameters of diodes.*
- *To learn and gain insight into the operation, characteristics and functional aspects of BJT indifferent configurations.*
- *To understand in depth the construction, operation, characteristics and various parameters ofJFET and MOSFET.*
- *To study the construction, operation and characteristics several special semiconductordevices.*
- *To acquaint the various rectifier circuits with filters and IC regulator circuits.*

Course Contents:

MODULE I **9 Hours**

Introduction to Semiconductor Physics: Review of Quantum Mechanics, Electrons in periodic Lattices, E-k diagrams. Energy bands in intrinsic and extrinsic silicon; Carrier transport: diffusion current, drift current, mobility and resistivity; sheet resistance, design of resistors.

MODULE II **9 Hours**

Semiconductor Diodes: PN junction diode – operation, forward, reverse bias characteristics- theory of diode currents - diode equation - temperature effects – DC and AC resistance – diode equivalent circuit – transition and diffusion capacitances – diode switching times – Avalanche and Zener breakdown – Zener diode characteristics.

MODULE III **9 Hours**

Bipolar Junction Transistor: I-V characteristics, Field Effect Transistors - JFET – construction – operation - drain and transfer characteristics of JFET, MOSFET, Ebers Moll Model, MOS capacitor, characteristics of LED, photodiode and solar cell. Biasing and Stabilization: DC load line and Q-point – Need for biasing – Different types of BJT biasing.

MODULE IV **9 Hours**

Special Semiconductor Devices: Construction, principle of operation and characteristics of Schottky barrier diode, Metal-insulator-metal (MIM) diodes are quantum-tunneling devices, PIN diode, LED, LCD, UJT, SCR, DIAC and TRIAC. Photoconductivity – photodiode, APD, photo transistor, LDR, opto-coupler, solar cell, LASER diode and MESFET.

MODULE - V **9 Hours**

Power Supplies: Rectifiers – Half wave, Full wave and bridge rectifier – Ripple factor calculation for C, L, LC and CLC filter. Voltage regulators – Shunt voltage regulator – Series voltage regulator – types- Integrated circuit fabrication process: oxidation, diffusion, ion implantation, photolithography, etching, chemical vapor deposition, sputtering, twin-tub CMOS process.

Total No. of Hours: 45

Text Books:

1. G. Streetman, and S. K. Banerjee, Solid State Electronic Devices, 7th edition, Pearson, 2014.
2. Donald Neamen , Dhrubes Biswas "Semiconductor Physics and Devices" McGraw-Hill Education, 4th edition, 2021.

Reference Books:

1. Y. Tsividis and M. Colin, Operation and Modeling of the MOS Transistor. Oxford Univ. Press, 2011.
2. A.K. Maini, N. Maini, All-in-One Electronics Simplified, Khanna Book Publishing, New Delhi, 2021.
3. A.K. Maini, Analog Electronics, Khanna Book Publishing, New Delhi, 2022.

Course outcomes:

At the end of this course students will demonstrate the abilityto

1. Understand the principles of semiconductor Physics and apply it to electronic devices
2. Appreciate different devices for different applications.
3. Understand and utilize the mathematical models of semiconductor devices for circuits.
4. Understand the basic processes required for fabrication of electronic devices.
5. Explain the fundamental principles of power supply operation and different types ofpower supply topologies.

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ECP-202	Electronic Devices Lab	0L:0T:2 P	1 Credits

Course Objective:

- *To Understanding the characteristics of semiconductor devices*
- *Implementation of circuits experimentally based on the knowledge gained in semiconductor devices*

List of Experiments:

1. Determination V-I characteristics of semiconductor diodes a) PN Junction diode b) Point contact diode c) Zener diode.
2. Input and output characteristics of CB transistor configuration.
3. Input and output characteristics of CE transistor configuration.
4. Characteristics of JFET, Determination of output and transfer characteristics.
5. Characteristics of MOSFET, Determination of output and transfer characteristics.
6. Characteristics of UJT, SCR and TRIAC.
7. Characteristics of photonic devices, Determination of V-I characteristics of LED.
8. Design and testing of biasing circuits, fixed bias, Collector to base bias Self bias.
9. Rectifier and Voltage Regulators, Determination of ripple factor for different types of rectifiers with and without filters.
10. Clipper and clamper circuits using diodes a) AND and OR logic gates using diodes b) NOT gate using transistor.

Course Outcomes:

1. Understanding the characteristics of semiconductor devices.
2. Implementation of circuits experimentally based on the knowledge gained in semiconductor devices.
3. Gaining practical knowledge of resonant circuits by analysis of the frequency responses.

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ECT-203	Digital System Design	3L:0T:0P	3 Credits

Course Objective:

- *To understand the fundamentals of number systems and Boolean Algebra.*
- *To understand the concepts of MSI Devices and Applications.*
- *To understand the concepts of CombinationalLogic Design, Programmable Logic Devices.*
- *To conceptualize the working of Sequential Circuits, Synchronous Sequential Circuits.*
- *To gain the knowledge in VLSI Design flow.*

Course Contents:

MODULE I **9 Hours**

Logical Simplification: Review of Boolean Algebra and De Morgan"s Theorem, SOP & POS forms, Canonical forms, Karnaugh maps up to 6 variables, Binary codes, Code Conversion.

MODULE II **9 Hours**

Combinational Logic Design: Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display, Half and Full Adders, Subtractors, Serial and Parallel Adders, BCD Adder, Barrel shifter and ALU.

MODULE III **9 Hours**

Sequential Logic Design: Building blocks like S-R, JK and Master-Slave JK FF, Edge triggered FF, Ripple and Synchronous counters, Shift registers, Finite state machines, Design of synchronous FSM, Algorithmic State Machines charts. Designing synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator, Clock generation.

MODULE IV **9 Hours**

Logic Families and Semiconductor Memories: TTL NAND gate, Specifications, Noise margin, Propagation delay, fan-in, fan-out, Tristate TTL, ECL, CMOS families and their interfacing, Memory elements, Concept of Programmable logic devices like FPGA, Logic implementation using Programmable Devices.

MODULE V **9 Hours**

VLSI Design flow: Design entry: Schematic, FSM & HDL, different modeling styles in VHDL, Data types and objects, Dataflow, Behavioral and Structural Modeling, Synthesis and Simulation VHDL constructs and codes for combinational and sequential circuits.

Text Books: **Total No. of Hours: 45**

1. R.P. Jain, "Modern digital Electronics", Tata McGraw Hill.
2. R. Anand, Digital System Design Using VHDL, Khanna Book Publishing Company.

Reference Books:

1. Gothman, "Digital Electronics-An introduction to theory and practice", Pearson Education
2. Douglas-Hall, "Digital Circuits and Systems", Tata McGraw Hill.
3. Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill.

Course outcomes:

At the end of this course students will demonstrate the abilityto

1. Understand the basic logic operations and combinational logic elements.
2. Design and analyze combinational circuits.
3. Design and analyze synchronous sequential logic circuits.
4. Use HDL and appropriate EDA tool for digital logic design and simulation.
5. Design and analysis of VHDL Simulations constructs and codes for combinational and sequential circuits.

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EC04: Digital System Design Laboratory

ECP-204	Digital System Design Laboratory	0L:0T:2 P	1 Credit

Course Objective:

- *To represent logical functions in canonical and standard forms.*
- *To design and analyse the combinational logic circuits.*
- *To design and analyse the sequential logic circuits.*
- *To implement combinational and sequential logic circuits using Verilog HDL.*

List of Experiments:

1. Design and implementation of the following Code convertors
   a. BCD to excess-3 code and vice versa b. Binary to gray code and vice-versa
2. Design and implementation of 4 bit binary Adder/ Subtractor and BCD adder using IC7483
3. Magnitude comparator
   a. Studyof 4-bit magnitude comparator IC
   b. Realization of 8-bit magnitude comparator using 4-bit magnitude comparator ICs.
4. Multiplexers and Encoders
   a. Realization of 16×1 multiplexer using 8×1 multiplexer ICs
   b. Realization of a combinational circuit using multiplexer
   c. Construction and study of a simple Priority Encoder
5. Decoders and Demultiplexers
   a. Realization of 4 to 16 line decoder using 3 to 8 line decoder ICs
   b. Realization of a combinational circuit using a decoder IC
6. Shift register
   a. Construction of ring counter and Johnson counter using a shift register IC and study of their timingdiagrams
   b. Designing a PN Sequence Generator using a shift register IC
7. Ripple Counters and their timing diagrams
   a. 3-bit binary up/down counter
   b. A modulo-N-counter (where n is the no. of FFs used to construct the counter)
   c. BCD counter using mod-10 counter ICs
8. Design and implementation of Synchronous Counters and studyof their timing diagrams
   a. Binary counter
   b. Non-sequential binary counter
   c. 3-bit binary up/down counter
9. Studyof a Memory IC
   a. READ and WRITE operations involving memory chips
   b. Expansion of memory size
10. Simulate the following circuits:
    a. Ex-OR Gate
    b. Full Adder
    c. Multiplexer
    d. Binary Up-Counter
    e. Binary Up-down Counter
    f. Shift Register

Course Outcome:

At the end of the course the student should be able to

1. Understand the number systems and IC characteristics
2. Understand the Boolean algebra and its properties
3. Design and analyse the combinational logic circuits
4. Get grip on HDL syntax
5. Implement and simulate the combinational logic circuits using HDL

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ECT-205	Signals and System	3L:0T:0P	3 Credits

Course Objective

- *To introduce the concepts of continuous time and discrete time signals and systems including their classification and properties.*
- *To comprehend and analyze the frequency domain representation of continuous time signals.*
- *To learn and investigate the different types of representing continuous time LTI systems and their properties.*
- *To comprehend and analyze the frequency domain representation of discrete time signals.*
- *To learn and investigate the different types of representing discrete time LTI systems and their properties*

Course Contents:

MODULE I **9 Hours**

Representation And Classification Of Signals And Systems: Continuous time signals - Discrete time signals – Representation of signals – Step, Ramp, Pulse, Impulse, Sinusoidal, Exponential signals, Classification of continuous and discrete time signals -Operations on the signals. Continuous time and discrete time systems: Classification of systems – Properties of systems.

MODULE II **9 Hours**

Analysis Of Continuous Time Signals: Fourier series: Properties - Trigonometric and Exponential Fourier Series - Parsavel‟s relation for periodic signals - Fourier Transform: Properties - Rayleigh‟s Energy Theorem - Laplace Transformation: Properties, R.O.C -Inverse Laplace transform.

MODULE III **9 Hours**

Analysis Of Discrete Time Signals: Discrete Fourier Series**,** Discrete Time Fourier Transform: Properties; Z-Transformation: Properties – Different methods of finding Inverse Z-Transformation.

MODULE IV 9 Hours

Continuous And Discrete Time Systems: LTI continuous time systems- Differential equations – Transfer function and Impulse response – Convolution Integral- Block diagram representation and reduction -State variable techniques – State equations LTI Discrete time systems – Difference equations – System function and impulse response – Convolution Sum – Block diagram representation – Convolution Sum – State equations for discrete time systems

MODULE V **9 Hours**

Discrete Fourier Transform: DFT – Properties - FFT algorithms –advantages over direct computation of DFT – radix 2 algorithms – DIT and DIF algorithms – Computation of IDFT using FFT.

Total No. of Hours: 45

Text Books:

1. R. Anand, Signals and Systems, Khanna Publishing House, 2019.
2. P. Ramesh Babu and R.Anandanatarajan, “Signals and Systems”, Scitech Publishers, Fifth Edition, 2014.

Reference books:

1. Allan V.Oppenheim, Allan S.Willsky and S.Hamid Nawab, "Signals and Systems", Pearson, Second Edition, New Delhi, 2015.
2. H.P.Hsu and R.Ranjan, "Signals and Systems",Schaum"s Outlines, Tata McGraw Hill, Second Edition, 2017.
3. J Simon Haykins and Barry Van Veen, "Signals and Systems", Second Edition, Wiley, 2007.

Course outcomes:

At the end of this course students will demonstrate the ability to

1. Identifythe sources of signals, and systems in real life.
2. Characterize different types of signals and systems.
3. Represent continuous-time and discrete-time systems in different mathematical forms.
4. Analyze system behavior using time and frequencydomain techniques.
5. Analyze the Discrete Fourier Transform and Properties.

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ECT2-06	Network Theory	3L:0T:0P	3 Credits

Course Objective

- *To analyze the given electrical network using Kirchoff's laws.*
- *To introduce the basic knowledge of Laplace transform and Fourier Transform and to analyze the network using suitable technique.*
- *To analyze the two-port networks, passive filters, and attenuators.*
- *To understand the use of network topology in circuit solving.*

Course Contents:

MODULE I **9 Hours**

Node and Mesh Analysis: Kirchhoff‟s laws, Node and mesh equations, Matrix approach of complicated network containing voltage and current sources, and reactance‟s, source transformation ,three phase unbalanced circuits and power calculations.

MODULE II **9 Hours**

Network theorem: Superposition, Reciprocity, Thevenin‟s, Norton‟s, Maximum power Transfer, compensation and Tallegen's theorem as applied to AC. circuits.

MODULE III **9 Hours**

Two port networks and passive filters: Introduction to Low pass, High pass, Band pass, Band reject filters. Two port network and interconnections. Driving points and transfer functions poles and zeros of immittance function and their properties.

MODULE IV **9 Hours**

RLC circuits: Partial fraction, singularity functions, waveform synthesis, analysis of RC, RL, and RLC networks with and without initial conditions with Laplace transforms evaluation of initial conditions. Analysis of series and parallel resonance circuits.

MODULE V **9 Hours**

Network Topology: Network terminology- Graph of a network- Incidence and reduced incidence matrices-Trees- Cutset-Fundamental cutset- Cutset matrix Tieset- Link currents and Tieset schedules-Twig voltages and Cutset schedules, Duality and dual networks.

Total No. of Hours: 45

Text Books:

1. Van, Valkenburg.; “Network analysis”; Prentice hall of India, 2000.
2. A William Hayt, “Engineering Circuit Analysis” McGraw Hill Science Engineering, 8th Edition, 2013.

Reference Books:

1. Van, Valkenburg.; “Network analysis”; Prentice hall of India, 2000.
2. A William Hayt, “Engineering Circuit Analysis” McGraw Hill Science Engineering, 8th Edition, 2013.
3. Ashfaq Husain, Networks and Systems, Khanna Book Publishing, 2021.

Course Outcomes:

At the end of this course students will demonstrate the abilityto,

1. Analyze the circuit using Kirchhoff‟s law and Network simplification theorems.
2. Infer and evaluate Transient response and Steadystate response of a network.
3. Analyze electrical networks in the Laplace domain and understand concept of network functions and stability.
4. Compute the parameters of a two-portnetwork.
5. Analyze the network terminology.

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ECT-207	Probability Theory and Stochastic Processes	2L:1T:0P	3 Credits

Course Objective

- *To understand the basic probability concepts.*
- *To have an in depth knowledge of standard distribution which can describe reallife phenomena.*
- *To analyze the stochastic process.*
- *To understand and characterize phenomena which evolve with respect to time inprobabilistic manner.*
- *To analyze the response of random inputs to linear time invariant systems.*

Course Content:

MODULE I **9 Hours**

Probability Space, Conditional Probability and Random Variables: Probability space; Conditional probability and Baye‟s theorem with examples; Random variables, Probability functions and Distribution function with examples, Combinatorial probability and samplingmodels.

MODULE II **9 Hours**

Discrete and Continuous Random Variables : Binomial, Poisson, Geometric and Negative Binomial distributions with examples, Exponential, Gamma and Weibull distributions with examples and relation between the distributions.

MODULE III **9 Hours**

Two Dimensional and functions of Random Variables: Two dimensional random variables, Joint distributions, Conditional distribution, densities and moments; Characteristic functions of a random variable; Functions of one and two random variables. Moments; Characteristic functions of a random variable.

MODULE IV

Random Sequences and Convergence, Central Limit Theorem: **9 Hours**

Random sequences and Modes of Convergence (everywhere, almost everywhere, probability, distribution and mean square); Limit theorems; Strong and weak laws of large numbers, Central Limit Theorem

MODULE V **9 Hours**

Stochastic Processes and Spectral Densities : Random process. Stationary processes. Mean and Covariance functions. Ergodicity. Transmission of random process through LTI. Power spectral density

Total No. of Hours: 45

Text Book:

1. H. Stark and J. Woods, ``Probability and Random Processes with Applications to Signal Processing," Third Edition, Pearson Education.
2. A.Papoulis and S. Unnikrishnan Pillai, ``Probability, Random Variables and Stochastic Processes," Fourth Edition, McGraw Hill.

Reference Books:

1. H. Stark and J. Woods, ``Probability and Random Processes with Applications to Signal Processing," Third Edition, Pearson Education
2. A.Papoulis and S. Unnikrishnan Pillai, ``Probability, Random Variables and Stochastic Processes," Fourth Edition, McGraw Hill.
3. K. L. Chung, Introduction to Probability Theory with Stochastic Processes, Springer International

Course outcomes:

At the end of this course students will demonstrate the ability to,

1. Develop understanding of basics of probabilitytheory.
2. Identifydifferent distribution functions and their relevance.
3. Applythe concepts of probability theoryto different problems.
4. Extract parameters of a stochastic process and use them for process characterization.
5. Analyze the response of Stochastic Processes and Spectral Densities.

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BST-206	Nano-science Technology	2L:1T:0P	3 Credits

Course Objectives:

- Understand the principles and fundamentals of nanoelectronics and nanotechnology.
- Introduce students to the principles of quantum mechanics and its relevance in semiconductor nanostructures.
- Introduce students to the latest developments in nanoscale semiconductor devices.
- Provide students with an overview of various nanofabrication techniques used to create nanoscale structures and devices.
- Study the design, fabrication, and performance of nanomemory devices.

MODULE I Nano electronics & Nano computer architecture 9 Hours

Introduction to Nano computers, Nano computer Architecture, Quantum DOT cellular Automata (QCA), QCA circuits, Single electron circuits, molecular circuits, Logic switches – Interface engineering – Properties (Self-organization, Size-dependent) – Limitations.

MODULE II Quantum Phenomena in Semiconductor Nanostructures: 9 Hours

Introduction to nano-science and nanotechnology, Quantum confinement and size effects in nanostructures, Semiconductor nanowires, nanotubes, and nanoparticles, Quantum dots and their unique properties, Applications of semiconductor nanostructures in electronics and photonics.

MODULE III Emerging Nanoscale Semiconductor Devices: 9 Hours

Nanoscale MOSFETs and FinFETs: principles and benefits, Tunneling devices: Tunnel diodes and Tunnel FETs, Spintronics: Spin-based semiconductor devices and logic, Carbon-based nanomaterials: graphene and carbon nanotubes for electronic applications, Introduction to other novel nanoscale devices and technologies.

MODULE V Nanofabrication and Characterization Techniques: 9 Hours

Nanofabrication techniques: Top-down and bottom-up approaches, Photolithography and etching processes in nanofabrication, Scanning Probe Microscopy (SPM) for nanoscale characterization, Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM) in nano-science, Nanomaterial characterization using X-ray diffraction and spectroscopy, Hands-on nanofabrication and characterization laboratory sessions.

MODULE V Memory Devices and Sensors: 9 Hours

Memory devices and sensors – Nano ferroelectrics – Ferroelectric random access memory –Fe-RAM circuit design –ferroelectric thin film properties and integration – calorimetric -sensors – electrochemical cells – surface and bulk acoustic devices – gas sensitive FETs – resistive semiconductor gas sensors –electronic noses – identification of hazardous solvents and gases – semiconductor sensor array

Total No. of Hours: 45

Text books:

1. Edward L.Wolf , "Nanophysics and Nanotechnology: An Introduction to Modern Concepts in Nanoscience" Wiley-VCH, 2006
2. Chris Binns, "Introduction to Nanoscience and Nanotechnology" Wiley, 2010.

References Book:

1. Dieter Vollath, "Nanomaterials: An Introduction to Synthesis, Properties and Applications" Dieter Vollath, Wiley-VCH. 2013.
2. David J. Griffiths, "Introduction to Quantum Mechanics" Cambridge University Press, 3er Ed. 1985.

Courses Outcomes

1. Understand the behavior of materials at the nanoscale and the effects of quantum mechanicson electronic properties.
2. Comprehend the quantum mechanical effects in nanostructures and their impact on device performance.
3. Explore cutting-edge research and developments in nano electronic devices, includingmolecular electronics and 2D materials-based devices.
4. Explain the key nanofabrication techniques used to create nano electronic devices, including top-down and bottom-up approaches.
5. Understand the challenges and opportunities in nanomagnetic device technology.

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AU-203	Indian Constitution & Knowledge Systems	0L:1T:0P	No Credits

Course Objectives:

- *To recognize ones fundamental duties and rights*
- *To understand the structure and functions of legislature, executive and judiciary*
- *To understand the functioning of state governments and union territories*
- *To understand the centre-state relations and functioning of constitutional bodies*

MODULE I **9 Hours**

Introduction of Indian Constitution:

The Making of Indian Constitution - The Constituent Assembly - Sources of Indian Constitution - Preamble and the Supreme Court‟s Judgments on Preamble.

State, Rights and Duties: State and Union Territories – Citizenship - Fundamental Rights - Directive Principles of State Policy - Fundamental Duties.

MODULE II **9 Hours**

Union Government:

Union Government - The Powers and Functions of the President, Vice–President, Council of Ministers, Prime Minister, Judiciary, Supreme Court - Judicial Review - Judicial Activism- Public Interest Litigation - Power and Functions of the Parliament - Budget Power and Functions of Parliament, Speaker of Lok Sabha.

MODULE III **9 Hours**

State Governments:

State Governments – Governor - State Council of Ministers - Chief Minister- Legislative Assembly- High Courts - Union Territories - Panchayati Raj Institutions - 73th and 74th Constitutional Amendment - Gram Panchayats - Block Panchayats - Municipalities.

MODULE IV **9 Hours**

Union- State Relations, Constitutional Bodies:

Centre – State Relations - Public Service - Election Commission - NITI Ayog, Emergency Powers of the President- Constitution Amendment Procedure- Right to Information Act - Right to Education. Major Constitutional Amendments and their impact on Indian Political System

MODULE V **9 Hours**

Indian traditional knowledge:

Basic structure of Indian knowledge system, Modern science and Indian knowledge system, Yoga and holistic Health care. Philosophical tradition, Indian linguistic tradition, Indian artistic tradition.

Total No. of Hours: 45

Text Books:

1. N. Sivaramakrishnan (Ed.) Culteral Heritage of India – Course Materal, Bharatiya Vidya Bhavan, Mumbai 5th edition, 2014.
2. Swami Jitatmanand, Modern Physics and Vedanta, Bharatiya Vidya Bhavan.

Reference Books:

1. Fritzof Capra, Tao of Physics.
2. Yoga Sutra of Patanjali, Ramakrishna Mission, Kolkatta.
3. R.N. Jha, Science of Conciousness Psychotherapy and yoga Practices, Vidyanidhi Prakashan, Delhi 2016.

Course Outcome

The course will enable the student to:

1. Understand the structure, duties and functions of legislature, executive and judiciary
2. Understand the functioning of state governments and union territories
3. Understand the centre-state relations and functioning of constitutional bodies
4. Understand connect up and explain basics of Indian traditional knowledge in modern scientific perspective.
5. Under the Basic structure of Indian knowledge system.

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SEMESTER – IV

ECT-208	Analog Circuits	3L:0T:0P	3 Credits

Course Objective

- *To analyze different amplifier models.*
- *To pioneer the high frequency transistor models and feedback topologies*
- *To understand the concepts of oscillators*
- *To conceptualize the working of OP-AMP and its applications*
- *To gain the knowledge of Digital-to-analog converters*

Course Contents:

MODULE I **9 Hours**

Amplifiers: Voltage amplifier, current amplifier, trans-conductance amplifier and trans-resistance amplifier. Biasing schemes for BJT and FET amplifiers, bias stability, small signal analysis, low frequency transistor models, estimation of voltage gain, input resistance, output resistance etc., design procedure for particular specifications, low frequency analysis of multistage amplifiers

MODULE II **9 Hours**

High frequency transistor models: frequency response of single stage and multistage amplifiers, cascode amplifier. Power amplifiers (Class A, B, AB, C etc.), their power efficiency and linearity issues. Calculation with practical circuits, concept of stability, gain margin and phase margin.

MODULE III **9 Hours**

Oscillators: Review of the basic concept, Barkhausen criterion, RC oscillators (phase shift, Wien bridge etc.), LC oscillators (Hartley, Colpitt, Clapp etc.), non-sinusoidaloscillators.

Differential amplifier: Basic structure and principle of operation, calculation of differential gain, common mode gain, CMRR and ICMR. OP-AMP design: design of differential amplifier for a given specification,design of gain stages and output stages, compensation.

MODULE IV **9 Hours**

OP-AMP applications: review of inverting and non-inverting amplifiers, integrator and differentiator, summing amplifier, precision rectifier, Schmitt trigger and its applications. Active filters: Low pass, high pass, band pass and band stop, design guidelines. Multivibitor and based oscillator.

MODULE V **9 Hours**

Digital-to-analog converters (DAC): Weighted resistor, R-2R ladder, resistor string etc. Analog-to-digital converters (ADC): Single slope, dual slope, successive approximation, flash etc. Timer 555 , PLL (565).

Total No. of Hours: 45

Text Books:

1. A.V.N. Tilak, Design of Analog Circuits, Khanna PublishingHouse, 2022.
2. Simon Haykin, "Communication Systems", Wiley Publication, New Delhi,2011.

Reference Books:

1. Paul R.Gray & Robert G.Meyer, Analysis and Design of Analog Integrated Circuits, John Wiley,3rd Edition.

2. A.S. Sedra and K.C. Smith, Microelectronic Circuits, Saunder's College Publishing, EditionIV

3. KennedyG, "Electronic Communication systems", Tata McGraw Hill, New Delhi, 2009.

Course outcomes:

At the end of this course students will demonstrate the abilityto

1. Understand different circuit configuration of different devices for various applications.
2. Design circuits by using appropriate device models
3. Design various analog circuits required in electronic systems.
4. Design mixed circuits such as ADC
5. Design mixed circuits such as DACs

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EC09: Analog Circuit Laboratory

ECP-209	Analog Circuit Laboratory	0L: 0T:2 P	1 Credits

Course Objective:

- *Knowledge to design and test different applications of IC 741*
- *To Understanding the characteristics of OP-AMP and its applications*
- *Analyzing and comparing the operations of different Oscillators*
- *Implementation of circuits experimentally based on the knowledge gained in Digital-to-analog converters*

List of Experiments:

1. Amplifier design , CE , Emitter follower.
2. Applications of Op-amp ,To studythe application of Op amp IC741 as
   a. Inverting amplifier & Non-inverting amplifier d. Summer & Subtractor

2 .Differentiator and Integrator

To studythe op amp performance as differentiator and integrator for various time constants

3. Comparator circuits

To studyzero crossing detectors, window detector and Schmitt trigger using op amp 741

4. Active filters using Op-amp

To design and test the performance of a 2nd order LPF, HPF, BPF and BSF

5. Log, antilog and instrumentation amplifier

To study a. Logarithmic and antilog amplifiers b. Instrumentation amplifier

6. Multivibrators using Op-Amp

To design and study the working of

a. Astable Multivibrator b. Monostable Multivibrator using IC 741.

7. Design of Oscillators for the given Specifications

a. RC Phase shift Oscillators b. Colpitts Oscillator c. Hartley Oscillator

8. Design of Power Amplifiers for the given Specifications using BJT

a. Class B Power Amplifiers b. Class AB Power Amplifiers

9. Data converters

Construction and study performance of a. DAC circuits – R-2R and ladder type b. Successive approximation type ADC.

10. Signal converters, To study operation of op-amp as V to I and I to V converters.
11. Timer 555
12. Phased Locking using 565.

Course outcomes:

1. Understanding the effects of feedback on input impedance, output impedance and Gain of the amplifiers.
2. Analyzing and comparing the operations of different power amplifiers with their characteristics.
3. Knowledge to design and test the different types of oscillators for the generation of required frequency.

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ECT-210	Microcontrollers	3L:0T:0P	3 Credits

Course Objective

- *To understand the Architecture of 8085, 8086 and its assembly language programming*
- *To study the interfacing of peripheral devices*
- *To understand the features of 8-bit Microcontroller and system design*
- *To explore the features of 16 bit and higher Microprocessors' architectures*
- *To Design and Implement Microcontroller based Systems.*

Course Contents:

MODULE I **9 Hours**

Introduction to Processors: Overview of microcomputer systems and their building blocks, memory interfacing, concepts of interrupts and Direct Memory Access, instruction sets of microprocessors (with examples of 8085 and 8086).

MODULE II **9 Hours**

8051 Architecture: Interfacing with peripherals - timer, serial I/O, parallel I/O, A/D and D/A converters; Arithmetic Coprocessors; System level interfacing design.

Memory: Concepts of virtual memory, Cache memory, Advanced coprocessor Architectures-286, 486, Pentium; Microcontrollers: 8051 systems, Introduction to RISC processors; ARM microcontrollers interface designs.

MODULE III **9 Hours**

Introduction to PIC Microcontroller : Microchip‟s PIC Microcontroller - Salient features – Harvard architecture – register file structure –addressing modes – CPU registers – Instruction set – External interrupts – Timers: Compare & Capture modes – PWM outputs – SSP and SPI – I2C bus – ADC characteristics – UART- serial programming.

MODULE IV **9 Hours**

Introduction to ARM Microcontroller: RISC versus CISC – ARM Processor Fundamentals -ARM 7 Architecture – LPC2148 microcontroller introduction – Internal memory map – Thumb/ARM instructions – Assembly Language Programming. Peripheral details – Implementation of GPIO, Timer/Counter, UART, Interrupt architecture – ADC and DAC. SPI, I2C and USB features of LPC2148.

MODULE V **9 Hours**

Programming and Applications of Microcontrollers: Firmware development using Embedded C – introduction to data types – conditional statements – loops – simple programs using embedded „C‟.

Application of microcontrollers|: Traffic Light control system – DC Motor Speed control – Network Router.

Total No. of Hours: 45

Text Books:

1. Krishna Kant, "Microprocessors and Microcontrollers: Architecture, Programming and System Design 8085, 8086, 8051, 8096", PHI Learning Pvt. Ltd., Second Edition, 2013.
2. A.K. Ray and K.M.Burchandi, and A.K.Ray, "Advanced Microprocessor and Peripherals", McGraw Hill International Edition, Third Edition, 2017.

Reference Books:

1. John B. Peatman, "Design with PIC Microcontrollers", Pearson Education, 2013
2. Andrew N. Sloss Dominic Symes and Chris Wright, "ARM System Developer"s Guide Designing and Optimizing System Software", Morgan Kaughmann/Elsevier Publishers, 2006.
3. Muhammad Ali Mazidi, SarmadNaimi, SepehrNaimi, and Janice Mazidi, "ARM Assembly Language Programming & Architecture", II Edition, 2016.

Course outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the architecture of microprocessors and microcontrollers
2. Develop programs for various microcontrollers.
3. Interface various peripherals with microcontrollers and programs it for various systems
4. Understand the architecture of ARM and PIC.
5. Design and implement real-life engineering applications.

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EC11: Microcontrollers Lab

ECP-211	Microcontrollers Lab	0L: 0T:2 P	1 Credits

Course Objective:

- *To Understanding the working of microcontroller*
- *Knowledge to program, debug and analyze codes*
- *Acquiring and applying microcontroller programming and interfacing skills*

Experiments Using PIC and ARM Controller

1. Implementation of Simple Programs
2. Implementation of Interrupts
3. Implementation of UART features.
4. Implementation of SPI and I2C communication
5. Implementation of Real-Time Clock using timer and interrupt
6. Interfacing with Keyboard matrix
7. Interfacing with Single/Multi channel Analog to Digital Convertor
8. Interfacing with Digital to Analog Convertor
9. Implementation of Watch dog timer
10. Traffic Lights Control
11. Stepper Motor interface
12. Speed control of DC motors
13. Parallel port interface with printer
14. Sound Generation: Generate simple musical tones using a piezo buzzer connected to a microcontroller.

Course outcomes:

1. Interface Microprocessor with different kinds of Peripherals.
2. Identify and understand the function of PIC microcontroller & its Peripherals.
3. Understand, Design and execute programs based on microcontroller.
4. Design and Implement Microcontroller based Systems.

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ECT-212	Analog and Digital Communication	3L:0T:0P	3 Credits

Course Objective

- *To analyze the various filters and receivers*
- *To understand the basic types of modulation*
- *To analyze the basic concepts of spread spectrum technology*
- *To understand the concept of synchronization*
- *To analyze the different encryption standards*

Course Contents:

MODULE I **9 Hours**

Introduction to Analog modulation Techniques: Need for modulation- frequency domain of signals-Principles of Amplitude Modulation Systems-Different types of AM modulators-SSB , DSB and VSB modulation-Angle Modulation-Principle of frequency and phase modulation-Relation between FM and PM waves-Spectral characteristics of angle modulated signals.

MODULE II **9 Hours**

Noise in Analog Techniques : External and internal noise-Noise figure and noise temperature-AWGN Noise characteristics - Noise performance of AM system- Model for linear modulation system-S/N for SSB-SC and DSB-SC - . Noise performance of frequency modulated system. Pre-emphasis and De-emphasis -Threshold effect in FM.

MODULE III **9 Hours**

Base band Techniques: Sampling process- Uniform quantization and non-uniform quantization- PCM-DPCM-DM-ADM systems- Noise considerations in PCM-Companding- Detection of signals in Gaussian noise-Inter Symbol Interference and Nyquist criterion- Time Division multiplexing, Digital Multiplexers.

MODULE IV **9 Hours**

Band Pass Digital Modulation schemes: Coherent and Non-coherent detection of ASK, FSK and PSK- QPSK, DQPSK, MSK, QAM -Comparison of error performance of non- coherently and coherently detected ASK, FSK and PSK systems - M-ary signaling.

MODULE V **9 Hours**

Information Measures: Discrete Source models – Memoryless and Stationary- Mutual Information, Self-Information, Conditional Information,-Average Mutual Information, Entropy- Conditional Entropy-construction of basic codes – shannon‟s coding- Huffman coding.

Total No. of Hours: 45

Text Books:

1. B.P.Lathi,Zhi Ding “Modern Digital and Analog Communication”, Oxford, 4th Edition,2011
2. R. Anand, Communication Systems, Khanna Book Publishing Company, 2011.

Reference Books:

1. Simon Haykin, “Communication Systems”, Wiley Publication, New Delhi, 2011.
2. Taub and Schilling, "Principles of Communication Systems", McGraw Hill International edition, New Delhi, 2006.
3. Carlson A B, "Communication systems: An Introduction to signals and noise in electrical communication", McGraw Hill, NewDelhi, 2002.

Course Outcomes:

At the end of this course, the students should be able to

1. Illustrate the principles of amplitude and angle modulation techniques
2. Analyze the performance of waveform coding techniques.
3. Compare bandpass digital modulation techniques for bit error rate, bandwidth and power requirements
4. Understand the concept of information rate and channel capacity.
5. Understand the concept of Information Measures.

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EC13: Analog and Digital Communication Laboratory (Any ten Experiments)

ECP-213	Analog and Digital Communication Lab	0L:0T:2 P	1 Credits

Course Objective:

- *To interpret the transmitter and receiver blocks of various waveform coding techniques*
- *To analyze various line coding techniques in time and frequency domains.*
- *To identify the role of baseband and band pass formats for effective transmission of signals*
- *Implementation of circuits experimentally based on the knowledge gained in Communication*

List of Experiments: simulation and hard ware based

1. AM modulator and demodulator circuits.
2. FM modulator and demodulator circuits
3. Pre-emphasis and de-emphasis
4. TDM, To construct TDM circuit and to trace the multiplexed and de-multiplexed waveform.
5. Construct an Amplitude Shift Keying (ASK) modulator and demodulator circuit. Obtain the ASK modulated and demodulated waveforms.
6. Construct a Frequency Shift Keying (FSK) modulator and demodulator circuit. Obtain the FSK modulated and demodulated waveforms.
7. Construct a Binary Phase Shift Keying (BPSK) modulator and demodulator circuit. Obtain the BPSK modulated and demodulated waveforms.
8. Construct a Pulse code modulator and demodulator circuit. Obtain the coded output for the given sine wave.
9. Construct a Delta modulator and demodulator circuit. Obtain the coded output for the given sine wave.

Simulation based Experiments

10. Simulation of AM, FM, PAM, PWM and PPM
11. To simulate PAM, PWM and PPM to trace the time domain and frequency domain waveform.
12. To simulate Pre-emphasis and De-emphasis and to trace their characteristics.

Course Outcomes:

1. Understanding the working of PCM, DM and compare its performance.
2. Practically analyzing and verifying the various line coding ad source coding signaling formats scramblers and equalizers.
3. Practically verifying the working of pulse shaping filters.
4. Realizing the practical circuits and verify the working of digital modulation formats and validating it with simulations

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EST-206	Numerical Techniques	2L:0T:2P	3 Credits

Course Objectives:

- *Cover certain basic, important computer oriented numerical methods for analyzing problems that arise in engineering and physical sciences.*
- *To obtain solutions to a few problems that arise in their respective engineering courses.*
- *To Impart skills to analyze problems connected with data analysis,*
- *Solve ordinary and partial differential equations numerically*

Course Contents:

MODULE I **9 Hours**

Interpolation: Interpolation by polynomials, error of the interpolating polynomial, piecewise linear and cubic spline interpolation.

MODULE II **9 Hours**

Numerical Integration: Numerical integration, Simpson rule, composite rules, error formulae, Gauss quadrature.

MODULE III **9 Hours**

System of Linear Equations: Solution of a system of linear equations, implementation of Gaussian elimination and Gauss- Seidel methods, partial pivoting, row echelon form, LU factorization, Cholesky's method, ill- conditioning, norms.

MODULE IV **9 Hours**

Non-linear Equation: Solution of a nonlinear equation, bisection and secant methods. Newton-Raphson method, rateof convergence, solution of a system of nonlinear equations.

MODULE V **9 Hours**

Numerical solution of Ordinary Differential Equations: Euler and Runge-Kutta methods, multistep methods, predictor-corrector methods, order of convergence, finite difference methods, numerical solutions of elliptic, parabolic, and hyperbolic partial differential equations. Eigenvalue problem, power method, QR method, Gershgorin‟s theorem. Exposure to software packages.

Total No. of Hours: 45

Text Books:

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering, 2012, New Age International Ltd., 6th Edition.
2. R.L. Burden and J. D. Faires, Numerical Analysis, , 2012, 4th Edition, Brooks Cole.

Reference Books:

1.E. Kreyszig, Advanced engineering mathematics (8th Edition), John Wiley (1999).
2.Reena Garg, Advanced Engineering Mathematics, Khanna Book Publishing (2022).
3.R. Agor, Elements of Mathematical Analysis, Khanna Publishing House, 2015.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand different numerical integration techniques, and numericallysolve differential equations.
2. Perform various matrix computations and solve simultaneous linear equations.
3. Find roots of a transcendental equation using different methods.
4. Implement different interpolation schemes.
5. Understanding of Eigenvalue problem and power method.

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PRJ EC-201	Micro Project	0L:0T:4P	4 Credits

A. Project: ECP1 Micro Project

Guidelines: The micro-project is a team activity having 3-4 students in a team. This is electronic circuit building and testing for developing real life small electronic applications. The micro-project may be a complete hardware or hardware with small programming aspect. It should encompass electronics components, devices, analog or digital ICs, micro controller etc. Micro-Project should cater to a small system required in laboratory or real-life application. Based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of Micro-project.

Course Outcomes:

At the end of the micro project, students will demonstrate the ability to:

1. Identify and define a problem statement from the requirements raised from literature survey /need analysis
2. Build and Test electronic circuits/prototype for developing real life small electronic applications.
3. Work in teams; write comprehensive report and effective presentation of the project work.
4. Rapid prototyping which will lead them towards entrepreneurship.

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HSMC-203	Life Skills	3L:0T:0P	3 Credits

Course Objectives:

- *To Identify different life skills required in personal and professional life*
- *To apply well-defined techniques to cope with emotions and stress.*
- *To understand the basic mechanics of effective communication and demonstrate these through presentations.*
- *To use appropriate thinking and problem solving techniques to solve new problems*
- *To understand the basics of teamwork and leadership*

Course Contents:

MODULE I **9 Hours**

Overview of Life Skills: Meaning and significance of life skills, Life skills identified by WHO: Self awareness, Empathy, Critical thinking, Creative thinking, Decision making, problem solving, Effective communication, interpersonal relationship, coping with stress, coping with emotion.

Life skills for professionals: positive thinking, right attitude, attention to detail, having the big picture, learning skills, research skills, perseverance, setting goals and achieving them, helping others, leadership, motivation, self-motivation, and motivating others, personality development, IQ,EQ, and SQ.

MODULE II **9 Hours**

Self-awareness: definition, need for self-awareness; Coping With Stress and Emotions, Human Values, tools and techniques of SA: questionnaires, journaling, reflective questions, meditation, mindfulness, psychometric tests, feedback.

Stress Management: Stress, reasons and effects, identifying stress, stress diaries, the four A's of stress management, techniques, **Approaches:** action-oriented, emotion-oriented, acceptance oriented, resilience, Gratitude Training, **Coping with emotions:** Identifying and managing emotions, harmful ways of dealing with emotions, PATH method and relaxation techniques. **Morals, Values and Ethics:** Integrity, Civic Virtue, Respect for Others, Living Peacefully. Caring, Sharing, Honesty, Courage, Valuing Time, Time management, Cooperation, Commitment, Empathy, Self-Confidence, Character, Spirituality, Avoiding Procrastination, Sense of Engineering Ethics.

MODULE III **9 Hours**

21st century skills: Creativity, Critical Thinking, Collaboration, Problem Solving, Decision Making, Need for Creativity in the 21st century, Imagination, Intuition, Experience, Sources of Creativity, Lateral Thinking, Myths of creativity, Critical thinking Vs Creative thinking, Functions of Left Brain & Right brain, Convergent &Divergent Thinking, Critical reading & Multiple Intelligence.

Steps in problem solving: Problem Solving Techniques, Six Thinking Hats, Mind Mapping, Forced Connections. Analytical Thinking, Numeric, symbolic, and graphic reasoning. Scientific temperament and Logical thinking.

MODULE IV **9 Hours**

Group and Team Dynamics: Introduction to Groups: Composition, formation, Cycle, thinking, Clarifying expectations, Problem Solving, Consensus, Dynamics techniques, Group vs Team, Team Dynamics, Virtual Teams. Managing team performance and managing conflicts, Entrepreneurship.

MODULE V **9 Hours**

Leadership: Leadership framework, entrepreneurial and moral leadership, vision, cultural dimensions. Growing as a leader, turnaround leadership, managing diverse stakeholders, crisis management. Types of Leadership, Traits, Styles, VUCA Leadership, Levels of Leadership, Transactional vs Transformational Leaders, Leadership Grid, Effective Leaders.

Total No. of Hours: 45

Text Books:

1. Kalyana, “Soft Skill for Managers”; First Edition; Wiley Publishing Ltd, 2015.
2. Larry James, “The First Book of Life Skills”; First Edition, Embassy Books, 2016

References books:

1. Remesh S., Vishnu R.G., "Life Skills for Engineers", Ridhima Publications, First Edition, 2016.
2. Training in Interpersonal Skills: Tips for Managing People at Work, Pearson Education, India; 6 edition, 2015.
3. 12. The Ace of Soft Skills: Attitude, Communication and Etiquette for Success, Pearson Education; 1 edition, 2013.

Course Outcomes:

On the successful completion of the course, student will be able to:

1. Define and Identify different life skills required in personal and professional life
2. Develop an awareness of the self and apply well-defined techniques to cope with emotions and stress.
3. Explain the basic mechanics of effective communication and demonstrate these through presentations and take part in group discussions.
4. Use appropriate thinking and problem solving techniques to solve new problems.
5. Understand the basics of teamwork and leadership

AU-204	Environmental Science	1L:0T:1P	No Credits

Course Objective:

- *It is concerned with the exploration, investigation and development of an understanding of the natural, human and social dimensions of local and wider environments.*
- *It provides opportunities to engage in active learning, to use a wide range of skills, and to acquire open, critical and responsible attitudes.*
- *The objective of this activity is to raise awareness about sustainable living practices and encourage students to adopt eco-friendly habits in their daily lives.*

Course Contents:

MODULE I

Eco system: Introduction- Abiotic and Biotic components, Structure and functions of Ecosystem – Food Chain, Food web, Ecological pyramids, Energy flow and biogeochemical cycles.

MODULE II

Biodiversity: Values, Type and levels of Biodiversity. Causes of depletion. Conservation of biodiversity

MODULE III

Pollutions: Water Pollution-Sources of water, water quality standards, type of pollutants – its sources and effects. **Air Pollution** – composition of atmosphere, Air quality standards, Sources and adverse effects of air pollution, Greenhouse effect, global warming, acid rain, ozone depletion **Noise Pollution** – Introduction, Level of noise, Sources and adverse effects of noise, Control of noise pollution.

MODULE IV

Solid Waste Management: Municipal waste – Introduction, classification of solid waste, composition and characteristics of solid waste

MODULE V

Activity for Environmental Studies in Engineering Colleges

1. **Green Campus Initiative:** Organize a campus-wide green initiative to promote sustainable practices, such as recycling, reducing energy consumption, and minimizing water wastage. Conduct workshops and awareness campaigns on campus to involve students and staff actively.
2. **Waste Audit and Management:** Conduct a waste audit on campus to analyze the types and quantities of waste generated. Based on the findings, implement effective waste management practices, including recycling programs and proper waste disposal.
3. **Environmental Impact Assessment:** Assign students real-life projects to conduct environmental impact assessments of construction projects or industrial facilities to identify potential environmental impacts and propose mitigation measures.
4. **Energy Efficiency Workshop:** Organize workshops and seminars on energy efficiency, renewable energytechnologies, and energy conservation to educate students about sustainable energypractices.
5. **Green Design Competition:** Host a green design competition where students come up with sustainable engineering solutions for environmental challenges. Encourage innovative designsthat promote sustainability and eco-friendliness.
6. **Nature Walk and Biodiversity Study:** Organize nature walks and biodiversity study trips to nearby natural areas. Students can learn about local ecosystems, wildlife, and the importance of conserving biodiversity.
7. **Sustainable Transportation Campaign:** Raise awareness about sustainable transportation options such as cycling, carpooling, and public transit. Encourage students to use these eco-friendly modes of transportation on campus.
8. **Water Conservation Challenge:** Run a water conservation challenge where students compete to reduce water usage in their hostels or departments. Monitor water consumption and reward the most water-conscious groups.

9. **Community Outreach Program:** Engage with the local community on environmental issues through outreach programs. Students can conduct workshops on waste management, renewable energy, or other eco-friendly practices.
10. **Green Tech Exhibition:** Organize a green technology exhibition to showcase sustainable engineering solutions and environmentally friendly projects developed by students. Invite industry experts and environmentalists to judge and provide feedback.

Text Books:

1. 1. P.Yugananth, R.Kumaravelan, Environmental Science and Engineering, Scitech Publications (Inida) P.Ltd., Delhi, 2017.
2. 2. John Pichtel, Waste Management Practices: Municipal, Hazardous and Industrial, CRC Press, 2014.

Reference Books:

1.V.S.K.V.Harish, Arunkumar, Green Building Energy Simulation and Modeling, Elsevier Science & Technology,2018.

2. Anubha Kaushik and C.P.Kaushik, Environmental Science and Engineering, New Age International (P) Ltd., New Delhi, 2010.

3. S.S.Dara, A text book of Environmental Chemistry and Pollution Control, S.Chand and Company Ltd., New Delhi, 2014.

Course Outcome:

After completion of this course, students will be able to:

1. Recognize the impact of environmental depletion especially on ecosystem and biodiversity
2. Identify factors causing land, water, air and noise pollution
3. Determine the effects of pollution
4. Develop keen understanding of non conventional energy source, solid waste management and technologies for sustainable development
5. Understand the environment legislations in India

SEMESTER – V

ECT-314	Digital Signal Processing	3L:1T:0P	4 Credits

Course Objectives:

- *To introduce the theory and applications of IIR filters.*
- *To introduce the design principles of FIR filters and smoothing using windows*
- *To impart knowledge on the various types of errors that affect signals during digital signal processing.*
- *To introduce the concepts of power spectral density estimation for random signals and the concepts and applications of multirate sampling.*
- *To introduce the architecture of DSP processor*.

Course Contents:

MODULE I INFINITE IMPULSE RESPONSE FILTERS: 12 Hours

Design of IIR Digital Filters: Butterworth, Chebyshev and Elliptic Approximations; Low pass, Band pass, Band stop and High pass filters. Realization of IIR filter - direct form I, direct form II, Cascade, parallel realizations.

MODULE II - FINITE IMPULSE RESPONSE FILTERS 12 Hours

: Design of FIR Digital filters: Window method, Park-McClellan's method. Realization of FIR filters – Transversal, linear phase and poly phase realization structures.

MODULE III - FINITE WORD LENGTH EFFECTS: 12 Hours

Fixed point and floating point number representation - ADC - quantization - truncation and rounding - quantization noise - input / output quantization - coefficient quantization error - product quantization error - overflow error - limit cycle oscillations due to product quantization and summation - scaling to prevent overflow.

MODULE IV - SPECTRUM ESTIMATION AND MULTIRATE SIGNAL PROCESSING 12 Hours

: Periodogram estimation – nonparametric methods – Bartlett and Welch methods – parametric methods – AR, MA and ARMA models. Principles of multirate DSP – Decimation and Interpolation by integer factors – subband coding of speech signals-QMF Filters. Application of DSP to Speech and Radar signal processing.

MODULE V - DIGITAL SIGNAL PROCESSORS: 12 Hours

Introduction to programmable DSP processors – Von Neumann architecture- Harvard architecture- VLIW architecture – MAC unit- pipelining.- Special addressing modes in P-DSPs- On chip peripherals, PDSPs with RISC and CISC- Architecture and addressing modes of TMS320C50 and TMS320C6X.

Total No. of Hours: 60

Text Books:

1. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", PHI learning, New Delhi, Fourth edition 2008.
2. A.V. Oppenheim and Schafer, "Discrete Time Signal Processing", Pearson, 3rd edition, 2021.

Reference Books:

1. L. R. Rabiner and B. Gold, "Theory and Application of Digital Signal Processing" PHI Learning, New Delhi, 1998.
2. Sanjit K. Mitra, "Digital Signal Processing: A Computer Based Approach, Tata McGraw – Hill, Third Edition, 2005.
3. P.RameshBabu, "Digital Signal processing", Scitech Publications, Sixth Edition, 2014.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Design IIR digital filters based on given specifications, considering different filter design methods and optimization criteria.
2. Design FIR digital filters based on given specifications, and apply window functions for smoothing.
3. Explain the error corrections required to eliminate the finite word length effects.
4. Understand the concepts and applications of multirate signal processing, including decimation, interpolation, and sample rate conversion.
5. Discuss the DSP processor architecture and programming concept.

*****

ECP-315	Digital Signal Processing Lab	0L:0T:2P	1 Credits

Course Objective:

- *To practice several DSP based experiments.*
- *To design IIR and FIR filters.*
- *To implement the applications of multirate sampling.*
- *To implement several experiments using DSP processor.*

List of Experiments:

Any software package based Experiments:

1. Generation of Standard Discrete-Time Signals.
2. Linear and Circular convolution of two sequences.
3. Auto correlation and Cross Correlation of two signals.
4. Frequency Analysis using DFT.
5. Fast Fourier Transform using DIT-FFT and DIF-FFT.
6. Design of FIR filters (LPF/HPF/BPF/BSF) and demonstrates the filtering operation.
7. Design of Butterworth and Chebyshev IIR filters (LPF/HPF/BPF/BSF) and demonstrate the filtering operations.
8. Multirate signal processing (Up Sampling and Down sampling of signals).

DSP Processor based Experiments:

1. Study of architecture of Digital Signal Processor.
2. Perform MAC operation using various addressing modes.
3. Generation of various signals and random noise.
4. Linear and circular convolution of signals.
5. DFT and FFT of signals.
6. FIR Filter for Low pass, High pass, Band pass and Band stop filtering.
7. Butter worth and Chebyshev IIR Filters for Low pass, High pass, Band pass and Band stop filtering.
8. Implement an Up-sampling and Down-sampling operation in DSP Processor.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Design IIR and FIR filters.
2. Apply signal processing algorithms for real time applications.
3. Perform several experiments using DSP processor.

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ECT-316	Electromagnetic Waves	3L:1T:0P	4 Credits

Course Objective:

- *To impart knowledge on the basics of transmission lines*
- *To learn basic electromagnetic equations*
- *To make students have depth understanding of EM waves and the propagation of EM waves.*
- *To introduce waveguides and radiation*
- *To learn antenna characteristics, linear antennas and their arrays*

Course Contents:

MODULE I TRANSMISSION LINES: 12 Hours

Equations of Voltage and Current on TX line, Propagation constant, Characteristic impedance and reflection coefficient, Impedance Transformation, Loss-less and Low Loss Transmission line and VSWR, Power transfer on TX line, Smith Chart, Admittance Smith Chart, Applications of transmission lines, Impedance Matching, Lossy transmission line, Problems on Transmission line, Types of transmission line.

MODULE II - ELECTRO MAGNETIC WAVE EQUATIONS 12 Hours

: Maxwell‟s Equations- Basics of Vectors, Vector calculus, Basic laws of Electromagnetics, Maxwell's Equations, Boundary conditions at Media Interface.

MODULE III -UNIFORM PLANE WAVES 12 Hours

Uniform plane wave, Propagation of wave, Wave polarization, Pioncere's Sphere, Wave propagation in conducting medium, Wave propagation and phase velocity, Power flow and Poynting vector, Surface current and power loss in a conductor. Plane Waves at a Media Interface- Plane wave in arbitrary direction, Plane wave at dielectric interface, Reflection and refraction at media interface, Total internal reflection, Polarization at media interface, Reflection from a conducting boundary.

MODULE IV - WAVEGUIDES 12 Hours

Parallel plane waveguide, wave propagation in parallel plane waveguide, Analysis of waveguide general approach, Rectangular waveguide, Modal propagation in rectangular waveguide, Surface currents on the waveguide walls, Field visualization and Attenuation in waveguide, Attenuation in waveguide continued.

MODULE V -RADIATION 12 Hours

Solution for potential function, Radiation from the Hertz dipole, Power radiated by hertz, dipole, thin linear antenna, Radiation Parameters of antenna, receiving antenna, Monopole and Dipole antenna, Fourier transform relation between current and radiation pattern.

Total No. of Hours: 60

Text Books:

1. R.K. Shevgaonkar, “Electromagnetic Waves”, Tata McGraw Hill India, 2005.
2. E.C. Jordan & K.G. Balmain, “Electromagnetic waves & Radiating Systems”, Prentice Hall, India, Second Edition, 2007.

Reference Books:

1. R.L. Yadav, “Electromagnetic Fields and Waves”, Khanna Book Publishing, 2021
2. Narayana Rao, “N: Engineering Electromagnetics”, Prentice Hall, India, Third Edition, 1997.
3. William H. Hayt, “Engineeering Electromagnetics”, McGraw Hill, Fifth Edition, 2008.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Appreciate the importance of transmission lines and analyze transmission line problems like impedance transformation and matching using analytical and graphical methods.
2. Solve Maxwell‟s equations to understand propagation of electromagnetic waves in unbound medium and across media interfaces.
3. Analyze electromagnetic wave propagation in rectangular metallic waveguides and resonators.
4. Understand antenna characteristics, and design linear antennas and their arrays.
5. Illustrate the basic principles of radiation of electromagnetic waves in through basic antennas.

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ECP-317	Electromagnetic Waves Lab	0L:0T:2P	1 Credits

Course Objective:

- *To analyze impedance measurement, frequency measurement transformation and electromagnetic wave propagation mechanism*
- *To understand propagation of electromagnetic waves in unbound medium and across media interfaces.*
- *To analyze electromagnetic wave propagation in rectangular metallic waveguides.*
- *To understand antenna characteristics, and design linear antennas.*

List of Experiments:

1. Electric Field Mapping: To map the electric field lines around different charge distributions and study the concept of electric flux density and Gauss's law.
2. Magnetic Field Mapping: To map the magnetic field around different current-carrying conductors and study the behavior of magnetic field intensity using Ampere's law.
3. Inductance Measurement: To measure the inductance of different coil configurations and study the concept of self-inductance and mutual inductance.
4. Faraday's Law Demonstration: To demonstrate Faraday's law of electromagnetic induction and study the generation of induced electromotive force (EMF) in a coil due to a changing magnetic field.
5. Transmission Line Parameters: To measure the characteristic impedance and propagation constant of transmission lines and study the wave propagation in lossless and conducting media.
6. Electromagnetic Wave Propagation: To study the reflection and refraction of plane waves at the interface of different dielectric materials and measure the depth of penetration of electromagnetic waves.
7. Polarization of Electromagnetic Waves: To study the polarization states of electromagnetic waves and demonstrate linear, circular, and elliptical polarization.
8. Poynting Vector Measurement: To measure the Poynting vector and study the power flow in electromagnetic waves.
9. Impedance measurement and Frequency measurement using rectangular waveguide.
10. Using simulation software
    1. Plot radiation pattern of dipole antenna
    2. Plot radiation pattern of monopole antenna

Course outcomes:

At the end of this course students will demonstrate the ability to

1. Analyze impedance measurement, frequency measurement transformation and electromagnetic wave propagation mechanism..
2. Prove Maxwell‟s equations to understand propagation of electromagnetic waves in unbound medium and across media interfaces.
3. Analyze electromagnetic wave propagation in rectangular metallic waveguides.
4. Understand antenna characteristics, and design linear antennas.

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ECT-318	Computer Architecture	3L:0T:0P	3 Credits

Course Objectives:

- *To impart basic concepts of computer architecture and organization.*
- *To explain key skills of constructing cost-effective computer systems.*
- *To familiarize the basic CPU organization.*
- *To help students in understanding various memory devices.*
- *To facilitate students in learning IO communication.*

Course Contents:

MODULE I - BASICS OF COMPUTER AND PROGRAMS: 9 Hours

Basic Structure of Computers, Functional units, software, performance issues software, machine instructions and programs, Types of instructions, Instruction sets: Instruction formats, Assembly language, Stacks, Queues, Subroutines.

MODULE II - PROCESSOR ORGANIZATION AND ALU OPERATIONS: 9 Hours

Processor organization, Information representation, number formats. Multiplication & division ALU design, Floating Point arithmetic, IEEE 754 floating point formats.

MODULE III 9 Hours

Micro-Programmed and CPU Control: Control Design, Instruction sequencing, Interpretation, Hard wired control - Design methods, and CPU control unit. Micro-programmed Control - Basic concepts, minimizing micro instruction size, multiplier control unit. Micro-programmed computers - CPU control unit.

MODULE IV - MEMORY SYSTEMS 9 Hours

Memory organization, device characteristics, RAMS, ROM, Memory management, Concept of Cache & associative memories, Virtual memory.

UNIT V - INPUT/OUTPUT INTERFACING: 9 Hours

System organization, Input - Output systems, Interrupt, DMA, Standard I/O interfaces Concept of parallel processing, Pipelining, Forms of parallel processing, interconnect network.

Total No. of hours: 45

Text Books:

1. V. Carl Hamacher, Zvonko G. Varanesic and Safat G. Zaky, "Computer Organisation", McGraw Hill Education (India), Fifth Edition, 2011.
2. A.S.Tanenbum, "Structured Computer Organisation", PHI, Third edition, 2013
3. John L Hennessey and David A Patterson, "Computer Architecture AQuantitative Approach", Morgan Kaufmann/ Elsevier, Fifth Edition, 2012.

Reference Books:

1. Y.Chu, "Computer Organisation and Microprogramming", II, Englewood Chiffs, N.J.,PrenticeHall,Edition, 2018.
2. M. Morris. Mano, "Computer System Architecture", Pearson; 3rd edition (1992).
3. William Stallings," Computer Organization and Architecture‖", Seventh Edition, Pearson Education, 2006.

.**Course Outcomes:**

At the end of this course students will demonstrate the ability to

1. Analyze the computing systems and their development processes.
2. Analyze the performance of computers and the role of software and hardware in it.
3. Interface memory and I/O devices to CPU to make a complete system.
4. Understand the architecture of modern CPUs and issues related to them such as Cache memories, out of order instruction execution.
5. Demonstrate the memory operations and I/O interfacing techniques.

*****

ECT-319	Control Systems	3L:0T:0P	3 Credits

Course Objectives:

- *To be able to design control systems that meet design specifications.*
- *To introduce the components and their representation of control systems.*
- *To be able to obtain a working mathematical model of a system.*
- *To learn various methods for analyzing the time response, frequency response and stability of the systems.*
- *To learn the various approaches for state variable analysis.*

Course Contents:

MODULE I - INTRODUCTION TO CONTROL PROBLEM: 9 Hours

Industrial Control examples, Transfer function models of mechanical, electrical, thermal and hydraulic systems, System with dead-time, System response, Control hardware and their models: potentiometers, synchros, LVDT, dc and ac servomotors, tacho-generators, electro hydraulic valves, hydraulic servomotors, electro pneumatic valves, pneumatic actuators, Closed-loop systems, Block diagram and signal flow graph analysis, transfer function.

MODULE II - CHARACTERISTICS OF FEEDBACK CONTROL SYSTEMS: 9 Hours

Basic modes of feedback control: proportional, integral and derivative. Stability concept, relative stability, Routh stability criterion. Time response of second-order systems, steady- state errors and error constants, Performance specifications in time-domain, Root locus method of design.

MODULE III - FREQUENCY RESPONSE ANALYSIS: 9 Hours

Relationship between time & frequency response, Polar plots, Bode‟s plot, stability in frequency domain, Nyquist plots, Nyquist stability criterion, Performance specifications in frequency-domain, Frequency-domain methods of design, Compensation & their realization in time & frequency domain, Lead and Lag compensation, Op-amp based and digital implementation of compensators, Tuning of process controllers, State variable formulation and solution.

MODULE IV - STATE VARIABLE ANALYSIS: 9 Hours

Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability & observability.

MODULE V - OPTIMAL CONTROL & NONLINEAR CONTROL: 9 Hours

Optimal Control problem, Regulator problem, Output regulator, tracking problem, Nonlinear system: Basic concept & analysis.

Total No. of Hours: 45

Text Books:

1. Gopal. M., “Control Systems: Principles and Design”, Tata McGraw-Hill, 1997.
2. Ambikapathy A., Control Systems, Khanna Book Publications, 2019.

Reference Books:

1. Kuo, B.C., “Automatic Control System”, Prentice Hall, sixth edition, 1993.
2. Ogata, K., “Modern Control Engineering”, Prentice Hall, second edition, 1991.
3. Nagrath & Gopal, “Modern Control Engineering”, New Age International, New Delhi.1990

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the concepts of control systems and importance of feedback in control systems.
2. Perform computations and solve problems on frequency response analysis.
3. Analysis the various frequency response plots and its system. Apply the concepts of various system stability criterions.
4. Evaluate different types of state models and time functions.
5. Analyse different types of control systems like linear and non-linear control systems, etc.Design various transfer functions of digital control system using state variable models.

*****

ECT-320	Embedded Systems	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the fundamental concepts of embedded systems, microcontrollers, and microprocessors.*
- *To design and develop embedded systems using programming languages like C and C++.*
- *To explore interfacing techniques for various peripherals and sensors with microcontrollers.*
- *To introduce real-time operating systems and software development for embedded systems.*
- *To understand the recent trends in embedded systems.*

MODULE I - INTRODUCTION TO EMBEDDED SYSTEMS: 9 Hours

Definition and characteristics of embedded systems, Embedded system architecture and components, Microcontrollers and microprocessors basics, Introduction to System on Chip (SoC) and Field Programmable Gate Arrays (FPGAs), overview of embedded system development tools, C and C++ programming for embedded systems.

MODULE II - REAL TIME OPERATING SYSTEMS: 9 Hours

Issues in Real Time Computing, Structure of a real time system, Process, task, threads, classification of tasks, task scheduling, classification of scheduling algorithms. Inter Process Communication:- Shared data problem, Use of Semaphore(s), Priority Inversion Problem and Deadlock Situations - Evaluating operating system performance – Power optimization strategies for processes. **MODULE III - EMBEDDED SYSTEM DESIGN AND PROGRAMMING: 9 Hours**

GPIO (General Purpose Input/Output) interfacing, Analog-to-digital conversion (ADC) and digital-to-analog conversion (DAC), Interfacing with various sensors and actuators, Interrupts and timers in embedded systems, Memory management in resource-constrained devices, Introduction to ARDUINO programming.

MODULE IV - COMMUNICATION & NETWORKING: 9 Hours

Serial communication (UART, SPI, I2C), Wireless communication standards -Wi-Fi, Bluetooth, Zigbee, IoT protocols and communication techniques, Introduction to wireless sensor networks (WSN), Edge computing and fog computing in IoT systems, Cybersecurity challenges and counter measures in embedded networks.

MODULE V - RECENT TRENDS IN EMBEDDED SYSTEMS: 9 Hours

Introduction to modern programming languages for embedded systems, AI/ML in embedded systems: Implementing machine learning models on microcontrollers and AI accelerators for edge devices. Case studies of AI-powered embedded applications (e.g., robotics, autonomous vehicles). Embedded vision and computer vision applications, Internet of Things (IoT) and its significance in embedded systems, Industry 4.0 and Smart Manufacturing using embedded systems, wearable and biomedical devices in the context of IoT applications.

Total no. of Hours : 45

Text Books:

1. Rajkamal, "Embedded Systems Architecture, Programming and Design," TATA McGraw-Hill, Second Edition, 2008.
2. C.M.Krishna and Kang G. Shin, "Real Time Systems," TATA McGraw-Hill, Third Edition, 2010.

Reference Books:

1. J.W. Valvano, "Embedded Microcomputor System: Real Time Interfacing", Brooks/Cole, 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", Newnes, 1999.
3. V.K. Madisetti, "VLSI Digital Signal Processing", IEEE Press (NY, USA), 1995.

Course Outcomes:

At the end of this course students will demonstrate the ability to

- Recall the fundamental concepts and components of embedded systems.
- Examine the concepts of RTOS and understand how to develop real-time applications on embedded systems.
- Demonstrate the programming of microcontrollers or microprocessors in languages like C/C++ to control and interact with external hardware.
- Explain networking protocols and techniques to enable communication between embedded systems and the outside world.
- Discuss real-world applications of embedded systems, such as IoT devices, automotive systems, medical devices, consumer electronics, and industrial automation.

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ECP-321	Embedded Systems Lab	0L:0T:2P	1 Credits

Course Objectives:

- *To familiarize students with communication protocols used in embedded systems.*
- *To encourage innovation and problem-solving skills.*
- *To gain practical knowledge through hands-on lab sessions.*

List of Experiments:

1. Interface an LED with a microcontroller and blink it at different rates using timers.
2. Design and control the direction and speed of a DC motor and servo motor using PWM signals.
3. Establish communication between two microcontrollers using UART and exchange data.
4. Create and schedule multiple tasks with different priorities using an RTOS.
5. Deploy a pre-trained machine learning model on a microcontroller for classification tasks.
6. Capture and process images in real-time using a camera module and embedded system.
7. Develop an IoT-based application to monitor sensor data remotely using MQTT.
8. Establish communication between two embedded systems using Bluetooth or Wi-Fi.
9. Design a model for Interrupt Handling- use interrupts to respond to external events (e.g., button press) and perform specific actions.
10. Design of Water Pump Controller to sense the water level in a tank
11. Design a lamp controller having a light sensor and a timer.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Design systems for various embedded applications.
2. To gain practical knowledge through hands-on lab sessions.
3. To innovate and enhance problem-solving skills to do mini-projects and final project.

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HSMC-304	Principles of Management & Quality	3L:0T:0P	3 Credits

Course Objectives:

- *To inculcate the students with the Knowledge and Understanding of the principles of management*
- *To enable the students to gain valuable insight in to the working of business*
- *The course will review the evolution of management thoughts, functions and practices through thefocus on Indian experiences, approaches and cases.*
- *After undergoing this course student will get clear idea about Total Quality Management and will be able to work efficiently in a Total Quality Management organization.*
- *Also they can be a member of Total Quality Management Implementation team in an organization*

Course Contents:

MODULE I **9 Hours**

Functions Of Management: Overview of Management: Definition –Nature and scope of management- Importance - skills of managers–Levels of Management

Planning : Definition -Nature and purpose – Planning process – Importance of planning – types of plan- Decision making - Definition –steps and process and various types of decisions

MODULE II **9 Hours**

Organizing: Definition -Types of organization – Organizational structure –Span of control – use of staff MODULE s and committees. Delegation: Delegation and Centralization. Centralization and Decentralization

MODULE III **9 Hours**

Directing: Definition -Nature and purpose of Directing - Principles – Motivation - Definition - Theories of Motivation, Leadership: Definition- Styles – Communication: Definition - Importance of Communication – Methods of Communication – Types – Barriers

Controlling: Meaning and importance of controlling–control process–Requisites of an effective control system–Relationship between planning and controlling

MODULE IV **9 Hours**

The Foundations of TQM - Understanding quality, Models and frameworks for total quality management

Planning - Policy, strategy and goal deployment, Design for quality

TQM – performance - . Performance measurement frameworks, Benchmarking

MODULE V **9 Hours**

TQM – Processes - Process management, Process redesign/engineering, Quality management system, Continuous improvement

TQM – People and Implementation - Communications, innovation and learning, Implementation

. **Total No. of Hours: 45**

Text Books:

1. P.C.Tripathi&P.NReddy,PrinciplesofManagements-TataMc.GrawHill-NewDelhi,2012
2. Harold Koontz and Heinz Weihrich, Essentials of Management: An International,Innovation, And Leadership Perspective, 10th edition, Tata McGraw-Hill Education, 2015.

Reference Books:

1. Tim Hannagan, "Management concepts and Practices", Mac Millan India Ltd.1997
2. Peter Eichhorn & Ian Towers, Principles of Management: Efficiency and Effectiveness in the Private and Public Sector, Springer International Publishing. 2018
3. Feigenbaum, A.V., 1983. Total Quality Control, McGraw-Hill, New York.

Course Outcomes:

On the successful completion of the course, student will be able to:

1. Examine and explain the management evolution and how it will affect future managers.
2. Estimate the conceptual framework of planning and decision-making in day to daylife.
3. Explain the various managerial functions to achieve the goals and objectives of the organization.
4. Analyze the theories of motivation, leadership and communication in a variety of circumstances andmanagement practices in organizations.
5. An ability to understanding of professional and ethical responsibility

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AU-305	Professional Ethics	1L:0T:1P	0 Credit

Course Objectives:

- *To understand the ethical and moral principles and analyze them.*
- *The skills to confront moral issues and dilemmas.*
- *To apply the ethical theories to resolve moral issues.*

Course Contents:

MODULE -I ETHICS AND MORAL PRINCIPLES: 6 Hours

Profession – Morals – Ethics and Moral – Professional Ethics – Ethics and Science. Types of Ethics – Normative Ethics, Meta-Ethics and Applied Ethics

MODULE -II ANALYSIS OF ETHICAL PROBLEMS: 6 Hours

Ethical problems and analysis – Engineering Ethics – Micro-Ethics, Macro-Ethics. Ethical analysis – Normative Inquiry, Conceptual Inquiry and Factual Inquiry – Case Study

MODULE -III MORAL DILEMMAS: 6 Hours

Moral Dilemmas – definition – examples of moral dilemmas – methodology for resolving moral dilemmas. Kohlberg‟s theory of moral development – Heinz‟s dilemma – Gilligan‟s theory – Case study. Consensus and Controversy – Authority and Autonomy – Multiple Motives – Safety in Engineering

MODULE -IV ETHICAL THEORIES: 6 Hours

Ethical Theories – Virtue Ethics: Aristotle and MacIntyre, Utilitarian Ethics: Act Utilitarian and Rule Utilitarian, Duty Ethics and Rights Ethics - Case Study.

MODULE -V APPLICATION OF ETHICAL THEORIES 6 Hours

Engineering as Social Experimentation

Total Periods: 30

Text Books:

1. Mike W. Martin and Roland Schinzinger, “Ethics in Engineering”, Tata McGraw Hill, New Delhi, 2003.
2. Charles B. Fleddermann, “Engineering Ethics”, Pearson Prentice Hall, New Jersey, 2004.

Reference Books:

1. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, “Engineering Ethics – Concepts and Cases”, Thompson Wadsworth, A Division of Thomson Learning Inc., UnitedStates, 2000.
2. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.
3. Edmund G Seebauer and Robert L Barry, “Fundametals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.

Course Outcomes:

1. Knowledge in ethical and moral principles.
2. Understanding the ethical problems and analyze them.
3. Knowledge and skills to confront moral issues and dilemmas.
4. Knowledge in major ethical theories.
5. Knowledge to apply the ethical theories to resolve moral issues.

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SEMESTER – VI

ECT-322	Computer Networks	3L:0T:0P	3 Credits

Course Objectives:

- *To introduce the division of network functionalities into layers.*
- *To familiarize with the components required to build different types of networks.*
- *To study the required functionality of each layer.*
- *To learn the flow control and congestion control algorithms.*
- *To study the application layer and principles of user interface*

Course Contents:

MODULE I - INTRODUCTION TO COMPUTER NETWORKS: 9 Hours

Introduction to Data Network and ISO-OSI protocol, Fundamentals of Physical Layer and different modes of data communication.

Link layer: ALOHA, Multiple access protocols, IEEE 802 standards, Local Area Networks, addressing, Ethernet, Hubs, Switches.

MODULE II SWITCHING NETWORKS: 9 Hours

Classification and requirements of switches, a generic switch, Circuit Switching, Time-division switching, Space-division switching, Crossbar switch and evaluation of blocking probability, 2- stage, 3-stage and n-stage networks, Packet switching, Blocking in packet switches, Three generations of packet switches, switch fabric, Buffering, Multicasting, Statistical Multiplexing.

MODULE III NETWORK AND TRANSPORT LAYERS: 9 Hours

Virtual circuit and Datagram networks, Router, Internet Protocol, Routing algorithms, Broadcast and Multicast routing.

Transport layer: Connectionless transport - User Datagram Protocol, Connection-oriented transport – Transmission Control Protocol, Remote Procedure Call.

MODULE IV - RESOURCE ALLOCATION AND CONGESTION CONTROL: 9 Hours

Issues in Resource Allocation, Queuing Disciplines, TCP congestion Control, Congestion Avoidance Mechanisms and Quality of Service.

MODULE V - APPLICATION LAYER: 9 Hours

Principles of network applications, The Web and Hyper Text Transfer Protocol, File transfer, Electronic mail, Domain name system, Peer-to-Peer file sharing, Socket programming, Layering concepts.

Total Periods: 45

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand data communication and the functions of each layer of ISO-OSI protocols.
2. Perform computations and solve networking and routing problems.
3. Describe the functionalities of the network and transport layers and their interactions in data transmission.
4. Evaluate the challenges of resource allocation and congestion control in computer networks and understand the various algorithms and mechanisms used for resource management and congestion avoidance.
5. Familiarize with commonly used application layer protocols and their purposes in network communication.

Text books:

1. Andrew Tanenbaum, “Computer networks”, Prentice Hall, Fourth Edition. 2002.
2. B. A. Forouzan, “Data Communications and Networking”, Tata McGraw Hill, Fifth Edition, 2013.

Reference books:

1. J.F. Kurose and K. W. Ross, “Computer Networking – A top down approach featuring the Internet”, Pearson Education, 5th Edition, 2009.
2. T. Viswanathan, “Telecommunication Switching System and Networks”, Prentice Hall. 1994.
3. William Stallings, “Data and computer communications”, Prentice Hall, Second Edition, 2008.

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ECP-323	Computer Network Laboratory	0L:0T:2P	1 Credit

Course Objectives:

- *To introduce the division of network functionalities into layers.*
- *To familiarize with the components required to build different types of networks.*
- *To study the required functionality of each layer.*
- *To learn the flow control and congestion control algorithms.*

List of Experiments:

1. Generation of PDF
   To study, generate and trace the following PDF
   i. Gaussian distribution
   ii. Uniform distribution
   iii. Exponential distribution
   iv. Rayleigh distribution
   v. Binomial distribution
   vi. Negative binomial distribution
   vii. Gamma distribution
   viii. Poisson distribution
2. Simulation of ON-OFF and voice traffic model
   a) To simulate the ON-off traffic model and plot the following waveform
   i. User numbers Vs ON period.
   ii. Time slot Vs number of users.
   iii. Time slot Vs bandwidth allotted.
   b) To simulate voice traffic model and obtain
   i. Time slot Vs bandwidth plot.
   ii. Time slot Vs error plot.
   iii. Average error rate.
   iv. The optimum buffer size for which error rate will be less than stipulated value.
3. Simulation of data traffic and video traffic model
   To simulate the data traffic and multiple rate video traffic for multiple users and to obtain
   i. Time slot Vs bandwidth plot.
   ii. Time slot Vs BER plot.
   iii. The optimum buffer size for which error rate will be less than stipulated value.
4. Simulation of ISDN traffic model
   To simulate the ISDN traffic model for multiple users and to obtain
   i. Time slot VS bandwidth plot.
   ii. Time slot Vs BER plot.
   iii. Time slot Vs un-served video user.
   iv. Time slot Vs un-served data user.

5. PN sequence generation and testing

To generate maximal and non maximal length PN sequence and test its randomness properties.

6. M/M/1 queuing model

To simulate M/M/1 queuing model and obtain

i. Time slot Vs packet loss plot.
ii. Maximum and average packet loss without buffer.
iii. Buffer size for the given loss.
iv. Maximum and average packet loss with buffer.

7. M/G/1 and G/G/1 queuing model.

To simulate a M/G/1 and G/G/1 queuing model and obtain

i. Time slot Vs packet loss plot.
ii. Maximum average packet loss without buffer.
iii. Buffer size for the given loss.
iv. Maximum and average packet loss with buffer.

8. Encryption and decryption

To simulate and test the following encryption and decryption algorithm.

i. Mono alphabetic cipher- caeser cipher.
ii. Poly alphabetic cipher- Trithemius key, Vigenere key, Vigenere plain and Cipher key.
iii. RSA with and without digital signature.

9. Flow control

To simulate and test

i. Stop and wait protocol
ii. Go back N protocol
iii. Selective repeat protocol

10. Error control protocol

To simulate and test

i. Cyclic redundancy check
ii. Hamming code

11. Routing algorithms

To simulate and test

i. Shortest path routing algorithm
ii. Hierarchical routing algorithm
iii. AODV routing algorithm
iv. DV routing algorithm
v. DSR routing algorithm

12. Wireless LAN

To establish wireless LAN test bed (or) wireless LAN environment and perform

i. Uni-cast
ii. Multicast
iii. File transfer protocol

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Perform computations and solve networking and routing problems.
2. Implement simple connections between two or more processes running in single or different computing systems.
3. Performing the simulation of queueing systems in MM1 and MG1 models.
4. Evaluate the performance of flow control , error control and routing algorithms.
5. Implement the wireless LAN systems and evaluate its performance.

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ECT-324	VLSI Design	3L:0T:0P	3 Credits

Course Objectives:

- *To learn about CMOS circuit design*
- *To learn the fundamental principles of VLSI circuit design in digital domain*
- *To learn the fundamental principles of VLSI circuit design in analog domain*
- *To learn the fundamental principles of Digital System Design using VHDL and Verilog HDL & Implement using FPGA.*
- *To learn simple simulation of VLSI circuits.*

Course Contents:

MODULE I - INTRODUCTION TO VLSI BASICS: 9 Hours

Layout representations, Stick diagrams, Design partitioning, Logic design, Circuit design, Physical design, Design verification, fabrication, packaging and testing, Design Flow. Modeling of MOS transistor, Capacitance voltage characteristics, non-ideal effects, DC transfer characteristics, MOS Inverter, MOS Transistor Switches, CMOS Logic design, Circuit and System Representations, Design Equations, Static Load MOS Inverters, Transistor Sizing, Static and Switching Characteristics; Body Effect, Noise Margin;

MODULE II - DELAY AND POWER: 9 Hours

Transient Response, RC Delay Model, Effective Resistance, Gate and Diffusion Capacitance, Equivalent RC Circuits, Transient Response, Layout Dependence of Capacitance, Determining Effective Resistance, Parasitic Delay, Delay in a Logic Gate, Drive, Extracting Logical Effort from Datasheets, Logical Effort of Paths, Delay in Multistage Logic Networks, Choosing the Best Number of Stages, Sources of power dissipation, dynamic power , static power, Wire Geometry, Example of Metal Stacks, Interconnect Modelling, Resistance, Capacitance Inductance, Temperature Dependence, Interconnect Impact, Delay ,Energy, Crosstalk, Inductive Effects,

MODULE III - COMBINATIONAL AND SEQUENTIAL CIRCUITS DESIGN: 9 Hours

Circuit Families, Static CMOS, Ratioed Circuits, Cascode Voltage Switch Logic, Dynamic Circuits, Pass-Transistor Circuits, Sequencing Static Circuits, Sequencing Methods, Max-Delay Constraints, Min-Delay Constraints, Time Borrowing, Clock Skew, Circuit Design of Latches and Flip-Flops, Conventional CMOS Latches, Conventional CMOS Flip-Flops, Pulsed Latches, Resettable Latches and Flip-Flops, Enabled Latches and Flip-Flops, Incorporating Logic into Latches.

MODULE IV SUB SYSTEMS DESIGN: 9 Hours

Adders, zero one detectors, comparators, counters, Memory subsystems SRAM, Read and write operation, DRAM, sense amplifiers.

MODULE V PROGRAMMING IN HDL 9 Hours

: Basic Concepts-identifiers-gate primitives, gate delays, operators, timing controls, procedural assignments conditional statements, Data flow and RTL, Structural gate level switch level modeling, Design Hierarchies, Behavioral and RTL modeling, Test benches, Structural gate level description of decoder, equality detector, comparator, priority encoder, half adder, full adder, ripple carry adder, D latch and D flip-flop.

Total no. of Hours: 45

Text Books:

1. N.H.E. Weste and D.M. Harris, "CMOS VLSI design: A Circuits and Systems Perspective", 4th Edition, Pearson Education India, 2011.
2. C. Mead and L. Conway, "Introduction to VLSI Systems", Addison Wesley, 1979.

Reference Books:

1. S. M. Kang and Y. Leblebici, "CMOS Digital Integrated Circuits : Analysis and Design", Third Edition, MH, 2002.
2. J. M. Rabaey, A. P. Chandrakasan and B. Nikolic, "Digital Integrated Circuits : A Design Perspective", Second Edition, PHI /Pearson, 2003.
3. J. P. Uyemura, "CMOS Logic Circuit Design", Springer; 2001,.

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the models of MOS transistors and its use in circuit simulations.
2. Illustrate the use of various delay models and optimize the CMOS circuit delay.
3. Understand the effects of interconnects on the circuit performance
4. Design and analyze various CMOS combinational and sequential circuits, data path and memory subsystems.
5. Implement the simple VLSI circuits using simulation tool for Hardware description language.

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EC-25	VLSI Design Laboratory	0L:0T:2P	1 Credits

Course Objectives:

- *To implement the fundamental principles of VLSI circuit design in digital domain*
- *To implement the fundamental principles of VLSI circuit design in analog domain*
- *To simulate fundamental principles of Digital System Design using VLSI software and kit.*

Design, Simulate and implement the following Experiments using any VLSI software and kit:

1. Basic Logic gates circuits.
2. Basic combinational and sequential (Flip-flops) circuits.
3. Adder and Multiplier.
4. Memories.
5. Finite State Machine (Moore/Mealy).
6. 3-bit synchronous up/down counter.
7. Shift registers.
8. CMOS Basic Gates.
9. Synchronous counter using Flip-Flops.
10. CMOS Inverter.
11. Combination circuits using FPGA
12. Sequential circuits using FPGA

Course Outcomes:

At the end of this course students will demonstrate the ability to

- Design, simulate and implement digital circuits using VLSI software and kit.
- Design and analyze various CMOS combinational and sequential circuits, data path and memory subsystems.
- Implement digital logic using FPGA

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ECT-326	Mobile Communication and Networks	3L:1T:0P	4 Credits

Course objectives:

- To introduce the basic cellular concepts.
- To understand the various signal propagation effects.
- To study various multiple access schemes.
- To familiarize with various mobile standards.
- To study the implementation of MIMO systems for high speed communication

Course Contents:

MODULE I - BASICS OF CELLULAR CONCEPTS AND MOBILE ANTENNAS: 12 Hours

Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, power control; **Antennas:** antennas for mobile terminal, monopole antennas, PIFA, base station antennas and arrays.

MODULE II - SIGNAL PROPAGATION 12 Hours

Propagation mechanism, reflection, refraction, diffraction and scattering, large scale signal propagation and lognormal shadowing. Fading channels-Multipath and small-scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, flat and frequency selective fading, slow and fast fading, average fade duration and level crossing rate. Capacity of flat and frequency selective channels.

MODULE III - MULTIPLE ACCESS AND MODULATION TECHNIQUES 12 Hours

FDMA, TDMA, CDMA, SDMA, OFDM. Receiver structure- Diversity receivers- selection and MRC receivers, RAKE receiver, equalization: linear-ZFE and adaptive, DFE. Transmit diversity Altamonte scheme. Introduction to Spread spectrum Techniques.

MODULE IV - CELLULAR WIRELESS STANDARDS: 12 Hours

Wireless Standards: Overview of 2G 3G, 4G and 5G cellular mobile standards. System examples- GSM, EDGE, GPRS, IS-95, CDMA 2000 and WCDMA, 3G, 4G and 5G mobile communications.

MODULE V – MIMO SYSTEMS 12 Hours

MIMO and space time signal processing, spatial multiplexing, diversity/multiplexing tradeoff. Performance measures- Outage, average SNR, average symbol/bit error rate.

Text Books:

1. Erik Dahlman ," 4G, LTE-Advanced Pro and The Road to 5G", Third Edition, 2016.
2. Sassan Ahmadi, "5G NR: Architecture, Technology, Implementation, and Operation of 3GPP New Radio Standards "Hardcover – 1, June 2019.

Reference Books:

1. Vijay K. Garg, "Wireless Communication and Networking", Elsevier, Morgan Kaufmann, Reprinted 2012.
2. T.S.Rappaport, "Wireless Communications Principles and Practice", PHI, Second Edition, 2006.
3. William Lee ,"Mobile Cellular Telecommunications: Analog and Digital Systems", McGrawHill Education, Second Edition, July 2017.

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Course Outcomes:

At the end of this course students will demonstrate the ability to

- Understand cellular concepts and signal propagation in mobile communication.
- Understand the fundamental principles of signal propagation in wireless communication.
- Compare and contrast various multiple access techniques and their suitability for different applications. Evaluate the advantages and limitations of different modulation schemes
- Understand the architecture of mobile communication networks, including GSM, CDMA, 3G, 4G LTE, and 5G.
- Design MIMO configurations to enhance wireless communication systems.

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PRJ EC-302	Mini Project	0L:0T:6P	3 Credits

Guidelines: The mini project is a team activity having 3-4 students in a team. This is electronic product design work with a focus on electronic circuit design. The mini project may be a complete hardware or a combination of hardware and software. Mini Project should cater to a small system required in laboratory or real life. It should encompass components, devices, analog or digital ICs, micro controllers with which functional familiarity is introduced. Based on comprehensive literature survey/ Industry requirements analysis, the student shall identify the title and define the aim and objectives of the mini project. Students are expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within the first week of the semester. The student is expected to exert on design, development, and testing of the proposed work as per the schedule. Layout should be made using CAD based PCB simulation software. Due considerations should be given for power requirements of the system, mechanical aspects for enclosure and control panel design. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester.

Course Outcomes:

At the end of the mini project work, students will demonstrate the ability to

1. Identify a problem statement either from a rigorous literature survey or the industry requirements analysis.
2. Design a solution for the identified problem by applying acquired technical knowledge.
3. Simulate, Develop and Test the Prototype with a standard solution/ process.
4. Learn to work in a team and coordinate within the group for timely completion of targeted work

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SEMESTER – VII

HSMC-405	Entrepreneurship Development	3L: 0T:0P	3 Credits

Course Objectives:

- *To understanding of Entrepreneurship and design thinking.*
- *To understanding of model development and MVP.*
- *To gain knowledge about costing and revenue.*
- *To learn about marketing and sales.*
- *To understand of team formation and compliance requirements.*

Course Contents:

MODULE I - PROBLEM AND CUSTOMER PERIODS: 9 Hours

Effectuation, Finding the flow. Entrepreneurial style, business opportunity, problems worth solving, methods for finding problems, problem interviews. Design Thinking, Consumer and customer, market types, segmentation and targeting, early adopters, Gains, Pains and "Jobs-To be done, Value Proposition Canvas (VPC), Identifying Unique Value Proposition (UVP).

MODULE II - BUSINESS MODEL AND VALIDATION 9 Hours

: Types of Business Models, Lean Canvas, Risks. Building solution demo, solution interviews, problem-solution test, competition, Blue Ocean Strategy. MVP- Build- Measure- Learn feedback loop, MVP Interviews, MVP Presentation.

MODULE III - REVENUE AND COST PERIODS: 9 Hours

Revenue Streams-Income, costs, gross and net margins - primary and secondary revenue streams- Different pricing strategies - product costs and Operations costs; Basics of unit costing. Financing New Venture- various sources - investor expectation- Pitching to Investors.

MODULE IV - MARKETING AND SALES PERIODS 9 Hours

: Difference between product and brand - positioning statement. Building Digital Presence, Social media- company profile page – Sales Planning - buying decisions, Listening skills, targets. Unique Sales Proposition (USP), sales pitch, Follow-up and closing a sale.

MODULE V - TEAM AND SUPPORT PERIODS: 9 Hours

Team Building - Shared leadership - role of a good team - team fit - defining roles and responsibilities - collaboration tools and techniques- project management, time management, workflow, delegation of tasks. Business regulations - starting and operating a business - compliance requirements.

Total Periods: 45

Course Outcomes:

1. Identify and define real-world problems or unmet needs that can potentially be addressed through entrepreneurial ventures.
2. Design and formulate a viable business model canvas that outlines the key components of a business idea.
3. Analyze revenue streams and pricing strategies to determine the most suitable pricing model for the product or service.
4. Create a comprehensive marketing strategy to reach the target audience and generate brand awareness.
5. Identify the key roles and skill sets required to build a successful startup team.

Text Books:

1. Nandan H, "Fundamentals of Entrepreneurship", Prentice Hall India, 2013.
2. Sangeetha Sharma, "Entrepreneurship Development", Prentice Hall India, 2017.

Reference Books:

1. Khanka S.S, "Entrepreneurial Development", S Chand & Company, 2007.
2. Anil Kumar.S, "Entrepreneurship Development", New Age Publishers, 2003.
3. LearnWISE, "Digital learning platform", Wadhwani Foundation, www.learnwise.org

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SEM EC 27	Seminar	0L: 0T:2P	1 Credits

Guidelines: Select a topic relevant to ECE domain and suitable for UG level presentation. For selection topics refer to internationally reputed journals. The primary reference should be published during the last two or three years. - Some of the journals/publications suitable for reference are: IEEE/the IET/IETE/Springer/Science Direct/ACM journals.

Course Outcomes:

At the end of the course, students will demonstrate the ability to:

1. Identify contemporary topics/concepts pertaining to recent trends in electronics and communication engineering and prepare documentation.
2. Present the selected topic with superioritydemonstrating good communication skills.

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INT EC 28	Internship	0L: 0T:4P	2 Credits

Guidelines: The main purpose of internship is to enhance the general professional outlook and capability of the student to advance his chances of improving the career opportunities. The student is required to undergo „internship" in industry / research laboratory / higher learning institution for a minimum period of 6 weeks in a maximum of 3 spells during vacations. Each spell of internship shall be for a period of not less than 2 weeks. The student will make the presentation for duration of 20 to 25 minutes and also submit a detailed report after completion for the purpose of assessment.

Course Outcome:

1. Knowledge to gain practical expertise on one or more applications of the core courses learned.
2. Knowledge to gain experience in a field thereby makes a careertransition.
3. Knowledge to establish professional connections and enhancenetworking.
4. Gaining valuable skills and knowledge.
5. Knowledge to acquire an inside view of an industry andorganization/company.

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SEMESTER – VIII

PRJ EC-403	Project	0L: T:24P	12 Credits

Guidelines: After interactions with project guides/industry experts, based on a comprehensive literature survey/ Industry requirements analysis, the student shall identify the title and define the aim and objectives of a project. The student is expected to work on details specifications, methodology, resources required, critical issues in design and implementation, and submit the project proposal within the first two weeks of semester. The student is expected to work on the design, development, and testing of the proposed project work as per the schedule.

The project report is to be submitted at the end of the semester. This report includes a summary of the literature survey, detailed objectives, project specifications, design, and proof of concept, developed system/Algorithm, results, contributions, and innovations in project work.

Course Outcomes:

At the end of the project work, students will demonstrate the ability to

1. Identify a problem statement from a rigorous literature survey or the industry requirements analysis.
2. Simulate and design a solution for the identified problem by applying acquired technical knowledge.
3. Develop and test the prototype/algorithm to solve the complex engineering problem.
4. Accomplish all objectives of the project in an allocated period with efficient team work.
5. Present project work orally and through a comprehensive report.

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Appendix-I

Program Elective Courses

Program Elective Courses

Sr. No.	Course Code	Course Title	Hrs /Week L: T: P	Credits
1	ECEL1	Microwave Theory and Techniques	3:0:0	3
2	ECEL2	Fiber Optic Communications	3:0:0	3
3	ECEL3	Information Theory and Coding	3:0:0	3
4	ECEL4	Digital Audio Processing	3:0:0	3
5	ECEL5	Introduction to MEMS	3:0:0	3
6	ECEL6	Adaptive Signal Processing	3:0:0	3
7	ECEL7	Antennas and Propagation	3:0:0	3
8	ECEL8	Bio-Medical Electronics	3:0:0	3
9	ECEL9	5G Communications	3:0:0	3
10	ECEL10	Digital Image Processing	3:0:0	3
11	ECEL11	Mixed Signal Design	3:0:0	3
12	ECEL12	Wireless Sensor Networks	3:0:0	3
13	ECEL13	Power Electronics	3:0:0	3
14	ECEL14	Satellite Communication	3:0:0	3
15	ECEL15	High Speed Systems	3:0:0	3
16	ECEL16	Nanoelectronics	3:0:0	3
17	ECEL17	Problem Solving using Python	3:0:0	3
18	ECEL18	Internet of Things and Applications	3:0:0	3
19	ECEL19	Cyber Security	3:0:0	3
20	ECEL20	Machine Learning for wireless Applications	3:0:0	3
21	ECEL21	AI For Image Processing	3:0:0	3
22	ECEL22	Underwater Communication	3:0:0	3
23	ECEL23	AI for Wireless Communication	3:0:0	3
24	ECEL24	Sequential Circuit Design	3:0:0	3
25	ECEL25	FSO and Light wave Communication	3:0:0	3

ECEL1	Microwave Theory and Techniques	3L:0T:0P	3 Credits

Course Objectives:

- *To develop mathematical models for transmission lines and waveguides.*
- *To understand functioning of passive and Active microwave devices.*
- *To design basic microwave circuits and do microwave measurements.*
- *To understand and analyze microwave systems for different applications.*

Course Contents:

MODULE I **9 Hours**

Introduction to Microwaves-History of Microwaves, Microwave Frequency bands; Applications of Microwaves: Civil and Military, Medical, EMI/ EMC. Mathematical Model of Microwave Transmission-Concept of Mode, Features of TEM, TE and TM Modes, Losses associated with microwave transmission, Concept of Impedance in Microwave transmission.

MODULE II **9 Hours**

Analysis of RF and Microwave Transmission Lines- Coaxial line, Rectangular waveguide, Circular waveguide, Strip line, Micro strip line. Microwave Network Analysis- Equivalent voltages and currents for non-TEM lines, Network parameters for microwave circuits, Scattering Parameters.

Passive and Active Microwave Devices- Microwave passive components: Directional Coupler, Power Divider, Magic Tee, Attenuator, Resonator. Microwave active components: Diodes, Transistors, Oscillators, Mixers. Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes. Microwave Tubes: Klystron, TWT, Magnetron.

MODULE III **9 Hours**

Microwave Design Principles-Impedance transformation, Impedance Matching, Microwave Filter Design, RF and Microwave Amplifier Design, Microwave Power Amplifier Design, Low Noise Amplifier Design, Microwave Mixer Design, Microwave Oscillator Design. Microwave Antennas-Antenna parameters, Antenna for ground based systems, Antennas for airborne and satellite borne systems, Planar Antennas.

MODULE IV **9 Hours**

Microwave Measurements- Power, Frequency and impedance measurement at microwave frequency, Network Analyzer and measurement of scattering parameters, Spectrum Analyzer and measurement of spectrum of a microwave signal, Noise at microwave frequency and measurement of noise figure. Measurement of Microwave antenna parameters.

MODULE V **9 Hours**

Microwave Systems- Radar, Terrestrial and Satellite Communication, Radio Aidsto Navigation,RFID, GPS. Modern Trends in Microwaves Engineering- Effect of Microwaves on human body, Medical and Civil applications of microwaves, Electromagnetic interference and Electromagnetic Compatibility (EMI & EMC), Monolithic Microwave ICs, RFMEMS for microwave components, Microwave Imaging.

Total No. of Hours: 45

Text Book

1. R.E. Collins, Microwave Circuits, McGraw Hill
2. David M. Pozar , Microwave Engineering, 4th Edition, Wiley India, 2012.

Reference Books:

1. Kulkarni M, “Microwave and Radar Engineering”, 4th Edition, Umesh Publications, 2012.
2. G.S. Raghuvanshi “Microwave Engineering” , Cengage Learning, New Delhi,2012.
3. Samuel Y. Liao, “Microwave Devices and Circuits”, 3rd Edition, Pearson Education,2003.

Course Outcomes:

At the end of this course, the students should be able to

1. Analysis of RF and Microwave Transmission Lines
2. Develop mathematical models for transmission lines and waveguides.
3. Understand functioning of Passive and Active microwave devices.
4. Design basic microwave circuits and do microwave measurements.
5. Understand and analyze microwave systems for different applications.

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ECEL02: Fiber Optic Communication

ECEL02	Fiber Optic Communication	3L:0T:0P	3 Credits

Course Objectives:

- *To understand different models of light and their limitations.*
- *To understand propagation of light in different types of optical fibers and signal degradation.*
- *To design analog and digital optical communication links and analyze their performance.*
- *To understand, analyze and design high-capacity advanced optical communication systems.*

Course Contents:

MODULE I: OVERVIEW OF OPTICAL FIBER COMMUNICATION 9 Hours

The general system, advantages of optical fiber communications. Optical fiber wave guides-introduction, ray theory transmission, total internal reflection, acceptance angle, numerical aperture, skew rays. Cylindrical fibers- modes, V number, mode coupling, step index fibers, graded index fibers.

MODULE II: SINGLE MODE FIBERS 9 Hours

Cut off wavelength, mode field diameter, effective refractive index. Signal distortion in optical fibers-attenuation, absorption, scattering and bending losses, core and cladding losses. Group delay, types of dispersion - material dispersion, wave-guide dispersion, polarization mode dispersion, intermodal dispersion. Pulse broadening.

MODULE III: FIBER SPLICING 9 Hours

Splicing techniques, splicing single mode fibers. Fiber alignment and joint loss multimode fiber joints, single mode fiber joints. Optical fiber connectors: connector types, single mode fiber connectors, connector return loss. Fiber materials: Glass, halide, active glass, chalgenide glass, plastic optical fibers. Source to fiber power launching - output patterns, power coupling, power launching, equilibrium numerical aperture, laser diode to fiber coupling.

MODULE IV: OPTICAL SOURCES 9 Hours

LEDs, structures, materials, quantum efficiency, power, modulation, power bandwidth product. Injection laser diodes- Modes, threshold conditions, external quantum efficiency, laser diode rate equations, resonant frequencies. Reliability of LED and ILD. Optical detectors: physical principles of PIN and APD, detector response time, temperature effect on avalanche gain, comparison of photodetectors.

MODULE V: OPTICAL SYSTEM DESIGN 9 Hours

Considerations, component choice, multiplexing. Point-to- point links, system considerations, link power budget with examples. Overall fiber dispersion in multi-mode and single mode fibers, rise time budget with examples.

Total No. of Hours: 45

Text Book:

1. J. Keiser, Fibre Optic communication, McGraw-Hill, 2nd Ed. 1992.
2. John M Senior," Optical Fiber Communications Principles and Practice", Pearson 3rd Edition

Reference Books:

1. T. Tamir, Integrated optics, (Topics in Applied Physics Vol.7), Springer-Verlag, 1975.
2. J. Gowar, Optical communication systems, Prentice Hall India, 1987.
3. G. Agrawal, Fiber optic Communication Systems, John Wiley and sons, New York, 1992

Course outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the overview of optical fiber communication
2. Understand different models of light and their limitations.
3. Understand propagation of light in different types of optical fibers and signal degradation.
4. Design analog and digital optical communication links and analyze their performance.
5. Understand, analyze and design high-capacity advanced optical communication systems.

******

ECEL03: Information Theory and Coding

ECEL03	Information Theory and Coding	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the basics of Information theory, techniques of coding and decoding.*
- *To analyze and compare different coding and decoding schemes*
- *To solve numerical problems on channel capacity and coding.*
- *To evaluate and case study broadcast channels for different coding schemes and also multiuser channel coding.*

Course Contents:

MODULE I: INFORMATION ENTROPY FUNDAMENTALS **9 Hours**

Uncertainty, Information, Entropy, Source coding Theorem, Huffman coding, Shannon Fano coding, Discrete Memory less channels, Channel capacity, Channel coding Theorem, Channel capacity Theorem.

MODULE II: DATA AND VOICE CODING **9 Hours**

Pulse code Modulation, Differential Pulse code Modulation, Adaptive Differential Pulse Code Modulation, Adaptive sub band coding, Delta Modulation, Adaptive Delta Modulation, Coding of speech signal at low bit rates, Vocoders, Linear Prediction Coding.

MODULE III: ERROR CONTROL CODING **9 Hours**

Linear Block codes, Syndrome Decoding, Minimum distance consideration, Cyclic codes, Generator Polynomial, Parity check polynomial, Encoder for cyclic codes, Calculation of syndrome, Convolutional codes.

MODULE IV: COMPRESSION TECHNIQUES **9 Hours**

Principles, Text compression, Static Huffman Coding, Dynamic Huffman coding, Arithmetic coding, Image Compression, Graphics Interchange format, Tagged Image File Format, Digitized documents and Introduction to JPEG standards.

MODULE V: AUDIO AND VIDEO CODING **9 Hours**

Linear Predictive coding, Code excited LPC, Perceptual coding, MPEG audio coders, Dolby audio coders, Video compression, Principles, Introduction to H.261, MPEG Video standards.

Text Books: **Total No. of Hours: 45**

1. N. Abramson, Information and Coding, McGraw Hill, 1963.
2. M. Mansurpur, Introduction to Information Theory, McGraw Hill, 1987.

Reference Books:

1. R.B. Ash, Information Theory, Prentice Hall, 1970.
2. Shu Lin and D.J. Costello Jr., Error Control Coding, Prentice Hall, 1983.
3. A. El Gamal and Y. H. Kim, Network Information Theory, Cambridge University Press, 2011

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the basics of Information theory, techniques of coding and decoding.
2. Analyze different error control coding schemes.
3. Analyze and compare different coding and decoding schemes.
4. Evaluate Solve numerical problems on channel capacity and coding.
5. Understand the case study broadcast channels for different coding schemes and also multiuser channel coding.

******

ECEL04: Digital Audio Processing

ECEL04	Digital Audio Processing	3L:0T:0P	3 Credits

Course Objectives:

- *To understand different characteristics of Audio signals.*
- *To analyze different speech analysis and synthesis systems.*
- *To write an algorithm for automatic speech recognition system*
- *To design models and algorithms for audio andspeech processing applications.*

Course Contents: **9 Hours**

MODULE I

Audio Signal Characteristics, Production model, Hearing and Auditory model, Acoustic characteristic of speech, Speech production models, Linear Separable equivalent circuit model, Vocal Tract and Vocal Cord Model.

MODULE II **9 Hours**

Audio signal acquisition, Representation and Modelling, Enhancement of audio signals**:** Spectral Subtraction, Weiner based filtering, Neural nets.

MODULE III **9 Hours**

Audio/ Speech Analysis and Synthesis Systems: Digitization, Sampling, Quantization and coding, Spectral Analysis, Spectral structure of speech, Autocorrelation and Short Time Fourier transform, Window function, Sound Spectrogram, Mel frequency Cepstral Coefficients, Filter bank and Zero Crossing Analysis, Analysis –by-Synthesis, Pitch Extraction**.**, Linear Predictive Coding Analysis**.**

MODULE IV **9 Hours**

Psychoacoustics, Multi-microphone audio processing: Room acoustics, Array beamforming**.** Acoustic sound source localization and tracking

MODULE V **9 Hours**

Applications: Principles of Automatic Speech Recognition **(**ASR**)**,Theory and implementationof Hidden Markov Model **(**HMM**)** for ASR, Speaker Recognition, Evolution of Speech APIs, Natural Language Processing, Sound source separation models**.**

Text/References: **Total No. of Hours: 45**

1. Sen, Soumya, Dutta, Anjan Dey, Nilanjan, Audio Processing and Speech Recognition,1st edition, 2019, Springer
2. Gold, B.; Morgan, N.; Ellis, D. Speech and audio signal processing**:** processing and perception of speech and music**.** 2nd rev**.** ed**.** Wiley-Blackwell, 2011**.**

Reference Books:

1. Bali & Bali, Audio Video Systems, Khanna Book Publishing**.**
2. Sadaoki Furui, **"**Digital Speech Processing, Synthesis and Recognition**"** 2/e**.**
3. Rabiner and Schafer, **"**Digital Processing of Speech Signals**"**, Pearson Education

Course Outcomes:

At the end of this course, the students should be able to

1. Understand different characteristics of Audio signals.
2. Analyze different speech analysis and synthesis systems.
3. Understand the Multi-microphone audio processing.
4. Write an algorithm for automatic speech recognition system
5. Design models and algorithms for audio and speech processing applications.

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ECEL05: Introduction to MEMS

ECEL05	Introduction to MEMS	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the multidisciplinary aspects of MEMS and NEMS and their applications*
- *To understand the methods of fabrication and modeling methods.*
- *To appreciate the underlying working principles of MEMS and NEMS devices*

Course Contents:

MODULE I **9 Hours**

Scaling laws in miniaturization: Heat conduction in micro- and nano- systems: heat conduction equation, Newton‟s cooling law, heat conduction in multilayered thin films, heat conduction in submicron scale - Quantum phenomena in nano-systems: photonic band gap structure, quantum states in nano-sized structures, quantum transport

MODULE II **9 Hours**

Clean room: Need for a clean room – Types of clean rooms – maintenance of different types of clean rooms – oxidization and metallization- masking and patterning

MODULE III **9 Hours**

Preparation techniques: Basic micro- and nano-fabrication techniques: thin film deposition, ion implantation, diffusion, oxidation - surface micromachining, LIGA process -Packaging: die preparation, surface bonding, wire bonding, sealing, assembly Measurement techniques : scanning tunneling microscope, atomic force microscope, focused ion beam technique-nanoindentation, nanotribometer

MODULE IV **9 Hours**

Nano-fabrication: principles and techniques: Etching technologies - wet and dry etching - photolithography – Drawbacks of optical lithography for nanofabrication - electron beam lithography – ion beam lithography -dip-pen nanolithography, stamping techniques, strain-induced self-assembly for Nanofabrication of quantum dot and molecular architectures - Polymer processing for biomedical applications

MODULE V **9 Hours**

Applications and devices: Mechanics for micro- and nano-systems: bending of membrane and cantilever, resonance vibration, fracture, stress, nano Tribology -Fluid dynamics for micro- and nano- systems: surface tension, viscosity, continuity equation -laminar fluid flow, fluid flow in submicron and nanoscale- Surface acoustic wave (SAW) devices, microwave MEMS, field emission display devices, nano diodes, nano switches, molecular switches, nano-logic elements- Super hard nanocomposite coatings and applications in tooling- Biochemistry and medical applications: lab-on-a- chip systems.

Total No. of Hours: 45

Text Book:

1. G. K. Ananthasuresh, K. J. Vinoy, S. Gopalkrishnan K. N. Bhat, V. K. Aatre, Micro and Smart Systems, Wiley India, 2012.
2. S. E.Lyshevski, Nano-and Micro-Electromechanical systems: Fundamentals of Nano-and

Reference Books:

1. Microengineering (Vol. 8). CRC press, (2005).
2. S. D. Senturia, Microsystem Design, Kluwer Academic Publishers, 2001.
3. M.H. Bao, Micromechanical Transducers: Pressure sensors, accelerometers, and

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the Scaling laws in miniaturization
2. Understand the methods of fabrication and modeling methods.
3. Appreciate the underlying working principles of MEMS and NEMS devices
4. Design and model MEMS devices
5. Understand the multidisciplinary aspects of MEMS and NEMS and their applications

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ECEL06: Adaptive Signal Processing

ECEL06	Adaptive Signal Processing	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the general concepts of adaptive filtering and estimation.*
- *To analyze different types of adaptive filters used in signal processing.*
- *To solve numerical problems on correlation, convergence and filtering aspects.*
- *To evaluate and compare different adaptive signal processing techniques.*

Course Contents:

MODULE I: ADAPTIVE SYSTEMS **9 Hours**

Definition and Characteristics; areas of application; general properties, open- and closed-loop adaptation; applications of closed-loop adaptation. Adaptive Linear Combiner: General description, Input signal and weight vectors; desired response and error, The performance function; gradient and minimum mean-square error, Alternative expression of the gradient; decorrelation of error and input components.

MODULE II: PROPERTIES OF THE QUADRATIC PERFORMANCE SURFACE **9 Hours**

Normal form of the input correlation matrix; eigenvalues and eigenvectors of the input correlation matrix, geometrical significance of eigenvectors and eigenvalues; (i) Searching the Performance Surface, Methods of searching the performance surface; basic ideas of gradient search methods, A simple gradient search algorithm and its solution; stability and rate of convergence the learning curve; gradient search by Newton‟s Method; Newton‟s Method in multidimensional space. gradient search by the Method of Steepest Descent; comparison of learning curves.

MODULEIII: GRADIENT ESTIMATION AND ITS EFFECT ON ADAPTATION **9 Hours**

Gradient component estimation by derivative measurement, the performance penalty; derivative measurements and performance penalties with multiple weights, variance of the gradient estimate; effects on the weight-vector solution, excess mean-square error and time constants, Mis adjustment; comparative performance of Newton‟s and Steepest-Descent Methods, Total mis adjustment and other practical considerations.

MODULE IV: OTHER ALGORITHMS **9 Hours**

Derivation of the LMS algorithm; convergence of the weight vector, an example of convergence; learning curve, noise in the weight-vector solution; mis adjustment; performance, normalized and other LMS-based adaptive filters, Discrete Kalman filter; recursive least squares algorithm.

MODULEV: APPLICATIONS **9 Hours**

Applications: Adaptive Modeling and System Identification: General description, adaptive modeling of a multipath communication channel, adaptive modeling in FIR digital filter synthesis, Adaptive Interference Cancellation: Concept of adaptive noise cancelling, stationary noise-cancelling solutions; effects of signal components in the reference input, Term Project: Matlab implementation of the various learning algorithms with applications

Total No. of Hours: 45

Text Books:

1. S. Haykin, Adaptive filter theory, Prentice Hall, 1986.
2. Bernard Widrow and Samuel D. Stearns, Adaptive signal processing, Prentice Hall, 1984.

Reference Books:

1. by Tulay Adali and Simon Haykin, Adaptive Signal Processing: Next Generation Solutions; Pub: Wiley

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the general concepts of adaptive filtering and estimation.
2. Understand the general concepts of properties of the quadratic performance surface
3. Analyze different types of adaptive filters used in signal processing.
4. Solve numerical problems on correlation, convergence and filtering aspects.
5. Evaluate and compare different adaptive signal processing techniques.

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ECEL07: Antennas and Propagation

ECEL07	Antennas and Propagation	3L:0T:0P	3 Credits

Course Objectives:

- *To understand antenna characteristics for different applications.*
- *To analyze and design different types of antennas.*
- *To design antenna arrays and understand operation of smart antennas.*
- *To investigate different modes of propagation and their suitability for wireless communication.*

Course Contents:

MODULE I **9 Hours**

Antenna Fundamentals: Power density, directivity, gain, radiation resistance, input impedance, radiation patterns, beam width, bandwidth and polarization. Retarded potential- Radiation from a current element and monopole – Radiation of half-wave andcentre-fed dipole – Near and far fields, current distribution of dipole antennas. Linear array antennas - Arrays of two point sources – Broad side and end fire arrays, binomial array - Principle of pattern multiplication –Adaptive arrays.

MODULE II **9 Hours**

Aperture and Slot Antennas: Radiation from rectangular apertures, Uniform and Tapered aperture, Aperture blockage, Feeding structures, Horn antenna, Reflector antenna, Cassegrain reflector, Babinet‟s principle, Slot antennas, Lens antenna, Microstrip antennas – Radiation mechanism – Application.

MODULE-III **9 Hours**

Travelling Wave and Broadband Antenna: Travelling wave wire, V and Rhombic antenna, folded dipole, Yagi-Uda antenna, Log-periodic antenna, Biconical antenna, Spiral antenna, Helical antenna, Loop antenna.

MODULE-IV **9 Hours**

Special Antenna and Antenna measurements: Electromagnetic compatibility antenna –Calibration- Reconfigurable antenna, Active antenna, Dielectric antennas, Electronic band gap structure and applications, Patch antenna, Smart antenna - Antenna Measurements-Test Ranges, Measurement of Gain, Radiation pattern, Polarization, VSWR.

MODULE-V **9 Hours**

Propagation: Factors involved in the propagation of radio waves - Ground wave, reflection of radio waves by the surface of the earth - Space wave propagation, considerations in space wave propagation, atmospheric effect in space wave propagation - Ionosphere and its effect on radio waves, Mechanism of ionospheric propagation- Ray paths – Skip distance -Critical frequency- Maximum usable frequency
- Fading of signal - Types of fading- Diversity reception.

Total No. of Hours: 45

Text Books:

1. J.D. Kraus, Antennas, McGraw Hill, 1988.
2. C.A. Balanis, Antenna Theory - Analysis and Design, John Wiley, 1982.

Reference Books:

1. R.E. Collin, Antennas and Radio Wave Propagation, McGraw Hill, 1985.
2. R.C. Johnson and H. Jasik, Antenna Engineering Handbook,cGraw ill, 1984.
3. R.K. Shevgaonkar, Electromagnetic Waves, TataMcGraw Hill, 2005

Course outcomes:

At the end of this course students will demonstrate the ability to

1. Understand antenna characteristics for different applications.
2. Understand the concepts of Aperture and Slot Antennas
3. Analyze and design different types of antennas.
4. Design antenna arrays and understand operation of smart antennas.
5. Investigate different modes of propagation and their suitability for wireless communication.

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ECEL08: Bio-Medical Electronics

ECEL08	**Bio-Medical Electronics**	**3L:0T:0P**	**3 Credits**

Course Objectives:

- *To explain the origin of biopotentials and various electrodes for sensing and conditioning bio signals.*
- *To analyze the human cardio- vascular, central nervous and muscular system and explain the different measurement techniques for the signals originating from these systems.*
- *To apply image processing principles in imaging techniques such as X-rays, image intensifiers, CT scanners, ultrasound scanners and MRI.*
- *To select suitable transducers for medical applications.*

MODULE I **9 Hours**

ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING: The origin of Bio-potentials; biopotential electrodes, biological amplifiers, ECG, EEG, EMG, PCG, lead systems and recording methods, typical waveforms and signal characteristics.

MODULE II **9 Hours**

BIO-CHEMICAL AND NON ELECTRICAL PARAMETER MEASUREMENT: pH, PO2, PCO2, colorimeter, Auto analyzer, Blood flow meter, cardiac output, respiratory measurement, Blood pressure, temperature, pulse, Blood Cell Counters.

MODULE III **9 Hours**

ASSIST DEVICES: Cardiac pacemakers, DC Defibrillator, Dialyser, Heart lungmachine

MODULE IV **9 Hours**

PHYSICAL MEDICINE AND BIOTELEMETRY: Diathermies- Shortwave, ultrasonic and microwave type and their applications, Surgical Diathermy Telemetry principles, frequency selection, biotelemetry, radio pill, electrical safety

MODULE V **9 Hours**

RECENT TRENDS IN MEDICAL INSTRUMENTATION: Thermograph, endoscopy unit, Laser in medicine, cryogenic application, Introduction to telemedicine

Text /Reference books: **Total No. of Hours: 45**

1. Leslie Cromwell, Fred J. Weibull, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", Pearson Education, 2nd edition, 1980.
2. R. S. Khandpur, "Handbook of Biomedical Instrumentation", TMH, 2nd edition, 2000

Reference Books:

1. Vander, Shermen, "Human Physiology– The Mechanism of Body Functions", TMH, 13th edition, 2013.
2. Tompkins, "Biomedical Digital Signal Processing", PHI, 5th edition, 2010.

Course Outcomes:

At the end of this course, the students should be able to

1. Explain the origin of biopotentials and various electrodes for sensing and conditioning bio signals.
2. Understand the concepts of the bio-chemical and non electrical parameter measurement.
3. Analyze the human cardio- vascular, central nervous and muscular system and explain the different measurement techniques for the signals originating from these systems.
4. Apply image processing principles in imaging techniques such as X-rays, image intensifiers, CT scanners, ultrasound scanners and MRI.
5. Select suitable transducers for medical applications.

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ECEL09	5G Communications	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the evolution of mobile communication standards developed over the years.*
- *To solve numerical problems on different frequency division multiple access techniques.*
- *To assess how softwarization of network functions helps in scalability and ease of operations.*
- *To evaluate the use of advanced techniques in cellular communications.*

Course Contents:

MODULE I **9 Hours**

Mobile Communications Overview: Evolution from 1G to 5G, Analog voice systems in 1G, digital radio systems in 2G, voice and messaging services, TDMA based GSM, CDMA, 2.5G (GPRS), 2.75G(EDGE); IMT2000, 3G UMTS, W-CDMA, HSPA, HSPA+, 3G services and data rates, IMT Advanced, 4G, LTE, VoLTE, OFDM, MIMO, LTE Advanced Pro (3GPP Release 13+), IMT2020, enhancements in comparison to IMT Advanced.

MODULE II **9 Hours**

Introduction to 5G Communication: 5G potential and applications, Usage scenarios, enhanced mobile broadband (eMBB), ultra reliable low latency communications (URLLC), massive machine type communications (MMTC), D2D communications, V2X communications, Spectrum for 5G, spectrum access/sharing, millimeter Wave communication, channels and signals/waveforms in 5G, carrier aggregation, small cells, dual connectivity.

MODULE III **9 Hours**

5G Network: New Radio (NR), Standalone and non-standalone mode, non-orthogonal multiple access(NOMA), massive MIMO, beam formation, PHY API Specification, flexible frame structure, Service Data Adaptation Protocol (SDAP), centralized RAN, open RAN, multi-access edge computing (MEC); Introduction to software defined networking (SDN), network function virtualization (NFV), network slicing; restful API for service-based interface, private networks.

MODULE IV **9 Hours**

Mobility And Handoff Management In 5G: Network deployment types, Interference management in 5G, Mobility management in 5G, Dynamic network reconfiguration in 5G.

MODULE V **9 Hours**

Current state and Challenges ahead: 5G penetration in developed countries; deployment challenges in low-middle income countries, stronger backhaul requirements, dynamic spectrum access and usage of unlicensed spectrum, contrasting radio resource requirements, large cell usage, LMLC, possible solutions for connectivity in rural areas (BharatNet, TVWS, Long-range WiFi, FSO); non-terrestrial fronthaul / backhaul solutions: LEOs, HAP/UAV.

Total No. of Hours: 45

Text and References Books:

1. Mobile Communications by Jochen Schiller Pub: Financial Times / Imprint of Pearson

2. Mobile Cellular Telecommunications: Analog and Digital Systems by William Lee, Pub: McGrawHill Education

Reference Books:

1. Mobile Communications Design Fundamentals by William Lee, Pub: Wiley India Pvt. Ltd.

2. Wireless Communications: Principles and Practice by Theodore S. Rappaport, Pub: Pearson

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the evolution of mobile communication standards developed over the years.
2. Understand the 5G Communication systems.
3. Perform computations and solve numerical problems on different frequency division multiple access techniques.
4. Assess how softwarization of network functions helps in scalability and ease of operations.
5. Evaluate the use of advanced techniques in cellular communications.

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ECEL10	Digital Image Processing	3L:0T:0P	3 Credits

Course Objectives:

- *To understand fundamentals of digital image processing and representation of images in spatial and transform domain.*
- *To apply image enhancement restoration techniques for improving quality of images.*
- *To develop algorithms for image compression, coding, and segmentation.*
- *To apply multi-resolution techniques for image processing.*

Course Contents:

MODULE I **9 Hours**

Introduction To Image Processing:

Components of an image processing system - Image sensing and acquisition – Simple image formation model – representation of a digital image- Sampling and quantization Aliasing – Zooming and Shrinking – Basic relations between pixels - .Image types - Image file formats – applications of image processing

MODULE II **9 Hours**

Two Dimensional Signals &Systems And Transforms:

Two dimensional signals – 2D systems and classifications – 2D convolution -2D correlation – Need for transforms – 2D DFT – Walsh transform – Hadamard transform – Haar Transform – Slant transform – DCT – KL transform.

MODULE III **9 Hours**

Image Enhancement And Image Restoration: Basic gray level transformations – histogram processing – smoothing and sharpening spatial filters – Smoothing and sharpening frequency domain filters – Image degradation/restoration model – Inverse filtering – Wiener filtering

MODULE IV **9 Hours**

Image Compression Techniques : Need for image compression – Lossless compression : Variable length coding , LZW coding ,Bit plane coding – Lossless predictive coding- - Lossy compression: Lossy predictive coding model , Transform coding – Image compression standards

MODULE V **9 Hours**

Image Segmentation Techniques: Need for image segmentation – detection of discontinuities – Thresholding – Region based segmentation

Text Books: **Total No. of Hours: 45**

1. R.C.Gonzalez and R.E. Woods, “Digital Image Processing”, Second Edition, Pearson Education.
2. Anil Kumar Jain, “Fundamentals of Digital Image Processing”, Prentice Hall of India.

Reference Books:

1. Murat Tekalp, “Video Processing”.

Course outcomes: At the end of this course students will demonstrate the ability to

1. Understand fundamentals of digital image processing and representation of images in spatial and transform domain.
2. Understand the Two Dimensional Signals &Systems And its Transforms
3. Apply image enhancement restoration techniques for improving quality of images.
4. Develop algorithms for image compression, coding, and segmentation.
5. Apply multi-resolution techniques for image processing.

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ECEL11	Mixed Signal Design Course Contents	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the concepts for mixed signal circuits.*
- *To analyze the characteristics of IC based CMOSfilters.*
- *To design of various data converter architecture circuits.*
- *To analyze the signal to noise ratio and modeling of mixed signals.*

MODULE I SUBMICRON CMOS CIRCUIT DESIGN

Submicron CMOS: Overview and Models, CMOS process flow, Capacitors and Resistors. Digital circuit design: The MOSFET Switch, Delay Elements, An Adder. Analog Circuit Design: Biasing, Op-Amp Design, Circuit Noise.

MODULE II INTEGRATOR BASED CMOS FILTERS 9 Hours

Integrator Building Blocks- low pass filter, Active RC integrators, MOSFET-C Integrators, gm- C integrators, Discrete time integrators. Filtering Topologies: The Bilinear transfer function, The Biquadratic transfer function, Filters using Noise shaping.

MODULE III DATACONVERTER ARCHITECTURES 9 Hours

DAC Architectures- Resistor string, R-2R ladder Networks, Current Steering, Charge Scaling DACs, Cyclic DAC, and Pipeline DAC. ADC Architectures- Flash, Two-step flash ADC, Pipeline ADC, Integrating ADC,,s, Successive Approximation ADC.

MODULE IV DATA CONVERTER MODELING AND SNR 9 Hours

Sampling and Aliasing: A modeling approach, Impulse sampling, The sample and Hold, Quantization noise. Data converter SNR: An overview, Clock Jitter, Improving SNR using Averaging, Decimating filter for ADCs, Interpolating filter for DACs, Band pass and High pass sinc filters - Using feedback to improve SNR.

MODULE V OSCILLATORS AND PLL 9 Hours

LC oscillators, Voltage Controlled Oscillators. Simple PLL, Charge pumps PLLs, Non ideal effects in PLLs, Delay Locked Loops.

Text Book: **Total No. of Hours: 45**

1. R.Jacob Baker, "CMOS Mixed Signal Circuit Design", Wiley India, IEEE Press, reprint 2008.
2. R.Jacob Baker,"CMOS Circuit Design, Layout and Simulation", Wiley India, IEEE Press, Second Edition, reprint 2009.

Reference Books:

1. Behzad Razavi,"Design ofAnalog CMOS Integrated Circuits" McGraw Hill, 33rd Reprint, 2016.

Course Outcome:

At the end of this course students will demonstrate the ability to

1. Understand the concepts for mixed signal circuits.
2. Understand the integrator based CMOS filters
3. Analyze the characteristics of IC based CMOS filters.
4. Design of various data converter architecturecircuits.
5. Analyze the signal to noise ratio and modeling of mixed signals.

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ECEL12	Wireless Sensor Networks	3L:0T:0P	3 Credits

Course Objectives:

- *To understand principles of sensor networks and its difference with mobile ad hoc networks.*
- *To evaluate computations related to energy saving using different routing schemes.*
- *To analyze different MAC protocols used for different communication standards in WSN.*
- *To design small sensor networks for different applications.*

Course Contents:

MODULE I Introduction **9 Hours**

Cellular and Ad hoc wireless Networks – Mobile Ad-Hoc Networks – Sensor Networks – Comparison - Applications –Categories – Issues and challenges in designing a sensor network – Operating environment- Propagation and Propagation Impairments- Architecture – Sensor node technology – Hardware and Software – Performance Metrics – Taxonomy

MODULE II Middleware and Transmission Technologies **9 Hours**

Middleware - Functions – Architecture – Data management functions - Operating Systems – Design issues –ExamplesAvailable wireless Technologies – WSN Campus Applications - Bluetooth – WLAN – Zigbee – WiMax –3G and beyond - Performance modeling of WSN - Metrics – Task-driven sensing– Basic models – Traffic model – Energy model – Node model - Network models – MAC model – Routing model – System model.

MODULE III MAC Protocols for WSN **9 Hours**

Fundamentals of MAC – Requirements and design constrains – MAC protocols for WSN - Schedule-based protocols -SMAC – LEACH – TRAMA – Contention-based protocols – CSMA – PAMAS IEEE 802.15.4 standard-Case Study -PHY layer – MAC layer- Network architecture and types/roles of nodes- Super frame structure -GTS management -Data transfer procedures- Slotted CSMA-CA protocol –Non beaconed mode Case study of Sensor MAC - Protocol Overview- Periodic Listen and Sleep Operations –Schedule Selection and Coordination-Schedule Synchronization- Adaptive Listening- Access Control and Data Exchange- Message Passing

MODULE IV Routing Protocols and Network Management for WSN **9 Hours**

Routing Protocols- Challenges and Issues – Data Dissemination and Gathering – Location Discovery - Routing strategies – Flooding and its variants -Gossiping – SPIN – PEGASIS – Geographical routing – Localized and globalised forwarding – Greedy perimeter stateless routing - GEAR - Attribute-based routing – Direct diffusion – Rumor routing – Geographic hash tables Network Management for Wireless Sensor Networks –Requirements-Issues- Naming- Localization

MODULE V Transport Protocols and Applications of WSN **9Hours**

Transport Protocols -Design Issues – Traditional transport protocols- TCP-UDP-Mobile IP-Feasibility of using TCP/UDP for WSN – Design Considerations – CODA – GARUDA – Performance of Transport Control Protocols. Applications of WSN- Case Study: Sensing Global Phenomena – for tracking a moving chemical plume using airborne and ground-based chemical sensors Case Study : Simple computation of the System Life Span for a two-tiered topology WSN.

Text Books: **Total No. of Hours: 45**

1. Waltenegus Dargie , Christian Poellabauer, "Fundamentals Of Wireless Sensor Networks Theory And Practice", ByJohn Wiley & Sons Publications
2. Sabrie Soloman, "SENSORS" HANDBOOK by Mc Graw Hill publication.

Reference Books:

1. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks", Elsevier Publications.
2. Kazem Sohrby, Daniel Minoli, "Wireless Sensor Networks": Technology, Protocols and Applications, Wiley-Inderscience
3. Philip Levis, And David Gay Tinyos "Programming" by Cambridge University Press

Course Outcomes

At the end of this course students will demonstrate the ability to

1. Understand principles of sensor networks and its difference with mobile ad hoc networks.
2. Understand the concepts of Middleware and Transmission Technologies
3. Evaluate computations related to energy saving using different routing schemes.
4. Analyze different MAC protocols used for different communication standards in WSN.
5. Design small sensor networks for different applications.

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ECEL13: Power Electronics

ECEL13	**Power Electronics**	**3L:0T:0P**	**3 Credits**

Course Objectives:

- *To learn how to analyze inverters and some basic applications.*
- *To analyze and design SMPS, controlled rectifiers DC to DC converters. and, DC to AC inverters.*
- *To learn and design DC to AC inverters, Charge controllers*
- *To analyze typical industrial application requirements and build a solution with commercially available power electronic devices.*

Course Contents:

MODULE I: POWER SEMI CONDUCTOR DEVICES **9 Hours**

Power switching devices overview: ideal & real switching characteristics -power diode, BJT, SCR, TRIAC, MOSFET, GTO, IGBT- V-I characteristics, turn-on, turn-off methods; protection-di/dt,dv/dt,overcurrent, overvoltage; specifications, losses, thermal characteristics, series and parallel operation, triggering circuits

MODULE II: CONTROLLED RECTIFIERS **9 Hours**

Operation and analysis of single and three phase rectifiers – half and fully controlled Converters with R, RL and RLE loads with and without freewheeling diodes; converter and inverter operation – waveforms, gate time control, output voltage, input current, power factor, effect of load and source inductances. Power factor and harmonic improvement methods in converters. Series converter, twelve pulse converters, dual converter four-quadrant operation with and without circulating current

MODULE III: CHOPPERS **9 Hours**

Principles of high power chopper circuits –class A, B, C, D and E chopper, voltage commutated, current commutated chopper, multi-phase chopper-multi-quadrant operation, principle of operation of buck, boost and buck boost regulators; time ratio control, variable frequency control, duty cycle.

MODULE IV: INVERTERS **9 Hours**

Principles of high power VSI and CSI inverters, Modified McMurray, auto sequential inverter– waveforms at load and commutating elements; inverters: analysis of three phase inverter circuits with star and delta loads; control and modulation techniques: unipolar, bipolar schemes– voltage and frequency control; harmonics study

MODULE V : AC CHOPPER AND CYCLO CONVERETERS AC **9 Hours**

voltage controller - Principle of single phase and three-phase AC voltage controller –ON/OFF and phase angle control Cyclo converters- Principle of single phase and three phase cyclo converters circuits, input and output performances-different control techniques and firing pulse generation. Applications – regulated power supply, UPS, solid-state motor starters, HVDC systems, reactive power compensation.

Total No. of Hours: 45

Text /Reference Books:

1) P.S. Bimbhra, Power Electronics, Khanna Book Publishing, 2022.
2) M Singh, K Khanchandani, "Power Electronics" McGraw Hill Education, 2nd Ed., 2017

Reference Books:

1) Muhammad H. Rashid, "Power electronics" Prentice Hall of India.
2) Cyril W., Lander," Power Electronics", edition III,McGraw Hill.
3) G K Dubey,S R Doradla,:Thyristorised Power Controllers",New Age International Publishers. SCR manual from GE, USA.

Course Outcomes*:*

At the end of this course students will demonstrate the ability to

1. Learn how to analyze inverters and some basic applications.
2. Understand the operation and analysis of single and three phase rectifiers.
3. Analyze and design SMPS, controlled rectifiers DC to DC converters. and, DC to AC inverters.
4. Learn and design DC to AC inverters, Charge controllers
5. Analyze typical industrial application requirements and build a solution with commercially available power electronic devices.

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ECEL14: Satellite Communication

ECEL14	Satellite Communication	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the sub-systems of satellite communication systems and ground stations.*
- *To understand the signal power calculation and issues in communication satellite tracking.*
- *To compute parameters of orbital motions and understand communication with non-geosynchronous satellite*
- *To understand different modulation types and interfacing the modems in satellite receivers.*

Course Contents:

MODULE-I **9 Hours**

Introduction to Satellite Communication: Types of satellites- Satellite orbit- satellite constellation- orbital mechanics- equation of orbit-orbital elements- look angle determination- limits of visibility- eclipse- sub satellite point- sun transit outage- space craft technology structural, primary power, attitude and orbit control, thermal, propulsion, telemetry, tracking and command, communication and antenna subsystems- launching procedures and launch vehicles

MODULE-II **9 Hours**

Earth Station and Satellite Link Design: Earth station technology- terrestrial interface, receiver and transmitter, antenna systems-Basic transmission theory- satellite uplink and down link analysis and design for IMMARSAT, INTELSAT etc. Link budget and Eb/No calculation. Performance impairments – system noise, inter modulation and interference. Propagation characteristics and frequency consideration- system reliability and design life time

MODULE-III **9 Hours**

Satellite Access: Types- FDMA concepts- inter modulation and back off- SPADE system- TDMA concept- frame and burst structure- satellite switch TDMA- CDMA concept- DS & FH CDMA system- comparison of multiple access scheme.

MODULE-IV **9 Hours**

Laser Satellite Communication: Inter satellite links- optical communication for satellite networks- laser cross link analysis- optical beam acquisition, tracking and pointing.

MODULE-V **9 Hours**

Satellite Services: Packet satellite networks and services, fixed satellite services, broadcast satellite services, mobile satellite services- VSAT, global positioning satellite system, maritime satellite services, gateways, ATM over satellite, role of satellite in future network.

Text Books*:* **Total No. of Hours: 45**

1. TimothyPratt and Jeremy Allnutt: "Satellite Communications": Ed 3, 2021.Wiley India.
2. Dennis Roddy: Satellite Communication: 4th Edition, McGraw Hill, 2001

Reference Books:

1. Varsha Agrawal, Anil K. Maini, "Satellite Communications" Wiley India 2010.
2. Tri T. Ha: Digital Satellite Communications: Tata McGraw Hill.

Course Outcomes*:*

At the end of this course students will demonstrate the ability to

1. Understand the sub-systems of satellite communication systems and ground stations.
2. Understand the signal power calculation and issues in communication satellite tracking.
3. Analysis the Satellite Access and its types.
4. Compute parameters of orbital motions and understand communication with non-geosynchronous satellite
5. Understand different modulation types and interfacing the modems in satellite receivers.

*****

ECEL15	High Speed Systems	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the concepts of high speed data communication.*
- *To understand the methodologies for design of high speed buses.*
- *To analyze the effect of noise on the performance of the high speed circuits.*
- *To design of printed circuit board which can handle high speed power transfer.*

Course Contents:

MODULE-I

Introduction High Speed Electronics: Transmission line theory (basics) crosstalk and non ideal effects; signal integrity: impact of packages, vias, traces, connectors; non-ideal return current paths, high frequency power delivery, methodologies for design of high speed buses; radiated emissions and minimizing system noise.

MODULE-II

Noise Analysis: Sources, Noise Figure, Gain compression, Harmonic distortion, Inter modulation, Cross-modulation, Dynamic range

MODULE-III

Devices: Passive and active, Lumped passive devices (models), Active(models, low vs high frequency) RF Amplifier Design, Stability, Low Noise Amplifiers, Broadband Amplifiers (and Distributed)

MODULE-IV

Power Amplifiers: Class A, B, AB and C, D E Integrated circuit realizations, Cross-over distortion Efficiency RF power output stages, Mixers –Up conversion Down conversion, Conversion gain and spurious response. OscillatorsPrinciples.PLL Transceiver architectures

MODULE-V

Printed Circuit Board Anatomy, CAD tools for PCB design, Standard fabrication, Microvia Boards. Board Assembly: Surface Mount Technology, Through Hole Technology, Process Control and Design challenges.

Text Books:

1. Stephen H. Hall, Garrett W. Hall, James A. McCall "High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices", August 2000, Wiley-IEEE Press
2. Thomas H. Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", Cambridge University Press, 2004, ISBN 0521835399.

Reference Books:

1. Behzad Razavi, "RF Microelectronics", Prentice-Hall 1998, ISBN 0-13-887571-5.
2. Guillermo Gonzalez, "Microwave Transistor Amplifiers", 2nd Edition, Prentice Hall.
3. R.G. Kaduskar and V.B.Baru, Electronic Product design, Wiley India, 2011

Course Outcome:

At the end of this course students will demonstrate the ability to

1. Understand the concepts of high speed data communication.
2. Understand the methodologies for design of high speed buses.
3. Analyze the effect of noise on the performance of the high speed circuits.
4. Design of printed circuit board which can handle high speed power transfer.
5. Analyze the printed circuit board anatomy.

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ECEL16	**Nanoelectronics**	**3L:0T:0P**	**3 Credits**

Course Objectives:

- *To get introduced to Nanoelectronics and nanotechnology.*
- *Understand working of Nano scale devices such as transistors.*
- *Understand modeling aspects of Nanoscale devices from the perspective of circuit applications.*
- *Design of Carbon based Nanoelectronic devices*

Course Contents:

MODULE I **9 Hours**

Scaling laws in miniaturization: Heat conduction in micro- and nano- systems: heat conduction equation, Newton‟s cooling law, heat conduction in multilayered thin films, heat conduction in submicron scale - Quantum phenomena in nano-systems: photonic band gap structure, quantum states in nano-sized structures, quantum transport

MODULE II **9 Hours**

Clean room: Need for a clean room – Types of clean rooms – maintenance of different types of clean rooms – oxidization and metallization- masking and patterning

MODULE III **9 Hours**

Preparation techniques: Basic micro- and nano-fabrication techniques: thin film deposition, ion implantation, diffusion, oxidation - surface micromachining, LIGA process -Packaging: die preparation, surface bonding, wire bonding, sealing, assembly Measurement techniques : scanning tunneling microscope, atomic force microscope, focused ion beam technique-nanoindentation, nanotribometer

MODULE IV **9 Hours**

Nano-fabrication: principles and techniques: Etching technologies - wet and dry etching - photolithography – Drawbacks of optical lithography for nanofabrication - electron beam lithography – ion beam lithography -dip-pen nanolithography, stamping techniques, strain-induced self-assembly for Nanofabrication of quantum dot and molecular architectures - Polymer processing for biomedical applications

MODULE V **9 Hours**

Applications and devices: Mechanics for micro- and nano-systems: bending of membrane and cantilever, resonance vibration, fracture, stress, nano Tribology -Fluid dynamics for micro- and nano- systems: surface tension, viscosity, continuity equation -laminar fluid flow, fluid flow in submicron and nanoscale- Surface acoustic wave (SAW) devices, microwave MEMS, field emission display devices, nano diodes, nano switches, molecular switches, nano-logic elements- Super hard nano composite coatings and applications in tooling- Biochemistry and medical applications: lab-on-a- chip systems.

Total No. of Hours:45

Text Books

1. G.W. Hanson, Fundamentals of Nanoelectronics, Pearson, 2009.
2. W. Ranier, Nano electronics and Information Technology (Advanced Electronic Material and Novel Devices), Wiley-VCH, 2003.

Reference Books:

1. K.E. Drexler, Nano systems, Wiley, 1992.
2. J.H. Davies, The Physics of Low-Dimensional Semiconductors, Cambridge University Press,1998.
3. C.P. Poole, F. J. Owens, Introduction to Nanotechnology, Wiley, 2003

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. To get introduced to Nanoelectronics and nanotechnology.
2. Understand working of Nano scale devices such as transistors.
3. Understand modeling aspects of Nanoscale devices from the perspective of circuit applications.
4. Design of Carbon based Nano electronic devices
5. Understand the Nano devices and its application.

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ECEL17	PROBLEM SOLVING USING PYTHON	3L:0T:0P	3 Credits

Course Objective:

- *To know the basics of algorithmic problem solving*
- *To read and write simple Python programs.*
- *To develop Python programs with conditionals and loops.*
- *To define Python functions and call them.*
- *To use Python data structures –- lists, tuples, dictionaries and to do input/output with files in Python.*

Course Contents:

MODULE – I - ALGORITHMIC PROBLEM SOLVING 9 Hours

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

MODULE – II - DATA, EXPRESSIONS, STATEMENTS 9 Hours

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two point.

MODULE – III - CONTROL FLOW, FUNCTIONS 9 Hours

Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search. .

MODULE – IV - LISTS, TUPLES, DICTIONARIES 9 Hours

Lists- list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, listparameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations andmethods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

MODULE – V - FILES, MODULES, PACKAGES 9 Hours

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

Total No. of Hours:45

Text Books:

1. Allen B. Downey, "Think Python: How to Think Like a Computer Scientist" 2nd Edition,Updated forPython 3, Shroff/O"Reilly Publishers 2016

2. Guido van Rossum and Fred L. Drake Jr, ―An Introduction to Python – Revised and updated for Python.2,Network Theory Ltd., 2011.

References:

1. John V Guttag, ―Introduction to Computation and Programming Using Python,,,,, Revised and expandedEdition, MIT Press , 2013

2. Robert Sedgewick, Kevin Wayne, Robert Dondero, ―Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.

3. Timothy A. Budd, ―Exploring Python‖, Mc-Graw Hill Education (India) Private Ltd., 2015.

Course outcomes:

After completion of course, students would be able to:

1. Explain the fundamental concepts of programming, including variables, data types, and basic syntax.
2. Utilize Python's built-in data structures (lists, tuples, dictionaries) for data manipulation and Apply arithmetic, comparison, logical, and assignment operators effectively.
3. Implement conditional statements (if, else, elif) to control program flow based on conditions.
4. Define and call functions in Python to structure code and make it reusable.
5. Read from and write to files using Python to store and retrieve data persistently and Access and utilize external libraries (e.g., NumPy, Pandas) to enhance Python's functionality

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ECEL18	Internet of Things and Applications	3L:0T:0P	3 Credits

Course Objectives:

- *To demonstrate the fundamentals of IoT*
- *To identify suitable hardware and interfaces for IoT deployments.*
- *To develop cloud computing model and service options.*
- *To point up data analytics and security for IoT.*

Course Contents:

MODULE-I Introduction to IoT **9 Hours**

Definitions and Functional Requirements –Motivation – Architecture - Web 3.0 View of IoT– Ubiquitous IoT Applications – Four Pillars of IoT – DNA of IoT - The Toolkit Approach for End- user Participation in the Internet of Things. Middleware for IoT: Overview – Communication middleware for IoT –IoT Information Security.

MODULE-II IoT Protocols and Applications **9 Hours**

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols –Issues with IoT Standardization – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus – KNX – Zigbee Architecture – Network layer – APS layer – Security

MODULE-III Web of things **9 Hours**

Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization forWoT– Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals and Business Intelligence. Cloud of Things: Grid/SOA and Cloud Computing – Cloud Middleware – Cloud Standards – Cloud Providers and Systems – Mobile Cloud Computing – The Cloud of Things Architecture

MODULE-IV Integrated Internet of Things **9 Hours**

Integrated Billing Solutions in the Internet of Things Business Models for the Internet of Things - Network Dynamics: Population Models – Information Cascades - Network Effects - Network Dynamics: Structural Models - Cascading Behavior in Networks - The Small-World Phenomenon

MODULE-V Applications **9 Hours**

The Role of the Internet of Things for Increased Autonomy and Agility in Collaborative Production Environments - Resource Management in the Internet of Things: Clustering, Synchronisation and Software Agents. Applications - Smart Grid – Electrical Vehicle Charging

Text Books: **Total No. of Hours:45**

1. Arshdeep Bahga and Vijay Madisetti , “Internet of Things, a hands on approach” , Universities Press (India) Pvt. Ltd. 2017.

2. Rajkumar Buyya, Amir Vahid Dastjerdi, “Internet of Things Principles and Paradigms”Copyright © 2016 Elsevier Inc.

References Books:

3. D. Hanes and G. Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things," Cisco Press, 2017.
4. Satish Jain and Shashi Singh," O Level Made Simple – Internet of Things (IOT) & Its Applications," BPB Publications, January 2020.
5. William Stallings, " Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud" Publisher: Addison-Wesley 2015

Course Outcomes:

At the end of the course, students will demonstrate the ability to

1. Illustrate the fundamentals of IoT
2. Identify suitable hardware and interfaces for IoT deployments.
3. Develop cloud computing model and service options.
4. Illustrate data analytics and security for IoT.
5. Understand the concepts of IoT and its applications.

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ECEL19	Cyber Security	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the basic concept of cyber security and its importance.*
- *To analyze and distinguish various security threats and attacks that are prevalent now.*
- *To find different ways for safety of assets and systems by increasing the strength of security parameters.*
- *To perform simple simulations of cyber security attacks and ways to mitigate those.*

Course Contents:

MODULE-I Cyber Security

Overview of Cyber Security– Challenges and Constraints, Cyber Threats:- Cyber Warfare-Cyber Crime, Cyber terrorism, Cyber Espionage, Cyber Operations, Cyber Weaponry, Cyber world, Advanced Persistent Threat- Need for a Comprehensive Cyber Security Policy, Need for a Nodal Authority, Need for an International convention on Cyberspace.

MODULE-II Cyber Security Vulnerabilities and Cyber Security Safeguards **9 Hours**

Cyber Security Vulnerabilities-Overview, vulnerabilities in software, System administration and Open Access to Organizational Data, Unprotected Broadband communications, Poor Cyber Security Awareness. Cyber Security Safeguards- Overview, Security Services and Mechanism, Audit, Denial of Service Filter, Ethical
Hacking.

MODULE-III Securing Web Application, Services and Servers - **9 Hours**

Introduction, Basic security for HTTP Applications and Services, Basic Security for SOAP Services, Identity Management and Web Services, Authorization Patterns, Security-Intrusion, Physical Theft, Abuse of Privileges, Unauthorized Access by Outsider, Malware infection, Intrusion detection and Prevention Techniques, Anti-Malware software, Security Information Management, Network Session Analysis, System Integrity Validation.

MODULE-IV Cyberspace and the Law **9 Hours**

Introduction to Cyberspace environment and its characteristics, Cyberspace Operations – Network Operations (NETOPS), Defensive Cyberspace Operations (DCO), Offensive Cyberspace Operations (OCO), Operational methodologies to conduct cyberspace operations, Cyber Security Regulations, Roles of International Law, the state and Private Sector in Cyberspace, Cyber Security Standards. The INDIAN Cyberspace, National Cyber Security Policy 2013.

MODULE-V Cyber Forensics **9 Hours**

Introduction to Cyber Forensics, Spyware and Adware, Handling Preliminary Investigations, Controlling an Investigation, Conducting disk-based analysis, Investigating Information-hiding, Scrutinizing E-mail, Validating E-mail header information, Tracing Internet access, Tracing memory in real-time, Biometric security System.

LIST OF SUGGESTED BOOKS

1. Jeeva Jose & Vijo Mathew, Introduction to Security of Cyber-Physical Systems, Khanna Book Publishing Company, 2023.
2. William Stallings, "Cryptography and Network Security", Pearson Education/PHI, 2006.

Reference Books: **Total No. of Hours:**45

1. V.K. Jain, "Cryptography and Network Security", Khanna Publishing House.
2. Gupta Sarika, "Information and Cyber Security", Khanna Publishing House, Delhi.
3. V.K. Pachghare, "Cryptography and Information Security", PHI Learning

Course Outcomes:

At the end of this course students will demonstrate the ability to

1. Understand the basic concept of cyber security and its importance.
2. Analyze and distinguish various security threats and attacks that are prevalent now.
3. Find different ways for safety of assets and systems by increasing the strength of security parameters.
4. Perform simple simulations of cyber security attacks and ways to mitigate those.

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Course ECEL20	Machine Learning for Wireless communication	3L:0T:0P	3 Credits

Objectives:

- *To grasp and develop algorithms for linear, logistic, and multivariate regression.*
- *To design and implement linear and nonlinear classifiers based on SVM, Neural networks and Decision trees.*
- *To identify and implement clustering techniques for moderate to large size data.*
- *To evaluate and interpret the results of the machine learning algorithms.*

Course Contents:

MODULE I **9 Hours**

Introduction to machine learning, Supervised and Unsupervised Learning, Linear Regression,Logistic Regression, Generalized Linear Models.

MODULE II **9 Hours**

Gaussian Discriminant Analysis (GDA), Naive Bayes, Support Vector Machines, K-Nearest Neighbor, Decision Trees, Random forest.

MODULE III **9 Hours**

Clustering in Machine Learning, Different Types of Clustering Algorithm, K-Means Clustering, Gaussian Mixture Models, Bias-variance trade off.

MODULE IV **9 Hours**

Introduction to Neural Networks, Feed-forward Network, Gradient descent optimization, Error Back propagation, Evaluation of error-function derivatives, Efficiency of back propagation, under and over fitting.

MODULE V **9 Hours**

Introduction to Convolutional neural network (CNN),Back propagation in CNN, Sparse Kernel Machines, Markov Chain Monte Carlo, Introduction to Reinforment learning.

Total No. of Hours:45

Text Books:

1. Rajiv Chopra, Machine Learning, Khanna Book Publishing Company, 2023.
2. Hastie, T. R. Tibshirani, and J. G. Friedman, "The Elements of Statistical Learning: DataMining, Inference and Prediction", New York, NY: Springer,

Reference Books:

1. Ethem Alpaydin, “Introduction to Machine Learning”, PHI, 2005.
2. Mitchell Tom, “Machine learning”, New York, NY: McGraw-Hill,
3. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani “Introduction to StatisticalLearning”, Springer, 2013.

Course Outcomes:

At the end of this course, the students should be able to

1. Grasp and develop algorithms for linear, logistic, and multivariate regression.
2. Design and implement linear and nonlinear classifiers based on SVM, Neural networks and decision trees.
3. Identify and implement clustering techniques for moderate to large size data.
4. Evaluate and interpret the results of the machine learning algorithms.
5. Understand the concepts of the Convolution neural network

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ECEL21	AI FOR IMAGE PROCESSING	3L:0T:0P	3 Credits

Course Objectives:

- *Understand Image Processing Fundamentals: Basics of digital images, representation, image acquisition, storage, and common formats; image enhancement and spatial domain filtering.*
- *Explore AI Fundamentals: Overview of AI, machine learning, supervised and unsupervised learning; basics of neural networks and deep learning.*
- *Master Advanced AI Techniques: CNNs for image classification, transfer learning, object detection using YOLO and SSD.*
- *Develop Image Generation and Style Transfer Skills: GANs for image synthesis, conditional GANs, Neural Style Transfer, and CycleGAN for style transfer.*
- *Explore Medical Image Processing Applications: Medical imaging modalities, preprocessing, image registration, AI-based disease detection, segmentation, and ethical considerations.*

Course Contents

MODULE I: Introduction to Image Processing 9 Hours

Introduction to Image Processing: Basics of digital images and their representation-Image acquisition, storage, and display-Common image formats and their characteristics.Image Enhancement Techniques-Point processing operations (brightness and contrast adjustment)-Histogram equalization and normalization-Spatial domain filtering (smoothing and sharpening filters). Image Transformation and Segmentation: Geometric transformations (translation, rotation, scaling)-Thresholding techniques for image segmentation-Region-based segmentation methods-Feature Extraction Techniques: Edge detection algorithms (Sobel, Canny) Corner detection (Harris corner detection)-Feature descriptors

MODULE II: AI Fundamentals 9 Hours

Introduction to Artificial Intelligence and Machine Learning: Overview of AI and its applications in image processing-Introduction to supervised and unsupervised learning-Basics of neural networks and deep learning. Advanced AI for Image Analysis: Convolutional Neural Networks (CNNs) for image classification-Transfer learning and pre-trained CNN models-Object detection using CNNs (YOLO, SSD).

MODULE III: Image Recognition and Object Detection 9 Hours

Image Classification with Deep Learning: Training CNNs for image classification tasks.-Evaluating model performance and fine-tuning-Handling imbalanced datasets and overfitting. Object Detection Techniques: Sliding window approach for object detection-Region-based Convolutional Neural Networks (R-CNN)- Single Shot Multibox Detector (SSD) and You Only Look Once (YOLO).Face Recognition and Biometric Systems: Face detection and alignment techniques-Face recognition using CNNs-Challenges and ethical considerations in biometric systems.

MODULE IV: Image Generation and Style Transfer 9 Hours

Image Generation with Generative Models: Introduction to Generative Adversarial Networks (GANs)-Training GANs for image synthesis-Conditional GANs for controlled image generation. Style Transfer Techniques: Neural Style Transfer with CNNs-CycleGAN for unpaired image-to-image translation-Applications of style transfer in art and design.

MODULE V: Advanced Topics in Medical Image Processing **9 Hours**

Medical Image Analysis: Introduction to medical imaging modalities (MRI, CT, X-ray)-Preprocessing medical images for analysis-Image registration and fusion techniques.

AI in Medical Image Diagnosis: AI-based disease detection and diagnosis-Segmentation of medical structures and lesions-Deep learning applications in radiology and pathology. Ethical Considerations and Future Trends: Ethical challenges in AI for image processing-Emerging trends and applications in AI for image processing-Current research and future directions in the field.

Total Hours: 45

Text Book:

1. "Computer Vision: Models, Learning, and Inference" by Simon J. D. Prince (1st Edition, 2012)
2. "Deep Learning for Computer Vision" by Rajalingappaa Shanmugamani (1st Edition, 2019)

Reference Book:

1. "Digital Image Processing" by Rafael C. Gonzalez and Richard E. Woods (4th Edition, 2017)
2. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, and Aaron Courville (1st Edition, 2016)
3. "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron (2nd Edition, 2019)

Course Outcomes:

On learning this course students will be able to

1. Understand Image enhancement, transformation, and segmentation expertise.
2. Understand about AI concepts applied to image analysis.
3. Implementing CNNs, training models for image classification, and object detection.
4. Generating synthetic images and applying artistic styles.
5. Analyzing medical images, AI-based disease detection, and segmentation skills.

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ECEL22	Underwater Communication	3L:0P:0T	3 Credits

Course Objectives:

- *Understand the significance, challenges, and properties of underwater communication, and compare acoustic and optical communication in water.*
- *Explore underwater communication technologies, including underwater acoustics, optical communication, and underwater wireless sensor networks (UWSNs).*
- *Study underwater network communication aspects, such as architectures, routing, multi-hop communication, and MAC protocols, along with addressing challenges.*
- *Examine real-world applications of underwater communication, including communication with AUVs, ROVs, environmental monitoring, underwater robotics, and military applications.*
- *Investigate underwater communication security concerns, encryption techniques, underwater IoT, communication with drones, and emerging trends.*

Course Contents:

Module 1: Introduction to Underwater Communication: **9 Hours**

Overview of underwater communication: Importance, applications, and challenges- Properties of water affecting communication: Absorption, scattering, and propagation-Acoustic and optical communication comparison.

Module 2: Underwater Communication Technologies: **9 Hours**

Basics of underwater acoustics: Wave properties, equations, and signal processing- Optical communication in water: Light propagation, modulation techniques, and system design- Underwater wireless sensor networks (UWSNs) architecture and protocols.

Module 3: Underwater Network Communication: **9 Hours**

Underwater network architectures: Topology, routing, and multi-hop communication-MAC protocols for underwater communication-Challenges and solutions in underwater network communication.

Module 4: Underwater Communication Applications: **9 Hours**

Communication with autonomous underwater vehicles (AUVs) and remotely operated vehicles (ROVs)-Underwater communication for environmental monitoring and underwater robotics-Military and defense applications of underwater communication.

Module 5: Underwater Communication Security and Emerging Trends: **9 Hours**

Security threats and encryption techniques in underwater communication- Underwater IoT and underwater communication with drones-Emerging trends and future directions in underwater communication.

Total No. of Hours: 45

Text Books:

1. "Underwater Acoustics: Analysis, Design, and Performance of Sonar" by Richard P. Hodges and Paul C. Etter
2. "Underwater Communications: A Practical Guide" by Lufen Xu and Zhengyong Zhang
3. "Underwater Wireless Communication Systems: Channel Modeling and Physical Layer Design Considerations" by Khalid Qaraqe and Erchin Serpedin
4. "Underwater Networks: Algorithms, Protocols, and Applications" by Jun-Hong Cui, Dario Pompili, and Tommaso Melodia.
5. "Handbook of Underwater Acoustic Networking and Communication" edited by Xiaohua Zhu and Athanasios V. Vasilakos

Reference Books:

1. “Underwater Acoustics: Theory and Applications" by Dale C. Carder and Roger N. McDonough
2. "Underwater Communications Systems" by Krzysztof Wesolowski
3. "Optical Wireless Communications for Underwater Sensor Networks" by Raed Mesleh and Harald Haas
4. "Introduction to Sonar" by Paul A. Lynn and John J. Lavery
5. "Acoustic Communication" edited by Jens Foell, Michael D. Powers, and Richard R. Fay
6. "Underwater Acoustic Modeling and Simulation" by Paul C. Etter
7. "Underwater Communications and Networking" edited by Aylin Yener and Michele Zorzi

Course Outcomes:

On successful completion of this course, the students will be able to

1. Demonstrate a comprehensive understanding of underwater communication's importance, challenges, and water properties' impact on signal propagation.
2. Analyze underwater acoustics, optical communication, and UWSNs, and apply signal processing techniques for underwater communication.
3. Design underwater network architectures, understand routing, multi-hop communication, and MAC protocols for efficient underwater communication.
4. Apply underwater communication technologies to AUV and ROV communication, environmental monitoring, underwater robotics, and military defense applications.
5. Evaluate security threats, encryption methods, and future trends in underwater communication, including IoT and communication with drones, to address emerging challenges.

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ECEL23	AI for Wireless Communication	3L:0P:0T	3 Credits

Course Objective:

- *Understand AI's applications in wireless communication.*
- *Employ AI techniques for resource management in wireless networks.*
- *Implement AI-driven signal processing and beamforming in wireless systems.*
- *Design AI-optimized wireless networks using self-organizing and autonomous management.*
- *Explore AI's role in emerging wireless technologies like 5G and ultra-dense networks.*

Module 1: Introduction to AI and Wireless Communication: **9 Hours**
Overview of AI and its applications in wireless communication-Evolution of wireless communication technologies and standards-The role of AI in addressing wireless communication challenges-Ethical considerations in AI-driven wireless networks **AI for Resource Management**: Dynamic spectrum allocation using AI techniques-Energy-efficient power control and optimization in wireless networks-AI- driven resource allocation for improved network efficiency

Module 2: AI in Signal Processing and Beamforming: **9 Hours**
AI-based channel estimation and equalization-Machine learning for beamforming in MIMO systems-AI-powered interference mitigation techniques. **AI for Network Optimization**: AI-driven network planning, deployment, and optimization-Self-organizing networks and autonomous network management-AI-enabled traffic management and load balancing

Module 3: Cognitive Radio and Spectrum Sensing: **9 Hours**
Introduction to cognitive radio and spectrum sensing-AI techniques for spectrum sensing and decision-making-Applications of cognitive radio in dynamic spectrum allocation. **AI for Security in Wireless Communication**: AI-driven intrusion detection and prevention-Privacy and security challenges in AI-driven networks-AI-enhanced authentication and access control

Module 4: AI in 5G and Beyond: **9 Hours**
AI-powered network slicing and orchestration in 5G- AI-enabled massive MIMO and beam formingtechniques-AI applications in ultra-dense networks and small cell deployments. **AI-Enabled Wireless Applications**: AI-driven Internet of Things (IoT) networks and applications-AI for wireless localization and positioning systems-AI in wireless multimedia and virtual/augmented reality applications

Module 5: Future Trends and Challenges: **9 Hours**
Emerging trends in AI and wireless communication-AI's impact on the evolution of communication standards-Addressing challenges and potential ethical concerns

Total Hours: 45

Text Books:

1. "Artificial Intelligence: A Guide to Intelligent Systems" by Michael Negnevitsky
2. "Wireless Communications: Principles and Practice" by Theodore S. Rappaport
3. "Reinforcement Learning: An Introduction" by Richard S. Sutton and Andrew G. Barto
4. "Machine Learning: A Probabilistic Perspective" by Kevin P. Murphy
5. "5G Mobile and Wireless Communications Technology" by Afif Osseiran, Jose F. Monserrat, and Patrick Marsch

Reference Books:

1. "Artificial Intelligence for Wireless Communication" by P. Chandrasekhar, C. Masouros, J. Thompson, and P. Gao
2. "Machine Learning for Wireless Communication" by X. Zhang, H. Dai, A. Molisch, and S. Zhou
3. "Cognitive Radio Communications and Networks: Principles and Practice" by A. Wyglinski, M. Nekovee, and Y. T. Hou
4. "5G NR: The Next Generation Wireless Access Technology" by E. Dahlman, S. Parkvall, and J. Sköld
5. "Wireless Communications: Principles and Practice" by T. Rappaport, R. Heath, R. Daniels, and J. Murdock

Course Outcomes:

On successful completion of this course, the students will be able to,

1. Demonstrate a comprehensive understanding of AI's applications in wireless communication.
2. Apply AI algorithms for dynamic spectrum allocation and energy-efficient power control.
3. Implement AI-based channel estimation, equalization, and interference mitigation techniques.
4. Design wireless networks with AI-driven planning, deployment, and traffic management.
5. Gain insights into emerging trends and ethical considerations in AI for wireless communication.

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ECEL24	Sequential Circuit Design	3L:0T:0P	3 Credits

Course Objective:

- *understanding of sequential logic, including flip-flops, latches, and their operation, and distinguish between synchronous and asynchronous sequential circuits.*
- *ability to design synchronous and asynchronous sequential circuits using Finite State Machines (FSMs) and Algorithmic State Machines (ASMs).*
- *Learn state reduction, state assignment, and optimization techniques to minimize the complexity and improve the efficiency of sequential circuits.*
- *Explore challenges related to multi-clock systems, and apply synchronization techniques to resolve metastability issues during clock domain crossing.*
- *Engage in hands-on projects to design, simulate, and verify various sequential circuits, honing practical design skills and understanding real-world applications of sequential circuit design principles*

Module 1: Introduction to Sequential Logic: **9 Hours**

Overview of sequential logic and its applications-Classification of sequential circuits: Synchronous vs. Asynchronous- Review of flip-flops, latches, and their operation **Synchronous Sequential Circuit Design**: Finite State Machines (FSMs) and State Diagrams-Designing synchronous sequential circuits using FSMs-Analysis of clocking schemes and timing considerations

Module 2: Algorithmic State Machines (ASM): **9 Hours**

Introduction to ASM charts and ASM block diagrams-ASM design methodology for sequential circuits-ASM-based optimization and state reduction techniques. **Asynchronous Sequential Circuit Design**: Hazard and race condition analysis in asynchronous circuits-Designing hazard-free asynchronous circuits-Metastability and techniques for avoiding metastability

Module 3: Memory Elements and Registers: **9 Hours**

Analysis and design of various types of flip-flops and latches-Design and implementation of shift registers and counters-Register file design and applications. **Advanced Sequential Circuit Design**: Design of sequence detectors and pattern recognition circuits-Finite State Machines for digital control applications- State encoding and optimization techniques for large FSMs

Module 4: Sequential Circuit Testing and Verification: **9 Hours**

Test generation techniques for sequential circuits-State-based and path-based testing methodologies-Formal verification of sequential circuits. **Clock Domain Crossing and Synchronization**: Challenges of crossing clock domains in multi-clock systems-Synchronization techniques and synchronizer design-Metastability resolution in clock domain crossing

Module 5: Introduction to Hardware Description Languages: **9 Hours**

Overview of Verilog or VHDL for digital circuit description: Writing behavioral and structural descriptions of sequential circuits-Simulation and synthesis of sequential circuits using HDLs

Total Hours: 45

Text Books:

1. "Digital Design: Principles and Practices" by John F. Wakerly
2. "Digital Systems: Principles and Applications" by Ronald J. Tocci, Neal S. Widmer, and Gregory L. Moss
3. "Digital Design and Computer Architecture: ARM Edition" by Sarah L. Harris and David Money Harris
4. "Logic and Computer Design Fundamentals" by M. Morris Mano and Charles R. Kime
5. "Introduction to Logic Design" by Alan B. Marcovitz

Reference Books:

1. "Digital Design and Computer Architecture" by David Money Harris and Sarah L. Harris
2. "Sequential Logic and Verilog HDL Fundamentals" by Joseph Cavanagh
3. "Modern Digital Design" by R. C. Jain.
4. "Digital Systems Engineering" by William J. Dally and John W. Poulton
5. "Sequential Logic: Analysis and Synthesis" by Joseph Cavanagh

Course Outcome:

On successful completion of this course, the students will be able to

1. understand of the principles, methodologies, and techniques involved in designing sequential digital circuits.
2. Design synchronous and asynchronous sequential circuits using Finite State Machines (FSMs) and Algorithmic State Machines (ASMs).
3. Apply state reduction, state assignment, and optimization techniques to minimize the complexity of sequential circuits, leading to efficient designs.
4. Analyzing and verifying the correctness and functionality of designed sequential circuits through simulation and testing methodologies.
5. Demonstrate the ability to apply sequential circuit design concepts to real-world engineering problems, enabling them to contribute effectively in digital system design and related industries.

ECEL25	FSO AND LIGHTWAVE COMMUNICATION	3L:0T:0P	3 Credits

Course Objectives:

- *To study about the various optical fiber modes, configuration and transmission characteristics of optical fibers*
- *To learn about the various optical sources, detectors and transmission techniques*
- *To explore various idea about optical fiber measurements and various coupling techniques*
- *To enrich the knowledge about optical communication systems and networks*

MODULE I
INTRODUCTION TO FREE SPACE COMMUNICATION:
Free-space optical channels with and without memory, calculation of channel capacity and various techniques to achieve channel capacity: water-filling, channel inversion, optical phase conjugation, multiplexed coding and decoding, advanced detection techniques.

MODULE II
DIVERSITY AND MIMO TECHNIQUES:
Diversity techniques, MIMO channel model, parallel decomposition, beam forming, space-time modulation and coding, suboptimum receiver interfaces (linear and nonlinear), channel-state information influence, free-space optical MIMO channel capacity.

MODULE III
OPTICAL SOURCES AND DETECTORS:

Sources: Intrinsic and extrinsic material-direct and indirect band gaps-LED-LED structures surface emitting LED-Edge emitting LED-quantum efficiency and LED power-light source materials-modulation of LED-LASER diodes-modes and threshold conditions-Rate equations-external quantum efficiency-resonant frequencies-structures and radiation patterns-single mode laser-external modulation-temperature effort.

Detectors: PIN photo detector-Avalanche photo diodes-Photo detector noise-noise sources-SNR-detector response time-Avalanche multiplication noise-temperature effects comparisons of photo detectors.

MODULE IV
OPTICAL RECEIVER, MEASUREMENTS AND COUPLING

Fundamental receiver operation-preamplifiers-digital signal transmission-error sources-Front end amplifiers-digital receiver performance-probability of error-receiver sensitivity-quantum limit.Optical power measurement-attenuation measurement-dispersion measurement- Fiber Numerical Aperture Measurements-Fiber cut- off Wave length Measurements- Fiber diameter measurements-Source to Fiber Power Launching-Lensing Schemes for Coupling Management-Fiber to Fiber Joints-LED Coupling to Single Mode Fibers- Fiber Splicing Optical Fiber connectors.

MODULE V
OPTICAL COMMUNICATION SYSTEMS AND NETWORKS

System design consideration Point – to –Point link design –Link power budget –rise time budget, WDM – Passive DWDM Components-Elements of optical networks-SONET/SDHOptical Interfaces-SONET/SDH Rings and Networks-High speed light wave Links-OADM configuration-Optical ETHERNET-Soliton.

Text Books:

1. P Chakrabarti, "Optical Fiber Communication‖, McGraw Hill Education (India)Private Limited, 2016
2. Gred Keiser,"Optical Fiber Communication‖, McGraw Hill Education (India) Private Limited. Fifth Edition, Reprint 2013.
3. B.Djordjevic, Advanced Optical and Wireless Communications Systems. Springer International Publishing AG, 2018.

References:

1. John M.Senior, ―Optical fiber communication‖, Pearson Education, second edition.2007.
2. Rajiv Ramaswami, ―Optical Networks ― , Second Edition, Elsevier , 2004.
3. J.Gower, ―Optical Communication System‖, Prentice Hall of India, 2001.
4. Govind P. Agrawal, ―Fiber-optic communication systems‖, third edition, John Wiley & sons, 2004.

Appendix-II

Open Elective Courses

Offered by
Electronics and Communication Engineering Department

OPEN ELECTIVES

Offered by Electronics and Communication Engineering Department

Sr. No.	Course Code	Course Title	Hrs/Week L: T: P	Credits
1	OEEC001	Fundamentals of Electronic Devices and Circuits	3:0:0	3
2	OEEC002	Signals and System	3:0:0	3
3	OEEC003	VLSI Design	3:0:0	3
4	OEEC004	Automotive Electronics	3:0:0	3
5	OEEC005	Networking Essentials	3:0:0	3
6	OEEC006	Advanced Wireless Communication	3:0:0	3
7	OEEC007	Communication For Engineers	3:0:0	3
8	OEEC008	Contemporary Consumer Devices	3:0:0	3
9	OEEC009	Fundamentals of Image and Video Processing	3:0:0	3
10	OEEC010	8051 Microcontroller	3:0:0	3
11	OEEC011	Digital System Design Using Simulation	3:0:0	3
12	OEEC012	IoT and Its Applications	3:0:0	3
13	OEEC013	Nanoelectronics	3:0:0	3

OEEC001	Fundamentals of Electronic Devices and Circuits	3L:0T:0P	3 Credits

Course Objectives:

- *To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits .*
- *To analyze the frequency response of small signal amplifiers*
- *To design and analyze single stage and multistage amplifier circuits*
- *To study about feedback amplifiers and oscillators principles*
- *To understand the analysis and design of multi vibrators*

CONTENTS

MODULE I-SEMICONDUCTOR DEVICES 9 Hours

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

MODULE II-AMPLIFIERS 9Hours

Load line, operating point, biasing methods for BJT and MOSFET**,** BJT small signal model – Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

MODULE III-MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER 9 Hours

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods.

MODULE IV-FEEDBACK AMPLIFIERS AND OSCILLATORS 9 Hours

Advantages of negative feedback – Analysis of Voltage / Current, Series , Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.

MODULE V-POWER AMPLIFIERS AND DC/DC CONVERTERS 9 Hours

Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design.

Total No of Lectures:45

Course Outcomes:

At the end of the course the students will be able to

- Explain the structure and working operation of basic electronic devices.
- Design and analyze amplifiers.
- Analyze frequency response of BJT and MOSFET amplifiers
- Design and analyze feedback amplifiers and oscillator principles.
- Design and analyze power amplifiers and supply circuits

Text Books

1. David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press,5th Edition, 2010.
2. Robert L. Boylestad and Louis Nasheresky, “Electronic Devices and Circuit Theory”, 10th Edition, Pearson Education / PHI, 2008.
3. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7th Edition, 2014.

References

1. Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.
2. D.Schilling and C.Belove, "Electronic Circuits", McGraw Hill, 3 rd Edition, 1989
3. Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI , 2004.

OEEC002	**Signals and System**	**3L:0T:0P**	**3 Credits**

Course Objectives:

- To understand the basic properties of signal & systems
- To know the methods of characterization of LTI systems in time domain
- To analyze continuous time signals and system in the Fourier and Laplace domain
- To analyze discrete time signals and system in the Fourier and Z transform.
- To study the LTIS system performance

CONTENTS

MODULE I-CLASSIFICATION OF SIGNALS AND SYSTEMS 9 Hours

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids_Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals -

Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant& Time-invariant,Causal & Non-causal, Stable & Unstable.

MODULE II-ANALYSIS OF CONTINUOUS TIME SIGNALS 9 Hours

Fourier series for periodic signals - Fourier Transform – properties- Laplace Transforms and Properties

MODULE III-LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS9 Hours

Impulse response - convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems - Systems connected in series / parallel.

MODULE IV-ANALYSIS OF DISCRETE TIME SIGNALS 9 Hours

Baseband signal Sampling–Fourier Transform of discrete time signals (DTFT)– Properties of DTFT - Z Transform & Properties.

MODULE V-LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 9 Hours

Impulse response–Difference equations-Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel.

Total No of Lectures: 45

Text Books:

1. Oppenheim, Willsky and Hamid, "Signals and Systems", 2nd Edition, Pearson Education, New Delhi, 2015.
2. Simon Haykin, Barry Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2002.

Reference Books:

1. B. P. Lathi, "Principles of Linear Systems and Signals", 2nd Edition, Oxford, 2009.
2. M. J. Roberts, "Signals and Systems Analysis using Transform methods and MATLAB", McGraw- Hill Education, 2018.
3. John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007.

Course Outcomes

At the end of the course, the student will be able to:

- Determine if a given system is linear/causal/stable
- Determine the frequency components present in a deterministic signal
- Characterize continuous LTI systems in the time domain and frequency domain
- Characterize discrete LTI systems in the time domain and frequency domain
- Compute the output of an LTI system in the time and frequency domains

OEEC003	VLSI Design	3L:0T:0P	3 Credits

Course Objectives:

- Understand the fundamentals of IC technology components and their characteristics.
- Understand combinational logic circuits and design principles.
- Understand sequential logic circuits and clocking strategies.
- Understand Interconnects and Memory Architecture.
- Understand the design of arithmetic building blocks

CONTENTS

MODULE I-MOS TRANSISTOR PRINCIPLES 9 Hours

MOS logic families (NMOS and CMOS), Ideal and Non-Ideal I-V Characteristics, CMOS devices. MOS(FET) Transistor DC transfer Characteristics, small signal analysis of MOSFET.

MODULE II-COMBINATIONAL LOGIC CIRCUITS 9 Hours

Propagation Delays, stick diagram, Layout diagrams, Examples of combinational logic design, Elmore‟s constant, Static Logic Gates, Dynamic Logic Gates, Pass Transistor Logic, Power Dissipation.

MODULE III-SEQUENTIAL LOGIC CIRCUITS AND CLOCKING STRATEGIES9 Hours

Static Latches and Registers, Dynamic Latches and Registers, Pipelines, Timing classification of Digital Systems, Synchronous Design, Self-Timed Circuit Design.

MODULE IV-INTERCONNECT, MEMORY ARCHITECTURE 9 Hours

Interconnect Parameters – Capacitance, Resistance, and Inductance, Logic Implementation using Programmable Devices (ROM, PLA, FPGA), Memory Architecture and Building Blocks.

MODULE V-DESIGN OF ARITHMETIC BUILDING BLOCKS 9 Hours

Arithmetic Building Blocks: Data Paths, Adders-Ripple Carry Adder, Carry-Bypass Adder, Carry Select Adder, Carry-Look Ahead Adder, Multipliers, Barrel Shifter, power and speed tradeoffs.

Total No of Lectures: 45

Text books:

1. Jan D Rabaey, Anantha Chandrakasan, “Digital Integrated Circuits: A Design Perspective”, PHI, 2016.
2. Neil H E Weste, Kamran Eshranghian, “Principles of CMOS VLSI Design: A System Perspective,” Addison Wesley, 2009.

Reference Books:

1. D.A. Hodges and H.G. Jackson, Analysis and Design of Digital Integrated Circuits, International Student Edition, McGraw Hill 1983
2. P. Rashinkar, Paterson and L. Singh, "System-on-a-Chip Verification-Methodology and Techniques", Kluwer Academic Publishers,2001
3. Samiha Mourad and YervantZorian, “Principles of Testing Electronic Systems”, Wiley 2000
4. M. Bushnell and V. D. Agarwal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers,2000

Course Outcomes

At the end of the course, the student will be able to:

- Determine if a given system is linear/causal/stable
- Determine the frequency components present in a deterministic signal
- Characterize continuous LTI systems in the time domain and frequency domain
- Characterize discrete LTI systems in the time domain and frequency domain
- Compute the output of an LTI system in the time and frequency domains

OEEC004	Automotive Electronics	3L:0T:0P	3Credits

Course Objectives:

This course will enable students to:

- Understand the basics of automobile dynamics and design electronics to complement those features.
- Design and implement the electronics that attribute the reliability, safety, andsmartness to the automobiles, providing add-on comforts
- To study the basic Electronic sensors in automotive.
- To study the digital engine control systems
- To understand the diagnostic and future automotive systems

CONTENTS

MODULE I-AUTOMOTIVE FUNDAMENTALS 9 Hours

Evolution of Automotive Electronics, Automobile Physical Configuration, Survey of Major Automotive Systems, The Engine – Engine Block, Cylinder Head, Four Stroke Cycle, Engine Control, Ignition System - Spark plug, High voltage circuit and distribution, Spark pulse generation, Ignition Timing, Drive Train - Transmission, Steering System, Starter , Battery – Operating principle.

The Basics of Electronic Engine Control – Motivation for Electronic Engine Control – Exhaust Emissions, Concept of an Electronic Engine control system, Control Strategy, Electronic Fuel control system, Analysis of intake manifold pressure, Electronic Ignition.

MODULE II-AUTOMOTIVE SENSORS AND ACUTATORS 9 Hours

Airflow rate sensor, Strain Gauge MAP sensor, Engine Crankshaft Angular Position Sensor, Magnetic Reluctance Position Sensor, Hall effect Position Sensor, Shielded Field Sensor, Optical Crankshaft Position Sensor, Throttle Angle Sensor(TAS), Engine Coolant Temperature (ECT) Sensor, Exhaust Gas Oxygen (O2/EGO) Lambda Sensors, Piezoelectric Knock Sensor. **Automotive Actuators –** Solenoid, Fuel Injector, EGR Actuator, Ignition System

MODULE III-DIGITAL ENGINE CONTROL SYSTEMS 9 Hours

Digital Engine control features, Control modes for fuel Control (Seven Modes), EGR Control, Integrated Engine Control System - Secondary Air Management, Evaporative Emissions Canister Purge, Automatic System Adjustment, System Diagnostics.

MODULE IV- NETWORKING & VEHICLE MOTION CONTROL 9 Hours

Bus Systems – Classification, Applications in the vehicle, Coupling of networks, Examples of networked vehicles, Buses - CAN Bus, LIN Bus, MOST Bus, Bluetooth, Flex Ray, Diagnostic Interfaces.

Vehicle Motion Control – Typical Cruise Control System, Digital Cruise Control System, Digital Speed Sensor, Throttle, Actuator, Digital Cruise Control configuration, Cruise Control Electronics (Digital only), Antilock Brake System (ABS).

MODULEV-AUTOMOTIVE DIAGNOSTICS& FUTURE AUTOMOTIVE ELECTRONIC SYSTEM **9 Hours**

Timing Light, Engine Analyzer, Onboard diagnostics, Off-board diagnostics, Expert Systems, Occupant Protection Systems – Accelerometer based Air Bag systems.

Future Automotive Electronic Systems – Alternative Fuel Engines, Electric and Hybrid vehicles, Fuel cell powered cars, Collision Avoidance Radar warning Systems, Low tire pressure warning system, Heads Up display, Speech Synthesis, Navigation – Navigation

Sensors - Radio Navigation, Signpost navigation, dead reckoning navigation, Voice Recognition Cell Phone dialing, Advanced Cruise Control, Stability Augmentation, Automatic driving Control.

Total No of Lectures:45

Text books:

1. William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, Elsevier Publishing, 2003.
2. Robert Bosch Gmbh (Ed.) Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th edition, John Wiley&Sons Inc., 2007.

References Books:

1.P.D.Kulkarni, "Automotive Electrical and Electronicsystems",1st EditionNiralaiPrakasan Publishing, 2020.

Kishore,"Automotive Electrical and Electronic systems", Lakshmi Publication,2017.

Course Outcomes:

- Acquire an overview of automotive components, subsystems, and basics of Electronic Engine Control in today‟s automotive industry.
- Use available automotive sensors and actuators while interfacing with microcontrollers & microprocessors during automotive system design.
- Understand the networking of various modules in automotive systems, communication protocols and diagnostics of the subsystems.
- Design and implement the electronics that attribute the reliability, safety, and smartness to the automobiles, providing add-on comforts and get fair idea on future Automotive Electronic System.
- Understand the automotive diagnostics and its future enhancements.

OEEC005	Networking Essentials	3L:0T:0P	3 Credits

Course Objectives:

- *To understand the concept of layering in networks.*
- *To know the functions of protocols of each layer of TCP/IP protocol suite.*
- *To visualize the end-to-end flow of information.*
- *To learn the functions of network layer and the various routing protocols*
- *To familiarize the functions and protocols of the Transport layer*

CONTENTS

MODULE I- INTRODUCTION AND APPLICATION LAYER **9 Hours**

Data Communication - Networks – Network Types – Protocol Layering – TCP/IP Protocol suite – OSI Model – Introduction to Sockets - Application Layer protocols: HTTP – FTP – Email protocols (SMTP - POP3 - IMAP - MIME) – DNS – SNMP

MODULE II- TRANSPORT LAYER **9 Hours**

Introduction - Transport-Layer Protocols: UDP – TCP: Connection Management – Flow control - Congestion Control - Congestion avoidance (DECbit, RED) – SCTP – Quality of Service

MODULE III- NETWORK LAYER **9 Hours**

Switching : Packet Switching - Internet protocol - IPV4 – IP Addressing – Subnetting - IPV6, ARP, RARP, ICMP, DHCP

MODULE IV- ROUTING **9 Hours**

Routing and protocols: Unicast routing - Distance Vector Routing - RIP - Link State Routing – OSPF – Path-vector routing - BGP - Multicast Routing: DVMRP – PIM.

MODULE V- DATA LINK AND PHYSICAL LAYERS **9 Hours**

Data Link Layer – Framing – Flow control – Error control – Data-Link Layer Protocols – HDLC – PPP - Media Access Control – Ethernet Basics – CSMA/CD – Virtual LAN – Wireless LAN (802.11) - Physical Layer: Data and Signals - Performance – Transmission media- Switching – Circuit Switching.

Total No of Lectures:45

Text Books:

1. James F. Kurose, Keith W. Ross, Computer Networking, A Top-Down Approach Featuring the Internet, Eighth Edition, Pearson Education, 2021.
2. Behrouz A. Forouzan, Data Communications and Networking with TCP/IP Protocol Suite, Sixth Edition TMH, 2022

Reference Books:

1. Larry L. Peterson, Bruce S. Davie, Computer Networks: A Systems Approach, Fifth Edition, Morgan Kaufmann Publishers Inc., 2012.
2. William Stallings, Data and Computer Communications, Tenth Edition, Pearson Education, 2013.
3. Nader F. Mir, Computer and Communication Networks, Second Edition, Prentice Hall, 2014.
4. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw Hill, 2012.

Course Outcomes:

At the end of this course, the students will be able to:

- Explain the basic layers and its functions in computer networks.
- Understand the basics of how data flows from one node to another.
- Analyze routing algorithms.
- Describe protocols for various functions in the network.
- Analyze the working of various application layer protocols.

OEEC006	Advanced Wireless Communication	3L:0T:0P	3 Credits

Course Objectives:

- *To study the architectures of wireless networks.*
- *To study the modulation and multiplexing schemes.*
- *To study the different wireless communication systems*
- *To study the wireless application in other technologies like VLC, WSN, IoT etc.*
- *To know the future networks and emerging technology.*

CONTENTS

MODULE 1- WIRELESS ARCHITECTURES **9 Hours**

Introduction to Wireless Communication-Basic concepts and principles of wireless communication-Evolution of wireless technologies and standards-Wireless communication system architecture-Wireless communication challenges and opportunities

MODULE2- MODULATION AND MULTIPLEXING SCHEMES **9 Hours**

Wireless Transmission Techniques-Modulation techniques: AM, FM, PM, and digital modulation (e.g., QPSK, QAM)-Multiple Access Techniques: FDMA, TDMA, CDMA, OFDMA-MIMO (Multiple-Input Multiple-Output) technology-Wireless channel models and fading effects-Diversity techniques for mitigating fading

MODULE 3- WIRELESS NETWORKS **9 Hours**

Wireless Networking and Protocols-Wireless local area networks (WLANs) - IEEE 802.11 standards-Wireless metropolitan area networks (WMANs) - IEEE 802.16 standards-Wireless personal area networks (WPANs) - Bluetooth, Zigbee-Mobile communication standards: 2G, 3G, 4G, and beyond-Mobile IP and Mobile Ad hoc Networks (MANETs)

MODULE 4- ADVANCED TOPICS IN WIRELESS COMMUNICATION **9 Hours**

Cognitive radio and dynamic spectrum access-Green communication: Energy-efficient wireless systems-Cooperative communication and relaying techniques-Visible Light Communication (VLC)-Wireless sensor networks (WSNs) and Internet of Things (IoT)

MODULE 5 - EMERGING TRENDS AND FUTURE DIRECTIONS **9 Hours**

5G and beyond: Key features and technologies-Millimeter-wave communication and massive MIMO-Ultra-wideband communication (UWB)-Wireless power transfer and charging-Satellite communication and space-based networks.

Textbooks:

1. Jochen Schiller, "Mobile Communications" Pearson Education, 2008.
2. Dharma P. Agrawal and Qing-An Zeng, "Introduction to Wireless and Mobile Systems" Cengage Learning ,4th edition, 2017
3. William Stallings"Wireless Communications & Networks" Pearson New International Edition (2nd edition), 2013.

Reference Books:

1. William Webb, "Wireless Communications: The Future", John Wiley, 2007.
2. Kaveh Pahlavan and Prashant Krishnamurthy, "Principles of Wireless Networks: A Unified Approach" Prentice Hall, 2002.
3. Savo G. Glisic"Advanced Wireless Communications: 4G Cognitive and Cooperative Broadband Technology" Wiley, 2nd edition 2013.

Course Outcomes:

On successful completion of the module, a student should able to:

- Develop a comprehensive understanding of the fundamental concepts, principles, and challenges of wireless communication systems and their evolution over time.
- Gain knowledge of various wireless transmission techniques, modulation methods, multiple access techniques, MIMO technology, and fading effects, enabling the ability to analyze and design wireless communication links.
- Acquire an in-depth understanding of different wireless networking standards such as IEEE 802.11, IEEE 802.16, Bluetooth, and Zigbee, as well as mobile communication standards like 2G, 3G, and 4G, enabling the design and analysis of wireless network architectures.
- Explore cutting-edge topics in wireless communication, including cognitive radio, green communication, cooperative communication, visible light communication, and wireless sensor networks, fostering an awareness of the latest advancements and future directions in the field.
- Understand the latest developments in wireless communication, including 5G and beyond, millimeter-wave communication, ultra-wideband communication, wireless power transfer, and satellite communication, enabling the ability to evaluate and predict future trends in the wireless communication industry.

OEEC007	Communication For Engineers	3L:0T:0P	3 Credits

Course Objectives:

- *To introduce the basics of electronic communication*
- *To introduce different analog modulation systems.*
- *To introduce the operation of modulator and demodulator for different analogmodulation systems.*
- *To explore the use of pulse modulation system*
- *To introduce the techniques of digital modulation.*

CONTENTS

MODULE I-AM MODULATION **9 Hours**

Amplitude Modulation Systems-External and internal noise - Noise figure - Need for modulation - Amplitude modulation –Frequency spectrum of AM wave – Representation of AM – Power relation – Generation of AM waves –Balanced modulators – Suppression of carrier – DSB and SSB –Demodulation of AM waves – Synchronous and envelope detectors.

MODULE II- FM MODULATION **9 Hours**

Angle Modulation System-Frequency modulation and phase modulation – Mathematical representation of FM – Frequency spectrum of FM wave – Generation of FM wave – Direct and Indirect methods – Demodulation of FM waves – Slope detector –Balanced slope detector – Foster-Seeley discriminator – Ratio detector.

MODULE III- PULSE MODULATION **9 Hours**

Pulse Modulation-Principles of pulse modulation – sampling theorem, PAM – PWM – PPM– Generation of PAM, PPM and PWM waves – Demodulation of PAM, PWM and PPM. Principle of Pulse code modulation - elements of PCM system- Delta modulation and DPCM-transmitter and receiver

MODULE IV- DIGITAL MODULATION **9 Hours**

Digital Communication- Principle of ASK- Transmitter and receiver for coherent BPSK, BFSK and QPSK- Principle of QAM - transmitter and receiver for 8- QAM and 8-PSK. Basic principle of M-ary PSK and M-ary FSK.Bandwidth efficiency and error performance comparisons of PSK, FSK and QAM (detailed derivations not required)

MODULE V- RECEIVERS **9 Hours**

Transmitters and Receivers- Low level and high level AM transmitters – FM transmitter – Super heterodyne AM receiver – Receiver characteristics - Communication receiver – Diversity reception – FM receivers.

Text Books:

1. George Kennedy and Bernard Davis, “Electronic Communication Systems”, Tata Mc Graw Hill, Fourth edition,2008.

2. Simon Haykin, Communication Systems, Wiley, Fourth edition, 2013

Reference Books:

1. Wayne Tomasi, “Electronic Communication Systems”, Pearson Education, Fifth edition, 2008.

2. D. Roddy and Coolen, “Electronic Communications”, Pearson Education, Fourth edition, 2008.

Course Outcomes:

On successful completion of the course students:

- Learn about amplitude modulation systems, including how to generate and demodulate AM waves, and understand the importance of modulation in communication.
- Understand frequency modulation (FM) and phase modulation systems, how to generate FM waves, and how to demodulate them using various techniques like slope detector, balanced slope detector, Foster-Seeley discriminator, and ratio detector.
- Understand about transmitters and receivers, including low-level and high-level AM transmitters, FM transmitters, superheterodyne AM receivers, communication receivers, diversity reception techniques, and FM receivers
- Understand pulse modulation principles, PAM, PWM, PPM generation, demodulation, PCM fundamentals, Delta modulation, and DPCM for transmitters and receivers.
- Understand digital communication principles, including ASK, BPSK, BFSK, QPSK, QAM, and M-ary PSK/FSK, and compare their bandwidth efficiency and error performance.

OEEC008	Contemporary Consumer Devices	3L:0T:0P	3 Credits

Course Objectives:

- *To introduce about Audio and video systems, like speakers and TVs.*
- *To introduce about Domestic appliances, such as washing machines and microwaves.*
- *To learn about Power supplies and preventive maintenance techniques.*
- *To introduce about Everyday systems like remote controls and barcodes.*
- *To learn about Product safety and compliance standards for electronic devices.*

CONTENTS

MODULE I – AUDIO SYSTEMS **9 Hours**

Microphones, loudspeakers baffle and enclosure, Acoustics, mono, stereo, Quad, Amplifying System, Equalizers and Mixers Synthesizers, Commercial Sound, Theatre Sound System.

MODULE II-VIDEO SYSTEMS AND DISPLAYS: **9 Hours**

Monochrome, Colour TV standards, TFT, Plasma, HDTV, LCD,LED TV, Direct-To-Home(DTH- Set Top Box), Video Telephone and Video Conferencing.

MODULE III-DOMESTIC & CONSUMER APPLIANCES: **9 Hours**

Washing machines, Microwave ovens, Air-conditioners and Refrigerators, Computers office System, Telephone & Mobile Radio System

MODULE IV- POWER SYSTEMS AND INTERFACE **9 Hours**

Power Supplies SMPS/UPS and Preventive Maintenance and others systems such as Remote controls, Bar codes, RFID

MODULE V-PRODUCT COMPLIANCE: **9 Hours**

Product safety and liability issues; standards related to electrical safety and fire hazards, EMI/EMC requirements, design techniques for ESD, RF interference and immunity ,line current harmonics and mains voltage surge.

Text Books:

1. SP Bali, “Consumer Electronics”, Pearson Education. 1st edition, 2004.
2. J.S. Chitode, “Consumer Electronics” Technical Publications, Pune, 2007.

Reference Books:

1. Philip Hoff and Ken Juneau, “Consumer Electronics for Engineers", Cambridge University Press, 1998.
2. Dr. B.R. Gupta, V. Singhal" Consumer Electronics", S.K. Kataria & Sons, 6th Edition2013.
3. Homer L. Davidson, "Consumer Electronics Troubleshooting and Repair Handbook"McGraw-Hill, 1998.

Course Outcomes:

Upon the completion of this course, students will demonstrate the ability to:

- Understand electronics engineering concepts used in consumer electronics systems.
- Identify the need of preventive maintenance in various electronic appliances.
- Use different product safety, compliance standards and techniques associated with electronic products.
- Evaluate and analyze different electronic products and systems based on specifications.
- Manage multi-faceted and multi-disciplinary projects with significant technical considerations using a broad systems perspective.

OEEC009	Fundamentals of Image and Video Processing	3L:0T:0P	3 Credits

Course Objectives:

- *To Understanding Image and Video Basics and Compression techniques.*
- *To study techniques for enhancing image and video quality, including contrast adjustment, histogram equalization, and spatial domain filtering.*
- *To explore methods for restoring images and videos that have been degraded by noise, blurring, or other artifacts.*
- *To discuss various segmentation and edge detection techniques.*
- *To study how to partition images and videos into meaningful regions using segmentation techniques.*

MODULE 1- FUNDAMENTALS OF IMAGE AND COMPRESSION STANDARDS

9 Hours

Structure of the Human Eye, Light, Brightness adaption and discrimination, Pixels, coordinate conventions, Imaging Geometry, Spatial Domain Filtering**.** Basics of Discrete Cosine Transform, JPEG compression standard, H.261 video compression standard.

MODULE II- SPATIAL AND FREQUENCY DOMAIN FILTERING 9 Hours

Intensity transformations, contrast stretching, histogram equalization, Correlation and convolution, Smoothing filters, sharpening filters, gradient and Laplacian, Frequency domain filtering. **Color Image Processing:** Color Fundamentals Color space transformation Models Pseudo-color Image Processing.

MODULE III-EDGE DETECTION AND IMAGE RESTORATION 9 Hours

Edge Detection of Discontinuities, Edge detectors, Canny edge detector, Hough Transform. Basic Framework, Image degradation model, Noise characterization, Noise restoration filters, Adaptive filters, and Estimation of Degradation functions, Restoration Techniques.

MODULE VI- MORPHOLOGICAL AND IMAGE SEGMENTATION 9 Hours

Basics of Structuring Element, Erosion, Dilation, Opening, Closing. Pixel and Region-Based Segmentation.

MODULE V – VIDEO PROCESSING 9 Hours

Overview of video processing ;Video representation and formats; Human visual perception and video quality assessment. Video Acquisition and Preprocessing- Video capture devices and sensors, Frame rate conversion and frame interpolation, Noise reduction and video denoising. Video Enhancement–Spatial domain techniques for video enhancement, Temporal filtering and video stabilization, Contrast enhancement and histogram equalization.

Total no. of Hours 45

Textbooks:

1. R. C. Gonzalez, R. E. Woods, "Digital Image Processing", Addison Wesley, 4th Edition2018.
2. Sridhar, "Digital Image Processing", Oxford University Press, 2nd Edition 2017.

References Books:

1. Vipula Singh, Digital Image Processing with MATLAB and LabView, Elsevier, 2012.
2. S. Jayaraman, S.Esakkirajan, T.Veerakumar, Digital Image Processing, TMH. 2nd Edition 2020.

Course Outcomes:

On successful completion of the course the students will be able to:

- Apply spatial and frequency domain image filters for image enhancement.
- Comprehend image degradation models for image restoration and color space transforms for color image processing.
- Interpret and apply edge detection, image segmentation and representation for image recognition.
- Demonstrate the use of image and video processing algorithms for different applications.
- Discuss the video acquisition and video enhancement techniques.

OEEC010	8051 Microcontroller	3L:0T:0P	3 Credits

Course Objectives:

This course will enable students to:

- *Understand the difference between a Microprocessor and a Microcontroller andembedded microcontrollers.*
- *Familiarize the basic architecture of 8051 microcontroller.*
- *Program 8051microprocessor using Assembly Level Language and C.*
- *Understand the interrupt system of 8051 and the use of interrupts.*
- *Understand the operation & use of inbuilt Timers/Counters and Interface 8051 toexternal memory using I/O ports.*

MODULE I -8051 MICROCONTROLLER: 9 Hours

Microprocessor Vs Microcontroller, Embedded Systems, Embedded Microcontrollers, 8051 Architecture- Registers, Pin diagram, I/O ports functions, Internal Memory organization. External Memory (ROM & RAM) interfacing.

MODULE II-8051 INSTRUCTION SET: 9 Hours

Addressing Modes, Data Transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Bit manipulation instructions. Simple Assembly language program examples (without loops) to use these instructions.

MODULEIII- 8051 STACK, I/O PORT INTERFACING 9 Hours

8051 Stack, Stack and Subroutine instructions. Assembly language program examples on subroutine and involving loops - Delay subroutine, Factorial of an 8 bit number (result maximum 8 bit), Block move without overlap, Addition of N 8 bit numbers, Picking smallest/largest of N 8 bit numbers. Interfacing simple switch and LED to I/O ports to switch on/off LED with respect to switch status.

MODULE IV:8051 TIMERS AND SERIAL PORT 9 Hours

8051 Timers and Counters – Operation and Assembly language programming to generate a pulse using Mode-1 and a square wave using Mode-2 on a port pin. 8051 Serial Communication- Basics of Serial Data Communication, RS-232 standard, 9 pin RS232 signals, Simple Serial Port programming in Assembly and C to transmit a message and to receive data serially.

MODULE V: 8051 INTERRUPTS ANDINTERFACING APPLICATIONS 9 Hours

8051 Interrupts. 8051 Assembly language programming to generate an external interrupt using a switch, 8051 C programming to generate a square waveform on a port pin using a Timer interrupt. Interfacing 8051 to ADC-0804, LCD and Stepper motor and their 8051 Assembly language interfacing programming.

Total No. of Hours: 45

Textbooks:

1. Muhammad Ali Mazidi and Janice Gillespie Mazidi and Rollin D, "The 8051 Microcontroller and Embedded Systems – using assembly and C", McKinlay; PHI, 2006 / Pearson, 2006.
2. Kenneth J. Ayala, "The 8051 Microcontroller", 3rd Edition, Thomson/Cengage Learning. 2004.

Reference Books:

1. "The 8051 Microcontroller Based Embedded Systems", Manish K Patel, McGraw Hill, 2014,
2. "Microcontrollers: Architecture, Programming, Interfacing and System Design", Raj Kamal, Pearson Education, 2005.

Course Outcomes:

On successful completion of this course, the students will be able to,

- Explain the difference between Microprocessors & Microcontrollers, Architecture of 8051 Microcontroller, Interfacing of 8051 to external memory and Instruction set of 8051.
- Explain the Interrupt system, operation of Timers/Counters and Serial port of 8051.
- Write 8051 Assembly language program to generate timings and waveforms using 8051 timers, to send & receive serial data using 8051 serial port and to generate an external interrupt using a switch.
- Write 8051 C programs to generate square wave on 8051 I/O port pin using interrupt and to send & receive serial data using 8051 serial port.
- Interface simple switches, simple LEDs, ADC 0804, LCD and Stepper Motor to 8051 using 8051 I/O ports.

OEEC011	Digital System Design Using Simulation	3L:0T:0P	3 Credits

Course Objectives:

This course will enable students to:

- *Understand the concepts of Simulation Language.*
- *Design the digital systems as an activity in a larger systems design context.*
- *Study the design and operation of semiconductor memories frequently used in application specific digital system.*
- *Inspect how effectively IC's are embedded in package and assembled in PCB's for different application.*
- *Design and diagnosis of processors and I/O controllers used in embedded systems.*

MODULE I- INTRODUCTION AND METHODOLOGY 9 Hours

Digital Systems and Embedded Systems, Real-World Circuits, Models, Design Methodology. Combinational Basics: Combinational Components and Circuits, Verification of Combinational Circuits. Sequential Basics: Sequential Data paths and Control Clocked Synchronous Timing Methodology.

MODULE II-MEMORIES:9 Hours

Concepts, Memory Types, Error Detection and Correction**.** Designing memory elements (RAM, ROM), Introduction to programmable logic devices (PLDs).Packaging and Circuit boards, Interconnection and Signal integrity.

MODULE III-I/O INTERFACING: 9 Hours

I/O devices, I/O controllers, Parallel Buses, Serial Transmission, I/O software

MODULE IV-DESIGN METHODOLOGY: 9 Hours

Design flow, Design optimization, Design for test, Nontechnical Issues. Flip-flops and registers. Designing finite state machines (FSMs). Timing considerations in sequential circuits.

MODULE V-TESTING AND EMERGING TOPICS: 9 Hours

Integrated Circuits, Digital System Testing and Verification: Testbench automation and coverage analysis, Assertion-based verification (ABV), Introduction to formal verification. Advanced Topics and Emerging Trends:-Design for testability (DFT) techniques, Low-power design considerations, Emerging trends in digital system design and simulation.

Total No. of Hours: 45

Textbooks:

1. Peter J. Ashenden, "Digital Design: An Embedded Systems Approach Using VERILOG", Elesvier, 2010.
2. John M Yarbrough, "Digital Logic Applications and Design", Thomson Learning, 2001.

Reference Books:

1. Charles H Roth Jr., "Fundamentals of logic design", Cl-Engineering; 7th edition, 2013.
2. Sudhakar Samuel, "Logic Design", Pearson/ Sanguine, 2007.
3. Franco Fummi, Cristiano Metra, and Giovanni Perbellini, "Design for Testability in Digital Integrated circuits and Systems"2006

Course Outcomes:

On successful completion of this course, the students will be able to,

- Construct the combinational circuits, using discrete gates and programmable logic devices.
- Describe simulation model for sequential circuits and test pattern generation. Design asemiconductor memory for specific chip design.
- Design embedded systems using small microcontrollers, larger CPUs/DSPs, or hard or soft processor cores.
- Synthesize different types of processor and I/O controllers that are used in embedded system.
- Implement the design and testing analysis in digital system design.

OEEC012	IoT and its Applications	3L:0T:0P	3 Credits

Course Objectives:

This course will enable students to:

- *To study the fundamentals about IoT.*
- *To study about IoT Access technologies.*
- *To study the design methodology and different IoT hardware platforms.*
- *To study the basics of IoT Data Analytics and supporting services.*
- *To study about various IoT case studies and industrial applications.*

MODULE I -FUNDAMENTALS OF IoT **9 Hours**

Evolution of Internet of Things, Enabling Technologies, M2M Communication, IoT World Forum (IoTWF) standardized architecture, Simplified IoT Architecture, Core IoT Functional Stack, Fog, Edge and Cloud in IoT, Functional blocks of an IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects.

MODULE II-IoT PROTOCOLS: **9 Hours**

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE802.15.4, 802.11ah and Lora WAN, Network Layer: IP versions, Constrained Nodes and Constrained Networks,6LoWPAN, Application Transport Methods: SCADA, Application Layer Protocols:CoAP and MQTT.

MODULE III -DESIGN AND DEVELOPMENT: **9 Hours**

Design Methodology, Embedded computing logic, Microcontroller, System on Chips, IoT system building blocks. IoT Platform overview: Overview of IoT supported Hardware platforms such as: Raspberry pi, Arduino Board details.

MODULE IV- DATA ANALYTICS AND SUPPORTING SERVICES: **9 Hours**

Data Analytics: Introduction, Structured Versus Unstructured Data, Data in Motion versus Data at Rest, IoT Data Analytics Challenges, Data Acquiring, Organizing in IoT/M2M. **Supporting Services:** Computing Using a Cloud Platform for IoT/M2M Applications/Services, Everything as a service and Cloud Service Models.

MODULE V-INDUSTRIAL APPLICATIONS: **9 Hours**

IoT applications in home, infrastructures, buildings, security, Industries, Home appliances, other IoT electronic equipment‟s, Industry 4.0 concepts.

Total No. of Hours : 45

Textbooks:

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internetof ThingsCisco Press, 2017.
2. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”,Universities Press, 2015.

Reference Books:

1. Olivier Hersent, David Boswarthick, Omar Elloumi,“The Internet of Things – Key applications and Protocols”,Wiley, 2012.
2. Jan Ho¨ ller, VlasiosTsiatsis, Catherine Mulligan, Stamatis,Karnouskos, Stefan Avesand. David Boyle ,“From Machine-to-Machine to the Internet of Things – Introduction to a New Ageof Intelligence”,Elsevier, 2014.
3. Dieter Uckelmann, Mark Harrison, Michahellesand Florian (Eds), “Architecting the Internet of Things”,Springer,2011.

Course Outcomes:

On successful completion of this course, the students will be able to,

- Understand the basics of IoT.
- Implement the state of the Architecture of anIoT.
- Understand design methodology and hardware platforms involved in IoT.
- Understand how to analyze and organize the data.
- Compare IOT Applications in Industrial & real world.

OEEC013	Nanoelectronics	3L:0T:0P	3 Credits

Course Objectives:

This course will enable students to:

- *To study the fundamentals about Nanoelectronics.*
- *To study about architectures of nanocomputer.*
- *To study the fabrication methodology of nanoelectronics.*
- *To study the basics of spintronics.*
- *To study about various memory devices and sensors.*

MODULE I- INTRODUCTION TO NANO ELECTRONICS 9 Hours

Recent past, the present and its challenges, Future, Overview of basic Nano electronics: nanomaterials, types of nano structures, properties and applications.

MODULE II-NANO-ELECTRONICS & NANO-COMPUTER ARCHITECTURES:9 Hours

Introduction to Nano-computers, Nano-computer Architecture, Quantum DOT cellular Automata (QCA), QCA circuits, Single electron circuits, molecular circuits, Logic switches – Interface engineering – Properties (Self-organization, Size-dependent) – Limitations.

MODULE III-NANOELECTRONIC ARCHITECTURES: 9 Hours

Nanofabrication – Nanopatterning of Metallic/Semiconducting nanostructures (e-beam/X-ray, Optical lithography, STM/AFM- SEM & Soft-lithography) – Nano phase materials – Self assembled Inorganic/Organic layers.

MODULE IV-SPINTRONICS: 9 Hours

Introduction, Overview, History & Background, Generation of Spin Polarization Theories of spin Injection, spin relaxation and spin dephasing, Spintronic devices and applications, spin filters, spin diodes, spin transistors.

MODULE V-MEMORY DEVICES AND SENSORS: 9 Hours

Memory devices and sensors – Nano ferroelectrics – Ferroelectric random access memory – Fe-RAM circuit design –ferroelectric thin film properties and integration – calorimetric - sensors – electrochemical cells – surface and bulk acoustic devices – gas sensitive FETs – resistive semiconductor gas sensors –electronic noses – identification of hazardous solvents and gases – semiconductor sensor array.

Total No. of Hours: 45

Textbooks:

1. J.M. Martinez-Duart, R.J. Martin Palma, F. Agulle Rueda “Nanotechnology for Microelectronics and optoelectronics” , Elsevier, 2006.
2. W.R. Fahrner, “Nanotechnology and Nanoelectronics”, Springer, 2005.

Reference Books:

1. Chattopadhyay, Banerjee, "Introduction to Nanoscience & Technology", PHI 2012.
2. Poole, "Introduction to Nanotechnology", John Wiley 2006.
3. George W. Hanson, "Fundamentals of Nanoelectronics", Pearson Education, 2009.

Course Outcomes:

On successful completion of this course, the students will be able to,

- Understand the basics of nanoelectronics.
- Implement the state of the Architectures of nano-computer.
- Understand fabrication methodology of nanoelectronics.
- Understand the basics of spintronics.
- Distinguish about various memory devices and sensors.

Appendix-III

Minor Degree courses

Offered by

Electronics and Communication

Engineering (ECE)

I. Minor Degree in Embedded Systems

Sl.No.	Course Code	Course Title	Hrs /Week L: T: P	Credits
1	ECM4001	Microcontrollers and its Applications	4:0:0	4
2	ECM4002	Embedded Core Design	4:0:0	4
3	ECM4003	Embedded C Programming and RTOS	4:0:0	4
4	ECM4004	Embedded Networking	4:0:0	4
5	ECM1005	System design using ARM Controllers	4:0:0	4
6	ECM1006	Embedded Software Testing	4:0:0	4

MINOR IV
EMBEDDED SYSTEMS

ECM4001	MICROCONTROLLER & ITS APPLICATIONS	4L:0T:0P	4 Credits

Course Objectives:

- *Understanding Microcontroller Architecture: To provide students with a thorough understanding of the internal architecture and organization of microcontrollers, including the CPU, memory, peripherals, and I/O ports.*
- *Programming Skills: To teach students how to write efficient and effective programs for microcontrollers using embedded C or other relevant programming languages.*
- *Interfacing Techniques: To introduce students to various interfacing techniques required to connect microcontrollers with external devices and sensors, both digital and analog.*
- *Real-World Applications: to showcase the versatility of microcontrollers by exploring their applications in different fields such as robotics, home automation, industrial control, medical devices, automotive systems, etc.*
- *To study about the various microcontroller development boards.*

Course Contents:

MODULE-I

MICROCONTROLLER BASICS: 12 hours

Architecture of MCS-51 microcontroller. Memory structure, different registers (SFR's), addressing modes. Timing Diagram, timing diagram for execution cycle. Concept of assembler directives, editor, linker, loader, debugger, simulator, emulator. Instruction set, basic programming using 8051 instructions RISC Microcontrollers, introduction to AVR series microcontrollers. Introduction to ARM7 microcontroller (LPC2148)

MODULE -II

MICROCONTROLLER PROGRAMMING: 12 hours

Introduction to embedded-C, Integrated Development Environment (IDE), cross compiler, ISP, software delay generation. Programming with alphanumeric LCD and matrix keypad. I/O Programming: I/O programming, interfacing with simple switch, LED. Seven segment interfacing techniques.

MODULE -III

MICROCONTROLLER INTERFACING: 12 hours

On-Chip Peripheral Interfaces: Programming with on-chip Timers, Counters, UART, RS485 transceiver. External Interfaces: Analog to digital convertor, interfacing with external serial and parallel ADC's, Digital to analog convertor (DAC), interfacing with DAC, Interfacing with stepper motor and DC motor.

MODULE- IV

MICROCONTROLLER APPLICATIONS: 12 hours

Embedded Systems: Home automation, Industrial automation control, Automotive systems
Consumer electronics (e.g., smart devices)Internet of Things (IoT) Devices: Sensor nodes for data collection, Remote monitoring and control systems

MODULE- V

MICROCONTROLLER DEVELOPMENT BOARDS: 12 hours

Introduction to popular microcontroller development boards like Arduino, Raspberry Pi, STM32, ESP8266 and ESP32 Boards, PIC Development Boards, Teensy Boards, Beagle Bone, Adafruit and Spark Fun Boards

Total No. of Hours: 60

Text Books:

1. The 8051 Microcontroller and Embedded Systems Using Assembly and C" by Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin D. McKinlay.
2. Microcontrollers: From Assembly Language to C Using the PIC24 Family" byRobert B. Reese, J.W. Bruce, and Bryan A. Jones.

Reference Books:

1. Ayala, K.J., The 8051 Microcontroller Architecture, Programming and Applications, Penram International Publishing (India) Pvt. Ltd. (2007).
2. Mazidi, M.A., The 8051 Microcontroller and Embedded System, Pearson Education (2008).
3. Predko, M., Customizing the 8051 Microcontroller, Tata McGraw-Hill (2002)

COURSE OUTCOMES:

On successful completion of this course, the students will be able to

- Describe the internal architecture of microcontrollers
- Write, debug, and optimize embedded C programs for microcontrollers
- Understand the concepts of timers and interrupts and apply them effectively for precise timing and event handling in real-time applications.
- Explore advanced topics such as power management, real-time operating systems (RTOS),and low-power techniques for optimizing microcontroller-based systems.
- Gain knowledge about various microcontroller development boards.

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ECM4002	EMBEDDED CORE DESIGN	4L:0T:0P	4 Credits

Course Objectives:

- To Understand Embedded Systems: Introduce students to the concept of embedded systems, their characteristics, and their role in various applications and industries.
- To Study Core Processor Architecture: Familiarize students with the internal architecture and organization of core processors, including CPU, memory, registers, and I/O peripherals.
- To Learn Assembly and C Programming: Enable students to learn and apply programming skills using both assembly language and higher-level programming languages like C for core processors.

- To Interface Peripherals and Devices: Teach students how to interface various peripherals, sensors, and external devices with core processors, allowing them to interact with the outside world.
- To Implement Communication Protocols: Introduce students to common communication protocols (e.g., UART, SPI, I2C) and provide hands-on experience in implementing them for data exchange between the core processor and external devices.

MODULE –I

ELEMENTS OF EMBEDDED SYSTEM : 12 hours

Abstraction levels – Transistors to Programs – Mixed level hardware – Design Specification – **Embedded system design flow** – Hardware / Software Partitioning – Hardware port – Software Port – Interconnection Specification – Common Hardware/ Software Simulation – Hardware Synthesis – Software Compilation – Interconnection Hardware Generation – Design Integrator – **Design Tools** – Block Diagram Description – HDL and other hardware Simulators – Hardware synthesis tool – Compiler for Machine Language Generation – Software Builder and Debugger – Embedded System Integrator – Hardware design trends – Configurable processors – Standard Bus Structure – Software Programming – Software Utilities.

MODULE –II

RTL DESIGN WITH VHDL : 12 hours

Basic Structures of VHDL – VHDL Overview and Concepts – VHDL Types – VHDL Object Classes – VHDL Design Units – Basic Language Elements – Lexical Elements – Syntax – Types and Subtypes – Attributes – Control Structures – if statement – case statement – loop statement – Drivers – Resolution function – Drivers – Ports – VHDL Timing – Signal Attributes – WaitStatement – Modeling with zero time delays – Inertial / Transport Delay –Elements of Entity / Architecture – Entity – Architecture – Process Statement – Concurrent Signal Assignment Statement
– Component Instantiation Statement – Concurrent Procedure Call – Generate Statement – Concurrent Assertion Statement – Block Statement – Subprograms – Subprogram Definition –Functions and Procedures – Packages.

MODULE –III

FIELD PROGRAMMABLE DEVICES : 12 hours

Read Only Memories – Basic ROM Structure – NOR Implementation – Distributed Gates – Array Programmability – Memory View – ROM Variations – **Programmable Logic Arrays** – PAL Logic Structure – Product Term Expansion – Three State Outputs – Registered Outputs – Commercial Parts – **Complex Programmable Logic Devices** – Altera‘s MAX 7000S CPLD – Field Programmable Gate Arrays – Altera‘s Flex 10K FPGA – Altera‘s Cyclone FPGA.

MODULE- IV

DESIGN WITH EMBEDDED PROCESSORS : 12 hours

Embedded Design Steps – Processor Selection – Processor Interfacing – Developing Software – **Filter Design** – Filter Concepts – FIR Filter Hardware Implementation – FIR Embedded Implementation – Building the FIR filter – **Design of a Microcontroller** – System Platform – Microcontroller Architecture.

MODULE- V

DESIGN OF AN EMBEDDED SYSTEM : 12 hours

Designing an Embedded System – **Nios II Processor** – Configurability Features of Nios II – Processor Architecture – Instruction Set – Nios II Alternative Cores – **Avalon Switch Fabric** – Avalon Specification – Address Decoding Logic – Data Path Multiplexing – Wait – state insertion –

Pipelining – Endian Conversion – Address Alignment and Dynamic Bus sizing – Arbitration for Multi-Master systems – Burst management – Clock Domain Crossing – Interrupt Controller – Reset Distribution – **SOPC Builder Overview** – Architecture of SOPC Builder Systems – Functions of SOPC Builder – **Integrated Development Environment** – IDE Project Manager – Source Code Editor – C/C++ Compiler – Debugger – Flash Programmer- **Case Study**: Calculator – System Specification – Calculator IO Interface – Design of Calculating Engine – Building Calculator Software – Calculator Program – Completing the calculator System.

Total No. of Hours:60

Text Books:

1. ZainalabedinNavabi, ―Embedded Core Design With FPGAs―, Tata McGraw Hill, 2008.
2. Ben Cohen, ‑VHDL Coding Styles and Methodologies,‖ Kluwer Academic Publishers, 2007.

Reference Books:

1. ZainalabedinNavabi, ―VHDL Analysis and Modeling of Digital Systems,‖ Tata McGraw Hill, 1992.
2. Patterson.D.A, J.L.Hennessy and P.J. Ashenden, ―Computer Organization and Design: The Hardware / Software Interface,‖ 3rd Edition, 2004.
3. J.Bhasker, ‑VHDL Primer,‖ 3rd Edition, Dorling Kindersley (india) Pvt Ltd.,2007.

Course Outcome:

- Understand Embedded Systems Gain a solid understanding of embedded systems, their components, and their role in various applications.
- Comprehend the internal architecture and organization of core processors, including CPU, memory, registers, and I/O peripherals.
- Develop proficiency in programming core processors using both assembly language and higher-level programming languages like C.
- Learn how to interface various peripherals, sensors, and external devices with core processors.
- Understand and implement communication protocols (e.g., UART, SPI, I2C) for data exchange between the core processor and external devices.

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ECM4003	EMBEDDED C PROGRAMMING AND RTOS	4L:0T:0P	4 Credits

Course Objective:

- *Understand the fundamentals of embedded systems and their applications in real-world scenarios.*
- *Familiarize with the 8051 microcontroller family, including its architecture, I/O capabilities, timers, and serial interface.*
- *Learn techniques for reading switches and handling switch bounce effectively.*
- *Gain knowledge about adding structure to embedded code using object-oriented programming in C.*
- *Explore real-time constraints in embedded systems and learn to create hardware and software timeouts.*

Course Contents :

MODULE – I **12 hours**

Programming Embedded Systems in C Introduction ,What is an embedded system, Which processor should you use, Which programming language should you use, Which operating system should you use, How do you develop embedded software, Conclusions Introducing the 8051 Microcontroller Family Introduction, What‘s in a name, The external interface of the Standard 8051, Reset requirements ,Clock frequency and performance, Memory issues, I/O pins, Timers, Interrupts, Serial interface, Power consumption ,Conclusions

MODULE – II **12 hours**

Reading Switches Introduction, Basic techniques for reading from port pins, Example: Reading and writing bytes, Example: Reading and writing bits (simple version), Example: Reading and writing bits (generic version), The need for pull-up resistors, Dealing with switch bounce, Example: Readingswitch inputs (basic code), Example: Counting goats, Conclusions

Adding Structure to the Code Introduction, Object-oriented programming with C, The Project Header (MAIN.H), The Port Header (PORT.H), Example: Restructuring the _Hello Embedded World‘ example, Example: Restructuring the goat-counting example, Further examples, Conclusions

MODULE – III **12 hours**

Meeting Real-Time Constraints Introduction, Creating _hardware delays‘ using Timer 0 and Timer 1, Example: Generating a precise 50 ms delay, Example: Creating a portable hardware delay, Why not use Timer 2, The need for _timeout‘ mechanisms, Creating loop timeouts, Example: Testing loop timeouts, Example: A more reliable switch interface, Creating hardware timeouts, Example: Testing a hardware timeout, Conclusions

Case Study: Intruder Alarm System Introduction, The software architecture, Key software components used in this example, running the program, the software, Conclusions

MODULE-IV **12 hours**

Rtos Based Embedded System Design Operating : System Basics, Types of Operating Systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling.

MODULE- V **12 hours**

Task Communication: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization:Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, Methods to Choose an RTOS.

Total No. of Hours: 60

Text Books :

1. Embedded C - Michael J. Pont, 2nd Ed., Pearson Education, 2008
2. Advanced C - Peter D. Hipson, Sams Publishing, USA, 1992

Reference Books :

1. PICmicro MCU C-An introduction to programming, The Microchip PIC in CCS C - Nigel Gardner
2. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill.
3. Embedded Systems - Raj Kamal, TMH.

4. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.
5. Embedded Systems – Lyla, Pearson, 2013
6. An Embedded Software Primer - David E. Simon, Pearson Education

Course Outcome:

On Completion of the course the students will be able to develop the

- Ability to design and develop embedded systems using the 8051 microcontroller family.
- Proficiency in reading and writing data from/to port pins and handling switch inputs reliably.
- Competence in restructuring code using object-oriented principles for better maintainability and modularity.
- Skill in meeting real-time constraints by creating hardware delays and timeouts.
- Understanding of operating system basics, multitasking, task communication, and synchronization in RTOS-based embedded system design.

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ECM4004	EMBEDDED NETWORKING	4L:0T:0P	4 Credits

Course Objectives:

- *To expose the students to the fundamentals of wired embedded networking techniques.*
- *To introduce the concepts of embedded ethernet.*
- *To expose the students to the fundamentals of wireless embedded networking.*
- *To discuss the fundamental building blocks of digital instrumentation.*
- *To introduce design of Programmable measurement & control of electrical Device.*

Course Contents :

MODULE – I **12 hours**

EMBEDDED PROCESS COMMUNICATION WITH INSTRUMENT BUS : Embedded networking: Introduction – Cluster of instruments in System: Introduction to bus protocols – comparison of bus protocols – RS 232C, RS 422, RS 485 and USB standards – embedded Ethernet – MOD bus, LIN bus and CAN bus.

MODULE- II **12 hours**

EMBEDDED ETHERNET: Elements of a network – Inside Ethernet – Building a Network : Hardware options – Cables, Connections and network speed – Ethernet controllers – Inside the internet protocol – Exchanging messages using UDP and TCP – Email for Embedded systems using FTP – Keeping devices and network secure

MODULE III **12 hours**

WIRELESS EMBEDDED NETWORKING : Wireless sensor networks – Introduction – Node architecture – Network topology -Localization – Time synchronization – Energy efficient MAC protocols – SMAC – Energy efficient and robust routing – Data centric routing - WSN Applications - Home Control - Building Automation - Industrial Automation

MODULE IV **12 hours**

BUILDING SYSTEM AUTOMATION : Sensor Types & Characteristics: Sensing Voltage, Current, flux, Torque, Position, Proximity, Accelerometer - Data acquisition system- Signal conditioning circuit design- Uc

Based & PC based data acquisition – UC for automation and protection of electrical appliances –processor based digital controllers for switching Actuators: Stepper motors, Relays –System automation with multi- channel Instrumentation and interface

MODULE V **12 hours**

COMMUNICATION FOR LARGE ELECTRICAL SYSTEM AUTOMATION: Data Acquisition, Monitoring, Communication, Event Processing, and Polling Principles, SCADA system principles – outage management– Decision support application - substation automation, extended control feeder automation, Performance measure and response time, SCADA Data Models, need, sources, interface.

Total No. of Hours: 60

Textbooks:

1. "Embedded Systems: Architecture, Programming, and Design" by Raj Kamal.
2. "Embedded Systems: Real-Time Operating Systems for ARM Cortex-M Microcontrollers" by Jonathan Valvano.
3. "TCP/IP Illustrated, Volume 1: The Protocols" by W. Richard Stevens, Gary R. Wright.
4. "Wireless Sensor Networks: Principles and Practice" by Narendra Kumar, S. C. Sharma, Manoj Kumar.
5. "Industrial Automation and Robotics: An Introduction" by A. K. Gupta, S. K. Arora.

Reference Books:

1. "Interfacing PIC Microcontrollers: Embedded Design by Interactive Simulation" by Martin P. Bates.
2. "Embedded Systems Design with the Atmel AVR Microcontroller" by Steven F. Barrett, Daniel J. Pack.
3. "Ethernet: The Definitive Guide" by Charles E. Spurgeon.
4. "Industrial Automation: Hands-On" by Frank Lamb.
5. "SCADA: Supervisory Control and Data Acquisition" by Stuart A. Boyer, Edward J. Wegman.

Course Outcome:

- Ability to design and implement communication interfaces using various bus protocols, Ethernet, and wireless sensor networks for embedded systems.
- Proficiency in selecting appropriate hardware options, cables, and connections for building efficient networks.
- Competence in programming microcontrollers and developing embedded systems for automation, data acquisition, and control applications.
- Skill in utilizing sensors and actuators for building automation and developing digital controllers for switching applications.
- Understanding of SCADA system principles, data models, and their application in large electrical system automation for efficient monitoring, control, and decision support.

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ECM1005	SYSTEM DESIGN USING ARM CONTROLLERS	4L:0T:0P	4 Credits

Course Objectives:

At the end of the course, the students will be able to

- *Understand the embedded system based on ARM processor and its hardware (ARM processor Core).*
- *Understand the techniques and rules for writing efficient C code and optimizing ARM assembly code.*
- *Discuss various Cache technologies and Architecture that surrounds the ARM cores.*
- *Understand the various memory management techniques in RISC.*
- *Understand the architecture of ARM CORTEX-M3.*

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Course Contents :

MODULE-I **12 hours**

ARM Architecture: ARM Design Philosophy, Registers, Program Status Register, Instruction Pipeline, Interrupts and Vector Table, Architecture Revision, ARM Processor Families.

MODULE-II **12 hours**

ARM Programming Model – I:Instruction Set: Data Processing Instructions, Addressing Modes, Branch, Load -Store Instructions, PSR Instructions, Conditional Instructions. **ARM Programming Model – II:** Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing Instructions, Single-Register and Multi Register Load-Store Instructions, Stack, Software Interrupt Instructions.

MODULE-III **12 hours**

ARM Programming: Simple C Programs using Function Calls, Pointers, Structures, Integer and Floating Point Arithmetic, Assembly Code using Instruction Scheduling, Register Allocation, Conditional Execution and Loops. Exception Handling , Interrupts , Interrupt handling schemes, Firmware and boot loader.

MODULE-IV **12 hours**

Memory Management: Cache Architecture, Polices, Flushing and Caches, MMU, Page Tables, Translation, Access Permissions, Context Switch.

MODULE-V **12 hours**

ARM Cortex-M3: ARM Cortex-M3 Processor –Architecture- Instruction Set Development-The Thumb-2 Technology and Instruction Set Architecture-CORTEX-M3 Applications.

Total No. of Hours: 60

Text Books:

1. Marilyn Wolf, Computers as Components – Principles of Embedded Computing System Design, Third Edition Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.
2. Raj Kamal Embedded Systems: Architecture, Programming and Design 3rd Edition, Mc Graw Hill India 2014.
3. Jonathan W. Valvano, Embedded Systems: Real-Time Interfacing to Arm Cortex-M

Microcontrollers 5th Edition, Createspace Independent Publishing Platform, 2016.

References Books:

1. Jason Bakos, Embedded systems: ARM programming and optimization Morgan Kaufmann, 2015.
2. Steve Furber, ARM System-on-Chip Architecture (2nd Edition) Pearson India, 2015.
3. Joseph Yiu, The Definitive Guide to ARM Cortex -M3 and Cortex -M4 Processors, Third Edition 3rd Edition, Elsevier Inc, 2014.

Course Outcome:

At the end of the course, the students will be able to

- Understand the fundamentals of ARM architecture, including its registers, instruction pipeline, and interrupt handling.
- Gain proficiency in programming ARM processors using both the ARM and Thumb instruction sets.
- Develop the skills to write simple C programs for ARM-based systems, including using function calls, pointers, and structures.
- Learn about memory management, cache architecture, and MMU, enabling efficient memory usage and context switching in ARM systems.
- Acquire knowledge of the ARM Cortex-M3 processor, its instruction set, and its applications, enabling the development of embedded systems using this architecture.

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ECM1006	EMBEDDED SOFTWARE TESTING	4L:0P:0T	4 Credits

Course Objective:

- *Learn the basics of embedded software testing and understand the testing process for embedded systems.*
- *Develop skills in writing and executing test cases for embedded software units and components.*
- *Gain knowledge of integration testing techniques and challenges in testing communication interfaces.*
- *Understand validation and verification processes, including code coverage analysis.*
- *Explore advanced testing techniques, including performance testing, security testing, and continuous testing for embedded systems.*

Module I: 12 hours

INTRODUCTION TO EMBEDDED SOFTWARE TESTING:

Understanding the basics of embedded systems and their software components-Overview of the software development life cycle for embedded systems-Introduction to testing concepts, test levels, and types-Unit testing: Writing and executing test cases for individual software units-Basic test automation techniques for embedded systems.

Module II: 12 hours

EMBEDDED SYSTEM TEST TECHNIQUES:

Boundary value analysis and equivalence partitioning for input testing-Static and dynamic analysis of embedded code-White-box and black-box testing techniques for embedded software-Structural

and functional testing methods for different components-Techniques for testing interrupts, timers,and I/O operations.

Module III: 12 hours

INTEGRATION TESTING IN EMBEDDED SYSTEMS:

Understanding the challenges of integrating embedded software modules-Developing test scenarios for integration testing-Integration testing approaches: Top-down and bottom-up-Testing communication interfaces and data flow between modules-Techniques for simulating external devices and peripherals.

Module IV 12 hours

VALIDATION AND VERIFICATION-SOFTWARE VALIDATION:

Ensuring the software meets user requirements-Developing validation test cases based on system requirements-Verification techniques: Inspecting and reviewing software artifacts-Code coverage analysis for assessing testing completeness-Validation and verification of safety-critical embedded systems.

Module V 12 hours

ADVANCED TESTING TECHNIQUES FOR EMBEDDED SYSTEMS:

Performance testing and optimization for resource-constrained systems-Stress testing and reliability testing in embedded environments-Security testing and vulnerability assessment for embedded software-Test case reuse and regression testing strategies-Implementing continuous integration and continuous testing for embedded systems.

Total No. of Hours: 60

Textbooks:

1. "Embedded Software Testing: Techniques and Tools" by Bart Broekman and Edwin Notenboom (1st edition, 2018).
2. "Embedded Systems: Introduction to Arm® Cortex™-M Microcontrollers" by Jonathan W. Valvano (6th edition, 2020).
3. "Testing Embedded Software" by Bart Broekman and Edwin Notenboom (1st edition, 2008).
4. "Embedded Systems: Real-Time Operating Systems for Arm Cortex-M Microcontrollers" by Jonathan W. Valvano (5th edition, 2019).
5. "Testing Embedded Software Using the C++ Standard Template Library" by Doug Abbott (1st edition, 2017).

Reference Books:

1. "Embedded Systems: Design, Analysis and Verification" by Prabhat Mishra and Nikolaos Bourbakis (2nd edition, 2020).
2. "Embedded Systems: Architecture, Programming and Design" by Raj Kamal (2nd edition, 2020).
3. "Embedded Software: The Works" by Colin Walls (1st edition, 2012).
4. "Software Testing Techniques: Finding the Defects that Matter" by Rex Black, Erik van Veenendaal, and Dorothy Graham (3rd edition, 2019).
5. "Embedded Software Development with C" by Kai Qian, David Den Haring, and Li Cao (1st edition, 2019).

Course Outcome:

- Proficiency in testing embedded software components using unit testing and integration testing techniques.
- Ability to apply boundary value analysis and equivalence partitioning for effective testing.
- Understanding of validation and verification methods, ensuring software meets requirements.
- Competence in testing communication interfaces and handling external devices in embedded systems.
- Knowledge of advanced testing techniques for reliable and secure embedded software development.

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Appendix-IV

Courses for Honors

Courses for Honors.

Sr. No.	Course Code	Course Title	Hrs /Week L:T: P	Credits
1	ECHO01	Optical Networks	4:0:0	4
2	ECHO02	Millimeter Wave Communication	4:0:0	4
3	ECHO03	Multi-rate Digital Signal Processing	4:0:0	4
4	ECHO04	Fuzzy Logic and Neural Networks	4:0:0	4
5	ECHO05	Speech Processing	4:0:0	4
6	ECHO06	Analog Layout Design	4:0:0	4
7	ECHO07	Crytography And Network Security	4:0:0	4
8	ECHO08	Cognitive Radio Networks	4:0:0	4
9	ECHO09	Pattern Recognition and Underwater Imaging	4:0:0	4
10	ECHO10	System design using FPGA	4:0:0	4
11	ECHO11	ASIC Design	4:0:0	4
12	ECHO12	RF IC Design	4:0:0	4

ECHO01	Optical Networks	4L:0T:0P	4 Credits

Course Objectives:

- *To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.*
- *To understand the different kind of losses, signal distortion, SM fibers.*
- *To learn the various optical sources, materials and fiber splicing*
- *To learn the fiber optical receivers and noise performance in photo detector.*
- *To learn link budget, WDM, solitons and SONET/SDH network.*

Course Contents:

MODULE I - OPTICAL NETWORKING COMPONENTS 12 hours
First- and second-generation optical networks, Components: couplers, isolators, circulators, multiplexers, filters, amplifiers, switches, and wavelength converters.

MODULE II - SONET AND SDH NETWORKS 12 hours
Integration of TDM signals, Layers, Framing, Transport overhead, Alarms, Multiplexing, Network elements, Topologies, Protection architectures, Ring architectures, Network Management.

MODULE III - BROADCAST – AND- SELECT NETWORKS 12 hours
Topologies, Single-hop, Multihop, and Shuffle net, multihop networks, Media-Access control protocols, Test beds.

MODULE IV - WAVELENGTH-ROUTING NETWORKS 12 hours
Node designs, Issues in Network design and operation, Optical layer cost Tradeoffs, Routing and Wavelength assignment, Wavelength routing test beds.

MODULE V - HIGH CAPACITY NETWORKS 12 hours
SDM, TDM, and WDM approaches, Application areas, Optical TDM Networks: Multiplexing and demultiplexing, Synchronization, Broadcast networks, Switch-based networks, OTDM test beds.

Total No. of Hours: 60

Course Outcomes:
On successful completion of this course, the students will be able,

- To get a good understanding of physical properties of optical networks.
- To get a profound understanding of protocols applied in optical networks: MPLS-TP, GMPLS, SDN, OTN, and Ethernet PBB-TE.
- To get a profound understanding of optical switching methods and networking techniques, circuit, packet, hybrid, burst and flow.
- To get a basic understanding of optical components and optical node design.
- To be able to communicate reason and creatively think about optical networks and To be able to design optical networks, taking both physical transmission properties and optical networking constraints into account.

Text Books:

1. Gerd Keiser, ―Optical Fiber Communication‖, 5th Edition, Mc Graw Hill Education (India) Private Limited, 2015.

2 John M Senior, ―Optical Fiber Communications, Principles and Practice‖, 3rd Edition, Pearson Education, 2010,

Reference Books:

1. Rajiv Ramaswami and Kumar Sivarajan, Optical Networks: A practical perspective, Morgan Kaufmann, 2nd edition, 2001.
2. Vivek Alwayn, Optical Network Design and Implementation, Pearson Education, 2004.
3. Hussein T.Mouftab and Pin-Han Ho, Optical Networks: Architecture and Survivability, Kluwer Academic Publishers, 2002.

ECHO02	**Millimeter Wave Communication**	**4L:0T:0P**	**4 Credits**

Course Objectives:

- *To develop a brief theoretical foundation of MmWave technology, its potential use in Wireless Communications and its standards.*
- *To learn various channel effects in MmWave scenario and exposing the students to baseband techniques, antenna requirements, and Physical layer design and algorithms.*
- *To get exposed to the goals and challenges of new emerging applications of MmWave in Wireless Communications.*
- *To apply the acquired knowledge in the field of MmWave Wireless Communication in the future communication technologies.*
- *To review the literature related to Mm wave for Wireless Communication and to report it ethically.*

Course Contents:

MODULE I - INTRODUCTION 12 hours
Preview of MmWave Implementation Challenges, Emerging Applications of MmWave Communications, MmWave Standardization.

MODULE II - RADIO WAVE PROPAGATION FOR MMWAVE 12 hours
Large-Scale Propagation Channel Effects, Small Scale Channel Effects, Spatial Characterization of Multipath and Beam Combining, Angle Spread and Multipath Angle of Arrival, Antenna Polarization, Outdoor and Indoor Channel Models.

MODULE III -ANTENNAS AND ARRAY FOR MMWAVE APPLICATION 12 hours
Fundamentals of On-Chip and In-Package MmWave Antennas, Fundamentals of On-Chip and In-Package MmWave Antennas, In-Package Antennas, Antenna Topologies for MmWave Communications, Techniques to Improve Gain of On-Chip Antennas, Adaptive Antenna Arrays — Implementations for MmWave Communications, Characterization of On-Chip Antenna Performance.

MODULE IV - MULTI-GBPS DIGITAL BASEBAND CIRCUITS 12 hours
Review of Sampling and Conversion for ADCs and DACs, Device Mismatches: An Inhibitor to ADCs and DACs, Goals and Challenges in ADC Design, Encoders, Trends and Architectures for MmWave Wireless ADCs, Digital to Analog Converters.

MODULE V- MMWAVE PHYSICAL LAYER DESIGN AND ALGORITHMS 12 hours
Practical Transceivers, High-Throughput PHYs, PHYs for Low Complexity, High Efficiency, Future PHY Considerations, Challenges when Networking mmWave Devices.

Total No. of Hours: 60

Course Outcomes:

On successful completion of this course, the students will be able to,

- Be able to explain the fundamental concepts of Mm Wave Wireless Communication.
- Be able to analyze various channel effects in Mm Wave communication scenario and understand various design considerations.
- To get exposed to the goals and challenges of new emerging applications of Mm Wave in Wireless Communications.
- Be able to analyze challenges and various emerging applications of Mm Waves in Wireless Communications research field.
- Be able to review the literature related to Mm wave for Wireless Communication and to report it ethically.

Text Books:

1. Theodore S. Rappaport, Robert W. Heath Jr., Robert C. Daniels, James N. Murdock, ―Millimeter Wave Wireless Communications‖, Prentice Hall, 2014.
2. K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.

Reference Books:

1. Prakash Bhartia, and Inder Bahl, MmWave Engineering and Applications, WileyInterscience.
2. John S. Seybold ―Introduction to RF propagation,‖John Wiley and Sons, 2005.
3. Chia-Chin Chong, Kiyoshi Hamaguchi, Peter F. M. Smulders and Su-Khiong, ―Millimeter – Wave Wireless Communication Systems: Theory and Applications,‖ Hindawi Publishing Corporation, 2007.

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ECHO03	**MULTIRATE DIGITAL SIGNAL PROCESSING**	**4L:0T:0P**	**4 Credits**

Course Objective:

- *To provide students with a comprehensive understanding of the theory, techniques, and applications of multirate signal processing.*
- *To learn how to manipulate signals at different sampling rates efficiently.*
- *To equip students with the necessary mathematical background and practical skills to analyze, design, and implement multirate systems for various applications in digital signal processing.*
- *To analyse various types of disortion and two channel filter banks.*
- *To study multicarrier filter banks using OFDM techniques.*

Course Contents:

MODULE I - INTRODUCTION TO MULTI-RATE SYSTEMS **12 hours**

Introduction - Overview of Sampling and Reconstruction - Discrete-Time Systems, digital filters. Oversampling techniques- Discrete Time processing of Continuous Time signals- Fundamentals of Multi-rate Systems, Basic building blocks – Up sampling, down sampling, Aliasing.

MODULE II - MATHEMATICAL FRAMEWORK FOR FILTER BANK RECONSTRUCTION

12 hours

Mathematical framework for sampling rate change- Sampling rate change and filtering, Fractional sampling rate change. Interconnection of multirate DSP blocks, Multiplexer and Demultiplexer functionality, Poly phase decomposition, Noble Identities.

MODULE III - APPLICATIONS OF MULTIRATE DSP 12 hours

Efficient implementation of sampling rate conversion. Applications of Multirate DSP - DFT-based Filter banks, Interpolated FIR filter design, Cascaded-Integrator-Comb (CIC) filters, Trans multiplexer, Filter bank interpretation of Spectral analysis using DFT.

MODULE IV - FILTER BANKS 12 hours

Two channel maximally decimated filter bank, Signal impairments - Aliasing, Magnitude distortion, Phase distortion, Aliasing cancellation. All pass filters, properties, application in two channel filter banks, Half- band filters, Power complementary filter pairs, M^{th} band filters, two channel perfection reconstruction filter banks.

MODULE V- MULTICARRIER FILTER BANKS 12 hours

Capacity of wireless channels-Water filling method, motivation for Multicarrier modulation. Block transceivers with redundancy, Zero-padding, cyclic prefix- OFDM- extensions of OFDM including Multicarrier Filter bank - Introduction to wavelets.

Total no. of Hours: 60

Course Outcomes:

On successful completion of this course, the students will be able to,

- Grasp the fundamental concepts of multirate systems including sampling rate conversion, interpolation, decimation and their applications in DSP.
- Understand the mathematical principles behind multirate DSP, including discrete-time signal processing, z-transforms, and discrete Fourier transform (DFT).
- Knowledge of different filter design techniques used in multirate systems, including polyphase decomposition, cascade form, and efficient filter implementation structures like the half-band and the lattice structure.
- Understand the concepts of different types of disortion, two channel filter banks and its types.
- Gain Knowlegde about the multicarrier filter banks, OFDM and Wavelets.

Text Books:

1. Vaidyanathan, Parishwad P., ‒Multirate systems and filter banks‖, Pearson Education India, 2006.
2. Mitra, Sanjit Kumar, and Yonghong Kuo, ‒Digital signal processing: a computer-based approach‖, Vol. 2, New York: McGraw-Hill, 2006.

Reference Books:

1. Oppenheim A V and Sehafer R W, ‒Discrete Time Signal Processing‖, Prentice Hall (1989).
2. Proakis J G and Manolakis D G, ‒Digital Signal Processing‖, Pearson Education India.

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ECHO04	**Fuzzy Logic And Neural Network**	**4L:0T:0P**	**4 Credits**

Course Objective:

- *To provide students with a comprehensive understanding of both fuzzy logic and neural network theories, their applications, and their integration*
- *To equip students with the knowledge and practical skills needed to design, analyze, and apply fuzzy logic systems and neural networks for solving complex real-world problems.*
- *To learn about the principles of fuzzy logic, neural network architectures, training algorithms, and how to combine these two powerful paradigms to create hybrid systems.*
- *To analyze the algorithm and applications of neural network based competitive networks.*
- *To study the concept of special neural networks using Fuzzy logic system.*

Course Contents:

MODULE I - FUNDAMENTALS OF FUZZY LOGIC **12 hours**

Basic concepts: fuzzy set theory- basic concept of crisp sets and fuzzy sets- complements- union intersection-combination of operation- general aggregation operations- fuzzy relations-compatibility relations-orderings-morphisms- fuzzy relational equations-fuzzy set and systems.

MODULE II - ARCHITECTURE OF NEURAL NETWORKS **12 hours**

Architectures: motivation for the development of natural networks-artificial neural networks-biological neural networks-area of applications-typical Architecture-setting weights-common activations functions Basic learning rules- Mcculloch-Pitts neuron- Architecture, algorithm, and applications-single layer net for pattern classification- Biases and thresholds, linear separability - Hebb'srule- algorithm -Perceptron - Convergence theorem-Delta rule.

MODULE III - BASIC NEURAL NETWORK TECHNIQUES **12 hours**

Back propagation neural net:standard back propagation-architecture algorithm- derivation of learning rulesnumber of hidden layers--associative and other neural networks- hetro associative memory neural net, auto associative net- Bidirectional associative memory-applications-Hopfield nets-Boltzman machine.

MODULE IV- COMPETITIVE NEURAL NETWORKS **12 hours**

Neural network based on competition: fixed weight competitive nets- Kohonenself organizing maps and applications-learning vector quantization-counter propagation nets and applications adaptive resonance theory: basic architecture and operation-architecture, algorithm, application and analysis of ART1 & ART2.

MODULE V - SPECIAL NEURAL NETWORKS **12 hours**

Cognitron and Neocognitron - Architecture, training algorithm and application-Fuzzy associate memories, Fuzzy system architecture- Comparison of Fuzzy and Neural systems.

Total no. of Hours: 60

Course Outcomes:

On successful completion of this course, the students will be able to,

- Demonstrate a solid understanding of fuzzy logic concepts, including fuzzy sets, membership functions, fuzzy rules, and fuzzy inference systems.
- Integrate fuzzy logic and neural networks to create hybrid systems that leverage the strengths of both paradigms, allowing them to handle complex and uncertain data.
- Evaluate the performance of fuzzy logic and neural network models by analyzing accuracy, convergence, robustness, and generalization capabilities.
- Understand the various algorithm and applications of neural network based competitive networks.
- Remember the concept of special neural networks using Fuzzy logic system.

Text books:

1. Kliryvan, ―Fuzzy System & Fuzzy logic‖, Prentice Hall of India, First Edition.
2. Lawrence Fussett, ―Fundamental of Neural network‖, Prentice Hall, First Edition.

Reference Books:

1. Bart Kosko, ―Neural network and Fuzzy System‖, Prentice Hall-1994.
2. J.Klin and T.A.Folger, ―Fuzzy sets‖, University and information- Prentice Hall -1996.
3. J.M.Zurada, ―Introduction to artificial neural systems‖, Jaico Publication house, Delhi 1994.
4. Vallusu Rao and Hayagvna Rao , ―C++ Neural network and fuzzy logic‖, BPB and Publication, New Delhi,1996.

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ECHO05	Speech Processing	4L:0T:0P	4 Credits

Course Objectives:

- *To understand the fundamentals of the speech processing*
- *To Explore the various speech models*
- *To Gather knowledge about the phonetics and pronunciation processing*
- *To Perform wavelet analysis of speech*
- *To understand the concepts of speech recognition*

Course Contents:

MODULE I - INTRODUCTION **12 hours**

Introduction - knowledge in speech and language processing - ambiguity - models and algorithms – language thought - understanding - regular expression and automata - words & transducers – N grams

MODULE II - SPEECH MODELLING **12 hours**

Word classes and part of speech tagging – hidden markov model – computing likelihood: the forward algorithm – training hidden markov model – maximum entropy model – transformation- based tagging – evaluation and error analysis – issues in part of speech tagging – noisy channel model for spelling.

MODULE III -SPEECH PRONUNCIATION AND SIGNAL PROCESSING **12 hours**

Phonetics - speech sounds and phonetic transcription - articulatory phonetics - phonological categories and pronunciation variation - acoustic phonetics and signals - phonetic resources - articulatory and gestural phonology

MODULE IV -SPEECH IDENTIFICATION 12 hours

Speech synthesis - text normalization - phonetic analysis - prosodic analysis – diphone waveform synthesis - unit selection waveform synthesis - evaluation

MODULE V - SPEECH RECOGNITION 12 hours

Automatic speech recognition - architecture - applying hidden markov model - feature extraction: mfcc vectors - computing acoustic likelihoods - search and decoding - embedded training - multipass decoding: n- best lists and lattices- decoding - context-dependent acoustic models: triphones - discriminative training - speech recognition by humans

Total No. of Hours: 60

Course Outcomes:

On Successful completion of the course , Students will be able to

- Create new algorithms with speech processing
- Derive new speech models
- Perform various language phonetic analysis
- Create a new speech identification system
- Generate a new speech recognition system

Text Books:

1. Daniel Jurafsky and James H. Martin, ―Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition‖, Person education,2013.
2. Lawrence Rabinerand Biing-Hwang Juang, ―Fundamentals of Speech Recognition‖, Pearson Education, 2003.
3. Daniel Jurafsky and James H Martin, ―Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition‖, Pearson Education.

Reference Books:

1. Kai-Fu Lee, ―Automatic Speech Recognition‖, The Springer International Series in Engineering and Computer Science, 1999.
2. Himanshu Chaurasiya, ―Soft Computing Implementation of Automatic Speech Recognition‖, LAP Lambert Academic Publishing, 2010.
3. Claudio Becchetti, Klucio Prina Ricotti, ―Speech Recognition: Theory and C++ implementation‖,Wiley publications 2008.

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ECHO06	Analog Layout Design	4L:0T:0P	4 Credits

Course Objective

- *To provide comprehensive understanding of the principles, techniques, and best practices involved in designing analog integrated circuits layouts.*

- *To equip students with the knowledge and practical skills needed to create layouts for analog circuits, considering various factors such as matching, parasitic, noise, and manufacturability.*
- *To learn about the layout design rules, tools, and methodologies used in the industry to ensure the robustness and performance of analog integrated circuits.*
- *To create Layout and Challenges ESD Protection devices, FET, analog and digital integrated chips.*
- *To learn about the interconnecting model for cross talk and jitters*

Course Contents:

MODULE I - INTRODUCTION TO ANALOG LAYOUT DESIGN 12 hours

IC design flow. Different layout styles: symmetrical, asymmetrical, and array-based layouts. Introduction to design rules and technology constraints in the IC fabrication process. Minimum feature size, spacing, and width requirements Metal layer stack-up and routing guidelines.

MODULE II- MOSFET DEVICE AND PROCESS TECHNOLOGY 12 hours

MOSFET operation and characteristics CMOS process technology, Inverter design .MOSFET layout techniques: device matching, fingered devices, and common centroid layout. Parasitic effects and techniques for minimizing them. Layout of differential pairs and current mirrors. Techniques for maintaining symmetry and matching.

MODULE III - LAYOUT DESIGN TECHNIQUES 12 hours

Layout of basic analog building blocks like current sources, voltage references, amplifiers, and operational transconductance amplifiers (OTAs). Techniques for matching devices to improve performance. Layout techniques for improving linearity. Layout design of feedback systems in amplifiers. Layout considerations for RF amplifiers. Spiral Inductor – SERDES layout.

MODULE IV- LAYOUT PROTECTION AND CHALLENGES 12 hours

Layout techniques for providing ESD protection in analog circuits ESD protection devices and placement. Challenges and techniques for integrating analog and digital components on the same chip. Extractingparasitic elements from layout Post-layout simulation for verifying circuit performance Well ProximityEffect, Shallow Trench Isolation, Metal Density Effects. Latch up and prevention. Fin FET Basics.

MODULE V- INTERCONNECTS EFFECTS 12 hours

Distributed RC interconnect model, Elmore delay, Elmore delay in interconnects, RC tree and branched interconnects. Electromigration in interconnects, Mitigation of electromigration. Capacitive coupling in interconnects. Cross-talk and timing jitters in two identical interconnects. Effects of cross-talk and timing jitters.

Total no. of Hours: 60

Course Outcomes:

On successful completion of this course, the students will be able,

- Demonstrate a solid understanding of various analog circuit components, including transistors, resistors, capacitors, and inductors, and their layout considerations.
- Understand the impact of parasitic components in analog layouts and how to perform parasitic extraction for accurate circuit simulations.

- Incorporate Electrostatic Discharge (ESD) protection structures in analog layouts to enhance circuit reliability and prevent damage from ESD events.
- Create and draw the Layout diagram for ESD Protection devices, FET, analog and digital integrated chips.
- Learn the System interconnecting model for cross talk, RC tree, Electromigration and jitters.

Text Books:

1. Alan Hastings, ―The Art of Analog Layout‖, 1st edition Pearson Education India
2. Jacob Baker. R, ―CMOS Circuit Design, Layout and Simulation‖, 3rd edition John Wiley & Sons.

References Books:

1. Neil H.E. West, D.M.Harris, ―CMOS VLSI Design: A Circuits and Systems Perspective‖
2. Dan Clein, ―Layout Techniques for MOSFETs (Synthesis Lectures on Emerging Engineering Technologies)‖, Morgan and Claypool Life Sciences.

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ECHO07	CRYTOGRAPHY AND NETWORK SECURITY	4L:0T:0P	4 Credits

Course Objectives:

- *Introduction to the fundamental concepts of information security, including various security attacks, threats, and vulnerabilities.*
- *Understanding of symmetric encryption techniques, block ciphers, and modern encryption standards.*
- *Principles of public key cryptography, its practical applications, and key management.*
- *Introduction to the concepts and practical implementation of secure network protocols, including SSL/TLS, IPsec, SSH, and others.*
- *Comprehensive understanding of network security principles and mechanisms, including firewalls, intrusion detection, and network access control*.

Course Contents:

MODULE I- INTRODUCTION TO SECURITY ATTACKS SERVICES AND MECHANISM 9 Hours

Security trends - Legal, Ethical and Professional Aspects of Security, Need for Security at Multiple levels, Security policies. Introduction to cryptography - Conventional Encryption: Conventional encryption model, Classical encryption techniques: substitution techniques, transposition techniques, steganography).

MODULE II- SYMMETRIC CIPHERS 12 hours

Stream and Block ciphers - Modern Block Ciphers: Block ciphers principals - Shannon's theory of confusion and diffusion - Fiestal structure - Data encryption standard(DES) - strength of DES - differential and linear crypt analysis of DES - block cipher modes of operations - Triple DES – Advanced Encryption Standard.

MODULE III- PUBLIC KEY CRYPTOGRAPHY AND AUTHENTICATION REQUIREMENTS 12 hours

Principles of public key crypto systems - RSA (Rivest-Shamir-Adleman) algorithm - security of RSA - key

management –Diffle-Hellman key exchange algorithm - introductory idea of Elliptic curve cryptography – Elgamel encryption - Message Authentication and Hash Function: Authentication requirements - authentication functions - message authentication code - hash functions - birthday attacks – security of hash functions and MACS.

MODULE IV- SECURE NETWORK PROTOCOL 12 hours

SL/TLS (Secure Socket Layer/Transport Layer Security)-IPsec (Internet Protocol Security)- SSH (Secure Shell)- S/MIME (Secure/Multipurpose Internet Mail Extensions)- HTTPS (Hypertext Transfer Protocol Secure)-DNSSEC (Domain Name System Security Extensions)-SRTP (Secure Real-time Transport Protocol)-SIP (Session Initiation Protocol) security and SRTP usage- FTPS (File Transfer Protocol Secure).

MODULE V- NETWORK SECURITY 12 hours

Firewalls and Intrusion Detection/Prevention Systems (IDS/IPS)- Types of firewalls: Packet-filtering, Stateful, Application-layer, and Next-Generation Firewalls. IDS vs. IPS: Intrusion Detection and Intrusion Prevention Systems- Network Access Control (NAC)-Network Address Translation (NAT): NAT principles and its role in IP address conservation. Virtual Local Area Networks (VLANs) and Segmentation- Denial-of- Service (DoS) and Distributed Denial-of-Service (DDoS) Mitigation: DoS/DDoS mitigation techniques (Ratelimiting, Traffic filtering, Anycast).

Course Outcomes:

- Recognize the importance of security mechanisms, policies, and legal, ethical, and professional aspects of security.
- Demonstrate a comprehensive understanding of symmetric encryption techniques, block ciphers, and modern encryption standards.
- Assess the security properties of public key cryptographic systems.
- Comprehend the concepts and practical implementation of secure network protocols, including SSL/TLS, IPsec, SSH and utilize secure network protocols effectively to safeguard data transmission.
- Identify and mitigate common network security threats, including DoS and DDoS attacks. Apply network security best practices to secure data and resources.

Textbook:

1. William Stallings, ―Crpyptography and Network security Principles and Practices‖, Pearson/PHI.
2. Wade Trappe, Lawrence C Washington, ― Introduction to Cryptography with coding theory‖, Pearson.
3. Eric Rescorla , "SSL and TLS: Designing and Building Secure Systems", Omsha, 2003
4. William Stalling, "Network Security Essentials : Applications and Standards ", Pearson; 6th edition, 2016

Reference Book:

1. W. Mao, ‒Modern Cryptography – Theory and Practice‖, Pearson Education.
2. Charles P. Pfleeger, Shari Lawrence Pfleeger – Security in computing – Prentice Hall of India
3. Bernard Menezes , "Network Security and Cryptography", Wadsworth Publishing Company, 2012.

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ECHO08	Cognitive Radio Networks	4L:0T:0P	4 Credits

Course Objectives:

- *To understand the evolving software defined radio and cognitive radio techniques and their essential functionalities*
- *To study the basic architecture and standard for cognitive radio*
- *To understand the physical, MAC and Network layer design of cognitive radio.*
- *To expose the student to evolving applications and advanced features of cognitive radio.*
- *To study about the advance techniques of cognitive network system.*

Course Contents:

MODULE I- INTRODUCTION TO SOFTWARE-DEFINED RADIO AND COGNITIVE RADIO **12 hours**

Evolution of Software Defined Radio and Cognitive radio: goals, benefits, definitions, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations.

MODULE II- COGNITIVE RADIO ARCHITECTURE **12 hours**

Cognition cycle – orient, plan, decide and act phases, Organization, SDR as a platform for Cognitive Radio – Hardware and Software Architectures, Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

MODULE III- SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS **12 hours**

Introduction – Primary user detection techniques – energy detection, feature detection, matched filtering, cooperative detection and other approaches, Fundamental Tradeoffs in spectrum sensing, Spectrum Sharing Models of Dynamic Spectrum Access - Unlicensed and Licensed Spectrum Sharing, Fundamental Limits of Cognitive Radio.

MODULE IV- MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO **12 hours**

MAC for cognitive radios – Polling, ALOHA, slotted ALOHA, CSMA, CSMA / CA, Network layer design – routing in cognitive radios, flow control and error control techniques.

MODULE V- ADVANCED TOPICS IN COGNITIVE RADIO **12 hours**

Overview of security issues in cognitive radios, auction based spectrum markets in cognitive radio networks, public safety and cognitive radio, cognitive radio for Internet of Things.

Total No. of Hours: 60

Course Outcomes:

On Successful completion of the course, Students will be able to

- Gain knowledge on the design principles on software defined radio and cognitive radio
- Develop the ability to design and implement algorithms for cognitive radio spectrum sensing and dynamic spectrum access.
- Build experiments and projects with real time wireless applications
- Apply the knowledge of advanced features of cognitive radio for real world applications
- Understand the advance techniques of cognitive network system based on public safety and security.

Text Books:

1. Alexander M. Wyglinski, Maziar Nekovee, Thomas Hou, ―Cognitive Radio Communications and Networks‖, Academic Press, Elsevier, 2010.
2. Huseyin Arslan (Ed.), ―Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems‖, Springer, 2007.

Reference Books:

1. Bruce Fette, ―Cognitive Radio Technology‖ ‖, Newnes, 2006.
2. Kwang-Cheng Chen, Ramjee Prasad, ―Cognitive Radio Networks‖, John Wiley and Sons, 2009.
3. Ezio Biglieri, Professor Andrea J. Goldsmith, Dr Larry J. Greenstein, Narayan B. Mandayam, H. Vincent Poor, ―Principles of Cognitive Radio‖ , Cambridge University Press, 2012.

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ECHO09	Pattern Recognition and Underwater Imaging	4L:0T:0P	4 Credits

Course Objectives:

- *To Understand the principles and techniques of pattern recognition.*
- *To Gain knowledge of image processing and analysis methods.*
- *To Learn about the applications of pattern recognition and imaging in various fields.*
- *To Develop skills in implementing algorithms for pattern recognition and image processing.*
- *To Explore the challenges and advancements in underwater imaging.*

Course Contents:

MODULE I - INTRODUCTION TO PATTERN RECOGNITION AND UNDERWATER IMAGING 12 hours

Definition of pattern recognition and Importance and applications of pattern recognition in various fields, Examples of pattern recognition systems and their real-world applications. Underwater Imaging: Challenges and Importance-image formation process in water - Absorption, scattering,
and attenuation of light and sound in water.

MODULE II - IMAGE PROCESSING AND FEATURE EXTRACTION FOR UNDERWATER IMAGING 12 hours

Preprocessing methods to improve underwater image quality, Contrast enhancement, noise reduction, and dehazing techniques, Image restoration and deblurring methods for underwater images Image feature representation and descriptors , Color-based, texture-based, and shape-based features for underwater images, Feature extraction techniques for underwater object recognition.

MODULE III – PATTERN RECOGNITION ALGORITHMS FOR UNDERWATER DATA 12 hours

Challenges in applying standard pattern recognition algorithms to underwater data, Preprocessing techniques for handling underwater-specific characteristics (e.g., noise, distortion). Semi-Supervised Learning for Limited Underwater Data. Ensemble Learning Methods.

MODULE IV - OBJECT DETECTION AND TRACKING IN UNDERWATER IMAGING 12 hours

Object detection and tracking in underwater imaging: Applications of object detection and tracking in marine research, robotics, and surveillance. Overview of object detection algorithms for underwater imaging, Feature-based methods (e.g., SIFT, SURF) for object detection- Deep learning-based object detection architectures (e.g., YOLO, SSD)

MODULE V – DEEP LEARNING FOR PATTERN RECOGNITION IN UNDERWATER IMAGING **12 hours**

Deep learning architectures- Introduction to deep learning and its applications in underwater data analysis : - Convolutional Neural Networks (CNNs) for underwater image recognition,-Recurrent Neural Networks (RNNs) for sequence-based underwater data.

Total No. of Hours: 60

Course Outcomes:

On successful completion of this course, the students will be able to,

- Apply pattern recognition techniques to solve real-world problems.
- Analyze and process images using various algorithms and tools.
- Design and implement image recognition systems.
- Evaluate and interpret results obtained from pattern recognition and imaging experiments.
- Demonstrate an understanding of the principles and challenges of underwater imaging.

Textbooks:

1. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2016.
2. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Pearson, 4ed, 2017.
3. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer; 2nd ed. 2021.

Reference Books:

1. Richard O. Duda, Peter E. Hart, and David G. Stork, "Pattern Classification", Wiley; Second edition, 2007.
2. Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, and Machine Vision", Cengage India Private Limited; Fourth edition, 2017.
3. Simon J.D. Prince, "Computer Vision: Models, Learning, and Inference" Cambridge University Press; 1st edition, 2012.

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ECHO10	**System design using FPGA**	**4L:0T:0P**	**4 Credits**

Course Objectives:

- *To Understand Digital system design using HDL.*
- *To Know FPGA architecture, interconnect and technologies.*
- *To Know different FPGA's and implementation methodologies.*
- *To Understand configuring and implementing digital embedded system, microcontrollers, microprocessors, DSP algorithm on FPGA.*
- *To design synchronous circuits.*

Course Contents:

MODULE I- VERILOG HDL CODING STYLE **12 hours**

Lexical Conventions - Ports and Modules – Operators – Gate Level Modeling - System Tasks &Compiler Directives - Test Bench - Data Flow Modeling - Behavioral level Modeling -Tasks & Functions.

MODULE II- OVERVIEW OF FPGA ARCHITECTURES AND TECHNOLOGIES 12 hours

FPGA Architectural options, coarse vs fine grained, vendor specific issues (emphasis on Xilinx FPGA), Antifuse, SRAM and EPROM based FPGAs, FPGA logic cells, interconnection network and I/O Pad.

MODULE III- VERILOG MODELLING OF COMBINATIONAL AND SEQUENTIAL CIRCUITS **12 hours**

Behavioral, Data Flow and Structural Realization – Adders – Multipliers- Comparators - Flip Flops - Realization of Shift Register - Realization of a Counter- Synchronous and Asynchronous FIFO – Single portand Dual port RAM – Pseudo Random LFSR – Cyclic Redundancy Check.

MODULE IV - SYNCHRONOUS SEQUENTIAL CIRCUIT **12 hours**

State diagram-state table –state assignment-choice of flip flops – Timing diagram –One hot encoding Mealy and Moore state machines – Design of serial adder using Mealy and Moore state machines - State minimization – Sequence detection- Design examples: Sequence detector, Serial adder, Vending machine using One Hot Controller.

MODULE V -SYSTEM DESIGN EXAMPLES USING FPGAs **12 hours**

Traffic light Controller, Real Time Clock - Interfacing using FPGA: VGA, Keyboard, LCD, Embedded Processor Hardware Design.

Course Outcomes :

- Describe the fundamental differences between FPGA and ASIC architectures. Explore FPGA-specificimplementation techniques, such as look-up tables (LUTs), flip-flops, and block RAMs
- Perform timing analysis to ensure proper operation and timing closure for FPGA
- Design and implement combinational and sequential circuits on FPGA using HDL.
- Know about the design of synchronous sequential circuits and various state machine models.
- Explain the advantages and limitations of using FPGA and ASIC for different types of applications.

Text Books:

1. M.J.S. Smith, ―Application Specific Integrated Circuits‖, Pearson, 2000.
2. Peter Ashenden, ―Digital Design using VHDL‖, Elsevier, 2007.
3. Peter Ashenden, ―Digital Design using Verilog‖, Elsevier, 2007. 4. W. Wolf, ―FPGA based system design‖, Pearson, 2004.

Reference Books:

1. Clive Maxfield, ―The Design Warriors's Guide to FPGAs‖, Elsevier, 2004
2. Samir Palnitkar, ―Verilog HDL: A Guide to Digital Design and Synthesis‖ Prentice Hall, Second Edition, 2003.
3. T.R. Padmanabhan, B.Bala Tripura Sundari, ―Design through Verilog HDL‖ Wiley Interscience, 2004. S. Ramachandran, ―Digital VLSI System Design: A Design Manual for implementation of Projects on FPGAs and ASICs Using Verilog‖ Springer Publication, 2007.
4. Wayne Wolf, ―FPGA Based System Design‖, Prentices Hall Modern Semiconductor Design Series.
5. Stephen Brown &ZvonkoVranesic, ―Digital Logic Design with Verilog HDL‖ TATA McGraw Hill Ltd. 2nd Edition 2007.

ECHO11	**APPLICATION SPECIFIC INTRAGATED CIRCUITS**	**4L:0T:0P**	**4 Credits**

Course Objectives:

- *To design fundamentals the CMOS logic, and library cell Comprehend the ASIC design flow, including CMOS transistors and design rules.*
- *To Understand the working principles of programmable ASIC technologies like Anti fuse, Static RAM, EPROM, and EEPROM and get acquainted with popular programmable ASIC devices from Actel, Xilinx, and Altera.*
- *To Learn about interconnect structures in Actel, Xilinx, and Altera programmable ASICs and explore low-level design entry methods using HDL (Hardware Description Language) and EDIF (Electronic Design Interchange Format).*
- *To Explore the design flow and challenges involved in integrating various IP (Intellectual Property) blocks in an SOC and learn about FPGA (Field-Programmable Gate Array) to ASIC conversion and SOC verification techniques.*
- *To Learn about modern physical design techniques and guidelines for efficient ASIC layout and understand power dissipation issues in ASICs and the principles of low-power design, along with relevant tools.*

Course Contents:

Module I – INTRODUCTION TO ASIC **12 hours**

Types of ASICs - Design flow – CMOS transistors- CMOS Design rules –Combinational logic Cell Sequential logic cell - Transistor as Resistors - Transistor parasitic capacitance – Logical effort - Library cell design – Library architecture.

Module II- PROGRAMMABLE ASICS **12 hours**

Programmable ASIC Logic cells & Programmable ASIC I/O cells: Anti fuse - Static RAM - EPROM andEEPROM technology - PREP benchmarks - Actel ACT - Xilinx LCA – Altera FLEX - Altera MAX DC & AC inputs and outputs - Xilinx I/O blocks.

Module III- PROGRAMMABLE ASIC INTERCONNECT, PROGRAMMABLE ASIC 09 DESIGN SOFTWARE & LOW LEVEL DESIGN ENTRY **12 hours**

Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Altera MAX 9000 - Altera FLEX – Design systems - Logic Synthesis - Half gate ASIC -Low level design language - PLA tools EDIF- CFI design representation.

Module IV- SILICON ON CHIP DESIGN **12 hours**

Voice over IP SOC - Intellectual Property – SOC Design challenges- Methodology and design-FPGA to ASIC conversion – Design for integration-SOC verification-Set top box SOC.

Module V- Physical and Low Power Design **12 hours**

Over view of physical design flow- tips and guideline for physical design- modern physical design techniques- power dissipation-low power design techniques and methodologies-low power design tools-tipsand guideline for low power design.

Course Outcomes:

- Identify different types of ASICs and their applications in various domains. Differentiate between combinational and sequential logic cells and their use in ASIC design.
- Comprehend the working principles of programmable ASIC technologies like Anti-fuse, Static RAM,EPROM, and EEPROM.
- Demonstrate proficiency in low-level design entry methods using HDL (Hardware Description Language) and EDIF (Electronic Design Interchange Format).

- Analyze FPGA to ASIC conversion and employ SOC verification methods & gain insight into SOC design challenges, methodologies, and verification techniques.
- Understand the physical design flow and tools used for ASIC implementation and Apply principles oflow-power design and use relevant tools for power optimization.

Text Book:

1. Neil H.E. Weste and David Harris , "CMOS VLSI Design: A Circuits and Systems Perspective"
2. Jan M. Rabaey, Anantha Chandrakasan, and Borivoje Nikolic,"Digital Integrated Circuits: A DesignPerspective"
3. Keith Barr, "ASIC Design in the Silicon Sandbox: A Complete Guide to Building Mixed-Signal Integrated Circuits"

Reference Book:

1. Ashok B. Mehta, "ASIC/SoC Functional Design Verification: A Comprehensive Guide to Technologies and Methodologies"
2. Ronald J. Tocci, Neal S. Widmer, and Gregory L. Moss "Digital Systems: Principles and Applications"
3. "Introduction to VLSI Circuits and Systems" John P. Uyemura

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ECHO12	**RF IC Design**	**4L:0T:0P**	**4 Credits**

Course Objectives :

- *To equip students with the knowledge and practical skills needed to design RFICs for various wireless communication systems and applications.*
- *To learn about RF circuit design principles, the use of RF simulation tools, and the integration.*
- *To provide techniques involved in the design and implementation of RF integrated circuits of RF building blocks into complex systems.*
- *To understand the concepts of oscillator and synthesizers.*
- *To acquire knowledge of PLL and synthesizers*

Course Contents:

MODULE I- FUNDAMENTALS OF RF CIRCUITS AND SYSTEMS 12 hours

Duplexing, FDMA, dB, dBm, Voltage gain, Channel, ACR, AACR, Noise factor, NF of a cascaded system, Sensitivity, HD, Gain compression, P1dB, Cross modulation, Inter modulation, IM3, IIP3, SFDR, Transmit mask. Review of modulation schemes, Receiver architectures and Transmitter architectures.

MODULE II - PASSIVE AND ACTIVE COMPONENTS FOR CMOS RFIC 12 hours

Review of MOSFET, RF transistor layout, CMOS process, Capacitors, Varactors, Resistors, Inductors, Transformers, Transmission lines Resonance, Matching, S-parameters. Noise in electrical circuits two port noise theory Resistive terminated CS and CG LNA, Inductive degenerated LNA, Shunt feedback LNA, Noisecanceling LNAs, Linearity improvement techniques.

MODULE III - POWER AMPLIFIERS & MIXERS 12 hours

Power Amplifiers: Basics and Class A, B, C, D, E, F and other configurations, Power combining, Linearity improvement techniques. Mixers*:* Specifications, NL system as a mixer, Active mixers, Passive mixers.

MODULE IV- OSCILLATORS & SYNTHESIZERS 12 hours

VCO fundamentals, basic principles, topologies. Voltage controlled oscillators with wide tuning range and Varactor Q limitations, Phase noise concept and analysis, Low-noise VCO topologies. Radio frequency

Synthesizers- PLLS, Various RF synthesizer architectures and frequency dividers, Design issues in integratedRF filters.

MODULE V- PHASE LOCKED LOOPS **12 hours**

PLL basics –Charge pumps- PLL dynamics integer- Spurious frequencies fractional and synthesis- Fractionalspurs- Delta and sigma modulation. Frequency synthesizers: Integer N synthesizers, Dividers.

Total no. of Hours: 60

Course Outcomes:

On successful completion of this course, the students will be able to,

- Demonstrate a solid understanding of radio frequency concepts, including impedance matching, noise, linearity, and the behavior of passive and active RF components.
- Analyze the performance of RF circuits and systems in terms of gain, noise figure, linearity, power consumption, and frequency response.
- Apply various RFIC design techniques, such as impedance matching networks, RF filters, low-noise amplifiers (LNAs), mixers, oscillators, and power amplifiers.
- Understand the concepts of oscillator and synthesizers.
- Gain the knowledge about the Phase Locked Loops and synthesizers.

Text Books:

1. B. Razavi, ―RF Microelectronics‖, PHI 1998
2. R. Jacob Baker, H.W. Li, D.E. Boyce, –CMOS Circuit Design, layout and Simulation‖, PHI

Reference Books:

1. Thomas H. Lee, –Design of CMOS RF Integrated Circuits‖, Cambridge University press 1998.
2. Y.P. Tsividis, ―Mixed Analog and Digital Devices and Technology‖, TMH 1996.
3. Phillip E. Allen and Douglas R. Holberg' –CMOS Analog Circuit Design‖, Oxford University Press - 3 rd Ed., -2011.
4. https://nptel.ac.in/courses/117102012.

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