DEPARTMENT OF ELECTRONICS ENGINEERING

SCHOOL OF ENGINEERING AND TECHNOLOGY

PONDICHERRY UNIVERSITY

B.Tech.(ECE)

REVISED REGULATIONS, CURRICULUM AND SYLLABUS

(for University Department)

with effect from 2026- 27

PONDICHERRY UNIVERSITY

REVISED REGULATIONS (2026-27)

for

BACHELOR OF TECHNOLOGY IN ELECTRONICS AND COMMUNICATION ENGINEERING

(EIGHT SEMESTERS)

1. Introduction:

- Government of India has launched the National Education Policy (NEP 2020), encompassing radical changes in the delivery and governance of Higher Education in the Country

- Pondicherry University has adopted the NEP and its Curriculum Framework from the Academic Year 2023-24 in its campus and proposing to implement in affiliated Colleges.

- These NEP Regulations are expected to provide clear direction and procedure for implementation of different provisions of NEP for starting 4-year Undergraduate Degree program in ECE.

2. Admission Requirements:(Multiple Entry)

Sl. No.	Year of Entry	Requirements
i.	1st year	Candidates should be required to have passed: • The Higher Secondary Examination of the (10+2) curriculum (Academic Stream) prescribed by the Central/State Government of India or any other examination equivalent there to with minimum of 45% marks (a mere pass for OBC and SC/ST candidates) in aggregate of subjects – Mathematics, Physics and any one of the following optional subjects: Chemistry / Computer Science / Biology (Botany & Zoology) or an Examination of any University or Authority recognized by the Executive Council of the Pondicherry University as equivalent there to and UG CUET Exam for University Departments
ii.	2nd year	• Completion of Certificate Course at the end of 1st year with minimum of 39 credits (or) • 10th Standard Pass and minimum THREE Years/ 12th Standard Pass and minimun TWO Years (Lateral Entry) Diploma Examination with at least 45% marks (40% marks in case of candidates belonging to SC/ST/OBC category) in ECE branch or allied streams (or) • Passed, D.Voc. stream in the ECE or allied streams

		(Note: The Department will offer suitable bridge courses based on the knowledge level of the students if required to achieve desired learning outcomes of the program)
iii.	3rd year	Completion of Diploma in ECE at the end of 2nd year with minimum of 81credits.
iv.	4th year	• Completion of B.Sc. (Engg.) in the ECE branch or allied streams at the end of 3rd year with minimum of 125 credits. • A minimum CGPA of 7.5 is required in the fourth year of the UG program to continue the Bachelors' degree with research/honors/minor.

3. AGE LIMIT: As per AICTE/University norms

4. SHORT-TITLE AND DEFINITIONS:

4.1. Short-title, Commencement and Application

i. These revised Regulations shall come into force from the Academic Year 2026-27. These Regulations shall apply to B.Tech., offered by the Pondicherry University Departments.

iii. As this program is governed by AICTE, the regulations brought out by AICTE in this regard shall be adopted wherever required.

4.2 Definitions

Terms used in the NEP-CBCS Regulations shall have the meaning assigned to them as given below unless the context otherwise requires:

a. "**Academic Year**" means the year starting on 1st day of July and ends on the 30th day of June succeeding year.

b. "**Residence Time**" means the time a student spends for attending classes in the College/Institution (either Online/Offline) as a full-time student and enrolled in B.Tech.(ECE) of the University Department

c. "**Semester**" means 18 weeks (90 Working days) of teaching-learning session of which two weeks shall be set apart for examinations and evaluation.

d. "**Credit"** A credit is the number of hours of instruction required per week for the given subject in a given semester of 18 weeks. One credit is equivalent to 15 hours of teaching (lecture or tutorial) or 30 hours of practice (field work or community engagement or social services) per Semester.

e. "**Grade**" means a letter grade assigned to a student in a course for his/her performance at academic sessions as denoted in symbols of: A^+(Excellent), A (Very

Good), A^- (Good), B^+ (Satisfactory), B (above Average), C (Average), P (Pass) , F (Fail), F^R (Fail due to Attendance) and AB (Absent) with a numeric value of A^+=10, A=9, A^-=8, B^+=7, B=6, C=5, P=4, F<4, F^R=0 and AB=AA.

f. "**Grade Point Average (GPA)**" means an average of the grades secured by a student in all courses in a given academic session duly weighted by the number of credits associated to each of the courses.

g. "**Cumulative GPA (CGPA)**" is the weighted average of all courses the student has taken in a given Program.

h. "**A Common Course**" means the set of courses that all students who are admitted to B.Tech.(ECE) program of the University are required to study; these courses include, Languages (English/Modern Indian Languages), NEP specific courses viz. Understanding India, Environmental Sciences/Education, Health and Wellbeing/Yoga, Digital & Technological Solutions.

i. "**Major Discipline**" means the core subject mandatory for the program, major discipline may be a single discipline or interdisciplinary/ multidisciplinary courses. Eg. B.Tech (ECE)

j. "**Minor Discipline**" means allied or elective subjects to major discipline.

k. "**Minor Discipline Cognate**" refers to a pool of courses offered by the parent department/ cognate (allied) departments. Eg. B.Tech (ECE) may have minors streams leading in 2/3 to B.Tech (Embedded System), B.Tech (Wireless Communication), B.Tech (VLSI) or B.Tech (Telecommunications)

l. "**Minor Discipline Generic**" refers to the subsidiary/elective subjects chosen from a basket of courses offered by different departments other than the minors offered by the parent department. Eg. B.Tech. (AI&DS)

m. "**Credit Requirements**" for a Degree/Diploma/Certificate Program means the minimum number of credits that a student shall accumulate to achieve the status of being qualified to receive the said Degree/Diploma/Certificate as the case may be.

n. "**Multiple Exit Option**" means the option exercised by the students to leave the program at the end of 1st Year or 2nd Year or 3rd Year or 4th Year of B.Tech program of any given academic year.

o. "**Multiple Entry Option**" means the option exercised by the students to join the program at the starting of 1st Year or 2nd Year or 3rd Year or 4th Year of B.Tech program of any given academic year.

p. "**Skill-based Learning/Project"** refers to activities designed to understand the different socio-economic contexts, first-hand understanding of the policies, regulations, organizational structures, processes, and programs that guide the

development process.

q. "**Work-based Internship"** refers to structured internships with local industry, businesses, artists, crafts persons etc. which will further improve employability.

5. Duration of Program:

The Bachelor of Technology degree program 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 18 weeks (90 days).

6. Program Structure:

The medium of instruction is English.

i. The B.Tech. (ECE) is a four year Undergraduate Program with eight semesters having two semesters in each year

ii. A student admitted to the B.Tech program in ECE will earn the **B.Tech (ECE) degree** alone in that branch by fulfilling all the requirements prescribed in the regulations during the course of study.

iii. Also, the student is permitted to opt for earning a **B.Tech degree with Research or Honors degree** in the same Discipline of Engineering **or Minor degree** in another Discipline of Engineering in addition to the degree in his/her own discipline of engineering. The student will be allowed to exercise this option at the end of first year based on students' academic performance in the first year. The students admitted in the second year can exercise this option at the end of third semester, based on the GPA scored in the third semester examination.

iv. The student opting for **B.Tech degree with Research** required earning additional **12 credits** by doing research project within the course period (4 Years).

v. The student opting for **B.Tech degree with Honors or B.Tech degree with Minor** is required to earn additional **18 credits** starting from the third semester. The students admitted in the second year and opting for Honors / Minor degree will earn the additional 18 credits starting from the fourth semester.

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

Details regarding the award of B.Tech degree as well as possible exit for a B.Tech student in line with one of the goals of the National Education Policy (NEP) 2020 are provided below:

Sl. No.	Year of Exit	Conditions for Exit
A	Exit after 1st year and requirement for the award of the	• The student must have acquired 40 credits for the award of a certificate.

	Certificate in Electronics Engineering.	Also, the student should pass any of the following two additional 3 credits courses to qualify for certification a) Electronic Devices b) Digital System Design **OR** Two months Internship for 6 credits
B	Exit after 2nd year and requirement for the award of a Diploma in Electronics and Communication Engineering.	• The student must have acquired a minimum of 81 credits during the first two years, • Also, the student should pass any of the following two additional 3 credits courses in either design stream or manufacturing stream to qualify for diploma a) Programming Skills b) Program Elective Subject which is offered in the Department. **OR** Two months Internship for 6 credits
C	Exit after 3rd year and requirement for the award of B.Sc. (Engg.) in Electronics and Communication Engineering	• The student must have acquired minimum of 125 credits during the first three years, Also, the student should pass any of the following two additional 3 credits courses in either design stream or manufacturing stream to qualify for each course. a) Networking Course b) Program Elective Subject which is offered in the Department. **OR** Two months Internship for 6 credits

Note: i) No candidate shall be eligible for the award of the degree of B.Tech.(ECE) unless he/she completes the program with the minimum credits required for the multiple exits as the case may be shown in Serial No. 9 to 12 of Section 9.2.

ii) The internship given in the above Table (Sl.No. a, b, c) can be Completed within one year and two internal Faculty Members shall be assigned to evaluate the internship course done by the students.

8. Course Structure and Subjects of Study:

8.1. 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

8.2 Breakup of Credits and Courses

The minimum number of credits that a Bachelor student has to earn in 4-year period.

Breakup of Credits and Courses for University Departments

Sl. No.	Component	4 Year B.Tech Degree
1	Major Disciplinary Courses	66 Credits (28 Courses)
2	Minor Discipline Courses	12 Credits (4 Courses)
3	Multi-Disciplinary Courses	12 Credits (4 Courses)
4	Ability Enhancement Courses	22 Credits (6 Courses)
5	Skill Enhancement Courses	18 Credits (6 Courses)
6	Common Value-Added Courses	14 Credits
7	Research Dissertation Project	20 Credits
8	Mandatory Courses	No Credit
9	Total (4 year) Credits Required	**164 Credits**
10	B.Tech (Research)	176 Credits (164+12) (Research Project of 12 Credits)
11	B.Tech (Honors)	182 Credits (164 + 18) (4 Courses of 4 credits each and one NPTEL Course of 2 credits from III Semester to VII Semester)
12	B.Tech (Minor)	182 Credits (164 + 18) (4 Courses of 4 credits each and one NPTEL course of 2 credits from III Semester to VII Semester)

8.3 Subjects of Study:

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 this B.Tech program 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 of 3 credits. The student can earn the credits towards the Open Elective Courses (OEC) by completing either through offline mode courses or the online courses offered in NPTEL/SWAYAM courses anytime between Fifth and Eighth semester on prior approval from the Concerned Program Committee of University Department. Students must register through the SWAYAM/NPTEL portal and submit proof of enrollment. Credits will be awarded only upon presenting the official NPTEL certificate with SUCCESSFUL completion. The Program Committee of University Department will map NPTEL courses with appropriate OEC categories. Students may register multiple NPTEL courses (e.g., 3+3+3+3 credits) to satisfy the 12-credit requirement of OEC. All certificates must be submitted within the semester / academic year timeline for credit transfer.

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

(iv) In total, 20 credits are assigned for Micro Project, Mini Project, Project Work, Internship and Seminar.

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

9. 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).

9.1 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 Micro Project/Mini Project/Project Work, the weightage of internal assessment is 60% and end semester examination is 40%
- For Internship and Seminar, the weightage of end semester examination is 100%.

9.2. 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 (I+II)	30
b) Attendance	5
c) Assignment(s)	5
Total	**40**

Marks for Attendance is as follows:

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

The Head of the Department of the University schedules the Internal Assessment tests for all courses. All faculty members are expected to conduct the Internal Assessment tests for 1.30 hours duration.

The evaluated marks are required to be uploaded by the concerned faculty members in the Samarth Portal with the help of Head of the Department. University Departments are also requested to preserve the answer sheets of internal assessment tests until declaration of results by the University.

9.3. Internal Assessment (Practicals)

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
b) Mid Semester Exam	15
c) Viva Voce	5
d) Attendance	10
Total	**60**

Marks for Attendance is as follows:

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

9.4. Internal Assessment (Micro Project/Mini Project)

The Micro Project/Mini Project shall be evaluated for a maximum of 60 marks as internal assessment. There shall be one assessment during the $4^{th}/6^{th}$ semester by a review committee. The Head of the Department shall constitute the review committee consisting of project coordinator and internal faculty members, from the Department for the internal assessment.

9.5. Internal Assessment (Project Work)

The Project work shall be evaluated for a maximum of 60 marks as internal assessment. There shall be two assessments during the eighth semester by a review committee. The Head of the Department shall constitute the review committee consisting of supervisor, project coordinator and another faculty member from the Department for the internal assessment (60 marks). The contribution by the respective supervisor of a student for 25 marks shall be accounted for the internal marks of 60. The Project work carried out in the eighth semester shall be assessed as follows:

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

9.6. Assessment (Internship/Seminar)

In this regard, a presentation should be given regarding the training or program underwent during the period with the submission of a report. There shall be an end semester evaluation (100 marks) done by the committee comprising of internal members and one external member from other department of the same institute constituted by Head of the Department. The distribution of 100 marks will be decided by the committee.

9.7. Requirement for Appearing the University Examination

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 medical officer not below the rank of Assistant Director*)

ii. He / She earns a progress certificate from the Head of the Department / 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 Department/ Institution.

A candidate who has satisfied the requirement (i) to (iii) shall be deemed to have satisfied the course requirements for the semester.

(Note: *The Head of the University Department schedules the End-Semester exams for all theory/practical courses/project work based on the University academic calendar. A detailed Exam Time Table shall be circulated at least 15 days before the start of exams.*)

9.8 End Semester Exam Evaluation Pattern

Course	Maximum marks
a) Theory Course (Part A, Part B and Part C based on the questions from all units of syllabus) (Note: Part A consists of five 2Marks Questions; Part B consists of six 5 Marks Questions and Part C consists of two 10 Marks Questions with either or choice option)	60 marks
b) Practical Course (Based on End Semester Practical /Record/ Viva)	40 marks
c) Micro Project/ Mini Project/ Project (Based on Project Work / Report / Presentation and Viva Voce)	40 marks

The end semester Practical Exam/Micro Project/Mini Project/Project Exam (for 40 Marks) shall be conducted by the faculty in charge along with the external member nominated by the Head of the Department

9.9. Consolidation of Marks and Passing Minimum

The Academic Section of University consolidates the Internal Assessment marks uploaded by the faculty incharge of the department 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% of total 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 re-appear 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 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 Department along with their valuation fee prescribed by the University.

9.10. Arrear Exams

A student who failed to secure 40% marks in aggregate is declared as "Fail" and the student can register that failed subject and reappear for the exam when it is offered in the department in the subsequent semester. All other candidates who failed due to shortage of attendance and those seeking to improve the grade shall repeat the course.

9.11. 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/Project Work) 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	A-	8
61-70	B+	7
51-60	B	6
46-50	C	5
40-45	D	4
<40	F	0
-	F^R	0
-	AB	0

Note: F- denotes failure in the course; F^R - denotes Failed due to shortage of attendance; AB denotes Absent for the University Exam as per 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/institution in which the candidate has studied.

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

c) The GPA for the semester and the 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 registered and 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 and F^R grades are to be excluded for calculating GPA and CGPA.

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

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

10. Duration for Completing the B.Tech Program:

The entire B.Tech course should be completed **within 7 years (14 semesters)** by the students admitted at first year/ **6 years (12 semesters)** by the students admitted at second year / **5 years (10 semesters)** by the students at third year of the program.

However, a candidate can 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 he has registered for the university examinations of the previous semester in all the subjects as well as all arrear subjects if any.

11. 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 the candidates admitted at second year/ four semesters for the candidates admitted at third year) within a maximum period of 7 years (6 years for the candidates admitted at second year/5 years (10 semesters) by the students at third year of the program) 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 1 to 8 in his/her first appearance within 8 consecutive semesters (4 academic years) and in addition secures a CGPA of 8.50 and above for the semesters 1 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 first semester and in

addition secures CGPA not less than 6.5 shall be 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 Gold Medal (First Rank Holder and fulfilling other conditions) and University ranks for this branch of study, the CGPA secured from the 1st to 8th semester should be considered and it is mandatory that the candidate should have passed all the subjects from the1st to 8th semester in the first attempt. Rank certificates would be issued to the first ten candidates in the branch of study.

12. Provisions for Multiple Exits in B.Tech Degree as well as Research/Honors/Minor Degree along with B.Tech degree:

The curriculum and the syllabus for B.Tech (ECE) program have been planned in compliance with the NEP guidelines proposed by AICTE. Accordingly, students joining B.Tech (ECE) program shall have all benefits offered under NEP offers in terms of exercising exit option during the course of study. The B.Tech (ECE) program governed under this school board shall adopt the NEP guidelines, as and when proposed/amended by AICTE, and the following scheme will be applied.

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 three possible exits before the completion of the Full Engineering degree and may get a Certificate or Diploma or B.Voc. or B.Tech. degree in the relevant discipline (ECE) if he/she fulfills the following conditions: (Subject to change as per AICTE/University guidelines)

12.1 Certificate in Electronics Engineering

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

a. 25% of the credits for B.Tech (40 Credits)

b. 25 % of the program core courses

c. Students exiting the program after earning 25% credit requirements will be awarded a **Certificate** provided they secure an additional 6 credits through summer internships of 2 months duration.

12.2 Diploma in Electronics and Communication Engineering

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

a. 50% of the credits for B.Tech (82 Credits) and at least 2 years in the program

b. 50% of the program core courses

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

d. Students admitted at second year cannot exercise the exit option as he will not be able to meet out the 50% credits requirement for B.Tech degree.

12.3 B.Sc.(Engg.) in ECE

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

a. 75% of the credits for B.Tech (126 credits) and at least 3 years in the program.

1.75% of the core program courses

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

c. Students admitted at third year cannot exercise the exit option as he will not be able to meet out the 75% Credits fequirement for B.Tech degree.

12.4 B.Tech (ECE) Degree

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

a. 100% of the credits for B.Tech (minimum 162 credits for affiliated colleges & 164 for university departments) and at least 4 years in the program.

b. 100% of the core program courses

c. Students exiting the program after earning 100% credit requirements will be awarded a **B.Tech** provided they have done project work of 20 credits in the eighth semester.

12.4.1 B.Tech (ECE) Degree with Research

a. The student shall be given an option to earn a research degree in ECE at the end of first year based on his/her academic performance in the first year.

b. A student is eligible to exercise this option if and only if he/she 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. The student is required to earn an additional 12 credits by doing research project (over and above the prescribed maximum credits in the curriculum) starting from the third semester onwards to become eligible for the award of research degree.

d. The students admitted in the second year will also be given a chance to opt for research 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 12 credits

e. A student is eligible to get the research degree only on completing the program in First Class.

f. Nomenclature of research Degree is 'B.Tech degree with Research'

12.4.2 B.Tech (ECE) Degree with Honors

a. The student shall be given an option to earn an Honors degree in ECE at the end of first year based on his/her academic performance in the first year.

b. A student is eligible to exercise this option if and only if he/she 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 ECE shall be offered for a batch of students if and only if a minimum of 10 eligible students opt for it.

d. The student is required to earn an additional 18 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. 18 credits shall be earned by the student by completing 4 additional courses of 4 credits each and one additional NPTEL Course, one in each of the 5 semesters starting from the third to seventh semester. The syllabus of these 4 courses is framed so as to cover advanced topics in that discipline of engineering.

e. The students admitted in the second year 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 12 credits and one additional NPTEL Course, by registering the prescribed courses offered up to the seventh semester. The respective program committee 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 program in 'First Class with Distinction' class.

g. A student can exercise the option to withdraw from the Honors degree at any time after entry. Further, if a student fails in any one of the Honors degree, then that student is ineligible to obtain the Honors degree.

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 (XXX) in ECE', where ECE is Discipline in which the student has enrolled.

12.4.3 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/her choice at the end of first year based on his/her academic performance in the first year.

b. A student is eligible to exercise this option if he/she 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 10 eligible students opt for it.

d. The student is required to earn an additional 18 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. 18 credits shall be earned by the student by completing 4 additional courses of 4 credits each and one additional NPTEL Course, one in each of the 5 semesters starting from the third to seventh semester. The curricular content of these 4 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 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 12 credits and one additional NPTEL Course, by registering for prescribed courses offered up to seventh semester. The respective program committee 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 ECE with Minor in YYY', where ECE 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.

12.5 Completion Possibility in other Institutions

A student can earn B.Sc.(Engg.) in ECE in one institution 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 bonafide credentials for the purposes of recruitment and/or eligibility for admission to programs, appearing in competitive examinations, etc.)

13. 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.

14. Discontinuation of the Course:

If a student wishes to temporarily discontinue the course for valid reasons like medical, entrepreneurship, etc. he/she shall apply through the Head of the Institution in advance and obtain a written order from the University permitting discontinuance. Student after temporary discontinuance 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 course reckoned from the commencement of the first semester to which the student was admitted shall not in any case exceed 7 years (However, the entire course should be completed within 14 consecutive semesters) including of the period of discontinuance.

15. Powers to Resolve the Grievance:

Not withstanding to the above provisions of these Regulations, the Chairman of Academic Council/Vice-Chancellor of Pondicherry University has the ultimate authority to interpret, modify and relax any of the above mentioned provisions/Guidelines. He / She may constitute such Committees from time to time for smooth implementation of AICTE NEP Framework across all Colleges affiliated to Pondicherry University.

16. Revised Curriculum and Syllabus

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

GENERAL COURSE STRUCTURE

&

CREDIT DISTRIBUTION

&

REVISED CURRICULUM AND SYLLABUS

GENERAL COURSE STRUCTURE & THEME

A. Range of Credits:

For University Departments, the total number of credits proposed for the four-year B.Tech in Electronics and Communication Engineering is kept at 164.

B. 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:

For University Departments

Sl.No	Category	Credit Breakup	Percentage of Credit Breakup
1	Humanities and Social Sciences including Management courses	14	9%
2	Basic Science courses	22	14%
3	Engineering Science courses including workshop, drawing, basics of electronics/ electrical/ mechanical/computer etc.	18	10%
4	Professional core courses	66	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	20	10%
8	Mandatory non-Credit Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Knowledge Tradition]	(no -credit)	-
Total		**164**	**100%**

C. 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 hundreds 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: 5
(ii) Credits: 1

S.No.	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	BTEN 111	Communicative English	I	2	0	2	3
2.	HSMC112	Universal Human Values-II	II	2	0	2	3
3.	HSMC201	Life Skills/ Languages	IV	1	0	2	2
4.	HSMC305	Total Quality Management	V	3	0	0	3
5.	HSMC407	Entrepreneurship Development	VII	2	0	2	3
						Total Credits	**14**

BASIC SCIENCE COURSE [BSC]

(i) Number of Basic Science Courses: 6
(ii) Credits: 22

S.No.	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1.	BSC101	Chemistry	II	3	0	2	4
2.	BSC102	Mathematics-I	I	3	1	0	4
3.	BSC103	Physics	I	3	0	2	4
4.	BSC104	Mathematics-II	II	3	1	0	4
5.	BSC105	Biology for Engineers	II	2	1	0	3
6.	BSC201	Nano Science Technology	III	2	1	0	3
						Total Credits	**22**

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ENGINEERING SCIENCE COURSE [ESC]

(i) Number of Engineering Science Courses:6
(ii) Credits: 18

S.No.	Code No.	Course Title	Semester	Hours per week			Total Credits
				Lecture	Tutorial	Practical	
1	ESC101	Basic Electrical Engineering Theory and Lab.	I	2	1	2	4
2	ESC102	Engineering Graphics & Design	I	1	0	4	3
3	ESC103	Design Thinking and Idea Lab	I	1	0	2	2
4	ESC104	Programming for Problem Solving Theory and Lab	II	2	0	4	4
5	ESC105	Digital Fabrication Lab	II	0	0	4	2
6	ESC206	Numerical Techniques	IV	2	0	2	3
Total Credits							**18**

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PROFESSIONAL CORE COURSES [PCC]

(i) Number of Professional Core Courses: 28

(ii) Credits: 66

S.No.	Course Code	Course Title	Preferred Semester	Hrs /Week L: T: P	Credits
1.	CECE231	Electronic Devices	III	3:0:0	3
2.	PECE231	Electronics Devices Lab	III	0:0:2	1
3.	CECE232	Digital Electronics	III	3:0:0	3
4.	PECE232	Digital Electronics Lab	III	0:0:2	1
5.	CECE233	Signals and Systems	III	3:1:0	4
6.	CECE234	Network Theory	III	3:0:0	3
7.	CECE241	Digital Signal Processing	IV	3:0:0	3
8.	PECE241	Digital Signal Processing Lab	IV	0:0:2	1
9.	CECE242	Analog Circuits	IV	3:0:0	3
10.	PECE242	Analog Circuits Lab	IV	0:0:2	1
11.	CECE243	Microcontrollers	IV	3:0:0	3
12.	PECE243	Microcontrollers Lab	IV	0:0:2	1
13.	CECE244	Probability Theory and Stochastic Processes	III	3:1:0	4
14.	CECE351	Analog and Digital Communication	V	3:0:0	3
15.	PECE351	Analog and Digital Communication Lab	V	0:0:2	1
16.	CECE352	Electromagnetic Waves	V	3:0:0	3
17.	PECE352	Electromagnetic Waves Lab	V	0:0:2	1
18.	CECE353	Embedded Systems	V	3:0:0	3

19.	PECE353	Embedded Systems Lab	V	0:0:2	1
20.	CECE354	Information Theory and Coding	V	3:0:0	3
21.	CECE355	Control Systems	V	3:1:0	4
22.	CECE361	Computer Networks	VI	3:0:0	3
23.	PECE361	Computer Networks Lab	VI	0:0:2	1
24.	CECE362	VLSI Design	VI	3:0:0	3
25.	PECE362	VLSI Design Lab	VI	0:0:2	1
26.	CECE363	Mobile Communication and Networks	VI	3:1:0	4
27.	CECE471	Microwave and Optical Communication	VII	3:0:0	3
28.	PECE472	Microwave and Optical Communication Lab.	VII	0:0:2	1
				Total Credits	**66**

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PROFESSIONAL ELECTIVES [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	EECE36X	Professional Elective-I	VI	3	0	0	3
2	EECE471X	Professional Elective-II	VII	3	0	0	3
3	EECE472X	Professional Elective-III	VII	3	0	0	3
4	EECE48X	Professional Elective- IV	VIII	3	0	0	3

PROGRAM ELECTIVE COURSES

S. No.	Course Code	Course Title	Hrs /Week L: T; P	Credits
Semester 6				
1.	EECE361	Antenna and Wave Propagation	3:0:0	3
2.	EECE362	Detection and Estimation of Signals	3:0:0	3
3.	EECE363	Embedded Networks and Protocols	3:0:0	3
4.	EECE364	Introduction to Quantum Technology	3:0:0	3
Semester 7				
5.	EECE4711	Bio-Medical Electronics	3:0:0	3
6.	EECE4712	Introduction to Artificial Intelligence	3:0:0	3
7.	EECE4713	Satellite Communication	3:0:0	3
8.	EECE4714	Wireless Networks	3:0:0	3
Semester 7				
9.	EECE4721	Digital Image Processing	3:0:0	3
10.	EECE4722	Information Security	3:0:0	3
11.	EECE4723	Introduction to MEMS and NEMS	3:0:0	3
12.	EECE4724	IoT System Engineering	3:0:0	3
Semester 8				
13.	EECE481	ASIC Design	3:0:0	3
14.	EECE482	Free Space Optical Communication	3:0:0	3
15.	EECE483	Green Communication System	3:0:0	3
16.	EECE483	Underwater Networking System	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	OECEXXX	Open Elective-I	VI	3	0	0	3
2	OECEXXX	Open Elective-II	VII	3	0	0	3
3	OECEXXX	Open Elective-III	VII	3	0	0	3
4	OECEXXX	Open Elective-IV	VIII	3	0	0	3
						Total Credits	**12**

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PROJECT/SEMINAR/INTERNSHIP COURSES

(i) Number of Courses: 5
(ii) Credits: 20 (University Department)

S.No.	Course Code	Course Title	Semester	Hours per week			Credits
				Lecture	Tutorial	Practical	
1.	RECE 241	Micro project	IV	0	0	4	2
2.	RECE 362	Mini project	VI	0	0	6	3
3.	RECE 483	Project	VIII	0	0	24	12
4.	SECE360	Seminar	VI	0	0	2	1
5.	IECE 470	Internship	VII	0	0	4	2
						Total	**20**

SEMESTER WISE STRUCTURE

For University _ ECE Department

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.	BSCT102	Mathematics-I	3	1	0	4	40	60	100
3.	ESCT102	Programming for Problem Solving	3	0	0	3	40	60	100
4.	BSCT103	Biology for Engineers	3	0	0	3	40	60	100
5.	BSCP101	Chemistry laboratory	0	0	2	1	60	40	100
6.	ESCP101	Engineering Graphics & Design	1	0	4	3	60	40	100
7.	ESCP102	Programming for Problem Solving Laboratory	0	0	2	1	60	40	100
8.	ESCP103	Design Thinking and IDEA Lab.	1	0	2	2	60	40	100
9.	AU101^	Career Development Skills	0	0	2	0	-	-	-
Total						**20**	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	2	1	0	3	40	60	100
2.	BSCT105	Mathematics-II	3	1	0	4	40	60	100
3.	ESCT104	Basic Electrical Engineering	2	1	0	3	40	60	100
4.	BTEN 111	Communicative English	2	0	2	3	60	40	100
5.	HSMC112	Universal Human Values -II	2	0	2	3	40	60	100
6.	BSCP104	Physics Laboratory	0	0	2	1	60	40	100
7.	ESCP104	Basic Electrical Engineering Laboratory	0	0	2	1	60	40	100
8.	ESCP105	Digital Fabrication Lab.	0	0	4	2	60	40	100
9.	AU102^	Sports and Yoga	0	0	2	0	-	-	-
Total						**19**	400	400	800

Note: ^ represents “Audit Course”.

Semester-III

S.No.	Course Code	Course Title	L	T	P	Credit	Marks		
							IA	UE	TM
1	CECE231	Electronic Devices	3	0	0	3	40	60	100
2	CECE232	Digital Electronics	3	0	0	3	40	60	100
3	CECE233	Signals and Systems	3	1	0	4	40	60	100
4	CECE234	Network Theory	3	0	0	3	40	60	100
5	ESCT 206	Numerical Techniques	2	1	0	3	40	60	100
6	BSCT206	Nano-science Technology	2	1	0	3	40	60	100
7	PECE231	Electronic Devices Lab	0	0	2	1	60	40	100
8	PECE232	Digital Electronics Lab	0	0	2	1	60	40	100
9	AU203^	Indian Constitution & Knowledge Systems	1	0	0	0	-	-	-
TOTAL						**21**	360	440	800

Semester-IV

S.No.	Course Code	Course Title	L	T	P	Credit	Marks		
							IA	UE	TM
1.	CECE241	Analog Circuits	3	0	0	3	40	60	100
2.	CECE242	Microcontrollers	3	0	0	3	40	60	100
3.	CECE243	Digital Signal Processing	3	0	0	3	40	60	100
4.	CECE244	Probability Theory and Stochastic Processes	3	1	0	4	40	60	100
5.	HSMC201	Life Skills	1	0	2	2	40	60	100
6.	PECE241	Analog Circuits Lab	0	0	2	1	60	40	100
7.	PECE242	Microcontrollers Lab	0	0	2	1	60	40	100
8.	PECE243	Digital Signal Processing Lab	0	0	2	1	60	40	100
9.	RECE241	Micro Project	0	0	4	2	60	40	100
10.	AU204^	Environmental Science	1	0	0	0	-	-	-
TOTAL						**21**	440	460	900

Note: ^ represents “Audit Course”.

Semester-V

S. No.	Course Code	Course Title	L	T	P	Credit	Marks		
							IA	UE	TM
1.	CECE 351	Analog and Digital Communication	3	0	0	3	40	60	100
2.	CECE 352	Electromagnetic Waves	3	0	0	3	40	60	100
3.	CECE 353	Embedded Systems	3	0	0	3	40	60	100
4.	CECE 354	Information Theory and Coding	3	0	0	3	40	60	100
5.	CECE 355	Control Systems	3	1	0	4	40	60	100
6.	HSMC304	Total Quality Management	3	0	0	3	40	60	100
7.	PECE 351	Analog and Digital Communication Lab	0	0	2	1	60	40	100
8.	PECE 352	Electromagnetic Waves Lab	0	0	2	1	60	40	100
9.	PECE 353	Embedded Systems Lab	0	0	2	1	60	40	100
10.	AU305^	Professional Ethics	1	0	0	0	-	-	-
TOTAL						**22**	420	480	900

Note: ^ represents “Audit Course”.

Semester-VI

S.No.	Course Code	Course Title	L	T	P	Credit	Marks		
							IA	UE	TM
1.	CECE361	Computer Networks	3	0	0	3	40	60	100
2.	CECE362	VLSI Design	3	0	0	3	40	60	100
3.	CECE363	Mobile Communication and Networks	3	1	0	4	40	60	100
4.	EECE36X	Program Elective-1	3	0	0	3	40	60	100
5.	OECEXXX	Open Elective-1	3	0	0	3	40	60	100
6.	PECE361	Computer Networks Lab	0	0	2	1	60	40	100
7.	PECE362	VLSI Design Lab	0	0	2	1	60	40	100
8.	RECE362	Mini Project	0	0	6	3	60	40	100
9.	SECE360	Seminar	0	0	2	1	100		100
TOTAL						**22**	480	420	900

Semester-VII

SL.No.	Course Code	Course Title	L	T	P	Credit	Marks		
							IA	UE	TM
1	CECE471	Microwave and Optical Communication	3	0	0	3	40	60	100
2	EECE471X	Program Elective-2	3	0	0	3	40	60	100
3	EECE472X	Program Elective-3	3	0	0	3	40	60	100
4	OECEXXX	Open Elective-2	3	0	0	3	40	60	100
5	OECEXXX	Open Elective-3	3	0	0	3	40	60	100
6	HSMC404	Entrepreneurship Development	2	0	2	3	40	60	100
7	PECE471	Microwave and Optical Communication Lab	0	0	2	1	60	40	100
9	IECE470	Internship	0	0	4	2	100		100
TOTAL						**21**	400	400	800

Semester-VIII

S.No.	Course Code	Course Title	L	T	P	Credit	Marks		
							IA	UE	TM
1	EECE48X	Program Elective-4	3	0	0	3	40	60	100
2	OXXXXXX	Open Elective-4	3	0	0	3	40	60	100
3	RECE473	Project	0	0	24	12	60	40	100
TOTAL						**18**	140	160	300

LIST OF OPEN ELECTIVES

(Offered by ECE Dept. for other Dept. Students)

S.No.	Course Code	Course Title	L	T	P	Credits	Marks		
							IA	UE	TM
1.	OECE001	Embedded System Design	3	0	0	3	40	60	100
2.	OECE 002	Semiconductor Devices	3	0	0	3	40	60	100
3.	OECE003	Internet of Things	3	0	0	3	40	60	100
4.	OECE004	Mobile Communication	3	0	0	3	40	60	100
5.	OECE005	Principles of Communication System	3	0	0	3	40	60	100
6.	OECE006	Introduction to VLSI Design	3	0	0	3	40	60	100

MINOR DEGREE-(B.Tech.(XXX)_Modern Communication Systems)

(Offered by ECE Dept. for other Dept. Students)

S. No	Course Code	Course Title	L	T	P	Credits	Marks		
							IA	UE	TM
1	MECE001	Cellular & Wireless Communication	3	1	0	4	40	60	100
2	MECE002	Emerging Technologies in Wireless Networks	3	1	0	4	40	60	100
3	MECE003	Satellite & Radar Communication	3	1	0	4	40	60	100
4	MECE004	Underwater Communication	3	1	0	4	40	60	100
5	MECE005	NPTEL Course related to Drone Technology/5G	-	-	-	2	-	100	100
TOTAL						**18**	160	340	500

LIST OF HONORS DEGREES
(Offered by ECE DEPARTMENT)

1. B.Tech. HONORS DEGREE(COMPUTATIONAL SIGNAL AND VISUAL INTELLIGENCE)

S. No	Semester	Course Code	Course Title	L	T	P	Credits	Marks		
								IA	UE	TM
1.	III	HECE131	Digital Signal Processing Architecture	3	1	0	4	40	60	100
2.	IV	HECE142	Machine Learning and Deep Learning for Image Processing	3	1	0	4	40	60	100
3.	V	HECE153	Speech Processing	3	1	0	4	40	60	100
4.	VI	HECE164	Statistical Digital Signal Processing	3	1	0	4	40	60	100
5.	VII	HECE175	NPTEL Course (Any one course related to Computational Signal Processing /Pattern Recognition etc.)	-	-	-	2	-	100	100
TOTAL							**18**	**160**	**340**	**500**

2. B.Tech. HONORS DEGREE (QUANTUM TECHNOLOGIES)

S. No	Semester	Course Code	Course Title	L	T	P	Credits	Marks		
								IA	UE	TM
1.	III	HECE231	Quantum Computing	3	1	0	4	40	60	100
2.	IV	HECE242	Quantum Communication	3	1	0	4	40	60	100
3.	V	HECE253	Quantum Sensing	3	1	0	4	40	60	100
4.	VI	HECE264	AI in Quantum Technology	3	1	0	4	40	60	100
5.	VII	HECE275	NPTEL Course (Any one course related to either Quantum Computing or Quantum Electronics etc.)	-	-	-	2	-	100	100
TOTAL							**18**	**160**	**340**	**500**

3, B.Tech. HONORS DEGREE (VLSI DESIGN)

S. No	Semester	Course Code	Course Title	L	T	P	Credit	Marks		
								IA	UE	TM
1.	III	HECE331	MOSFET Fundamentals and Analog Circuit Design	3	1	0	4	40	60	100
2.	IV	HECE342	Digital Integrated Circuits Design	3	1	0	4	40	60	100
3.	V	HECE353	VLSI Design Flow: RTL to GDS	3	1	0	4	40	60	100
3.	VI	HECE364	VLSI Testing and Testability	3	1	0	4	40	60	100
5.	VII	HECE375	NPTEL Course (Any one course related to VLSI Design.)	-	-	-	2	-	100	100
TOTAL							**18**	**160**	**340**	**500**

SEMESTER–I

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

Course Objectives:

In this course, the students will be able to

i. Correlate atomic and molecular structures to the properties of advanced materials like liquid crystals, fullerenes, and nanomaterials.
ii. Explain the principles of various spectroscopic techniques and their applications in chemical analysis.
iii. Apply thermodynamic principles and the Nernst equation to predict the spontaneity of electrochemical processes.
iv. Rationalize periodic trends in atomic properties and molecular geometries using fundamental chemical concepts.
v. Classify polymers and organometallic compounds and describe their methods of synthesis and industrial applications.

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 Nano materials 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, Ultraviolet &Visible and Raman spectroscopy.

MODULE III: ELECTROCHEMISTRY 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 (Buna-S, Buna-N, Neoprene, Nylon-6, nylon-6, 6 and Terylene); General methods of synthesis of organo-metallic 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 Publishing Company, 2009
3. Engineering Chemistry by Jain and Jain, Dhanpat Rai Publishing Company, New Delhi, 16th Edition, 2017

Reference Books:

1. Peter Atkins, Julio de Paula & James Keeler, "Physical Chemistry", 12th Edition., Oxford University Press, 2022.
2. B.L.Tembe, Kamaluddin and M.S.Krishnan, "Engineering Chemistry (NPTEL Web-book).
3. P.W.Atkins, Juliode Paula, "Physical Chemistry" , Oxford University Press, 2018

Web References:

1. NPTEL- "Chemistry-I" (IIT Bombay) https://archive.nptel.ac.in/courses/104/101/10410112/
2. NPTEL - "Spectroscopic Methods in Chemistry" (IIT Kanpur) https://archive.nptel.ac.in/courses/104/106/104106120/
3. NPTEL - "Polymer Science" (IIT Delhi) https://archive.nptel.ac.in/courses/118/104/118104002/

Course Outcomes:

On successful completion of this course, the students will have the ability to

i. Understand atomic and molecular structures to explain properties of solids, liquid crystals, fullerenes, and nanomaterials.
ii. Interpret electronic, rotational, vibrational, UV–Vis, and Raman spectra for chemical identification and analysis.
iii. Evaluate electrochemical systems using thermodynamic principles, EMF measurements, and the Nernst equation.
iv. Analyze periodic trends and atomic properties to predict molecular geometry, bonding, and reactivity.
v. Identify polymer types, organometallic reagents, and industrial polymers, explaining their synthesis and applications

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

Course Objectives:

In this course, the students will be able to:

i. Understand the Eigen values and Eigen vectors, Cayley-Hamilton theorem, and quadratic forms.
ii. Acquire knowledge of differential equations and their applications.
iii. To comprehend the concepts of partial differentiation, total derivatives, and Taylor's series for functions of two variables
iv. Understand the concept of double integration, triple integrations and its theorems.
v. Become familiar with vector differential operators, integral theorems (Green's, Stokes's, Gauss divergence), and vector field properties.

Course Contents:

MODULE I: LINEAR ALGEBRA (MATRICES) 12 Hours

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 Hamilton theorem (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 Hours

Differential Equations of First Order- Exact equations, Leibnitz's linear equations, Bernoulli's equation, 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 Hours

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

MODULE IV: MULTIVARIABLE CALCULUS (MULTIPLE INTEGRALS) 12 Hours

Double integration (Cartesian form and Polar form), constant limits, variable limits over the region R, Change of variables in double integrals (Cartesian to polar), Application 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 Hours

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.

Total No. of Hours: 60

Text Books:

1. Veerarajan T., "Engineering Mathematics -I & II", Tata McGraw-Hill, New Delhi, 2015.
2. Bali N.P. and Manish Goyal, "A Text Book of Engineering Mathematics", Laxmi Publications (P) Ltd., 9th Edition, 2014.

Reference Books:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014
2. Dr. M. K. Venkataraman, "Engineering Mathematics – Volume I and II", National Publishing Company, Chennai, 2008.
3. Erwin Kreysig, "Advanced Engineering Mathematics", John Wiley & Sons, New Delhi, 9th Edition, 2011

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Web References:

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:

On successful completion of this course, the students will have the ability to:

i. Solve matrix-related problems using concepts of rank, eigenvalues, eigenvectors, diagonalization, and quadratic forms.
ii. Apply standard techniques to solve first-order and higher-order linear differential equations with constant or variable coefficients.
iii. Evaluate partial derivatives, total derivatives, and identifies extrema of multivariable functions using appropriate calculus tools.
iv. Compute double and triple integrals in various coordinate systems and applies them to determine areas and volumes.
v. Utilizes vector differential operators and integral theorems to analyze vector fields and evaluate line and surface integrals.

ESCT103	PROGRAMMING FOR PROBLEM SOLVING	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Introduce the basic components of a computer system and the fundamental concepts of programming.
ii. Develop problem-solving abilities using algorithmic thinking and structured programming concepts.
iii. Design, code, test, and debug programs using the C programming language.
iv. Familiarize with the use of functions and its examples in program development.
v. Learn pointers, and structure and to inculcate good programming practices and logical skills for solving real-world computational problems.

Course Contents:

MODULE I: INTRODUCTION TO PROGRAMMING 9 Hours

Introduction to components of a computer system: disks, memory, processor, program storage and execution through processor, operating system, compilers etc.; Number System (Binary, Decimal, octal, and Hexadecimal) , Idea of Algorithm: steps to solve logical and numerical problems, Representation of Algorithms, Flowchart/Pseudocode with examples.

MODULE II: ALGORITHMS TO PROGRAMS 9 Hours

Problem formulation and Problem Solving: Introduction to C programming, structure of a program, compilation and linking processes; Constants, Variables, Data Types, Expressions using operators, storage classes; Managing Input and Output operations; Decision Making (Branching and Looping); Solving simple scientific and statistical problems.

MODULE III: INTRODUCTION TO ARRAYS AND APPLICATIONS 9 Hours

Arrays: Initialization, Declaration, one dimensional and two-dimensional arrays, Matrix operations, Character arrays and Strings, Basic Searching Algorithms (Linear and Binary), Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, Notion of order of complexity through example programs (no formal definition required).

MODULE IV: FUNCTIONS 9 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 9 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. Preprocessor directives (File inclusion, Macro substitution, Conditional Compilation).

Total No. of Hours: 45

Text Books:

1. Byron Gottfried, Schaum's, "Outline of Programming with C", Mc Graw-Hill ,2nd Edition 2022
2. E. Balaguruswamy, "Programming in ANSI C", Tata McGraw-Hill, 9th Edition, 2024.

Reference Books:

1. Brian W. Kernighan and Dennis M.Ritchie, "The C Programming Language" , Prentice Hall of India, Second Edition, 2015.
2. Kanetkar,Y, "Let Us C", BPB Publications, 18th Edition, 2021.
3. Hanly, J.R., & Koffman, E.B. , "Problem Solving and Program Design in C", Pearson, 8th Edition, 2016.
4. Ashok N. Kamthane "Programming in C" Pearson, 3rd Edition , 2011.

Web References:

1. NPTEL - "Problem Solving through Programming in C" (IIT Kharagpur) https://nptel.ac.in/courses/106105171
2. NPTEL - "Programming, Data Structures and Algorithms using C" (IIT Madras) https://archive.nptel.ac.in/courses/106/106/106106127/
3. NPTEL - "Programming in C" (IIT Kanpur) https://archive.nptel.ac.in/courses/106/104/106104128/

Course Outcomes:

On successful completion of this course, the students will have the ability to

i. Understand computer fundamentals and programming basics, including computer components, number systems, algorithms, and flowchart design.
ii. Develop structured C programs using variables, data types, operators, and control statements to solve computational problems.
iii. Apply data handling techniques through the use of arrays, strings, and basic searching and sorting algorithms.
iv. Implement modular programming concepts using functions, recursion, and efficient algorithms such as Quick Sort and Merge Sort.
v. Utilize advanced C programming features such as structures, pointers, file handling, and preprocessor directives to develop modular and real-world applications.

BSCT103	BIOLOGY FOR ENGINEERS	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Establish foundational biology principles and distinctions from engineering.
ii. Explain core genetic laws and their application to human disorders.
iii. Describe the structure and function of biomolecules and enzymes.
iv. Analyze the mechanisms of genetic information transfer and regulation.
v. Integrate concepts of microbiology, protein function, and bioenergetics.

Course Contents:

MODULE I: 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 18^{th} 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 of organisms based on (a) energy and carbon utilization - autotrophs, heterotrophs, lithotrophs (b) ammonia excretion –aminotelic, uricoteliec, ureotelic (c) Ecosystems: aquatic and 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 recessiveness and dominance; concept of chromosomal mapping; single gene disorders in humans; concept of complementation using human genetics.

MODULE III: BIOMOLECULES AND ENZYMES 9 Hours

Monomeric units, polymeric structures of carbohydrates -sugars, starch and cellulose; amino acids and proteins, lipids; 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. definition of gene in terms of complementation and recombination. DICOM image formats; DNA technology (use and application) Regulation Bill, 2019.

MODULE V: MICROBIOLOGY ANALYSIS 9 Hours

Concept of species and strain; Classification and identification of microorganisms; Microscopy; Culturing of microorganisms in the lab- isolation, inoculation, spread plate method, pour plate method; Sterilization and types of media compositions; Growth kinetics.

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. Mallick, B., "Biology for Engineers", McGraw Hill Education (India) Pvt Ltd, 2022.
3. Odaneth, A., "Biology for Engineers", All India Council for Technical Education (AICTE), 2023.

Reference Books:

1. Koduru, U.D., "General Biology", Khanna Book Publishing Company, 2022.
2. Campbell, N.A., Reece, J.B., Lisa, U, Cain M.L., Wasserman, S.A., Minorsky, P.V., Jackson, R. B., "Biology: A global approach", Pearson Education Ltd., 12th Edition 2020.
3. Wiley, J.M., Sherwood, L.M., Woolverton, C.J., Prescott's, "Microbiology", 9th Edition. McGraw Hill International, 2013.

Web References:

1. NPTEL - "Introductory Biology" (IIT Bombay) https://archive.nptel.ac.in/courses/102/106/102106110/
2. NPTEL - "Microbiology" (IIT Kharagpur) https://archive.nptel.ac.in/courses/102/103/102103012/
3. NPTEL - "Biochemistry" (IIT Kharagpur) https://archive.nptel.ac.in/courses/104/105/104105016/

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Relate fundamental biological principles to engineering concepts and historical technological breakthroughs.
ii. Apply Mendelian genetics to predict inheritance patterns and understand the basis of genetic disorders.
iii. Classify biomolecules and enzymes and analyze their structure-function relationships and catalytic kinetics.
iv. Explain the central dogma of molecular biology, from DNA structure to the universal genetic code.
v. Correlate protein structure with its diverse functions and analyze microbial classification and bio-energetics.

BSCP101	CHEMISTRY LABORATORY	0L:0T:2P	1 Credit

Course Objectives:

In this course, the students will be able to:

i. Determine key physicochemical properties like surface tension.
ii. Apply analytical techniques for quantitative chemical analysis of water.
iii. Synthesize compounds and analyze reaction products like polymers.
iv. Utilize instrumental methods including potentiometry.
v. Investigate colloidal behavior.

Course Contents:

List of Experiments:
(Any 10 Experiments from the list below)

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 an egg.

Total No. of Hours:36

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Operate standard lab equipment to measure and interpret physicochemical properties.
ii. Quantify unknown ion concentrations and analyze chemical composition of samples.
iii. Execute organic synthesis and analyze product characteristics using physicochemical principles.
iv. Operate analytical instruments to verify laws, determine concentrations, and separate mixtures.
v. Explain colloidal stability, crystal packing, and apply ion exchange for water treatment.

ESCP101	ENGINEERING GRAPHICS & DESIGN	1L:0T:4P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Provide the basic knowledge about Engineering Drawing.
ii. Learn the concepts of projections, technical drawing, dimensioning, and specifications.
iii. Understand the engineering graphics standards and solid modeling.
iv. Learn the analysis of isometric views.
v. 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: ISOMETRICPROJECTIONS

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

List of Experiments

1. Lines, lettering and dimensioning.
2. Geometrical Constructions.
3. Orthographic projections.
4. Projections of points and straightlines
5. Projections of planes.
6. Projections of solids.
7. Section of solids.
8. Isometric Projections.

Total No. of Hours: 45

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Describe engineering design and its place in society.
ii. Discuss the visual aspects of engineering design.
iii. Use engineering graphics standards.
iv. Illustrate solid modeling
v. Use computer-aided geometric design.

ESCP102	PROGRAMMING FOR PROBLEM SOLVING LABORATORY	0L:0T:2P	1 Credit

Course Objectives:

In this course, the students will be able to:

i. Understand the fundamentals of computers and the programming environment for problem- solving.
ii. Develop logical thinking skills through problem formulation using algorithms and flowcharts
iii. Write and execute C programs for solving computational and scientific problems using decision-making and looping constructs.
iv. Apply the concepts of arrays, functions, pointers, and structures for efficient data manipulation and modular programming.
v. Demonstrate file handling and preprocessor directives for building complete and well-structured C programs.

Course Contents:

List of Experiments:
(Any 10 Experiments from the list below:)

1. Study of computer fundamentals – evolution, classification, components, and programming environment.
2. Formulation and solution of problems using algorithms and flowcharts.
3. Solving simple computational problems using arithmetic expressions.
4. Scientific problem solving using decision-making and looping constructs.
5. Manipulation of one-dimensional arrays.
6. Operations on two-dimensional arrays – matrix-related problems and string handling.
7. Implementation of basic searching and sorting techniques.
8. Implementations of simple functions – call by value and call by reference.
9. Development of recursive functions.
10. Implementation of pointers and structures.
11. Performing file handling operations.
12. Use of preprocessor directives.

Total No. of Hours: 36

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Apply fundamental programming concepts and logical problem-solving techniques to design algorithms and implement them using the C language.
ii. Develop and execute C programs using control structures, arrays, functions, pointers, and structures to solve real-world computational problems.
iii. Utilize file handling and preprocessor directives to create efficient, modular, and well-structured C programs.

ESCP103	DESIGN THINKING AND IDEA LAB	1L:0T:2P	2 Credits

Course Objectives:

In this course, the students will be able to:

i. Identify and describe the five stages: Empathize, Define, Ideate, Prototype, and Test.
ii. Articulate the value of human-centered design in problem-solving.
iii. Analyze user needs, behaviour's, and pain points to inform design decisions.
iv. Conduct user research using interviews, observations, and surveys.
v. Synthesize research insights into actionable "How Might We" questions.

Course Contents:

MODULE I: FUNDAMENTALS OF DESIGN THINKING 9 Hours

Design Thinking Process: Types of the thinking process, Common methods to change the human thinking process, Design thinking: Definition, Origin of design thinking, Importance of design thinking, Design vs Design thinking, Problem solving, the need of design thinking; An approach to design thinking**,** Design thinking Process model, Design thinking tools.

Case Studies: General, Engineering and Service applications

Activities: Identify Opportunity and Scope of the Project. Explore the possibilities and prepare a design brief.

MODULE II: EMPATHIZE AND DEFINE 9 Hours

Design thinking phases, how to empathize, Role of empathy in design thinking, the purpose of empathy maps, Things to be done before empathy mapping, Activities during and after the session, Understanding empathy tools: Customer Journey Map, Personas.

Define-Methods of Define Phase: Storytelling, Critical items diagrams, Define success

Activities: Apply the methods of empathizing and Define Phases Finalize the problem statement

MODULE III: IDEATION 6 Hours

Challenges in idea generation, Visualize, Empathize, and Ideate method, Importance of visualizing and empathizing before ideating, Applying the method, Create Thinking, Generating Design Ideas, Lateral Thinking, Analogies, Brainstorming, Mind mapping, National Group Technique, Synectic's**,** Development of work**,** Analytical Thinking**,** Group Activities. Ideation Tools: How Might We? (HMW), Storyboard, Brainstorming. What is design innovation? A mindset for innovation**,** and asking, "What if?" asking "What wows?" and "What works?"

Activities- Apply the methods of Ideate Phase: Generate Lots of Ideas

MODULE IV: PROTOTYPING 6 Hours

What is a prototype - Prototyping as a mindset, prototype examples, prototype for products; Why we prototype Fidelity for prototypes: The process of prototyping - Minimum Viable Prototype.

Activities: Apply the Methods of the Prototype Phase: Create prototypes for selected ideas

MODULE V: TESTING **6 Hours**

Prototyping for digital products: What s unique for digital products, Preparation; Prototyping for physical products: What s unique for physical products, Preparation; Testing prototypes with users. Create a Pitch Plan for scaling up: Roadmap for Implementation, Fine-Tuning, and Submission of the project report.

Activities: Collect feedback; iterate and improve ideas. Present your solution using the Storytelling method.

Total No. of Hours: 36

Textbooks:

1. Tim Brown, "Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation", Harper Collins Publishers Ltd., 2019
2. Idris Mootee, "Design Thinking for Strategic Innovation", John Wiley & Sons, 2013

Reference Books:

1. Peter G. Rowe, " Design Thinking: Understanding How Designers Think and Work", MIT Press, 1991.
2. Don Norman, "The Design of Everyday Things", Basic Books, 2013.
3. Tom Kelley and David Kelley, "Creative Confidence: Unleashing the Creative Potential within Us All", Crown Business, 2013.
4. Todd Zaki Warfel, "Prototyping: A Practitioner s Guide", Rosenfeld Media, 2009.
5. CliveL.Dym, Patrick Little, Elizabeth J.Orwin, "Engineering Design: A Project-Based Introduction", Wiley, 2011.
6. Karl T. Ulrich and Steven D. Eppinger, "Product Design and Development", McGraw- Hill Education, 2015.
7. Charles Platt, "Make: Electronics: Learning Through Discovery", Maker Media, 2011.

Web References:

1. COURSESA"design-thinking-innovation" https://www.coursera.org/learn/uva- darden-design-thinking- innovation
2. NPTEL - "Design Thinking - A Primer" by IIT Bangalore https://nptel.ac.in/courses/110106124
3. SWAYAM - "Design Thinking and Creativity" by AICTE https://onlinecourses.swayam2.ac.in/cec22_ed10/preview

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Explain the design thinking process and its importance in problem-solving.
ii. Apply empathy and define phase tools to formulate a human-centered problem statement
iii. Generate a wide range of innovative ideas using structured ideation techniques.
iv. Create low-fidelity prototypes to visualize and communicate potential solutions.
v. Test prototypes with users, iterate based on feedback, and present a final solution.

AU101	CAREER DEVELOPMENT SKILLS	0L:0T:2P	0 Credit

Course Objectives:

In this course, the students will be able to

i. Equip students with career planning skills through self-assessment, goal setting, and structured action plans.
ii. Develop motivation, personality effectiveness, positive habits, and disciplined behaviour through practical activities.
iii. Build professional grooming, hygiene awareness, and socially appropriate attitudes, manners, and etiquette.
iv. Enhance self-awareness, time management, stress management, and emotional intelligence for personal and academic growth.
v. Introduce pathways for higher education, competitive exams, and entrepreneurship with foundational skills in idea and business planning.

Course Contents:

MODULE I: CAREER PLANNING **6 Hours**

Career Planning: Introduction to Career Planning - Self-Assessment for Career Planning Exploring Career Options- Developing a Career Plan; Goal Settings: Understanding Goal Setting - Setting Effective Goals - Action Plan Development - Practical Exercises

MODULE II: MOTIVATION **6 Hours**

Motivation: Definition and Importance of Motivation - Types of Motivation - Theories of Motivation - Factors Affecting Motivation Personality Effectiveness: Components of Personality Effectiveness - Communication Skills - /Interpersonal Skills - Practical Exercises Building Personality and Discipline: Introduction to Personality Development - Building Positive Habits - Discipline and Self-Control - Practical Application

MODULE III: GROOMING, HYGIENE AND CLEANLINESS **6 Hours**

Grooming, hygiene and Cleanliness: Personal Hygiene Practices - Body Grooming Techniques - Environmental Cleanliness - Mental and Social Impact of Grooming and Hygiene. Attitudes, Manners and Behaviors: Understanding Attitudes - Developing Positive Attitudes - Manners and Etiquette - Procedures and Protocols

MODULE IV: SELF-AWARENESS & SELF-CONFIDENCE **6 Hours**

Self-Awareness & Self-Confidence: Introduction to Self-Awareness- Understanding Strengths and Weaknesses- Building Self-Confidence- Practical Application Time Management: Introduction to Time Management - Planning and Prioritizing Tasks-Overcoming Procrastination- Practical Time Management Stress Management: Understanding Stress- Stress Management Techniques-Coping Strategies Practical Application Emotional Intelligence: Introduction to Emotional Intelligence- Managing Emotions- Social Awareness and Relationship Management-Practical Exercises

MODULE V: HIGHER EDUCATION & COMPETITIVE EXAMS **6 Hours**

Introduction to Higher Education, Competitive exams: Overview of Higher Education- Competitive Exams Overview - Exam Preparation Techniques Introduction to Entrepreneurship: Understanding Entrepreneurship- Developing a Business Idea - Business Planning

Total No. of Hours: 36

Textbooks:

1. Stephen P. Robbins & Timothy A. Judge, "Organizational Behavio*r",* Pearson, 19th Ed., 2024.
2. Brian Tracy, "Goals: How to Get Everything You Want Faster*"*, Updated Edition, Berrett-Koehler, 2020.

Reference Books:

1. Stephen P. Robbins, "Self-Development and Career Management", Pearson, 2023.
2. Alain de Botton, "The School of Life: An Emotional Education", Penguin, 2020.
3. Eric Ries, "The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation", Updated Edition, Currency, 2020

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Develop the ability to assess personal strengths, explore career options, set effective goals, and create a structured career action plan.
ii. Apply principles of goal setting, time management, and self-discipline for personal effectiveness.
iii. Demonstrate professional etiquette, positive attitudes, and effective interpersonal communication skills.
iv. Utilize strategies for self-awareness, emotional intelligence, and stress management to enhance resilience.
v. Evaluate pathways for career advancement, including higher education, competitive exams, and entrepreneurship.

SEMESTER–II

BSCT104	PHYSICS	2L:1T:0P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Analyze harmonic oscillators, rigid body equilibrium, and apply the work-energy theorem.
ii. Explain concepts of heat transfer, calorimetry, and the properties of sound waves.
iii. Formulate Maxwell's equations and understand their significance in electromagnetic theory.
iv. Apply quantum mechanical principles like the Schrödinger equation to model systems.
v. Describe wave optics phenomena including interference, diffraction, and polarization.

Course Contents:

MODULE I: MECHANICS 9 Hours

Harmonic oscillations –Simple harmonic, damped and forced oscillators – Series LCR resonant circuit – Parallel LCR resonant circuit – Q-factor and resonance, Static and dynamic equilibrium under forces and torques – Lami's theorem, Equilibrium of a rigid body under coplanar forces, Motion in an inclined plane, Defining couple and moment of a couple – Moment of a force – Conditions for the equilibrium of a rigid body – Resultant of forces Work energy theorem - Force as the gradient of a scalar field – Conservative force – Potential energy curves – Stable and unstable equilibrium, Defining center of mass – Rigid body dynamics: Defining moment of inertia – Parallel and perpendicular axes theorems – Relation between angular momentum, angular velocity, and moment of inertia.

MODULE II: HEAT AND SOUND 9 Hours

Thermal Expansion, Electrical equivalent of heat, Mechanical equivalent of heat, Specific Heat, Calorimetry, Latent heat, Heat transfer, Definition of Waves, Transverse and longitudinal waves, Wave equation, Superposition, interference, and reflection of waves, Acoustic Waves, Speed in different media, Doppler Effect for sound, Decibel Scale.

MODULE III: ELECTROMAGNETIC THEORY 9 Hours

Ampere’s law and Faraday’s law of electromagnetic induction, Derivation of Maxwell’s equations and their physical significance, Correction of Ampere’s law by Maxwell, Concept of displacement current, Poynting theorem, Maxwell’s equations in free space & velocity of electromagnetic waves, Transverse character of the wave and orthogonality of E, H and k vectors, Maxwell’s equation in dielectric medium and velocity of EM. Wave, Comparison with free space, Maxwell’s equations in conducting media, and solution of differential equations in this case, penetration depth & its significance.

MODULE IV: QUANTUM MECHANICS 9 Hours

Dual nature of matter & radiation, Heisenberg’s uncertainty Principle and its applications, wave packet concept, Davisson-Germer experiment, Photoelectric effect, Postulates of quantum mechanics, Significance of wave function, Derivation of Schrodinger equation for time-independent and time-dependent cases. Applications of the Schrodinger wave equation for a free particle, Particle in a box (one-dimensional and three-dimensional cases), and Simple harmonic oscillator (one-dimensional case).

MODULE V: OPTICS **9 Hours**

Coherent sources, Interference in uniform and wedge-shaped thin films, Necessity of extended sources, Newton's Rings and its applications, Introduction to diffraction, Fresnel and Fraunhoffer diffraction, Diffraction at single slit and double slit, Diffraction grating, Spectra with grating, Dispersive power, resolving power, Rayleigh's criterion of resolution, Resolving power of grating. Polarization of light, Retarder plates, States of polarization of light, Optics of Colour Vision, Concepts of working principle and design of Laser.

Total No. of Hours: 45

Text Books:

1. R.K.Shukla, "Engineering Physics", Pearson Education,Vol.-II,2014
2. R.K.Shukla, Electrical Engineering Materials, McGraw Hill, 1st Edition, 2012

Reference Books:

1. Marcelo Alonso, J.Finn Edwards, "Fundamental university physics", Vol.-I: Mechanics, Addison- Wesley,1st Edition,1967.
2. Arthur Beiser, "Concepts of Modern Physics", McGraw-Hill, 6th Edition, 2003
3. David Griffiths, "Introduction to Electrodynamics", Cambridge University Press ,4th Edition, 2017

Web References:

1. https://nptel.ac.in/courses/122101002
   [IITBombay, Prof. D.K. Ghosh]
2. https://nptel.ac.in/courses/122103011
   [IITGuwahati,Prof.AlikaKhare,Prof.PratimaAgarwal,Prof.S.Ravi]
3. https://nptel.ac.in/courses/115105099
   [IITKharagpur,Prof.AmalKumarDas]
4. https://nptel.ac.in/courses/115101005
   [IIT Bombay,Prof. D.K. Ghosh]
5. https://nptel.ac.in/courses/115101005
   [IIT Madras, Prof. S. Lakshmi Bals

Course Outcomes:

On successful completion of this course, the students will have the ability to :

i. Calculate moment of inertia, angular momentum, and analyze conditions for mechanical equilibrium.
ii. Solve problems related to calorimetry, wave propagation, and the Doppler Effect.
iii. Derive the electromagnetic wave equation and interpret concepts like displacement current.
iv. Solve the Schrödinger equation for a particle in a box and a simple harmonic oscillator.
v. Analyze interference and diffraction patterns and calculate the resolving power of gratings.

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

Course Objectives:

In this course, the students will be able to:

i. Introduce methods for forming and solving first- and higher-order partial differential equations.
ii. Develop understanding of Laplace transforms, their properties, and their use in engineering applications.
iii. Strengthen skills in applying inverse Laplace transforms and convolution to solve ordinary differential equations.
iv. Provide foundational knowledge of Fourier transforms and their properties for analyzing signals and functions.
v. Enable students to represent periodic functions using Fourier series and apply related theorems for practical computation.

Course Contents:

MODULE I: PARTIAL DIFFERENTIAL EQUATIONS 12 Hours

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 Hours

Existence conditions, transforms of elementary functions, Properties, transforms 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 Hours

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

MODULE IV: FOURIER TRANSFORM 12 Hours

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

MODULE V: FOURIER SERIES 12 Hours

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.

Total No. of Hours: 60

Text Books:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2021.
2. Veerarajan T, "Transforms and Partial Differential Equations", Tata Mc Graw-Hill, New Delhi, 2016.

Reference Books:

1. Bali N.P. and Manish Goyal, "A Text Book of Engineering Mathematics", Laxmi Publications (P) Ltd., 9th Edition, 2014.
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, 2006.

Web References:

i. Laplace Transform: (https://nptel.ac.in/courses/111106139)
ii. Partial Differential Equations: (https://nptel.ac.in/courses/111101153)
iii. Advanced Engineering Mathematics: (https://nptel.ac.in/courses/111107119)

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Solve a variety of partial differential equations using standard methods and classification techniques.
ii. Apply Laplace transform properties to simplify and analyze engineering-related mathematical problems.
iii. Utilize inverse Laplace transforms and convolution to determine solutions of linear differential equation systems.
iv. Perform Fourier transform operations and interprets results for continuous-time signal analysis.
v. Expand periodic and non-periodic functions into Fourier series and uses Parseval- based results for evaluation.

BSCT107	BASIC ELECTRICAL ENGINEERING	2L:1T:0P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Understand and gain basic knowledge about DC circuits.
ii. Learn the concept of single-phase and three-phase circuits with power measurement.
iii. Study the operating principles of transformers.
iv. Explore the working of DC machines and motors.
v. Study the three-phase induction motors.

Course Contents:

MODULE I: DC 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 Faraday's 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: AC CIRCUITS **9 Hours**

Generation of sinusoidal voltage: Definition of average value, RMS 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 AC Circuits: Necessity and advantages; Relationship between line and phase values of balanced star and delta connections; 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 of DC motors and their constructional features; EMF equation of generator; DC motor working principle; Back EMF and its significance; Applications; Necessity of a starter for DC motor.

MODULE V: THREE PHASE INDUCTION MOTORS **9 Hours**

Concept of rotating magnetic field; Principle of operation, types and constructional features of Single phase and 3 phase Induction Motors; Slip and its significance; Applications of squirrel cage and slip ring motors, Star-delta starter.

Total No. of Hours: 45

Text Books:

1. D.P. Kothari and Nagrath I.J .and , "Basic Electrical Engineering" 4th Edition, Tata Mc Graw Hill, 2019
2. Hayt and Kimberly, "Engineering Circuit Analysis", 8th Edition, Tata Mc Graw Hill, 2013

Reference Books:

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

Web References:

1. NPTEL - "Basic Electrical Circuits" (IIT Madras) https://archive.nptel.ac.in/courses/108/105/108105129/
2. NPTEL - "Electrical Machines I" (IIT Kharagpur) https://archive.nptel.ac.in/courses/108/105/108105102/
3. NPTEL - "Introduction to Electrical Machines" (IIT Kanpur) https://archive.nptel.ac.in/courses/108/105/108105083/

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Understand the concept of DC circuits and electromagnetic principles over inductors.
ii. Explain the concepts of AC circuits over RLC circuits, with knowledge of power and load performance, and obtain the power measurement using single-phase and three-phase circuits.
iii. Discuss the principles of operation and construction of single-phase transformers.
iv. Explain the operation and characteristics of DC machines and motors.
v. Illustrate the principle of the three-phase induction motors.

HSMC 101	UNIVERSAL HUMAN VALUES-II	2L:0T:2P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Introduce the need for value education and the process of self-exploration.
ii. Facilitate understanding of harmony between the self ('I') and the body.
iii. Develop sensitivity for maintaining harmony in family and society.
iv. Foster an understanding of harmony in nature and existence.
v. Apply a holistic understanding to ensure ethical human conduct in personal and professional life.

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 Harmony of 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.

MODULE IV: 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.

MODULE V: 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 Hours: 45

Text Books:

1. RR Gaur, R Asthana, GP Bagaria, "A Foundation Course in HumanValues and Professional Ethic", Excel Books, 2nd Revised Edition, New Delhi, 2019.
2. RRGaur, RAsthana, GPBagaria, "Teachers " Manual for A Foundation Course in Human Values and Professional Ethics", Excel Books, 2nd Revised Edition New Delhi, 2019.

Reference Books:

1. Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak,"Jeevan Vidya" 1999.
2. A.N.Tripathi, "HumanValues" New Age Intl. Publishers, New Delhi, 2004.

Web References:

1. https://uhv.org.in/UHV-II_Course_Material
2. https://uhv.org.in/uhve

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Distinguish between right understanding, relationships, and physical facilities.
ii. Differentiate between the needs of these lf and the needs of the body.
iii. Practice foundational human values like trust and respect in relationships.
iv. Explain the harmony; inter dependence, and mutual fulfillment in nature.
v. Integrate ethical human conduct and holistic models into professional practice.

BTENG 111	COMMUNICATIVE ENGLISH	2L:0T:2P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Achieve Advanced English Proficiency: Master grammatical structures, apply precise subject–verb agreement, use appropriate tenses, and employ active or passive voice strategically to produce clear, professional, and impactful documents.

ii. Enhance Comprehensive Listening Skills: Develop advanced active listening strategies to move beyond passive reception, ensuring accurate comprehension that enables technically precise, contextually appropriate, and actionable responses in meetings, presentations, and collaborative discussions

iii. Demonstrate Professional Speaking Proficiency: Cultivate confident, articulate, and persuasive communication skills essential for delivering clear technical presentations,excelling in job interviews, engaging effectively in team collaborations and maintaining polished etiquette in telephone and virtual meetings.

iv. Improve Reading Skills: Strengthen the ability to comprehend, interpret, and critically analyse diverse and complex texts to extract meaning and apply information effectively

v. Excel in Professional Written Communication: Develop the expertise to craft coherent,grammatically sound, and contextually appropriate documents for professional contexts,including technical reports, project summaries, persuasive cover letters, and targeted CVs.

MODULE 1 BASIC GRAMMAR

1.1 Foundations of Grammar

Importance of grammar in professional communication;Sentence structure: subject, predicate, object-; Phrases and clauses: definitions and functions

1.2 Parts of Speech

Nouns: countable/uncountable, proper/common, abstract/concrete ;Pronouns: personal, relative, demonstrative, reflexive ;Verbs: main, auxiliary, transitive/intransitive/ditransitive, linking verbs;Adjectives and adverbs: forms, degrees of comparison, placement;Prepositions and conjunctions: types and usage; Interjections: basic introduction; Articles: rules, omission, and professional usage

1.3 Grammar and Tense Structure

Tenses: present, past, and future (simple, continuous, perfect, perfect continuous);Subject–verb agreement: rules and exceptions ; Active and passive voice: formation and usage;Phrasal verbs and modal verbs ; Impressions I, Chapter 5, Two Gentlemen of Verona

1.4 Applied Grammar Exercises

Identifying parts of speech and tense;Tense conversion; Active to passive voice conversion

MODULE II – ESSENTIAL COMMUNICATION SKILLS

2.1 Introduction

Meaning and process of communication; Formal and informal communication;Verbal and non-verbal communication; Characteristics of technical communication; Communication barriers and strategies to overcome them; Intercultural communication; Common pronunciation errors in Indian English3 of 4; Neutral language and tone in professional contexts ;Impressions I, Chapter 6, Punishment in Kindergarten

2.2 Fundamentals of Communication

Importance of active listening and effective speaking in professional contexts; Decoding content, purpose, and tone; Listening and responding in lectures, meetings, and workplace settings; Overcoming listening and speaking barriers; Video-conference etiquette

2.3 Exercises and Practice

Classifying formal and informal conversations; Tone modulation for neutral and polite delivery ;Pronunciation drills; Identifying tone, intent, and attitude from audio samples;Note-taking from video lectures using the Cornell method ; Video-conference simulation (greeting, turn-taking, closure)

MODULE III – PROFESSIONAL COMMUNICATION

3.1 Effective Professional Communication

Professional and peer introductions;Oral summaries of reports and readings; Technical presentations: structure, slides, rehearsal;Group discussions: turn-taking, summarising,idea-building;Job interviews;Interview skills: answering and asking questions ;Persuasive speaking: pitching, debating, negotiating;Impressions I, Chapter 4, "The Model Millionaire"

3.2 Applied Listening and Speaking Exercises

Audio/video listening tasks with follow-up responses;Q&A sessions, role plays, and simulated workplace interactions ;Evaluating accuracy, bias, and relevance in listening;Mock group discussions and interviews

with feedback; Presentations and performance evaluation;Virtual meetings, project briefings, and academic seminars

MODULE IV – READING AND WRITING SKILLS

4.1. Fundamentals of Reading

Purpose of reading in academic and professional contexts; Types of reading: skimming, scanning, intensive, extensive; Identifying main ideas and supporting details ;SQ3R / SQW3R method (Survey–Question–Read–Write/Recite–Review) ; Focused note-taking: abbreviations, mapping, Cornell method;Reading speed and comprehension drills ;Impressions I, Chapter 2, My Early Days

4.2. Exercises:

Identifying main ideas in reading passages;Skimming and scanning tasks;Note-making and summarising exercises;Reading comprehension and inference-building

4.3. Fundamentals of Writing

Sentence as the basic unit of thought4 of 4 ;Types of sentences: declarative, interrogative, imperative, exclamatory ;Sentence structures: simple, compound, complex, and compound–complex ;Common sentence faults: fragments, run-ons, misplaced modifiers ;Punctuation and mechanics: commas, semicolons, colons, dashes, quotation marks, apostrophes; Avoiding redundancy, ambiguity, and wordiness

4.4. Exercises:

Sentence correction and punctuation practice ; Paragraph coherence and logical flow; Writing for conciseness and clarity ;Short writing tasks based on academic or workplace contexts

MODULE V - ADVANCED PROFESSIONAL WRITING SKILLS

5.1. Principles and Forms of Professional Writing

Clarity, conciseness, and coherence in writing;Tone and audience awareness in academic and technical writing ;Writing professional emails and memos;Preparing office documents: notices, circulars, meeting agendas, and minutes ;Preparing research and project proposals: objectives, methodology, expected outcomes;Crafting targeted CVs and résumés for academic and industry contexts ;Writing persuasive cover letters and Statements of Purpose (SoPs) ;Editing and proofreading for tone, coherence, grammar, and accuracy

5.2. Applied Writing Practice

Report writing from given data;Professional emails and memos;Career writing: CVs, SoPs, cover letters;Error correction in professional contexts;Peer review and proofreading practice

Total No. of Hours: 45

Text Books:

1. Kul Bhushan Kumar, "Effective Communication Skills", Khanna Book Publishing, 2022.
2. S.P. Dhanavel, English and Communication Skills for Students of Science and Engineering, Orient BlackSwan, 23rd Edition, 2020.

Reference Books:

1. G. Radhakrishna Pillai & Geetha Rajeevan, *Impressions 1: A Multi-Skill Course in English*, (Chapters 2, 4, 5, 6) Cambridge University Press, New Delhi, 2010.
2. Meenakshi Raman and Sangeetha Sharma, *Technical Communication* (Chapters 1, 2, 3, 4, 6, 10), OUP, New Delhi, 2011.
3. M. Ashraf Rizvi, *Effective Technical Communication* (Chapters 3, 4, 10, 11, 12, 15, 16, 17, 19, 20), Tata McGraw-Hill, NewDelhi, 2005.
4. Raymond Murphy, *Essential English Grammar* (Units 1, 2, 6, 7, 12, 19, 30, 31, 54, 64, 67, 68, 69, 79, 80, 85, 86, 99, 100, 101), Cambridge University Press, New Delhi, 2012.

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Demonstrate advanced written proficiency by accurately applying grammatical structures, subject–verb agreement, appropriate tenses, and the strategic use of active and passive voice to produce professional documents.
ii. Employ effective listening strategies to achieve accurate comprehension and generate contextually appropriate, precise, and actionable responses in professional and academic interactions.
iii. Display professional speaking proficiency by delivering clear and persuasive technical presentations, performing confidently in interviews, engaging productively in team discus sions, and maintaining effective etiquette in virtual and telephonic communication.
iv. Interpret and critically analyse complex texts to extract relevant information, evaluate argu ments, and apply insights to academic and professional contexts.
v. Produce professional written communication that is coherent, grammatically accurate, and lored to context, including technical reports, project summaries, persuasive cover letters, and targeted CVs.

BSCP104	PHYSICS LABORATORY	0L:0T:2P	1 Credit

Course Objectives:

In this course, the students will be able to:

i. Comprehend the concept of interference and how waves combine constructively and destructively to produce varying amplitudes.
ii. Understand the single-slit diffraction pattern and calculate the angles of diffraction for different wavelengths and slit sizes.
iii. Understand the double-slit interference pattern and calculate fringe spacing and 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 principles of laser operation, including stimulated emission, population inversion, and optical gain.

Course Contents:

List of Experiments

(Atleast one Experiment from each section with total of 12 based on the functioning and availability of the setup)

A Mechanics & Properties of Matter

1. Determination of the moment of inertia of a flywheel.
2. To determine the acceleration due to gravity (g) using Kater's Pendulum.
   a. Torsional pendulum – Determination of rigidity modulus of wire and moment of inertia of the disc.
3. Determination of Young's modulus – Non-uniform bending and uniform bending.
4. To find the thickness of the given glass plate using a single optic lever.
5. To determine the rigidity modulus of the material rod by static torsion.

B. Magnetic

1. Measurement of magnetic susceptibility: Quincke's Method / Gouy's Balance.
2. Current-carrying coil: To determine the variation in magnetic field with distance along the axis of a current-carrying coil and estimate the radius of the coil.
3. Hall Effect: To determine the Hall coefficient, carrier density, and mobility of a semiconductor.
4. Magnetic Hysteresis: To draw the B-H curve of ferromagnetic iron and determine the hysteresis loss.

C. Thermodynamics

1. To determine the thermal conductivity of a metal by Searle's method.
2. To determine the thermal conductivity of a bad conductor by Lee's disc method.
3. To determine the specific heat capacity of a liquid and verify Newton's Law of Cooling by the method of cooling.
4. To determine the emissivity of the surface of the spherical calorimeter.

D. Sound

1. To verify the laws of transverse vibration and longitudinal vibration using a sonometer.
2. Determination of wavelength of ultrasonic waves using Kundt's tube method.

E. Optical

1. Laser: To study the laser diffraction, laser beam profile, and beam quality.
2. Optical Fibre: To determine the numerical aperture, fibre loss, and LED/Laser diode characteristics.
3. Michelson Interferometer: To measure the wavelength and coherence time of the light source.
4. Laurent's Half-shade Polarimeter: Determination of specific rotatory power.

Total No. of Hours: 36

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Perform experimental measurements to determine mechanical properties such as moment of inertia, modulus of elasticity, and rigidity modulus.

ii. Analyze magnetic behaviour of materials through susceptibility measurements, Hall effect studies, and hysteresis characterization.

iii. Determine key thermal parameters including thermal conductivity, specific heat, cooling rates, and emissivity using standard methods.

iv. Verify acoustic principles and evaluates the properties of sound waves using sonometer and ultrasonic wave techniques.

v. Apply optical instruments such as lasers, optical fibres, interferometers, and polarimeters to measure wavelength, fibre characteristics, and optical rotation.

ESCP104	BASIC ELECTRICAL ENGINEERING LABORATORY	0L:0T:2P	1 Credit

Course Objectives:

In this course, the students will be able to:

i. Understand the importance of electrical safety in handling electrical equipment and wiring.
ii. Understand the techniques for making secure and reliable electrical joints.
iii. Understand the principles of series and parallel circuits and their applications in lamp circuits.
iv. Learn the concept and purpose of staircase wiring in residential and commercial settings.
v. Learn the concept of load tests in motors and transformers

Experiment List

(Any 10 Experiments from the below list)

1. Electrical safety, precautions, study of tools and accessories.
2. Practice of different joints; wiring and testing of series and parallel lamp circuits.
3. Staircase wiring and doctor's room wiring.
4. Bedroom and godown wiring.
5. Wiring and testing of ceiling fan and fluorescent lamp circuit.
6. Study of different types of fuses, circuit breakers, and A.C. and D.C. meters.
7. O.C. and S.C. test on single-phase transformer.
8. Load test on single-phase transformer.
9. Load test on D.C. shunt motor.
10. Two-wattmeter method of power measurement.
11. Load test on single-phase induction and three-phase induction motor.
12. Speed control methods of D.C. motor.

Total No. of Hours: 36

Course Outcomes:

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

i. Demonstrate safe electrical practices, proper handling of tools, and awareness of protection devices.
ii. Perform different wiring systems—including series, parallel, staircase, and room wiring and tests their functionality.
iii. Conduct installation and testing of household electrical appliances such as ceiling fans and f luorescent lamps.
iv. Evaluate the performance of transformers and motors through O.C., S.C., load tests, and power measurement methods.
v. Apply speed control techniques and interprets characteristics of D.C. motors and A.C. induction motors in practical conditions.

ESCP105	DIGITAL FABRICATION LAB	0L:0T:4P	2 Credits

Course Objectives:

In this course, the students will be able to:

i. Develop CAD models for 3D printing.
ii. Import and Export CAD data and generate .stl file
iii. Select a specific material for the given application
iv. Selecta 3D printing process for an application
v. Produce a product using 3D Printing or Additive Manufacturing (AM).

Experiment List:

1. **Introduction to Digital Fabrication Tools**
   a. Familiarization with 2D/3D design software (TinkerCAD/FreeCAD/SketchUp).
   b. Creating simple shapes (cube, cylinder, gear).
2. **2D Design & Laser Cutting Basics**
   Drawing simple 2D patterns (nameplate, college logo).
   Exporting design for laser cutting.
3. **3D Printing–Part1**
   Designing a keychain/pen holder in CAD. Converting to STL and slicing with Prusa Slicer/Cura.
4. **3D Printing–Part2**
   Printing a small object (cube, whistle, gear).
   Observing layer thickness, infill, and supports.
5. **Vinyl Cutting**
   Designing stickers/simple text cut-outs. Printing and applying on surface.
6. **PCB Design Basics**
   Creating a simple PCB layout (LED circuit) using EAGLE/KiCAD.
   Exporting Gerber files.
7. **CNC Plotting/Engraving (Demo Experiment)**
   Simple text engraving or drawing using CNCplotter.
8. **3D Scanning(Demo)**
   Introduction to 3D scanning using a mobile app/scanner.
   Converting scan into editable 3D model.
9. **Mini Project (Group Activity)**
   Fabricating a small product using at least two tools (e.g., a 3D printed pen stand with a vinyl logo, a laser-cut keychain with an engraved name).

Total No. of Hours: 36

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Use 2D and 3D design software to create basic digital models suitable for fabrication.
ii. Apply laser cutting, vinyl cutting, and CNC plotting techniques to produce simple physical designs.
iii. Operate 3D printers effectively by preparing STL files, slicing models, and evaluating print parameters.
iv. Design basic PCB layouts and generates Gerber files for electronics fabrication.
v. Integrate multiple digital fabrication tools to develop a functional mini-project with real-world applications.

AU102	SPORTS AND YOGA	0L:0T:2P	0 Credit

Course Objectives:

In this course, the students will be able to:

1. Make the students understand the importance of sound health and fitness principles as they relate to better health.
2. Expose the students to a variety of physical and yogic activities aimed at stimulating their continued inquiry about Yoga, physical education, health and fitness
3. Create a safe, progressive, methodical and efficient activity based planto enhance improvement and minimize risk of injury
4. Develop among students an appreciation of physical activity as a lifetime pursuit and a means to better health

Course Contents:

Physical Education is compulsory for all the undergraduate students

1. The activities will plan on Games, Sports and Yoga/extension lectures.
2. In the above activities, the student participation shall be for a minimum period of 30 hours.
3. The above activities will be monitored by the Director of Physical Education.

Total No. of Hours**: 30**

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Improve physical fitness and proficiency in selected games or sports.
ii. Apply techniques and principles of yoga for enhancing flexibility and mental focus.
iii. Exhibit teamwork, sportsmanship, and leadership skills through group sporting activities.
iv. Develop a sustainable personal fitness regimen incorporating exercise and healthy habits.
v. Cultivate discipline and stress management through regular physical activity and mindfulness.

SEMESTER-III

CECE 231	ELECTRONIC DEVICES	3 L : 0 T : 0 P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Understand the fundamental physics of semiconductors and carrier transport mechanisms.
ii. Study the characteristics and applications of PN junction and Zener diodes.
iii. Analyse the operation, biasing, and characteristics of BJTs and FETs.
iv. Explore the working principles of special semiconductor devices like MOSFETs, Schottky diodes, and MESFETs.
v. Gain knowledge of integrated circuit fabrication processes and modern semiconductor manufacturing techniques.

Course Contents:

MODULE I: INTRODUCTION TO SEMICONDUCTOR PHYSICS 9 Hours

Classical vs Quantum Mechanics, Electrons in periodic Lattices for Semiconductor materials ((Si, GaAs) and characteristics, Energy bands diagrams: intrinsic and extrinsic semiconductor; Carrier transport: diffusion current, drift current, mobility and resistivity; sheet resistance

MODULE II: SEMICONDUCTOR DIODES 9 Hours

PN junction diode: operation, VI characteristics, diode equation, temperature effects, DC and AC resistance, transition and diffusion capacitances, diodes switching times; Zener diode: Avalanche and Zener breakdown, Zener diode characteristics; Applications: Clippers, Clampers, Rectifiers, Voltage Regulators

MODULE III: TRANSISTORS 9 Hours

Structure of NPN & PNP, Regions of operation (cutoff, active, saturation), Input and Output characteristics, Types of configurations; Ebers–Moll Model (large signal behavior); Biasing and Stabilization of BJT: DC Load Line & Q-Point, Need for Biasing, Different types of BJT biasing; Field Effect Transistors (FETs): Construction and Operation Drain (output) characteristics and Transfer characteristics

MODULE IV: SPECIAL SEMICONDUCTOR DEVICES 9 Hours

MOSFET: Construction, Operation, Characteristics, Enhancement & Depletion types; UJT, SCR; LED, LASER, Photodiodes (PN, PIN, APD); Schottky barrier diode; MESFET; Quantum-tunneling diodes.

MODULE V: FABRICATION 9 Hours

Integrated circuit fabrication process: Crystal growth, Epitaxy, Dielectric Film, Oxidation, Diffusion, Ion implantation, Photolithography, Etching, Metallisation (Sputtering), Packaging; Thin and Thick Film Technology

Total No. of Hours: 45

Text Boks:

1. G. Streetman, and S. K. Banerjee, "Solid State Electronic Devices", Pearson, 7th Edition, 2014.
2. Thomas L.Floyd, David M. Buchla and Gary D. Synder, "Electronics Fundamentals: Circuits Devices and Applications", Pearson, 9th Edition, 2025

Reference Books:

1. R.S. Sedha, "Applied Electronics", S. Chand and Company Ltd., New Delhi, 2001
2. A.K. Maini, N. Maini, "All-in-One Electronics Simplified", Khanna Book Publishing, New Delhi, 2021.
3. Donald Neamen, Dhrubes Biswas, "Semiconductor Physics and Devices McGraw-Hill Education, 4th edition, 2022

Web References:

1. NPTEL: https://nptel.ac.in/courses/108108112

Course Outcomes:

On successful completion of this course, the students will have the ability to :

i. Analyze semiconductor energy band structures and carrier transport mechanisms and also properties of materials.
ii. Demonstrate the operation and characteristics of PN and Zener diodes and applies them in rectifier and regulator circuits.
iii. Interpret the behavior of BJTs and FETs through characteristic curves, biasing methods, and device models.
iv. Explain the working principles and characteristics of advanced semiconductor devices such as MOSFETs, LEDs, photodiodes, and Schottky diodes.
v. Describe major IC fabrication steps including oxidation, lithography, doping, deposition, and packaging in modern semiconductor manufacturing.

CECE 232	DIGITAL ELECTRONICS	3 L: 0 T : 0 P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Understand the fundamentals of number systems and Boolean Algebra.
ii. Understand the concepts of Combinational Logic Design.
iii. Conceptualize the working of Sequential Circuits, Synchronous Sequential Circuits.
iv. Introduce the concept of Finite State Machines and its various application circuits.
v. Know the different Logic families, concept of memory and different Logic devices

Course Contents:

MODULE I: LOGICAL SIMPLIFICATION 9 Hours

Number System, Logic Gates, Review of Boolean Algebra and De Morgan's Theorem; SOP & POS forms - Canonical forms; Karnaugh maps up to 6 variables; Codes: Binary Code, Code Convertors.

MODULE II: COMBINATIONAL LOGIC DESIGN 9 Hours

Adders/Subtractors: Half Adders, Full Adders, Subtractors, Parallel Adders, BCD Adder; Comparators, Multiplexers, Encoder, Decoder, Driver & Multiplexed Display; Barrel shifter, ALU.To

MODULE III: SEQUENTIAL LOGIC DESIGN 9 Hours

Building blocks like S-R, JK, Master-Slave JK FF, D FF, T FF-Edge triggered FF; Counters: Ripple counters, Synchronous counters; Shift registers.

MODULE IV: FINITE STATE MACHINES 9 Hours

Design of synchronous FSM, Algorithmic State Machines charts; Designing synchronous circuits like Pulse train generator, Pseudo Random Binary Sequence generator, Clock generation.

MODULE V: LOGIC FAMILIES AND SEMICONDUCTOR MEMORIES 9 Hours

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.

Total No. of Hours: 45

Text Books:

1. R.P. Jain, "Modern Digital Electronics", Tata McGraw Hill, 5th Edition, 2022
2. R. Anand, "Digital System Design Using VHDL", Khanna Book Publishing Company, 1st Edition, 2023

Reference Books:

1. Gothman, "Digital Electronics-An introduction to theory and practice", Pearson Education, 2009.
2. Douglas-Hall, "Digital Circuits and Systems", Tata McGraw Hill, 1989.
3. Charles Roth, "Digital System Design using VHDL", Tata McGraw Hill, 2nd Edition, 2012

Web References:

1. https://nptel.ac.in/courses/108105132

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Simplify Boolean expressions and number systems using K-maps and applies code converters in digital circuits.
ii. Design combinational circuits such as adders, comparators, multiplexers, encoders, decoders, and ALU modules.
iii. Develop sequential circuits using flip-flops, counters, and shift registers for timing and control applications.
iv. Construct finite state machines and implements synchronous digital systems using ASM-based design.
v. Evaluate logic families, memory devices, and programmable digital hardware such as FPGAs for modern digital designs.

CECE-233	SIGNALS AND SYSTEMS	3 L : 1 T : 0 P	4 Credits

Course Objectives:

In this course, the students will be able to :

1. Introduce the concepts of continuous time and discrete time signals and systems including their classification and properties.
2. Comprehend and analyze the frequency domain representation of continuous time signals.
3. Equip students with skills to analyze discrete-time signals using DFS, DTFT, and Z-transform methods.
4. Provide understanding of continuous-time LTI system characterization using differential equations, convolution, transfer functions, and state-space models.
5. Learn and investigate the different types of representing discrete time LTI systems and their Properties.

Course Contents:

MODULE I: REPRESENTATION & CLASSIFICATION OF SIGNALS & SYSTEMS **12 Hours**

Continuous time signals, Discrete time signals, Representation of signals, Operations on the signals : Classification of systems, Properties of systems.

MODULE II: ANALYSIS OF CONTINUOUS TIME SIGNALS **12 Hours**

Fourier series: Properties, Trigonometric and Exponential Fourier series, Parseval's relation for periodic signals; Fourier Transform: Properties, Rayleigh's Energy Theorem; Laplace Transformation: Properties, R.O.C , Inverse Laplace transform.

MODULE III: ANALYSIS OF DISCRETE TIME SIGNALS **12 Hours**

Discrete Fourier Series; Discrete Time Fourier Transform: Properties; Z Transformation: Properties, Different methods of finding Inverse Z-Transformation.

MODULE IV: CONTINUOUS TIME SYSTEMS **12 Hours**

LTI continuous time systems: Differential equations, Transfer function and Impulse response Convolution Integral, Block diagram representation and reduction, State variable techniques, State equations.

MODULE V: DISCRETE TIME SYSTEM **12 Hours**

LTI Discrete time systems, Differential equations, System function and impulse response, Convolution Sum , Block diagram representation, State equations for discrete time systems.

Total No. of Hours: 60

Text Books:

1. R. Anand, "Signals and Systems", Khanna Publishing House, 2019.
2. P. Ramesh Babu and R.Anandanatarajan, "Signals and Systems", 5th Revised Edition, Vijay Nicole Imprints, 2022.

Reference Books:

1. Allan V. Oppenheim, Allan S.Willsky and S.Hamid Nawab, "Signals and Systems", Pearson, 2nd Edition, New Delhi, 2015.
2. H. P. Hsu and R.Ranjan, "Signals and Systems", Schaums Outlines, Tata McGraw Hill, 2nd Edition, 2017.
3. J Simon Haykins and Barry Van Veen, "Signals and Systems", Wiley, 2nd Edition,2007
4. S. Poornachandra and B.Sasikala "Signals and Systems", Tata McGraw Hill, First Reprint 2008.

Web References:

1. NPTEL: https://nptel.ac.in/courses/117101055

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Represent and classifies continuous-time and discrete-time signals and systems and performs basic signal operations.
ii. Analyze periodic and aperiodic continuous-time signals using Fourier series, Fourier transform, and Laplace transform.
iii. Evaluate discrete-time signals using DFS, DTFT, Z-transform, and applies inverse transform techniques.
iv. Determine the behavior of continuous-time LTI systems using differential equations, convolution, transfer functions, and state-space models.
v. Analyze discrete-time LTI systems through difference equations, convolution sum, system functions, and state-space representations.

CECE-234	NETWORK THEORY	3 L : 0 T : 0 P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Analyze the given electrical network using Kirchoff's laws.
ii. Learn different theorems for DC networks
iii. Introduce the basic knowledge of Laplace transform to analyze the different networks using suitable technique.
iv. Analyze the two-port networks and passive filters.
v. Understand the use of network topology in circuit solving.

Course Contents:

MODULE I: NODE AND MESH ANALYSIS 9 Hours

Kirchhoff's laws, Node and mesh equations, Matrix approach of complicated network containing voltage and current sources and reactances, Source transformation, three phase unbalanced circuits and power calculations.

MODULE II: NETWORK THEOREM 9 Hours

Superposition, Reciprocity, Thevenin's, Norton's, Maximum power Transfer, compensation and Tellegen's theorem as applied to DC

MODULE III: RLC CIRCUITS 9 Hours

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 IV: PASSIVE FILTERS AND TWO PORT NETWORKS 9 Hours

Introduction to Passive filters.; Two port network and interconnections, Driving points and transfer functions poles and zeros of admittance function and their properties.

MODULE V: NETWORK TOPOLOGY 9 Hours

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", 3rd Edition, Pearson Education, 2019.
2. A William Hayt, "Engineering Circuit Analysis", McGraw Hill Science Engineering, 8th Edition, 2013.

Reference Books:

1. Ashfaq Husain, "Networks and Systems" , Khanna Book Publishers, 2021.
2. M. E. Van Valkenburg, "Network Analysis", 3rd Edition, Pearson, 2015.
3. Robert L. Boylestad, " Introductory Circuit Analysis", 14th Edition , Pearson, 2021.

Web References:

1. NPTEL: https://nptel.ac.in/courses/108105159

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Apply node and mesh analysis techniques to solve complex AC and DC electrical networks.
ii. Use network theorems to simplify circuits and determine equivalent representations for analysis.
iii. Analyze the transient and steady-state behavior of RLC circuits using Laplace transform methods.
iv. Evaluate passive filters and characterize two-port networks using network parameters and transfer functions.
v. Apply network topology principles to construct graph models and evaluate circuit behavior through cut-set and tie-set analysis.

ESCT-206	NUMERICAL TECHNIQUES	2 L : 1 T : 0 P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Apply interpolation techniques like polynomial and spline methods to approximate functions from discrete data.
ii. Learn numerical integration rules, including Simpson's and Gauss quadrature, to evaluate definite integrals.
iii. Solve systems of linear equations using direct methods like Gaussian Elimination and iterative methods like Gauss-Seidel.
iv. Learn the procedure to determine roots of nonlinear equations using iterative algorithms such as Bisection, Secant, and Newton-Raphson methods.
v. Study the method to obtain numerical solutions for ordinary and partial differential equations using finite difference and Runge-Kutta methods.

Course Contents:

MODULE I: INTERPOLATION **9 Hours**

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

MODULE II: NUMERICAL INTEGRATION **9 Hours**

Numerical integration, Simpson rule, composite rules, error formulae, Gauss quadrature

MODULE III: SYSTEM OF LINEAR EQUATIONS **9 Hours**

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: NON-LINEAR EQUATION **9 Hours**

Solution of a nonlinear equation, bisection and secant methods. Newton-Raphson method, rate of convergence, solution of a system of nonlinear equations

MODULE V: NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS **9 Hours**

Euler and Runge-Kutta methods, multistep methods, predictor-corrector methods, orderof 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", New Age International Ltd., 8th edition, 2022.
2. R.L. Burden and J. D. Faires, "Numerical Analysis", 4th edition, Brooks Cole, 2012.

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.

Web References:

1. NPTEL: https://nptel.ac.in/courses/111107105

Course Outcomes:

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

i. Implement different interpolation schemes
ii. Understand different numerical integration techniques, and numerically solve differential equations.
iii. Perform various matrix computations and solve simultaneous linear equations.
iv. Explain the solutions of non linear equations using different methods.
v. Understand Eigenvalue problem and power method.

BSCT-206	NANO SCIENCE TECHNOLOGY	2 L : 1 T : 0 P	3 Credits

Course Objectives:

In this course, the students will be able to:

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

Course Contents:

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 IV: NANOFABRICATION AND CHARACTERIZATION TECHNIQUES9 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

Reference Books:

1. Dieter Vollath, "Nanomaterials: An Introduction to Synthesis, Properties and Applications", Wiley-VCH. 2013.
2. Vladimir V. Mitin, Viatcheslav A. Kochelap & Michael A. Stroscio, "Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and Applications", 2nd Edition, Cambridge University Press, 2022**.**
3. Charles P. Poole & Frank J. Owens, "Introduction to Nanotechnology", Wiley, 2017.

Web References:

1. NPTEL: https://nptel.ac.in/courses/113106093

Course Outcomes:

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

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

PECE-231	ELECTRONIC DEVICES LAB	0 L : 0 T : 2 P	1 Credit

Course Objectives:

In this course, the students will be able to:

i. Understand the characteristics of semiconductor devices
ii. Construct the circuits experimentally based on the applications of semiconductor devices

Course Contents:

List of Experiments:

(Any 10 Experiments from the below list)

1. Determination of 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. Determination of output and transfer characteristics of JFET
5. Determination of output and transfer characteristics of MOSFET
6. Characteristics of UJT
7. Characteristics SCR
8. Determination of V-I characteristics of LED.
9. Design and testing of biasing circuits, fixed bias, Collector to base bias Self bias.
10. Determination of ripple factor for different types of rectifiers with and without filters.
11. Voltage Regulators using Zener diode
12. Clipper and clamper circuits using PN Junction diode
13. Rectifiers using PN Junction diode

Total No. of Hours: 36

Course Outcomes:

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

i. Demonstrate the characteristics of semiconductor devices.
ii. Implement circuits experimentally based on the knowledge gained in semiconductor devices.
iii. Gain practical knowledge of resonant circuits by analysis of the frequency responses.

PECE-232	DIGITAL ELECTRONICS LABORATORY	0 L : 0 T : 2 P	1 Credit

Course Objectives:

In this course, the students will be able to:

i. Represent logical functions in canonical and standard forms.
ii. Design and analyze the combinational logic circuits.
iii. Design and analyze the sequential logic circuits.
iv. Implement combinational and sequential logic circuits using Verilog HDL.

Course Contents:

List of Experiments:

(Any 10 experiments from the below list)

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. Study of 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 timing diagrams
   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. Study of a Memory IC
   a. READ and WRITE operations involving memory chips
   b. Expansion of memory size

10. Simulate of the Gates:
    a. Basic Gate
    b. Universal Gates
11. Simulate the Combinational circuits
    a. Full Adder
    b. Multiplexer
12. Simulate the Combinational circuits
    a. Binary Up-Counter
    b. Binary Up-down Counter
    c. Shift Register

Total No. of Hours: 36

Course Outcomes:

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

i. Understand the number systems and IC characteristics
ii. Understand the Boolean algebra and its properties
iii. Design and analyze the combinational logic circuits
iv. Get grip on HDL syntax
v. Implement and simulate the combinational logic circuits using HDL

AU-203	INDIAN CONSTITUTION & KNOWLEDGE SYSTEMS	1 L : 0 T: 0 P	0 Credit

Course Objectives:

In this course, the students will be able to :

i. Recognize one's fundamental duties and rights
ii. Understand the structure and functions of legislature, executive and judiciary
iii. Understand the functioning of state governments and union territories
iv. Understand the centre-state relations and functioning of constitutional bodies
v. Understand the Indian Traditional knowledge system

Course Contents:

MODULE I: INTRODUCTION OF INDIAN CONSTITUTION 6 Hours

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: UNION GOVERNMENT 6 Hours

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: STATE GOVERNMENTS 6 Hours

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

MODULE IV: UNION-STATE RELATIONS, CONSTITUTIONAL BODIES 6 Hours

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: INDIAN TRADITIONAL KNOWLEDGE 6 Hours

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: 30

Text Books:

1. Granville Austin, **"**The Indian Constitution: Cornerstone of a Nation", Oxford University Press, 2018.
2. P.M. Bakshi, "The Constitution of India (with latest amendments)**",** Universal Law Publishing, 2022**.**
3. Michel Danino**, "**Indian Knowledge System", NCERT, 2021**.**

Reference Books:

1. Basu, Durga Das., "Introduction to the Constitution of India", LexisNexis, 25th Edition, 2020.
2. Fadia B. L., and Fadia, Kuldeep, "Indian Government and Politics", Sahitya Bhawan Publications, 2021.
3. Sharma, Brij Kishore, " Introduction to the Constitution of India", PHI Learning Pvt. Ltd., 7th Edition, 2018.

Course Outcomes:

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

i. Explain the history, sources, and foundational principles of the Indian Constitution, including rights, duties, and state structures.
ii. Describe the roles and powers of key Union Government institutions such as the President, Prime Minister, Parliament, and Judiciary.
iii. Interpret the structure, functioning, and authority of State Governments, including Panchayati Raj institutions and constitutional amendments.
iv. Analyze Centre State relations, constitutional bodies, and key legislations such as RTI, RTE, and emergency provisions.
v. Appreciate the Indian Knowledge System by understanding its philosophical, scientific, linguistic, and artistic traditions and their relevance to holistic living.

SEMESTER-IV

CECE-241	ANALOG CIRCUITS	3 L : 0 T : 0 P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Analyze the BJT amplifiers at low and high frequencies hybrid- π model
ii. Learn the multistage BJT Amplifiers
iii. Learn the different types of power amplifiers
iv. Study the different types of oscillators
v. Conceptualize the working of OP-AMP and its applications

Course Contents:

MODULE I: BJT AMPLIFIERS **9 Hours**

Frequency response of an amplifier, Analysis at low and high frequencies of CE- Hybrid-pi (π) model, Validity of hybrid- π model, Variation of hybrid – π parameters, Millers theorem and its dual, CE short circuit current gain, current gain with resistive load, Gain-Bandwidth product.

MODULE II: MULTISTAGE BJT AMPLIFIERS **9 Hours**

Distortion in amplifiers, Analysis of Cascode, Cascaded amplifier, Darlington pair, Coupling schemes: RC coupled amplifier, Transformer Coupled amplifier, Direct coupled Amplifier; Frequency response of single stage and multistage amplifier.

MODULE III: POWER AMPLIFIERS **9 Hours**

Power amplifiers (Class A, B, AB, Complementry Symmetry Push Pull Amplifier, C etc.), Power efficiency, distortion and linearity issues; Concept of stability, gain margin and phase margin

MODULE IV: OSCILLATORS **9 Hours**

Conditions for oscillators: Barkhausen criterion; RC oscillators: phase shift, Wien bridge; LC oscillators: Hartley, Colpitt, Clapp; Crystal Oscillator; Non-sinusoidal oscillators

MODULE V: OP-AMP AND IT'S APPLICATIONS **9 Hours**

OP-AMP: Internal Block Diagram, AC and DC characteristics; Inverting and non-inverting amplifiers, Integrator and Differentiator, Summing amplifier, Subtractor, Logarithmic and Instrumentation Amplifier, Precision Rectifier; Schmitt Trigger, Active filters; Digital-to-Analog Converters (DAC): Weighted resistor, R-2R ladder, Analog-to-digital converters (ADC): Dual slope, successive approximation, flash; Timer 555: Types of multivibrators

Total No. of Hours: 45

Text Books:

1. J. Millman and C. Halkias, "Electronic Devices and Circuits", Tata Mc Graw-Hill, 2010
2. Jacob Millman and Christos C. Halkias, "Integrated Electronics: Analog and Digital Electronics Circuits and Systems", 2nd Edition,Tata Mc Graw Hill, 2017,
3. D. Roy Choudhury and Shail B. Jain, " Linear Integrated Circuits", New Age International Publishers, 2006

Reference Books:

1. A. Anand Kumar, "Pulse and Digital Circuits" , PHI, 2005
2. K.LalKishore, "Electronic Circuit Analysis", BSP, 2004
3. A.K. Maini, "Analog Electronics", Khanna Book Publishing, New Delhi, 2022

Web Resources:

https://nptel.ac.in/courses/108106188

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Analyze BJT amplifier behavior at low and high frequencies using hybrid-π models and evaluate gain-bandwidth performance.
ii. Examine multistage BJT amplifier configurations, their distortion characteristics, and associated frequency response.
iii. Evaluate the operation, efficiency, and nonlinearity aspects of various power amplifiers and assess amplifier stability.
iv. Interpret the design and working principles of sinusoidal and non-sinusoidal oscillators using established oscillator criteria.
v. Apply operational amplifiers and mixed-signal circuits (DAC/ADC/555) to design analog signal processing and conversion applications.

CECE 242	MICROCONTROLLERS	3 L : 0 T : 0 P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Understand the architecture of 8085, 8086 and its assembly language programming
ii. Study the features of 8-bit Microcontroller as well as interfacing of peripheral devices with 8051
iii. Understand the architecture of PIC and its peripheral interface modules
iv. Explore the features of ARM and its instructions
v. Design and implement Microcontroller based applications

Course Contents:

MODULE I: INTRODUCTION TO PROCESSORS 9 Hours

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: 8051 ARCHITECTURE 9 Hours

8051 Microcontroller: Architecture and Features; 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

MODULE III: PIC MICROCONTROLLER 9 Hours

Microchips: 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, UART, ADC and DAC, serial programming.

MODULE IV: ARM MICROCONTROLLER 9 Hours

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: PROGRAMMING AND APPLICATIONS OF MICROCONTROLLERS 9 Hours

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., 2nd Edition, 2013.
2. A.K. Ray and K.M.Burchandi, and A.K.Ray, "Advanced Microprocessor and Peripherals", McGraw Hill International Edition, 3rd 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, Sarmad Naimi, Sepehr Naimi, and Janice Mazidi, "ARM Assembly Language Programming & Architecture", Micro Digital ed.com, 2nd Edition, 2016.

Web References:

1. NPETL: https://www.nptelprep.in/courses/108105102\

Course Outcomes:

On successful completion of this course, the students will have the ability to :

i. Describe the architecture, instruction sets, and interrupt concepts of major microprocessors and microcontrollers.
ii. Demonstrate interfacing techniques for timers, serial/parallel I/O, ADC/DAC, and memory systems.
iii. Develop basic embedded programs for PIC and ARM microcontrollers using appropriate instructions.
iv. Apply Embedded C constructs to create simple firmware for embedded applications.
v. Design microcontroller-based solutions for tasks like traffic control, motor control, and networking.

CECE 243	DIGITAL SIGNAL PROCESSING	3 L : 0 T : 0 P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Introduce the theory and applications of IIR filters.
ii. Introduce the design principles of FIR filters and smoothing using windows
iii. Impart knowledge on the various types of errors that affect signals during digital signal processing.
iv. Introduce the concepts of power spectral density estimation for random signals and the concepts and applications of multirate sampling.
v. Introduce the architecture of DSP processor.

Course Contents:

MODULE I: INFINITE IMPULSE RESPONSE FILTERS 9 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 9 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 9 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 9 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 9 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: 45

Text Books:

1. John G. Proakis and Dimitris G. Manolakis, "Digital Signal Processing: Principles, Algorithms, and Applications", 5th Edition, PHI learning, New Delhi, 2021.
2. A.V. Oppenheim and Schafer, "Discrete Time Signal Processing", 3rd Edition, Pearson, 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, 3rd Edition, Tata McGraw - Hill, 2005.
3. Ramesh Babu, "Digital Signal processing", 6th Edition , SciTech Publications, 2014.

Web References:

1. NPTEL: nptel.ac.in › courses › 108106151

Course Outcomes:

On successful completion of this course, the students will have the ability to:

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

CECE-244	PROBABILITY THEORY AND STOCHASTIC PROCESSES	3 L : 1 T : 0 P	4 Credits

Course Objectives:

In this course, the students will be able to:

i. Understand the basic probability concepts.
ii. Get in depth knowledge of various distribution which can describe real life phenomena.
iii. Study the functions of random variables
iv. Understand the characteristic of random sequences and centre limit theorem
v. Learn the stochastic process and its spectral densities.

Course Contents:

MODULE I: PROBABILITY SPACE, CONDITIONAL PROBABILITY AND RANDOM VARIABLES **12 Hours**

Probability space; Conditional probability and Baye's theorem with examples; Random variables, Probability functions and Distribution function with examples, Combinatorial probability and sampling models.

MODULE II: DISCRETE AND CONTINUOUS RANDOM VARIABLES **12 Hours**

Binomial, Poisson, Geometric and Negative Binomial distributions with examples, Exponential, Gamma and Weibull distributions with examples and relation between the distributions.

MODULE III: TWO DIMENSIONAL AND FUNCTIONS OF RANDOM VARIABLES **12 Hours**

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 **12 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: STOCHASTIC PROCESSES AND SPECTRAL DENSITIES **12 Hours**

Random process, Stationary processes Mean and Covariance functions, Ergodicity, Transmission of random process through LTI, Power spectral density

Total No. of Hours: 60

Text Books:

1. H. Stark and J. Woods, ``Probability and Random Processes with Applications to Signal Processing," 4th Edition, Pearson Education, 2011
2. A.Papoulis and S. Unnikrishnan Pillai, ``Probability, Random Variables and Stochastic Processes," 5th Edition, McGraw Hill, 2025

Reference Books:

1. K. L. Chung, “Elementary Probability Theory with Stochastic Processes”, Springer,2003

Web References:

1. https://nptel.ac.in/courses/111102111

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Develop understanding of basics of probability theory.
ii. Identify different distribution functions and their relevance.
iii. Apply the concepts of probability theory to different problems.
iv. Compute relevant parameters of a stochastic process and employ them for systematic characterization.
v. Analyze the response of Stochastic Processes and Spectral Densities.

HSMC-201	LIFE SKILLS	1 L : 0 T : 2 P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Identify different life skills required in personal and professional life
ii. Apply well-defined techniques to cope with emotions and stress.
iii. To understand the basic mechanics of effective communication and demonstrate these through presentations.
iv. Use appropriate thinking and problem solving techniques to solve new problems
v. Understand the basics of teamwork and leadership

Course Contents:

MODULE I: OVERVIEW OF LIFE SKILLS 9 Hours

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: SELF-AWARENESS 9 Hours

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: 21ST CENTURY SKILLS 9 Hours

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: GROUPAND TEAM DYNAMICS 9 Hours

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: LEADERSHIP **9 Hours**

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", Wiley Publishing Ltd,1st Edition 2015.
2. Larry James, "The First Book of Life Skills", Embassy Books, 1st Edition, 2016

Reference Books:

1. Remesh S., Vishnu R.G., "Life Skills for Engineers", Ridhima Publications, 1st Edition , 2016.
2. Stephen P. Robbins & Phillip L. Hunsake, "Training in Interpersonal Skills: Tips for Managing People at Work", Pearson Education, India, 6th Edition 2015.
3. Gopalaswamy Ramesh & Mahadevan Ramesh, "The Ace of Soft Skills: Attitude, Communication and Etiquette for Success", Pearson Education; 1st Edition, 2013.

Web References:

https://nptel.ac.in/courses/109104107

Course Outcomes:

On successful completion of this course, the students will have the ability to:

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

PECE-241	ANALOG CIRCUITS LAB	0 L : 0 T : 2 P	1 Credit

Course Objectives:

In this course, the students will be able to:

i. Gain knowledge to design and test different applications of IC 741
ii. Understand the characteristics of OP-AMP and its applications
iii. Analyse and compare the operations of different Oscillators
iv. Implement Digital-to analog converters circuits experimentally based theory knowledge

Course Contents

List of Experiments:

(Any 10 Experiments from the below list)

1. Darlington Pair
2. Cascade Pair
3. To study the application of Op amp IC741 as
   a. Inverting amplifier & non-inverting amplifier
   b. Summer & Subtractor.
   c. Differentiator and integrator for various time constants.
4. Comparator circuits
   To study zero crossing detectors, window detector and Schmitt trigger using op amp 741
5. Active filters using Op-amp
   To design and test the performance of a 2nd order LPF, HPF, BPF and BSF.
6. Log, antilog and instrumentation amplifier
7. Multivibrators using Op-Amp
   To design and study the working of a. Astable Multivibrator b. Monostable Multivibrator using IC 741.
8. Design of Oscillators for the given Specifications
   a. RC Phase shift Oscillators
   b. Colpitts Oscillator
   c. Hartley Oscillator
9. Design of Power Amplifiers for the given Specifications using BJT
   a. Class B Power Amplifiers
   b. Class AB Power Amplifiers
10. Data converters construction and study performance of
    a. DAC circuits – R-2R and ladder type
    b. Successive approximation type ADC
11. Signal converters
    To study operation of op-amp as V to I and I to V converters
12. Multvibrators using 555
13. Simulation of Inverting and Non-Inverting Amplifier

14. Simulation of Multistage Amplifiers
15. Simulation of Active Filters

Total No. of Hours: 36

Course Outcomes:

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

i. Understand the effects of multistage amplifier on input impedance, output impedance and gain of the amplifiers.
ii. Analyze and compare the operations of different power amplifiers with their characteristics.
iii. Gain knowledge to design and test the different types of oscillators for the generation of required frequency.

PECE 242	MICROCONTROLLERS LAB	0 L : 0 T : 2 P	1 Credit

Course Objectives:

In this course, the students will be able to:

i. Understand the working of microcontroller
ii. Learn to do program, debug and analyze codes
iii. Acquire and apply microcontroller programming and interfacing

Course Contents:

Experiments Using PIC and ARM Controller
(Any 10 Experiments from the below list)

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 Converter
9. Implementation of watchdog 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.

Total No. of Hours: 36

Course Outcomes:

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

i. Interface Microprocessor with different kinds of Peripherals.
ii. Identify and understand the function of PIC microcontroller & its Peripherals.
iii. Understand, Design and execute programs based on microcontroller.
iv. Design and Implement Microcontroller based Systems.

PECE 243	DIGITAL SIGNAL PROCESSING LAB	0 L : 0 T : 2 P	1 Credit

Course Objectives:

In this course, the students will be able to:

i. Practice several DSP operations
ii. Design IIR and FIR filters.
iii. Implement the applications of multirate sampling
iv. Implement several experiments using DSP processor

Course Contents

List of Experiments:

(Any 10 experiments from the below list)

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).
9. Study of architecture of Digital Signal Processor.
10. Perform MAC operation using various addressing modes.
11. Generation of various signals and random noise.
12. Linear and circular convolution of signals.
13. DFT and FFT of signals.
14. FIR Filter for Low pass, High pass, Band pass and Band stop filtering.
15. Butter worth and Chebyshev IIR Filters for Low pass, High pass, Band pass and Band stop\ filtering.
16. Implement an Up-sampling and Down-sampling operation in DSP Processor.

Total No. of Hours: 36

Course Outcomes:

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

i. Design IIR and FIR filters.
ii. Apply signal processing algorithms for real time applications.
iii. Perform several experiments using DSP processor.

RECE 241	MICRO PROJECT	0 L : 0 T : 4 P	2 Credits

Course Objectives:

In this course, the students will be able to:

i. Identify a real-world problem and define a specific aim for an electronic solution through need analysis.
ii. Design a complete electronic circuit schematic using appropriate components, devices, and ICs.
iii. Construct and assemble the hardware prototype on a PCB or breadboard for testing.
iv. Test the functionality of the built circuit and troubleshoot any operational issues.
v. Demonstrate a working, small-scale electronic system that integrates hardware and/or basic programming.

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.

Total No. of Hours: 36

Course Outcomes:

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

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

AU-204	ENVIRONMENTAL SCIENCE	1 L : 0 T : 0 P	0 Credit

Course Objectives:

In this course, the students will be able to:

i. Concern with the exploration, investigation and development of an understanding of the natural, human and social dimensions of local and wider environments.
ii. Provide opportunities to engage in active learning, to use a wide range of skills, and to acquire open, critical and responsible attitudes.
iii. Raise awareness about sustainable living practices and encourage students to adopt eco- friendly habits in their daily lives

Course Contents:

MODULE I: HUMAN AND ENVIRONMENT 6 Hours

Man-Environment Interactions : Environmental science and its scope; Environmental History: Early humans, great ancient civilizations and industrialization and its impact on the environment, Global environmental change; Emergence of environmentalism : Perspectives of environmentalism, school of thoughts on human environment interactions - Anthropocentrism and Ecocentrism; International efforts on environmental protection : UN Conference on Human Environment – 1972, World Commission on Environment and Development - 1983, Reo summit (1992) and subsequent international efforts.

MODULE II: NATURAL RESOURCES AND SUSTAINABLE DEVELOPMENT 6 Hours

Overview of Natural resources : Definition and classification; Biotic resources : Major biotic resources - Forests, Grasslands, Wetlands, Wildlife and Aquatic life, over-exploitation and impact on the environment; Abiotic resources : Water resources – Classification, Availability and Use of water resources, Over-exploitation and impact on the environment; Soil and Mineral resources – Important minerals and their use, Over-exploitation and impact on environment; Energy Resources: Classification of energy resources- Renewable and Non-renewable resources; Introduction to Sustainable development: Sustainable Development Goals (SDGs) - Targets, indicators, challenges and Strategies.

MODULE III: CONSERVATION OF BIODIVERSITY AND ECOSYSTEM 6 Hours

Biodiversity and its distribution; Biodiversity as natural resource, levels and types of biodiversity, biodiversity in India and the world, biodiversity hotspot; Ecosystem and Ecosystem services: Types and characteristics of major ecosystems in India; Threats to biodiversity and Ecosystems: Land use and land cover change, commercial exploitation of species, invasive species, forest fire, disasters and climate change; Major conservation policies : The role of traditional knowledge, Ex-situ and In-situ conservation approaches, Major protected areas; National and international instruments for biodiversity conservation, Gender and conservation

MODULE IV: ENVIRONMENTAL POLLUTION AND CLIMATE CHANGE 6 Hours

Understanding Environmental pollution : Production processes, generation of waste, assimilative capacity of the environment, definition of pollution, point source and non-point sources of pollution; Air pollution: sources of air pollution, primary and secondary pollutants, criteria pollutants, national

air quality standards, air pollution and its adverse impacts on human health; Water Pollution: Sources of water pollution, water quality parameters and standards, water pollution and its adverse impacts on human health; Soil Pollution: Sources of soil pollution, soil and hazardous waste, soil pollution and its adverse impacts on human health, Noise pollution and its adverse impacts on human health, Thermal and radioactive pollution and its adverse impacts on human health; Global Environmental Change: Understanding Climate change, Impacts, adaptations and Mitigation

MODULE V: ENVIRONMENTAL MANAGEMENT: LEGISLATURE, LAWS AND TREATIES **6 Hours**

Introduction to environmental legislature, laws and regulations: Constitutional provisions, environmental rights; Introduction to environmental legislation on the forest, wildlife and pollution control; Environmental Management System: ISO14001; Life Cycle Assessment (LCA)- Cost- benefit analysis, Environmental Impact Assessment; Pollution Control and Management: Concept of 3R, Ecolabelling, Eco-mark, Carbon footprint and Carbon Credits

Case studies and Field work

- Discussion on one national and one international case study related to the environment and sustainable development.
- Field visits to identify local/regional environmental issues, make observations including data collection and prepare a brief report.
- Participation in plantation drive and nature camps.
- Documentation of campus biodiversity.
- Campus environmental management activities such as solid waste disposal, water management and sanitation, and sewage treatment.

Total No. of Hours: 30

Text Books:

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

Reference Books:

1. V.S.K.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 Outcomes:

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

i. Recognize the impact of environmental depletion especially on ecosystem and biodiversity
ii. Identify factors causing land, water, air and noise pollution
iii. Determine the effects of pollution
iv. Develop keen understanding of non-conventional energy source, solid waste management and technologies for sustainable development
v. Understand the environment legislations in India

SEMESTER-V

CECE 351	ANALOG AND DIGITAL COMMUNICATION	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Understand the basic concept of analog modulation and its types.
ii. Study the various types of noises in communication
iii. Understand the representation of digital signals
iv. Study the different types of Base Band techniques
v. Study the various Pass Band Digital Modulation techniques

Course Contents:

MODULE I: INTRODUCTION TO ANALOG MODULATION TECHNIQUES **9 Hours**

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, between FM and PM waves, Spectral characteristics of angle modulated signals.

MODULE II: NOISE IN ANALOG TECHNIQUES **9 Hours**

External and internal noise, Noise figure and noise temperature; AWGN Noise characteristics, Noise performance of AM system: Model for AM modulation system with Noise, 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: REPRESENTATION OF DIGITAL SIGNALS **9 Hours**

Inter Symbol Interference, Pulse Shaping to Reduce ISI, Two Types of Error, Performance Degradation, Detection of Shaped Pulses, Equalization, Channel Characterization, Eye Pattern , Equalization Filter Types, Preset and Adaptive Equalization , Filter Update Rate

MODULE IV: BASE BAND MODULATION TECHNIQUES **9 Hours**

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 V: BAND PASS DIGITAL MODULATION SCHEMES **9 Hours**

Coherent and non-coherent detection of ASK, FSK, MSK, and PSK: QPSK, DQPSK, QAM; ;Comparison of error performance of non- coherently and coherently detected ASK, FSK and PSK systems , M-ary signaling

Total No. of Hours: 45

Text Books:

1. B. P. Lathi, Zhi Ding "Modern Digital and Analog Communication" Oxford, 4th Edition, 2017
2. Bernald Sklar, "Digital Communication: Fundamentals and Applications", Prentice Hall, 3rd Edition ,2021.

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. R. Anand, "Communication Systems" , Khanna Book Publishing Company, 2011.
4. Carlson A B, "Communication systems: An Introduction to Signals and Noise in Electrical Communication", McGraw Hill, New Delhi, 2002.

Web References:

1. https://nptel.ac.in/courses/117105143
2. https://nptel.ac.in/courses/117105144

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Explain the basic concept of analog modulation and its types.
ii. Analyse the various types of noises in communication
iii. Understand the representation of digital signals
iv. Understand the concept of base band techniques
v. Explain the various band pass modulation techniques

CECE 352	ELECTROMAGNETIC WAVES	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Impart knowledge on the basics of transmission lines
ii. Learn basic electromagnetic wave equations
iii. Understand EM waves and the propagation of EM waves.
iv. Study waveguides and radiation
v. Learn the radiation pattern from different antenna like monopole, dipole and linear antennas

Course Contents:

MODULE I: TRANSMISSION LINES 9 Hours

Equations of Voltage and Current on transmission line, Propagation constant, Characteristic impedance, VSWR, and reflection coefficient, Impedance Transformation, Loss-less and Low Loss Transmission line and Power transfer on Transmission 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: ELECTROMAGNETIC WAVE EQUATIONS 9 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 9 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 9 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

MODULE V: RADIATION 9 Hours

Solution for potential functions: Radiation from the Hertz dipole, Power radiated by hertz dipole, Radiation Parameters of antenna: Thin linear antenna, Monopole and Array antennas, Fourier transform relation between current and radiation pattern.

Total No. of Hours: 45

Text Books:

1. R.K. Shevgaonkar,"Electromagnetic Waves", Tata McGraw Hill India, 1st Edition, 2017.
2. E.C.Jordan and K.G. Balmain, "Electromagnetic waves and Radiating Systems", Prentice Hall India, Second Edition, 2015

Reference Books:

1. R.L. Yadav, "Electromagnetic Fields and Waves", Khanna Book Publisher, 2021
2. Nannapaneni Narayana Rao, Elements of Engineering magnetics", Prentice Hall, 6th Edition, 2014.
3. William H.Hayt, "Engineering Electromagnetics", McGraw Hill, 5th Edition, 2008.

Web References:

1. https://nptel.ac.in/courses/108106157
2. https://www.nptelprep.in/courses/108104130

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Gain the importance of transmission lines and analyze transmission line problems like impedance transformation and matching using analytical and graphical methods.
ii. Solve Maxwell's equations to understand the propagation of electromagnetic waves
iii. Analyse the propagation of waves in unbound media and across media interfaces.
iv. Understand the electromagnetic wave propagation in rectangular metallic waveguides and resonators.
v. Design and understand antenna characteristics for antennas like dipole, linear antennas and their arrays.

CECE 353	EMBEDDED SYSTEMS	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Understand the fundamental concepts of Embedded systems
ii. Design and develop embedded systems using programming languages like C and C++.
iii. Explore real-time operating system structures, task scheduling, inter-process communication issues.
iv. Study various communication and networking protocols.
v. Understand the recent trends in embedded systems.

Course Contents:

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.

MODULE II: EMBEDDED SYSTEM DESIGN AND PROGRAMMING 9 Hours

General Purpose Input/Output (GPIO) 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, C and C++ programming for embedded systems.

MODULE III: 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 IV: COMMUNICATION AND NETWORKING 9 Hours

Serial communication (UART, SPI, I2C), Wireless Communication standards:Wi-Fi, Bluetooth, Zigbee, IoT protocols, 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

AI in embedded systems: Implementing Machine learning models on microcontrollers with programming languages and AI accelerators for edge devices, Case studies of AI-powered embedded applications (e.g., robotics, autonomous vehicles); Embedded vision and computer vision applications, Industry 4.0, 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, 3rd Edition, 2017.
2. C. M. Krishna and Kang G. Shin, "Real Time Systems," Tata Mc Graw-Hill, 3rd 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", Newness, Imprint of Elseiver, 2008.

Web References:

1. NPTEL: https://nptel.ac.in/courses/106105159

Course Outcomes:

On successful completion of this course, the students will have the ability to:

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

CECE354	INFORMATION THEORY AND CODING	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Understand the basics of Information theory and basic coding techniques
ii. Analyze and compare different modulation techniques
iii. Study various error correcting codes
iv. Understand the concept of various compression techniques
v. Analyze various audio and video Coding Techniques

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

Total No. of Hours: 45

Text Books:

1. Gareth A. Jones, “Information and Coding Theory “, Springer, 2004.
2. Muralidhar Kulkarni and K.S Shivapraksha, “Information Theory and Coding”, Wiley, 2019

Reference Books:

1. Predang Ivanis and Dusan Drajic, “Information Theory and Coding - Solved Problems”, Springer, 2018
2. R.B. Ash, “Information Theory”, Prentice Hall, 2003
3. A. El Gamal and Y. H. Kim, “Network Information Theory”, Cambridge University Press, 2011

Web References:

1. https://nptel.ac.in/courses/108102120
2. https://nptel.ac.in/courses/108102117

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Explain the basics of Information theory, techniques of coding and decoding.
ii. Demonstrate different coding and decoding schemes
iii. Solve numerical problems on channel capacity and coding
iv. Explain the various compression techniques
v. Analyse various audio and video coding schemes

CECE 355	CONTROL SYSTEMS	3L:1T:0P	4 Credits

Course Objectives:

In this course, the students will be able to:

i. Study the design of control systems that meet design specifications.
ii. Introduce the components and their representation of control systems.
iii. Learn the frequency response analysis
iv. Learn the various approaches for state variable analysis.
v. Understand optimal control and Non-linear Control system

Course Contents:

MODULE I: INTRODUCTION TO CONTROL PROBLEM 12 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, Electrohydraulic 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 12 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 12 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 12 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 and observability.

MODULE V: OPTIMAL CONTROL & NONLINEAR CONTROL 12 Hours

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

Total No. of Hours: 60

Text Books:

1. Gopal.M., "Control Systems: Principles and Design", Tata McGraw-Hill, 4th Edition, 2012
2. Ambikapathy A.," Control Systems" , Khanna Book Publications, 2019.

Reference Books:

1. Nagoor Kani, "Control System engineering ", RBA ,2013
2. Farid Golnaraghi, and Kuo, B.C., "Automatic Control System", Prentice Hall, 10th Edition, 2017.
3. Ogata, K., "Modern Control Engineering", Prentice Hall, 5th Edition, 2010
4. I.J. Nagrath & Gopal, "Control System Engineering", New Age International, New Delhi, 4th Edition, 2003

Web References:

1. NPTEL: https://nptel.ac.in/courses/107106081

Course Outcomes

On successful completion of this course, the students will have the ability to

i. Design and analyse the mechanical, electrical, thermal and hydraulic systems using transfer fucntions and block diagrams
ii. Evaluate feedback control system behaviour using stability tests, error analysis and time-domain performance criteria
iii. Aply frequency response techniques such as Bode, Nyquist and polar plots for system analysis and Controller design
iv. Develop and solve state-space models and assess controllability and observability of dynamic systems
v. Design optimal and nonlinear control strategies for regulator and tracking problems in practical engineering systems

HSMC-304	TOTAL QUALITY MANAGEMENT	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Understand fundamental management concepts, functions, and planning processes for effective organizational decision-making.
ii. Learn various organizational structures, delegation principles, and approaches to centralization and decentralization.
iii. Explore directing and controlling functions through motivation theories, leadership styles, communication methods, and control systems.
iv. Study the foundations, models, and strategic frameworks of Total Quality Management for organizational excellence.
v. Analyze TQM processes including process management, quality systems, continuous improvement, and effective implementation strategies.

Course Contents:

MODULE I: FUNCTIONS OF MANAGEMENT AND PLANNING 9 Hours

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: ORGANIZING 9 Hours

Definition, Types of organization, Organizational structure, Span of control, use of staff and committees, Delegation: Delegation and Centralization, Centralization and Decentralization

MODULE III: DIRECTING AND CONTROLLING 9 Hours

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: FOUNDATIONS OF TQM 9 Hours

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: TQM PROCESSES 9 Hours

Process management, Process redesign/engineering, Quality management system, Continuous improvement; People and Implementation: Communications, innovation and learning, Implementation

Total No. of Hours: 45

Text Books:

1. Sunil Luthra, Dixit Garg & Ashish Agarwal, "Total Quality Management (TQM): Principles, Methods, and Applications", CRC Press, 2021.
2. P. N. Mukherjee, "Total Quality Management ", PHI Publication, 2nd Edition, 2024.

Reference Books:

1. Poornima Charantimath, "Total Quality Management", Pearson, 4th Edition 2022.
2. Peter Eichhorn & Ian Towers, "Principles of Management: Efficiency and Effectiveness in the Private and Public Sector", Springer International Publishing. 2018.
3. Abdul Razzak Rumane, "Total Quality Management: Applications and Concepts for Construction Projects", CRC Press, 2024.

Web References:

1. NPTEL: https://nptel.ac.in/courses/110104080

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Apply the principles of planning, organizing, directing, and controlling to solve basic managerial problems in organizational settings.
ii. Analyze organizational structures, delegation practices, and decision-making processes for effective management performance.
iii. Demonstrate an understanding of motivation theories, leadership styles, and communication methods to enhance workplace effectiveness.
iv. Evaluate Total Quality Management models, performance measurement frameworks, and benchmarking techniques for quality improvement.
v. Implement TQM-based process management, continuous improvement strategies, and quality system practices in real-world scenarios.

PECE 351	ANALOG AND DIGITAL COMMUNICATION LABORATORY	0L:0T:2P	1Credit

Course Objectives:

In this course, the students will be able to:

i. Design and analyze the working principles of Amplitude Modulation (AM) and Frequency Modulation (FM) systems, including their modulation and demodulation processes.
ii. Study and verify the concepts of pre-emphasis and de-emphasis used in improving signal-to-noise ratio in communication systems.
iii. Design and construct Time Division Multiplexing (TDM) circuits and observe multiplexed and demultiplexed signals.
iv. Construct and analyze various digital modulation techniques such as Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), and Binary Phase Shift Keying (BPSK) and to observe their modulated and demodulated waveforms.
v. Perform simulation-based experiments on AM, FM, PAM, PWM, and PPM using simulation tools and analyze both time-domain and frequency-domain characteristics

Course Contents:

List of Experiments:
(Any 10 Experiments from the below list)

1. Construct an AM modulator and demodulator circuits
2. Construct a FM modulator and demodulator circuits
3. Construct Pre-emphasis and de-emphasis
4. Construct TDM circuit and 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 Quadrature Binary Phase Shift Keying (BPSK) modulator and demodulator circuit. Obtain the QPSK modulated and demodulated waveforms.
9. Construct a Pulse code modulator and demodulator circuit. Obtain the coded output for the given sine wave.
10. Construct a Delta modulator and demodulator circuit. Obtain the coded output for the given sine wave
11. Construct a GMSK modulator and demodulator circuit. Obtain the output for the given input.
12. Equalizers
13. Simulation of AM, FM, PAM, PWM and PPM to trace the time domain and frequency domain waveform
14. Simulation of ASK, FSK, QPSK and QAMs to trace their characteristics.

Total No. of Hours: 36

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Understand the working of PCM, DM and compare its performance.
ii. Practically analyze and verify the various line coding ad source coding signaling formats scramblers and equalizers.
iii. Practically verify the working of pulse shaping filters.
iv. Realize the practical circuits and verify the working of digital modulation formats and validating it with simulations

PECE352	ELECTROMAGNETIC WAVES LAB	0L:0T:2P	1Credit

Course Objectives:

In this course, the students will be able to:

i. Analyze impedance measurement, frequency measurement transformation and electromagnetic wave propagation mechanism
ii. Understand propagation of electromagnetic waves in unbound medium and across media interfaces.
iii. Analyzeelectromagneticwavepropagationinrectangularmetallicwaveguides.
iv. Understand antenna characteristics, and design linear antennas.

Course Contents:

List of Experiments:

(Any 10 experiments from the below list)

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 of transmission lines
6. Electromagnetic Wave Propagation: To study the wave propagation in lossless and conducting media and 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 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. Analyse of Two Port Network using Spectrum Analyser
11. Radiation Pattern of Dipole Antenna using Network Analyser
12. Radiation Pattern of Monopole Antenna using Network Analyser
13. Radiation pattern of Micropatch Antenna using Network Analyser

Total No. of Hours: 36

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Experimentally map electric and magnetic fields and verify Gauss's and Ampere's laws.
ii. Prove Maxwell equations to understand propagation of electromagnetic waves in unbound medium and across media interfaces.
iii. Analyze electromagnetic wave propagation in rectangular metallic waveguides.
iv. Understand antenna characteristics, and design linear antennas.

ECP-353	EMBEDDED SYSTEMS LAB	0L:0T:2P	1Credit

Course Objectives:

In this course, the students will be able to:

i. Provide hands-on experience in programming and interfacing microcontrollers with various peripherals such as LEDs, sensors, actuators, and communication modules.
ii. Understand and implement Pulse Width Modulation (PWM) techniques for controlling the speed and direction of DC and servo motors.
iii. Establish serial communication between embedded systems using UART, Bluetooth, and Wi-Fi protocols.
iv. Introduce Real-Time Operating Systems (RTOS) concepts by creating and scheduling multiple tasks with different priorities.
v. Gain experience in image acquisition and real-time processing using camera modules and embedded hardware.

Course Contents:

List of Experiments:

(Any 10 experiments from the below list)

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 of Water Pump Controller to sense the water level in a tank
10. Design a lamp controller having a light sensor and a timer.
11. Design of Traffic Controller using Microcontroller

Total No. of Hours: 36

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Design systems for various embedded applications.
ii. Gain practical knowledge through hands-on lab sessions.
iii. Innovate and enhance problem-solving skills to do mini-projects and final project

AU-305	PROFESSIONAL ETHICS	1L:0T:1P	0 Credit

Course Objectives:

In this course, the students will be able to:

i. Understand the ethical and moral principles and analyze them.
ii. Study the ethical problems and the corresponding analysis
iii. Know the skills to confront moral issues and dilemmas.
iv. Apply the ethical theories to resolve moral issues.
v. Apply the ethics in engineering and medical discipline problems

Course Contents:

MODULE I: ETHICS AND MORAL PRINCIPLES 6 Hours

Profession: Morals, Ethics; 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 ETHICALTHEORIES 6 Hours

Ethical Theories in Engineering, Social Experimentation, Ethical Methods for Medical Sciences, Ethical Methods for Administrative Sections

Total No. of Hours: 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., United States, 2000.
2. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.

3. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Gain knowledge in ethical and moral principles.
ii. Narrate the ethical problems and analyze them.
iii. Gain knowledge and skills to confront moral issues and dilemmas.
iv. Gain knowledge in major ethical theories.
v. Knowledge to apply the ethical theories to resolve moral issues.

SEMESTER-VI

CECE 361	COMPUTER NETWORKS	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Introduce the division of network functionalities into layers.-
ii. Familiarize with the components required to build different types of networks.
iii. Study the required functionality of each layer.
iv. Learn the flow control and congestion control algorithms.
v. Study the application layer and principles of user interface

Course Contents:

MODULE I: INTRODUCTION TO COMPUTER NETWORKS 9 Hours

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, and Switches.

MODULE II: SWITCHING NETWORKS 9 Hours

Classification and requirements of switches, a generic switch, Circuit Switching, Time-division switching, Space-division switching, Cross bar 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 CONGESTIONCONTROL 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 No. of Hours: 45

Text Books:

1. Andrew Tanenbaum, "Computer networks", Prentice Hall, 6th Edition, 2022.
2. B.A. Forouzan, "Data Communications and Networking", Tata McGraw Hill, 6th Edition, 2022.

Reference Books:

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

Web References:

1. NPTEL: https://nptel.ac.in/courses/106105183

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Understand data communication and the functions of each layer of ISO-OSI protocols.
ii. Perform computations and explain networking and routing problems.
iii. Describe the functionalities of the network and transport layers and their interactions in data transmission.
iv. 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.
v. Familiarize with commonly used application layer protocols and their purposes in network communication.

CECE 362	VLSI DESIGN	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Understand MOS transistor operation, modeling, non-ideal effects, and CMOS inverter characteristics for foundational VLSI design.
ii. Analyze delay, parasitic effects, logical effort, and power dissipation in digital VLSI circuits.
iii. Design and evaluate combinational and sequential logic circuits using various CMOS logic families.
iv. Study and model VLSI subsystems including adders, comparators, counters, and memory structures such as SRAM and DRAM.
v. Develop and verify digital circuits using Verilog HDL through structural, dataflow, and behavioral modeling.

Course Contents:

MODULE I: INTRODUCTION TO VLSI BASICS 9 Hours

MOS Current Equation, Electrical Characteristics, Modelling of MOS transistor, Capacitance voltage, characteristics, non-ideal effects, MOS transistor as a Switch, DC transfer characteristics of CMOS Inverter, Dynamic behaviour of CMOS, Noise margin, Stick diagram and Layout diagram

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, Transistor Sizing, Elmore Constant, Logical effort, Logical Effort of Paths, Delay in Multistage Logic Networks, Choosing the Best Number of Stages, Sources of power dissipation, dynamic power, static power and leakage power

MODULE III: COMBINATIONAL AND SEQUENTIAL CIRCUITS DESIGN 9 Hours

Circuit Families, Pass-Transistor logic, Static CMOS logic, Ratioed logic, Differential Cascode Voltage Switch Logic, Dynamic CMOS logic, Latches and Flipflops, Clock Skew, and jitter, Master and Slave Register, C2MOS Register, Pulsed Latches.

MODULE IV: SUBSYSTEMS DESIGN 9 Hours

Adders, Zero one detectors, Comparators, Counters, Memory subsystems: SRAM, Read and write operation, DRAM, sense amplifiers.

MODULE V: PROGRAMMING IN Verilog 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. Saurabh, Sneh, “Introduction to VLSI Design Flow”, Cambridge University Press, 2023.
2. Taraate, Vaibbhav, “ASIC Design and Synthesis: RTL Design Using Verilog”, Springer, 2021.

Reference Books:

1. Kahng, Andrew B., Lienig, Jens, Markov, Igor L., Hu, Jin , “VLSI Physical Design: From Graph Partitioning to Timing Closure”, Springer, 2022.
2. Churiwala, Sanjay; Mehta, Usha; Dhare, Vaishali, “Digital Design and Verification Using Verilog and System Verilog” , Wiley, 2025.
3. Chakravarthi, Veena S. , “A Practical Approach to VLSI System on Chip (SoC) Design: A Comprehensive Guide”, Springer, 2022.

Web References:

1. NPTEL: https://onlinecourses.nptel.ac.in/noc23_ee137/

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Model and analyze MOS transistors and CMOS inverters for digital VLSI circuit design.
ii. Evaluate circuit delay, parasitic effects, logical effort, and power consumption in multistage digital circuits.
iii. Design efficient combinational and sequential circuits using static, dynamic, and pass-transistor logic families.
iv. Implement and analyze subsystems including arithmetic units, comparators, detectors, counters, and memory blocks.
v. Write Verilog HDL code and simulate digital circuits using RTL, behavioral, and structural modeling approaches.

CECE-363	MOBILE COMMUNICATION AND NETWORKS	3L:1T:0P	4 Credits

Course Objectives:

In this course, the students will be able to:

i. Introduce the basic cellular concepts.
ii. Understand the various signal propagation effects.
iii. Study various multiple access schemes.
iv. Familiarize with various mobile standards.
v. Study the MIMO systems for high speed communication

Course Contents:

MODULE I: BASICS OF CELLULAR CONCEPTS 12 Hours

Cell structure, frequency reuse, channel assignment, handoff, interference, capacity improvement, spread spectrum techniques, 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 log normal shadowing; Small Scale Propagation: Fading channels, Multipath and small-scale fading; Parameter of small scale fading: Doppler Shift, Power Delay Profile, average and rms delay spread, coherence bandwidth and coherence time; Types of small scale fading : Flat and Frequency selective fading, Slow and Fast fading, Average fade duration and level crossing rate; Capacity of flat and frequency selective channels, Statistical multipath channel models, Narrowband and wideband fading models.

MODULE III: MULTIPLE ACCESS AND EQUALIZERS 12 Hours

FDMA, TDMA, CDMA, SDMA, OFDM; Receiver structure: Diversity receivers, selection and MRC receivers, RAKE receiver; Equalization: linear and Non Linear, ZFE , DFE and adaptive,Transmit diversity scheme.

MODULE IV: CELLULAR WIRELESS STANDARDS 12 Hours

Wireless Standards: Overview of 2G 3G, 4G, 5G and 6G cellular mobile standards; System examples: GSM, EDGE, GPRS, IS-95, CDMA 2000 and WCDMA, 4G and 5G mobile communications.

MODULE V: MIMO SYSTEMS 12 Hours

MIMO : Beamforming, Alamouti Schemes, Space Time Codes, Spatial multiplexing, Diversity/multiplexing trade off; Performance measures: Outage, average SNR, average symbol/bit error rate.

Total No. of Hours: 60

Text Books:

1. T.S. Rappaport, "Wireless Communications Principles and Practice", 2nd Edition, PHI, 2010.
2. Vijay K. Garg, "Wireless Communication and Networking", Elsevier, Morgan Kaufmann, Reprinted 2012.

Reference Books:

1. Erik Dahlman,"4G, LTE-Advanced Pro and The Road to 5G", Science Direct, 3rd Edition, 2016.
2. Sassan Ahmadi, "5G NR: Architecture, Technology, Implementation and Operation of 3GPP New Radio Standards", June 2019.
3. William Lee, "Mobile Cellular Telecommunications: Analog and Digital Systems",McGraw Hill Education, 2nd Edition, July 2017.

Web References:

1. NPTEL: https://nptel.ac.in/courses/106106167

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Understand cellular concepts in mobile communication.
ii. Understand the fundamental principles of signal propagation in wireless communication.
iii. Compare various multiple access techniques and their suitability for different applications.
iv. Understand the architecture of mobile communication networks, including GSM, CDMA, 3G, 4G LTE, and 5G.
v. Design MIMO configurations to enhance wireless communication systems.

PECE 361	COMPUTER NETWORK LABORATORY	0L:0T:2P	1Credit

Course Objectives:

In this course, the students will be able to:

i. Understand and analyze the various random-access techniques
ii. Simulate and study different types of traffic models such as ON–OFF, voice, data, and video traffic to evaluate network performance parameters like bandwidth, buffer size, and error rate.
iii. Model and evaluate the performance of ISDN traffic systems for multiple users using simulation tools.
iv. Simulated and test congestion control algorithm and apply this algorithm for communication applications.
v. Simulate and analyze different queuing models (M/M/1, M/G/1, G/G/1) to study network delay, packet loss, and buffering effects.

Course Contents:

List of Experiments:

(Any 10 Experiments from the below list)

1. Simulation of ALOHA and S-ALOHA
2. Simulation of CSMA and CSMA-CD
3. Study of Circuit Switching and Packet Switching
4. Simulation of ON-OFF and voice traffic model and obtain the corresponding plots
   a) To simulate the ON-off traffic model and obtain
   i. User numbers Vs ON period.
   ii. Time slot Vs number of users.
   iii. Timeslot Vs bandwidth allotted.
   b) To simulate voice traffic model and obtain
   i. Timeslot Vs bandwidth plot.
   ii. Timeslot Vs error plot.
   iii. Average error rate.
   iv. The optimum buffer size
5. Simulation of VBR and data traffic model
6. Simulation of ISDN traffic model
7. Congestion Control Algorithm
8. M/M/1 queuing model
   To simulate M/M/1 queuing model and obtain
   i. Timeslot 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.
9. M/G/1 and G/G/1 queuing
   To simulate a M/G/1 and G/G/1queuingmodelandobtain
   i. Timeslot 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

10. Error Control Protocol
11. Cyclic redundancy check Hamming code
12. Flow Control
    a) Stop and wait protocol
    b) Goback N protocol
    c) Selective repeat
13. Routing algorithms
14. Wireless LAN

    To establish wireless LAN test bed(or)wireless LAN environment and perform
    i. Uni-cast
    ii. Multicast
    iii. File transfer protocol

Total No. of Hours: 36

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Perform computations and solve networking and routing problems.
ii. Implement simple connections between two or more processes running in single or different computing systems.
iii. Perform the simulation of queueing systems for MM1 and MG1models.
iv. Evaluate the performance of low control, error control and routing algorithms.
v. Implement the wireless LAN systems and evaluate its performance.

PECE 362	VLSI DESIGN LABORATORY	0L:0T:2P	1 Credit

Course Objectives:

In this course, the students will be able to:

i. Design and implement the basic logic gates, combinational, and sequential circuits using HDL and kits.
ii. Design, simulate, and verify arithmetic circuits such as adders, multipliers, and counters using HDL and VLSI tools.
iii. Explore memory design concepts by implementing SRAM, DRAM, or simple register-based memory modules.
iv. Analyze and implement Finite State Machines (FSMs) such as Moore and Mealy models for sequential logic applications.
v. Study and design CMOS-based logic gates and inverters, understanding transistor-level implementation and switching characteristics.

Course Contents:

List of Experiments

(Any 10 Experiments from the below list)

Design, simulate the following Experiments using any VLSI software and implement in any FPGA 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. Combinational circuits using FPGA
12. Sequential circuits using FPGA

Total No. of Hours: 36

Course Outcomes:

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

i. Design and implement basic logic gates, combinational circuits, and sequential circuits such as flip-flops, registers, and counters.
ii. Analyze and construct arithmetic circuits including adders and multipliers for digital system applications.
iii. Demonstrate the operation of memory elements and finite state machines using Moore and Mealy models.
iv. Implement CMOS-based logic gates and inverters, and evaluate their behavior in digital circuit design.
v. Develop and verify combinational and sequential digital circuits on FPGA platforms using appropriate design methodologies.

RECE 362	MINI PROJECT	0L:0T:6P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Conduct a comprehensive analysis to define a complete system specification based on industry or real-world requirements.
ii. Design and simulate a sophisticated electronic circuit, integrating analog/digital ICs and a microcontroller, using CAD tools.
iii. Develop a fully engineered prototype, considering PCB layout, power systems, mechanical enclosure, and control panels.
iv. Systematically test the integrated hardware and software to validate functionality against the initial specifications.
v. Produce professional documentation detailing the entire design process, from proposal and methodology to final results.

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.

Total No. of Hours: 45

Course outcomes:

At the end of the mini project work, students will be able to

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

SECE 360	SEMINAR	0L: 0T:2P	1 Credit

Course Objectives:

The primary objective of this seminar is to:

i. Cultivate research literacy and
ii. Explore technical communication skills by engaging with contemporary advancements in the ECE field

Guidelines:

Select a topic relevant to ECE domain and suitable for UG level presentation. Refer to internationally reputed journals for selecting the seminar. The primary reference paper should be published during the last two or three years. The journals considered for reference are: IEEE/ IET/IETE/Springer/Science Direct/ACM journals. The student should make the presentation for duration of 20 to 25 minutes and also submit a detailed report after completion for the purpose of assessment.

Total No. of Hours: 30

Course Outcomes:

Upon completion of the course, students will demonstrate the ability to:

i. Identify contemporary topics/concepts pertaining to recent trends in electronics and communication engineering and prepare documentation
ii. Develop good communication skills in demonstrating the technical concepts

SEMESTER-VII

BSCT101	MICROWAVE AND OPTICAL COMMUNICATION	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Study the functions of all basic microwave devices
ii. Learn the operations of microwave components and microwave measurements as well as analyze scattering parameters.
iii. Understand the principles of fibre optic communication and its degradation factors
iv. Know the importance and operations of optical sources and detectors
v. Design an optical fiber link and study its features

Course Contents:

MODULE I: MICROWAVE DEVICES **9 Hours**

Introduction, Two cavity Klystron amplifier, Reflex Klystron, Travelling Wave Tube Amplifier, Magnetron Oscillators; Gunn Diodes and its modes of operation, Tunnel Diode, Varactor Diode, IMPATT and TRAPATT Diodes, Microwave Transistors

MODULE II: MICROWAVE COMPONENTS AND MEASUREMENTS **9 Hours**

Hybrid Tee, Hybrid Rings (Rat-Race), Matched Load, Wave Guide Corners, Directional Couplers, Attenuator, Circulators, Isolators; Scattering Parameters: S- Matrix derivation for Wave Guide; Microwave Measurements: Frequency Measurement, Measurement of Scattering Parameters of a Network, Radiation Pattern Measurement, Microwave Power Measurement, Spectrum Analyser, Network Analyser

MODULE III: OPTICAL FIBER SYSTEM **9 Hours**

Block Diagram of Optical Fiber Communication, Ray Theory Transmission: Total internal Reflection, Acceptance Angle, Numerical Aperture, Skew Rays; Fiber attenuation and Dispersion: absorption, scattering and bending losses, Dispersion: Material and wave guide dispersion; Cylindrical Fiber: V number, mode coupling; Types of Fibers: Step index fibers, Graded index fibers-Single mode fibers, Multimode fibers.

MODULE IV: OPTICAL SOURCES AND DETECTORS **9 Hours**

LEDs: quantum efficiency, Power, modulation, Power bandwidth product; Injection laser diodes: Modes, threshold conditions, external quantum efficiency, laser diode rate equations; Optical detectors: physical principles of PIN and APD, detector response time, temperature effect on avalanche gain; comparison of photo detectors.

MODULE V: OPTICAL COMMUNICATION **9 Hours**

Block diagram of digital optical link: Modulation Schemes, Multiplexing Techniques, Detection Schemes; Losses and Attenuation Measurement, Eye Pattern Measurement, Link Budget analysis, Rise Time and Fall Time

Total No. of Hours: 45

Text Books:

1. Kulkarni. M, "Microwave and Radar Engineering", Umesh Publications, 4th Edition ,2012.
2. David M.Pozar, "Microwave Engineering", Wiley India, 4th Edition, 2012.
3. J. Keiser, "Fibre Optic communication", Mc Graw-Hill, 5th Edition, 2017.
4. John M Senior, "Optical Fiber Communications Principles and Practice", 3rd Edition, Pearson, 2014

Reference Books:

1. Samuel Y. Liao, "Microwave Devices and Circuits", Pearson Education, 3rd Edition2003.
2. Satinder Bal Gupta and Ashish Goel, Optical Communication Systems, Laxmi Publications, 2011.

Web References:

1. https://nptel.ac.in/courses/117101054
2. https://www.nptelprep.in/courses/108103141
3. https://onlinecourses.nptel.ac.in/e-learning/preview/noc19_ee57
4. https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee42

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Analyze the working principles and characteristics of various microwave devices
ii. Compare the operational principles, performance parameters and applications of
iii. optical sources(LEDs, LASER Diodes) and detectors(PIN, APD)
iv. Demonstrate the digital optical link and evaluate its performance parameters
v. Design and evaluate fundamentatl microwave components and circuits using S-parameters and perform key microwave mesasurements
vi. Evaluate the transmission characteristics of optical fibers, including signal degradation due to attenuation and dispersion

HSMC404	ENTREPRENEURSHIP DEVELOPMENT	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Understand Entrepreneurship and design thinking
ii. Understand model development and MVP
iii. Gain knowledge about costing and revenue
iv. Learn about marketing and sales
v. 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 No. of Hours: 45

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. Robert D. Hisrich, Michael Peters, Dean Shepherd, Entrepreneurship, 11th Edition, 2021.

Web References:

1. NPTEL: https://onlinecourses.nptel.ac.in/noc21_mg70/preview

Course Outcomes:

On successful completion of this course, the students will have the ability to:

i. Identify and define real-world problem so unmet needs that can potentially be addressed through entrepreneurial ventures
ii. Design and formulate a viable business model canvas that outlines the key components of a business idea
iii. Analyse revenue streams and pricing strategies to determine the most suitable pricing model for the product of service
iv. Create a comprehensive marketing strategy to reach the target audience and generate brand awareness
v. IDentify the key roles and skill sets required to build a successful startup team

PECE471	MICROWAVE AND OPTICAL COMMUNICATION SYSTEM LABORATORY	0L:0T:2P	1Credit

Course Objectives:

In this course, the students will be able to:

i. Learn the working of various microwave components.
ii. Study the characteristics of microwave devices
iii. Study the microwave measurement procedures.
iv. Learn the characteristics of optical sources by conducting experiments and measuring various parameters.
v. Study the losses of optical fiber links.

LIST OF EXPERIMENTS:
(Any 10 Experiments from the below list)

MICROWAVE LAB (PART-A):

1. Reflex Klystron Characteristics.
2. Gunn Diode Characteristics.
3. VSWR and Frequency Measurement
4. Measurement of E Plane and H Plane Characteristics
5. Measurement of dielectric constant for given solid dielectric cell.
6. Directional Coupler Characteristics.
7. Antenna Pattern Measurement
8. .Frequency and Wavelength measurements using slotted section
9. Study of Vector Network Analyser

OPTICAL FIBER LAB (PART-B):

1. Design of Analog Optical Link.
2. Measurement of Numerical Aperture of the given fiber.
3. Measurement of Losses for Analog Optical link.
4. Characterization of Laser Diode.
5. Intensity modulation of Laser output through an optical fiber.
6. Design of Digital Optical Link
7. Study of optical networks

Total No. of Hours: 36

Course Outcomes

Upon completion of this course, students will have the ability to

i. Demonstrate the working of various microwave components
ii. Demonstrate the characteristics of microwave devices and anlayze the various microwave measurements
iii. Explain the characteristics of optical sources by conducting experiments and measuring various parameters
iv. Analyse the losses of digital fiber links

IECE 470	INTERNSHIP	0L: 0T:4P	2 Credits

Course Objectives:

The primary objective of the internship is to

i. Bridge the gap between academic learning and professional practice.
ii. Gain practical, hands-on experience in a professional industrial, research, or academic environment.
iii. Develop essential professional skills, including technical competencies, teamwork, and workplace communication.
iv. Document the technical work along with learning outcomes, and overall experience gained during the internship.
v. Synthesize the experience into a comprehensive technical report and a clear, concise professional presentation.
vi. Enhance their professional outlook and career readiness by understanding industry practices and expectations.

Guidelines:

The main purpose of internship is to enhance the general professional outlook and capability of the student to advance his/ her 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 8 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 should make the presentation for duration of 20 to 25 minutes and also submit a detailed report after completion for the purpose of assessment.

Course Outcomes:

Upon completion of the course, students will have the ability to:

i. Gain practical expertise on one or more applications of the core courses learned.
ii. Gain experience in a field, thereby making a career transition.
iii. Establish professional connections and enhance networking.
iv. Gain valuable skills and knowledge.
v. Acquire an inside view of an industry and organisation/company.

SEMESTER-VIII

RECE 483	PROJECT	0L: T:24P	12 Credits

Course Objectives:

The primary objective of the project is to demonstrate the ability to conceive, plan, and execute a significant technical project from inception to completion. Specifically, the student will be able to:

i. Identify a relevant problem and define a project title, aim, and specific objectives through literature review and expert consultation.
ii. Formulate a detailed project proposal, including specifications, methodology, resource planning, and a critical risk analysis.
iii. Execute the project plan by engaging in the design, development, and systematic testing of the proposed work.
iv. Analyze and document the entire process, results, and innovations in a comprehensive, structured final report.
v. Demonstrate independent problem-solving skills, technical competency and professional project management capabilities.

Guidelines:

The student shall identify the title and define the aim and objectives of a project after interactions with project guides /industry experts, based on comprehensive literature survey / Industry requirements analysis, The student is expected to work on detailed specifications, methodology, resources required, critical issues in design and implementation, and then submit the project proposal with in 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, results, contributions, and innovations in project work.

Total No. of Hours: 60

Course Outcomes:

Upon completion of this project work, students will demonstrate the ability to

i. Identify a problem statement from a rigorous literature survey or the industry requirements analysis.
ii. Design a solution for the identified problem by applying acquired technical knowledge.
iii. Develop /Simulate and test the prototype/algorithm to solve the complex engineering problem.
iv. Accomplish all objectives of the project in an allocated period with efficient teamwork.
v. Present project work orally along with a comprehensive report.

Program Elective Courses

EECE601	ANTENNA AND WAVE PROPAGATION	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able

i. Understand the fundamental principles of antenna theory, equivalent circuits and electromagnetic wave propagation
ii. Analyze various types of antenna arrays along with their radiation characteristics
iii. Design and analyse the narrow, broadband, and reconfigurable antennas for specific applications
iv. Understand the different types of propagation like ground, space and sky wave propagation and their important factors
v. Apply numerical methods, measurement techniques, and simulation tools in antenna design and validation

Course Contents:

MODULE I: INTRODUCTION TO ANTENNA THEORY 9 Hours

Basic Concepts of Antennas and Radiation; Antenna Parameters: Gain, Directivity, Efficiency; Antenna Equivalent Circuits; Types of Antennas: Dipole, Monopole, Loop, Slot, Microstrip; Antenna Theorems and Reciprocity.

MODULE II: ANTENNA ARRAYS AND IMPEDANCE MATCHING 9 Hours

Linear and Planar Arrays; Array Factor and Directivity; Impedance Matching Techniques; Bandwidth and Polarization Considerations; Smith Chart and its Applications; Introduction to Adaptive Arrays and Smart Antennas (Beamforming).

MODULE III: NARROW AND BROADBAND ANTENNAS 9 Hours

Slot Antennas; Log-Periodic and Spiral Antennas; Aperture Antennas; Design of Broadband and Multiband Antennas: Microstrip Antennas; Fractal Antennas; Reconfigurable Antennas.

MODULE IV: PROPAGATION OF ELECTROMAGNETIC WAVES 9 Hours

Introduction to Wave Propagation; Free-Space Propagation; Ground Wave and its important phenomena, Space wave and its important factors and Sky Wave Propagation: Critical Frequency; MUF, Virtual Height; Effects of Terrain and Atmospheric Conditions.

MODULE V: ANTENNA MEASUREMENTS AND APPLICATIONS 9 Hours

Anechoic Chambers and Measurement Techniques; Near-field vs. Far-field Measurement; Antenna Radiation Patterns and Gain Measurements; Antenna Testing Standards; Applications: Antenna for 5G and 6G Standards

Total No. of Hours: 45

Text Books:

1. Constantine A. Balanis **"**Antenna Theory: Analysis and Design", Wiley, 4th Edition, 2016
2. Warren L. Stutzman & Gary A. Thiele **"**Antenna Theory and Design*"*, Wiley, 3rd Edition, 2012

Reference Books:

1. Thomas A. Milligan**, "**Modern Antenna Design", Wiley, 3rd Edition, 2020
2. K.D. Prasad**, "**Antenna and Wave Propagation**",** Satya Prakashan, 1st Edition, 2020

3. John D. Kraus & Ronald J. Marhefka, "Antennas for All Applications", McGraw-Hill, 4th Edition, 2017

Web References:

1. https://nptel.ac.in/courses/108105114
2. http://digimat.in/nptel/courses/video/108101092/L01.html

Course Outcomes:

Upon completion of the course the student will have the ability to

i. Explain the principles of antennas, equivalent circuits, and wave propagation.
ii. Analyze the performance of antennas arrays.
iii. Design broadband like facial and reconfigurable antennas for practical applications
iv. Explain the propagation of waves and its effects
v. Apply measurement techniques and simulation tools to validate antenna designs for IoT , Satellite and 5G/6G systems

EECE602	DETECTION AND ESTIMATION OF SIGNALS	3L:0T:0P	3 Credits

Course Objectives:

In this course, students will be able to

i. Understand the statistical nature of signals and noise, including random processes and Gaussian models.
ii. Learn principles of signal detection, including hypothesis testing, likelihood ratio tests, and matched filters.
iii. Study detection methods for random signals, including Bayesian and energy detectors.
iv. Understand estimation theory, including parameter estimation, Cramer-Rao bounds, and maximum likelihood techniques.
v. Understand and apply advanced signal detection and estimation techniques in modern communication systems.

Course Contents:

MODULE I: INTRODUCTION AND STATISTICAL SIGNAL MODELS 9 Hours

Signals and Noise: Definitions and Models; Random Processes: Mean, Autocorrelation, Power Spectr Density; Probability Concepts: PDFs, CDFs, Joint, Conditional, Bayes' Theorem; Gaussian Rando Processes.

MODULE II: DETECTION OF DETERMINISTIC SIGNALS IN NOISE 9 Hours

Hypothesis Testing: Null and Alternative Hypotheses; Likelihood Ratio Test (LRT); Matched Filter Detectors; Performance Metrics: Probability of Detection, False Alarm, ROC Curves; Neyman-Pearson Criterion

MODULE III: DETECTION OF RANDOM SIGNALS 9 Hours

Detection of Signals with Random Parameters; Bayesian Detectors and Minimax Detectors; Energy Detection and Quadratic Detectors; Multichannel and Multivariate Signal Detection.

MODULE IV: ESTIMATION THEORY 9 Hours

Parameter Estimation: Bias, Consistency, Efficiency; Maximum Likelihood Estimation (MLE); Least Squares Estimation; Cramer-Rao Lower Bound (CRLB); Bayesian Estimation Techniques.

MODULE V: ADVANCED SIGNAL DETECTION AND ESTIMATION 9 Hours

Signal Detection in Communication Systems (AWGN, Fading Channels); Detection of Non-Gaussian and Nonlinear Signals; Radar Signal Detection and Estimation; Adaptive Filters for Estimation; Kalman Filter, Particle Filter.

Total No. of Hours: 45

Text Books:

1. H. Vincent Poor**, "**An introduction to Signal Detection and Estimation", Springer, 2nd Edition, 2020.
2. S. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory, Prentice Hall, 2nd Edition, 2021.
3. S. Kay**,** "Fundamentals of Statistical Signal Processing: Estimation Theory", Prentice Hall, 2nd Edition, 2021.

Reference Books:

1. H. L. Van Trees, "Detection, Estimation, and Modulation Theory", Part I, Wiley, 2021.
2. Simon Haykin, "Adaptive Filter Theory", Pearson, 6th Edition, 2020.
3. P. K. Varshney, "Distributed Detection and Data Fusion", Springer, 1st Edition, 2020.
4. Louis Scharf, "Statistical Signal Processing"**,** Addison-Wesley, 1st Edition, 2021

Web References:

NPTEL Web Course: https://nptel.ac.in/courses/117103018

Course Outcomes:

Upon successful completion of the course the student will have the ability to:

i. Model and analyze signals and noise statistically, understanding PDFs, ` autocorrelation,and power spectral density.

ii. Design and evaluate detectors for deterministic signals using matched filters, likelihood ratio tests, and ROC curves.

iii. Implement detection techniques for random signals**,** including Bayesian, minimax, and energy detection approaches.

iv. Perform parameter estimation using maximum likelihood, least squares, and Bayesian methods while understanding estimator efficiency and Cramer-Rao bounds**.**

v. Apply detection and estimation methods, including adaptive and Kalman filters, for communication systems with AWGN and Fading channels.

EECE603	EMBEDDED NETWORKS AND PROTOCOLS	3L:0T:0P	3 Credits

Course Objectives:

In this course, students will be able to

i. Provide an understanding of Ethernet basics and its role in embedded systems.
ii. Explore embedded ethernet design, protocol stacks and real-time ethernet concepts
iii. Learn fundamentals and frame format of CAN protocol
iv. Study the industrial networking based embedded systems
v. Introduce RF communication concepts used in wireless embedded systems

Course Contents:

MODULE I: ETHERNET BASICS 9 Hours

Evolution of Ethernet Standards (IEEE 802.3); Ethernet Frame Format and Addressing; CSMA/CD Protocol and Collision Management; Switching, VLANs, and Full-Duplex Communication; TCP/IP Overview in the Context of Embedded Systems; Gigabit and 10G Ethernet Overview; Quality of Service (QoS) in Ethernet.

MODULE II: EMBEDDED ETHERNET 9 Hours

Need for Ethernet in Embedded Systems; Embedded TCP/IP Protocol Stack; Lightweight TCP/IP (lwIP) Implementation; Real-Time Ethernet (RTE) Concepts: Latency, Throughput, Jitter; Embedded Ethernet Hardware and Interfaces (PHY, MAC); Security in Embedded Ethernet (SSL/TLS, Secure Web Servers); Case Studies: Embedded Web Servers, Smart Meters, IoT Gateways.

MODULE III: INTRODUCTION TO CAN PROTOCOL 9 Hours

Overview of Serial Bus Systems in Embedded Applications; CAN Protocol Fundamentals: Frame Formats, Data, Remote, Error, Overload; Arbitration, Error Detection, and Fault Confinement; CAN Physical Layer and Transceivers; CAN FD (Flexible Data Rate); Comparison with LIN and FlexRay Protocol; Applications of CAN in Automotive and Industrial Systems.

MODULE IV: INDUSTRIAL NETWORKING 9 Hours

Industrial Ethernet: PROFINET, Ether CAT, Modbus TCP/IP; Device Net and Profibus Protocols; Time-Triggered Protocol (TTP); Time-Sensitive Networking (TSN, IEEE 802.1); OPC-UA Protocol for Industry 4.0; Safety Protocols (PROFIsafe, Safety over Ether CAT); Case Studies: Networking in Automation, Robotics, and Smart Factories.

MODULE V: RF COMMUNICATION FOR EMBEDDED SYSTEMS 9 Hours

Fundamentals of RF Communication in Embedded Networks; Short-Range Protocols: Bluetooth, BLE, ZigBee; LPWAN Protocols: LORA WAN, NB-IoT; Wi-Fi and Wi-Fi 6 for Embedded Applications; Ultra-Wideband (UWB) for Localization; RFID/NFC Protocols in IoT and Automation; Introduction to 5G NR Features for Embedded IoT Devices.

Total No. of Hours: 45

Text Books:

1. Colt Correa , Simon, Gubow, Bhagwat, "Automotive Ethernet: The Definitive Guide, 2nd Edition, Intrepid Control Systems, 2022
2. Robert Sobot, "Wireless Communication Electronics: Introduction to RF Circuits and DesignTechniques" , 1st Edition, Springer, 2021
3. Sunit Kumar Sen, "Fieldbus and Networking in Process Automation", 2nd Edition, CRC Press, 2022

Reference Books:

1. P.S. Marshall & J.S. Rinaldi, "Industrial Ethernet: How to Plan, Install, and Maintain TCP/IP Ethernet Networks: The Basic Reference Guide for Automation and Process Control Engineers, 3rd Edition, ISA,2025
2. Smain Femmam & Pascal Lorenz (eds.), Recent Advances in Communication Networks and Embedded Systems", 1st Edition, Conference Proceedings Springer ,2024/25
4. Richard Zurawski, "Embedded Systems Handbook: Networked Embedded Systems",1st Edition, CRC Press, 2017

Web References:

NPTEL Web Course: https://nptel.ac.in/courses/106105183

Course Outcomes:

Upon successful completion of the course the student will have the ability to

i. Describe Ethernet basics, QoS, and its role in embedded communication.
ii. Implement Embedded Ethernet using lwIP stacks and address security in real- time applications.
iii. Explain the CAN fundamentals and its application in embedded systems
iv. Analyze industrial networking protocols such as Ether CAT, PROFINET, OPC-UA, and TSN.
v. Demonstrate the RF Communication in Embedded Networks

EECE604	INTRODUCTION TO QUANTUM TECHNOLOGY	3L:0T:0P	3 Credits

Course Objectives:

In this course, students will be able to

i. Introduce fundamental quantum mechanics principles relevant to modern technology.
ii. Explain qubits, superposition, entanglement, and quantum gates in practical applications.
iii. Explore quantum communication systems, quantum cryptography, and key distribution.
iv. Study quantum sensors and devices for signal detection, imaging, and precision measurement.
v. Familiarize students with quantum hardware platforms and simulation tools for research and technology development.

Course Contents:

MODULE I: FUNDAMENTALS OF QUANTUM MECHANICS 9 Hours

Quantum vs Classical Systems; Quantum States, Superposition, No Cloning and Measurement; Qubits and Bloch Sphere Representation; Quantum Noise and Decoherence; Quantum Harmonic Oscillator; Multi-Qubit Superposition Concepts.

MODULE II: QUANTUM COMPUTING CONCEPT 9 Hours

Quantum Gates and Circuits (Pauli, Hadamard, CNOT); Quantum Algorithms for Signal Processing and Optimization (Quantum Fourier Transform); Reversible Logic and Error Correction Basics; Quantum Simulation of Classical Systems; Error Mitigation Techniques.

MODULE III: QUANTUM COMMUNICATION SYSTEMS 9 Hours

Quantum Key Distribution (BB84, E91 Protocols); Entanglement-based Communication and Quantum Teleportation; Quantum Repeaters and Network Architectures; Secure Data Transfer Applications; Quantum Dense Coding; Quantum Secure Direct Communication (QSDC); Practical QKD Implementations (Fiber & Free-Space).

MODULE IV: QUANTUM SENSORS AND APPLICATIONS 9 Hours

Quantum Sensors for Electromagnetic, Optical, and Magnetic Signals; Quantum Metrology and Precision Measurement (Atomic Clocks, Interferometry); Quantum-enhanced Techniques for Accuracy Improvement; Quantum Photonics for Sensing; Magnetometry Using NV Centers in Diamond; Applications in Signal Detection, Imaging, and Measurement.

MODULE V: QUANTUM HARDWARE AND SIMULATIONS 9 Hours

Physical Implementations: Superconducting Qubits, Ion Traps, Photonic Qubits; Quantum Devices for Communication and Signal Processing; Cloud-based Quantum Computing Platforms and Simulation Tools (QTCAD, QuTiP)

Total No. of Hours: 45

Text books:

1. Michael A. Nielsen and Isaac L. Chuang, " Quantum Computation and Quantum Information", 11th Edition, Cambridge Universitt Press,2022
2. Jonathan P. Dowling and Gerard J. Milburn, " Quantum Technology : Concepts and Applications", 2nd Edition , CRC Press,2021
3. Eleanor Rieffel and Wolfgang Polak, " Quantum Computing: A Gentle
4. Introduction", 2nd Edition , MIT Press, 2020

Reference Books:

1. Bernhard Schmitt, "Introduction to Quantum Technology", 1st Ed., Springer, 2020.
2. David McMahon, "Quantum Computing Explained", 2nd Ed., Wiley, 2021.
3. Peter Wittek, "Quantum Machine Learning: What Quantum Computing Means to Data Mining", 1st Ed.,2020.
4. Mark M. Wilde, "Quantum Information Theory",1st Ed., Cambridge University Press, 2021.

Web References:

1. https://nptel.ac.in/courses/106106232
2. https://onlinecourses.nptel.ac.in/noc22_ph15/preview

Course Outcomes:

Upon successful completion of the course the student will be able

i. Explain quantum mechanics principles as applied to modern technology and devices.
ii. Apply quantum gates and circuits for computational and signal processing tasks.
iii. Analyze quantum communication protocols, secure data transfer, and emerging networks.
iv. Understand and design quantum sensors for measurement, imaging, and Detection applications.
v. Evaluate quantum hardware platforms, hybrid architectures, and simulation tools f practical applications in technology development

EECE711	BIO MEDICAL ELECTRONICS	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to

i. Understand the origin of bio-potentials and the principles of bio potential recording systems
ii. Study biochemical and non-electrical parameter measurement techniques
iii. Learn the design and working principles of assist devices
iv. Understand the concepts of physical medicine and biotelemetry
v. Explore recent trends in medical instrumentation

Course Contents:

MODULE I: ELECTRO-PHYSIOLOGY AND BIO-POTENTIAL RECORDING 9 Hours

Origin of bio-potentials; biopotential electrodes; biological amplifiers; ECG: lead systems, recording methods, typical waveforms, signal characteristics; EEG: lead systems, recording methods, typical waveforms, signal characteristics; EMG: lead systems, recording methods, typical waveforms, signal characteristics; PCG: lead systems, recording methods, typical waveforms, signal characteristics.

MODULE II: BIOCHEMICAL & NON-ELECTRICAL PARAMETER MEASUREMENT 9 Hours

pH, PO_2, PCO_2 Acid-Base Balance, Blood Gas Analysis, Measurement Techniques; colorimeter; auto analyser; blood flow meter; cardiac output; respiratory measurement; blood pressure; temperature; pulse; blood cell counters.

MODULE III: ASSIST DEVICES: 9 Hours

Cardiac Pacemakers: Indications types, Components, Implantation procedure, Pacing modes and Programming (NBG code), Complications and long-term management; DC defibrillator: Principles of Electrical Shock for arrhythmias, Types (external, ICDs, wearable); Waveforms and Energy Levels dialyzer: Principles, Anatomy Membrane types and biocompatibility, Performance Metrics; Heart-lung machine.

MODULE IV: PHYSICAL MEDICINE AND BIOTELEMETRY 9 Hours

Diathermies: shortwave, ultrasonic, and microwave types, their applications; surgical diathermy; telemetry principles; frequency selection; biotelemetry; radio pill; electrical safety.

MODULE V: RECENT TRENDS IN MEDICAL INSTRUMENTATION: 9 Hours

Thermograph; Endoscopy unit; Laser in medicine; Cryogenic applications; Introduction to telemedicine; Overview of wearable devices and IoT-based health monitoring

Total No. of Hours: 45

Text Books:

1 . Leslie Cromwell, Fred J.Weibull, Erich A.P Feiffer, "Biomedical Instrumentation and Measurements", Pearson Education, 2nd Edition, 2015.
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.

Web References:

NPTEL Web Course: https://nptel.ac.in/courses/108108180

Course Outcomes:

Upon completion of this course, the students will have the ability to

i. Understand the origin of bio potentials and various electrodes for sensing.
ii. Understand the concepts of the bio-chemical and non-electrical parameter measurement.
iii. Analyze the different assist devices and its usages
iv. Understand the physical medicine.
v. Analyze suitable transducers for medical applications

EECE712	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to

i. Understand the fundamentals of Artificial Intelligence, intelligent agents, search strategies, and planning techniques.
ii. Study basic machine learning concepts, learning types, evaluation metrics, and model performance issues.
iii. Explore supervised learning algorithms and apply them to regression and classification tasks.
iv. Learn the unsupervised learning methods such as clustering and dimensionality reduction.
v. Examine the concepts of reinforcement learning and deep learning architectures for Intelligent decision making.

Course Contents:

MODULE I: INTRODUCTION TO AI 9 Hours

Brief history; agents and rationality; task environments; agent architecture types; search and knowledge representation; planning: hierarchical planning, informed and uninformed search algorithms.

MODULE II: MACHINE LEARNING BASIC CONCEPTS 9 Hours

Types of learning techniques; terminologies; real-world examples; dataset; samples; features; model; evaluation metrics; bias and variance trade-off; underfitting and overfitting.

MODULE III: SUPERVISED LEARNING 9 Hours

Regression and classification; linear and polynomial regression models; gradient descent; classification algorithms: KNN, Naïve Bayes, Logistic Regression, SVM; ensemble models: bagging and boosting; case studies on regression and classification problems.

MODULE IV: UNSUPERVISED LEARNING 9 Hours

Clustering and dimensionality reduction; Clustering: partitioning and hierarchical methods; dimensionality reduction: PCA; case studies on clustering and dimensionality reduction techniques.

MODULE V: REINFORCEMENT LEARNING & DEEP LEARNING 9 Hours

Reinforcement learning: basic concepts; Neural networks: basic concepts of neurons, types of networks, activation functions, loss function, back propagation network, CNN, RNN, GAN and its applications.

Total No. of Hours: 45

Text Books:

1. Stuart Russell & Peter Norvig, "Artificial Intelligence: A Modern Approach", 4th Edition, Pearson, 2020.
2. E. Alpaydin, "Introduction to Machine Learning", 4th Ed., MIT Press, 2023.

Reference Books:

1. Richard O. Duda, Peter E. Hart, David G. Stork. "Pattern Classification", 2nd Edition, John Wiley & Sons, 2006.
2. Trevor Hastie, Robert Tibshirani, Jerome Friedman "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", 2nd Edition, Springer 2009.
3. A. Géron, "Hands-On Machine Learning with Scikit-Learn, Keras & TensorFlow", 3rd Edition, O'Reilly, 2023.

Web References:

NPTEL Web Course: https://nptel.ac.in/courses/106102220

Course Outcomes:

Upon completion of this course, the students will have the ability to

i. Understand the fundamental concepts of Artificial Intelligence, intelligent agents, searchstrategies, and planning methods.
ii. Demonstrate knowledge of basic machine learning concepts, evaluation metrics and model performance trade-offs.
iii. Apply supervised learning algorithms such as regression and classification to solve real-worldproblems.
iv. Implement unsupervised learning techniques including clustering and dimensionality reduction for data analysis.
v. Explore and analyze reinforcement learning principles and deep learning architectures for intelligent system design.

EECE713	SATELLITE COMMUNICATION	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to

i. Provide a comprehensive understanding of fundamentals of satellite communication
ii. Impart knowledge on earth station technology and satellite link design
iii. Introduce multiple access techniques for satellite communication
iv. Explore advanced concepts in laser satellite communication
v. Familiarize students with satellite services and applications

Course Contents:

MODULE I: INTRODUCTION TO SATELLITE COMMUNICATION 9 Hours

Types of satellites; orbits and constellations; orbital mechanics; orbital elements; look angle; visibili limits; eclipse; sun transit outage; spacecraft subsystems: power, attitude/orbit control, therma propulsion, TT&C, Transponder; launch vehicles and procedures.

MODULE II: EARTH STATION AND SATELLITE LINK DESIGN 9 Hours

Earth station subsystems; terrestrial interface, transmitters, receivers, antennas; uplink and downlin design: link budget and Eb/No; impairments: noise, interference, intermodulation; propagation effect frequency considerations; system reliability and lifetime.

MODULE III: SATELLITE MULTIPLE ACCESS 9 Hours

FDMA: concepts, intermodulation, SPADE system; TDMA: frame, burst, switched TDMA; CDM DS and FH CDMA, PDMA; comparison of FDMA, TDMA, CDMA.

MODULE IV: LASER SATELLITE COMMUNICATION 9 Hours

Inter-satellite links; optical/laser communication; cross-link analysis; optical beam acquisitio tracking, pointing; comparison with RF communication.

MODULE V: SATELLITE SERVICES AND APPLICATIONS 9 Hours

Packet satellite networks; fixed, broadcast, mobile services; VSAT; GPS; maritime communicatio gateways; ATM over satellite; Satellites in future networks.

Total No. of Hours: 45

Text Books:

1. Timothy Pratt and Jeremy Allnutt ,"Satellite Communications", 3rd Edition, Wiley, 2021.
2. Klaus Schilling, " Small Satellite Missions: An Introduction", Springer, 2023.

Reference Books:

1. Varsha Agrawal, Anil K. Maini, "Satellite Communications", 1st Edition, WileyIndia2010.
2. Tirtha "Digital Satellite Communications", 2nd Edition, Tata Mc Graw Hill 2017.
3. Dennis Roddy, Jones Linwood, David G. Long "Satellite Communications", 5th Edition, McGraw Hill, 2024.

Web References:

NPTEL Web Course: https://nptel.ac.in/courses/117105131

Course Outcomes:

Upon completion of this course, the students will have the ability to

1. Analyze satellite orbits, orbital mechanics, and the key subsystems of a spacecraft.
2. Design a satellite link budget, accounting for impairments and propagation effects.
3. Compare the operation, advantages, and limitations of FDMA, TDMA, and CDMA multiple access schemes.
4. Evaluate the principles and challenges of laser-based inter-satellite links compared to RF systems.
5. Propose satellite-based solutions for modern services like VSAT, GPS, and mobile communication.

EECE714	WIRELESS NETWORKS	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to

i. Understand the fundamentals of wireless communication and radio propagation characteristics.
ii. Explore MAC protocol issues and their applications in wireless networks.
iii. Analyze various routing protocols used in wireless and mobile networks.
iv. Explore QoS mechanisms and energy management techniques in wireless systems.
v. Gain knowledge of wireless network security standards, threats, and countermeasures.

Course Contents:

MODULE I: FUNDAMENTALS OF WIRELESS NETWORKS 9 Hours

Fundamentals of wireless communication technology, Electromagnetic Spectrum, Characteristics of Wireless Channels; Switching Techniques, Evolution of Wireless Networks: Wireless LANs, WMANs, WWANs, Adhoc Networks, WPANs (System Architecture and Protocol Stack); Wireless Internet: Mobile IP Scenario, IPv4 and IPv6

MODULE II: MAC PROTOCOLS 9 Hours

Issues in designing MAC protocols, Design goals, Classification of MAC protocols: Random Access Techniques, MAC protocols for WiFi, WPANs; Location discovery

MODULE III: ROUTING PROTOCOLS 9 Hours

Issues in designing routing protocols; classification of routing protocols: table-driven, on-demand, hybrid, flooding, hierarchical, and power-aware routing protocols.

MODULE IV: QOS AND ENERGY MANAGEMENT 9 Hours

Issues and challenges in providing QoS; Classification of QoS solutions for MAC and network layer solutions, QoS frameworks; Need for Energy Management, Classification of energy management schemes; Battery, Transmission Power and System Power management.

MODULE V: SECURITY IN WIRELESS NETWORKS 9 Hours

Security Issues in Wi-Fi (IEEE 802.11), Common Wireless Attacks: Sniffing, Eavesdropping, Rogue AP, Evil Twin, Jamming; Encryption Schemes: Wired Equivalent Privacy (WEP), Wi- Fi Protected Access (WPA/WPA2/WPA3) Protocols; Mobile Network Security (2G/3G/4G/5G): SIM Security, CDMA Security, LTE Security, 5G Security (Architecture); Emerging Trends in Wireless Security: Cyber Security , IDS and AI based Security schemes

Total No. of Hours: 45

Text Books:

1. Vijay K. Garg, "Wireless Communications and Networking", The Morgan Kaufmann Series in Networking, 2008.
2. William Stallings, "Wireless Communications & Networks",Pearson Education, 2nd Edition, 2005.

Reference Books:

1. Carlos de Morais Cordeiro and Dharma Prakash Agrawal, "Ad Hoc and Sensor Networks: Theory and Applications", 2nd Edition, World Scientific Publishing, 2006.
2. Asoke K. Talukder and Hasan Ahmad, "Mobile Computing", McGraw-Hill, 2nd Edition, 2010.

Web References:

https://nptel.ac.in/courses/106105160
http://www.digimat.in/nptel/courses/video/117102062/L01.html
https://onlinecourses.nptel.ac.in/noc25_ee109/preview

Course Outcomes:

Upon completion of this course, the students will have the ability to

i. Explain the core concepts of wireless communication and the behavior of wireless channels.
ii. Analyse various MAC protocols and determine their suitability for different wireless applications.
iii. Analyze wireless routing protocols and differentiates their performance across network scenarios.
iv. Assess QoS requirements and apply energy-efficient strategies for optimized wireless network operation.
v. Identify wireless security vulnerabilities and recommend appropriate mitigation techniques across modern standards.

EECE721	DIGITAL IMAGE PROCESSING	3L:0T:0P	3Credits

Course Objectives:

In this course, the students will be able to

i. Understand fundamentals and representation of digital images.
ii. Learn various image transforms for two dimensional images.
iii. Understand image restoration and segmentation techniques.
iv. Develop algorithms for compression, coding, and segmentation.
v. Explore multi-resolution techniques with AI integration.

Course Contents:

MODULE I: INTRODUCTION TO DIGITAL IMAGE PROCESSING 9 Hours

Components of an image processing system; image sensing and acquisition; simple image formation model; digital image representation; sampling and quantization; aliasing; zooming and shrinking; pixel relationships; image types and file formats; color image processing; applications of image processing

MODULE II: IMAGE TRANSFORMS 9 Hours

Two-dimensional signals; 2D systems and classifications; 2D convolution and correlation; Need for transforms; 2D Discrete Fourier Transform (DFT); Walsh, Hadamard, Haar, and Slant transforms; Discrete Cosine Transform (DCT); Karhunen–Loève (KL) transform.

MODULE III: IMAGE RESTORATION AND SEGMENTATION 9 Hours

Classical methods: gray-level transformations, histogram processing, spatial and frequency domain filters, image degradation/restoration models, inverse filtering, Wiener filtering. Classical segmentation: detection of discontinuities, thresholding, region-based segmentation- water shed algorithm

MODULE IV: IMAGE COMPRESSION TECHNIQUES 9 Hours

Principles of image compression; text compression; static and dynamic Huffman coding; arithmetic coding; graphics interchange format (GIF), TIFF, digitized documents; introduction to JPEG standards and its versions.

MODULE V: AI FOR IMAGE PROCESSING 9 Hours

Introduction to AI; AI agents, type of learning techniques, Neural Networks: CNN, feature extraction and classification using CNNs, CNNs based image denoising: auto encoder-based restoration; Case studies in medical imaging, remote sensing, and autonomous systems.

Total No. of Hours:45

Text Books:

1. R.C. Gonzalez and R.E. Woods, "Digital Image Processing", 4th Edition, Pearson Education, 2018
2. William K. Pratt, "Digital Image Processing" PIKS Scientific Inside, 4th Edition, Wiley, 2007.

Reference Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning," 1st Edition, MIT Press, 2016
2. Milan Sonka, Vaclav Hlavac, and Roger Boyle, "Image Processing, Analysis, and Machine Vision" ,4th Edition, Cengage Learning, 2014.
3. A. Singh & R. Arora, "Deep Learning for Image Processing", 1stEdition, Springer, 2021.

Web References:

NPTEL Web Course: https://nptel.ac.in/courses/117105135

Course Outcomes:

Upon completion of this course, the students will have the ability to

i. Explain the fundamental concepts of digital image formation, representation, and color models.
ii. Apply various image transforms to improve image quality in both spatial and frequency domains.
iii. Analyze and implement image restoration and segmentation methods to extract meaningful information from images.
iv. Evaluate and apply different image compression techniques and standards for efficient storage and transmission.
v. Design and implement basic AI based solutions for advanced image processing tasks in various application domains.

EECE722	INFORMATION SECURITY	3L:0T:0P	3Credits

Course Objectives:

In this subject, the students will be able to

i. Understand the need and fundamental principles of information security as well as different types of attacks and malwares
ii. Learn authentication mechanisms, authorization models, and access control methods.
iii. Understand cryptographic techniques, algorithms, and digital signatures.
iv. Study encryptions algorithms
v. Explore internet security mechanisms, cyber laws, and security solutions.

Course Contents:

MODULE I: INFORMATION SECURITY OVERVIEW 9 Hours

Need of information security, Information classification, Criteria for information classification; Basic principles of information security: Confidentiality, Authentication, Integrity, Availability, Access Controls, Repudiation; Type of Attacks: Denial of Service, DDOS, Backdoors and Trapdoors, Sniffing, phishing, Spoofing, Man in the Middle, Replay, TCP/IP Hacking, Encryption attacks, Social Engineering; Types of Malwares and their impact on security and prevention: Virus, Worms, Trojan horse, Spyware, Adware, Ransomware, Logic Bombs, Rootkits, Backdoors, Key loggers; Relation between threat, vulnerability, risks.

MODULE II: AUTHENTICATION AND ACCESS CONTROL 9 Hours

Identification and Authentication methods: Electronic user authentication, multi-factor authentication, token-based authentication, Biometrics; Password attacks: Guessing password, Piggybacking, Shoulder surfing, Dumpster diving; Biometrics: Finger prints, Hand prints, Retina scan patterns, Voice patterns; Authorization: Definition, goals of authorization; Access controls: Access control principles, Access rights and Access control policies: Discretionary Access Control (DAC), Mandatory Access Control (MAC), Role-based Access Control (RBAC), Attribute-based Access Control (ABAC).

MODULE III: FUNDAMENTALS OF CRYPTOGRAPHY 9 Hours

Cryptography, Cryptanalysis, Cryptology, Encryption, Decryption; Symmetric and Asymmetric cryptography, key management; Substitution techniques: Caesar cipher, Play fair cipher, Vigenere cipher, Vernam cipher (One-time pad); Transposition techniques: Rail fence technique, Simple columnar technique; Steganography: Features and working of steganography

MODULE IV: ENCRYPTION ALGORITHMS 9 Hours

Data Encryption Standard algorithm, Advanced Encryption Standard algorithm, RSA algorithm. Diffie-Hellman key exchange algorithm; Hash Function: Features of Hash Functions, MD5 and SHA algorithm; Digital Signature: Need and working of Digital Signature; Threats to mobile phone and its security measures.

MODULE V: INTERNET SECURITY AND CYBER LAW 9 Hours

Firewall: Need of firewall, Types of Firewalls: Packet filters, Stateful packet filters, Firewall policies, Demilitarized zone (DMZ); Gateways: Importance and working of gateways; Intrusion Detection System (IDS): Network-based IDS, Host-based IDS, Honeypots; E-mail security: SMTP, PGP, S/MIME; Cybercrime: Hacking, Digital forgery, Cyber stalking/Harassment, Cyber pornography, Identity theft & fraud, Cyber terrorism, Cyber defamation, OS finger printing; Cyber Laws: Need and Categories: Crime against individual, Government, Property.

Total No. of Hours: 45

Text Books:

1. William Stallings, "Cryptography and Network Security: Principles and Practice",8th Global Edition, Pearson, 2024.
2. Charlie Kaufman, Radia Perlman, Mike Speciner & Ray Perlner, "Network Security: Private Communication in a Public World", Addison-Wesley Professional, 3rd Edition, 2022.

Reference Books:

1. Jonathan Katz and Yeluda Lindell, " Introduction to Modern Cryptography", CRC Press(Routledge), Revised 3rd Edition, 2025
2. Behrouz A. Forouzan, " Cryptography and Network Security", McGraw Hill, 2nd Edition, 2022
3. Mark Stamp, " Information Security: Principles and Practice",3rd Edition, Reprint, Wiley, 2023

Web References

NPTEL Web Course: https://nptel.ac.in/courses/108101585

Course Outcomes:

Upon completion of this course, the students will have the ability to

i. Identify security requirements, attacks and also malware and classify information based on security principles.
ii. Apply authentication methods and access control models for secure system design.
iii. Demonstrate the working of cryptographic algorithms and digital signature processes.
iv. Explain firewall mechanisms and working of gateways
v. Explain IDS strategies, e-mail security protocols, and cyber laws.

ECE723	INTRODUCTION to MEMS and NEMS	3L:0T:0P	3Credits

Course Objectives:

In this course, the students will be able to

i. Explain the fundamentals and advantages of MEMS and NEMS.
ii. Describe materials and fabrication techniques for micro/nano devices.
iii. Analyze the principles and design of micro/nano sensors and actuators.
iv. Analyze the structure and operation of electrostatic actuator types.
v. Apply MEMS/NEMS concepts to real-world applications.

Course Contents:

MODULE I: INTRODUCTION TO MEMS AND NEMS: 9 Hours

Overview of micro/nano systems; advantages of MEMS; materials for MEMS/NEMS; potential applications.

Introduction to NEMS: Nano-scaling issues, Nano-structured materials, multilayer structures, atomic structures, and basic quantum mechanics principles relevant to NEMS.

MODULE II: FABRICATION OF MEMS AND NEMS 9 Hours

Oxidation, Photolithography, ion implantation, diffusion, Thin film deposition: LPCVD, sputtering, evaporation, electroplating; Etching techniques: wet, dry, and electrochemical etching; Micromachining: bulk and surface micromachining, LIGA, SOI, MUMPS.

MODULE III: MICRO AND NANO SENSORS 9 Hours

Acoustic sensors: quartz crystal microbalance, surface acoustic wave, flexural plate wave; vibratory gyroscopes, capacitive and piezoresistive pressure sensors, nano gas sensors; applications in biomedical, robotics, and industrial domains.

MODULE IV: MICRO AND NANO ACTUATORS 9 Hours

Electrostatic actuators: parallel plate and interdigitated capacitors; piezoelectric, thermal, and shape-memory alloy actuators; microgrippers, micromotors, microvalves, micropumps, nano energy harvesters.

MODULE V: PACKAGING AND CHARACTERIZATION OF MEMS AND NEMS 9 Hours

Micro/nano system packaging, Material selection and essentials technologies; Characterization techniques: SEM, TEM, AFM, STM, and spectroscopic methods; Design considerations and evaluation for practical applications.

Total No. of Hours: 45

Text Books:

1. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures",CRC Press, 1st Edition, 2002.
2. Chang Liu, "Foundations of MEMS", Pearson education India limited, 1ST Edition, 2006.

Reference Books:

1. K.E. Drexler, "Nano systems", Wiley, 1st Edition,1992.
2. J.H. Davies, "The Physics of Low-Dimensional Semiconductors", Cambridge University Press, 1st Edition, 1998.

Web References:

NPTEL Web Course: https://nptel.ac.in/courses/117105082

Course Outcomes:

Upon completion of this course, the students will have the ability to

i. Understand micro/nano electromechanical structures, devices, systems, theory, and applications.
ii. Identify materials and fabrication methods (surface/bulk micromachining, LIGA).
iii. Analyze the performance of micro/nano sensors and actuators.
iv. Compare different micro actuator technologies for applications such as micro grippers, micro motors, micro valves, and micro pumps.
v. Assess MEMS/NEMS design for practical use.

EECE724	IOT SYSTEMS ENGINEERING	3L:0T:0P	3 Credits

Course Objectives::

In this course, the students will be able to

i. Demonstrate the fundamentals of IoT
ii. Identify suitable protocols and standards for IoT deployments.
iii. Develop cloud computing model and service options.
iv. Learn business models for IoT.
v. Understand the concepts of IoT and its applications.

Course Contents:

MODULE I: INTRODUCTION TO IOT 9 Hours

Definitions and functional requirements; motivation; IoT architecture; Web 3.0 view; ubiquitous IoT applications; four pillars of IoT; DNA of IoT; end-user toolkit approach. Middleware for IoT: overview, communication middleware, and IoT information security.

MODULE II: IOT PROTOCOLS AND STANDARDS 9 Hours

Protocol standardization for IoT; M2M and WSN protocols; SCADA and RFID protocols; issues with standardization; unified data standards; IEEE 802.15.4; BACNet, Modbus, KNX; Zigbee: architecture, network layer, APS layer, and security considerations.

MODULE III: WEB AND CLOUD OF THINGS 9 Hours

Web of Things versus IoT; two pillars of the web; architecture standardization for WoT; platform middleware; unified multitier architecture; WoT portals and business intelligence. Cloud of Things: grid/SOA and cloud computing; cloud middleware, standards, providers, and systems; mobile cloud computing; Cloud of Things architecture.

MODULE IV: INTEGRATED IOT AND BUSINESS MODELS 9 Hours

Integrated billing solutions; IoT business models; network dynamics: population models, information cascades, structural models; cascading behavior in networks; small-world phenomenon.

MODULE V: IOT APPLICATIONS 9 Hours

IoT for increased autonomy and agility; resource management: clustering, synchronization, software agents; applications in smart grid, electric vehicle charging, and other industrial or consumer environments

Total No. of Hours: 45

Text Books:

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things, a hands-on approach", Universities Press (India) Pvt. Ltd., 2nd Edition, 2017.
2. Rajkumar Buyya, Amir Vahid Dastjerdi, "Internet of Things Principles and Paradigms", Elsevier Inc., 1st Edition, 2016.

Reference Books:

1. D. Hanes and G. Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Cisco Press, 1st Edition, 2017.
2. Satish Jain and Shashi Singh, " Internet of Things (IOT) & Its Applications", BPB Publications, 1st Edition, January 2020.
3. William Stallings, "Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud" Publisher, Addison-Wesley, 1st Edition, 2015.

Web References:

http://digimat.in/nptel/courses/video/106105166/L02.html
https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_cs38
https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ee85

Course Outcomes:

Upon completion of this course, the students will have the ability to

i. Explain the fundamental architecture, pillars, and middleware of IoT systems.
ii. Analyze and compare various IoT protocols, standards, and their security considerations.
iii. Differentiate between the Internet of Things, Web of Things, and Cloud of Things architectures.
iv. Evaluate IoT business models and the network dynamics that influence their adoption.
v. Design IoT solutions for real-world applications in smart grids and industrial environments.

EECE801	ASIC DESIGN	3L:0T:0P	3 Credits

Course Objectives:

In this course, the students will be able to

i. Explain ASIC types and design flow
ii. Analyze system-level trade-offs and low-power design
iii. Perform ASIC physical design: floor planning, placement, routing
iv. Understand SoC architectures and on-chip communication
v. Apply high-performance algorithms and case studies

Course Contents:

MODULE I: INTRODUCTION TO ASIC AND DESIGN FLOW 9 Hours

Types of ASICs: full-custom, semi-custom, programmable; VLSI design flow; Programmable ASICs: Antifuse, SRAM, EPROM, EEPROM; logic and I/O cells; Programmable interconnects; Overview of modern FPGAs, CPLDs, and soft-core processors.

MODULE II: SYSTEM-LEVEL DESIGN AND OPTIMIZATION 9 Hours

System-level trade-offs: Speed, Area, Power; Asynchronous design; Low-power design principles; High speed design issues; System partitioning and power dissipation; Design constraints.

MODULE III: ASIC PHYSICAL DESIGN 9 Hours

Floor planning: objectives, constraints, methods; placement techniques: goals, algorithms, challenges; routing: global and detailed routing; optimization strategies and performance issues.

MODULE IV: SYSTEM-ON-CHIP (SOC) DESIGN 9 Hours

SoC design flow: platform-based and IP-based designs, bus-based communication architectures, on-chip communication standards; Low-power SoC design techniques.

MODULE V: HIGH-PERFORMANCE ALGORITHMS AND CASE STUDIES 9 Hours

High-performance algorithms: CSD arithmetic, constant multiplication, distributed arithmetic; Digital filters for sigma-delta ADC; Case studies: USB controllers, OMAP architectures.

Total No. of Hours: 45

Text Books:

1. J. M. Rabaey, A. Chandrakasan, and B. Nikolic, "Digital Integrated Circuit Design Perspective", PHI, 2nd Edition, 2003.
2. M.J.S. Smith, "Application-Specific Integrated Circuits", Pearson, 2nd Edition, 2003

Reference Books:

1. D. A. Hodges, "Analysis and Design of Digital Integrated Circuits", McGraw- Hill, 3rd Edition, 2004.
2. S. Pasricha and N. Dutt, "On-Chip Communication Architectures: System on Chip Interconnect", Elsevier, 1stEdition, 2008.

Web References:

NPTEL Web Course: https://nptel.ac.in/courses/117106092

Course Outcomes:

Upon completion of this course, the students will have the ability to

i. Explain the types of ASICs, VLSI design flow and programmable logic technologies including FPGAs, CPLDs, and soft-core processors.
ii. Analyze system-level design trade-offs and optimization techniques with respect to speed, area, and power.
iii. Apply physical design methodologies including floor planning, placement, and routing to optimize ASIC performance.
iv. Evaluate SoC design methodologies, communication architectures, and low-power design strategies.
v. Implement and analyze high-performance algorithms and study real-world case studies in modern ASIC and SoC applications.

EECE802	FREE SPACE OPTICAL COMMUNICATION	3L:0T:0P	3Credits

Course Objectives:

In this course, the students will be able to

i. Explain the fundamental principles, components, and network architectures of Free Space Optical (FSO) communication systems.
ii. Analyze the FSO Channels on FSO link and analyse the different modulation schemes used for FSO
iii. Learn the basic concepts of Optical Wireless Communication (OWC) links for various environments, including terrestrial, indoor, and UAV-based scenarios.
iv. Learn the chaotic OWC concepts, including chaotic encryption for security and the fundamentals of quantum cryptography.
v. Apply knowledge of hybrid FSO/RF systems and emerging technologies to address modern communication challenges.

Course Contents:

MODULE I: FUNDAMENTALS OF FREE SPACE OPTICS (FSO) 9 Hours

Introduction to FSO communication, FSO architectures/topologies, FSO Network implementation, Integrated FSO for satellite, terrestrial and home networks, FSO MANET, Underwater FSO communication, Indoor FSO communication.

MODULE II: CHANNEL AND MODULATION TECHNIQUES 9 Hours

FSO communication channel models: Band limited channel, fading and randomly varying optical channel; modulation schemes in FSO communication-: on/off keying, PPM and BPSK, channel capacity and coding for FSO communication.

MODULE III: OPTICAL WIRELESS COMMUNICATION FUNDAMENTALS 9 Hours

NLOS UV communication: UV communications, source-detector, channel model, indoor link configurations, indoor optical wireless system, performance analysis of indoor FSO system; Propagation modeling Free space optical platforms: unmanned aerial vehicle FSO communication- UAV scenarios for FSO communication link, alignment and tracking, practical issues and recent development, mobile FSO communication

MODULE IV: CHAOTIC OPTICAL COMMUNICATION 9 Hours

Basics of chaotic optical communication, Chaotic FSO communication over turbulent channel, Chaos based secure FSO communication link; Indoor THz communication, THz wireless communication; Fundamental of free space quantum communication-quantum cryptography

MODULE V: APPLICATIONS AND EMERGING TRENDS 9 Hours

MRR technologies: Description of MRR FSO communication systems, Significance of MRR based FSO communication systems, performance analysis; Applications: Hybrid optical RF communications- FSOC systems-RF communications systems-Network systems.

Total No. of Hours: 45

Text Book:

1. Arun K. Majumdar," Advanced Free space optics – A systems approach", Springer, 2015.
2. Heinz Willebrand and Bhaksheesh S. Ghuman, "Free space optics: Enabling optical connectivity in Today's network", SAMS publishing, 2002.
3. Arun K. Majumdar and Jeniffer Ricklin, "Free space laser communications", Springer, 2008.

Reference Books:

1. John M.Senior, "Optical fiber communication", Pearson Education, second edition.2007.
2. P.Chakrabarti, "Optical Fiber Communication" ,McGraw Hill Education (India) Private Limited , 1st Edition, 2016

Web References:

NPTEL Web Course: https://nptel.ac.in/courses/108104113

Course Outcomes:

Upon completion of this course, the students will be able

i. Gain knowledge on fundamentals of FSO and its effects through atmospheric channel
ii. Analyse the performance of modulation techniques with AWGN channels
iii. Gain knowledge on optical wireless communication for indoor, UAV models
iv. Gain knowledge on basis of chaotic and THz wireless communication with free space quantum communication and cryptography
v. Gain knowledge on advancements of FSO communication

EECE803	GREEN COMMUNICATION SYSTEM	3L:0T:0P	3Credits

Course Objectives:

In this course, the students will be able to

i. Understand the need for energy-efficient communication technologies and sustainable system design.
ii. Analyze energy consumption in cellular and heterogeneous networks
iii. Apply green transmission techniques including adaptive modulation, MIMO, and beam forming
iv. Understand green communication architectures, standards, and protocols
v. Explore energy management, AI/ML-based optimization, and future trends

Course Contents:

MODULE I: INTRODUCTION TO GREEN COMMUNICATION 9 Hours

Fundamentals of green communication; need for energy-efficient wireless systems; impact of ICT on global energy consumption; carbon footprint of communication systems; energy-saving metrics; overview of sustainable communication technologies.

MODULE II: ENERGY EFFICIENCY IN WIRELESS NETWORKS 9 Hours

Energy consumption in cellular networks; Energy-efficient base stations: Sleep mode techniques, Dynamic spectrum access, Cognitive radio for energy saving, Small cells and Heterogeneous networks, Renewable energy-powered base stations.

MODULE III: GREEN TRANSMISSION TECHNIQUES 9 Hours

Transmission power control; adaptive modulation and coding for energy efficiency; MIMO and beamforming; cooperative relaying; cross-layer design for energy saving; energy-efficient MAC protocols.

MODULE IV: GREEN COMMUNICATION ARCHITECTURES AND STANDARDS 9 Hours

Green wireless network architectures; green Cloud radio access networks (C-RAN); Energy-efficient IoT communication protocols; Energy-aware routing in wireless sensor networks; Role of 5G and 6G in green communication; Standardization efforts by ITU, IEEE, 3GPP.

MODULE V: ENERGY MANAGEMENT AND FUTURE TRENDS 9 Hours

QoS–energy trade-offs; Energy harvesting techniques: solar, wind, RF; Energy storage management; green data centers; AI for energy optimization in networks; sustainability challenges.

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

Text Books:

1 . Konstantinos Samdanis, Peter Rost, Andreas Maeder, "Green Communications: Principles,Concepts And Practice", Wiley, 1st Edition, 2015
2. Sudeep Tanwar, Sudhanshu Tyagi, Neeraj Kumar, "Green Communication and Networking", CRC Press, 1st Edition, 2019.

Reference Books:

1. Jinsong Wu, Sundeep Rangan, Honggang Zhang, "Green Communications: Theoretical Fundamentals, Algorithms and Applications", CRC Press, 1stedition, 2012.
2. Bhuvan Unhelkar, "Green IT Strategies and Applications: Using Environmental Intelligence", CRC Press, 1stedition, 2011.

Web References:

1. **NPTEL Web Course:** https://nptel.ac.in/courses/112104225

Course Outcomes:

Upon completion of this course, the students will have the ability to

i. Describe Green Communication Principles and Energy-Saving Metrics
ii. Analyze Energy Efficiency In Cellular Networks and Iot Systems
iii. Apply Energy-Efficient Transmission and MAC Techniques
iv. Explain Green Network Architectures and Standardization Efforts
v. Evaluate Energy Management, AI-Based Optimization, And Sustainability Challenges

EECE804	UNDERWATER NETWORKING SYSTEM	3L:0P:0T	3 Credits

Course Objectives:

In this course, the students will be able

i. Understand the significance, challenges, and properties of underwater communication, and compare acoustic and optical communication in water.
ii. Explore underwater communication technologies, including underwater acoustics, optical communication, and underwater wireless sensor networks.
iii. Study underwater network communication aspects, such as architectures, routing, multi- hop communication, and MAC protocols, along with addressing challenges.
iv. Examine real-world applications of underwater communication, including communication with AUVs, ROVs, environmental monitoring, underwater robotics, and military applications.
v. Investigate underwater communication security concerns, encryption techniques, underwater IoT, communication with drones, and emerging trends.

Course Contents:

MODULE I: INTRODUCTION TO UNDERWATER COMMUNICATION 9 Hours

Overview of underwater communication; importance, challenges and, applications, properties of water affecting communication: absorption, scattering, propagation; comparison of acoustic and optical communication.

MODULE II: UNDERWATER COMMUNICATION TECHNOLOGIES 9 Hours

Underwater acoustics: wave properties, equations, and signal processing; optical communication in water: light propagation, modulation techniques, system design; Underwater Wireless Sensor Networks (UWSNs) architecture and protocols.

MODULE III: UNDERWATER NETWORK COMMUNICATION 9 Hours

Network architectures: topology, routing, multi-hop communication; MAC protocols for underwater communication; challenges and solutions in underwater networks.

MODULE IV: UNDERWATER COMMUNICATION APPLICATIONS 9 Hours

Communication with Autonomous Underwater Vehicles (AUVs) and Remotely Operated Vehicles (ROVs); environmental monitoring; underwater robotics; military and defense applications.

MODULE V: UNDERWATER COMMUNICATION SECURITY AND EMERGING TRENDS 9 Hours

Security threats and Encryption techniques; Emerging trends: underwater IoT and communication with drones

Total No. of Hours: 45

Text Books:

1. Richard, P.Hodges and Paul C.Etter , "Underwater Acoustics: Analysis, Design, and Performance of Sonar", Wiley, 1st Edition, 2010
2. Yi Lou, Niaz Ahmed, "Underwater Communications and Networks" , Springer, 1st Editon, 2022.

Reference Books:

1. Robert Istepanian& Milica Stojanovic, "Underwater Acoustic Digital Signal Processing and Communication Systems", Springer, 2nd Edition, 2010
2. Kristian Werth, Robert W. Heath & Milica Stojanovic, "Underwater Acoustic Networking Techniques", Wiley, 1st Edition, 2012
3. Yang Xiao & Jun-Hong Cui, "Underwater Acoustic Sensor Networks: Current Status and Future Trends", CRC Press, 2ndEdition, 2014

Web References

1. https://nptel.ac.in/courses/112104212
2. http://acl.digimat.in/nptel/courses/video/108106190/L20.html
3. https://onlinecourses.nptel.ac.in/noc25_ee88/preview

Course Outcomes:

On successful completion of this course, students will have the ability to :

i. Explain underwater communication principles and challenges
ii. Analyze acoustic, optical, and UWSN technologies
iii. Design and analyse network architectures and protocols
iv. Apply UV communication in AUVs and ROVs,
v. Assess security and emerging trends in UV networking system

Open Electives Offered by ECE Department

OECE001	EMBEDDED SYSTEM DESIGN	L	T	P	3 Credits
		3	0	0	

Course Objectives:

In this course, students will be able to

i. Introduce the fundamentals of Embedded Systems and their role in real-world applications.

ii. Understand processor architectures, memory, and interfacing techniques.

iii. Learn embedded programming concepts using C/Embedded C.

iv. Explore Real-Time Operating Systems (RTOS) and their applications.

v. Provide exposure to embedded system design methodologies and emerging trends (IoT, AI integration).

Course Contents:

MODULE I: INTRODUCTION TO EMBEDDED SYSTEMS 9 Hours
Definition and Features of Embedded Systems; Hardware/Software Co-design; Typical applications: Consumer Electronics, Healthcare, Industrial Automation; Design Challenges: Power, Cost, and Reliability

MODULE II: EMBEDDED HARDWARE ARCHITECTURE 9 Hours
PIC Microcontrollers Architecture; ARM Cortex-M Architecture basics; Memory Organization: RAM, ROM, Flash, EEPROM; I/O devices and Interfacing: GPIO, ADC/DAC, UART, SPI, CAN, I²C; Timers/Counters, Watchdog Timers, Interrupt Controllers

MODULE III: EMBEDDED SOFTWARE DEVELOPMENT 9 Hours
Embedded C Programming; Interrupts, and Event Handling; Device drivers and Low-Level Programming; Cross-Compilers, Assemblers, Debuggers, and IDEs; Code Optimization, Debugging and Profiling Techniques

MODULE IV: REAL-TIME OPERATING SYSTEMS 9 Hours
Concept of Real-Time Systems; Scheduling: Pre-emptive, Cooperative; Task Communication and Synchronization (semaphores, queues, mutex); Case study: Free RTOS basics, μC/OS-II basics, VxWorks, RTEMS

MODULE V: EMERGING TRENDS IN EMBEDDED SYSTEM 9 Hours
Embedded systems in IoT and Industry 4.0; Role of AI in embedded systems; Energy-efficient system design; Case Studies: Smart Home, Wearables, Robotics, Autonomous Vehicle

Total No. of Hours:45

Text Books:

1. Raj kamal, "Embedded Systems: Architecture, Programming and Design", McGraw Hill, 3rd Edition, 2020
2. Jonathan W Valvano, " Embedded Systems: Real-Time Operating Systems for ARM Cortex-M Microcontrollers", Create Space, 5th Edition, 2022
3. Shibu K.V., " Introduction to Embedded Systems", Mc Graw Hill,3rd Edition, 2021

Reference Books:

1. Peter Marwedel, " Embedded System Design: Embedded Systems Foundation of Cyber Physical Systems and the Internet of Things", Springer, 4th Edition,2021
2. Lyla B.Das, " Embedded Systems: An Integrated Approach", Pearson Education, 2nd Edition ,2020
3. Qing Li and Caroline Yao, "Real-Time Concepts for Embedded Systems", CMP Books,2nd Edition,2021

Web References:

1. NPTEL Web Course: 1. http://nptel.ac.in/courses/108102045/

Course Outcomes:

Upon successful completion of the course the student will have the ability to:

i. E xplain the basic concepts and components, applications of Embedded Systems.

ii. U nderstand different processor architectures and interfacing techniques.

iii. D evelop embedded C programs for microcontrollers-based applications.

iv. A pply RTOS concepts in real-time embedded applications.

v. D esign simple embedded systems for IoT, robotics, and automation

OECE002	SEMICONDUCTOR DEVICES	L	T	P	3 Credits
		3	0	0	

Course Objectives:

In this course, students will be able to:

i. Introduce the various steps involved in the fabrication of devices

ii. Understand the semiconductor materials and its characteristics

iii. Learn the principle of operation of basic devices

iv. Explore the working principle MOS Diode and MOSFET.

v. Introduce the high speed devices and its significance.

Course Objectives:

MODULE I: FABRICATION TECHNIQUES 9 Hours

Crystal Growth and Wafer Preparation, Epitaxy, oxidization techniques, Dielectric film deposition, Masking and lithography techniques (optical, e-beam lithography techniques) , Etching, Diffusion, ion implantation, metallization, Packaging

MODULE II: SEMICONDUCTOR MATERIALS & PROPERTIES 9 Hours

Introduction to Semiconductors: Intrinsic Semiconductors, Extrinsic Semiconductors: Carrier Concentration, Energy Band Diagram, Semiconductor Material (Si, Ge, GaAs, InP): Features and Energy Band Diagram, Carrier Transport Mechanism; Properties of Semiconductors : Thermal Properties, Optical and High Electric Field Properties

MODULE III: BASIC DEVICES 9 Hours

PN Junction Diode: Structure, Operation, I-V Characteristics: Zener Diode: Structure, Operation and I-V Characteristics; BJT: Structure, Operation, Configuration, Input and output Characteristics; JFET: Structure, Operation, Drain and Transfer Characteristics; UJT: Structure, Operation

MODULE IV: MOS DEVICES 9 Hours

M-S Junction: Structure, operation, characteristics; MOS Diode: Structure, band diagram, operation, C–V characteristics, effects of oxide charges; MOSFET: Structure, Band diagram operation, I–V characteristics (analytical expressions) ; MOSFET breakdown and punch through; Advanced MOSFET: MOSFET scaling down, High k-dielectric materials, SOI MOSFET, buried channel MOSFET.

MODULE V: HIGH SPEED DEVICES 9 Hours

Benefits of Hetero Structure Devices, HBT and HEMT Devices: AlGaAs/ GaAs, SiGe/Si based HBT and HEMT structure, band diagram, operation, characteristics (analytical expressions) ; Nano devices: Resonant tunneling diode, SET, FinFET, nanowire FET

Total No. of Hours:45

Text Books:

1. Nandita Das Gupta and Amitava Das Gupta, "Semiconductor Devices: Modeling and Technology", Prentice Hall of India, 2004.
2. S. M. Sze, "Physics of Semiconductor Devices", John Wiley and Sons, 3rd Edition, 2008.

Reference Books:

1. J. Singh, "Semiconductor Devices: Basic Principles", John Wiley and Sons, 2007.
2. Waser R, "Nanoelectronics and Information Technology", Wiley, 2nd Edition 2012.

Web References

1. https://nptel.ac.in/courses/108106181.
2. http://digimat.in/nptel/courses/video/108108112/L1-L38.html

Course Outcomes:

Upon successful completion of the course the student will have the ability

i. Explain the fabrication steps for the manufacturing of devi
ii. Understand the characteristics of semiconductor materials.
iii. Explain the operation of basic devices.
iv. Understand the working principle of MOS devices.
v. Enlighten the significance of high speed devices

OECE003	INTERNET OF THINGS (IOT)	L	T	P	3 Credits
		3	0	0	

Course Objectives:

In this course, students will be able to:

i. Understand the fundamentals of IoT, including its definition, characteristics, functional requirements, and applications.

ii. Analyze IoT architecture and hardware components, including sensors, actuators, micro controllers, and embedded platforms.

iii. Explore IoT communication technologies and protocols, including short-range wireless, cellular IoT, LPWAN, and IoT protocols.

iv. Examine IoT platforms, cloud/edge/fog computing solutions, analytics tools, and interoperability standards.

v. Recognize IoT security challenges and evaluate emerging trends such as AI integration, blockchain, and Industry 4.0

Course Contents:

MODULE I: INTRODUCTION 9 Hours
Definition, Characteristics, Functional Requirements and Motivation of IoT, Four pillars of IoT:M2M, RFID, WSN, SCADA; IoT Applications: Smart homes, Smart Cities, Healthcare, Agriculture

MODULE II: IOT ARCHITECTURE AND HARDWARE UNITS 9 Hours
Basic IoT Architecture: Perception, Network, and Application Layers; Hardware Units: Sensors, Actuators and Microcontrollers; Embedded platforms: Arduino, Raspberry Pi, ESP32; Edge devices and Gateways; Power Management and Energy Efficiency Technique.

MODULE III: IOT COMMUNICATION TECHNOLOGIES AND PROTOCOLS 9 Hours
Short-range wireless: Bluetooth, ZigBee, RFID, Z-Wave, NFC-Cellular IoT: LTE-M, NB-IoT; LPWAN technologies: LoRaWAN, Sigfox, BACNet, Modbus, KNX; IoT protocols: MQTT, CoAP, 6LoWPAN.

MODULE IV: IOT PLATFORMS 9 Hours
Web of Things versus IoT; Cloud platforms: AWS IoT, Google Cloud IoT, Azure IoT Hub-Edge and Fog computing concepts; IoT Analytics and Dashboards (Node-RED, Things Board); Interoperability and standardization in IoT platforms.

MODULE V: IOT SECURITY AND FUTURE TREND 9 Hours
Security Goals: Authentication, Privacy, Data Protection- Blockchain for IoT security (conceptual), GDPR and data privacy regulations; Emerging trends: Role of AI in IoT, Digital twins, Industry 4.0, 6G- enabled IoT, IoT in robotics.

Total No of Lectures: 45

Text Books:

1. Rajkumar Buyya, Amir Vahid Dastjerdi, "Internet of Things: Principles and Paradigms", Morgan Kaufmann Publisher, 1st edition, 2021.
2. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-On Approach", Universities Press, 2nd Edition, 2020

Reference Books:

1. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things: Key
2. Applications and Protocols", Wiley, 2nd Edition, 2021.
3. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", Wiley, 2nd Edition, 2022.
4. Yunchuan Sun, "IoT Security: Advances in Authentication", Springer, 1st Edition ,2021

Web References:

1. http://digimat.in/nptel/courses/video/106105166/L02.html
2. https://onlinecourses.nptel.ac.in/noc22_cs53/preview

Course Outcomes:

Upon successful completion of the course the student will have the ability to

i. Explain the fundamentals, characteristics, and applications of IoT across various domains**.**

ii. Design IoT architectures using sensors, actuators, and embedded platforms**.**

iii. Compare and implement IoT communication technologies for practical applications.

iv. Utilize IoT platforms, cloud/edge/fog computing, and analytics tools to develop functional IoT solutions.

v. Identify and address IoT security challenges and evaluate emerging trends such as AI integration, blockchain, and Industry 4.0**.**

OECE004	MOBILE COMMUNICATION	L	T	P	3 Credits
		3	0	0	

Course Objectives:

In this course, students will be able to:

i. Study the evolution of mobile communication and cellular system concepts.

ii. Learn multiple access techniques and propagation models in mobile networks.

iii. Study mobile communication standards including GSM, CDMA, LTE, and 5G technologies.

iv. Explore mobility management, handoff techniques, security and optimization in mobile networks.

v. Explore applications and emerging trends such as edge computing, cloud computing, cognitive radio, and future 6G systems.

Course Contents:

MODULE I: INTRODUCTION TO MOBILE COMMUNICATION 9 Hours

Evolution of Wireless Communication: 1G to 5G, Cellular System: Block Diagram, Mobile Communication: Basics: Frequency Reuse, Cell Splitting, Capacity Coverage, Hand- off and Link Budget Analysis; Transmission Impairments: Path Loss, Fading, Interference, Multipath

MODULE II: MULTIPLE ACCESS TECHNIQUES AND PROPAGATION MODELS9 Hours

FDMA, TDMA, CDMA, WCDMA, OFDMA, SDMA; Radio Propagation: Propagation Mechanisms, Large Propagation Models: Free-Space, Two-Ray Ground, Hata Model and Small-Scale Propagation Models

MODULE III: MOBILE COMMUNICATION STANDARDS 9 Hours

GSM Architecture, Channels, and Services; CDMA Features and System Architecture; LTE Concepts: OFDM, MIMO and Network Architecture, Handoff Strategies; 5G Technologies and Use Cases

MODULE IV: MOBILITY MANAGEMENT AND SECURITY 9 Hours

Handoff mechanisms: Hard vs. soft handoff, Roaming and call management; Mobile IP concepts and Scenario, Mobile network optimization: Self-Organizing Networks (SON), Network Function Virtualization (NFV) in mobile networks; Security: Encryption, Authentication and Privacy

MODULE V: APPLICATION AND FUTURE TRENDS 9 Hours

Mobile Data Services and Wireless Internet; Mobile Applications: IOT, Smart Cities and Healthcare; Edge Computing and Cloud Computing in Mobile Networks; Software-Defined Networking (SDN) and Cognitive Radio for Efficient Spectrum Utilization; Future Trends: 6G and Satellite-Integrated Mobile Systems

Total No of Lectures: 45

Text Books:

1. Theodore S. Rappaport, "Wireless Communications: Principles and Practice", Pearson, 2nd Edition,2010.
2. Wei Jiang, Bin Han, "Cellular Communication Networks and Standards: The Evolution from 1G to 6G", Springer, 1st Edition, 2024.
3. Andreas F. Molisch, " Wireless Communications", Wiley, 2nd Edition,2011

Reference Books:

1. Peter Jung, " Advanced Mobile Communication", De Gruyter, 1st Edition,2024
2. Mladem Bozanic Saurabh Sinha, " Mobile Communication Networks: 5G and a Vision of
3. 6G" , Springer , 1st Edition 2021
4. Dinesh Kumar, Shruti Jain , Nikhil Marriwala, C.C Tripathi, "Mobile Radio Communication and 5G Networks", (MRCN 2022 Proceedings), Springer, 1st Edition ,2023
5. C.K. Toh, "Adhoc Mobile Wireless NEtworks", Pearson Education, 1st Edition,2002

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Web References:

1. NPTEL Web Course: https://online courses.nptel.ac.in/noc21_ee66

Course Outcomes:

Upon successful completion of the course the students will have the ability to

i. Explain the evolution of mobile communication sytems and cellular concepts
ii. Demonstrate knowledge of multiple access techniques and propagation models used in mobile networks
iii. Apply mobile communication standards including GSM , CDMA , LTE and 5G technologies
iv. Analyse mobility management, handoff strtegies and optimization techniques in mobile networks
v. Design emerging applications and understand future trends in mobile communication including edge computing,cloud computing a, cognitive radio and 6g systems

OECE005	PRINCIPLES OF COMMUNICATIONS SYSTEMS	L	T	P	3 Credits
		3	0	0	

Course Objectives:

In this course, students will be able to:

i. Study the fundamentals of communication systems, including various blocks and t transmission media.

ii. Learn Analog modulation and demodulation techniques.

iii. Know Digital modulation and demodulation techniques.

iv. Explore noise and multiplexing techniques in communication systems.

v. Explore advanced and emerging communication systems, including remote systems, smart antennas and SDR

Course Contents:

MODULE I: INTRODUCTION TO COMMUNICATION SYSTEMS 9 Hours

Elements of Communication Systems; Electromagnetic Spectrum: Spectrum Allocation; Analog and Digital Communication and Applications; Types of Transmission Medium: Wired and Wireless.

MODULE II: ANALOG COMMUNICATION 9 Hours

Need for Modulation; Amplitude Modulation (AM); Frequency Modulation (FM); Phase Modulation (PM); Modulation & Demodulation Techniques of AM, FM and PM; Performance Comparison of AM, FM, PM; Superheterodyne Radio Receiver and its significance

MODULE III: DIGITAL COMMUNICATION 9 Hours

Pulse Modulation: PAM, PWM, PPM; Base Band Modulation: PCM, ADPCM, and DM; Digital Modulation: ASK, FSK, MSK, PSK, QPSK, QAM- Error Detection and Correction.

MODULE IV: NOISE AND MULTIPLEXING 9 Hours

Noise Sources and Noise Figure;Types of Noise and their effect on Signals; Time Division Multiplexing (TDM); Frequency Division Multiplexing (FDM); Orthogonal Frequency Division Multiple (OFDM)

MODULE V: EMERGING COMMUNICATION SYSTEMS 9 Hours

Introduction to Remote Communication Systems and Applications; Overview of MIMO Systems (Smart Antennas and Adaptive Beamforming Techniques); Basics of Software-Defined Radio (SDR) and its Significance; 5G Standards, 6G/ Terahertz Communication: Principles, Challenges, and Potential Applications.

Total No. of Hours:45

Text Books:

1. Simon Haykin, "Communication Systems", Wiley, 5th Edition, 2020
2. Sanjay Sharma, " Communication System: Analog and Digital", S.K. Katatia and Sons, 5th Edition, 2021
3. John G. Proakis, Massoud Salehi, " Fundamentals of Communication Systems", Pearson, 2nd Edition, 2020

Reference Books:

1. Bernard Sklar, " Digital Communications: Fundamentals and Applications", Pearson, 3rd Edition , 2021
2. Herbert Taub, Donald Schilling , " Principles of Communication Systems", McGraw Hill, 4th Edition,2020

Web References:

1. https://nptel.ac.in/courses/108104091
2. https://nptel.ac.in/courses/108104098
3. https://onlinecourses.nptel.ac.in/noc17_ec14/preview

Course Outcomes:

Upon successful completion of the course the student will have the ability to :

i. Explain the fundamental elements of communication systems and different types of transmission media
ii. Demonstrate analog modulation and demodulation techniques including AM,FM and PM.
iii. Apply digital modulation and demodulation techniques such as ASK, FSK and QAM including error detection and correction methods
iv. Analyse the effects of noise and explain multiplexing techniques in communication systems
v. Demonstrate emerging communication technologies such as remote systems and Software-Defined Radio(SDR)

OECE006	INTRODUCTION TO VLSI DESIGN	L	T	P	3 Credits
		3	0	0	

Course Objectives:

In this course, students will be able to:

i. Understand the fundamentals of VLSI systems and MOS transistor operation.

ii. Learn CMOS inverter and logic gate design principles including power and timing analysis.

iii. Gain knowledge of VLSI fabrication processes and design rules.

iv. Explore layout techniques, optimization, testing strategies, and EDA tools.

v. To study FPGA architecture, design flow, hardware-software co-design, and recent trends in VLSI technology.

Course Contents:

MODULE I : INTRODUCTION TO VLSI SYSTEMS **9 Hours**

Evolution of ICs and VLSI design flow; Applications of VLSI; MOS Transistor Basics: Threshold Voltage, I–V Characteristics; MOS Capacitances and Short-Channel Effects; Comparison of IC technologies: NMOS, CMOS, BiCMOS; Impact of Scaling on Delay, Power, Area and Cost.

MODULE II :CMOS LOGIC GATES **9 Hours**

CMOS Logic Gate Design: NAND, NOR, XOR, Transmission Gates; Power Dissipation Analysis (static and dynamic); Timing Analysis and Delay Calculation and Analysis; Noise Margin.

MODULE III: VLSI FABRICATION **9 Hours**

CMOS process flow: nMOS, pMOS, CMOS Fabrication; Design Rules and Scaling: Minimum Feature size, Lambda-Based rules, layout scaling; Parasitics in Interconnects: Capacitance, Resistance, Effects on Speed and Power; Yield and Defect density in IC Manufacturing.

MODULE IV: LAYOUT AND TESTING **9 Hours**

Layout Design Examples: Stick Diagrams, Layout Design Rules (Simple CMOS Gate), Area Estimation; Fault Models & Test Pattern Generation, Design for Testability (DFT), Built-in Self-Test (BIST); Layout Verification and Optimization Techniques; Layout Optimization for Low Power and High Speed; Introduction to EDA tools for layout and testing.

MODULE V: FPGA **9 Hours**

Introduction to FPGA Architecture (CLBs, IOBs, Routing Resources); FPGA Design Flow: HDL Coding, Simulation, Implementation; Hardware-Software Co-Design using FPGA; Applications: FPGA in AI accelerators, IoT devices; Recent trends in VLSI: Low-power design, 3D ICs, VLSI for IoT/A.

Total No of Lectures: 45

Text books:

1. Neil H.E. Weste, David Money Harris**, "**CMOS VLSI Design: A Circuits and Systems Perspective", 5th Edition, Pearson, 2023**.**

2 . Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic**,"**Digital Integrated Circuits: A Design Perspective", 3rd Edition, Pearson, 2023

Reference Books:

1. Douglas A. Pucknell, Kamran Eshraghian, "Basic VLSI Design", 4th Edition, PHI, 2022
2. S.M. Sze, " VLSI Technology ", 4th Edition, Mc Graw-Hill, 2021
3. Stephen Brown, Zvonko Vranesic, "Fundamentals of Digital Logic with VHDL Design", 5th Edition, McGraw-Hill, 2022

Web References:

- NPTEL Web Course: https://nptel.ac.in/courses/117106092
- NPTEL Video Course: https://nptel.ac.in/courses/108107129

Course Outcomes:

Upon successful completion of the course the student will have the ability to:

i. Explain the fundamentals of VLSI systems, MOS transistor operation, and IC technologies

ii. Design and analyze CMOS inverters with respect to switching performance, delay, noise margins, and power dissipation.

iii. Demonstrate VLSI fabrication processes, emerging technologies, and design rules

iv. Develop layouts, optimize performance, implement testing strategies and learn the usage of EDA tools

v. Implement FPGA designs, perform hardware-software co-design, and understand recent trends in VLSI technology.

MINOR Courses
For
Modern Communication SystemS

MECE001	CELLULAR AND WIRELESS COMMUNICATION	L	T	P	4 Credits
		3	1	0	

Course Objectives:

In this course, students will be able to:

i. Understand the fundamental mechanisms governing radio wave propagation in mobile environments.
ii. Know about the foundational Cellular Concept and the detailed architecture of GSM
iii. Gain insights about the principles and architecture of CDMA and its evolution into the 3G standard
iv. Understand the LTE (4G) standard, focusing on its architectural features and advanced physical layer techniques.
v. Introduce the motivations, core technologies and deployment scenarios of the 5G system.

Course Contents:

MODULE I: MOBILE RADIO PROPAGATION **9 Hours**

Three Basic Propagation Mechanisms: Reflection (Ground Reflection), Diffraction, Scattering; Large Scale propagation: Free Space Propagation Model, Two Ray Model, Relating Power to Electric Field; Small Scale propagation: Fading and Multipath, Delay Spread and Coherence Bandwidth, Doppler Spread and Coherence Time.

MODULE II: CELLULAR CONCEPT AND GSM **9 Hours**

Block diagram of Cellular System, Key Concepts in Cellular System; GSM: Significance, GSM System Architecture, GSM Channels, GSM System Operations, GSM Identities, Traffic cases.

MODULE III: CDMA TECHNOLOGY **9 Hours**

CDMA System Overview: Introduction, CDMA System Architecture, CDMA Channel Concepts, CDMA System (Layer 3) operations; WCDMA/UMTS: Importance, System Architecture, Services

MODULE IV: LTE (4G) **9 Hours**

Key Enablers for LTE 4G, LTE Network Architecture, Flat IP Architecture, Frame Structure, Resource Scheduling, OFDM, SC-FDE, SC-FDMA, Multi-Antenna Techniques, Timing and Frequency Synchronization, Peak to Average Power Ratio.

MODULE V: 5G **9 Hours**

Introduction to 5G, Evolving LTE to 5G Capability, 5G Standardization, 3GPP and IMT2020, Spectrum for 5G, 5G NR and 5G core network (5GCN), 5G deployment Options, 5G Use Cases.

Total No. of Hours:45

Text Books:

1. Theodore S. Rappaport, "Wireless Communications: Principles and Practice", Pearson, 2010.
2. Andreas F. Molisch, "Wireless Communications", Wiley, 2011.
3. Saad Z. Asif, "5G Mobile Communications Concepts and Technologies", CRC Press, 1st Edition, 2019.

Reference Books:

1. Arunabha Ghosh, Jan Zhang, Jefferey Andrews, Riaz Mohammed, "Fundamentals of LTE", Pearson education, 1st edition, 2018.
2. Harri Holma and Antti Toskala, "LTE for UMTS Evolution to LTE-Advanced", John Wiley and Sons, Ltd., 2nd Edition, 2018.
3. Mischa Dohler,Jose F. Monserrat, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016

Web References

1. https://onlinecourses.nptel.ac.in/noc24_ee05/preview
2. 5G PPP Initiative: https://5g-ppp.eu/
3. 6G Flagship Research: https://www.6gflagship.com/

Course Outcomes:

Upon successful completion of the course the student will have the ability to

i. Explain the phenomena of propagation mechanisms, fading and multipath propagation
ii. Describe the GSM and its architecture
iii. Explain the concept of CDMA and describe its system architecture,
iv. Describe the LTE Network Architecture and identify the key enablers that define 4G performance.
v. Describe the architecture of 5G NR and 5G Core Network (5GCN) and explains 5G deployment

MECE002	EMERGING TECHNOLOGIES IN WIRELESS NETWORKS	L	T	P	4 Credits
		3	1	0	

Course Objectives:

In this course, students will be able to:

i. Trace the historical evolution of Mobile Wireless Networks (1G to 5G) and understand the key characteristics of each generation
ii. Provide a conceptual understanding of the architectures and security issues related to widely deployed networks like Wi-Fi and WiMAX
iii. Introduce the architecture and protocols of the Internet of Things (IoT), explore dedicated WPWAN technologies, along with diverse IoT applications.
iv. Explore advanced network paradigms involving airborne platforms and the critical concepts of wireless power transfer and energy harvesting
v. Gain insight into various optimization techniques applied to wireless networks

Course Contents:

MODULE I: EVOLUTION OF WIRELESS NETWORKS **9 Hours**

Evolution: 1G (analog), 2G (digital voice), 3G (data), 4G (broadband), 5G (smart connectivity); Key performance indicators of each generation (bandwidth, latency, mobility); 6G vision: 6G paradigm shifts, 6G KPIs, Modulation, Channel Coding and Multiple Access for 6G (OFDM, OFDMA), 6G Coding Schemes (LDPC and Turbo Codes),6G Modulation Techniques, Candidate Waveform for 6G, use cases

MODULE II: WiFi and WiMAX NETWORK **9 Hours**

WiFi, WiMAX: System Architecture, Protocol stack, versions and services, Security issues for WiFi and WiMAX. (conceptual ideas)

MODULE III: INTERNET OF THINGS (IOT) AND LOW-POWER WAN (LPWAN) **9 Hours**

IoT: Challenges, Energy Constraints, IoT layered architecture and protocols (MQTT, CoAP); LPWAN technologies: Bluetooth, Zigbee, NB-IoT, LoRaWAN, Sigfox and Industrial IoT (IIoT), interoperability; Applications: healthcare, automotive, smart homes, agriculture

MODULE IV: AIRBORNE NETWORKS **9 Hours**

UAV-assisted and satellite-integrated wireless networks; Wireless power transfer and energy harvesting; Green communication and sustainability.

MODULE V: EMERGING TECHNOLOGIES **9 Hours**

Emerging paradigms: quantum communication, tactile internet; Optimization Techniques: AI in Resource Allocation, Routing of wireless networks (Conceptual ideas)

Total No. of Hours:45

Text Books

1. William Stallings, “Wireless Communications and Networks”, Pearson, 2005.
2. Vijay K. Garg, “Wireless Communications and Networking”, Morgan Kaufmann, 2010.
3. Gary Mullet, "Introduction to Wireless Telecommunications Systems and Networks", Cengage Learning India Pvt Ltd., 1st Edition, 2006

Reference Books

1. Afif Osseiran, “5G Mobile and Wireless Communications Technology”, CUP, 2016.
2. Theodore S. Rappaport, “Wireless Communications: Principles and Practice”, Pearson, 2010.
3. Andreas F. Molisch, “Wireless Communications”, Wiley, 2011.

Web References

1. http://www.digimat.in/nptel/courses/video/117102062/L01.html
2. LoRa Alliance (IoT Standards): https://lora-alliance.org/
3. 3GPP Mobile Standards: https://www.3gpp.org/

Course Outcomes:

By the end of this course, students will have the ability to:

i. Compare and contrast the five generations of wireless networks based on their core architecture and key performance indicators
ii. Describe the system architecture and protocol stack for both WiFi and WiMAX and identify the respective versions and standards defining them.
iii. Identify and explain the layers of the IoT architecture and describe the functionality of core IoT protocols like MQTT and CoAP.
iv. Explain the architecture and use cases of emerging Airborne networks, including UAV-assisted and satellite-integrated wireless networks.
v. Ooutline methods for network optimization, including techniques for routing and resource allocation, particularly those using Artificial Intelligence (AI).

MECE003	SATELLITE AND RADAR COMMUNICATION	L	T	P	4 Credits
		3	1	0	

Course Objectives:

This course will enable students to:

i. Study the fundamental elements of satellite communication.
ii. Know the architecture of satellite and earth station subsystems and satellite link budget design calculations.
iii. Explore major commercial and civil applications of satellite technology
iv. Introduce the basic configuration and operational principles of Radar.
v. Analyze advanced radar techniques used for MTI and Pulse Doppler Radar.

Course Contents:

MODULE I: SATELLITE FUNDAMENTALS AND ORBITAL MECHANICS 9 Hours
Elements of Satellite Communication, Orbital mechanics, look angle and orbit determination, orbital effects; Introduction to geo- synchronous and geo-stationary satellites.

MODULE II: SATELLITE SUB SYSTEMS AND LINK BUDGET DESIGN 9 Hours
Satellite sub-systems: Attitude and Orbit control systems, Telemetry, Tracking and command control system, Power supply system, Thrusters, spacecraft subsystem; earth station subsystem; Design of down link and uplink, design of satellite links for specified C/N.

MODULE III: DBS and GPS 9 Hours
Direct broadcast satellite television and radio, satellite navigation; Global positioning Systems (GPS): GPS position location principle, GPS receivers and codes, Satellite Signal Acquisition for GPS

MODULE IV: INTRODUCTION TO RADAR SYSTEMS 9 Hours
Radar block diagram and operation, radar frequencies; Radar Equation: Detection of signals in noise, SNR, Probabilities of detection and false alarm; Applications of radar.

MODULE V: ADVANCED RADAR TECHNIQUES 9 Hours
Tracking Radar: sequential lobbing, conical scan, mono-pulse tracking, low angle tracking, tracking in range; MTI and Pulse Doppler Radar: Block Diagram, Delay line cancellers, Staggered Pulse Reception Frequencies, Doppler Filter Banks, Digital MTI Processing, Moving Target Detector, Limitations

Total No. of Hours:45

Text Books:

1. Dennis Roddy, "Satellite Communications", McGraw Hill, 4th Edition, 2019.
2. Merrill I. Skolnik, "Introduction to Radar Systems", McGraw Hill, 3rd Edition, 2017.
3. B. Pratt, A. Polydoros, and M. Richharia, " Advanced Satellite Communications", CRC Press, 2001.

Reference Books:

1. Timothy Pratt, Charles Bostian, and Jeremy Allnutt, "Satellite Communications", Wiley, 2nd Edition, 2017.
2. M. Richharia, "Satellite Communications Systems: Design Principles", McGraw Hill, 1999.

Web References

https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ee114
https://nptel.ac.in/courses/117105131

Course Outcomes:

Upon successful completion of this course, students will have ability to:

i. Give an overview on various satellite orbits using principles of orbital mechanics.
ii. Identify and describe the operation of satellite subsystems.
iii. Explain the architecture and principle of DBS systems for television and radio.
iv. Explain the function of each block in a radar system.
v. Examine and compare different tracking radar methods.

MECE004	UNDERWATER COMMUNICATION	L	T	P	4 Credits
		3	1	0	

Course Objectives:

In this course, students will be able to:

i. Understand the significance and properties of underwater communication
ii. Explore underwater communication technologies.
iii. Study underwater network communication aspects, such as architectures, routing, multi-hop communication, and MAC protocols
iv. Examine real-world applications of underwater communication, including communication with AUVs, ROVs and underwater robotics
v. Investigate underwater communication security concerns and emerging trends.

Course Contents

MODULE I: INTRODUCTION TO UNDERWATER COMMUNICATION 9 Hours

Overview of underwater communication; importance, challenges and applications; Properties of water affecting communication: absorption, scattering, propagation; comparison of RF, acoustic and optical based underwater communication.

MODULE II: UNDERWATER COMMUNICATION TECHNOLOGIES 9 Hours

Underwater acoustics: wave properties, equations, and signal processing; optical communication in water: light propagation, modulation techniques, system design; Underwater Wireless Sensor Networks (UWSNs) architecture and protocols.

MODULE III: UNDERWATER NETWORK ARCHITECTURE 9 Hours

Network architecture: Challenges, topology, multi-hop communication; Routing and MAC protocols for underwater communication

MODULE IV: UNDERWATER COMMUNICATION APPLICATIONS 9 Hours

Communication with Autonomous Underwater Vehicles (AUVs) and Remotely Operated Vehicles (ROVs); environmental monitoring; military and defense applications.

MODULE V: SECURITY & EMERGING TRENDS 9 Hours

Security: Threats and encryption techniques; Emerging trends and future directions: underwater IoT and communication with drones; underwater robotics

Total No. of Hours:45

Text Books:

1. Richard, P.Hodges and Paul C.Etter , "Underwater Acoustics: Analysis, Design, and Performance of Sonar", Wiley, 1st Edition, 2010
2. Yi Lou, Niaz Ahmed, "Underwater Communications and Networks", Springer, 1st Editon, 2022.

Reference Books:

1. Robert Istepanian& Milica Stojanovic, "Underwater Acoustic Digital Signal Processing and Communication Systems", Springer, 2nd Edition, 2010
2. Kristian Werth, Robert W. Heath & Milica Stojanovic, "Underwater Acoustic Networking Techniques", Wiley, 1st Edition, 2012
3. Yang Xiao & Jun-Hong Cui, "Underwater Acoustic Sensor Networks: Current Status and Future Trends", CRC Press, 2nd Edition, 2014

Web References

https://nptel.ac.in/courses/108106588
https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ee61

Course Outcomes:

On successful completion of this course, students will have the ability to:

i. Understand underwater communication principles and challenges
ii. Analyze acoustic, optical, and UWSN technologies
iii. Evaluate network architectures and protocols
iv. Apply communication in AUVs, ROVs, and monitoring
v. Assess security and emerging trends.

Courses for HONORS Degree in Computational Signal and Visual Intelligence

HECE131	DIGITAL SIGNAL PROCESSING ARCHITECTURE	L	T	P	4 Credits
		3	1	0	

Course Objectives:

In this course, students will be able to

i. Understand in detail, the Digital Signal Processing architectures
ii. Study various processor elements and various instruction sets.
iii. Explore various memory strategies in DSP systems.
iv. Understand the code optimization techniques for real time implementation.
v. Explore the various Advanced Digital Signal processing platforms .

Course Contents:

MODULE I: FUNDAMENTALS OF DSP ARCHITECTURES 9 Hours

Overview of Digital Signal Processing; Von Neumann vs. Harvard architecture differences; DSP system components: ALU, MAC, registers, control unit - Pipelining and instruction parallelism in DSP; Popular DSP processors (TI C6000, ARM Cortex-M, SHARC) - Fixed-point vs. floating-point DSP architectures

MODULE II: PROCESSOR ELEMENTS AND INSTRUCTION SETS 9 Hours

Functional units: ALU, multiplier, accumulator, shifters; Instruction pipelining and execution stages; Addressing modes for DSP: direct, indirect, circular buffers; DSP assembly language programming and instruction optimization; Software tools for DSP programming and debugging.

MODULE III: MEMORY AND I/O ARCHITECTURES 9 Hours

On-chip and external memory mapping strategies; Memory hierarchy and cache in DSP systems; Direct Memory Access (DMA) and peripheral interfacing; Input/Output peripherals: A/D and D/A converters, timers; Interrupt handling and context switching in DSP processors - Memory optimization techniques for real-time DSP applications.

MODULE IV: REAL-TIME IMPLEMENTATION AND OPTIMIZATION 9 Hours

Code optimization techniques: speed vs. memory trade-offs; Parallelism: SIMD, VLIW, and multicore DSP architecture; Efficient implementation of FFT, filtering, and convolution; Real-time audio, speech, and image processing applications using DSP processors.

MODULE V: ADVANCED DSP PLATFORMS AND EMERGING TRENDS 9 Hours

FPGA-based DSP system design and implementation; GPU acceleration and heterogeneous computing for DSP; Low-power DSP architectures for IoT and edge devices; AI-enabled DSP and hardware accelerators; Reconfigurable and multicore DSP processors; Future trends and research directions in high-performance DSP.

Total No. of Hours: 45

Text Books:

1. B. Venkataramani and M. Bhaskar, "Digital Signal Processors: Architecture, Programming and Applications", McGraw Hill, 3rd Edition, 2023.
2. Naim Dahnoun, Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK, Wiley, 2nd Edition, 2023.

Reference Books:

1. Rulph Chassaing & Donald Reay, "Digital Signal Processing and Applications with the C6713 and C6416 DSK", Wiley, Updated Edition, 2022.
2. Uwe Meyer-Baese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer, 5th Edition, 2022.
3. Yoshifumi Nishio (Ed.), "Advances in DSP: Algorithms, Architectures, and Applications", Springer, 1st Edition, 2023.

Web References:

1. NPTEL: https://onlinecourses.nptel.ac.in/noc19_ee70/preview?utm_source
2. NPTEL: https://nptel.ac.in/courses/108105118?utm_source

Course Outcomes:

Upon successful completion of this course, students will have the ability to:

i. Analyse the DSP processor architectures.
ii. Develop assembly and high-level DSP programs for real-time tasks.
iii. Optimize memory and code for performance on DSP hardware.
iv. Interface DSP processors with memory, I/O, and peripherals efficiently.
v. Explore emerging DSP platforms including FPGA, GPU, and AI accelerators.

HECE142	MACHINE LEARNING AND DEEP LEARNING FOR IMAGE PROCESSING	L	T	P	4 Credits
		3	1	0	

Course Objectives:

In this course, students will be able to:

i. Introduce the fundamentals of Machine Learning and Deep Learning for Image processing
ii. Familiarize students with classical ML algorithms and their applications in image classification.
iii. Develop understanding of Deep Neural Networks and CNNs
iv. Explore advanced Deep Learning based techniques for image segmentation, generation, and restoration.
v. Provide exposure to real-world applications and ethical considerations in ML/DL for image processing.

Course Contents:

MODULE I: FUNDAMENTALS OF MACHINE LEARNING & IMAGE PROCESSING 9 hours

Introduction to Machine Learning (ML) and Deep Learning (DL);Types of Machine Learning: Supervised, Unsupervised, Reinforcement Learning; Overview of Image Processing: Basics and applications Data representation for images: Pixels, Color spaces (RGB, HSV, Grayscale);Image pre- processing techniques: Filtering, normalization, resizing, augmentation-Feature extraction basics: Edges and corners.

MODULE II: CLASSICAL MACHINE LEARNING METHODS FOR IMAGE PROCESSING9 hours

Review of classical ML algorithms: KNN, SVM, Decision Trees, Random Forests; Applying ML models to image classification and object detection , automatic feature learning; Case studies: Handwritten digit recognition (MNIST) using SVM and k-NN Clustering in images: K-means, Mean-shift for segmentation; Limitations of classical ML in image processing tasks.

MODULE III: INTRODUCTION TO DEEP LEARNING AND CNNS 9 hours

Basics of Neural Networks (NN)-Activation functions, loss functions, backpropagation- Convolutional Neural Networks (CNNs) fundamentals: convolution, pooling, fully connected layers-Popular CNN architectures overview (LeNet, Alex-Net, VGG).

MODULE IV: ADVANCED DEEP LEARNING FOR IMAGE PROCESSING 9 hours

Object detection and localization: R-CNN, Fast R-CNN, YOLO, SSD; Semantic and instance segmentation: Fully Convolutional Networks (FCN), U-Net, Mask R CNN; Generative models: Autoencoders, Variational Autoencoders (VAE), GANs basics-Image enhancement and restoration using DL (denoising, super-resolution).

MODULE V: APPLICATIONS AND TRENDS IN IMAGE PROCESSING WITH ML/DL 9 hours

Advanced applications: Medical imaging, autonomous driving, facial recognition, surveillance; Emerging trends: Self-supervised learning, Vision Transformers (ViT); Ethical considerations and bias in image datasets.

Total No. of Hours: 45

Text Books:

1. Ian Goodfellow, Yoshua Bengio, Aaron Courville, "Deep Learning", MIT Press, 1st Edition, 2016.
2. Arya, K. V., Rodriguez Rodriguez, C., Singh, S., & Singhal, *"*Artificial Intelligence and machine learning techniques in image processing and computer vision*"* Apple Academic Press,2024.

Reference Books:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications, Springer, 2nd Edition, 2022
2. Simon J.D. Prince, "Computer Vision: Models, Learning, and Inference", Cambridge University Press, 1st Edition, 2012.
3. Mark S. Nixon, Alberto S. Aguado, "Feature Extraction & Image Processing for Computer Vision", Academic Press, 4th Edition, 2019.
4. Mohamed Elgendy, "Deep Learning for Vision Systems", Manning Publications, 1st Edition, 2020.
5. Singh, H. . "Practical machine learning and image processing: For facial recognition, object detection, and pattern recognition using Python" , Apple Academic press,2 019.

Web References:

1. NPTEL – Deep Learning, Prof. B. Ravindran, IIT Madras.
2. NPTEL – https://nptel.ac.in/courses/106106198.

Course Outcomes:

Upon successful completion of this course, students will have the ability to:

i. Analyse various image data representations, preprocessing methods, and feature extraction techniques.
ii. Apply classical ML algorithms such as k-NN, SVM, and clustering methods to solve basic image processing tasks.
iii. Design and implement CNN-based models for image classification and recognition using standard architectures.
iv. Apply advanced DL models (R-CNN, YOLO, U-Net, GANs, etc.) for detection, segmentation, enhancement, and generation tasks.
v. Evaluate and deploy ML/DL solutions in real-world applications like medical imaging, autonomous driving, and facial recognition while considering ethical and societal impacts.

HECE153	SPEECH PROCESSING	L	T	P	4 Credits
		3	1	0	

Course Objectives:

In this course, students will be able to:

i. Introduce the fundamentals of speech production mechanisms, auditory perception, and speech signal characteristics.
ii. Familiarize students with time-domain and frequency-domain techniques for analyzing speech.
iii. Develop understanding of linear predictive and statistical models for speech coding, recognition, and synthesis.
iv. Explore various speech coding standards, enhancement techniques, and speech synthesis methods.
v. Provide exposure to advanced applications of speech processing using deep learning models and emerging technologies.

Course Contents:

MODULE I: FUNDAMENTALS OF SPEECH PRODUCTION AND PERCEPTION 9 Hours

Speech production mechanism: vocal tract, excitation models, articulators; Acoustic phonetics: vowels, consonants, phonemes and prosody; Speech signal characteristics: non-stationarity, short-time analysis, sampling; Auditory perception and psychoacoustics: critical bands, masking effects; Case studies: human speech vs. synthetic speech

MODULE II: TIME AND FREQUENCY DOMAIN ANALYSIS OF SPEECH 9 Hours

Short-Time Energy (STE), zero-crossing rate, pitch period estimation, Autocorrelation and AMDF methods; Fourier analysis of speech: Spectrograms, Short-Time Fourier transform (STFT) , Cepstrum analysis and homomorphic processing; Applications: pitch detection, voiced/unvoiced classification, prosody analysis

MODULE III: LINEAR PREDICTIVE AND STATISTICAL MODELS 9 Hours

Linear Predictive Coding (LPC): theory, coefficient estimation, all-pole modelling ; Formant analysis: estimation, tracking, and speech synthesis; Vector quantization, hidden Markov models (HMM) for speech recognition; Gaussian Mixture Models (GMM) and statistical learning approaches - Applications: speech compression, speaker verification, coding standards.

MODULE IV: SPEECH CODING, SYNTHESIS, AND ENHANCEMENT 9 Hours

Waveform coding: PCM, ADPCM, delta modulation; Vocoder methods: channel, formant, and LPC vocoders , CELP, MELP and low-bit-rate speech coding; Speech enhancement: spectral subtraction, Wiener filtering, MMSE estimators; Text-to-Speech (TTS) systems and parametric speech synthesis.

MODULE V: ADVANCED APPLICATIONS AND EMERGING TRENDS 9 Hours

Automatic Speech Recognition (ASR): feature extraction (MFCC, PLP), DNN-based models ; Speaker recognition and speaker diarization ; Speech in multimedia and telecommunications (VoIP, mobile, codecs); Emerging applications: voice assistants.

Total No. of Hours: 45

Text Books:

1. Daniel Jurafsky & James H. Martin, "Speech and Language Processing: An Introduction to NLP, Computational Linguistics, and Speech Recognition with Language Models", Pearson/Prentice Hall, 3rd Edition, 2025.
2. Zhang, Y. et al., "Speech Signal Processing Based on Deep Learning in Complex Acoustic Environments", Elsevier, 1st Edition, 2024.

Reference Books:

1. Mourad Abbas (Ed.), Analysis and Application of Natural Language and Speech Processing (Signals & Communication Technology Series), Springer, 1st Edition, 2023.
2. X. Huang, A. Acero, H. Hon, Spoken Language Processing: A Guide to Theory, Algorithm, and System Development, Latest Reprint, Prentice Hall, 2023.
3. Sadaoki Furui, Digital Speech Processing, Synthesis, and Recognition,), CRC Press, 2nd Edition, Revised Printing 2022.

Web References:

1. NPTEL: https://nptel.ac.in/courses/117105145
2. NPTEL: https://www.nptelprep.in/courses/117105145

Course Outcomes:

Upon successful completion of this course, students will have the ability to:

i. Analyze the mechanisms of human speech production, acoustic phonetics, and auditory perception.
ii. Apply time-domain and frequency-domain methods such as STE, ZCR, STFT and cepstrum for speech feature analysis.
iii. Implement LPC-based analysis, formant tracking, HMMs, and GMMs for speech recognition, coding, and verification.
iv. Design and evaluate speech coding and enhancement techniques including vocoders, CELP, and Wiener filtering.
v. Apply advanced speech processing methods such as MFCC, RNNs, LSTMs, and Transformers for ASR, speaker recognition, and modern applications like TTS and speech-to-text systems.

HECE164	STATISTICAL DIGITAL SIGNAL PROCESSING	L	T	P	4 Credits
		3	1	0	

Course Objectives:

In this course, students will be able to:

i. Introduce the fundamentals of random processes and their characterizations.
ii. Unerstand estimation techniques and performance bounds for parameter estimation in noisy environments.
iii. Explore detection strategies for signals under uncertainty using hypothesis testing approaches.
iv. Study parametric and non-parametric methods for spectral estimation of signals.
v. Learn adaptive filtering algorithms and Kalman filtering techniques for real-time signal processing applications.

Course Contents:

MODULE I: INTRODUCTION **9 Hours**

Convolution, DFT and ZT; FIR and IIR Filtering - a qualitative review, Stationary random processes, Autocorrelation, Filtering Random Process, Spectral Factorization, Rational power spectra - Yule Walker's equations.

MODULE II: ESTIMATION THEORY **9 Hours**

Non-Bayesian Estimation: Estimator Properties, Unbiasedness, minimum variance, efficiency, Sufficient statistics, Cramer-Rao bound; Estimation Method: Maximum Likelihood Estimation (MLE) and its properties; Bayesian Estimation: Minimum Mean Square Error (MMSE) and Maximum a Posteriori (MAP) estimation

MODULE III: DETECTION THEORY **9 Hours**

Binary hypothesis testing, Neyman-Pearson criterion, Likelihood ratio test (LRT), Receiver Operating Characteristic (ROC) curves, Bayesian detection, Detection in Gaussian noise; Matched filtering

MODULE IV: POWER SPECTRUM ESTIMATION **9 Hours**

Estimation of spectra using the DFT from finite duration signals, non– parametric methods for power spectrum estimation: Welch- Bartlett methods; Parametric methods for power spectrum estimation: Yule-Walker method, Linear Prediction: Forward and Backward Linear Prediction-Burg method for the ARM parameters.

MODULE V: ADAPTIVE FILTERING **9 Hours**

Wiener filters for filtering and prediction – FIR Wiener Filter – IIR Wiener Filter. adaptive filters – adaptive filters based on steepest descent method – LMS algorithm – Variants of LMS algorithm – adaptive noise cancellation – adaptive channel equalization.

Total No. of Hours: 45

Text Books:

1. Monson H. Hayes , "Statistical Digital Signal Processing and Modeling", Wiley India, 2nd Edition, 2017.
2. Steven M. Kay, "Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory", Prentice Hall, 1993.
3. Kan Li, Jose C. Principe, "Spectral Eigenfunction Decomposition for Kernel Adaptive Filtering", arXiv Preprint, 2025.

Reference Books:

1. Steven M. Kay, "Fundamentals of Statistical Signal Processing, Volume II: Detection Theory", Prentice Hall, 1998.
2. Simon Haykin , "Adaptive Filter Theory", Pearson, 5th Edition, 2013.
3. Dimitris G. Manolakis, Vinay K. Ingle, "Applied Digital Signal Processing: Theory and Practice", Cambridge University Press, 1st Edition, 2011.
4. P. P. Vaidyanathan, " Multirate Systems and Filter Banks", Pearson, 1st Edition, 2006.

Web References:

1. NPTEL – Statistical Signal Processing, Prof. Rajesh Hegde, IIT Kanpur.
2. NPTEL – Digital Signal Processing, Prof. Ramesh Babu, IIT Madras.

Course Outcomes:

On successful completion of this course, students will have the ability to:

i. Analyze stationary random processes, autocorrelation functions, and rational power spectra using statistical DSP tools.
ii. Design estimators and evaluate their performance using MLE, MMSE, MAP, and Cramer-Rao bounds.
iii. Apply likelihood ratio tests, ROC analysis, and matched filtering for reliable detection of signals in Gaussian noise.
iv. Apply and compare power spectrum estimation techniques using DFT, Welch, Bartlett, Yule–Walker, and Burg methods.
v. Design and implement Wiener, LMS, and Kalman filters for applications such as prediction, noise cancellation, and channel equalization.

Courses for HONORS Degree in Quantum Technologies

HECE231	QUANTUM COMPUTING	L	T	P	4 Credits
		3	1	0	

Course Objectives:

In this course, students will be able to:

i. Establish strong foundations of quantum mechanics and information theory for computation.
ii. Analyze quantum gates, circuits, and mathematical models of quantum computation.
iii. Implement and evaluate key quantum algorithms for search, factorization, and optimization.
iv. Study error correction, decoherence, and fault-tolerant approaches in real hardware platforms.
v. Explore emerging applications in quantum programming, quantum machine learning, and hybrid quantum–classical computing.

Course Contents:

MODULE I: QUANTUM INFORMATION AND QUBITS 9 Hours

Postulates of quantum mechanics relevant to computation; Qubits, Bloch sphere, multi- qubit systems, entanglement; Tensor product spaces, density matrices, and mixed states; Measurement theory and quantum parallelism; Complexity classes: P, NP, BQP.

MODULE II: QUANTUM GATES AND CIRCUIT MODEL 9 Hours

Universal quantum gates: Pauli, Hadamard, Phase, T, CNOT, Toffoli; Circuit depth, decomposition, and optimization; Reversible computation and quantum universality; Clifford group and stabilizer circuits - Case studies: simple algorithms on simulators (Qiskit, Cirq).

MODULE III: QUANTUM ALGORITHMS 9 Hours

Deutsch–Jozsa and Simon's algorithm; Grover's search and amplitude amplification; Shor's factoring algorithm and quantum Fourier transform; Phase estimation, HHL algorithm for linear systems; Variational algorithms: VQE, QAOA, quantum-enhanced optimization.

MODULE IV: QUANTUM ERROR CORRECTION AND HARDWARE 9 Hours

Quantum noise models: bit-flip, phase-flip, depolarizing, amplitude damping; Quantum error correction codes: Shor, Steane, Surface codes; Fault-tolerant quantum computation; Hardware platforms: superconducting circuits, trapped ions, photonic qubits, spin qubits, topological qubits ; NISQ era limitations, error mitigation strategies.

MODULE V: QUANTUM PROGRAMMING AND EMERGING DIRECTIONS 9 Hours

Quantum programming languages: Qiskit, Cirq, Q#, Pennylane - Hybrid quantum; classical algorithms: Quantum machine learning (QML) and quantum data, Cloud quantum platforms (IBM Quantum,Google Sycamore, Amazon Braket); Future roadmaps: National Quantum Mission (India), EU Quantum Flagship, US QIS, post-NISQ research challenges.

Total No. of Hours: 45

Text Books:

1. Michael A. Nielsen & Isaac L. Chuang, "Quantum Computation and Quantum Information",

10th Anniversary Edition, Cambridge University Press, 2024.
2. Phillip Kaye, Raymond Laflamme, Michele Mosca, "An Introduction to Quantum Computing", Oxford University Press, Reprint 2023.

Reference Books:

1. Jack D. Hidary, "Quantum Computing: An Applied Approach", Springer, 2nd Edition, 2024.
2. Mark M. Wilde, "Quantum Information Theory", Cambridge University Press, 2nd Edition, 2022.
3. Eleanor G. Rieffel & Wolfgang Polak, "Quantum Computing: A Gentle Introduction", Reprint, MIT Press, 2023.
4. Ronald de Wolf, "Quantum Computing: Lecture Notes", arXiv, 2022.

Web References:

1. NPTEL – Introduction to Quantum Computing (IIT Roorkee / IIT Madras)
2. NPTEL – Quantum Algorithms and Cryptography (IIT Madras)

Course Outcomes:

Upon successful completion of this course, students will have the ability to :

i. Apply quantum mechanics to model qubits and multi-qubit systems.
ii. Design and optimize universal quantum circuits.
iii. Implement quantum algorithms (Grover, Shor, HHL, variational methods).
iv. Evaluate error correction strategies and hardware realizations in the NISQ era.
v. Develop quantum programs on cloud-based platforms and assess future research directions.

HECE242	QUANTUM COMMUNICATION	L	T	P	4 Credits
		3	1	0	

Course Objectives:

In this course , students will be able to

i. Establish the theoretical foundations of Quantum Mechanics for communication.
ii. Analyze various protocols of Quantum Key Distribution (QKD), quantum cryptography beyond classical limits.
iii. Study quantum channels, noise models, Quantum Teleportation, and entanglement-based communication.
iv. Evaluate practical implementations of quantum communication over optical fibers and free-space links.
v. Explore emerging research directions in national/global quantum communication networks.

Course Contents:

MODULE I: FUNDAMENTALS OF QUANTUM COMMUNICATION 9 Hours

Postulates of quantum mechanics relevant to communication; qubits, entanglement, no- cloning theorem; Quantum vs classical communication; superdense coding ; Quantum measurement, uncertainty principle, and secure information transfer ; Bell states, CHSH inequality and EPR paradox Information; theoretic security and quantum advantage.

MODULE II: QUANTUM KEY DISTRIBUTION & CRYPTOGRAPHY 9 Hours

BB84, B92, E91 protocols, theory and implementation; Security proofs of QKD against eavesdropping (intercept–resend, photon-number-splitting), Entanglement-based QKD, Ekert protocol; Device-independent QKD and measurement-device-independent QKD; Practical QKD systems in optical fiber and free space.

MODULE III: QUANTUM CHANNELS & COMMUNICATION COMPLEXITY 9 Hours

Quantum noise and decoherence in communication channels; Quantum channel capacity and Holevo's theorem; Quantum error correction in communication; Quantum teleportation protocol and entanglement swapping ; Quantum communication complexity and applications.

MODULE IV: HARDWARE PLATFORMS AND QUANTUM NETWORKS 9 Hours

Photonic qubits for communication: polarization, time-bin, orbital angular momentum; Quantum repeaters: necessity, architecture, and entanglement purification; Free-space quantum communication and ground-to-satellite links ; Experimental demonstrations: Micius satellite, DARPA quantum network; Quantum internet architectures and trusted node models.

MODULE V: EMERGING DIRECTIONS AND NATIONAL MISSIONS 9 Hours

Continuous-variable quantum communication; Quantum-Secure Direct Communication (QSDC) ; Quantum internet protocols and entanglement distribution at scale ; National Quantum Mission (India); Quantum key distribution networks ; EU Quantum Internet Alliance, US DOE Quantum Networks, global roadmap for quantum communication.

Total No. of Hours: 45

Text Books:

1. Nicolas Gisin, Grégoire Ribordy, Wolfgang Tittel, Hugo Zbinden, "Quantum Cryptography and Quantum Communication", Cambridge University Press, Reprint, 2023.
2. M. Nielsen & I. Chuang, "Quantum Computation and Quantum Information", 10th Anniversary Edition, Cambridge University Press, 2024.

Reference Books:

1. Rodney Van Meter, "Quantum Networking", Wiley-IEEE Press, 2022.
2. Mark M. Wilde, "Quantum Information Theory", Cambridge University Press, 2nd Edition, 2022.
3. Alexander Holevo, "Quantum Systems, Channels, Information: A Mathematical Introduction", De Gruyter, 2023.
4. Eleni Diamanti & Anthony Leverrier, "Practical Security of Quantum Cryptography", Springer, 2022.

Web References:

1. NPTEL – Quantum Cryptography and Communication (IIT Madras / IIT Roorkee).
2. NPTEL – Quantum Information and Computation (IIT Bombay).

Course Outcomes:

Upon successful completion of this course, students will have the ability to:

i. Apply principles of quantum mechanics to model secure communication systems.
ii. Design and analyze QKD protocols and quantum cryptographic schemes.
iii. Evaluate quantum channels, teleportation, and entanglement distribution.
iv. Assess hardware platforms and quantum network architectures for real-world implementation.
v. Explore future directions in quantum internet and national/global quantum communication initiatives.

HECE253	QUANTUM SENSING	L	T	P	4 Credits
		3	1	0	

Course Objectives:

In this course, students will be able to:

i. Establish the theoretical foundations of quantum metrology and quantum-enhanced measurements.
ii. Study the quantum optical and atomic clocks, squeezing, and quantum coherence in high- precision sensing.
iii. Study quantum sensors for time, frequency, precision and gravitational field measurements.
iv. Evaluate error sources and quantum error mitigation in real-world quantum sensing systems.
v. Explore emerging directions such as quantum radar, biomedical sensing, and integration with quantum networks.

Course Contents:

MODULE I: FUNDAMENTALS OF QUANTUM METROLOGY 9 Hours

Basics of classical vs quantum measurement limits shot noise and Heisenberg limit; Quantum Fisher information and Cramér–Rao bound; Role of superposition, entanglement, and squeezing in sensing ; Quantum resources for enhanced sensitivity; Quantum-enhanced imaging and spectroscopy.

MODULE II: QUANTUM OPTICAL AND ATOMIC SENSORS 9 Hours

Squeezed light in interferometry, applications in LIGO; Atomic clocks: principles, performance metrics, and optical lattice clocks; Quantum magnetometers: NV centers in diamond, atomic vapor cells; Quantum gyroscopes and accelerometers; Frequency standards and precision timekeeping.

MODULE III: QUANTUM SENSING PLATFORMS 9 Hours

Superconducting qubits for sensing microwave fields; Trapped ions and ultracold atoms for precision measurement; Quantum optomechanics and force sensing; Photonic integrated quantum sensors; Noise sources and decoherence in quantum sensors.

MODULE IV: ADVANCED QUANTUM SENSING TECHNIQUES 9 Hours

Quantum error mitigation in sensing; Spin squeezing and entanglement-enhanced interferometry; Quantum non-demolition measurements; Quantum radar and quantum illumination protocols; Quantum sensing networks and distributed quantum metrology.

MODULE V: APPLICATIONS AND GLOBAL ROADMAPS 9 Hours

Quantum sensors for biomedical imaging and brain activity monitoring; Geophysical applications: underground mapping, mineral exploration, navigation; Space-based quantum sensors: gravity wave detection, satellite navigation; National Quantum Mission (India); quantum metrology goals; Global initiatives: EU Quantum Flagship, US Quantum Sensing Programs, UK Quantum Technologies Roadmap.

Total No. of Hours: 45

Text Books:

1. C. L. Degen, F. Reinhard, P. Cappellaro, "Quantum Sensing, Reviews of Modern Physics", Updated Edition, 2023.
2. Daniel D. Awschalom, Ronald Walsworth, "Principles of Quantum Sensing", Springer, 2024.

Reference Books:

1. Vlatko Vedral, "Introduction to Quantum Metrology", Oxford University Press, 2023.
2. Mark G. Raizen & Hidetoshi Katori, "Quantum Metrology and Fundamental Constants", Springer, 2022.
3. M. G. Paris & J. Rehacek, "Quantum State Estimation and Metrology", Springer, 2023 Reprint.
4. National Academies of Sciences, "Quantum Sensing and Metrology: Science and Applications", National Academies Press, 2023.

Web References:

1. NPTEL – Quantum Measurement and Quantum Metrology (IIT Bombay / IISc Bangalore).
2. NPTEL – Quantum Technologies and Applications (IIT Madras).

Course Outcomes:

Upon successful completion of this course, students will have the ability to:

i. Apply quantum mechanical principles to metrology and sensing.
ii. Analyze Quantum magnetometers and accelerometers along with enhancement strategies.
iii. Evaluate quantum sensors for time, frequency, magnetic, and inertial measurements.
iv. Assess practical implementations on quantum error mitigation with distributed topology considerations.
v. Explore global initiatives and emerging applications of quantum sensing in science, industry, and healthcare.

HECE264	AI In Quantum Technology	L	T	P	4 Credits
		3	1	0	

Course Objectives:

In this course, students will be able to:

i. Establish the foundations of AI in relevance to quantum systems.
ii. Analyze how AI enhances quantum hardware design, error mitigation, and algorithm optimization.
iii. Explore Quantum Machine Learning (QML) frameworks and hybrid quantum–classical approaches.
iv. Evaluate AI-driven applications in quantum communication, sensing, and simulation.
v. Study emerging directions in quantum–AI synergy for national and global technological missions.

Course Contents:

MODULE I: INTRODUCTION TO AI AND QUANTUM SYNERGY 9 Hours

Fundamentals of AI, ML, and deep learning in scientific computing; Overview of quantum technologies (computing, communication, sensing); Role of AI in quantum control, calibration, and optimization; Hybrid quantum–classical computing paradigm; Case studies: AI-assisted quantum circuit design.

MODULE II: QUANTUM MACHINE LEARNING MODELS 9 Hours

Variational quantum circuits for ML (VQE, QAOA); Quantum kernels and support vector machines; Quantum Boltzmann machines and quantum-inspired neural networks; Data encoding strategies: amplitude, angle, and basis encoding; Applications in classification, clustering, and generative modeling.

MODULE III: AI FOR QUANTUM HARDWARE AND ERROR MITIGATION 9 Hours

Reinforcement learning for quantum gate control; AI-driven error mitigation and noise characterization; Neural network approaches, quantum error correction; AI-assisted design of quantum hardware (superconducting, trapped-ion, photonic platforms); Adaptive AI strategies for NISQ-era devices.

MODULE IV: AI IN QUANTUM COMMUNICATION AND SENSING 9 Hours

AI-enhanced quantum key distribution and cryptographic security analysis; Machine learning for entanglement distribution and repeater optimization; AI for quantum imaging, biomedical quantum sensing, and radar; Quantum-enhanced learning: using entanglement in data-driven models; Case studies: AI-optimized free-space QKD and NV-diamond sensors.

MODULE V: EMERGING RESEARCH AND ROADMAPS 9 Hours

AI for scalable quantum network design and quantum internet; Quantum reinforcement learning and quantum AI agents; Integration with high-performance computing (HPC) and cloud quantum platforms ; National Quantum Mission (India): AI for quantum technologies; Global initiatives: EU Quantum Flagship, US QIS program, AI; Quantum convergence roadmaps.

Total No. of Hours: 45

Text Books:

1. Maria Schuld & Francesco Petruccione, "Supervised Learning with Quantum Computers", Springer, 2023.
2. Vedran Dunjko & Hans Briegel, "Machine Learning and Artificial Intelligence in Quantum Technologies", Cambridge University Press, 2024.

Reference Books:

1. Jack Hidary, "Quantum Computing: An Applied Approach", 2nd Edition, Springer, 2024.
2. Patrick Rebentrost & Seth Lloyd, "Quantum Machine Learning", MIT Press, 2023.
3. Jelena Lukic et al., "AI for Quantum: From Control to Applications", IEEE-Wiley, 2023.

Web References:

1. NPTEL – Quantum Machine Learning (IIT Madras / IISc Bangalore).
2. NPTEL – Artificial Intelligence for Quantum Systems (IIT Roorkee).

Course Outcomes:

Upon successful completion of this course, students will be able:

i. Apply AI techniques to quantum computing, communication, and sensing.
ii. Design and implement QML algorithms for classification, optimization, and learning tasks.
iii. Evaluate AI strategies for quantum hardware calibration and noise mitigation.
iv. Integrate AI with quantum communication protocols and sensing systems.
v. Explore global research directions in AI–Quantum synergy for next-generation technologies.

Courses for HONORS Degree in VLSI DESIGN

HECE331	MOSFET FUNDAMENTALS AND ANALOG CIRCUIT DESIGN	3 L : 0 T : 0 P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Learn the operation, modeling, and characteristics of MOS transistors used in analog ICs.
ii. Develop and analyze current mirrors and reference circuits for stable analog operation.
iii. Study the frequency response of single-stage, multistage, and differential amplifiers.
iv. Explore operational amplifier architectures and frequency compensation techniques
v. Analyze the performance trade-offs such as gain, bandwidth, noise, and stability in integrated analog circuit design.

MODULE I: MOSFET FUNDAMENTALS AND ANALOG DESIGN BASICS 9 Hours

Review of semiconductor basics and MOS transistor operation regions, MOSFET: structure, threshold voltage, and body effect, I–V characteristics and channel-length modulation, Small-signal and large- signal models of MOSFETs, Transconductance, output resistance, intrinsic gain, and bias point selection, Biasing techniques: self-bias, current-source biasing, and current mirror biasing.

MODULE II: CURRENT MIRRORS AND REFERENCE CIRCUITS 9 Hours

Basic current mirror: operation, compliance, and gain, Wilson and Widlar current mirrors for improved performance, Cascade current mirror and high output resistance design; Current steering circuits and active load design; Bandgap reference circuits: principle and temperature compensation; Biasing networks for analog building blocks and startup circuits

MODULE III: SINGLE-STAGE AND MULTISTAGE AMPLIFIERS 9 Hours

Common-source amplifier with resistive and active loads, Source follower and common-gate amplifiers : Design and Analysis: Gain, bandwidth, input/output resistance, and distortion. Active load design for high gain and high output swing, Multistage amplifier design and gain–bandwidth trade-offs, Frequency response, dominant pole analysis and compensation.

MODULE IV: DIFFERENTIAL AND OPERATIONAL AMPLIFIERS 9 Hours

Differential pair operation: resistive vs. active loads, Differential gain, common-mode gain and CMRR enhancement; Current mirror load and tail current source design, Two-stage CMOS operational amplifier design and small-signal analysis, Frequency compensation and stability improvement methods, Design parameters: offset voltage, slew rate, unity-gain bandwidth, and phase margin.

MODULE V: FREQUENCY RESPONSE, FEEDBACK, AND STABILITY 9 Hours

Low- and high-frequency response of amplifiers and poles/zeros identification, Miller effect, parasitic capacitance, and bandwidth limitations; Feedback topologies: voltage/current feedback and stability implications, Frequency compensation: single-pole and lead–lag techniques, Stability analysis using Bode plots, gain margin and phase margin; Slew rate, noise–bandwidth trade-offs and feedback noise analysis.

Total No. of Hours: 45

Text Books

1. Behzad Razavi**, "**Design of Analog CMOS Integrated Circuits", 2nd Edition, McGraw Hill, 2nd Edition, 2017.
2. Gray, Hurst, Lewis & Meyer**,** *"*Analysis and Design of Analog Integrated Circuits*"*, Wiley, 5th Edition, 2024

Reference Books

1. David A. Johns & Ken Martin, "Analog Integrated Circuit Design" , Wiley, 2nd Edition, 2011.
2. Phillip E. Allen & Douglas R. Holberg, "CMOS Analog Circuit Design", Oxford University Press, 3rd Edition, 2011.
3. R. Jacob Baker, CMOS: Circuit Design, Layout, and Simulation, IEEE Press/Wiley, , 4th Edition, 2019.

Web Reference s

1. NPTEL – Analog CMOS Integrated Circuits (IIT Kharagpur / IIT Delhi)
2. NPTEL – Analog VLSI Design (IIT Madras).

Course Outcomes

Upon completion of this course, students will have the ability to

i. Demonstrate understanding of MOSFET fundamentals, biasing networks and their performance metrics.
ii. Implement analog building blocks such as current mirrors and voltage references circuits
iii. Design and analyze single-stage and multistage amplifiers.
iv. Explain the characteristics of differential amplifiers and CMOS operational amplifiers
v. Demonstrate the frequency response and stability analysis of CMOS op-amps

HECE342	DIGITAL INTEGRATED CIRCUITS DESIGN	3 L : 0 T : 0 P	3 Credits

Course Objectives:

In this course, the students will be able to:

i. Learn CMOS fabrication steps and the layout along with the stick diagrams.
ii. Focus on the design and systematic analysis of CMOS Inverter.
iii. Study the design of static and dynamic CMOS design.
iv. Emphasize on the CMOS sequential logic circuit design.
v. Focus on the design of memories

Course Contents:

MODULE I: INTRODUCTION TO CMOS **9 Hours**

Issues in Digital IC Design, Quality Metrics of a Digital Design, MOS Transistor Theory; CMOS Fabrication and Layout: CMOS Process Technology N-well, P-well process, Stick diagram for Boolean functions, Optimization using Euler Theorem, Layout Design Rules.

MODULE II: CMOS INVERTER **9 Hours**

Static CMOS Inverter, Static and Dynamic Behavioural Practices of CMOS Inverter, Noise Margin; Components of Energy and Power, Switching, Short-Circuit and Leakage Components; Technology scaling and its impact on the inverter metrics, Passive and Active Devices.

Module III: STATIC & DYNAMIC CMOS DESIGN **9 Hours**

Delay Calculation using Logical Effort, Complementary CMOS -Ratioed Logic (Pseudo NMOS, DCVSL), Pass Transistor Logic, Transmission gate logic, Dynamic Logic Design Considerations, Speed and Power Dissipation of Dynamic logic, Signal integrity issues, Domino Logic.

MODULE IV: CMOS SEQUENTIAL LOGIC CIRCUIT DESIGN **9 Hours**

Introduction, Static Latches and Registers, Dynamic Latches and Registers, Pulse Based Registers, Sense Amplifier based registers, Latch vs. Register based pipeline structures.

MODULE V: DESIGNING MEMORY & ARRAY STRUCTURES **9 Hours**

SRAM and DRAM Memory Core, Memory peripheral circuitry, Memory reliability and yield, Power dissipation in memories.

Total No. of Hours: 45

Text Books

1. Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, "Digital Integrated Circuits: A Design Perspective", PHI, Second Edition, 2016
2. Neil.H, E.Weste, David Harris and Ayan Banerjee, "CMOS VLSI Design: A Circuit and Systems Perspective", Pearson Education, Fourth Edition, 2015

Reference Books

1. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits - Analysis and Design", Fourth Edition, McGraw-Hill, 2014
2. Sorab K Gandhi, "VLSI Fabrication Principles": Si and GaAs, John Wiley and Sons, 2nd Edition 2010

Web References:

1. **N P T E L :** https://nptel.ac.in/courses/108106158

Course Outcomes

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

i. Explain the CMOS fabrication and layout
ii. Describe the design and systematic analysis of CMOS Inverter.
iii. Apply the methods to design static and dynamic CMOS circuits.
iv. Design the CMOS sequential circuit with optimized power, area and delay
v. Design CMOS memory arrays, understand interconnect and clocking issues.

HECE353	VLSI DESIGN FLOW: RTL TO GDS	3 L : 0 T : 0 P	3 Credits

Course Objectives:

In this course, students will be able to:

i. Obtain foundational knowledge of complete VLSI design flow from RTL to GDSII.
ii. Develop competence in RTL coding, simulation, and testbench development using Verilog HDL.
iii. Enable students to perform logic synthesis and apply design optimization techniques.
iv. Train students in static timing analysis and timing closure methodologies.
v. Impart practical skills in floor planning, placement, routing, and signoff checks in ASIC design

Course Contents:

MODULE I: INTRODUCTION TO VLSI DESIGN FLOW **9 Hours**
ASIC vs FPGA, Front-end and Back-end design flow, EDA tools overview, RTL to GDS flow overview

MODULE II: RTL DESIGN AND SIMULATION **9 Hours**
Verilog HDL design constructs, RTL coding guidelines for synthesis, Functional simulation and testbench, Design Constraints (DC)

MODULE III: LOGIC SYNTHESIS **9 Hours**
Technology mapping, Combinational and sequential optimization, Multi-cycle and false path handling, Netlist generation and optimization

MODULE IV: STATIC TIMING ANALYSIS AND TIMING CLOSURE **9 Hours**
Setup and hold analysis, Timing paths and critical paths, Clock uncertainty, skew, and jitter, Timing Reports and fixing violations

MODULE V: FLOOR PLANNING AND PLACEMENT AND ROUTING **9 Hours**
I/O planning, Macro placement and power planning, Congestion analysis and legalization, Clock Tree Synthesis (CTS), Global and detailed routing, Crosstalk and IR drop analysis, Design Rule Check (DRC) and Layout vs Schematic (LVS), Final GDSII generation and signoff.

Total Periods: 45

Text Books:

1. Saurabh, Sneh, “Introduction to VLSI Design Flow”, Cambridge University Press, 2023.
2. Taraate, Vaibbhav, “ASIC Design and Synthesis: RTL Design Using Verilog”, Springer, 2021.

Reference Books:

1. Kahng, Andrew B., Lienig, Jens, Markov, Igor L., Hu, Jin, “VLSI Physical Design: From Graph Partitioning to Timing Closure”, Springer, 2nd Edition, 2022.
2. Roy, Shirshendu , “Advanced Digital System Design: A Practical Guide to Verilog Based FPGA and ASIC Implementation”, Springer, 2024.
3. Huriwala, Sanjay; Mehta, Usha; Dhare, Vaishali , “Digital Design and Verification Using Verilog and System Verilog”, Wiley, 2025.

Web Resources:

1. NPTEL: https://nptel.ac.in/courses/108106191
2. SWAYAM: https://onlinecourses.nptel.ac.in/noc23_ee137/preview

Course Outcomes:

On successful completion of the course, student will have the ability to:

i. Demonstrate a clear understanding of the complete VLSI design flow and its industrial applications.
ii. Develop synthesizable RTL code in Verilog and validate functionality through effective testbenches.
iii. Execute logic synthesis, analyzes generated netlists, and apply relevant optimization techniques.
iv. Perform static timing analysis, identifies timing violations, and apply appropriate timing closure methods.
v. Apply floor planning, placement, routing, and signoff procedures to produce a tape-out–r eady GDSII layout.

HECE364	VLSI TESTING AND TESTABILITY	3L:0T:0P	3 Credits

Course Objectives:

In this course, students will be able to

i. Introduce fundamental concepts of digital testing, fault models, and simulation techniques.
ii. Learn test generation methods for combinational and sequential circuits.
iii. Provide knowledge of design-for-testability (DFT) techniques for improving test coverage.
iv. Impart skills in BIST architectures, memory testing, and associated test algorithms.
v. Familiarize with logic-level fault diagnosis methodologies and self-checking circuit concepts.

MODULE I: BASICS OF TESTING AND FAULT MODELING **9 Hours**

Introduction to Testing, Faults in digital circuits, Modelling of faults, Logical Fault Models, Fault detection, Fault location, Fault dominance; Logic Simulation, Types of simulation, Delay models - Gate level Event-driven simulation.

MODULE II: TEST GENERATION FOR COMBINATIONAL AND SEQUENTIAL CIRCUITS **9 Hours**

Test generation for combinational logic circuits, Testable combinational logic circuit design, Test generation for sequential circuits , Design of testable sequential circuits. Design For Testability

MODULE III : DESIGN FOR TESTABILITY **9 Hours**

Ad-hoc design, Generic scan-based design, Classical scan-based design , System level DFT approaches.

MODULE IV: SELF-TEST AND TEST ALGORITHMS **9 Hours**

Built-In Self-Test, Test pattern generation for BIST, Circular BIST, BIST Architectures, Testable Memory Design, Test algorithms , Test generation for Embedded RAMs.

MODULE V: FAULT DIAGNOSIS **9 Hours**

Logic Level Diagnosis, Diagnosis by UUT reduction, Fault Diagnosis for Combinational Circuits, Self-checking

Total Periods of Hours: 45

Text Books

1. Ashok Kumar B., Senthilrani S., Revathy M., Umamaheswari S., "VLSI Testing & Design for Testability", Technical Publications, 2024.
2. A. Chrispin Jiji, Y. R. Annie Bessant, J. Grace Jency, S. Vanaja, Iffat Fatima, "VLSI Testing & Design for Testability", Booksclinic Publishing, 2025.

Reference Books

1. Tripathi S. L., Saxena S. and Mohapatra S. K., "Advanced VLSI Design and Testability Issues" , CRC Press, 2021.
2. Saurabh, S. , "Introduction to VLSI Design Flow", Cambridge University Press, 2023.
3. Saini, Sandeep, Lata, Kusum, Sinha, G. R., "VLSI and Hardware Implementations Using Modern Machine Learning Methods", CRC Press, 2021.

Web Resources:

1. NPTEL : https://nptel.ac.in/courses/106103016

Course Outcomes:

On the successful completion of this course, students will have the ability to

i. Demonstrate understanding of digital testing principles, logical fault models, and simulation methods.
ii. Apply test generation techniques to combinational and sequential circuits with testability considerations.
iii. Utilize DFT strategies, including scan-based methods, to enhance circuit testability.
iv. Implement BIST concepts, memory test algorithms, and evaluates built-in test architectures.
v. Analyze faults and perform diagnosis at logic level using structured diagnostic approaches.