



Electronics and Communication Engineering (ECE) Department

B.TECH. PROGRAMME

CURRICULUM

RELEASE DATE:

July, 2023

June, 2024

June, 2025

(Applicable from 2023 admitted batch)

Preamble

We, the members of the Electronics and Communication Engineering Department, dedicate ourselves to the advancement of knowledge and innovation in the fields of electronics and communication engineering. Guided by the principles of excellence, integrity, and collaboration, we strive to cultivate a dynamic learning environment where creativity thrives and boundaries are constantly challenged.

The curriculum for the B. Tech. in Electronics and Communication Engineering program has been modified as per the guidelines of AICTE and MAKAUT, and considering the new education policy (NEP) under Academic Regulation 2022 from the academic session 2023 - 2024. In addition, this outcome-based curriculum (OBC) is created with a choice-based credit system (CBCS), which enables students to develop professional competency through a multidisciplinary approach that satisfies the requirements of industry, academics and the different Accreditation bodies like NBA and NAAC. Courses such as Introduction to Machine Learning, Artificial Intelligence, Wireless Communication : 5G and beyond, Internet of Things, Design Thinking and Idea Lab etc. are included in the syllabus keeping in mind the industry demand, as well as the suggestions given by the NBA experts in the very recent visit. Basic mathematical courses like Algebraic structures, linear algebra, and optimization theory are included to strengthen students' mathematical skills that enables them to learn latest developments of computer science and be more innovative. Students are being motivated to select and study MOOC subjects of their choice towards attaining the degree with honors. Apart from this, the course code is now changed from 4 letters to 3 letters from the session 2023 – 2024 as per the suggestions came from the office of the controller of examinations. This will help to distinguish the new courses from the old ones. In accordance with this, the curriculum and syllabi are revised in a structured manner by implementing Feedback Mechanism on Curriculum from various stakeholders, including potential employers, alumni, and parents.

In pursuit of our vision, we embrace continuous learning and adaptation, remaining agile and responsive to the evolving needs of our students, our discipline, and society at large. Together, we aspire to be leaders in education, research, and innovation, shaping the future of electronics and communication engineering and making a lasting impact on the world.

Table of Contents

1. Institutional Vision & Mission	04
2. Departmental Vision & Mission	04
3. Components of curriculum.....	09
4. Compliance of curriculum.....	09
5. Credit Summary.....	10
6. Curriculum Structure.....	11
7. Curriculum Detail.....	21
8. APPENDIX – A: Guidelines of Massive Open Courses (MOOCs).....	133
9. APPENDIX – B : Point Description for Mandatory Additional Requirement.....	134
10. APPENDIX – C : Bloom’s Taxonomy	137

Institutional Vision & Mission

VISION:

To prepare dynamic and caring citizens to meet the challenges of global society while retaining their traditional values.

MISSION:

- To prepare students with strong foundation in their disciplines and other areas of learning.
- To provide an environment for critical and innovative thinking, and to encourage life-long learning.
- To develop entrepreneurial and professional skills.
- To promote research and developmental activities and interaction with industry.
- To inculcate leadership qualities for serving the society.

Departmental Vision & Mission

VISION

To produce graduates with firm foundation in electronics and Communication engineering, who will cater to the dynamic needs of the industry and who will provide a stimulating environment for higher education and quality research. They will be sensitive to the needs of the country and society and will prove themselves to be caring citizens.

MISSION

- To harmonize the teaching-learning process and also to provide basic foundation to the students of the department so that they can adapt to the changing market needs in electronics and communication domains.
- To empower the students to enrich themselves with the state-of-the-art developments through seminars, workshops, participation in technical competitions, interaction with industry experts and paper presentations in conferences.
- To enhance collaborative activities with academic institutions and industries for evolving indigenous technological solutions that address societal and dynamic market needs in the Electronics and Communication domains and interdisciplinary areas.

- To create research oriented mindset to help solve myriad challenges of the future which will come before society and nation.
- To help the students to develop leadership qualities, and mentoring qualities. It will ensure that they will be well-rounded and complete individuals.

Credit Summary for B Tech Programmes in ECE with effect from 2023-2024

Sl. No.	Course Type	ECE
1.	Humanities and Social Sciences including Management Courses	12
2.	Basic Science Courses	22
3.	Engineering Science Courses including Workshop, Drawing, Basics of Electrical / Mechanical / Computer, etc.	24
4.	Program Core Courses	62.5
5.	Program Elective Course Courses relevant to chosen Specialization / Branch	12
6.	Open Subjects – Electives from other Technical and/or Emerging Subjects	12
7.	Project Work, Seminar and Internship in industry or elsewhere	18.5
8.	Mandatory course Courses (Non-credit) [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Traditional Knowledge]	0
	Total	163
9	Honours Courses	20
	Grand Total	183

Definition of Credit (as per AICTE):

1 Hour Lecture (L) per Week = 1 Credit
 1 Hour Tutorial (T) per Week = 1 Credit
 1 Hour Practical (P) per Week = 0.5 Credits
 2 Hours Practical (Lab) per Week = 1 Credit

Range of Credits (as per AICTE):

A total of 163 credits will be necessary for a student to be eligible to get B Tech degree.
 A student will be eligible to get B Tech degree with Honours if he/she completes an additional 20 credits.
 These could be acquired through MOOCs.

Any student completing any course through MOOC will have to submit an appropriate certificate to earn the corresponding credit.

For any additional information, the student may contact the concerned HODs.

Curriculum Structure

1stYear 1stSemester:

A. Theory								
Sl. No.	Category	Course Code	Course Name	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Basic Science course	CHM1001	Chemistry I	3	0	0	3	3
2	Basic Science course	MTH1101	Mathematics I	3	1	0	4	4
3	Engineering Science course	CSE1001	Programming for Problem Solving	4	0	0	4	4
4	Engineering Science course	ELE1001	Basic Electrical Engineering.	3	1	0	4	4
5	Humanities and Social Sciences including Management courses	HUM1001	English for Technical Writing	2	0	0	2	2
			TOTAL	15	2	0	17	17

B. Practical								
1	Basic Science Course	CHM1051	Chemistry I Laboratory	0	0	2	2	1
2	Engineering Science course	CSE1051	Programming for Problem Solving Laboratory	0	0	3	3	1.5
3	Engineering Science course	ELE1051	Basic Electrical Engineering Laboratory	0	0	2	2	1

4	Humanities and Social Sciences including Management courses	HUM1051	English for Technical Writing Laboratory	0	0	2	2	1
Total Practical				0	0	9	9	4.5
Total of Semester				15	2	9	26	21.5

1st Year 2nd Semester:

A. Theory								
Sl. No.	Category	Course Code	Course Title	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Basic Science course	PHY1001	Physics I	3	0	0	3	3
2	Basic Science course	MTH1201	Mathematics II	3	1	0	4	4
3	Program Core Course	ECE1001	Introduction to Electronic Devices and Circuits	3	0	0	3	3
4	Humanities and Social Sciences including Management courses	HUM1002	Universal Human Values and Professional Ethics	2	1	0	3	3
Total Theory				11	2	0	13	13

B. Practical								
1	Basic Science course	PHY1051	Physics I Laboratory	0	0	2	2	1
2	Program Core Course	ECE1051	Introduction to Electronic Devices and Circuits Laboratory	0	0	2	2	1
3	Engineering Science course	MEC1051	Workshop/ Manufacturing Practices	1	0	3	4	2.5
4	Engineering Science course	MEC1052	Engineering Graphics & Design	1	0	3	4	2.5
Total Practical				2	0	10	12	7
Total of Semester				13	2	10	25	20

2nd Year 1st Semester:

A. Theory								
Sl. No.	Category	Course Code	Course Title	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Program Core Course	ECE2101	Analog Circuits	3	0	0	3	3
2	Program Core Course	ECE2102	Digital Systems Design	3	0	0	3	3
3	Program Core Course	ECE2103	Signals and Systems	3	0	0	3	3
4	Program Core Course	ECE2104	Network Theory	3	0	0	3	3
5	Basic Science course	MTH2101	Introduction to Complex and Fourier Analysis	2	0	0	2	2
6	Engineering Science course	CSE2004	Data Structure and Basic Algorithms	3	0	0	3	3
Total Theory				17	0	0	17	17

B. Practical								
1	Program Core Course	ECE2151	Analog Circuits Laboratory	0	0	2	2	1
2	Program Core Course	ECE2152	Digital Systems Design Laboratory	0	0	2	2	1
3	Program Core Course	ECE2156	Signals and Networks Laboratory	0	0	2	2	1
4	Engineering Science course	CSE2054	Data Structure and Basic Algorithms Laboratory	0	0	2	2	1

Total Practical	0	0	8	8	4
------------------------	---	---	---	---	---

C. Sessional								
1	Project	ECE2196	Micro Project : Design Thinking & Idea Lab (ECE)	0	0	2	2	1
Total Sessional				0	0	2	2	1
Total of Semester				17	0	10	27	22

2ndYear 2ndSemester:

A. Theory								
Sl. No.	Category	Course Code	Course Title	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Program Core Course	ECE2201	Introduction to Analog& Digital Communication	3	0	0	3	3
2	Program Core Course	ECE2202	Control Systems	3	0	0	3	3
3	Program Core Course	ECE2203	EM Theory & Transmission Lines	3	0	0	3	3
4	Program Core Course	ECE2204	Digital Signal Processing	3	0	0	3	3
5	Program Core Course	ECE2205	Electronic Devices	3	0	0	3	3
6	Basic Science Course	MTH2202	Advanced Numerical Methods	3	0	0	3	3
Total Theory				18	0	0	18	18

B. Practical								
1	Program Core Course	ECE2251	Introduction to Analog & Digital Communication Laboratory	0	0	2	2	1
2	Program Core Course	ECE2252	Control Systems Laboratory	0	0	2	2	1

3	Program Core Course	ECE2253	EM Theory & Transmission Lines Laboratory	0	0	2	2	1
4	Program Core Courses	ECE2254	Digital Signal Processing Laboratory	0	0	2	2	1
5	Basic Science courses	MTH2252	Advanced Numerical Methods Laboratory	0	0	2	2	1
Total Practical				0	0	10	10	5

C. Mandatory course Course(non-credit)

1	Mandatory Course	EVS2016	Environmental Sciences	2	0	0	2	0
Total of Semester				20	0	10	30	23

3rdYear1stSemester

A. Theory

Sl. No.	Category	Course Code	Course Title	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Program Core Course	ECE3101	Mobile Communication and Networks	3	0	0	3	3
2	Program Core Course	ECE3102	Microwave Engineering	3	0	0	3	3
3	Program Core Course	ECE3103	Processor Fundamentals and Microcontrollers	3	0	0	3	3
4	Program Core Course	ECE3104	Microelectronic Devices and Analog VLSI design	3	0	0	3	3
5	Program Elective Course-1	ECE3131	Artificial Intelligence	3	0	0	3	3
		ECE3132	Computer Networks					
		ECE3133	Introduction to Optical Communication					
		ECE3134	Computer Organization					
		i)ECE3121	i)Digital Image Processing & Pattern recognition	3	0	0	0	3

6	Open Elective course- 1	ii) AEI3122	ii) Fundamentals of Sensors & Transducers					
		iii) CSE3121	iii) Fundamentals of OS					
		iv) INF3121	iv) Introduction to Cryptography					
		v) MTH3122	v) Statistics and Information Theory					
Total Theory				18	0	0	18	18

B. Practical

1	Program Core Course	ECE3151	Mobile Communication and Networks Laboratory	0	0	2	2	1
2	Program Core Course	ECE3152	Microwave Engineering Laboratory	0	0	2	2	1
3	Program Core Course	ECE3153	Processor Fundamentals and Microcontrollers Laboratory	0	0	2	2	1
4	Program Core Course	ECE3154	Microelectronic Devices and Analog VLSI design Laboratory	0	0	2	2	1
5	Program Core Course	ECE3155	Introduction to Machine Learning using Python Laboratory	1	0	3	4	2.5
Total Practical				1	0	11	12	6.5

C. Mandatory course Course(non-credit)

1	Mandatory Course	INC3016	Indian Constitution and Civil Society	2	0	0	2	0
Total of Semester				21	0	11	32	24.5

Open Elective course - 1	i) ECE3121	i) Digital Image Processing & Pattern recognition
	ii) ECE3122	ii) Introduction to Machine Learning
	iii) ECE3123	iii) Error Control Coding for Secure Data Transmission
	iv) ECE3124	iv) Introduction to VLSI Design

Open Elective course -1 (to be offered by ECEDepartment)

3rdYear 2ndSemester:

A. Theory								
Sl. No.	Category	Course Code	Course Title	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Program Core Course	ECE3201	Digital VLSI Design	3	0	0	3	3
2	Engineering Science Course	CSE3208	Object Oriented Programming Concept using JAVA	3	0	0	3	3
3	Humanities and Social Sciences including Management courses	HUM3201	Economics for Engineers	3	0	0	3	3
4	Program Elective Course-2	ECE3231	Trends in Wireless Networks	3	0	0	3	3
		ECE3232	Information Theory and Coding					
		ECE3233	Fundamentals of Cognitive Radio& Network					
		ECE3234	Wireless Sensor Networks and security					
5	Program Elective Course-3	ECE3241	Internet of Things	3	0	0	3	3
		ECE3242	Wireless Communication: 5G and beyond					
		ECE3243	Intelligent Radio Design					
		ECE3244	Satellite Communication & Remote Sensing					
6	Open Elective course -2	ECE3221	Artificial Intelligence in Radio Communication	3	0	0	3	3
		CSE3221	Fundamental of RDBMS					
		BTC3223	Introduction to Biology					

		INF3221	Fundamentals of Cloud Computing					
		AEI3222	Instrumentation and Telemetry					
Total Theory				18	0	0	18	18

B. Practical								
1	Program Core Course	ECE3251	Digital VLSI Design Laboratory	0	0	2	2	1
2	Engineering Science Course	CSE3258	Object Oriented Programming Concept using JAVA Laboratory	0	0	3	3	1.5
3	Program Core Course	ECE3253	Embedded System Laboratory	1	0	2	3	2
Total Practical				1	0	7	8	4.5

C. Sessional								
1	Seminar	ECE3293	Seminar	0	0	2	2	1
2	Project	ECE3294	Mini Project: Fundamental System Design and Development Laboratory	0	0	3	3	1.5
3	Project	ECE3295	Project Stage – I	0	0	2	2	1
Total Sessional				0	0	7	7	3.5
Total of Semester				19	0	14	33	26

Open Elective course - 2	i) ECE3221 ii) ECE3222 iii) ECE3223 iv) ECE 3224	i) Artificial Intelligence in Radio Communication ii) Designing with Processors and Controllers iii) Analog and Digital Communication iv) Optical Fiber Communication
--------------------------	---	--

Open Elective course -2 (to be offered by ECEDepartment)

4thYear 1stSemester:

A. Theory								
Sl. No.	Category	Course Code	Course Title	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Program Elective Course-4	i) ECE4131	i) Introduction to MEMS	3	0	0	3	3
		ii)ECE4132	ii) Application of Green Energy					
		iii)ECE4133	iii) Network Security					
		iv)ECE4134	iv)Nanoelectronics&Nanophotonics					
		v) ECE4135	v) Electromagnetic Interference and Compatibility					
		vi) ECE4136	vi) Introduction to RF Biosensor					
2	Open Elective course- 3	i)ECE4121	i) Principles of Radar	3	0	0	3	3
		ii) ECE4122	ii) Bio sustainable solar energy					
		iii) CSE4121	iii) DevOps					
		iv) CBS4121	iv) Introduction to Software Engineering					
		v) AEI4121	v) Medical Instrumentation					
3	Open Elective course- 4	i)ECE4126	i)Industrial Safety Engineering	3	0	0	3	3
		ii)ECE4127	ii) System Design for Sustainability					
4	HU	HUM4101	Principles of Management	3	0	0	3	3
Total Theory				12	0	0	12	12

B. Sessional								
1	Industrial Training/ Internship	ECE4191	Industrial Training/Internship	-	-	-	-	2
2	Project	ECE4195	Project Stage – II	0	0	10	10	5
Total Sessional				0	0	10	10	7
Total of Semester				12	0	10	22	19

Open Elective course -3	i)ECE4121 ii)ECE4123 iii) ECE4124 iv) ECE4125	i) Principles of Radar ii) Evolution of Mobile Communication: 1G to 5G iii) Introduction to Software Defined Radio iv) Ad Hoc Wireless Networks
-------------------------	--	--

Open Elective course3 (to be offered by ECEDepartment)

4thYear 2ndSemester:

A. Sessional								
Sl. No.	Category	Course Code	Course Title	Contact Hours/Week				Credit Points
				L	T	P	Total	
1	Project Work	ECE4295	Project Work III& Dissertation	0	0	10	10	5
2	Viva Voce.	ECE4297	Comprehensive Viva Voce	-	-	-	-	1
3	Skill Development	SKD4296		-	-	-	-	1
Total Sessional				0	0	10	10	7

Total of Semester	0	0	10	10	7
-------------------	---	---	----	----	---

1ST YEAR 1ST SEMESTER

Course Title : Chemistry I					
Course Code : CHM1001					
Contact hrs. per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Course Outcomes:

The subject code CHM-1001 corresponds to Chemistry Theory classes (Chemistry-1) for the first year B. Tech students, offered as Chemistry for Engineering and is common to all Branches of Engineering Disciplines. The course provides basic knowledge of theory and applications in the subjects like Thermodynamics, Quantum mechanics, Electrochemistry, & Energy conversion, Structure and reactivity of molecules. Spectroscopic techniques and their applications, Synthesis & use of Drug molecules. The Course Outcome for the subject code CHM1001, is furnished below:

CHM1001.1. Knowledge acquisition of bulk properties of materials and understanding of reaction processes using thermodynamic considerations.

CHM1001.2. Conception of energy conversion and its importance in clean energy scenario, the operating principles for batteries, fuel cells and the materials and reactions involved there in, their applications as sustainable energy devices, particularly in automobiles sectors to reduce environmental pollution.

CHM1001.3. Analytic view of microscopic chemistry in terms of atomic structure, molecular orbital and intermolecular forces to reinforce strong background on materials science and engineering.

CHM1001.4. Rationalize periodic trends of elements to explain various physico - chemical properties.

CHM1001.5. Understanding of the spectrum of electromagnetic radiation used for exciting different molecular energy levels in various spectroscopic techniques.

CHM1001.6. Knowledge of stereochemistry and conception of the mechanism of major chemical reactions involved in synthesis of drug molecules.

MODULE 1

Thermodynamics

The 1st and 2nd laws of thermodynamics and thermodynamic functions like freeenergy, work function and entropy; Carnot cycle, Joule-Thomson effect, Gibbs-Helmholtz equation; Chemical Potential, Gibbs- Duhem Equation and Clausius-Clapeyron Equation. 5L

Electrochemical Cell

Generation of electromotive force in electrochemical cells and application of Nernst equation; Electrode potentials and the redox reactions; Cell configuration and half-cell reactions; Standard Hydrogen Electrode, Reference electrode, evaluation of thermodynamic functions; Electrochemical corrosion.

Electrochemical Energy Conversion: Primary & Secondary batteries, Fuel Cells. 4L

MODULE 2

Molecular Structure

Molecular geometry, Hybridization, Ionic, dipolar and van Der Waals interactions; Molecular Orbital Theory and its application in diatomic molecule; Pi-molecular orbital of unsaturated system; Band structure of solids, intrinsic and extrinsic semiconductors and the role of doping on band structures.

5L

Periodic Properties

Effective nuclear charge, penetration of orbitals; 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 acid base theory.

4L

MODULE 3

Atomic structure and Wave Mechanics

Brief outline of the atomic structure, wave particle duality, Heisenberg uncertainty principle; Introduction to quantum mechanics, Schrodinger wave equation for particle in one dimensional box.

5L

Spectroscopic Techniques & Applications

Electromagnetic spectrum: Interaction of EMR with matter; Principle and applications of Fluorescence & Phosphorescence, UV-Visible, Infrared and NMR spectroscopy.

4L

MODULE 4

Stereochemistry

Representations of 3- dimensional structures, structural isomers and stereo-isomers; configurations, symmetry and chirality; enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis.

5L

Organic reactions and synthesis of drug molecules

Introduction to reaction mechanism: substitution, addition, elimination and oxidation, reduction reactions. Synthesis of commonly used drug molecules.

4L

TEXT BOOKS

1. Atkins' Physical Chemistry, P.W. Atkins (10th Edition)
2. Organic Chemistry, I. L. Finar, Vol-1 (6th Edition)
3. Engineering Chemistry, Jain & Jain, (16th Edition)
4. Fundamental Concepts of Inorganic Chemistry, A. K. Das, (2nd Edition)
5. Engineering Chemistry -I, Gourkrishna Das Mohapatra, (3rd Edition)

REFERENCE BOOKS

1. General & Inorganic Chemistry, R. P. Sarkar
2. Physical Chemistry, P. C. Rakshit, (7th Edition)
3. Organic Chemistry, Morrison & Boyd , (7th Edition)
4. Fundamentals of Molecular Spectroscopy, C.N. Banwell, (4th Edition)
5. Physical Chemistry , G. W. Castellan, (3rd Edition)

Course Title: Chemistry I Laboratory					
Course Code : CHM1051					
Contact hrs per week :	L	T	P	Total	Credit points
	0	0	2	2	1

Course outcomes:

The subject code CHM1051 corresponds to chemistry laboratory classes for the first year B. Tech students. This course enhances the students' experience regarding handling of various chemicals along with various laboratory equipment. Hands on experiments increase the depth of knowledge that is taught in the theory classes as well as it increases research aptitude in students because they can see the direct application of theoretical knowledge in practical field. The course outcomes of the subject are

CHM1051.1. Knowledge to estimate the hardness of water which is required to determine the usability of water used in industries.

CHM1051.2. Estimation of ions like Fe^{2+} , Cu^{2+} and Cl^- present in water sample to know the composition of industrial water.

CHM1051.3. Study of reaction dynamics to control the speed and yield of various manufactured goods produced in polymer, metallurgical and pharmaceutical industries.

CHM1051.4. Handling physico-chemical instruments like viscometer, stalagmometer, pH-meter, potentiometer and conduct meter.

CHM1051.5. Understanding the miscibility of solutes in various solvents required in paint, emulsion, biochemical and material industries.

CHM1051.6. Knowledge of sampling water can be employed for water treatment to prepare pollution free water.

List of Experiments:

1. Estimation of iron using KMnO_4 : self indicator.
2. Iodometric estimation of Cu^{2+} .
3. Determination of Viscosity.
4. Determination of surface tension.
5. Adsorption of acetic acid by charcoal.
6. Potentio-metric determination of redox potentials.
7. Determination of total hardness and amount of calcium and magnesium separately in a given water sample.
8. Determination of the rate constant for acid catalyzed hydrolysis of ethyl acetate.
9. Heterogeneous equilibrium (determination of partition coefficient of acetic acid in n-butanol and water mixture).
10. Conductometric titration for the determination of strength of a given HCl solution against a standard NaOH solution.
11. pH-metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
12. Determination of chloride ion in a given water sample by Argentometric method (using chromate indicator solution)

Course Title : Mathematics-I					
Course Code: MTH1101					
Contact hrs per week:	L	T	P	Total	Credit points
	3	1	0	4	4

Course Outcomes

1. MTH 1101.1 Apply the concept of rank of matrices to find the solution of a system of linear simultaneous equations.
2. MTH 1101.2 Develop the concept of eigen values and eigen vectors.
3. MTH 1101.3 Combine the concepts of gradient, curl, divergence, directional derivatives, line integrals, surface integrals and volume integrals.
4. MTH 1101.4 Analyze the nature of sequence and infinite series
5. MTH 1101.5 Choose proper method for finding solution of a specific differential equation.
6. MTH 1101.6 Describe the concept of differentiation and integration for functions of several variables with their applications in vector calculus.

The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and linear algebra. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

Module I [10L]

Matrix:

Inverse and rank of a matrix; Elementary row and column operations over a matrix; System of linear equations and its consistency; Symmetric, skew symmetric and orthogonal matrices; Determinants; Eigen values and eigen vectors; Diagonalization of matrices; Cayley Hamilton theorem; Orthogonal transformation.

Module II [10 L]

Vector Calculus:

Vector function of a scalar variable, Differentiation of a vector function, Scalar and vector point functions, Gradient of a scalar point function, divergence and curl of a vector point function, Directional derivative, Related problems on these topics,

Infinite Series:

Convergence of sequence and series; Tests for convergence: Comparison test, Cauchy's Root test, D'Alembert's Ratio test (statements and related problems on these tests), Raabe's test; Alternating series; Leibnitz's Test (statement, definition); Absolute convergence and Conditional convergence.

Module III [10 L]

First order ordinary differential equations:

Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations solvable for p , equations solvable for y , equations solvable for x and Clairaut's type.

Ordinary differential equations of higher orders:

General linear ODE of order two with constant coefficients, C.F. & P.I., D-operator methods, Method of variation of parameters, Cauchy-Euler equations.

Module IV [10L]

Calculus of functions of several variables

Introduction to functions of several variables with examples, Knowledge of limit and continuity, Determination of partial derivatives of higher orders with examples, Homogeneous functions and Euler's theorem and related problems up to three variables,

Multiple Integration

Concept of line integrals, Double and triple integrals. Green's Theorem, Stokes Theorem and Gauss Divergence Theorem.

Suggested Books:

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 2000.
2. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2006.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
5. K. F. Riley, M. P. Hobson, S. J. Bence. Mathematical Methods for Physics and Engineering, Cambridge University Press, 23-Mar-2006.
6. S. L. Ross, Differential Equations", Wiley India, 1984.
7. G.F. Simmons and S.G. Krantz, Differential Equations, McGraw Hill, 2007.
8. Vector Analysis(Schaum's outline series): M.R. Spiegel, Seymour Lipschutz, Dennis Spellman (McGraw Hill Education)
9. Engineering Mathematics: S. S. Sastry (PHI)
10. Advanced Engineering Mathematics: M.C. Potter, J.L. Goldberg and E.F. Abonfadel (OUP), Indian Edition.
11. Linear Algebra (Schaum's outline series): Seymour Lipschutz, Marc Lipson (McGraw Hill Education)

Course Title: Programming for Problem Solving					
Course Code: CSE1001					
Contact Hours per week	L	T	P	Total	Credit Points
	4	0	0	4	4

Course outcome:

CSE1001.1: Remember and understand the functionalities of the different hardware and software components present in a computer system, the standard representations of various types of data in a computer system.

CSE1001.2: Illustrate how a computer system with one way of representation can be converted to another equivalent representation.

CSE1001.3: Construct flow charts for any arithmetic or logical problems in hand.

CSE1001.4: Remember and understand the C programming development environment, writing, compiling, debugging, linking and executing a C program using that development environment, basic syntax and semantics of C programming language and interpret the outcome of any given C program.

CSE1001.5: Use loop constructs, conditional branching, iteration, recursion to solve simple engineering problems.

CSE1001.6: Apply pointers, arrays, structures, files to formulate simple engineering problems.

Learning Objectives: Introduction to the concept of computer and computation and solving of problems using C as a programming language. Coverage of C will include basic concepts, arithmetic and logic, flow control, and data handling using arrays, structures, pointers and files.

Module I: [10L] Fundamentals of Computer

History of Computers, Generations of Computers, Classification of Computers.

Basic Anatomy of Computer System, Primary & Secondary Memory, Processing Unit, Input & Output devices. Basic Concepts of Assembly language, High level language, Compiler and Assembler.

Binary & Allied number systems (decimal, octal and hexadecimal) with signed and unsigned numbers using 1's and 2's complement) - their representation, conversion and arithmetic operations. Packed and unpacked BCD system, ASCII. IEEE-754 floating point representation (half- 16 bit, full- 32 bit, double- 64 bit).

Basic concepts of operating systems like MS WINDOWS, LINUX How to write algorithms & draw flow charts.

Module II: [10L] Basic Concepts of C

C Fundamentals:

The C character set identifiers and keywords, data type & sizes, variable names, declaration, statements. Operators & Expressions:

Arithmetic operators, relational and logical operators, type, conversion, increment and decrement operators, bitwise operators, assignment operators and expressions, precedence and order of evaluation. Standard input and output, formatted output -- printf, formatted input scanf.

Flow of Control:

Statement and blocks, if-else, switch-case, loops (while, for, do-while), break and continue, go to and labels.

Module III: [10L]

Program Structures in C

Basic of functions, function prototypes, functions returning values, functions not returning values. Storage classes -

auto, external, static and register variables – comparison between them. Scope, longevity and visibility of variables. C preprocessor (macro, header files), command line arguments.

Arrays and Pointers:

One dimensional arrays, pointers and functions – call by value and call by reference, array of arrays. Dynamic memory usage– using malloc(), calloc(), free(), realloc(). Array pointer duality.

String and character arrays; C library string functions and their use.

Module IV: [10L]

Data Handling in C

User defined data types and files:

Basic of structures; structures and functions; arrays of structures.

Files – text files only, modes of operation. File related functions – fopen(), fclose(), fscanf(), fprintf(), fgets(), puts(), fseek(), ftell();

Text Books

1. Schaum's outline of Programming with C – Byron Gottfried
2. Teach Yourself C- Herbert Schildt
3. Programming in ANSI C – E Balagurusamy

Reference Books

1. C: The Complete Reference – Herbert Schildt
2. The C Programming Language- D.M.Ritchie, B.W. Kernighan

Course Title: Programming for Problem Solving Lab					
Course Code: CSE1051					
Contact hrs per week:	L	T	P	Total	Credit Points
	0	0	3	3	1.5

Course Outcomes:

After completion of this course the students should be able:

- CSE1051.1.** To write simple programs relating to arithmetic and logical problems.
- CSE1051.2.** To be able to interpret, understand and debug syntax errors reported by the compiler.
- CSE1051.3.** To implement conditional branching, iteration (loops) and recursion.
- CSE1051.4.** To decompose a problem into modules (functions) and amalgamating the modules to generate a complete program.
- CSE1051.5.** To use arrays, pointers and structures effectively in writing programs.
- CSE1051.6.** To be able to create, read from and write into simple text files.

Software to be used: GNU C Compiler (GCC) with LINUX NB: Cygwin (Windows based) may be used in place of LINUX

Topic 1: LINUX commands and LINUX based editors

Topic 2: Basic Problem Solving

Topic 3: Control Statements (if, if-else, if-elseif-else, switch-case)

Topic 4: Loops - Part I (for, while, do-while)

Topic 5: Loops - Part II

Topic 6: One Dimensional Array

Topic 7: Array of Arrays

Topic 8: Character Arrays/ Strings Topic

9: Basics of C Functions

Topic 10: Recursive Functions

Topic 11: Pointers

Topic 12: Structures

Topic 13: File Handling

Text Books

1. Schaum's outline of Programming with C – Byron Gottfried
2. Teach Yourself C- Herbert Schildt
3. Programming in ANSI C – E Balagurusamy

Course Title: Basic Electrical Engineering					
Course Code : ELE1001					
Contact Hours per week	L	T	P	Total	Credit Points
	3	1	0	4	4

Course Outcomes

After attending the course, the students will be able to

ELE1001.1 Analyze DC electrical circuits using KCL, KVL and network theorems like Superposition Theorem, Thevenin's Theorem, Norton's Theorem and Maximum Power Transfer Theorem.

ELE1001.2 Analyze DC Machines; Starters and speed control of DC motors.

ELE1001.3 Analyze magnetic circuits.

ELE1001.4 Analyze single and three phase AC circuits.

ELE1001.5 Analyze the operation of single phase transformers.

ELE1001.6 Analyze the operation of three phase induction motors

Module-I: [11 L]

DC Network Theorem: Kirchhoff's law, Nodal analysis, Mesh analysis, Superposition theorem, Thevenin theorem, Norton theorem, Maximum power transfer theorem, Star-Delta conversion. [6L]

Electromagnetism: Review of magnetic flux, Force on current carrying conductors, Magnetic circuit analysis Self and Mutual inductance, B-H loop, Hysteresis and Eddy current loss, Lifting power of magnet. [5L]

Module-II[10L]

AC single phase system: Generation of alternating emf, Average value, RMS value, Form factor, Peak factor representation of an alternating quantity by a phasor, phasor diagram, AC series, parallel and series-parallel circuits, Active power, Reactive power, Apparent power, power factor, Resonance in RLC series and parallel circuit.

[10L]

Module-III [11 L]

Three phase system: Balanced three phase system, delta and star connection, relationship between line and phase quantities, phasor diagrams, power measurement by two wattmeter method. [4L]

DC Machines: Construction, EMF equation, Principle of operation of DC generator, Open circuit characteristics, External characteristics, Principle of operation of DC motor, speed-torque characteristics of shunt and series machine, starting of DC motor, speed control of DC motor.

[7L]

Module-IV [10L]

Transformer: Construction, EMF equation, no load and on load operation and their phasor diagram: Equivalent circuit, Regulation, losses of a transformer, Open and Short circuit tests, Efficiency, Introduction to three phase transformer.[6L]

Three-phase induction motor: Concept of rotating magnetic field, Principle of operation, Construction: Equivalent circuit and phasor diagram, torque-speed/slip characteristics, Starting of Induction Motor.[4L]

Text Books:

1. Basic Electrical engineering, D.P Kothari & I.J Nagrath, TMH, Second Edition
2. Basic Electrical Engineering, V.N Mittle & Arvind Mittal, TMH, Second Edition
3. Basic Electrical Engineering, Hughes
4. Electrical Technology, Vol-I,Vol-II,Surinder Pal Bali, Pearson Publication
5. A Text Book of Electrical Technology, Vol. I & II, B.L. Theraja, A.K. Theraja, S.Chand& Company

Reference Books:

1. Electrical Engineering Fundamentals, Vincent Del Toro, Prentice-Hall
2. Advance Electrical Technology, H.Cotton, Reem Publication
3. Basic Electrical Engineering, R.A. Natarajan, P.R. Babu, Sictech Publishers
4. Basic Electrical Engineering, N.K. Mondal, Dhanpat Rai
5. Basic Electrical Engineering, Nath & Chakraborti
6. Fundamental of Electrical Engineering, Rajendra Prasad, PHI, Edition 2005.

Course Title: Basic Electrical Engineering Laboratory					
Course Code : ELE1051					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes: The students are expected to

ELE1051.1 Get an exposure to common electrical apparatus and their ratings.

ELE1051.2 Make electrical connections by wires of appropriate ratings.

ELE1051.3 Understand the application of common electrical measuring instruments.

ELE1051.4 Understand the basic characteristics of different electrical machines.

List of Experiments:

1. Characteristics of Fluorescent lamps
2. Characteristics of Tungsten and Carbon filament lamps
3. Verification of Thevenin's & Norton's theorem.
4. Verification of Superposition theorem
5. Verification of Maximum Power Transfer theorem
6. Calibration of ammeter and voltmeter.
7. Open circuit and Short circuit test of a single phase Transformer.
8. Study of R-L-C Series / Parallel circuit
9. Starting and reversing of speed of a D.C. shunt Motor
10. Speed control of DC shunt motor.
11. No load characteristics of D.C shunt Generators
12. Measurement of power in a three phase circuit by two wattmeter method.

Course Title : English for Technical Writing					
Course Code : HUM1001					
Contact hrs per week:	L	T	P	Total	Credit Points
	2	0	0	2	2

Course Outcome:

Students will be able to

HUM1001.1. Communicate effectively in an official and formal environment

HUM1001.2. Use language as a tool to build bridges and develop interpersonal relations in multi-cultural environment

HUM1001.3. Use various techniques of communication for multiple requirements of globalized workplaces

HUM1001.4. Learn to articulate opinions and views with clarity.

HUM1001.5. Write business letters and reports.

HUM1001.6. Apply various communication strategies to achieve specific communication goals.

Module- I (6hrs.)

Introduction to Phonology and Morphology

- Phonetics- Vowel and Consonant Sounds (Identification & Articulation)
- Word- stress, stress in connected speech
- Intonation (Falling and Rising Tone)
- Vocabulary Building-The concept of Word Formation

Module- II (6hrs.)

Communication Skills

- The Basics of Business Communication- Process, types, levels
- Barriers to Communication Common obstacles to effective communication
- Approaches and Communication techniques for multiple needs at workplace: persuading, convincing, responding, resolving conflict, delivering bad news, making positive connections
- Identify common audiences and design techniques for communicating with each audience

Module- III (6hrs.)

Organizational Communication

- Business Letters
 - Organizational Communication: Agenda & minutes of a meeting, Notice, Memo, Circular
 - Organizing e-mail messages, E-mail etiquette
 - Techniques for writing precisely: Creating coherence, organizing principles –accuracy, clarity, brevity.
- Different styles of writing: descriptive, narrative, expository.

Module- IV (6hrs.)

Principles, techniques and skills for professional writing

- Logic in writing, thinking and problem-solving; applying deductive and inductive reasoning; Use of infographics in writing.
- Report Writing: Importance and Purpose, Types of Reports, Report Formats, Structure of Formal Reports, Writing Strategies. Interpreting data and writing reports
- Writing proposals and Statement of purpose

Text Books:

- 1 Kumar, S. & Lata, P. Communication Skills, OUP, New Delhi 2011
- 2 Rizvi, Ashraf, M. Effective Technical Communication, Mc Graw Hill Education (India) Pvt. Ltd., Chennai, 2018
- 3 Raman, M. and Sharma, S., Technical Communication: Principles and Practice, 2nd Ed., 2011

Reference Books:

1. Professional Writing Skills, Chan, Janis Fisher and Diane Lutovich. San Anselmo, CA: Advanced Communication Designs.
2. Hauppauge, Geffner, Andrew P. Business English, New York: Barron's Educational Series.

Course Title: English for Technical Writing Laboratory					
Course Code: HUM1051					
Contact hrs per week:	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcome:

Students will be able to

HUM1051.1. Communicate in an official and formal environment.

HUM1051.2. Effectively communicate in a group and engage in relevant discussion.

HUM1051.3. Engage in research and prepare presentations on selected topics.

HUM1051.4. Understand the dynamics of multicultural circumstances at workplace and act accordingly.

HUM1051.5. Organize content in an attempt to prepare official documents.

HUM1051.6. Appreciate the use of language to create beautiful expressions

Detailed Syllabus

Module- I (6hrs.)

The Art of Speaking

- Techniques for Effective Speaking
- Voice Modulation: Developing correct tone
- Using correct stress patterns: word stress, primary stress, secondary stress. Rhythm in connected speech
- Encoding Meaning Using Nonverbal Symbols,
- How to Improve Body Language
- Eye Communication, Facial Expression, Dress and Appearance
- Posture and Movement, Gesture, Paralanguage
- Encoding meaning using Verbal symbols: How words work and how to use words
- Volume, Pace, Pitch and Pause
- Structuring content for delivery in accordance with time, platform, and audience.

Module- II (6hrs)

Group Discussion

- Nature and purpose and characteristics of a successful Group Discussion
- Group discussion Strategies: Getting the GD started, contributing systematically, moving the discussion along, promoting optimal participation, Handling conflict, Effecting closure

Module- III (6hrs)

- Interviewing

Types of Interviews, Format for Job Interviews: One-to-one and Panel Interviews, Telephonic Interviews, Interview through video conferencing.

- Cover Letter & CV
- Interview Preparation Techniques, Frequently Asked Questions, Answering Strategies, Dress Code, Etiquette, Questions for the Interviewer, Simulated Interviews.

Module- IV (6hrs.)

Professional Presentation Skills

- Nature and Importance of Presentation skills
- Planning the Presentation: Define the purpose, analyze the Audience, Analyze the occasion and choose a suitable title.
- Preparing the Presentation: The central idea, main ideas, collecting support material, plan visual aids, design the slides
- Organizing the Presentation: Introduction-Getting audience attention, introduce the subject, establish credibility, preview the main ideas, Body-develop the main idea, present information sequentially and logically, Conclusion-summaries, re-emphasize, focus on the purpose, and provide closure.
- Improving Delivery: Choosing Delivery methods, handling stage fright
- Post-Presentation discussion: Handling Questions-opportunities and challenges.

References:

1. Carter, R. And Nunan, D. (Eds), The Cambridge guide to Teaching English to Speakers of Other Languages, CUP, 2001
2. Edward P. Bailey, Writing and Speaking At Work: A Practical Guide for Business Communication, Prentice Hall, 3rd Ed., 2004
3. Munter, M., Guide to Managerial Communication: Effective Business Writing and Speaking, Prentice Hall, 5th Ed., 1999
4. R. Anand, Job Readiness For IT & ITES- A Placement and Career Companion, , McGraw Hill Education.2015
5. Malhotra, A., Campus Placements, McGraw Hill Education.2015

1ST YEAR 2ND SEMESTER

Course Title : Physics I					
Course Code :PHY1001					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After successfully completing this course the students will be able to:

PHY1001.1. Understanding physical systems in terms of their modeling of time evolution.

PHY1001.2. Comprehending wave interpretation of natural phenomena and implications of allied observations.

PHY1001.3. Understanding theoretical backgrounds associated to some experiments based on wave phenomena.

PHY1001.4. Grasping an analytic view of micro and macroscopic world.

PHY1001.5. Accessing the knowledge of the behavior of a particle under the influence of different potential.

PHY1001.6. Understanding conservative systems based on their particle and wave nature.

Module –I

[10L]

Mechanics:

Plane-polar coordinate system-velocity and acceleration of a particle-trajectory under central force-conservation principle-Kepler's laws -Rotating frame of reference-Five point acceleration formula-Coriolis effect-deflection of a moving particle.

Module – II

[10L]

Oscillation:

Constitutive equation of damping-nature of solutions for large, critical and weak damping-relaxation time, logarithmic decrement, energy decay (qualitative discussion) -Forced oscillation-transient and steady state-amplitude and velocity resonance---power transfer theorem-quality factor-series LCR circuit with AC source.

Module –III

[10L]

Optics:

Plane Progressive Wave-phase/wave-length/frequency-qualitative description of light as an electromagnetic wave-Huygens principle-polarization (state of polarization, general equation of ellipse, transformation of polarized lights)-interference (basic theory from superposition principle)-Division of wave front (Young's double slit experiment)-Division of amplitude (thin film, wedge, Newton's ring)-Diffraction (single slit, double slit, grating, Resolving Power).

Module – IV

[10L]

Quantum Mechanics :

An informal discussion from Planck to de Broglie as the historical context of quantum mechanics-Quantum Mechanics of a particle-operator-eigenvalue problem- Unitary-Hermitian frame work-position and

momentum operator-Canonical Commutation Relations (CCR)- Schrodinger equation-time dependent/time independent Schrodinger equation-wave function-stationary states-probability density-probability current density-normalization-expectation value-uncertainty-Bound state problem-particle in a one dimensional box-scattering state problem-potential step-reflection and transmission coefficients- tunneling.

BOOKS

1. Theoretical Mechanics : M R Spiegel (Schaum Series) McGraw-Hill Book Company
2. Classical Mechanics: N C Rana and P S Joag Tata- McGraw-Hill Publishing Company Limited.
3. Vibrations and Waves : A P French, W W Norton and Company,
4. The Physics of Waves and Oscillations: N K Bajaj, Tata- McGraw-Hill Publishing Company Limited.
5. Optics : A Ghatak, Tata McGraw-Hill Publishing Company Limited.
6. Optics : E. Hecht, Addison Wesley
7. Fundamentals of Optics : F A Jenkins and H E White, McGraw-Hill Higher Education.
8. Atomic Physics (Modern Physics): S N Ghosal, S. Chand and Company.
9. Practical Quantum Mechanics : S Flugge, Springer (Reprint of the 1994 Edition)
10. Concepts of Modern Physics : A Baisier, Tata McGraw-Hill Publishing Company Limited.
11. Refresher Course in B.Sc. Physics – Vol1 and Vol 2 – C.L.Arora.

Course Title: Physics I Laboratory					
Course Code: PHY1051					
Contact hrs per week:	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

After successfully completing this course the students will be able to:

PHY1051.1 Understanding the usage of electrical and optical systems for various measurements.

PHY1051.2 Applying the analytical techniques and graphical analysis to the experimental data.

PHY1051.3 Understanding measurement technology, usage of new instruments and real time applications in engineering studies.

PHY1051.4 Evaluating intellectual communication skills and discuss the basic principles of scientific concepts in a group.

PHY1051.5 Construct the new idea by compiling their knowledge and can develop the new or improve the methodology.

MINIMUM OF SIX EXPERIMENTS TAKING ATLEAST ONE FROM EACH OF THE FOLLOWING FOUR GROUPS:

Optics Group

1. Determination of dispersive power of the material of a prism.
2. Determination of wavelength of a monochromatic light by Newton's ring.
3. Determination of specific rotation of sugar solution by using a Polarimeter.
4. Determination of wavelength of the given laser source by diffraction method.

Electricity & Magnetism Group

1. Determination of the magnetic field using circular current carrying coil.
2. Determination of dielectric constant of a given dielectric material.
3. Determination of Hall coefficient of a semiconductor by four probe method.
4. Determination of unknown resistance using Carey Foster's bridge

Quantum Physics Group

1. Determination of Stefan-Boltzmann constant.
2. Determination of Planck constant using photocell.
3. Determination of Rydberg constant by studying Hydrogen spectrum.
4. Determination of Band gap of semiconductor.

Miscellaneous Group

1. Determination of Young's modulus of elasticity of the material of a bar by the method of flexure
2. Determination of modulus of rigidity of the material of a rod by static method
3. Determination of rigidity modulus of the material of a wire by dynamic method
4. Determination of coefficient of viscosity by Poiseuille's capillary flow method

Course Title: Mathematics II					
Course Code: MTH1201					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	1	0	4	4

Course Outcomes

After successfully completing this course, the students will be able to:

1. MTH 1201. 1. Demonstrate the knowledge of probabilistic approaches to solve wide range of engineering problem.
2. MTH 1201. 2. Recognize probability distribution for discrete and continuous variables to quantify physical and engineering phenomenon.
3. MTH 1201. 3. Develop numerical techniques to obtain approximate solutions to mathematical problems where analytical solutions are not possible to evaluate.
4. MTH 1201. 4. Analyze certain physical problems that can be transformed in terms of graphs and trees and solving problems involving searching, sorting and such other algorithms.
5. MTH 1201. 5. Apply techniques of Laplace Transform and its inverse in various advanced engineering problems.
6. MTH 1201. 6. Interpret differential equations and reduce them to mere algebraic equations using Laplace Transform to solve easily.

The objective of this course is to familiarize the students with numerical techniques, integral transforms, graph theory and probability. It aims to equip the students with standard concepts and tools at an intermediate to advanced level that will serve them well towards tackling various problems in the discipline.

Module-I Fundamentals of Probability [10L]

Random experiment, Sample space and events

Classical and Axiomatic definition of probability

Addition and Multiplication law of probability

Conditional probability

Bayes' Theorem

Random variables

General discussion on discrete and continuous distributions

Expectation and Variance

Examples of special distribution: Binomial and Normal Distribution

Module-II Numerical Methods [10L]

Solution of non-linear algebraic and transcendental equations: Bisection Method, Newton-Raphson Method, Regula-Falsi Method.

Solution of linear system of equations: Gauss elimination method, Gauss-Seidel Method, LU Factorization Method, Matrix Inversion Method.

Solution of Ordinary differential equations: Euler's and Modified Euler's Method, Runge-Kutta Method of

4th order.

Module-III Basic Graph Theory [10L]

Graphs: Digraphs, Weighted graph, Connected and disconnected graphs, Complement of a graph, Regular graph, Complete graph, Subgraph

Walks, Paths, Circuits, Euler Graph, Cut sets and cut vertices

Matrix representation of a graph, Adjacency and incidence matrices of a graph

Graph isomorphism

Bipartite graph

Definition and properties of a tree

Binary tree, Spanning tree of a graph, Minimal spanning tree, properties of trees

Algorithms: Dijkstra's Algorithm for shortest path problem, Determination of minimal spanning tree using DFS, BFS, Kruskal's and Prim's algorithms

Module-IV Laplace Transformation [10L]

Basic ideas of improper integrals, working knowledge of Beta and Gamma functions (convergence to be assumed) and their interrelations.

Introduction to integral transformation

Functions of exponential order, Definition and existence of Laplace Transform (LT) (statement of initial and final value theorem only)

LT of elementary functions, Properties of Laplace Transformations, Evaluation of sine, cosine and exponential integrals using LT

LT of periodic and step functions

Definition and properties of inverse LT

Convolution Theorem (statement only) and its application to the evaluation of inverse LT

Solution of linear ODEs with constant coefficients (initial value problem) using LT

Suggested Books:

1. Advanced Engineering Mathematics , E.Kreyszig, Wiley Publications
2. Introduction to Probability and Statistics for Engineers and Scientists, S.Ross, Elsevier
3. Introductory methods of Numerical Analysis, S.S. Sastry, PHI learning
4. Introduction to Graph Theory, D. B. West, Prentice-Hall of India
5. Engineering Mathematics, B.S. Grewal, S. Chand & Co.

Course Title : Introduction to Electronic Devices and Circuits					
Course Code : ECE1001					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After going through this course, the students will be able to:

ECE1001.1. Categorize different semiconductor materials based on their energy bands and analyze the change in characteristics of those materials due to different types of doping.

ECE1001.2. Describe energy band of P-N Junction devices and solve problems related to P-N Junction Diode.

ECE1001.3. Design different application specific circuits using diodes.

ECE1001.4. Analyze various biasing configurations of Bipolar Junction Transistor.

ECE1001.5. Categorize different field-effect transistors and analyze their behavior.

ECE1001.6. Design and implement various practical electronic circuits.

Module I [10 L]

Basic Semiconductor Physics:

Crystalline materials, energy band theory, Conductors, Semiconductors and Insulators, Concept of Fermi energy level, intrinsic and extrinsic semiconductors, mass action law, drift and diffusion currents in semiconductor, Einstein relation.

Diodes and Diode Circuits:

Formation of p-n junction, energy band diagram, forward & reverse biased configurations, V-I characteristics, DC load line, breakdown mechanisms - Zener and avalanche breakdown, voltage regulation using Zener diode.

Rectifier circuits: half wave & full wave rectifiers: ripple factor, rectification efficiency, rectifier output without and with filters. Light emitting diode.

Module II [8 L]

Bipolar Junction Transistors (BJT):

PNP & NPN BJT structures, different operating modes of BJT, current components in BJT, dc current gains in CE & CB configurations and their interrelation, input & output V-I characteristics of CE & CB configurations. Concept of Biasing: DC load line, Q-point, basic concept of amplification using BJT.

Module III [9 L]

Field Effect Transistors (FET):

Classification of FET, basic structure and operation of Junction Field Effect Transistor (n-channel) along with its V-I characteristics.

Metal Oxide Semiconductor Field Effect Transistor (MOSFET): Enhancement & depletion type MOSFETs (for both n & p channel devices), drain & transfer characteristics.

Module IV [9 L]

Feedback in amplifiers:

Concept of feedback, different feedback topologies using block diagram only, effects of negative feedback (qualitative), Barkhausen criteria for sustained oscillation.

Operational Amplifier:

Usefulness of differential amplifier over single ended amplifier, ideal OPAMP characteristics, transfer characteristics of OPAMP, CMRR, slew rate, offset error voltages and current, concept of virtual ground

Basic circuits using OPAMP: Comparator, inverting and non-inverting amplifiers, voltage follower, adder, subtractor, integrator, differentiator.

Text Books:

1. Boylestad & Nashelsky: Electronic Devices & Circuit Theory
2. R.A Gayakwad: Op Amps and Linear IC's, PHI
3. D. Chattopadhyay, P. C Rakshit : Electronics Fundamentals and Applications

Reference Books:

1. Adel S. Sedra, Kenneth Carless Smith: Microelectronics Engineering
2. Millman & Halkias: Integrated Electronics.
3. Salivahanan: Electronics Devices & Circuits.
4. Albert Paul Malvino: Electronic Principle

Course Title : Introduction to Electronic Devices and Circuits Laboratory						
Course Code : ECE1051						
Contact Hours per week	L	T	P	Total	Credit Points	
	0	0	2	2	1	

Course Outcomes:

ECE1051.1. The students will correlate theory with diode behavior.

ECE1051.2. They will design and check rectifier operation with regulation etc.

ECE1051.3. Students will design different modes with BJT and FET and check operations.

ECE1051.4. They will design and study adder, integrator etc. with OP-AMPs.

List of Experiments

1. Familiarization with passive and active electronic components such as Resistors, Inductors, Capacitors, Diodes, Transistors (BJT) and electronic equipment like DC power supplies, multi-meters etc.
2. Familiarization with measuring and testing equipment like CRO, Signal generators etc.
3. Study of I-V characteristics of Junction diodes.
4. Study of I-V characteristics of Zener diodes.
5. Study of Half and Full wave rectifiers with Regulation and Ripple factors.
6. Study of I-V characteristics of BJTs in CB mode
7. Study of I-V characteristics of BJTs in CE mode
8. Study of I-V characteristics of Field Effect Transistors.
9. Determination of input-offset voltage, input bias current and Slew rate of OPAMPs.
10. Determination of Common-mode Rejection ratio, Bandwidth and Off-set null of OPAMPs.
11. Study of OPAMP circuits: Inverting and Non-inverting amplifiers, Adders, Integrators and Differentiators.

Course Name: Universal Human Values and Professional Ethics						
Course Code : HUM1002						
Contact Hours per week	L	T	P	Total	Credit Points	
	2	1	0	3	3	

Course Outcome:

Students will be able to

HUM1002.1. Appreciate the essential complementarity between ‘values and ‘skills’ to ensure sustained happiness and prosperity which are the core aspirations of all human beings.

HUM1002.2. Develop a Holistic perspective towards life and profession

HUM1002.3. Develop a correct understanding of the Human reality and the rest of existence

HUM1002.4. Appreciate the relationship of values in terms of ethical human conduct.

HUM1002.5. Understand the importance of trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

HUM1002.6. Differentiate between the characteristics and activities of different orders and study the mutual fulfilment among them.

Detailed Syllabus

Module 1 – Introduction to Value Education (6hrs.)

Understanding Values: Historical perspective to the development of values and its importance for the integration and harmony of the self and body

Understanding Human being as the Co-existence of the Self and the Body

Exploring Harmony of Self with the Body

Distinguishing between the Needs of the Self and the Body

Understanding and appreciating basic human aspirations-Maslow’s Hierarchy of Needs Theory

Strategies, Methods to Fulfil the Basic Human Aspirations

Continuous Happiness and Prosperity – the Basic Human Aspirations

Module 2 – Harmony in the Family and Society (10hrs.)

The self as a social being starting with the family as the smallest unit—the process of socialisation.

Development of the self in relation to the society – Cooley’s and Mead’s theories of socialization.

Self and Integrated personality-Morality, Courage and Integrity

Conflict of interest at home and society and its resolution through the implementation of the Human Values

Societal Values – Justice, Democracy and Rule of law

Establishing harmony in the society with the help of ethical conduct based on values- Ethics of Rights and Duties, Ethics of care, Ethics justice and Fairness, Work Ethics and quality of life at work.

Value crisis- disharmony in relationships, understanding harmony in the society

Solutions - contribution of the individual in establishing harmony in the society.

‘Trust’ and ‘Respect’--the Foundational Values in Relationship

Exploring the Feeling of Trust and Respect

Module 3 – Implications of the Holistic Understanding – a Look at Professional Ethics (10hrs.)

Ethics and Ethical Values

Principles and theories of ethics--Consequential and non-consequential ethics, Utilitarianism, Kant's theory and other non-consequential perspectives

Professional Ethics- Right understanding of Professional Ethics

Canons of professional Ethics

Technology – various perspectives-its use, overuse and misuse

Privacy, data security and data protection, Artificial intelligence-harmony or disharmony, misinformation, deep fake, cyber-crime - a sociological perspective.

Code of Ethics, Violation of code of ethics, Whistle blowing, Institutionalising Ethics

Vision for the Universal Human Order, Exploring Systems to fulfil Human Endeavours

Module 4 – Harmony in the Nature/Existence (10hrs.)

Understanding Harmony in the Nature -Ecological Ethics

Sustainable development- Definition and Concept

Strategies for sustainable development- Small is beautiful, slow is Beautiful
Sustainable Development--- The Modern Trends

Sustainable Development Goals- Case studies and Best practices

Exploring the Four Orders of Nature -Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature

The Holistic Perception of Harmony in Existence

Suggested Readings:

1. A Foundation Course in Human Values and Professional Ethics, R.R. Gaur, R. Asthana, G.P. Bagaria, Excel Books Pvt. Ltd. New Delhi
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews

Course Title: Workshop/Manufacturing Practices					
Course Code : MEC1051					
Contact Hours per week	L	T	P	Total	Credit Points
	1	0	3	4	2.5

Course Outcomes:

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

MEC1051.1. Follow the various safety practices in workshop and personal protective elements.

MEC1051.2. Identify tools, work material and measuring instruments useful for fitting, carpentry and sheet metal practices.

MEC1051.3. Operate machine tools, components and processes to prepare jobs of specific shape and size.

MEC1051.4. Acquire knowledge of foundry process and casting of a product.

MEC1051.5. Perform welding, brazing and soldering processes.

MEC1051.6. Assemble a simple product.

Syllabus:

Lectures: (13 hours)

Detailed contents

- | | |
|---|--------------|
| 1. Introduction on Workshop and familiarization with safety norms | (1 lecture) |
| 2. Carpentry and Fitting | (2 lectures) |
| 3. Sheet metal | (1 lecture) |
| 4. Metal casting | (1 lecture) |
| 5. Welding (arc welding & gas welding), brazing and soldering | (2 lectures) |
| 6. Manufacturing Methods- machining (Lathe, Shaping and Milling) | (4 lectures) |
| 7. Additive manufacturing | (1 lecture) |

(ii) Workshop Practice :(39 hours)

- | | |
|---------------------------------|-----------|
| 1. Safety practices in workshop | (3 hours) |
| 2. Carpentry shop | (3 hours) |
| 3. Fitting shop | (6 hours) |
| 4. Foundry shop | (3 hours) |
| 5. Machine shop | (9 hours) |
| 6. Welding shop-Arc welding | (3 hours) |
| 7. Sheet metal shop and brazing | (6 hours) |
| 8. Soldering operation | (3 hours) |
| 9. Assembling of a product | (3 hours) |

Suggested Text/Reference Books:

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., “Elements of Workshop Technology”, Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. And Steven S. Schmid, “Manufacturing Engineering and Technology”, 4th edition, Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu, “Manufacturing Technology – I” Pearson Education, 2008.
4. Roy A. Lindberg, “Processes and Materials of Manufacture”, 4th edition, Prentice Hall India, 1998.
5. Rao P.N., “Manufacturing Technology”, Vol. I and Vol. II, Tata McGrawHill House, 2017.

Course Title : Engineering Graphics and Design					
Course Code : MEC1052					
Contact hrs per week:	L	T	P	Total	Credit Points
	1	0	3	4	2.5

Course Outcomes:

After going through the course, the students will be able to

MEC1052.1. Visualize the basic concept of engineering drawing.

MEC1052.2. Use engineering drawing tools (conventional / modern tools).

MEC1052.3. Apply the various standards and symbols followed in engineering drawing.

MEC1052.4. Implement the concept of projections used in engineering graphics.

MEC1052.5. Relate the concept of sections to determine its true shape.

MEC1052.6. Execute the concept of isometric projections.

Lecture Plan (13 L)

1. Importance and principles of engineering drawing (1 L)
2. Lettering (1 L)
3. Concepts of Scale, dimensioning and Conic sections (3 L)
4. Introduction to concept of projection (Projections of points, lines and surfaces) (3 L)
5. Definitions of different solids and their projections (1 L)
6. Section of solids and sectional view (1 L)
7. Isometric projection (1 L)
8. Introduction to CAD (1 L)
9. Viva-voce (1L)

Detailed contents of Laboratory hours (39 hours)

Module 1: Introduction to Engineering Drawing (3 hours)

Principles of Engineering Graphics and their significance, usage of Drawing instruments, lines, lettering & dimensioning, Conic sections like Ellipse (General method only); Involute; Scales – Plain, Diagonal.

Module 2: Orthographic Projections (9hours)

Principles of Orthographic Projections - Conventions - Projections of Points and lines inclined to both planes; Projections on Auxiliary Planes; Projection of lamina.

Module 3: Projections of Regular Solids (6 hours)

Those axes inclined to both the Planes- Auxiliary Views.

Module 4: Sections and Sectional Views of Right Angular Solids (3 hours)

Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Sectional orthographic views of geometrical solids.

Module 5: Isometric Projections (6 hours)

Principles of Isometric projection -Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions.

Module 6: Overview of Computer Graphics (3 hours)

Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.; Isometric Views of lines, Planes, Simple and compound Solids.

Module 7: Customization& CAD Drawing (3 hours)

Consisting of set up of the drawing page and the printer, including scale settings, setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerance; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles.

Module 8: Annotations, layering & other functions (3 hours)

Applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation.

Module 9: Demonstration of a simple team design project that illustrates (3 hours)

Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame.

References:

1. Bhatt, N.D., Panchal V.M. & Ingle P.R., (2014) “Elementary Engineering Drawing”; CharotanPublishing House
2. Narayana, K.L. and Kannaaiah P “Engineering Graphics”; TMH
3. Lakshminarayanan, V. and Vaish Wanar, R.S “Engineering Graphics” Jain Brothers.
4. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Edication.
5. Agarwal B. & Agarwal C. M. (2012), Engineering graphics, TMH Publications.

2nd YEAR 1st SEMESTER

Course Title : Analog Circuits							
Course Code : ECE2101							
Contact	Hours	per	L	T	P	Total	Credit Points
week			3	0	0	3	3

Course Outcomes:

After going through this course, the students will be able to

ECE2101.1. Apply the previous knowledge gathered from Basic Electrical and Basic Electronics papers.

ECE2101.2. Understand the concepts of BJT, MOSFET and biasing techniques of BJT and MOSFET based amplifier circuits.

ECE2101.3. Analyze frequency response of amplifier circuits.

ECE2101.4. Design different type sinusoidal oscillators and multivibrator circuits.

ECE2101.5. Construct algebraic equations based amplifier and analog computers using OP-AMP

ECE2101.6. Design stable high-gain amplifier circuits.

MODULE 1: Analog Signals and Devices [9L]

Basic concepts and device biasing [5L]:

Analog, discrete and digital signals. Diode: piecewise-linear model, clipping and clamping operation. Diode, Application of Zener diode as voltage regulator, BJT biasing circuits, Q-point and stability.

Small Signal analysis of Amplifiers [4L]:

Small signal (h-parameter and re model) analysis of BJT CE mode amplifier circuit (derive input impedance, output impedance, voltage gain, current gain for the amplifiers).

MODULE 2: Oscillators and Frequency Responses of Amplifiers [9L]

Frequency Responses of Amplifiers [2L]:

Frequency response of CE mode RC-coupled amplifier; effect of external and parasitic capacitors on cut-off frequencies.

Oscillator Circuits [7L]:

Classification of Oscillator, Oscillators circuits: Phase-shift, Wien-Bridge, Hartley, Colpitt and Crystal Oscillators.

MODULE 3: Operational Amplifiers (OPAMPs) [7L]

Fundamentals of OPAMP [4L]:

Basic building blocks of OPAMP: Differential Amplifiers, Current source and current mirror circuits. Types of differential amplifiers, AC and DC analysis of differential amplifiers; Characteristics of an ideal and practical OPAMP.

Applications of OPAMP [3L]:

Inverting and non-inverting OPAMP amplifiers, Adder, Subtractor, Log-antilog amplifiers, Multiplier, Integrator, Differentiator, Analog computer, Instrumentation amplifier, Precision rectifiers, basic comparator, Schmitt Trigger.

MODULE 4: Analog Circuit Applications [7L]

Power Amplifiers [4L]:

Concepts and operations of Class A, B and AB amplifiers; Calculation of DC power, AC power and efficiency of these amplifiers. Class C amplifier.

Applications Analog IC [3L]:

Description of 555 Timer IC, astable and mono-stable operations using 555. Study of 78XX and 79XX voltage regulator ICs.

Books:

1. Microelectronic Circuits by Adel S. Sedra, Kenneth C. Smith
2. Electronics Devices and Circuits by Robert L. Boylestad, Louis Nashelskey
3. Fundamentals of Microelectronics by Behzad Razavi
4. Integrated electronics by Jacob Millman, Christos C. Halkias

Course Title:Analog Circuits Laboratory					
CourseCode:ECE2151					
Contact Hoursperweek	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

The students, after finishing the course, will be able to:

ECE2151.1. Study and compare frequency responses of amplifiers.

ECE2151.2. Design different timer circuits with 555 IC.

ECE2151.3. Design rectifiers and measure rectifier parameters.

ECE2151.4. Generate various waveforms using OP AMPs.

List of experiments:

Experiments using discrete components

1. Study of frequency response of RC coupled amplifier circuit.
2. Study of astable multi-vibrator using 555 timer IC.
3. Study of monostable multi-vibrator using 555 timer IC.
4. Study of full wave and half wave precision rectifier circuits.
5. Study of Wien-Bridge oscillator circuit.
6. Study of Phase Shift oscillator circuit.
7. Study of astable multi-vibrator using OPAMP.
8. Study of Triangular wave generator circuit using OPAMP.
9. Study of Schmitt trigger circuit.
10. Study of fixed voltage regulator circuits using 78XX and 79XX ICs.

Experiments using ASLKv2010 StarterKit

11. Negative feedback amplifiers and instrumentation amplifiers to measure parameters like time response, frequency response, DC transfer characteristics.
12. Study of analog filters like LPF, HPF, BPF and BSF.
13. Study of VCO and PLL
14. Automatic gain / volume control (AGC/AVC)
15. PC based Oscilloscope

Course Title: Digital Systems Design					
Course Code: ECE2102					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course outcomes:

The students after finishing this course will be able to

- ECE2102.1.** Students will learn about the Binary Number system and minimization of logic expression using different methods.
- ECE2102.2.** Students will design different Arithmetic Combinational circuits like Adder, Subtractor.
- ECE2102.3.** Students will be able to design Multiplexer, De-Multiplexer, Decoder, Encoder, etc and learn about applications
- ECE2102.4.** Students will be able to design Sequential Circuits such as flip flops and perform inter conversion of them.
- ECE2102.5.** Students will design various types of Registers and Counters Circuits using Flip-Flops (Synchronous, Asynchronous, Irregular, Cascaded, Ring, Johnson).
- ECE2102.6.** Students will learn basic gates using RTL, DTL, TTL, ECL, and CMOS logic families and analyze different memory systems including RAM, ROM, EPROM, EEROM, etc.

Module-1 [8L]

Data and number systems; Binary, Octal, and Hexadecimal representation and their conversions; BCD, Gray codes and their conversions; Signed binary number representation with 1's and 2's complement methods, Binary arithmetic. Boolean algebra, De-Morgan's theorem, Various Logic gates-their truth tables and circuits; Representation in SOP and POS forms; Minimization of logic expressions by algebraic method; Karnaugh-map method, Quine-Mc Cluskey method (3 & 4 variables).

Module-2: [11L]

Arithmetic Circuits: Adder circuit – Ripple Carry and BCD Adder; Subtractor circuit.

Combinational Circuit: Encoder, Decoder, Comparator, Multiplexer, De-Multiplexer and parity Generator; Shannon's Expansion Theorem.

Module-3: [10 L]

Sequential Circuits- Sequential circuits design methodology; Basic memory element S-R, J-K, D, and T Flip Flops, Inter conversions of Flip-Flop; Finite State Machine Design using Sequential circuit design methodology; various types of Registers (with Parallel load, shift Registers), and Counters (Asynchronous ripple counters, Synchronous counters: BCD, Ring, Johnson).

Module-4: [9 L]

Memory Systems: Concepts and basic designs of RAM, ROM, EPROM, EEROM, Programming logic devices and gate arrays (PLAs and PLDs) Tri-state logic.

Logic families- RTL, DTL, TTL, ECL, and CMOS, their operation and specifications.

Textbooks:

1. S.Salivahanan, S.Arivazhagan-Digital Circuit & Design, Oxford
2. Anand kumar-Fundamental of Digital Circuits, PHI
3. Virendra Kumar-Digital technology, New Age Publication
4. R.P.Jain-Modern Digital Electronics, 2/e, Mc Graw Hill

References:

1. H.Taub&D.Shilling-Digital Integrated Electronics, Mc Graw Hill
2. Tocci, Widmer, Moss-Digital Systems, 9/e, Pearson
3. Leach &Malvino-Digital Principles &Application, 5/e, Mc Graw Hill
4. Floyd & Jain-Digital Fundamentals, Pearson

Course Title:Digital Systems Design Lab					
CourseCode:ECE2152					
Contact Hoursperweek	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

The students after finishing this course will be able to :

ECE2152.1. Design code converters.

ECE2152.2. Design arithmetic circuits.

ECE2152.3. Design combinational logic circuits.

ECE2152.4. Realize flip-flops and counters.

List of Experiments:

1. Realization of basic gates using Universal logic gates.
2. Realization of code conversion circuits - BCD to Excess-3 and vice-versa.
3. Construction of simple arithmetic circuits - Adder, Subtractor.
4. Design of Parity Bit Generator and Checker circuits.
5. Construction of Decoder circuit using logic gates.
6. Construction of Multiplexer circuit using logic gates and realization of different combinational logic circuits using Multiplexer.
7. Design of 2-Bit Comparator Circuit.
8. Realization of RS, D and JK flip-flops using universal logic gates.
9. Realization of Asynchronous Up or Down counter.
10. Realization of Synchronous Up or Down counter.
11. Realization of Ring and Johnson's counters.

Course Title: Signals and Systems					
Course Code: ECE2103					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

The students after finishing this course will be able to

- ECE2103.1.** Apply the previous knowledge of mathematics on differential calculus
- ECE2103.2.** Categorize and identify the different types of signals and systems
- ECE2103.3.** Evaluate the responses of different systems with the applications of convolution and also be able to determine the stability of a system.
- ECE2103.4.** Analyze the frequency domain characteristics of signals using Fourier series, Fourier transforms, Laplace Transform and their application in communication system.
- ECE2103.5.** Implement and extend the concepts of transformation tools to study LTI systems and principles of Sampling.
- ECE2103.6.** Analyze random signals and their properties, understand their differences from deterministic signals, hence extending the concept towards understanding noise in communication circuits.

Module No-1: Introduction to Signal and Systems: [6 L]

Classification of Signals: Discrete time- continuous time signal, Periodic- aperiodic, Even – odd, Energy - power signals, Deterministic- random signals, Causal – noncausal signal, complex exponential and sinusoidal signals, periodicity, unit impulse, unit step, unit ramp Transformation of independent variable of signals-Time scaling, Time shifting.

Properties of Systems: Classification of systems, Linearity, Causality, Time invariance and BIBO Stability. Distortion-less systems, Invertible systems, Continuous – discrete system

Module No-2: Analysis of continuous time signals and LTIC System: [11 L]

Continuous time Fourier Series, Dirichlet's conditions. Fourier transformation of continuous time signals and their properties.

Impulse response of LTIC systems, Convolution in continuous time, Correlation of continuous –time signals, Stability analysis using impulse response, Laplace transformation and its Properties. Parseval's theorem. Computation of transfer function. Analysis of LTI systems using different transformations. Natural & Forced response.

Module No-3: Analysis of discrete time signals and LTID System: [11L]

Convolution in discrete time, Correlation of discrete time signals, Discrete time Fourier Series, Fourier transformation of discrete time signals and their properties.

Time domain analysis of LTID system, Natural & Forced response of a LTID system.

Application of Fourier Transform (understanding spectrum of time domain signals) in communication system.

Module No-4: Application of Signals and Systems theory: [8 L]

Sampling: Sampling Theorem, Types of sampling, Aliasing, Pre-alias filter, Reconstruction of a signal from its samples.

Random process and noise: Random variable, random process, ensemble, time average, ensemble average, stationary and ergodic process, correlation between two random variables. Distribution & density function, mean values & moments, function of two random variables, spectral densities, Noise sources in circuits, noise in communication circuits and systems, noise voltage.

Text Books:

1. A.V.Oppenheim, A.S.Willsky and S.H.Nawab -Signals & Systems, Pearson
2. B.P.Lathi- Signal Processing & Linear Systems- Oxford
3. P.Ramesh Babu & R.Anandanatarajan- Signals and Systems 4/e- Scitech
4. Sanjay Sharma-Signals and Systems, Kataria Publication

References:

1. G. Proakis & D.G. Melonakos- Digital Signal Processing Principles, Algorithms and Applications,.
2. A.Nagoor Kani- Signals and Systems- McGraw Hill
3. S.Haykin & B.V.Veen, Signals and Systems- John Wiley
4. S.Haykin, Digital Communication- John Wiley
5. Digital signal Processing by S.K. Mitra-Tata McGraw Hill

Course Title: Network Theory					
CourseCode:ECE2104					
Contact Hoursperweek	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

The students after finishing this course will be able to

ECE2104.1. Apply the previous knowledge gathered from Basic Electrical Engineering for understanding the basic concepts of this subject.

ECE2104.2. Apply Network Theorems to solve various complex electric circuits.

ECE2104.3. Analyze higher order circuits having reactive elements in Laplace domain.

ECE2104.4. Apply graph theory to solve various network related problems.

ECE2104.5. Analyze the input output behavior of two port networks using various types of parameters.

ECE2104.6. Design of various types of filter circuits and simulation using SPICE software.

Module-I [11 L]

Network equations: Concepts of independent and dependent types of voltage and current sources, Nodal and Mesh analysis of different circuits. Network Theorems: Superposition, Thevenin's, Norton's, Maximum Power Transfer Theorem, Reciprocity and Compensation theorem applied to circuits containing different types of sources. [5L]

Resonant Circuits: Series and parallel resonance, Impedance and admittance characteristics, Quality factor, Half power points, Bandwidth, Phasor diagrams. [4L]

Coupled Circuits: Self-inductance and mutual inductance, Coefficient of coupling, Dot convention, Analysis of coupled circuits. [2L]

Module-II [8 L]

Laplace Transform Fundamentals: Concept of complex frequency. Properties of Laplace transform: linearity, differentiation, integration, periodicity, initial and final value theorems. Transform of standard periodic waveforms. [3L]

Circuit elements, sources and their transformed equivalents, treatment of mutual couplings in time and Laplace domain. Transient and steady state response of RL, RC, LC and RLC with and without stored energy. Concept of natural frequency and damping. [3L]

Analysis of different circuits containing reactive elements and switches in Laplace domain. [2L]

Module-III [10L]

Graph theory: Fundamentals of graph theory related to circuit analysis, formation of Incidence matrix, tie-set matrix and f-cut set matrix and their properties. Construction of graph of any given network, Loop currents and node-pair potentials, matrix formation of KVL & KCL equations using graph theory. [4L]

Two port networks: Introduction to two port circuit analysis, Open circuit Impedance & Short circuit Admittance parameter, Transmission parameters, Hybrid parameters and inverse hybrid parameters. Inter relation between parameters. Inter connection between two port networks. Driving point impedance, transfer impedance & admittance. [5L]

Concept of characteristic impedance and its significance. [1L]

Module-IV [8L]

Filter Circuits: Concept and classification of filter circuits. Advantage of active filters over passive filters, Analysis and synthesis of Active Low pass, High pass, Band pass and Band reject filters of 1st and 2nd order using operational amplifier. Filter approximations: Butterworth, Chebyshev filters. [5L]

SPICE Simulation: Introduction to SPICE program, DC analysis, transient analysis and AC analysis of different circuits using SPICE, calculation of input and output Impedance using SPICE, Analysis of various circuits having dependent current and voltage sources using SPICE. [3L]

Text Books:

1. Networks and Systems, D. Roy Chowdhury, New Age International Publishers
2. Circuit theory, Dr. Abhijit Chakrabarty, Dhanpat Rai & Co Pvt. Ltd.
3. Network Analysis, M.E. Valkenburg, Pearson Education .
4. Fundamental of Electric circuit theory, D. Chattopadhyay& P.C. Rakshit, S. Chand.

Reference Books:

1. Engineering Circuit Analysis, W.H. Hyat, J.E. Kemmerly& S.M. Durbin, The Mc Graw Hill Company.
2. Modern Network Analysis, F.M.Reza&S.Seely, McGraw Hill.

Course Title: Introduction to Complex and Fourier Analysis

Course Code: MTH2101

Contact Hours per week	L	T	P	Total	Credit Points
	2	0	0	2	2

Course Outcomes:

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

MTH2101.1: Remember and understand the limit, continuity, differentiability and analyticity of functions of complex variables.

MTH2101.2: Apply the concepts of complex integration in different engineering domains.

MTH2101.3: Use the concepts of singularities, poles and residues in engineering problems.

MTH2101.4: Generate the complex exponential Fourier series and understand the use of Fourier series to represent periodical physical phenomena in engineering analysis.

MTH2101.5: Understand Fourier integral theorems, Fourier sine and cosine transforms by applying them to appropriate examples.

MTH2101.6: Interpret the nature of a physical phenomenon when the domain is shifted by Fourier transform e.g. continuous time signals and systems.

Module I: [10L] Functions of Complex Variables

Complex numbers and its geometrical representation. Stereographic projection. Functions of a complex variable – limits, continuity, and differentiability. Analytic Functions, Cauchy- Riemann equations, Necessary and sufficient conditions for analyticity of complex functions (Statement only), Harmonic functions. Milne-Thompson method. Conformal mapping.

Module II: [10L] Complex Integration

Line Integral on complex plane, Cauchy-Goursat theorem, Cauchy's Integral Formula. Taylor's and Laurent's series expansion. Zeros, Different types of Singularities. Definitions of poles and residues, Residue Theorem, Evaluation of real integrals using residue theorem, Integrals of the form $\int_{-\infty}^{\infty} \frac{P(x)}{Q(x)} dx$, $\int_{-\infty}^{\infty} \frac{P(x)}{Q(x)} \sin x dx$, $\int_{-\infty}^{\infty} \frac{P(x)}{Q(x)} \cos x dx$ and $\int_0^{\infty} \frac{P(x)}{Q(x)} dx$ for a real variable x with $Q(x) \neq 0$.

Module III: [10L] Fourier Series

Definite Integral, Orthogonality of trigonometric functions. Power Series and its convergence. Periodic functions, even and odd functions, Dirichlet's conditions, Euler formulas for Fourier coefficients,

Fourier series for functions of period $2l$. Fourier series representation of a function, e.g. Periodic square wave, Half wave rectifier, Unit step function. Half range Fourier sine series and cosine series, Parseval's identity.

Module IV: [10L] Fourier Transform

Fourier Integral theorem (statement only), Fourier transform, Fourier sine and cosine transform. Linearity, scaling, frequency shifting and time shifting properties. Parseval's identity for Fourier transforms. Inverse Fourier transform. Convolution Theorem. Discussion of some physical problems: e.g. Forced oscillations.

Text Books

1. Advanced Engineering Mathematics – Erwin Kreyszig.
2. Higher Engineering Mathematics – B. V. Ramana.

Reference Books

1. Complex Variables and Applications – J. W. Brown, R. V. Churchill.
2. Schaum's Outline of Complex Variables – Murray R. Spiegel, S. Lipschutz, J. J. Schiller, D. Spellman.
3. Schaum's Outline of Fourier Analysis with Applications to Boundary Value Problems – Murray R. Spiegel.
4. Integral Transforms for Engineers and Applied Mathematicians – Larry C. Andrews, B. K. Shivamoggi.

Course Title :Data Structure and Basic Algorithm					
Course Code :CSE2004					
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Course Outcomes:

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

CSE2004.1: Identify and select appropriate data structures as applied to specified problem definition.

CSE2004.2: Implement operations like searching, insertion, deletion, traversal etc. on linear data structures like array, stack and queue.

CSE2004.3: Implement operations like searching, insertion, deletion, traversal etc. on nonlinear data structures like tree and graph.

CSE2004.4: Apply appropriate sorting/searching technique for given problem.

CSE2004.5: Analyze and compare the different sorting algorithms.

CSE2004.6: Design advanced data structure using Nonlinear data structures.

MODULE 1: Linear Data Structure I: [8L]

Introduction (2L):

Concepts of data structures (Data, data structure, Abstract Data Type), Need of data structure, Basic idea of pseudo-code, algorithm analysis and Big O notation.

Array (2L):

Different representations – row major, column major. Sparse matrix – its implementation and usage. Array representation of polynomials.

Linked List (4L):

Singly linked list, Circular linked list, Doubly linked list (Creation, insertion at different positions, deletion from different positions of the list), Linked list representation of polynomial and applications.

MODULE 2: [6L]

Stack and Queue (4L):

Stack and its implementations (using array and linked list), applications.

Queue, circular queue, deque (using array and linked list).

Recursion (2L):

Principles of recursion – Design of recursive algorithms, differences between recursion and iteration, merits and demerits of recursion, Tail recursion.

MODULE 3: [12L]

Trees (9L):

Basic terminologies, tree representation (using array and linked list).

Binary trees – binary tree traversal (pre-order, in-order, post-order), threaded binary tree (examples only). Binary search tree and its operations (creation, insertion, deletion, searching).
Height Balanced binary tree – AVL tree and its operations (insertion, deletion with examples only).

Graphs (3L):

Basic terminologies, Graph representations/storage implementations (using adjacency matrix and adjacency list)
Graph traversal algorithms – Depth-first search (DFS), Breadth-first search (BFS).

MODULE 4: [10L]

Sorting Algorithms (6L):

Bubblesort, Insertionsort, Selectionsort, Mergesort, Quicksort, Heapsort and their comparisons.

Searching (1L):

Linear search, binary search and their comparisons.

Hashing (3L):

Basic terminologies, Different hashing functions, Collision resolution techniques (Open addressing and Chaining).

TEXT BOOKS

1. “Data Structures and Program Design in C”, 2/E by Robert L. Kruse, Bruce P. Leung.
2. “Fundamentals of Data Structures of C” by Ellis Horowitz, Sartaj Sahni, Susan Anderson-freed.
3. “Classic Data Structures” by D. Samanta.
4. “Data Structures in C” by Aaron M. Tanenbaum.
5. “Data Structures” by S. Lipschutz.

REFERENCE BOOKS

1. “Data Structures in C” by Aaron M. Tanenbaum.
2. “Data Structures” by S. Lipschutz.

Course Title: Data Structure and Basic Algorithm Laboratory

Course Code: CSE2054

Contact Hours per week	L	T	P	Total	Credit Points
	0	0	3	3	1.5

Course Outcomes:

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

CSE2054.1: Identify the appropriate data structure for given problem.

CSE2054.2: Understand the concept of Dynamic memory management, data types, algorithms etc.

CSE2054.3: Understand and implement basic data structures such as arrays, linked lists, stacks and queues.

CSE2054.4: Implement various applications involving array, stack, queue and linked lists.

CSE2054.5: Solve problem involving graphs and trees.

CSE2054.6: Apply algorithm for solving problems like sorting and searching.

List of experiments:

1. Implementation of array operations.
2. Stacks and Queues: adding, deleting elements, Circular Queue: Adding & deleting elements.
3. Evaluation of expressions operations on stacks.
4. Implementation of linked lists: inserting, deleting, and inverting a linked list.
5. Implementation of stacks & queues using linked lists
6. Polynomial addition.
7. Addition of Sparse matrices.
8. Traversal of Trees.
9. DFS and BFS implementation.
10. Sorting and searching algorithms.

TEXT BOOKS

3. "Data Structures and Program Design in C", 2/E by Robert L. Kruse, Bruce P. Leung.
4. "Fundamentals of Data Structures of C" by Ellis Horowitz, Sartaj Sahni, Susan Anderson-freed.
5. "Classic Data Structures" by D. Samanta.

REFERENCE BOOKS

1. "Data Structures in C" by Aaron M. Tanenbaum.
2. "Data Structures" by S. Lipschutz.

Course Title: Signals And Networks Laboratory					
Course Code : ECE2156					
Contact Hours per week	L	T	P	Total	Credit points
	0	0	2	2	1

Course Outcomes:

The students after finishing this course will be able to

ECE2156.1. Generate different signals and perform time domain operations on the signals

ECE2156.2. Analyze the time domain and frequency domain analysis of a system

ECE2156.3. Apply different circuit analysis methods using SPICE software.

ECE2156.4. Design different types of filters for applications in electrical networks

List of Experiments:

1. Generation of continuous-time signals: Periodic, Exponential, Sinusoidal, Damped Sinusoidal, Step, Impulse, Ramp signals.
2. Generation of Discrete-time signals: Periodic, Exponential, Sinusoidal, Damped Sinusoidal, Step, Impulse, Ramp signals
3. To study the different operations on signals- Time shifting, Time scaling, Time reversal
4. To study convolution theorem and verification of its properties.
5. Verification of Fourier Transform, Inverse Fourier transform and its properties
6. Verification of Laplace Transform, Inverse Laplace transform and its properties.
7. Study of transient responses of R-L and R-C networks using SPICE software.
8. Study of transient responses of R-L-C series and parallel circuits using SPICE software.
9. Verification of Reciprocity and Compensation theorems using SPICE software.
10. Determination of Impedance (Z) and Admittance (Y) parameters of two port networks using SPICE software.
11. Design and simulation of active low pass and high pass filters using SPICE software.
12. Design of band pass and band reject filters using active low pass and high pass filters and simulation using SPICE software.

Course Title: Micro Project: Design Thinking & Idea Lab (ECE)					
Course Code : ECE2196					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

The students after finishing this course will be able to

ECE2196.1. Develop new ways of creative thinking and learn the innovation cycle of design thinking process for developing innovative products.

ECE2196.2. Propose real-time innovative engineering product designs and choose appropriate frameworks, strategies, techniques during prototype development.

ECE2196.3. Learn all the skills associated with the tools and inventory associated with the IDEA Lab.

ECE2196.4. Learn necessary skills to build useful and standalone system/ project with enclosures.

Course contents:

(i) Lecture [L: 1; T: 0; P:0]

1. Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples).
2. Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving.
3. Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and functions.
4. What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example.
5. Understanding Individual differences & Uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences.
6. Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience.
7. Solving Practical Engineering Problem through Innovative Product Design & Creative Solution.

(ii) Laboratory: [L: 0; T: 0; P: 2]

1. Familiarization with the concepts of Design Thinking and different laboratory equipment (DSO, DMM, Signal and function generator). Introduction to the fundamentals of PCB & elementary PCB design.
2. Introduction to the fundamentals Vero board. Hands on practice of Soldering using soldering iron, and Vero board. In the process design and implement a bridge rectifier on Vero board using necessary circuit components.

3. Design of a RC filter as per the given specification and implement the corresponding circuit on the Vero board.
4. Design and implementation of a regulated power supply with the help of previously designed bridge rectifier and RC filter using zener diode and necessary circuit components. Study the load regulation of the designed regulated power supply.
5. Introduction to the Arduino architecture. Installation of the required files to interface Arduino with the PC. During the process, load a sample test program to Arduino in-order to check the functionality of the microcontroller kit.
6. Write a program to interface LCD display with the Arduino kit. Displaying different patterns as per the given specification on the LCD display.
7. Build a circuit by interfacing different sensors to the Arduino kit. Shape a prototype of a smart sensing device that will display the sensed data on the LCD display connected with the Arduino kit.

Text/Reference Books:

1. E Balaguruswamy (2022), Developing Thinking Skills (The way to Success), Khanna Book Publishing Company.
2. Make Your Own PCBs with EAGLE: From Schematic Designs to Finished Boards. Simon Monk and Duncan Amos. McGraw Hill Education. ISBN-13 : 978-1260019193.
3. Practical Electronics for Inventors. 4th edition. Paul Sherz and Simon Monk. McGraw Hill. ISBN-13: 978-1259587542
4. Simplified Q&A - Data Science with Artificial Intelligence, Machine Learning and Deep Learning, Rajiv Chopra, ISBN: 978-9355380821, Khanna Book Publishing Company, New Delhi.
5. The Big Book of Maker Skills: Tools & Techniques for Building Great Tech Projects. Chris Hackett. Weldon Owen; 2018. ISBN-13: 978-1681884325.

2nd YEAR 2nd SEMESTER

Course Title : Introduction to Analog & Digital Communication

Course Code: ECE2201

Contact hours per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing this course, the students will be able to:

ECE2201.1. Explain the operation of building blocks of a communication system.

ECE2201.2. Compare performances of analog modulation techniques and identify their applications

ECE2201.3. Analyze the functions of building blocks of a digital communication system

ECE2201.4. Identify the performance of various digital modulation & demodulation techniques

ECE2201.5. Explain basic working principle of practical communication systems.

ECE2201.6. Analyze the concept of information rate, channel capacity & channel coding.

Module -1: [8L]

Introduction to the concept of RF spectrum, building blocks of a communication system, necessity of modulation.

CW modulation: Amplitude modulation (DSB, SSB and VSB): Time & frequency domain representation, transmission BW & transmission efficiency.

Frequency Modulation (FM) and Phase Modulation (PM): Time and frequency domain representations, Transmission BW. Narrowband & Wideband FM.

Comparison between AM and FM. Practical uses of AM and FM. Double Super-heterodyne Receiver.

Module -2: [9L]

Digital Communication System: Building block, performance comparison of Analog and Digital communication technique.

Pulse Code Modulation: Sampling (natural sampler, flat top sampler & sample/hold circuit), Quantization, Quantization noise, Companding, Source encoding, differential pulse code modulation, Delta modulation, Adaptive delta modulation.

Line Coder: Desirable properties of line code, Polar/ Unipolar /Bipolar/ Manchester codes. Comparative study among these line codes,

Inter Symbol Interference (ISI), Eye pattern, Equalizer, Regenerative repeater.

Module 3: [9L]

Digital Modulation: Binary modulation: BASK, BFSK, BPSK and DPSK. Concept of M-ary Modulation, QPSK, OQPSK, QAM-8/16, Time and Frequency domain representations, Transmission bandwidth, Generation & Detection of digital modulation techniques. Signal space diagram of received signals.

Detection of signals in presence of noise, Matched Filter Receiver, Integrate and Dump type filter, probability of error calculation, Optimum threshold detection, BER, Comparative study of bit error probability of digital modulation systems.

Module 4: [10L]

Various multiplexing techniques used in communication systems (TDMA, FDMA, CDMA, SDMA). Spread Spectrum Technique. Practical examples of digital communication – Cordless & Cellular systems, Bluetooth.

Measures of Information-Discrete memory less model, Mutual Information, Self-information, Entropy, Entropy of a block, conditional entropy, codification of source information using Shannon-Fano theorem, Introduction to Channel coding: Fundamentals of error correction, Hamming codes, CRC.

Text Books:

1. B.P. Lathi, Modern Digital and Analog Communication System, Oxford University Press.
2. Haykin, Communication Systems- PHI
3. Principles of Communication Systems, H.Taub and D.L.Schilling, TMH Publishing Co.
4. Singh & Sapre—Communication Systems: 2/e, TMH
5. Digital Communications, J.G.Proakis, TMH Publishing Co.
6. Electronic Communications Systems, Wayne Tomasi, Pearson Education.
7. Carlson—Communication System, 4/e, McGraw Hill

Reference Books:

1. Digital Communications Fundamentals and Applications, B. Sklar and P.K.Ray, Pearson.
2. Digital Communication, A. Bhattacharya, TMH Publishing Co.
3. Wireless Communication and Networks: 3G and Beyond, I. Saha Misra, TMH Education.
4. L.W. Couch II, Modern Communication System, Prentice Hall India.
5. Roden, Analog & Digital Communication Systems, 5e, SPD
6. Communication Systems (Analog and Digital), Sanjay Sharma, Katson Books

Course Title: Introduction to Analog & Digital Communication Laboratory					
Course Code: ECE2251					
Contact hrs per week:	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

After completing this course, the students will be able to:

ECE2251.1. Design, implement & analyze AM and FM signals in time & frequency domain

ECE2251.2. Design, implement & analyze FDM system & sampler circuits

ECE2251.3. Design, implement & analyze PN sequence generator, line codes and various digital modulation and demodulation schemes.

ECE2251.4. Analyze eye pattern & constellation diagram

List of Experiments:

(All circuits will be implemented using software (LTspice) and hardware components)

1. Design & implementation of Amplitude modulation & demodulation system and analyze in time & frequency domain.
2. Design & implementation of a voltage-controlled oscillator (VCO). Implementation of FM modulator using VCO. Analyze the FM signal in time & frequency domain.
3. Implementation & study of Frequency Division Multiplexing & De-multiplexing system in time & frequency domain
4. Implementation & study of natural sampler, flat top sampler & sample/hold circuit
5. Implementation & study of 7-bit length and 15 bit length PN sequences using shift register
6. Implementation & study of Line Codes: Uni-Polar Non-Return to Zero, Polar Non-Return to Zero, Uni-Polar Return to Zero and Manchester Code.
7. Implementation and Study of BASK Modulator and demodulator.
8. Implementation and Study of BFSK Modulator and demodulator.
9. Study of Eye pattern for different bit rates
10. Study of Constellation Diagrams for QAM-8, QAM- 16 etc.

Course Title : Control Systems					
Course Code : ECE2202					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing this course, the students will be able to:

ECE2202.1. Relate their pre-requisite knowledge from Mathematics and Signals & Systems.

ECE2202.2. Develop the ability to understand mathematical model of physical systems and study their nature, configuration and relevant mapping into equivalent models.

ECE2202.3. Apply the concept and classification of control systems to identify, analyze and solve stability related issues in time response, error analysis and stability analysis in an advanced way.

ECE2202.4. Evaluate, categorize and justify the margin of stability with respect to the system's nature using frequency domain analysis tools.

ECE2202.5. Conceptualize different methods of evaluating system behavior with the help of models compatible to simulation.

ECE2202.6. Design controllers according to desired performance specifications which can be applied for system design in higher semesters.

MODULE – I [9 L]

Introduction:

Concepts of Control Systems, Open Loop and Closed Loop Control Systems, Different Control Systems, Classification of Control Systems, Feedback Characteristics, Effects of feedback. [4L]

Transfer Function Representation of LTI Systems:

Block diagram representation of systems, Block diagram algebra, Representation by Signal Flow Graph, Transfer function using Mason's Gain Formula. [5L]

MODULE –II [10 L]

Time Domain Analysis:

Standard test signals, Time response of first order systems, Characteristic equation of feedback control systems, Transient response of second order systems, Time domain specifications, Steady state response, Steady state errors and error constants. [5L]

Stability Analysis:

The concept of stability, Difference between absolute and relative stability, Routh's stability criterion, Root Locus Technique. [5L]

MODULE – III [10 L]

Frequency Domain Analysis:

Frequency domain specifications, Bode Plot, Phase margin & Gain margin, Stability Analysis from Bode Plot. [6L]

Polar Plot, Nyquist Plot, Stability Analysis. [4L]

MODULE –IV [11 L]

Classical Control Design Techniques:

Compensation techniques, Lag, Lead, Lead-Lag Controllers design in frequency Domain, PID Controllers, Introduction to non-linear control [6 L]

State Space Analysis of Continuous Time Systems:

Concepts of state, state variables and state model, Derivation of state models from block diagrams, Solving time invariant state equations, State Transition Matrix and its properties, Concepts of Controllability and Observability. [5 L]

Text Books:

1. Automatic Control Systems– by B. C. Kuo, John Wiley and Sons.
2. Control Systems Engineering – by I. J. Nagrath and M. Gopal, New Age International (P) Ltd.
3. Modern Control Engineering – by Katsuhiko Ogata , Prentice Hall of India Pvt. Ltd.
4. Modern Control Systems- by R.C. Dorf & R.H. Bishop- Addison- Wesley Longman.

Reference Books:

1. Control Systems Engg. by Norman S. Nise , John Wiley.
2. Control System Engineering by Ananda Natarajan , P. Ramesh Babu, Scitech Pub.
3. Automatic Control Systems- Basic analysis and design- by A. Wolovich- Oxford University Press.

Course Title : Control Systems Laboratory					
Course Code : ECE2252					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

After completing this course, the students will be able to:

ECE2252.1. Students will be able to understand the implementation of different system models using a system simulator.

ECE2252.2. Students will be able to analyze time domain behavior and system errors of 1st order and 2nd order systems.

ECE2252.3. Students will be able to evaluate the relative stability of systems using time and frequency domain analysis tools.

ECE2252.4. Students will be able to design controllers according to desired performance specifications of a system.

List of Experiments:

1. Familiarization with OCTAVE Control System Toolbox and SIMULINK.
2. Study of the effect of feedback on systems.
3. Study of first order systems having different time constants.
4. Study of second order systems having different damping ratios.
5. Verification and validation of time domain specifications of second order systems.
6. Study of steady state errors for different 'types' of systems.
7. Study of system stability using Root Locus Technique.
8. Study of system stability using Bode plot.
9. Study of system stability using Nyquist plot.
10. Study of system representation using State Model.
11. Study of P, PI, PD and PID controller action on system response.

Course Title: EM Theory And Transmission Lines					
Course Code: ECE2203					
Contact	L	T	P	Total	Credit Point
Hours per week	3	0	0	3	3

Course Outcomes:

After completing this course, the students will be able to:

ECE2203.1. Apply their pre-requisite knowledge of Electrostatics and Magneto statics.

ECE2203.2. Comprehend Electromagnetic wave propagation in different mediums.

ECE2203.3. Understand different electromagnetic phenomena associated with Transmission Lines.

ECE2203.4. Design of Impedance Matching Networks for two wire Transmission Lines.

ECE2203.5. Develop the ability to analyze the radiation characteristics of antenna configurations and identify respective areas of application.

ECE2203.6. Understand pattern synthesis and analysis in linear antenna array.

Module I: [6]

Faraday's law & Lenz's law, Transformer and Motional Electromotive Forces, Displacement Current, $J_C - J_D$ Relation, Maxwell's equations, Time Varying Potentials, Time-harmonic fields, Wave Equation, Boundary Conditions between media interface; Uniform Plane wave.

Module II: [10]

Plane Wave Propagation in Lossy Dielectric, Loss-less Dielectric, Good Conductor, Free space; Poynting Theorem, Power flow, Poynting vector, Skin Depth, Surface Resistance, Wave Polarization; Reflection and Transmission for normal and oblique incidence, Brief introduction to FDTD method in solving electromagnetic problems.

Module III: [12]

Transmission Lines; Concept of Lumped parameters and Distributed parameters. Line Parameters, Transmission line equations and solutions, Physical significance of the solutions, Propagation constant, Characteristic Impedance; Wavelength; Velocity of Propagation; Condition for minimum distortion and minimum attenuation, Transmission line losses, Distortion-less Line, Reflection and Transmission coefficients; Standing Waves, VSWR, Input Impedance, Smith Chart -Applications;

Load Matching Techniques using stub / Quarter wave Matching, Bandwidth problem; Low loss RF transmission lines, line as circuit elements.

Module IV: [6]

Antenna Concepts, Antenna Characteristic; Hertzian dipole (Radiation Fields, Radiation Resistance, Radiation patterns, Directive Gain); Properties and typical applications of Half-wave dipole, Loop antenna, Yagi-Uda array, Basic Concepts of antenna array.

Text Books

1. Principles of Electromagnetics, 4th Edition, Matthew O H Sadiku, Oxford University Press.
2. Electromagnetic Field Theory & Transmission Lines, G.S.N. Raju, Pearson Education.
3. Electromagnetic Waves Shevgaonkar, Tata-McGraw-Hill –R K
4. Antenna Theory: Analysis and Design, 3rd edition, C.A. Balanis, Wiley India.

Reference Books

1. Engineering Electromagnetics, 2nd Edition - Nathan Ida, Springer India.
2. Time Harmonic Electromagnetic Fields, Roger F. Harrington, IEEE Press Series.
3. Electromagnetic Theory & Applications, A. K. Saxena, Narosa Publishing House Pvt. Ltd.
4. Engineering Electromagnetics, 7th Edition-W.H.Hayt & J.A.Buck, Tata-McGraw-Hill.
5. Electromagnetic Waves and Transmission Lines- by G.Prasad, J.Prasad and J.Reddy-Scitech.

Course Title: EM Theory and Transmission Lines Laboratory					
Course Code: ECE2253					
Contact	L	T	P	Total	Credit Point
Hours per week	0	0	2	2	1

Course Outcomes:

After completing this course, the students will be able to:

ECE2253.1. The students will be able to plot SW pattern under different conditions.

ECE2253.2. They will learn generation and study of Smith Chart.

ECE2253.3. The students will be able to study radiation patterns of various types of antennae.

ECE2253.4. They will be able to undertake parametric study of antenna.

List of Experiments

1. Study of reflection of electromagnetic waves from plane boundary using FDTD method.
2. Plotting of Standing Wave Pattern along a transmission line when the line is open-circuited, short circuited and terminated by capacitive, inductive and resistive load at the load end.
3. Study of Smith chart on MATLAB/OCTAVE/PYTHON platform.
4. Radiation Pattern study of dipole antenna.
5. Radiation Pattern study of a folded-dipole antenna.
6. Radiation pattern study of Helical Antenna.
7. Parametric study (Gain, Directivity, HPBW and FNBW) of three, five and seven element Yagi Uda configurations.
8. Radiation pattern study of a Pyramidal Horn Antenna.
9. Design of half wave dipole antenna at 800 MHz using full wave electromagnetic simulator.

Course Title : Digital Signal Processing					
Course Code : ECE2204					
Contact	L	T	P	Total	Credit Points
Hours per week	3	0	0	3	3

Course outcomes:

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

ECE2204.1. Recall the concepts of trigonometry, complex algebra, Fourier transform to analyze different signals and systems.

ECE2204.2. Apply the concept of Z-transform, convolution to determine the transfer function of a system and evaluate the output of the system.

ECE2204.3. Extend the knowledge of discrete-time Fourier transform to interpret DFT, FFT and apply the concept as a frequency transformation tool.

ECE2204.4. Design transfer functions of IIR/FIR filters applying transformation techniques/windowing methods.

ECE2204.5. Construct and model digital filters from their transfer function, develop concept of multirate signal processing and architecture of digital signal processor.

ECE2204.6. Develop a thorough understanding of the central elements of digital signal processing theory and apply this theory to real-world signal processing applications.

MODULE I [7L]

Introduction to Digital signal processing

Prerequisites: Concept of sampling, construction of discrete-time signals and systems, aliasing effect, Reconstruction of signals, concept of convolution, graphical, analytical methods to compute convolution supported with examples and exercises, properties of convolution, interconnections of LTI systems with physical interpretations, stability and causality conditions, recursive and non-recursive systems, introduction to Z-transform, ROC, properties of Z-transform.

Introduction to Z-transform, ROC, properties of Z-transform, poles and zeros and stability of LTI discrete systems, mapping between s-plane and Z-plane, convolution, correlation and multiplication using Z-transform, initial value theorem, final-value theorem, Parseval's relation, inverse Z-transform, inverse Z-transform, solution of difference equation by Z-transform.

MODULE II [8L]

Discrete Fourier Transform

Prerequisites: Concept of DFT and IDFT, concept and properties for DFT/IDFT, Twiddle factors and their properties.

DFT/IDFT as linear transformations, DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs, circular convolution, computation of circular convolution by graphical, concentric circle, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences – Overlap-Save and Overlap-Add methods with examples and exercises, computational burden on direct DFT.

Fast Fourier Transform:

Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithms, signal flow graphs, Butterflies computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises, IDFT using DIT & DIF-FFT.

MODULE III [13 L]

Digital Filters

Filter Concepts: Introduction to the concept of Digital Filters, frequency response and filter characteristics, basic concepts of IIR and FIR filters.

IIR Filters:

Introduction to analog filter design: Butterworth and Chebyshev filters design, Transformation techniques: Impulse invariant method and bilinear transformation, warping effect and prewarping, design procedure for low pass digital Butterworth and Chebyshev filter design.

FIR Filters:

Linear phase filters: Condition for filter to have linear phase response and its frequency response (Type I, II, III, IV),

Design techniques:

Fourier series method, Gibb's phenomenon, Windowing method (Rectangular, Hamming and Hanning window), comparison study of windows,, advantages & disadvantages of FIR & IIR Filters.

MODULE IV [8L]

Realization of Digital Filters: Introduction Realization of discrete time systems: FIR and IIR system. Different methods of realizations: Direct form I, Direct form II, Cascade form structure, Parallel form structure, their advantages and disadvantages with examples.

Multi-rate Signal Processing: Understanding and necessity of multi-rate system, Decimation and interpolation- time domain and frequency domain behaviour of multi-rate systems, advantages and disadvantages (aliasing & anti-aliasing).

Introduction to Digital Signal Processor: TMS320C67XX families, architecture and applications.

Text Books:

1. Digital Signal Processing – Principles, Algorithms and Applications, J.G.Proakis&D.G.Manolakis, Pearson Ed.
2. Digital Signal processing – A Computer Based Approach, S.K.Mitra, TMH Publishing Co
3. Digital Signal Processing, P. Ramesh Babu, Scitech Publications (India).
4. Digital Signal Processing, A. Nagoor Kani, TMH Education .
5. Theory and application of digital signal processing- L.R. Rabiner & B. Gold- PHI.
6. Analog & digital Signal Processing- A. Ambardar- Books/Cole Pub.

Reference Books:

1. Digital Signal Processing, Tarun Kumar Rawat, Oxford Press
2. Digital Signal Processing, S.Salivahanan, A.Vallabraj& C. Gnanapriya, TMH Publishing Co .
3. Digital Signal Processing; A Hands on Approach, C. Schuler &M.Chugani, TMH Publishing Co.
4. Digital Signal Processing S. Poornachandra & B. Sasikala, MH Education .
5. Digital Signal Processing; Spectral Computation and Filter Design Chi-Tsong Chen, Oxford University Press.
6. Texas Instruments DSP Processor user manuals and application notes.

Course Title : Digital Signal Processing & Applications Laboratory					
Course Code : ECE2254					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	2	2	1

Course outcomes:

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

ECE2254.1. Interpret the response of discrete time systems using the concept of convolution.

ECE2254.2. Apply different transformation tools-Z-transform, discrete Fourier transform, fast Fourier transform on signals and justify their properties as well.

ECE2254.3. Compare the frequency response of FIR and IIR filters (LPF, HPF, BPF and BSF) of digital filters and implement the systems using suitable realization techniques.

ECE2254.4. Develop DSP processors based real time system to analyze different real time signals like speech signal, image signal and some other biomedical signals.

Simulation Laboratory using standard Simulator:

1. Convolution of two sequences using graphical methods and using commands- verification of the properties of convolution.
2. Z-transform of various sequences – verification of the properties of Z-transform.
3. Twiddle factors – verification of the properties.
4. DFTs / IDFTs using matrix multiplication and also using commands.
5. Circular convolution of two sequences using graphical methods and using commands, differentiation between linear and circular convolutions.
6. Verifications of different algorithms associated with filtering of long data sequences and Overlap–add and Overlap-save methods.
7. Butterworth IIR filters design with different set of parameters.
8. Chebyshev IIR filters design with different set of parameters.
9. FIR filter design using rectangular, Hamming and Blackman windows.

Hardware Laboratory using DSP Processor:

1. Hardware implementation to verify Convolution, DFT and IDFT using TMS320C67xx processor.
2. Hardware implementation to verify the results of different digital filters using TMS320C67xx processor.

Course Title : Electronic Devices					
Course Code : ECE2205					
Contact	L	T	P	Total	Credit Points
Hours per week	3	0	0	3	3

Course Outcomes:

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

ECE2205.1. Apply the knowledge of energy band diagram in analyzing different semiconducting materials

ECE2205.2. Understanding the concepts of carrier distribution and Fermi energy level in semiconductors under both equilibrium and non-equilibrium conditions.

ECE2205.3. Justify different operations of solid state devices using relative position of Fermi energy levels across homo and hetero p - n junctions.

ECE2205.4. Describe working principles of different devices using mathematical models and energy band diagrams.

ECE2205.5. Analyze different phenomena in bipolar junction transistor (BJT) using semiconductor physics and mathematical models.

ECE2205.6. Analyze the physics behind the working of different field effect transistors (FET) in both qualitative and quantitative ways.

Module -1 : Semiconductor Physics [10L]

Recapitulation of Quantum Mechanics. Kronig-Penny Model, Energy Band diagram, E-K diagram, Direct and Indirect Band-gap semiconductors, concept of effective mass, carrier distribution in solid, concept of density-of-states (only expression), Fermi-Dirac distribution function, Fermi level, Intrinsic and extrinsic semiconductors, idea of degeneracy and non-degeneracy, Fermi-level shift with the changes in doping and temperature. (5L)

Semiconductor under equilibrium: Carrier concentration in terms of effective Density of states, Mass-Action Law. (2L)

Semiconductor under Non-Equilibrium: Excess carrier generation and recombination with expression, concept of Quasi-Fermi level. Drift and Diffusion of carrier with expressions, continuity equation, Scattering effect, Hall effect, Piezoelectric effect. (3L)

Module -2 : Diodes [10L]

Homo-Junctions: p - n junction physics: derivations and plots of depletion charge, electric field, potential profiles; energy band diagram, depletion width, p - n junction resistances and capacitances,

Varactor diode, p - n junction current, concept about linearly graded and abrupt junctions, small-signal diode switching model. (4L)

Basic operations of different diodes : Tunnel diode, Photodiode (p - n , p - i - n , APD), Solar Cell, LED, OLED. (3L)

Hetero-junctions: Physics of Metal-Semiconductor junctions & Semiconductor-Semiconductor hetero-junctions, Rectifying & Non-Rectifying nature of Hetero-junctions, basic concept of potential-well and 2D-Electron Gas (2DEG), mobility and its variation with time & temperature, concept of HEMT, QLED. (3L)

Module -3 : Bipolar Junction Transistors (BJT) [8L]

BJT operating principle, minority carrier distributions, different modes of operations and respective energy band diagrams, input and output characteristics of BJT in different configurations, non-ideal effects in BJT, concepts about large and small-signal modeling of the device, Eber's Moll model, Hybrid- π model, Basic operation of Photo-transistor, High-Frequency Transistor: Heterojunction Bipolar Transistor (HBT).

Module -4 : Field Effect Transistors (FET) [8L]

MOSFET: Physics of 2-terminal MOS structures with proper band diagrams, formation of inversion layer, MOSFET classifications: Enhancement and depletion type MOSFETs, basic operations and I-V characteristics of both the devices; Concept of Threshold voltage and Flat-Band voltage, MOS capacitance-voltage (C-V) characteristics, Small-signal model of MOSFET, Introduction to CMOS technology and device fabrication.

Text Books:

1. Donald Neamen & Dhrubus Biswas – Semiconductor Physics and Devices, 4th Edition, McGraw Hill Education.
2. Ben G. Streetman & Sanjay Kumar Banerjee – Solid State Electronic Devices, 7th Edition, Pearson Education.
3. D. K. Bhattacharyya & Rajnish Sharma – Solid State Electronic Devices, 2nd Edition, Oxford University Press.
4. S. M. Sze & Kwok K. Ng -- Physics of Semiconductor Devices, 3rd Edition, Wiley.

Reference Books:

5. Vladimir V. Mitin, Viatcheslav Kochelap, and Michael A. Stroschio --- Quantum Heterostructures: Microelectronics and Optoelectronics, Cambridge University Press.
6. Paul Harrison – Quantum Wells, Wires, and Dots : Theoretical and Computational Physics of Semiconductor Nanostructures, 3rd Edition, Wiley.
7. David A. Bell – Electronics Devices & Circuits, 5th Edition, Oxford University Press.

Paper Name: **Advanced Numerical Methods (B. Tech. ECE)**

Paper Code: **MTH2202**

Contact hours per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcome:

After successfully completing this course the students will be able to:

MTH2202.1 Analyze certain algorithms, numerical techniques and iterative methods that are used for solving system of linear equations.

MTH2202.2 Implement appropriate numerical methods for solving advanced engineering problems dealing with interpolation, integration and differentiation.

MTH2202.3 Apply various methods for determining eigenvalues of a square matrix and estimating their location in case actual determination is not possible.

MTH2202.4 Develop an understanding to reduce a matrix to its constituent parts in order to make certain subsequent calculations simpler.

MTH2202.5 Apply various search techniques for solving non linear programming problems.

MTH2202.6 Compare the accuracy and efficiency of certain numerical methods.

Detailed Syllabus:

Module I: [10L]

System of Linear Equations: Gauss Elimination Method, pivoting and scaling. Gauss-Jordan, Gauss-Jacobi and Gauss-Seidel Methods and their computational complexity, Matrix Norm, Symmetric positive definite systems and indefinite systems: Cholesky factorization. Error Analysis: error prediction.

Module II: [10L]

Eigen Value problems: Eigenvalue location, QR decomposition and its application in finding eigenvalues and least square solutions, Power method and inversion iteration to find a dominant eigenvalue and eigenvector, Singular value decomposition.

Module III: [10L]

Interpolation, Integration & Differentiation: Purpose of interpolation, choice of interpolating function, Calculus of finite differences, Polynomial interpolation: Newton's forward and backward interpolation, Lagrange's method, Newton's divided difference interpolation, Computational complexity of these methods, Piecewise polynomial interpolation: cubic spline interpolation, General form of quadrature rule: Newton-Cotes quadrature. Trapezoidal rule, Simpson's 1/3rd rule, Simpson's 3/8th rule, Weddle's rule.

Module IV: [10L]

Prerequisites, Optimization: Unimodal functions, One-dimensional unconstrained optimization algorithms: Interval halving, Dichotomous search, Golden section search, Fibonacci search, Curve fitting and method of least squares.

Text Books:

1. Trefethen L. N. and Bau D. *Numerical Linear Algebra*, SIAM
2. Watkins D. S. *Fundamentals of Matrix Computation*, Wiley
3. B.S. Grewal, *Numerical Methods in Engineering and Science*, Khanna Publishers.
4. Jain M. K. and Iyengar S.R.K. *Numerical methods for scientific and engineering computation*, Newage International Publishers
5. Conte S. D. and Boor C. D. *Elementary Numerical Analysis - An Algorithmic Approach*, McGraw Hill
6. S.S. Sastry. *Introductory Methods of Numerical Analysis*, PHI Learning Pvt. Ltd.
7. S. S. Rao, *Engineering Optimization*, New Age International Publishers

Reference Books:

1. Golub G. H. and Van Loan C.F. *Matrix Computation*, John Hopkins U. Press, Baltimore
2. Stewart G. W. *Introduction to Matrix Computations*, Academic Press
3. Demmel J.W. *Applied numerical linear algebra*, SIAM, Philadelphia
4. N. Datta, R.N. Jana, *Introductory Numerical Analysis*, Shreedhar Prakashani
5. Babu Ram, *Numerical Methods*, Pearson
6. Heath M. T., *Scientific Computing: An Introductory Survey*, McGraw Hill
7. Joe D. Hoffman, *Numerical Methods for Engineers and Scientists*, McGraw Hill

Paper Name: Advanced Numerical Methods Laboratory
Paper Code: MTH2252

Contact hours per week:	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcome:

After successfully completing this course the students will be able to:

MTH2252.1 Write programs in C to solve problems based on numerical methods.

MTH2252.2 Apply the knowledge of C programming to find non-iterative exact solutions of a system of linear equations.

MTH2252.3 Use C programming to develop algorithms to find iterative approximate solutions of a system of linear equations.

MTH2252.4 Demonstrate their ability of C programming to solve problems involving interpolation.

MTH2252.5 Exhibit their ability of C programming to solve problems involving integration.

MTH2252.6 Develop a program in C to apply Power method for finding dominant eigenvalue and dominant eigenvector of a square matrix.

Detailed Syllabus:

Development of computer programs in C for the following problems:

1. Gauss elimination Method.
2. Gauss-Seidel Method.
3. Lagrange's interpolation.
4. Newton's forward interpolation.
5. Newton's backward interpolation.
6. Trapezoidal rule and Simpson's 1/3rd rule.
7. Weddle's rule.
8. Power method.

Books/References:

1. B. S. Grewal, Numerical Methods in Engineering and Science with Programs in FORTRAN 77, C and C++, **Khanna Publishers**.
2. T. Veerarajan, T. Ramachandran, Numerical Methods with Programs in C, **McGraw Hill**.

Subject Name: **Environmental Sciences**

Subject Code: **EVS2016**

Contact Hours per week	L	T	P	Total	Credit Points
	2	0	0	2	0

The subject code EVS2016 corresponds to basic environmental chemistry for the 2nd year B.Tech students, which is offered as Environmental Sciences and is mandatory for all branches of engineering. The course provides basic knowledge of various environmental pollutions as well as its impact and ways to curb it.

After successfully completing this course the students will be able to

EVS2016.1: Understand the natural environment and its relationships with human activities.

EVS2016.2: Characterize and analyze human impacts on the environment.

EVS2016.3: Integrate facts, concepts, and methods from multiple disciplines and apply to environmental problems.

EVS2016.4: Educate engineers who can work in a multi-disciplinary environment to anticipate and address evolving challenges of the 21st century.

EVS2016.5: Understand and implement scientific research strategies, including collection, management, evaluation, and interpretation of environmental data.

EVS2016.6: Design and evaluate strategies, technologies, and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.

Syllabus

Module 1

Socio Environmental Impact 6L

Basic ideas of environment and its component Population
 growth: exponential and logistic; resources; sustainable development. 3L
 Concept of green chemistry, green catalyst, green solvents
 Environmental disaster and social issue, environmental impact assessment, environmental audit, environmental laws and protection act of India. 3L

Module 2 6L

Air Pollution

Structures of the atmosphere, global temperature models
 Green house effect, global warming; acid rain: causes, effects and control. 3L
 Lapse rate and atmospheric stability; pollutants and contaminants; smog; depletion of ozone layer; standards and control measures of air pollution. 3L

Module 3 6L

Water Pollution

Hydrosphere; pollutants of water: origin and effects; oxygen demanding waste; thermal pollution; pesticides; salts.
 Biochemical effects of heavy metals; eutrophication: source, effect and control. 2L
 Water quality parameters: DO, BOD, COD.
 Water treatment: surface water and waste water. 4L

Module 4

6L

Land Pollution

Land pollution: sources and control; solid waste: classification, recovery, recycling, treatment and disposal. 3L

Noise Pollution

Noise: definition and classification; noise frequency, noise pressure, noise intensity, loudness of noise, noise threshold limit value; noise pollution effects and control. 3L

Text/Books

1. GourKrishna Das Mahapatra, Basic Environmental Engineering and Elementary Biology, Vikas Publishing House P. Ltd.
2. A. K. De, "Environmental Chemistry", New Age International.
3. A. K. Das, Environmental Chemistry with Green Chemistry, Books and Allied P. Ltd

References/Books

1. S. C. Santra, Environmental Science, New Central Book Agency P. Ltd
2. D. De, D. De, Fundamentals of Environment & Ecology, S. Chand & Company Ltd.

3rd YEAR 1st SEM

CourseName: Mobile Communication and Networks					
CourseCode:ECE3101					
Contact	L	T	P	Total	CreditPoints

Hours per week	3	0	0	3	3
----------------	---	---	---	---	---

Course Outcomes:

After completing the course, the students will be able to:

ECE3101.1. Explain operations of cellular communication systems - their architecture, functioning, and various standards.

ECE3101.2. Understand the evolution of mobile communication generations.

ECE3101.3. Explain the key features of mobile communication networks using up to 4G standards.

ECE3101.4. Analyze the emerging technologies required for fourth generation mobile systems such as SDR, MIMO etc. with confidence.

ECE3101.5. Understand the concepts of LTE-advanced, 4G features and challenges.

ECE3101.6. Analyze and compare architecture, functioning, protocols, capabilities and application of various mobile communication networks.

Module I [9 L]:

Cellular concepts:

Cell structure, frequency reuse, cell splitting, channel assignment, handoff, interference, capacity, power control; Evolution of mobile cellular communication: Overview of 2G 3G, 4G and 5G cellular mobile standards.

Module II [9 L]:

Signal propagation:

RF Propagation mechanisms and their characteristics. Fading channels-Multipath and small-scale fading- Doppler shift, statistical multipath channel models, narrowband and wideband fading models, power delay profile, average and rms delay spread, coherence bandwidth and coherence time, fading and study of some curious properties like flat and frequency selective fading, slow and fast fading. Free space propagation model, a couple of models like Hata, Okumura, Ground reflection (Two-Ray) model, Log distance path loss model. Antennas: antennas for mobile terminal, monopole antennas, PIFA, base station antennas and arrays, antennas for drones.

Module III [9 L]:

GSM, GPRS & CDMA systems-Architecture and Protocols: [6]

Introduction, GSM Subsystem—an overview, GSM Frequency Bands and Allocation Strategies, GSM Call Set-up Procedure, GPRS (2.5G) Network Architecture, GPRS Attachment and Detachment Procedure. CDMA Evolution-An overview, FH-SS and DS-SS, CDMA IS-95 Systems, CDMA Channel Concept-Forward and Reverse, RAKE Receiver. Transmission Power Control- Near Far Problem and Multipath Phenomenon, Handoff Process.

Module IV [8 L]:

Third Generation (3G) Wireless System: [5]

UMTS Core Network Architecture, Channel Structure in UMTS Terrestrial Radio Access Network, High-Speed Downlink Packet Access (HSDPA). Evolution of CDMA-One (IS-95) to CDMA-2000, Physical Channels of CDMA-2000, Differences between CDMA-2000 and WCDMA

Fourth Generation Systems: [4]

4G Vision, 4G Features and Challenges, Applications of 4G, 4G Technologies: Multicarrier Modulation, OFDM, Beam forming and MIMO, 3GPP LTE System, Core Architecture, LTE Bandwidth, VoLTE.

TextBooks:

1. T.S.Rappaport, "Wireless Communications Principles and Practice", PHI, II Edition, 2006.
2. Erik Dahlman , 4G, LTE-Advanced Pro and The Road to 5G.
3. From GSM to LTE-Advanced Pro and 5G: An Introduction to Mobile Networks and MobileBroadband, Martin Sauter, Wiley
4. Wireless Communication and Networks: 3G and Beyond, I. Saha Misra, TMH Education.

Reference Book:

1. Vijay K. Garg, "Wireless Communication and Networking", Elsevier, Morgan Kaufmann, Reprinted 2012.
2. William Lee , "Mobile Cellular Telecommunications: Analog and Digital Systems", McGraw Hill Education
3. Sassan Ahmadi, 5G NR: Architecture, Technology, Implementation, and Operation of 3GPP New Radio Standards Hardcover – 1 June 2019

CourseName: Mobile Communication and Networks Laboratory

CourseCode:ECE3151

Contact Hours per week	L	T	P	Total	CreditPoints
	0	0	2	2	1

Course Outcomes:

After completing this course, the students will be able to:

ECE3151.1: Analyze practical concepts of GSM, Bluetooth, and RF technologies.

ECE3151.2: Compare the relationships between RF parameters and system performance through hands-on experiments and simulations.

ECE3151.3: Evaluate the real-life applications like RFID, GPS, and RF power measurement systems of wireless technologies.

ECE3151.4: Analyze and evaluate wireless signal behaviors under different fading conditions and interference using simulators.

1. Perform the process of call connection and call release of cellular Mobile System
2. Measurement of parameters of Transceiver system on ISM band (using RF signal generator and AF generator- no RF link is required)
3. Study of RF power Measurement using Bird meter.
4. Apply RFID technology for real life applications using RFID kit.
5. Setting up GPS system and observation of features like signal-to-noise ratio (SNR) of the signals corresponding to the visible satellites.
6. Simulate Bluetooth voice transmission to observe the effect of AWGN and interference of 802.11b on transmission using simulator.
7. Simulate various fading conditions (Rayleigh and Rician) using simulator.
8. Simulate the Direct sequence spread spectrum using simulator.
9. Simulate the RF propagation models and monitor the variation of transmission power with distance measurement using simulation.
10. Experiment beyond Curriculum.

Course Name: Microwave Engineering

Course Code: ECE3102

Contact Hours per week	L	T	P	Total	Credit Point
	3	0	0	3	3

Course outcomes:

After completing this course, the students will be able to:

ECE3102.1. Apply previous E.M. theory concepts to understand microwave engineering.

ECE3102.2. Identify high frequency electromagnetic wave propagation characteristics through guided media.

ECE3102.3. Analyze microwave passive components and circuits.

ECE3102.4. Enhance their knowledge on semiconductor and vacuum tube devices operating at high frequency.

ECE3102.5. Design high frequency filters and amplifiers.

ECE3102.6. Implement the concepts in developing different prototype microwave systems.

Module I [12L]

Introduction: RF & Microwave Spectrum, Typical applications of RF and Microwave Engineering, Safety considerations [1L]

Waveguides and Resonators: Rectangular waveguides, TE & TM modes, TE₁₀ mode analysis, cut-off frequency, propagation constant, intrinsic wave impedance, phase and group velocity, Power transmission, attenuation, waveguide excitation, wall current. [5L]

Rectangular waveguide resonator- Design consideration, resonant frequency, Q-factor of a rectangular cavity resonator, excitation. Introduction of circular waveguide; Circular waveguides, TE₁₁ mode analysis. [3L]

Planar Transmission Lines Strip Line, Micro-strip lines, Coplanar waveguide, Slot line- design consideration, field patterns, propagation characteristics, Comparison for different characteristics of the above mentioned lines.[3L]

Module II [10L]

Microwave Network Representation Impedance and Equivalent Voltage and Current, Impedance and Admittance Parameters, Scattering Matrix, Properties of Scattering Parameters for Reciprocal and Lossless Network, Generalized S parameters, S parameters of Two-port Networks with Mismatched Load [5L]

Microwave Passive Devices T-Junctions: E/H/Hybrid T-junctions, Wilkinson Power Divider, Bethe hole coupler, Directional Couplers, Ratrace coupler, Isolator, Phase Shifters, Circulators, Attenuators, Methods for coupling of Microwave signal. [5L]

Module III [9L]

Microwave Tubes Principle of Electron beam & Field interaction for energy exchange in resonant (two cavity klystron, Reflex Klystron, Magnetron) and 'TWT' microwave active devices: Typical characteristics & applications (only physical explanation is required, no mathematical derivation required).[3L]

Semiconductor Microwave devices TED (Gunn diode), Modes of Gunn diode, Avalanche Transit Time (IMPATT) device, Tunnel diode, Schottky diode, PIN diode characteristics & applications; Microwave field effect transistor (MESFET), High Electron Mobility Transistor(HEMT)[6L]

Module IV [11L]

Microwave Filter Design procedure of filter design using insertion loss method (maximally flat and equi-ripple), low pass prototype design, conversion to other filter prototypes.[5L]

Microwave Amplifier Design Basic consideration in the design of RF amplifier- Transistor S-parameter, Stability, matching network, noise figure; Matching network design using lumped elements and L-Section. [6L]

TextBooks:

1. Microwave Engineering, 3rd edition, David M. Pozar, Wiley & Sons Inc.
2. Microwave Engineering, Monojit Mitra, Dhanpat Rai & Co.
3. Microwave Engineering, A Das & S Das, TMH.
4. Microwave Devices & Circuits, SY Liao, Pearson Education/PHI
5. Microwave Engineering Fundamentals, Design and Applications, Subal Kar, University Press.

Reference Books:

1. Microwave Engineering-Passive Circuits, PA Rizzi, Pearson Education.
2. Microwaves, K C Gupta, New Age Publishers.
3. Foundation of Microwave Engineering, 2nd edition, Robert E Collin, McGraw Hill, Inc.
4. Microwave Devices & Circuit Design, GP Srivastava & VL Gupta, PHI
5. Advanced RF & Microwave Circuit Design: The Ultimate Guide to Superior Design, M. Radmanesh, Artech house

Course Name: Microwave Engineering Laboratory
--

Course Code: ECE3152

Contact Hours per week	L	T	P	Total	Credit Point
	0	0	2	2	1

Course Outcome:

After completing the following experiments, students will be able to:

ECE3152.1. Understand electromagnetic wave propagation at high frequency.

ECE3152.2. Identify the difference between active and passive microwave devices

ECE3152.3. Analyze and Characterize Microwave Devices.

ECE3152.4. Design measurement setup to perform analysis of microwave devices.

LIST OF EXPERIMENTS:

1. Determination of phase and group velocities in a waveguide carrying TE_{10} , wave from Dispersion diagram [ω - β Plot].
2. Measurement of unknown impedance using shift in minima technique using a waveguide test bench/ Measurement of the susceptance of an inductive and or a capacitive window using shift in minima technique using a waveguide test bench.
3. Study of Reflex Klystron oscillator using X-band waveguide test bench.
4. Study of Gunn Diode Characteristics using X-band waveguide test bench.
5. Characterization of waveguide tee (magic tee / E-plane tee / H-plane tee) using waveguide test bench at X-band.
6. Analysis of directional coupler using X-band waveguide test bench set up.
7. Analysis of waveguide type filter using X-band waveguide test bench set up.
8. Design of microwave filter (low pass/ high pass/ band pass) using full wave e.m. simulator (HFSS/CST/IE3D)

CourseName: Processor Fundamentals and Microcontrollers

CourseCode: ECE3103					
Contact Hours perweek	L	T	P	Total	CreditPoints
	3	0	0	3	3

Course Outcomes:

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

ECE3103.1. Understand the architecture and instruction set of the Intel 8085 microprocessor.

ECE3103.2. Develop assembly language programs for 8085 using various addressing modes and instructions.

ECE3103.3. Explain the features and architectural evolution from 8086 to Pentium and ARM processors.

ECE3103.4. Illustrate the working and interfacing of peripheral devices like 8255, 8259, 8257, 8253, ADC, and DAC.

ECE3103.5. Analyse the architecture and functional blocks of the 8051 microcontroller.

ECE3103.6. Demonstrate basic embedded programming and interfacing techniques using serial and parallel communication protocols

Total Lectures = 36 L

Module I: [10L] Intel 8085 Microprocessor Architecture, Timing and Control Signals, Instruction classification, Instruction set, Addressing Modes, ALP format – Programming 8085, Memory Interfacing, Timing diagram, stack subroutine, and Interrupt structure of 8085 microprocessor. RISC & CISC architecture.

Module II: [10L] 8086 Architecture, Advanced Coprocessor Architecture 8088, 286, 386, 486, Pentium, Intel Core.

ARM Architecture: Memory Organization, Register Organization, Processor Modes, Instruction Set, Thumb instructions.

Module III: [8L] I/O Interfacing– PPI 8255, Programmable interrupt controller 8259 – Programmable DMA controller 8257 –Programmable interval timer 8253/4, ADC & DAC Interfacing.

Module IV: [8L] Architecture of 8051 Microcontroller, Signals & Memory, I/O ports, Counters and Timers, Serial (I2C, USB, PCIe) & Parallel (ISA, ATA, PCI) Interface, Assembly/Embedded programming concepts for various software routines.

Text Books:

1. R.S. Gaonkar. Microprocessor Architecture: Programming and Applications with the 8085/8080A, Penram International Publishing, 1996.

2. D. A. Patterson and J. H. Hennesey, “Computer Organization and Design The hardware and software interface. Morgan Kaufman Publishers.

3. M.A. Mazidi, Janice GilliMazidi, and R.D.Kinley, “The 8051 Micro Controller and Embedded Systems”, PHI Pearson Education, 5th Indian reprint, 2003.
4. Douglas Hall, Microprocessor Interfacing, Tata McGraw Hill, 1991.

Reference Books:

1. Kenneth J. Ayala, The 8051 Microcontroller, Penram International Publishing, 1996.
2. Steve Furber, ARM System on chip architecture, Pearson education.
3. L. B. Das, Embedded Systems an Integrated Approach, Pearson education

CourseCode:ECE3153					
Contact Hours perweek	L	T	P	Total	CreditPoints
	0	0	2	2	1

Course Outcomes:

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

ECE3153.1. Develop and execute assembly language programs for arithmetic operations, data transfer, and block manipulation using 8085 and 8086 microprocessors.

ECE3153.2. Interface peripheral devices like 8255 with 8085 to perform input/output operations and display control applications.

ECE3153.3. Design and implement basic embedded system applications using 8051 microcontrollers for I/O handling and control tasks.

ECE3153.4. Demonstrate the ability to use Raspberry Pi for basic interfacing and real-time control tasks in embedded applications.

List of experiments

1. Store two eight-bit numbers in memory. Add/Subtract the two numbers, checking for carry/borrow and then store the result and carry/borrow in consecutive memory locations (8085 ALP).
2. Exchange data between two separate N byte memories block (8085 ALP).
3. (a) Write a program to add two 8/16-bit numbers with and without carry (8086 ALP).
(b) Write a program to move a block of numbers from one memory location to another memory location using i) byte move ii) word move. (8086 ALP).
4. (a) Write a program to multiply two numbers A X B where A (multiplicand) is a byte and B (multiplier) is a byte/word and store the 16/32-bit results using instructions (MUL & IMUL). (8086 ALP)
(b) Write a program to divide two numbers A/B where B (divisor) is a byte, and A (dividend) is a byte/word and store the Quotient and Remainder using instructions (DIV & IDIV) (8086 ALP).
5. Interface 8255 with 8085 using port A as input and displaying input value at Port A and its 1's complement at port B and 2's complement at port C.
6. Use interfaced 8255 to have a multi digit display of the seven segments LED with multiplexing.
7. Use 8051 making LED blink with Input from port 2 and output from port 1.
8. Use 8051 to mimic traffic light conditions.
9. Set up the Raspberry pi 3 after loading Raspbian (Raspberry Pi OS) in provided Micro SD

card and next interface with Laptop. After successful configuration setup, connect two LEDs to Raspberry pi and make them blink in sequence and alternately

10. Use Raspberry pi 3 for room temperature measurement and display the measured value on computer monitor and an external LCD display device.

Course Code : ECE3104

Contact hours per week :	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes (COs):

After completing the course the students would be able to:

ECE3104.1. Understand the fundamentals of MOSFET Device Physics.

ECE3104.2. Correlate the fundamental understanding with the evolving VLSI Design Trends and Challenges.

ECE3104.3. Understand the IC Fabrication Process Flow and analog layout techniques for scaled MOSFETs.

ECE3104.5. Analyze and design MOS-based analog VLSI sub-circuits like current mirrors and bandgap references.

ECE3104.6. Design MOS circuits of practical importance e.g., common-source amplifiers, differential amplifiers, switched capacitor filters and level shifters.

ECE3104.7. Understand and apply the knowledge of analog VLSI sub-circuits to develop integrated subsystems for analog applications.

Module I: Introduction and the MOS Transistor [8L]

Unit1: Evolution of Microelectronics, Moore's Law, Process Node Definition, Evolution of Process Technology, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI, GSI), ITRS, VLSI Design Trend and Challenges.

Unit2: Structure and Principle of operation of enhancement-mode MOSFETs, MOS-Characteristics, MOS Capacitors, C-V characteristics of MOS gate capacitance, Scaling Theories: Constant Field Scaling, Constant Voltage Scaling and their effects on the device parameters, Short Channel MOSFETs, NMOS vs PMOS, SOI and FinFET structures.

Module II: Fabrication Flow [8L]

Unit1: IC Process Flow, clean room technology, Wafer Growth and Preparation, CVD Techniques, Epitaxy, Molecular Beam Epitaxy (MBE), Oxidation (Dry and Wet), LOCOS and STI, Photo

Lithography: Contact, Proximity, Projection, Photo Resist, Etching (Wet and Dry), Diffusion, Ion Implantation, Metallization and interconnects.

Unit2: CMOS Fabrication flow step by step using self-aligned techniques (N-well Process), CMOS Fabrication Process Overview and Structure for N-Well, P-Well, Twin Tub, Lambda and Micron rules, Stick Diagrams, Analog layout techniques of passive components, concept of fingering, interdigitated structure and common centroid technique.

Module III: Analog VLSI Sub-circuits [10L]

Unit1: Analog VLSI Design Steps, Basic Building Blocks of Analog VLSI Chips, large signal and small signal analysis and equivalent circuit model, small signal parameters for low frequency and high frequency model, MOS Switch

Unit2: MOS Diode, Active Load/Resistors, Voltage Dividers, Current Mirror, CMOS Current Mirror & Sink (Cascode), CMOS Bandgap Reference (Basic Circuit Only).

Module IV: Analog VLSI Circuits [10L]

Unit1: Common-Source single stage amplifier, Differential Amplifier: Common Mode, Differential Mode, Transfer Characteristic Curves, CMRR, and Differential Amplifier with Active Load.

Unit2: Switched Capacitor Circuit topologies, Filter, Integrator.

Unit 3: I/O Design: GPIO (General Purpose I/O) Transmitter and Receiver block diagram, Level Shifter Design.

Text Book:

1. VLSI Technology 2ND Edition, Author: Sze, S.M.; MCGRAW HILL COMPANIES .
2. CMOS Analog Circuit Design (second edition) Phillip E. Allen and Douglas R. Holberg (Oxford) .
3. Microelectronic Circuits- A.S. Sedra &K.C.Smith- Oxford International student edition.

Reference Books:

1. The MOS Transistor (second edition) Yannis Tsividis (Oxford) .
2. Design of Analog CMOS Integrated Circuit, B. Razavi, Mc, Graw Hill .

Course Title : Microelectronic Devices and Analog VLSI design Laboratory					
Course Code : ECE3154					
Contact hours per week :	L	T	P	Total	Credit Points
	0	0	2	2	1

Course Outcomes:

After completing the course the students would be able to:

ECE3154.1. Understand the basics of analog VLSI design flow.

ECE3154.2. Understand the basic principle of operation of MOS devices.

ECE3154.3. Analyze VLSI sub-circuits.

ECE3154.4. Design and analyze amplifier circuits.

List of Experiments:

1. Familiarization with Industry Standard Cadence Software Tool for Submicron Technology (45 nm)
2. Study of Transfer and Output Characteristics of NMOS
3. Study of Transfer and Output Characteristics of PMOS
4. Study of MOS as a Capacitor
5. Study of MOS as a Diode
6. Study of Voltage Divider using MOS as Active Resistor
7. Study of Current Mirror Circuit using MOS
8. Study of Cascode Current Mirror Circuit using MOS
9. Layout Design & Post Layout Simulation of Current Mirror Circuit (Using Common Centroid Analog Layout Technique of Matched Pairs)
10. Circuit analysis of a Single Stage Amplifier
11. Circuit analysis of a Differential Amplifier

Course Title : Artificial Intelligence					
Course Code : ECE3131					
Contact hours per week :	L	T	P	Total	Credit Points
	3	0	0	3	3

Professional Elective - 1

Course Outcome:

After completing the course, the student will be able to:

ECE3131.1. Apply fundamental engineering knowledge for AI agents, feature extraction and data processing techniques.

ECE3131.2. Understand the notion of problem-solving using AI searching techniques, analyze various search algorithms and evaluate and demonstrate their effectiveness.

ECE3131.3. Illustrate the concept of knowledge representation and reasoning, apply constraints and logic for intelligent systems

ECE3131.4. Explain probabilistic reasoning in an uncertain domain and understand planning.

ECE3131.5. Explain the fundamental concepts of different Machine learning models

ECE3131.6. Apply the concept of AI in solving real life problems.

Module I: [11L]

Introduction: Introduction to AI, Applications of AI techniques- Rational Intelligent Agents, Agents and Environments, Ethical and Legal Considerations in AI, Nature of Environments, Data processing, Feature selection, Principal Components Analysis (PCA). [5L]

Problem Solving by searching: State space search; Uninformed search: Depth First Search, Breadth First Search, Bidirectional Search; informed / heuristic search: Greedy Best-first Search, A* search[6L]

Module II: [8L]

Advanced intelligent search techniques: Stochastic Search- Hill Climbing, Simulated Annealing, and Evolutionary Search - Genetic Algorithm. [5L]

Knowledge Representation-I: Logic based representations, First Order Logic, Inference Rules. [3L]

Module III [11L]

Knowledge Representation-II: Rule based representations, forward and backward chaining. [3L]

Probabilistic reasoning and uncertainty: Uncertainty and methods to handle it, the semantics of Bayesian networks and reasoning with them, Dempster-Shafer (D-S) Theory, Brief discussion on Fuzzy sets and Fuzzy logic. [5L]

Planning: Planning with State Space Search, Planning graph. [3L]

Module IV [8L]

Machine Learning: Forms of learning, Test statistics, Linear regression, Classification-naive-Bayes, nearest neighbour, Decision trees, support vector machine, Clustering-K-means, Hierarchical Clustering, and Density-based Clustering, Neural Networks, Activation Functions: RELU, LRELU, Auto Encoders.[8L]

Text Books:

- 1) Stuart Russell, and Peter Norvig, “Artificial intelligence: a modern approach”, Prentice Hall.
- 2) N. J. Nilsson. “Principles of Artificial Intelligence”, Narosa Publishing House.
- 3) Kevin Night,, and Elaine Rich. “Artificial Intelligence (SIE)”, McGraw Hill.
- 4) Ian Good fellow, YoshuaBengio and Aaron Courville, “ Deep Learning”, MIT Press, 2017

Reference Books:

- 1) Charles Severance. “Python for Everybody”.
- 2) M. Bishop, “Pattern Recognition and Machine Learning”, Springer.
- 3) R. Brachman, and H. Levesque. “Knowledge Representation and Reasoning”, Morgan Kaufmann.
- 4) N.P. Padhy. Artificial Intelligence and Intelligent Systems, Oxford University Press.
- 5) Josh Patterson, Adam Gibson "Deep Learning: A Practitioner's Approach", O'Reilly Media, 2017.

Course Title: Computer Networks					
Course Code : ECE3132					
Contact	L	T	P	Total	Credit Points
Hours per week	3	0	0	3	3

Course outcomes:

After completing the course the student will be able to:

ECE3132.1. Gain knowledge of the fundamental concepts of computer networking.

ECE3132.2. Apply the basic taxonomy and terminology of the computer networking area.

ECE3132.3. Implement various flow control, and access control mechanisms and their functions within a network.

ECE3132.4. Understand internetworking devices & principles, addressing technique, routing principles and algorithms such as IP, IPv6, distance vector, and link state.

ECE3132.5. Design and analyze the performance of the transport layer and examine its associated protocols.

ECE3132.6. Familiarization with the DNS and essential protocols of computer networks, and their application in Application Layer.

Module I [6 L]:

Overview of Data Communication and Networking: Introduction; Data communications: components, data representation (ASCII, ISO etc.), direction of data flow (simplex, half duplex, full duplex); network criteria, physical structure (type of connection, topology), Internet: brief history, Protocols and standards; Reference models: OSI reference model, TCP/IP reference model, their comparative study.

Module II [12L]:

Design issues, error detection and correction, Framing(Character and bit stuffing), Flow control Protocols: Stop & wait ARQ, Go-Back- N ARQ, Selective repeat ARQ, HDLC; Medium Access sub layer, Point to Point Protocol, Token Ring, Reservation, Polling, Multiple access protocols: Pure ALOHA, Slotted ALOHA, CSMA, CSMA/CD, CSMA/CA; Traditional Ethernet, Fast Ethernet, IEEE 802 Standards, Local Area Networks.

Module III [12L]:

Internetworking & devices: Repeaters, Hubs, Bridges, Switches, Router, Gateway; Virtual Circuit and Datagram network, Addressing: IP addressing, Sub-netting; Routing techniques: static vs. dynamic routing; Unicast Routing Protocols: RIP, OSPF, BGP; Other Protocols: ARP, IP, IPV6.

Transport layer: Process to Process delivery; UDP; TCP; Quality of service: techniques to improve QoS, Leaky bucket algorithm, Token bucket algorithm.

Module IV [6L]:

Principal of network application, Introduction to Domain name system, The Web and Hyper Text Transfer Protocol, File Transfer, SMTP, SNMP, Telnet, Introduction to blue-tooth, Electronic Mail, Socket Addressing.

Books:

1. B. A. Forouzan – “Data Communications and Networking (6th Ed.) “ – TMH
2. A. S. Tanenbaum – “Computer Networks (6th Ed.)” – Pearson Education/PHI
3. W. Stallings – “Data and Computer Communications (10th Ed.)” – PHI/ Pearson Education
4. Zheng & Akhtar, Network for Computer Scientists & Engineers, OUP
5. Black, Data & Computer Communication, PHI

Course Name: Introduction to Optical Communication					
Course Code: ECE3133					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing the course, the student will be able to:

ECE3133.1. Apply the basic idea of electronics, physics and solid-state devices and explain the operation of different components in an optical communication system.

ECE3133.2. Understand the properties of optical fiber and categorize the transmission characteristics of a wave through the optical fiber.

ECE3133.3. Analyze the structure of various optical sources and can classify them according to the performance, efficiency and application.

ECE3133.4. Explain the operation of optical detectors and can analyze the performance parameters of a detector.

ECE3133.5. Recognize the current optical technologies used for long distance communication and their application in optical networks.

ECE3133.6. Solve the problems related to optical fiber communication and can justify the physical significance of the solutions.

Module I [8L]: Optical Fiber

- Introduction to communication systems:

Principles, Components; Different Forms of Communications, Advantages of Optical Fiber Communication and its Spectral Characteristics.

- Optical Fiber:

Cylindrical Fiber Structure, Fabrication and Related Parameters, Single and Multimode Operation; Attenuation & losses, Material and Wave Guide Dispersion. Dispersion Compensation and Management. Nonlinear effects in propagation of optical signal through fiber: Self phase modulation, Cross Phase Modulation, Four wave mixing, Fiber Splices, Fiber Optic Connectors.

Module II [10L]: Optical Sources

- Light Emitting Diode:

Principle of operation, Structures, Power And Efficiency, Surface Emitting LED And Edge Emitting LED, Super Luminescent Diode (SLD), Coupling of LEDs to Fibers. Modulation Response of an LED.

- Laser diodes:

Principle of operation, Coherence, Significance Of Modes, Double Heterostructure, Gain and Index Guiding, Distributed Lasers. Quantum Well Lasers and Narrow Line Width Lasers. Modulation; Bandwidth for Modulation, Optical Transmitters: Components.

Module III [11L]: Detectors & Other Network Components

- Photo Detectors:

Photo Diodes, Photo Conducting Detectors, Photo Transistors, Optical Detection Principles, PIN Photo Detector, Avalanche Photo Detector: Efficiency, Responsivity, Bandwidth.

- WDM System:

Preamplifiers; Noise Sources, Signal To Noise Ratio. WDM Link Analysis and BitError-Rate Calculation. Point-To-Point Link, Wavelength Division Multiplexing and Demultiplexing: Building Blocks; Multiplexing; Intensity Modulation/Direct Detection System; Principle Of Regeneration.

- Optical amplifiers & Filters:

EDFA, SOA, Raman Amplifier, Fabry-Perot Filters.

Module IV [7L]: Optical Network

- Network Topologies:

LAN, MAN, WAN; Topologies: Bus, Star, Ring; Ethernet; FDDI, PON (Passive Optical Network), FSO: The concept & Challenges

- Telecom Networking:

SDH/SONET, SONET/SDH Layers, SONET Frame Structure

Text Books:

1. Fiber Optics and Optoelectronics, R. P. Khare, Oxford University Press
2. Optical Fiber Communication: John M. Senior (Pearson)
3. Optical Networks – A Practical Perspective: Rajiv Ramaswami, K. N. Sivarajan, Galen H. Sasaki (Morgan-Kaufman)

4. Optical Communication Systems: John Gawar (PHI) Reference Book: 1. Optical Fiber Communication: Gerd Kaiser (TMH)

Reference Book:

1. Optical Fiber Communication: Gerd Kaiser (TMH)

Course Name: Computer Organization					
Course Code: ECE3134					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing this course, the students will be able to:

ECE3134.1. Solve basic binary math operations using the computer.

ECE3134.2. Demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target computer.

ECE3134.3. Apply knowledge of the processor's internal registers and operations by use of a PC based microprocessor simulator

ECE3134.4. Develop the capacity to simulate combinational and sequential logic required to interface I/O structures with processors using VHDL or Verilog.

ECE3134.5. Conceptualize the instruction set design with its associated microinstructions for a system.

ECE3134.6. Understand the knowledge of pipeline and vector computing to design parallel computer system.

Lectures total 36

Module 1: [10L] Functional Units of a computer, Princeton & Harvard Architecture, Flynn's Taxonomy, Instruction Set Architecture (ISA) covering Instruction format (IF) Instruction set (IS) and Addressing modes (AM), Inter-Process Communication (IPC), Instruction Cycle, Control Unit design, Hardwired and micro-programmed control unit, Microinstruction formats, Symbolic Micro-programs, RISC and CISC.

Module 2: [8L] Amdahl's law, Building data path & control, Single cycle and multi cycle processor, Pipelining, Instruction pipelining, Instruction level parallelism (ILP), Data and Control Hazard and their mitigation, Array, Vector Processor, Superscalar, Super Pipelined Computers, Accelerator.

Module 3: [10L] SRAM, DRAM, Primary and Secondary memory, Caching multi level, Cache schemes as Direct, Associative, Set associative, Processor - cache interactions for read/write request,

write-through/write-back cache, Average memory access time, Cache replacement policies (LRU, LFU), Memory interleaving.

Flash memory, I/O mapped & memory mapped I/O, data transfer techniques as Programmed I/O, Interrupt driven I/O, and DMA.

Module 4: [8L] Limits of ILP (Coarse and fine grained parallelism), Introduction to multi-core systems (chip multiprocessor) and cache coherence issues, multi-threaded processors, Simultaneous multi-threaded (SMT) processors, Using Microprocessor cores in System on Chip (SOC) design. Design the ISA (IF, IS & AM) of a 16 bit RISC based machine followed by its data path, MMU, ALU, CU, and I/O interface with required BUS system, using Verilog/VHDL.

Text books:

1. "Computer Organization and Design: The Hardware/Software Interface," David A. Patterson, and John L. Hennessy, 5th Edition Elsevier.
2. "Computer Organization & Architecture," Smruti Ranjan Sarangi, McGraw Hill
3. "Computer Organization and Embedded Systems," Carl Hamacher, 6th edition, McGraw Hill
4. "Computer Architecture and Organization," John P Hayes, 3rd Edition, WCB/McGraw Hill
5. "Computer Organization and Architecture: Designing for Performance," William Stallings, 10th Edition
6. "Computer System Design and Architecture," Vincent P. Heuring and Harry F. Jordan, 2nd Edition, Pearson Education
7. "Computer System Architecture," Morris M. Mano, 3rd Edition Pearson

Online Simulators

1. RIPS: <https://freesoft.dev/program/108505982>
2. GEM5: https://www.gem5.org/documentation/learning_gem5/introduction/
3. CACTI: <https://github.com/HewlettPackard/cacti>
4. PIN: <https://www.intel.com/content/www/us/en/developer/articles/tool/pin-a-binary-instrumentation-tool-downloads.html>
5. TEJAS: <https://www.cse.iitd.ac.in/~srsarangi/archbooksoft.html>
6. XILINX (VHDL/ Verilog tools): <https://www.xilinx.com/support/university/students.html>

Course Title : Introduction to Machine Learning using Python Laboratory					
Course Code : ECE3155					
Contact hours per week :	L	T	P	Total	Credit Points
	1	0	3	4	2.5

Course Outcomes:

After completing the course the student will be able to:

- ECE3155.1.** Explain fundamental concepts of Python programing related to Python libraries, data types, arithmetic and logic, flow control.
- ECE3155.2.** Apply Python programing knowledge to understand, visualize, analyze and preprocess the data from a source.
- ECE3155.3.** Illustrate supervised learning algorithms using Python programing.
- ECE3155.4.** Explain fundamental understanding of unsupervised learning algorithms using Python programing.

Lecture Content: [12L]

- **Fundamentals of Python:** Intro to Python Language, Setting up the development environment Variables, Functions, Conditionals, Recursion, Iteration, Nested loops. Basic Operations of NumPy , Pandas, Matplotlib.
- **Data Handling:** Data Normalization, Feature Reduction/Dimensionality reduction, Data Visualization, Filtering Data
- **Supervised Learning Techniques: Regression:** Ordinary Least Squares, Linear Regression, Gradient descent, Ridge Regression, Lasso Regression.
Classification: Learning a Class from Examples, Confusion matrix, Evaluation matrices. Learning algorithms: Support vector machine, K-Nearest Neighbours, Classification Trees.
Discussion on performance of different algorithms.
- **Unsupervised Learning:** Introduction to clustering, A Categorization of Major Clustering Methods, K-means clustering.

List of Experiments:

1. Write programs to introduce the basics of Python, libraries in Python.
2. Write programs to demonstrate different data types of Python.
3. Write programs to demonstrate the use of Variables, Functions, Conditionals in Python

4. Write programs to demonstrate the use of Recursion, Iteration, Nested loops, Libraries in Python
5. For a given set of training data examples stored in a .CSV file, write a program to demonstrate the working of data preprocessing.
6. Write a program to demonstrate the working of standardization, data visualization, and data filtering techniques.
7. Write a program to implement training testing split and validation techniques by forming confusion matrix for classification with KNN.
8. Write a program to demonstrate the supervised classification of data with linear and non-linear SVM.
9. Write a program to implement classification Tree algorithms for given data set.
10. Write a program to implement the non-parametric Regression algorithm in order to fit data
11. Write a program to demonstrate regression model: Lasso, Ridge regression.
12. Write a program to demonstrate unsupervised learning with K- Means Clustering

Text Books:

- 1) EthemAlpaydin, 'Introduction to Machine Learning' , MIT Press, Prentice Hall of India.
- 2) R.O. Duda, P.E. Hart, and D.G. Stork, "Pattern Classification", John Wiley.
- 3) M. Bishop, "Pattern Recognition and Machine Learning", Springer.
- 4) "The Elements of Statistical Learning" by Jerome H. Friedman, Robert Tibshirani, and Trevor Hastie.
- 5) Y. Daniel Liang. "Introduction to Programming Using Python", Pearson,

References:

- 1) T. M. Mitchell, "Machine Learning", McGraw Hill Education.
- 2) Murphy, Kevin, "Machine learning: a probabilistic perspective", MIT press.
- 3) Stuart Russell, and Peter Norvig, "Artificial intelligence: a modern approach", Prentice Hall.
- 4) "Deep Learning" by Ian Goodfellow, YoshuaBengio, Aaron Courville.
- 5) Richard S. Sutton and Andrew G. Barto, "Reinforcement learning: An introduction", Second Edition, MIT Press.

Course Title : Indian Constitution and Civil Society					
Course Code : INC3016					
Contact Hours per week	L	T	P	Total	Credit Points
	2	0	0	2	0

Course Outcomes:

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

- INC3016.1. Analyse the historical, political and philosophical context behind the Indian Constitution-making process
- INC3016.2. Appreciate the important principles characterizing the Indian Constitution and institute comparisons with other constitutions
- INC3016.3. Understand the contemporaneity and application of the Indian Constitution in present times
- INC3016.4. critique the contexts for constitutional amendments in consonance with changing times and society
- INC3016.5. establish the relationship between the Indian Constitution and civil society at the collective as well as the individual levels
- INC3016.6. consciously exercise the rights and the duties emanating from the Indian Constitution to one's own life and work

Module 1- 6L

Introduction to the Constitution of India-Historical Background

Making of Indian Constitution -the process of framing the constitution, the constituent assembly

Module II-6L

Salient Features of the Indian constitution

Comparison with the constitutions of other countries

Module III- 6L

Relevance of the Constitution of India

Constitution and Governance

Constitution and Judiciary

Constitution and Parliament-Constitutional amendments

Module IV-6L

Constitution and Society-democracy, secularism, justice

Constitution and the individual citizen- Fundamental Rights, Directive Principles of state policy and Fundamental Duties

Reference Books

1. C.M.Elliot, (ed.), Civil Society and Democracy, OUP, Oxford, 20012..
2. David Held et.al (ed),The Idea of the Modern State, Open Univ. Press, Bristol, 1993
3. NeeraChandoke, State and Civil Society, Sage, Delhi, 19953

Course Title : Digital Image Processing & Pattern recognition					
Course Code : ECE3121					
Contact hours per week :	L	T	P	Total	Credit Points
	3	0	0	3	3

OPEN ELECTIVE-1

(For ECEStudents)

Course outcomes:

After completing the course, the student will be able to:

ECE3121.1. Understand fundamentals of digital image processing and representation of images in spatial domain.

ECE3121.2. Image transformation, segmentation, compression and enhancement techniques and their applications for interpretation of images.

ECE3121.3. Understand and develop algorithms for feature extraction from images.

ECE3121.4. Gain knowledge about the fundamentals of Pattern Recognition, such as recognition, decision-making, and statistical learning problems.

ECE3121.5. Identify parametric and non-parametric techniques, as well as supervised, unsupervised, and semi-supervised learning of pattern recognition.

ECE3121.6. Design systems and algorithms for Image Processing and Pattern Recognition to solve real-world problems.

Digital Image Processing

Module 1 [12L]

Digital Image Fundamentals- Analog vs Digital Image Processing, Elements of visual perception, computer vision, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures.

Image Enhancement and filtering:

Spatial domain Processing-Pixel point processing: linear and piecewise linear transformations, log and power law transformations, Image Histogram and histogram equalization. Pixel Group Processing: Convolution in spatial domain, low frequency and high-frequency filtering, mean and median filters,

Frequency Domain Processing-Introduction to the Fourier transform, filtering in the frequency domain, Image smoothing and sharpening.

Module 2 [8L]

Colour Image Processing: RGB and HSI colour models and interrelation.

Image Compression Standards: Lossy and lossless compressions, BMP, TIFF & JPG image formats.

Image Segmentation: Detection of discontinuities, edge linking and boundary detection, thresholding – global and adaptive, region-based segmentation, dilation and erosion, etc.

Video Segmentation: Temporal segmentation – shot boundary detection, hard-cuts and soft-cuts; Spatial segmentation – motion-based; Video object detection and tracking.

Module 3 [10L]

Introduction to the Pattern Recognition System: Components of Pattern Recognition System, Learning and adaptation, Supervised Learning (Classification), Unsupervised Learning (Clustering) and Semi-Supervised Learning, Bayesian Decision Theory: classifiers, discriminant functions, decision surfaces, Discriminant functions for Normal density, Error bounds for Normal density, Maximum Likelihood, Random Forest and Bayesian Parameter Estimation, Fisher Linear Discriminant, Hidden Markov Models.

Module 4 [10L]

Non-parametric Techniques & Feature Extraction: Parzen window estimation, k-nearest neighbour classification, Logistic regression, Perceptron classifier, Support Vector Machines, Decision Tree based classifiers. Feature extraction – discrete cosine and sine transform, Principal Component analysis, Kernel Principal Component Analysis, clustering: K-means, Agglomerative, DBSCAN.

Textbooks:

1. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Pearson.
2. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley.
3. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press.
4. C. M. Bishop, Pattern Recognition and Machine Learning, Springer.

References:

1. C. Solomon, T. Breckon, Fundamentals of Digital Image Processing: A Practical Approach with Examples, Wiley
2. K. Fukunaga, Statistical Pattern Recognition, Academic Press.

Course Title : Fundamentals of Sensors And Transducers					
Course Code : AEI3122					
Contact hours per week :	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

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

AEI3122.1: Memorize the knowledge on mechanical, electromechanical, thermal and acoustic, and optical sensors.

AEI3122.2: Identify and classify the sensors based on type of measure and such as strain, force, pressure, displacement, temperature, flow, etc.

AEI3122.3: Choose the application specific Sensors and Transducers

AEI3122.4: Relate the sensors in various industrial applications.

AEI3122.5: Design and set up the sensing systems.

AEI3122.6: Create the applications of smart sensors

Module I – [10L]

Fundamentals: Definition, principle of sensing and transduction, classification of transducers, static and dynamic characteristics of Transducers.

Resistive Transducers: Potentiometric transducer- Theory, type, symbol, materials, error calculations due to loading effects, sensitivity, and specifications.

Strain gauge- Theory, type, symbol, materials, gauge factor, temperature compensation and dummy gauge, Strain measurement circuit- quarter, half and full bridge configuration, and specifications.

Inductive Transducers: Principle, common types, Reluctance change type, Mutual inductance change type, transformer action type. LVDT- Construction, working principle, characteristics (modulated and demodulated).

Module II - [8L]

Capacitive sensors: Parallel plate type- Variable distance, variable area, variable dielectric constant type, calculation of sensitivity, response characteristics, specifications, and applications.

Piezoelectric transducers: Piezoelectric effect, type, charge and voltage co-efficient and relationships, crystal model, materials, charge amplifier; Ultrasonic sensors- Liquid velocity and level measurements.

Module III-[10L]

Contact type Thermal Sensors:

Resistance change type:

Resistance Temperature Detector (RTD) - materials, temperature range, R-T characteristics, configurations, specifications, and applications. Thermistors- materials, temperature range, R-T characteristics, applications and specification.

Thermo-emf sensor:

Thermocouple- Thermo electric laws, types, temperature ranges, series and parallel configurations, cold junction compensation, compensating cables.

Introduction to semiconductor type temperature sensors.

Non-Contact type Thermal Sensors:

Thermal Radiation sensors- types, constructions, working, temperature ranges and comparison.

Module IV- [8L]

Radiation Sensors:

LED, LDR, photodiodes, Photovoltaic cells, photo emissive cell types, materials, construction, response, applications. Geiger counters, Scintillation detectors.

Introduction to smart sensors.

References:

1. A. K. Ghosh, Introduction to transducers, PHI, 2015
2. E. A. Doebelin, Measurement Systems: Application and Design, Mc Graw Hill, New York
3. H. K. P. Neubert, Instrument Transducers, Oxford University Press, London and Calcutta.
4. S. Renganathan, Transducer engineering, Allied Publishers Limited, 2003.
5. D. V. S. Murty, Transducer and instrumentation, PHI, second edition, 2008.
6. Jacob Fraden, Handbook of Modern Sensors: Physics, Designs and applications, Third edition, Springer International, 2010.
7. D Patranabis, Sensors and Transducers, PHI, 2nd ed.

Course Name: Fundamentals of Operating Systems

Course Code: CSE3121

Contact Hours per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Course Outcomes

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

CSE3121.1: Understand the underlying technologies and features of memory management and storage management.

CSE3121.2: Understand the various design issues in process management.

CSE3121.3: Apply knowledge of mathematics, science and engineering in the areas of process management, memory management and storage management.

CSE3121.4: Analyze operating system operations, structures.

CSE3121.5: Judge the primitive operations of operating systems.

CSE3121.6 : Assemble the concepts learned here which are used in their own field of work.

Detailed Syllabus

Module1 [7L]

Introduction of General Operating System: Introduction: What do OS do? Computer System Organization, Interrupt Driven System, Storage Structure, I/O Structure, Operating System Functions, OS Services, Dual Mode Operations, Kernel, System Calls, Types of System Calls

Types of Operating Systems: Computer System Architecture (Monolithic, Microkernel, Layered, Hybrid), Different types of O.S.(Batch, Multi-programmed, Time-sharing, Real-time, Distributed, Parallel, for Mobile Unit, Single Processor System, Multiprocessor Systems), Virtual Machines, System Boot.

Module2 [9L]

Process Concept: What is process, Operations on Process (Process States), Process Control Block, Process Scheduling, Scheduling Queues,

Cooperating Process: Co-operating Processes, Inter-process Communication. IPC, Examples in IPC, Communication in Client-Server Systems

Threads: Threads, Benefits of Threads, User and Kernel Threads.

CPU Scheduling: Scheduling Criteria, Pre-emptive & Non-pre-emptive Scheduling, Scheduling Algorithms (FCFS, SJF, RR, priority).

Module3 [10L]

Process Synchronization: Critical Section Problem, Critical Region, Synchronization Hardware. Petersons Solution, Classical Problems of Synchronization, Semaphores, Monitors, Synchronization examples, Atomic Transactions.

Deadlock: Deadlocks: System model, Deadlock characterization, Method of handling Deadlock, Deadlock Prevention, Avoidance, Detection, Recovery from deadlock.

Module4 [10L]

Memory Management Strategies: Contiguous Memory Allocation, Paging, Structure of Page Table, Segmentation, Demand Paging, Copy-on-Write, Swapping, Page Replacement, Allocation of Frames, Thrashing, Memory Mapped Files, Allocating Kernel Memory, Operating System examples.

File Management: File System: File Concept, Access Methods, Directory Structure, File System Mounting, File Sharing, Protection.

Textbooks

1. Silberschatz, P B Galvin, G Gagne, Operating systems, 9th edition/10th edition, John Wiley and sons.

Reference Books:

1. William Stalling, "Operating Systems: Internals and Design Principles", Pearson Education, 1st Edition, 2018.
2. Andrew S Tanenbaum, Herbert BOS, "Modern Operating Systems", Pearson Education, 4th Edition, 2016.

Course Title: Principles of Cryptography					
Course Code: INF3121					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

After successfully completing this course the students will be able to:

INF3121.1: Define the concepts of Network security. Classify different types of attack on Network security. Recall the principles of security.

INF3121.2: Classify different kinds of Substitution techniques and Transposition techniques and illustrate the concepts of Symmetric key cryptography and Asymmetric key cryptography.

INF3121.3: Discuss DES, RC5 and IDEA algorithm. Explain Diffie-Hellman Key exchange algorithm and Digital Envelope.

INF3121.4: Discuss RSA algorithm. Compare MAC, Message Digest and Hash function. Analyze HMAC algorithm. Illustrate Digital Signature and Password.

INF3121.5: Explain Authentication token and Classify between different types of Authentication tokens. Compare Certificate based authentication and Biometric Authentication. Illustrate Kerberos authentication protocol.

INF3121.6: Analyze the concept of SSL, PGP and PEM. Explain the concepts of Firewall and DMZ Network. Compare between Packet filtering router, Application-level gateway and Circuit-level gateway. Classify between different Firewall Configurations.

Module – I [9L]

Network Security and Cryptography- Concepts and Techniques

Need for Security, Security approaches, Principles of Security, Types of Active attack and Passive attack. Introduction to cryptography, Plaintext & Cipher text, Substitution Techniques, Transposition Techniques, Types of Cipher, Cryptanalysis and Brute-force attack, Type of attacks on encrypted text, Symmetric & Asymmetric key Cryptography.

Module – II [10L]

Symmetric Key Algorithms

Algorithm types & Modes, Diffie-Hellman key exchange algorithm, Digital Envelope, DES (Data Encryption Standard) algorithm & its variants, RC5 algorithm and IDEA (International Data Encryption Algorithm) algorithm.

Module – III [10L]

Asymmetric Key Algorithms, Digital Signature and User Authentication

Overview of Asymmetric key Cryptography, RSA algorithm, Digital Signature, Basic concepts of Message Authentication code, Message Digest and Hash Function, HMAC algorithm. Password, Kerberos authentication protocol, Authentication Token, Certificate based Authentication and Biometric Authentication.

Module – IV [10L]

Electronic mail security, SSL and Firewall

Basics of e-mail security, PEM, PGP, Secure Socket Layer (SSL) protocol. Introduction to Firewall, Characteristics of Firewall, Packet filtering router, Application-level gateway, Circuit-level gateway, Bastion Host, Firewall Configurations and DMZ Network.

Text Books

1. Cryptography and Network Security, William Stallings, 3rd Edition, Pearson Education Asia.
2. Cryptography & Network Security, Atul Kahate, TMH.

Reference Books

1. Cryptography and Network Security, Behrouz A. Forouzan, Special Indian Edition, 2007, TMH.
2. Network Security Essentials: Applications and Standards, William Stallings, Pearson.
3. Cryptography and Security, C K Shyamala, N Harini and Dr T R Padmanabhan, Wiley India
4. Network Security private communication in a public world, C. Kaufman, R. Perlman and M.Speciner, Pearson.

Course Name: Statistics and Information Theory					
Course Code:MTH3122					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

After successfully completing this course the students will be able to:

MTH3122.1: Solve the problems involving multiple random variables.

MTH3122.2: Compare and contrast different interpretations of probability theory selecting the preferred one in a specific context.

MTH3122.3: Formulate predictive models to tackle situations where deterministic algorithms are intractable.

MTH3122.4: Quantifies the amount of uncertainty involved in the value of a random variable or the outcome of a random process.

MTH3122.5: Understand mathematical analysis of problems in Information Theory.

MTH3122.6: Summarize data visually and numerically.

MODULE-I: Single and Bivariate Probability Distributions:

- Review of basic probability
- Moment generating functions
- Markov's inequality, Chebyshev's inequality and law of large numbers
- Joint distribution using joint probability mass/density function
- Finding marginal pmf/pdf from joint distribution
- Multiplicative property of joint pmf/pdf in case of independent random variables

MODULE-II: Markov Chains and Statistical Methods:

- Markov Chains: Introduction

- Chapman-Kolmogorov equations
- Classification of states
- Some applications: Gambler's Ruin Problem
- Measures of Central tendency: Moments, skewness and Kurtosis
- Spearman's Rank Correlation coefficient
- Curve fitting: Straight line and parabolas

MODULE-III: Statistics-II:

- Population and Samples,
- The sampling distribution of mean (standard deviation known),
- The sampling distribution of mean (standard deviation unknown),
- Point and Interval estimation,
- Null Hypotheses and Tests of Hypotheses.

MODULE-IV: Classical Information Theory:

- Motivation with some relevant examples
- Entropy : Definition with examples
- Joint Entropy and Conditional Entropy
- Relative Entropy and Mutual Information
- Relationship Between Entropy and Mutual Information
- Chain Rules for Entropy, Relative Entropy and Mutual Information
- Jensen's Inequality and Its Consequences

Text Books

1. Elements of Information Theory, Thomas M. Cover and Joy A. Thomas, Wiley
2. Fundamentals of Mathematical Statistics, S.C.Gupta and V. K. Kapoor, Sultan Chand and Sons
3. Business Statistics, J. K. Sharma, Vikas Publishing House

Suggested Books

1. Introduction to Probability Models, *S.M. Ross*, Elsevier.
2. Information Theory and Reliable Communication, *Robert G. Gallager*, John Wiley and Sons
3. Business Statistics Problem and Solutions, J. K. Sharma, Pearson.

OPEN ELECTIVES

Course Title : Digital Image Processing & Pattern recognition					
Course Code : ECE3121					
Contact hours per week :	L	T	P	Total	Credit Points
	3	0	0	3	3

(Offered by ECEDepartment)

3rd Year 1st Sem

Course outcomes:

After completing the course, the student will be able to:

ECE3121.1. Understand fundamentals of digital image processing and representation of images in spatial domain.

ECE3121.2. Image transformation, segmentation, compression and enhancement techniques and their applications for interpretation of images.

ECE3121.3. Understand and develop algorithms for feature extraction from images.

ECE3121.4. Gain knowledge about the fundamentals of Pattern Recognition, such as recognition, decision-making, and statistical learning problems.

ECE3121.5. Identify parametric and non-parametric techniques, as well as supervised, unsupervised, and semi-supervised learning of pattern recognition.

ECE3121.6. Design systems and algorithms for Image Processing and Pattern Recognition to solve real-world problems.

Digital Image Processing

Module 1 [12L]

Digital Image Fundamentals- Analog vs Digital Image Processing, Elements of visual perception, computer vision, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures.

Image Enhancement and filtering:

Spatial domain Processing-Pixel point processing: linear and piecewise linear transformations, log and power law transformations, Image Histogram and histogram equalization. Pixel Group Processing: Convolution in spatial domain, low frequency and high-frequency filtering, mean and median filters, Frequency Domain Processing-Introduction to the Fourier transform, Filtering in the frequency domain, Image smoothing and sharpening.

Module 2 [8L]

Colour Image Processing: RGB and HSI colour models and interrelation.

Image Compression Standards: Lossy and lossless compressions, BMP, TIFF & JPG image formats.

Image Segmentation: Detection of discontinuities, edge linking and boundary detection, thresholding – global and adaptive, region-based segmentation, dilation and erosion, etc.

Video Segmentation: Temporal segmentation – shot boundary detection, hard-cuts and soft-cuts; Spatial segmentation – motion-based; Video object detection and tracking.

Module 3 [10L]

Introduction to the Pattern Recognition System: Components of Pattern Recognition System, Learning and adaptation, Supervised Learning (Classification), Unsupervised Learning (Clustering) and Semi-Supervised Learning, Bayesian Decision Theory: classifiers, discriminant functions, decision surfaces, Discriminant functions for Normal density, Error bounds for Normal density, Maximum Likelihood, Random Forest and Bayesian Parameter Estimation, Fisher Linear Discriminant, Hidden Markov Models.

Module 4 [10L]

Non-parametric Techniques & Feature Extraction: Parzen window estimation, k-nearest neighbour classification, Logistic regression, Perceptron classifier, Support Vector Machines, Decision Tree based classifiers. Feature extraction – discrete cosine and sine transform, Principal Component analysis, Kernel Principal Component Analysis, clustering: K-means, Agglomerative, DBSCAN.

Textbooks:

1. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Pearson.
2. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley.
3. S.Theodoridis and K.Koutroumbas, Pattern Recognition, 4th Ed., Academic Press.
4. C. M. Bishop, Pattern Recognition and Machine Learning, Springer.

References:

1. C. Solomon, T. Breckon, Fundamentals of Digital Image Processing: A Practical Approach with Examples, Wiley
2. K. Fukunaga, Statistical Pattern Recognition, Academic Press.

CourseName:IntroductiontoMachineLearning					
CourseCode:ECE3122					
Contact Hoursperweek	L	T	P	Total	CreditPoints
	3	0	0	0	3

Courseoutcomes:

Aftercompletingthecoursethestudents willbeableto:

- ECE3122.1.** Apply fundamental engineering knowledge for analyzing data in a given feature space.
- ECE3122.2.** Explain the fundamental concepts of different Machine learning models and can evaluate a machine learning problem.
- ECE3122.3.** Apply machine learning techniques for classification and regression approaches in real-world applications.
- ECE3122.4.** Distinguish between supervised and unsupervised learning and able to apply machine learning tools for clustering approaches.
- ECE3122.5.** Analyze a machine learning problem with ensemble and reinforcement learning techniques.
- ECE3122.6.** Understand different techniques to create application using deep learning algorithms.

IntroductiontoMachineLearning

Module1

[9L]

Introduction: Foundations for ML: What is Machine Learning, Examples of Various Learning Paradigms, Perspectives and Issues, Version Spaces and Candidate Elimination Algorithm, Data Normalization, Feature Reduction/Dimensionality reduction, Validation Techniques (Cross-Validations), Bias-Variance Trade-off.

FeatureSelectionandDimensionalityReduction: Principal Components Analysis (PCA), Independent Component Analysis (ICA), and Linear Discriminate Analysis (LDA).

Module2

[11L]

Supervised Learning:

Classification: Learning from Examples, Linear, Non-linear, Multi-class and Multi-label classification, Regression and Classification Trees, Decision tree, Naïve Bayes, k-Nearest Neighbor. Support vector machines: Linear and Non-Linear, Kernel Functions. Artificial neural networks: Introduction, Introduction, Perceptron, Multilayer Perceptron, Backpropagation algorithm
Regression: Ordinary Least Squares, Linear Regression, Multiple Linear Regression: Ridge Regression, Lasso Regression, Non-Linear Regression, Logistic Regression.

Module 3

[7L]

Unsupervised Learning:

Introduction to clustering, A Categorization of Major Clustering Methods, Partitioning Methods, Density-Based Methods, Grid-Based Methods, Model-Based Clustering Methods, Hierarchical: AGNES, DIANA, Partitional: K-means clustering, Self-Organizing Map, Expectation Maximization, Gaussian Mixture Models.

Module 4

[8L]

Ensemble Learning: Ensemble Learning Model Combination Schemes, Voting, Error-Correcting Output Codes, Bagging: Random Forest Trees, Boosting: Adaboost.

Reinforcement Learning:

Introduction to reinforcement learning, Learning Framework and Markov Decision Process with some examples.

Deep Learning: Autoencoder, Convolutional Neural Networks, Recurrent Neural Networks- with some real life examples.

Text Books:

- 1) Ethem Alpaydin, "Introduction to Machine Learning", MIT Press, Prentice Hall of India.
- 2) R.O. Duda, P.E. Hart, and D.G. Stork, "Pattern Classification", John Wiley.
- 3) M. Bishop, "Pattern Recognition and Machine Learning", Springer.
- 4) "The Elements of Statistical Learning"
by Jerome H. Friedman, Robert Tibshirani, and Trevor Hastie.
- 5) Andreas C. Mueller, Sarah Guido, "Introduction to Machine Learning with Python: A Guide for Data Scientists", O'Reilly.
- 6) Sebastian Raschka, "Python Machine Learning".

References:

- 1) T.M. Mitchell, "Machine Learning", McGraw Hill Education.
- 2) Murphy, Kevin, "Machine Learning: A Probabilistic Perspective", MIT Press.
- 3) Stuart Russell, and Peter Norvig, "Artificial Intelligence: A Modern Approach", Prentice Hall.
- 4) "Deep Learning" by Ian Goodfellow, Yoshua Bengio, Aaron Courville.
- 5) Richard S. Sutton and Andrew G. Barto, "Reinforcement Learning: An Introduction", Second Edition

on,MITPress.

Course name: Error Control Coding for Secure Data Transmission					
Course Code: ECE3123					
Contact hours	L	T	P	Total	Credit points
per week	3	0	0	3	3

Course Outcome:

After completing the course, the students will be able to:

ECE3123.1. Distinguish between different types of source codes.

ECE3123.2. Figure out equations for entropy, mutual information and channel capacity for all types of channels, utilizing their knowledge on the elements.

ECE3123.3. Explain and estimate the merit of various methods for generating and detecting different types of error correcting codes.

ECE3123.4. Formulate the basic equations of linear block codes, cyclic codes.

ECEN3123.5. Outline the basics of convolution code, linear algebra and BCH code.

ECEN3123.6. Develop overall understanding about different types of codes applied to both source and channel end during data transmission

Module-1: Information theory, Source coding and channels [10L]

Information theory: Uncertainty and information, measure of information, Self and conditional

Information, mutual information and entropy, Fixed length code, Variable length code, Prefix code, Instantaneous code, Kraft Inequality,

Source Code: Source coding theorem, Huffman codes, Shannon- Fano coding, Arithmetic code

Channels: Discrete memory less channel, Channel matrix for different channel models- Lossless channel, Deterministic channel, Noise-less channel, Deterministic channel capacity, channel coding, Information capacity theorem, The Shannon limit.

Module-2: Error Control code: Linear Block Code [7L]

Block code: Hamming codes Minimum distance, Error detecting and Error-correcting capabilities of block code.

Linear Block Code: Definition & properties of linear block codes, Matrix description of linear block codes, Encoding of linear block code, parity check matrix, decoding of a linear block code, Syndrome and Error detection.

Module-3: Cyclic and BCH code [10L]

Cyclic Code: Definition & properties of cyclic codes, Code Polynomials, Generator Polynomials, Division algorithm for polynomials, a method for generating cyclic codes, matrix description of cyclic codes, Decoding of cyclic codes.

Galois Field: Introduction to Linear Algebra, Introduction to Galois Field, Primitive elements, generator polynomials in terms of minimal polynomials, Calculation of minimal polynomial.

BCH Code: Elementary concept of BCH Codes, Encoding and Decoding, Elementary concept of Reed Solomon Code.

Module-4: Convolution Codes: [9 L]

Encoding convolution code: Polynomial description of convolution codes, Distance notions for convolution codes and the generating function.

Decoding of convolution codes: Viterbi decoder, distance and performance bounds for convolution codes.

Example of convolution code - Turbo codes, Turbo decoding.

Graphical representation of convolution code: State diagram, Tree, Trellis diagram

Text Books:

1. Information theory, coding and cryptography - Ranjan Bose; TMH.
2. Introduction to Error Control Codes – S Gravano; Oxford Press
3. Information and Coding - N Abramson; McGraw Hill.

Reference Books:

1. Introduction to Information Theory - M Mansurpur; McGraw Hill.
2. Information Theory - R B Ash; Prentice Hall. 8. Error Control Coding - Shu Lin and D J Costello Jr; Prentice Hall

Course Title: Introduction To VLSI Design					
Course Code : ECE3124					
Contact Hours per week	L	T	P	Total	Credit points
	3	0	0	3	3

Course Outcomes:

After completing the course the student will be able to:

ECE3124.1. Learn about VLSI Technology Growth as driven by Moore's law

ECE3124.2. Understand Various VLSI Design Methodologies

ECE3124.3. Design Digital Combinational logic, Circuits and Layout using CMOS Technology

ECE3124.4. Design Digital Sequential logic and Circuits using CMOS Technology.

ECE3124.5. Learn RTL Design using Verilog Hardware Description Language

ECE3124.6. Learn Basic Building Blocks of Analog Circuit using CMOS Technology

Module I- [4L] VLSI Design Methodology: Moore's Law, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI, GSI), Technology growth and process Node, VLSI Design Trend and Challenges. VLSI Design Cycle, Y-Chart, Full Custom Design, Std Cell based Semi Custom Design, Gate Array Design, PLD: PLA, PAL, FPGA

Module II- [14L] Digital VLSI Circuits: **Unit1**: MOS Transistor Characteristics, MOS as Digital Switch, NMOS Logic Family, CMOS Logic Family, CMOS Inverter Characteristics (VTC), Inverter Delay & Noise, NAND and NOR gates, Complex Logic Circuits, Concept of Logical effort, Pass Transistor Logic & Transmission Gate, CMOS Sequential Circuits (Latch and Flip flop), Read and write operations of 1T1C DRAM and 6T1C SRAM cell.

Unit2: CMOS Cross Section, Inverter Layout, Lambda Rule vs Micron Rule, Stick Diagram, Euler Path Algorithm

Module III-[6L] Hardware Description Language: Introduction to Verilog Modeling: Behavioral, Data-Flow, Structural and Mixed Mode. Frontend Design Flow using Verilog (Behavioral, RTL and Gate Level), Combinational and sequential circuits with various examples, FSM Example: Mealy Machine and Moore Machine.

Module IV- [10L] Analog VLSI Circuits: MOS large signal model, Transconductance gain, MOS small signal model, MOS switch, MOS Diode, MOS Resistor, CMOS Current Source/Sink, Active Load, Voltage Dividers, CMOS Current Mirror.

Text Book:

1. CMOS VLSI Design, A Circuits and Systems Perspective (4th Edition) Author: Neil Weste, David Harris. Addison-Wesley, Pearson
2. Design of Analog CMOS Integrated Circuit, B. Razavi, Mc. GrawHill
3. Fundamentals of Digital Logic with Verilog Design, 3rd Edition, Brown and Vranesic, Mc. GrawHill

Reference Book:

4. Phillip E. Allen and Douglas R. Holberg, CMOS Analog Circuit Design, 2nd Ed., Oxford.
5. Digital Integrated Circuit, Design Perspective, Author: .M. Rabaey, Prentice-Hall
6. CMOS Digital Integrated Circuits, Analysis and Design, Author: Sung-Mo Kang, Yusuf Leblebici, Tata McGraw Hill (3rd Edition), 2006

3rd Year, 2nd semester

Program Core Course

Course Title: Digital VLSI Design					
Course Code: ECE3201					
Contact hrs per week	L	T	P	Total	Total Credits
	3	0	0	3	3

Course outcomes:

After completing this course, the students will be able to:

ECE3201.1: relate to different MOS structures and functions in order to apply the knowledge in building CMOS circuits

ECE3201.2. Students will learn VLSI Design Cycle, Style and Methodology.

ECE3201.3. Students will be able to determine logic and performance of CMOS combinational and Sequential Circuit including Memory Array Design.

ECE3201.4. Students will be able to construct Physical Layout Design and Stick Diagram of Digital Gates.

ECE3201.5. Students will be able to make use of various synthesis flow and HDL modeling in ASIC Semi Custom Design.

ECE3201.6. Students will be able to interpret Si Testing and Debug related algorithms and Fault Modeling.

Module I: VLSI Design Flow and CMOS Combinational Circuits [14L]

Unit1: Evolution of Microelectronics: Moore's Law, Process Node Definition, Evolution of Process Technology, Scale of Integration (SSI, MSI, LSI, VLSI, ULSI, GSI), VLSI Design Trend and Challenges.

Unit2: VLSI Design Cycle, Y-Chart, Design Styles: Full Custom Design, Std Cell based Semi Custom Design, Gate Array Design, PLD, FPGA: CLB, LUT, MUX.

Unit 3 : MOS as Digital Switch: Principle of operation and Characteristics of Enhancement mode MOS transistor, MOS as Capacitor, NMOS vs PMOS, CMOS Combinational Circuit: NMOS inverter issues, CMOS Inverter Transient Analysis, DC Characteristics and Noise Margin, Dynamic and Leakage Power Dissipation issues. Static CMOS Logic Gate Design, Pass Transistor Logic and Transmission Gate (TG) Design, Logical effort, pseudo-nMOS Gates, Dynamic and Domino logic.

Module II: CMOS Sequential and Memory Circuits and Physical Design [10L]

Unit 1 : Bi-stability principle, SR Latch circuit and Clocked SR Latch using CMOS. CMOS and Transmission Gate (TG) based D-latch & Edge triggered Master Slave flip-flop, Setup and Hold Definition,

Unit 2: Basic idea of 1-Transistor DRAM Operation. SRAM Array Design: 6-Transistor Bit cell Design, Write Circuit, Sense Amplifier and Read Circuit, Pre-Charge Circuit, Decoder and I/O Design.

Unit 3 : CMOS Cross Section, Layout and Mask layers, Inverter Layout, Lambda Rule vs Micron Rule, Std Cell Layout Topology, Stick Diagram, Euler Path Algorithm.

Module III: Synthesis and HDL [8L]

Unit 1 : Synthesis – High level Synthesis, Logic level Synthesis, Physical Automation: Brief ideas on Partitioning, Floor-planning, Placement, Routing and Compaction.

Unit 2 : HDL- Front-end Design Flow using HDL (Behavioral, RTL and Gate Level), Verilog Coding, Verilog Modeling: Behavioral, Data-Flow, Structural and Mixed, Test Bench coding,

Module IV: Test Methodology of VLSI Circuits [7L]

Unit 1 : Si Testing: Why Testing, Challenge of Si-Testing, Manufacturing Defects, Die (Inter and Intra) Variation, Yield, DPM, Logical Fault Modelling: Stuck at Faults (D-Algorithm), Bridging Fault, Transistor Stuck open/Stuck Short, ATPG, DFT, Scan Design, BIST.

Unit 2 : Reliability of MOS Devices: Transistor Aging: NBTI (Negative Bias Temperature Instability), PBTI (Positive Bias Temperature Instability), HCI (Hot Career Injection), Reliability issue in Wire: Electromigration and Self Heating in Interconnect.

Text Books:

1. Principles of CMOS VLSI Design, A Systems Perspective, Author: Neil Weste, Kamran Eshraghian, Addison Wesley, 2nd Edition, 2000.
2. CMOS VLSI Design, A Circuits and Systems Perspective (3rd Edition) Author: Neil Weste, David Harris, Ayan Banerjee. Pearson, 2011. Fundamental of VLSI Devices – Y. Taur& T.H. Ning- Cambridge University Press.

Reference Books:

1. CMOS Digital Integrated Circuits, Analysis and Design, Author: Sung-Mo Kang, Yusuf Leblebici, Tata McGraw Hill (3rd Edition), 2006.
2. Digital Integrated Circuit, Design Perspective, Author: .M. Rabaey, Prentice-Hall.
3. VLSI Design and EDA TOOLS, Author: Angsuman Sarkar, Swapnadip De, Chandan Kumar Sarkar, SCITECH PUBLICATIONS (India) Pvt. Ltd., 2011.

Course Title: Digital VLSI Design Laboratory					
Course Code: ECE 3251					
Contact hrs per week	L	T	P	Total	Total Credits
	0	0	2	2	1

Course Outcomes:

After completing the following experiments, students will be able to:

ECE 3251.1. Learn Industry Standard Backend and Frontend CAD Tools

ECE 3251.2. Design CMOS Combinational Digital Gates

ECE 3251.3. Design TG Sequential Digital Gates

ECE 3251.4. Learn Industry Standard Verilog HDL Design, simulation and Synthesis.

List of Experiments: 3 Category of Experiments:

1. Backend: Sub Micron and Deep Sub Micron Technology based Experiments: Backend Design flow using Industry Standard Mentor GraphicsCAD Tool including Eldo Circuit Simulator (SPICE Analysis):

- a. Transient analysis of CMOS Inverter Circuit
- b. DC & Parametric analysis of CMOS Inverter
- c. Design and Analysis of Various CMOS Logic Gates (NAND, NOR, other CMOS gates)
- d. Design and Analysis of Various TG (Transmission Gate) based Logic Gates (XOR, XNOR)
- e. Implementation of TG based Various Sequential Gates (D-Latch, D-Flip-Flop) and Setup/Hold Analysis.

2. Frontend: Introduction to XILINX-Vivado Simulator: Verilog Coding and Test Bench Simulation

- a. Logic Design and Verification of Digital Gates: Mux, Encoder, Decoder
- b. Logic Design and Verification of a 4bit Ripple-Carry Adder

c. Logic Design and Verification of Sequential Gates: D-Latch, D-Flip-Flop

d. Logic Design and Verification of a Finite State Machine

3. **Synthesis and P & R:FPGA Flow using XILINX Hardware Kits:** Implementing and verifying many of above experiments in FPGA hardware Kits.

Course Name: Object Oriented Programming Concept Using JAVA					
Course Code: CSE3208					
Contact	L	T	P	Total	Credit Points
Hours per Week	3	0	0	3	3

Course Outcomes:

The students after finishing this course will be able to:

CSE3208.1: Describe classes, objects, members of a class and relationships among them needed for a specific problem.

CSE3208.2: Explain the features of object-oriented principles such as encapsulation, polymorphism and composition of systems based on object identity.

CSE3208.3: Analyze the concepts of inheritance and its application in OO design with different design patterns.

CSE3208.4: Discuss simple abstract data types and design implementations using abstraction functions to document them.

CSE3208.5: Apply the concept of procedural language to implement the concept polymorphism, inheritance, abstraction, and encapsulation.

CSE3208.6: Apply the concepts of multithreading and exception handling to develop efficient and error free codes.

Detailed syllabus:

Module I: 10L

Introduction to Object Oriented Programming

Genesis of Object Oriented Programming. Problems with Procedural Programming, ObjectOriented Concepts – Objects & Classes, Abstraction, Encapsulation, Polymorphism, Inheritance, Message Passing,Access Specifiers.

Introduction to Java

Introduction and Overview, Java Virtual Machines (JVM) – concept, Garbage Collection. Basic Language Constructs, Arrays. String Class, String Methods, String Arrays, CommandLine Arguments, StringBuffer Class, StringBuffer Methods, String Tokenizer.

Module II: 9L

Classes and Objects

Defining a Class, Creating Objects, Assigning Object Reference Variables, Introducing Methods, Array of Objects, Constructors, , Passing and Returning Objects, this keyword, Static Members, Introducing Access Control, Inner and Nested Classes.

Inheritance

Inheritance and Code Reusability, Types of Inheritance, Dealing with —super, Multilevel Inheritance, Method Overriding, Method Overloading ,final keyword, Object Class, Abstract Classes.

Module III: 8L

Interface :Defining Interfaces, Implementing Interfaces, Extending Interfaces, Interfaces and Multiple Inheritance.

Generics: Generic collection classes.

Package : Using Packages, Java API, User Defined Packages.

Module IV: 9L

Exception Handling

Exception and Exception Handling, Exception Types, Built-in Exceptions, use of throw,throws, finally, Checked and Unchecked Exceptions, Creating User Defined Exceptions.

Multithreading

Multitasking & Multithreading, Java and Multithreading, Creating Threads, Life Cycle of a Thread, Thread Methods, Thread Priorities, Synchronization and Deadlock.

Text Books:

1. JAVA: The Complete Reference – Herbert Schildt, TMH.
2. JAVA and object-oriented programming paradigm – Debasish Jana, PHI.

Reference Books:

1. Object Oriented Modeling & Design -James R. RumBaugh, PHI.
2. The Java Programming Language – James Gosling, Addison Wesley.
3. Java – How to Program – Deitel and Deitel, PHI
4. Core Java I and II – Horstmann and Cornell, Oracle Corporation.

Course Name: Object Oriented Programming Concept Using JAVA LAB

Course Code: CSE3258

Contact	L	T	P	Total	Credit Points
Hours per Week	0	0	3	3	3

Course Outcomes:

The students after finishing this course will be able to:

- CSE3258.1:** Define an object oriented programming language, and associated class libraries and learn how to develop object oriented programs
- CSE3258.2:** Implement Object Oriented Programming Features to improve the solution designs.
- CSE3258.3:** Apply the concept of interfaces- multiple inheritance, extending interfaces.
- CSE3258.4:** Reconstruct the solution to a problem in GUI mode.
- CSE3258.5:** Analyze and use an integrated environment development by creating and accessing packages
- CSE3258.6:** Develop programs to implement multithreading aiming to increase code efficiency and exception handling to handle run-time errors efficiently.

Practice Java programming to cover the following major topics:

1. Assignments on class, constructor, overloading, inheritance, overriding
2. Assignments on wrapper class, arrays, Strings
3. Assignments on developing interfaces- multiple inheritance, extending interfaces
4. Assignments on creating and accessing packages
5. Assignments on exception handling, including user-defined exceptions.
6. Assignments on multi-threading

CourseName: EconomicsforEngineers					
Course Code: HUM 3201					
Contact hrsperweek:	L	T	P	Total	Creditpoints
	3	0	0	3	3

CourseOutcomes:

After the completion of the course, studentswillbeable to

HUM 3201. 1. Evaluateaprojectand estimatethetotalcostoftheproject.

HUM 3201. 2. Applyfinancialanalyticalmethodologiestoprepareareportregardingthefinancialperforma
nce ofanorganisation.

HUM 3201. 3. Participateactivelyinananorganisation’scapitalbudgetingprocess.

HUM 3201. 4. Providevitalinputsregarding thepricing ofaproduct.

HUM 3201. 5. Applytheknowledgeoftheinterplayofvariouseconomicvariablesandindicatorsin the
workplace.

HUM 3201. 6. Provide insight
aboutdifferentaccountingconceptsandapplybroaderconceptsslikecosts,revenues,assets,liabilities,capi
tal,profit,investmentandinterest.

Module 1: (6L)

Market:MeaningofMarket,TypesofMarket,PerfectCompetition,Monopoly,MonopolisticandOligopoly
market.

Thebasicconceptofeconomics –needs, wants, utility.

NationalIncome-

GDP,GNP.Demand&Supply,Lawofdemand,Roleofdemandandsupplyinpricedetermination,PriceElast
icity.

Inflation:meaning,reasons,etc.

ModuleII: (4L)

Business:Typesofbusiness,Proprietorship,Partnership,Joint-stockcompany,andcooperativesociety–
theircharacteristics.

Banking:roleofcommercialbanks;creditanditsimportance
inindustrialfunctioning.Roleofcentralbank:ReserveBankofIndia.
InternationalBusinessorTradeEnvironment.

ModuleIII: (14L)

FinancialAccounting-Journals.Ledgers,TrialBalance,Profit
&LossAccount,BalanceSheet.FinancialStatementAnalysis(RatioandCashFlow analysis).
Cost Accounting- Terminology, Fixed, Variable and Semi-variable
costs.BreakEvenAnalysis.CostSheet.BudgetingandVarianceAnalysis.
MarginalCostbaseddecisions.

ModuleIV: (12L)

TimeValueofMoney:PresentandFutureValue,Annuity,Perpetuity.EquityandDebt,CostofCapital.
Capital Budgeting: Methods of project appraisal - average rate of return - payback period -discounted
cash flow method:net present value, benefit cost ratio, internal rate of
return.Depreciationanditsypes,ReplacementAnalysis,SensitivityAnalysis.

Text Books:

1. R. Narayanswami, *Financial Accounting- A Managerial Perspective*. Prentice-Hall ofIndia PrivateLimited.NewDelhi
2. Horne,JamesCVan,*FundamentalsofFinancialManagement*.Prentice-HallofIndiaPrivate Limited,NewDelhi
3. H.L.Ahuja.,*ModernEconomicTheory*.S.Chand.NewDelhi.
4. Newman, Donald G., Eschenbach, Ted G., and Lavelle, Jerome P. *Engineering EconomicAnalysis*.NewYork:OxfordUniversityPress.2012

Program Elective Course-2

Course Title: Trends in Wireless Networks					
Course Code: ECE3231					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing this course, the students will be able to:

ECE3231.1. Understand the concepts of wireless communication from the knowledge gathered earlier

ECE3231.2. Interpret the evolution of wireless networking including fundamental principles, architectures, standards and application area.

ECE3231.3. Demonstrate the technologies used in wireless networks

ECE3231.4. Analyse advanced networking concepts and implement innovative techniques in wireless communication

ECE3231.5. Categorize emerging trends and challenges in designing next-generation wireless systems

ECE3231.6. Conversant with the advancements of wireless networks.

Module 1: Introduction to Wireless Networks [9L]

Evolution of Wireless Networks: From 1G to 5G and beyond. Basics of wireless communication: Spectrum, bandwidth, modulation techniques. Network architectures: Cellular networks, Ad Hoc networks, and infrastructure-less networks. Overview of wireless standards: Wi-Fi (802.11), Bluetooth, Zigbee, and 802.15.4. Applications of wireless networks: IoT, Smart cities, telemedicine, and autonomous vehicles.

Module 2: Wireless Network Technologies [9L]

Radio Access Technologies (RAT): GSM, CDMA, LTE, and NR (5G). Wireless LANs: IEEE 802.11 protocols and enhancements (Wi-Fi 6 and Wi-Fi 7). Low Power Wireless Networks: Zigbee, LoRaWAN, and NB-IoT. Cognitive Radio and Dynamic Spectrum Access. Antennas for wireless communication: MIMO, Beam forming, and Massive MIMO.

Module 3: Advanced Concepts in Wireless Networking [9L]

Multi-access Edge Computing (MEC) and network slicing in 5G. Software-Defined Networking (SDN) and its role in wireless networks. Security in wireless networks: WPA3, encryption, and attack vectors. Green wireless networks: Energy efficiency and sustainability. Integration with AI/ML: Predictive analysis, optimization, and automation.

Module 4: Emerging Trends and Future Wireless Networks [9L]

Private 5G : use cases, challenges and how it compares to Wi-Fi , Introduction to 6G: Use cases, challenges, and enabling technologies, Terahertz communication and its applications, Internet of Everything (IoE): Expansion of IoT for interconnected ecosystems, Satellite-based wireless communication and non-terrestrial networks, Quantum communication in wireless networks, Standardization and policy trends in wireless communication.

Text Books:

1. Wireless Communications: Principles and Practice by Theodore S. Rappaport
2. Wireless Communications and Networking" by Vijay K. Garg
3. 5G NR: The Next Generation Wireless Access Technology" by Erik Dahlman, Stefan Parkvall, and Johan Sköld
4. Wireless Networking: Understanding Internetworking Challenges" by Jack L. Burbank et al
5. Mobile and Wireless Communications for IMT-Advanced and beyond" edited by Afif Osseiran, Jose F. Monserrat, and Werner Mohr

Reference Books:

1. Fundamentals of Wireless Communication by David Tse and Pramod Viswanath.
2. Wireless Communications and Networks" by William Stallings.
3. Wireless Communication and Networks: 3G and Beyond, I. Saha Misra, TMH Education.
4. Emerging Wireless Communication and Network Technologies" by Nitin Kumar Tripathi and Jeffrey H. Reed

Course Title :Information Theory and Coding					
Course Code: ECE3232					
Contact hours per week :	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcome:

After completing the course the student will be able to:

ECE3232. 1. Understand the underlying physical principles and engineering concepts about entropy, mutual information, and outline channel capacity of different channels principles to solve engineering problems.

ECE3232. 2. Evaluate the scope of different source codes using basic mathematical techniques and engineering concepts.

ECE3232. 3. Assess the merit of various methods for generating and detecting different types of error-correcting codes using engineering concepts and mathematics.

ECE3232. 4. Formulate equations for linear and cyclic codes using scientific and engineering principles.

ECE3232. 5. Design convolution and BCH code using engineering mathematics and engineering concepts.

ECE3232. 6. Evaluate coding objectives for data transmission, understanding the overall system, the underlying principles and using mathematical and engineering principles.

Module I: Information theory, Source coding and channels [10L]

Information theory: Uncertainty and information, measure of information, Self and conditional Information, mutual information and entropy, Fixed length code, Variable length code, Prefix code, Instantaneous code, Kraft Inequality,

Source Code: Markov sources, Source coding theorem, Huffman codes, Shannon- Fano coding, Arithmetic code, Lempel-Ziv algorithm.

Channels: Discrete memory less channel, Channel matrix for different channel models- Lossless channel, Deterministic channel, Noise-less channel, Deterministic channel channel capacity, channel coding, information capacity theorem, The Shannon limit, Overview of multiple access

channel (MAC).

Module II: Error Control codes: Linear Block Codes [7L]

Block code:Hamming codes Minimum distance, Error detecting and Error-correcting capabilities of block code.

Linear Block Code: Definition & properties of linear block codes, Matrix description of linear block codes, Encoding of linear block code, parity check matrix, decoding of linear block code, Syndrome and Error detection, Standard Array, equivalent codes, perfect codes.

Module III Cyclic and BCH code [10L]

Cyclic Code:Definition & properties of cyclic codes, Code Polynomials, Generator Polynomials, Division algorithm for polynomials, a method for generating cyclic codes, matrix description of cyclic codes, Decoding of cyclic codes. Golay codes, LFSR.

Galois Field: Introduction to Linear Algebra, Introduction to Galois Field, Primitive elements, generator polynomials in terms of minimal polynomials, Calculation of minimal polynomial.

BCH Code: Elementary concept of BCH Codes, Encoding and Decoding, Elementary concept of Reed Solomon Code.

Module IV: Convolution Codes & others: [9 L]

Encoding convolution code: Polynomial description of convolution codes, Distance notions for convolution codes and the generating function.

Decoding of convolution codes: Viterbi decoder, distance and performance bounds for convolution codes.

Example of convolution code - Turbo codes, Turbo decoding.

Graphical representation of convolution code: State diagram, Tree, Trellis diagram.

Introduction to broadcast channel coding techniques: Fundamentals of Superposition coding scheme

Text Books:

- 5) Information theory, coding and cryptography –Ranjan Bose; TMH.
- 6) Introduction to Error Control Codes –S. Gravano; Oxford Press

Reference Books:

- 1) Information and Coding –N. Abramson; McGraw Hill.
- 2) Introduction to Information Theory –M. Mansurpur; McGraw Hill.

- 3) Information Theory - R B Ash ; Prentice Hall.
- 4) Error Control Coding - Shu Lin and D J Costello Jr; Prentice Hall.

Course Title : Fundamentals of Cognitive Radio and Network					
Course Code: ECE3233					
Contact hrs. per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing this course, the students will be able to:

ECE3233.1. Understand the fundamentals of cognitive radio technology

ECE3233.2. Analyze the underlying technologies and features of cognitive radio networks.

ECE3233.3. Evaluate the various deployment issues and design challenges of cognitive radio network.

ECE3233.4. Explain different spectrum sensing and detection schemes of cognitive radio.

ECE3233.5. Analyze various localization techniques for static and mobile radios within the network.

ECE3233.6. Evaluate the societal and industrial impacts of cognitive radio networks.

Module 1: [10L]

Introduction on Cognitive Radio [5L]

Radio flexibility and capability, aware & adaptive radio, policy based & learning radio, cognitive radio, cognition cycle – orient, plan, decide and action phases, radio framework, paradigms of cognitive radio, Artificial Intelligence.

Cognitive Radio Network [5L]

Classification of cognitive radio network, deployment strategy of cognitive radio network, transmit power optimization strategy, challenges associated with the network, architecture maps, building the cognitive radio architecture on software defined radio architecture.

Module 2: [9L]

Spectrum Sensing and Sharing [4L]

Spectrum Sensing, Spectrum management, spectrum mobility, unlicensed and licensed spectrum sharing, dynamic spectrum access, spectrum handoff, spectrum utilization strategies of overlay/underlay/interweave users, Opportunistic and Cooperative sharing.

Signal Detection [5L]

Cooperative & non cooperative detection, primary user signal detection techniques – energy detection, feature detection, matched filtering, waveform-based sensing, cyclostationary based sensing, fundamental limits of cognitive radio.

Module 3: [11L]

Localization [6L]

Importance of localization, cooperative and non-cooperative localization, miss-detection & false detection probability, localization algorithms, AOA, TDOA, DOA localization, RSSI based localization, weighted centroid localization, maximum likelihood detection, hybrid localization scheme.

Network Security [5L]

Security requirements, types of network security issues, primary user emulation attack, hidden and exposed terminal problem, cross layer issues, upper layer issues.

Module 4: [6L]

Application Domain [6L]

Application of cognitive radio technology, autonomous cognitive cellular network, cognitive radio networks in health care, cognitive vehicular networks, real time multimedia transmission, economic approaches in cognitive radio networks.

Text Books:

- 1) Kwang-Cheng Chen, Ramjee Prasad Cognitive Radio Networks. Germany: Wiley, 2009, ISBN: 9780470742013.
- 2) Ashish Bagwari, GeetamTomar, JyotshanaKanti. Introduction to Cognitive Radio Networks and Applications. United States: CRC Press, 2016. ISBN: 9781498762991.
- 3) Robert CaimingQiu, Zhen Hu, Husheng Li, Michael C. Wicks. Cognitive Radio Communication and Networking: Principles and Practice. Germany, Wiley, 2012. ISBN: 9781118376294

Reference Books:

- 1) Ekram Hossain, DusitNiyato, Zhu Han, “Dynamic Spectrum Access and Management in Cognitive Radio Networks”, Cambridge University Press, 2009.
- 2) Mubashir Husain Rehmani, RiadhDhaou, Cognitive Radio, Mobile Communications and Wireless Networks. Germany, Springer International Publishing, 2018, ISBN:9783319910024

Course Title :Wireless Sensor Networks and Security					
Course Code: ECE3234					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing this course, the students will be able to:

ECE3234.1. Understand the architecture, design principles, and operational protocols of WSNs

ECE3234.2. Analyse communication protocols and standards for efficient WSN performance.

ECE3234.3Analyse secure WSN systems by addressing key security challenges and vulnerabilities

ECE3234.4.Analyse the parameters for a routing protocol.

ECE3234.5. Understand the importance and use of energy processing for WSNs.

ECE3234.6. Explore advanced applications, future trends, and their implications for WSNs and security

Module 1: Fundamentals of Wireless Sensor Networks (WSNs) (9L)

Overview of WSNs: Concepts, architecture, and components (sensors, nodes, and gateways). Communication protocols: Medium Access Control (MAC), routing, and transport protocols in WSNs. Energy-efficient design: Power consumption and optimization techniques. Deployment strategies: Node placement, network topology, and coverage. Applications of WSNs: Environmental monitoring, healthcare, agriculture, and industrial automation.

Module 2: Protocols and Standards for WSNs (9L)

Overview of IEEE 802.15.4 standard and its relevance to WSNs. Routing protocols: Flat, hierarchical, and location-based routing. Data aggregation and dissemination techniques. MAC protocols for WSNs: Contention-based and contention-free protocols. Interoperability with IoT and emerging communication standards.

Module 3: Security in Wireless Sensor Networks (9L)

Security challenges in WSNs: Resource constraints, physical vulnerabilities, and different types of attacks. Cryptographic techniques: Lightweight encryption and authentication mechanisms. Secure routing and intrusion detection systems. Key management protocols for WSNs. Case studies: Addressing real-world security challenges in WSNs.

Module 4: Advanced Topics and Future Trends in WSNs (9L)

Integration with IoT: Smart sensor networks and edge computing. Machine Learning for WSNs: Predictive maintenance and anomaly detection. Wireless Body Sensor Networks (WBSNs) for healthcare applications. Energy harvesting and self-sustaining sensor networks. Emerging threats and countermeasures in WSNs security.

Text Books:

1. Waltenegus Dargie, Christian Poellabauer, —Fundamentals of Wireless Sensor Networks: Theory and Practice, Wiley 2010
2. Mohammad S. Obaidat, Sudip Misra, —Principles of Wireless Sensor Networks, Cambridge, 2014
3. LoWPAN: The Wireless Embedded Internet, Zach Shelby, Carsten Bormann, Wiley
4. Internet of Things: Converging Technologies for Smart Environments and Integrated Ecosystems, Dr. Ovidiu Vermesan, Dr. Peter Friess, River Publishers
5. C. Siva Ram Murthy and B. S. Manoj, "Ad-hoc Wireless Networks", Pearson Education, 2008.

Reference Books:

1. Ian F. Akyildiz, Mehmet Can Vuran, —Wireless Sensor Networks, Wiley 2010
2. C S Raghavendra, K M Sivalingam, Taieb Znati, —Wireless Sensor Networks, Springer, 2010
3. C. Sivarammurthy & B.S. Manoj, —Adhoc Wireless Networks, PHI-2004
4. FEI HU., XIAOJUN CAO, —Wireless Sensor Networks, CRC Press, 2013
5. Feng ZHAO, Leonidas GUIBAS, —Wireless Sensor Networks, ELSEVIER, 2004

Program Elective Course-3

Course Title: Internet of Things					
Course Code: ECE3241					
Contact hrs. per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing this course, the students will be able to:

ECEN3241.1: Explain the fundamental concepts, technology, and architecture of IoT systems.

ECEN3241.2: Analyze various IoT communication protocols such as MQTT, CoAP, and AMQP, and their applications.

ECEN3241.3: Evaluate the performance of IoT various communication technologies.

ECEN3241.4: Explain advanced IoT protocols like 6LoWPAN and RPL, and their relevance in next-generation IP-based systems.

ECEN3241.5: Analyze the security protocols and apply best practices to design secure IoT networks and ensure data integrity.

ECEN3241.6: Evaluate the significance of IoT applications.

Module I [10 L]

IoT- the concept and technology, architecture and ecosystem, protocols (MQTT, CoAP, AMQP), edge computing.

Module II [12 L]

M2M – the idea and the tools required. Zigbee, Bluetooth Low Energy (BLE), and Wi-Fi 6. IEEE802.15.4 – physical and medium access control (MAC) layer. LPWAN technologies (LoRa, NB-IoT, Sigfox), IPv4 and IPv6, next generation IP based protocols – 6LoWPAN and RPL.

Module – III [6 L]

IoT security and privacy, role of middleware in IoT ecosystems, device management in IoT system. Overview of popular IoT platforms (AWS IoT, Google Cloud IoT, Azure IoT). Real-world challenges in IoT deployment and integration.

Module – IV [8 L]

IoT applications- smart cities, agriculture and home automation, industrial IoT (IIoT)- smart factories and industry 4.0, IoT in healthcare, green IoT, 5G for IoT applications.

Text Books:

1. Internet of Things from Hype to Reality – The road to digitization: Ammar Rayes and Samer Salam, Springer
2. Internet Of Things: Converging Technologies For Smart Environment And Integrated Ecosystems - Vermesan, Ovidiu, Fries, Peter - River Publishers, 2013
3. Internet of Things: A Hands-On Approach- Arshdeep Bahga and Vijay Madisetti, Universities Press, ISBN:978-8173719547

Reference Books:

1. Understanding Smart Sensors - Frank, Randy, Artech House, 2013
2. Hanes, David, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, and Jerome Henry. IoT fundamentals: Networking technologies, protocols, and use cases for the internet of things. Cisco Press, 2017.
3. Minoli, Daniel. Building the internet of things with IPv6 and MIPv6: The evolving world of M2M communications. John Wiley & Sons, 2013.

Course Title : Wireless Communication: 5G and Beyond					
Course Code : ECE3242					
Contact hours per week :	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcome:

After completing the course, the student will be able to:

ECE 3242.1: Understand the evolution of cellular communication, 5G communication fundamentals and technological requirements of 5G system.

ECE 3242.2: Demonstrate 5G services and 5G verticals to achieve global digital transformation.

ECE 3242.3: Identify & explain the objective and functional requirements of core network and distributed heterogeneous network.

ECE 3242.4: Explore the system requirements and identify the design alternatives of multiple access technologies for 5G communication.

ECE 3242.5: Illustrate the used cases of 5G communication and analyse design objectives regarding the enabling technologies.

ECE 3242.6: Identify design requirements, objectives for the journey beyond 5G, technical advancements towards 5G advances, and 6G timelines with its vision.

Module 1: 5G basics[10L]

Cellular generations: 1G, 2G, 3G, 4G, Journey from 4G to 5 G, Cellular radio principles: Frequency reuse, power control, handover, uplink/ downlink, user/ control channel , Cellular architecture: gNB, UE, fronthaul, backhaul 5G spectrum: Spectrum allocation and sharing , 5G services: Enhanced mobile broadband (eMBB), ultra-reliable low latency communications (URLLC), massive machine type communications (mMTC), 5G verticals: Vehicle-to-everything (V2X) communication, Internet-of-things (IoT), Healthcare and telemedicine, Device-to-device (D2D) communication

Module 2: 5G architecture [6L]

Protocols and standards: 5G NR non-standalone (NSA), standalone (SA), 5G-Advanced , Radio access network: Radio unit (RU) and baseband unit (BBU), open-RAN (ORAN) with centralized unit (CU) and

distributed unit (DU), 5G core and interfaces, small cell, beamforming , Core network: Network function virtualization (NFV), software-defined network (SDN), network slicing

Module 3: 5G frames, channels and access technologies [8L]

Frame structure: Numerology, radio frames, slots, subframes and symbol , Overview of Uplink, Downlink channels and Reference / synchronization signals: Introduction to Physical broadcast channel (PBCH), Physical random-access channel (PRACH), control channels (PUCCH & PDCCH), Phase tracking reference signals (PT-RS), sounding reference signals (SRS), Initial access and mobility: Initial and random access, paging , Fundamentals of Modulation (e.g. OFDM), channel coding (e.g. LDPC, hybrid ARQ), multiple access (e.g. NOMA) techniques.

Module4: Beyond 5G and 6G [8L]

Use cases: Autonomous vehicle, Integrated space-air-ground network, Smart living, Immersive/ haptic/ holographic communication, Industry 5.0/ Society 5.0 , Enabling technologies: Reconfigurable intelligent surface (RIS), Integrated sensing and communication (ISAC), Non-terrestrial network (NTN), ultra-massive MIMO (umMIMO), AI/ML , 5G Advanced and 6G Timelines: IMT 2030 vision, 3GPP releases , 6G in India: Bharat 6G Vision, 6G ecosystem (telecom operators, standardization bodies, academic initiatives)

Textbooks

1. W. Chen, P. Gaal, J. Montojo, H. Zisimopoulos - Fundamentals of 5G Communications: Connectivity for Enhanced Mobile Broadband and Beyond - McGraw Hill (1st Edition, 2021, ISBN: 9781260459999).
2. C. Cox - An Introduction to 5G: The New Radio, 5G Network and Beyond – Wiley (1st Edition, 2020, ISBN: 9781119602668).
3. S. S. Husain, A. Prasad, A. Kunz, J. Song, A. Buckley, E. Pateromichelakis -End-to-End Mobile Communications: Evolution to 5G - McGraw Hill (1st Edition, 2021, ISBN: 9781260460254).
4. D. Chandramouli, R. Liebhart, J. Pirskanen - 5G for the Connected World- Wiley (1st Edition, 2019, ISBN: 9781119247081).

References

1. W. Tong, P. Zhu - 6G: The Next Horizon, From Connected People and Things to Connected Intelligence - Cambridge University Press (1st Edition, 2021, ISBN: 9781108989817).
2. T. P. Fowdur, M. Indoonundon, D. A. Milovanovic, Z. S. Bojkovic - 5G NR Modelling in MATLAB: Network Architecture, Protocols, and Physical Layer - CRC Press (1st Edition, 2024, ISBN: 9781003465393).

Course Title : Intelligent Radio Design					
Course Code: ECE 3243					
Contact hrs per week	L	T	P	Total	Total Credits
	3	0	0	3	3

Course Outcome

By the end of the course, students will be able to:

ECE3243.1 Understand the fundamentals of intelligent radio systems and their applications.

ECE3243.2 Explain the principles of cognitive radio and dynamic spectrum access.

ECE3243.3 Develop and implement basic algorithms for adaptive filtering and spectrum sensing.

ECE3243.4 Understand machine learning applications in radio design.

ECE3243.5 Steps to design and simulate an SDR-based communication system using platforms like MATLAB/Python.

ECE3243.6 Develop skill to test intelligent radio parameters.

Prerequisites: Basic knowledge of RF Communication, Signal Processing, and Embedded Systems

Module 1: Introduction to Intelligent Radio Systems (10L)

Evolution of wireless communication and radio technologies; Introduction to Software-Defined Radio (SDR) and Cognitive Radio; Concepts of intelligent, adaptive, and self-configuring radios; Overview of Machine Learning (ML) and AI applications in radio design.

Module 2: Fundamentals of Software-Defined Radio (8L)

SDR Architecture and Components; RF Front-End Design (ADC, DAC, Mixers, Filters); Digital Signal Processing (DSP) in SDR

Module 3: Cognitive Radio and Dynamic Spectrum Access (10L)

Cognitive Radio (CR) Architecture and Functionality; Spectrum Sensing Techniques; Energy Detection, Matched Filtering, Cyclostationary Detection; Spectrum Allocation and Sharing Policies; Adaptive Transmission and Power Control; Jamming and Anti-Jamming Techniques; Intrusion Detection in Wireless Networks.

Module 4: Adaptive Signal Processing in Intelligent Radios (8L)

Adaptive Filtering and Equalization; Channel Estimation and Interference Mitigation; Noise Reduction Techniques in Intelligent Radios; Basics of Machine Learning (ML) and Deep Learning (DL) in wireless communication; Signal classification using Neural Networks, SVM, and Decision Trees

Text Books :

1. "Cognitive Radio Communications and Networks" – Bruce Fette
2. "Software-Defined Radio for Engineers" – Travis Collins & Alexander M. Wyglinski
3. "Machine Learning for Wireless Communications" – Yonina Eldar & Osvaldo Simeone

Online Resources:

- MATLAB Communication Toolbox
- Python-based RF Signal Processing
- Research papers on intelligent radios and their applications

Course Title: Satellite Communication and Remote Sensing					
Course Code: ECE3244					
Contact hrs per week:	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing the course the student will be able to:

ECE 3244.1. Explain the basic principles of satellite communication and its various application areas in remote sensing.

ECE 3244.2. Identify the physical, architectural and networking issues of the satellite system.

ECE 3244.3. Analyze the areas as speech and video coding, satellite networking, internet over satellite and satellite personal communications.

ECE 3244.4. Understand parameters associated with remote sensing using satellites through the use of mathematical and logical tools to gain insight into the concept.

ECE 3244.5. Explain basics of remote sensing principles and technology acquire knowledge about the important applications for satellite remote sensing in research and the public and private sectors.

ECE 3244.6. Analyze the knowledge about the remote sensing techniques about various applications to improve social, economic and environmental conditions under agricultural, forestry and water body management.

Module 1: Basics of Satellite Communication (10L)

Overview: Historical background, principles, types, orbital & spacecraft problems (1L); Orbital descriptions: Orbital mechanics-Two body problem, Special orbits-LEO, MEO GEO, Geometry and movement, constellations, real world effects (2L); Launch Vehicles: Principles of Rocket propulsion, powered flight, Launch vehicles for communication satellite (1L); RF: Spectrum allocations, modulation, multiplexing, multiple access (2L); RF link: Basic RF link, satellite and inter-satellite links, optimization of RF link, noise temperature, antenna temperature, overall system temperature, propagation factors, rain attenuation model, tropospheric and ionospheric effects (4L).

Module 2: Satellite Communication Architecture and Networking (9L)

Features of Satellite communication systems in relation to terrestrial systems; Satellite orbits, earth segment and space segment components. Satellite orbital parameters, orbital perturbations, station

keeping, Geo stationary and non Geo-stationary orbits – Look Angle Determination (3L); Satellite subsystems and satellite link design- AOCS, TT&C, power system, spacecraft antenna, transponder, Friis transmission equation, G/T ratio of earth station (2L).

Module 3: Basics of Remote Sensing (9L)

Overview: Definition of Remote sensing, Electromagnetic(EM) radiation, and spectrum, EM radiation sources, Active & Passive sources, Radiometric terms and definitions, Radiation Principles(Plank's Law, Stephen Boltzmann law), Interaction of EM Radiation with atmosphere and target, Atmospheric Windows(2L); Imaging spectrometry, Spectral signature of various land cover features Ground and space based remote sensing technique, Concept of thematic mapping with remote sensed data (2L); Satellite mounted remote sensors, spatial, radiometric and temporal resolution, Field of View(FOV), Data acquisition platforms-Various types of platforms, different types of aircraft, Manned and Unmanned spacecrafts used for data acquisition - characteristics of different types of platforms-LANDSAT, SPOT, IRS, ERS, INSAT (3L); Image analysis and interpretation-thermal imaging-image processing, classification and interpretation; Satellite sensors, detectors and scanning techniques Radio Occultation (2L).

Module 4: Remote sensing systems (8L)

Weather forecasting radars, IR Radiometer Airborne and space borne radar, Satellite telemetry, telecommand and ranging stations, Light Detection And Ranging (LIDAR),Acoustic sounding systems, SOnic Detection And Ranging (SODAR) (4L), Tropical Rainfall Measuring Mission(TRMM), AURA MLS, Megha Tropiques, Altimeter, Scatterometry, Radiometer, sea surface temperature, wind speed, water vapour and trace gas measuring systems. Generic software used for Remote sensing (4L)

Total 36 Lectures

Text Books:

- 1) Satellite communication – D. Roddy (TMH)
- 2) Global Navigation satellite systems - B. S. Rao (TMH)
- 3) Remote Sensing & GIS – Basudeb Bhatta (Oxford University press)
- 4) Remote sensing of the environment : an earth resource perspective –John R Jenson(Pearson)
- 5) Satellite Communication System Engineering W.Pritchrd (Pearson)
- 6) Satellite Communication- Manojit Mitra PHI learning Pvt Ltd
- 7) T. Pratt, C. Bostian and J. Allnutt, “*Satellite Communications,*” 2nd Edition, Wiley India, 2006

Reference Books:

- 1) An Introduction to Remote Sensing And Its Applications: S.Somvansh&M.Kumari (S.K Kataria)
- 2) Remote Sensing - R.A. Schowengerdt)Academic press
- 3) NASA'S Remote Sensing Tutorial <http://rst.gsfc.nasa.gov/start.html>

4) Satellite Communication: Maini& Agrawal (Wiley)

5) G. Gordon and W. Morgan, “*Principles of Communications Satellites*,”Wiley-Interscience, 1st edition, 1993

Open Elective course -2

Course Title : Artificial Intelligence in Radio Communication					
Course Code: ECE3221					
Contact hrs per week	L	T	P	Total	Total Credits
	3	0	0	3	3

Course Outcomes:

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

ECE3221.1. Understand the fundamentals of radio communication and AI techniques.

ECE3221.2. Apply AI methods to optimize wireless communication performance and spectrum management.

ECE3221.3. Understand the concepts of different methods of learning in an AI based radio.

ECE3221.4. Develop intelligent cognitive radio systems leveraging AI frameworks.

ECE3221.5. Explore advanced applications and trends in AI-driven radio communication.

ECE3221.6. Explain the security requirement in AI-driven Radios.

Module 1: Fundamentals of Radio Communication and AI [10L]

Overview of radio communication systems: Components, modulation techniques, and performance metrics; Introduction to Artificial Intelligence (AI): Machine Learning (ML), Deep Learning (DL), and Neural Networks; Role of AI in modern communication systems; Overview of software tools: Python, MATLAB, Tensor Flow, and Scikit-learn; Applications of AI in wireless networks: Monitoring of network performance, Cognitive radios, interference management, and spectrum optimization.

Module 2: AI Techniques for Wireless Communication [8L]

Spectrum sensing using ML: Supervised and unsupervised learning approaches; Dynamic Spectrum Access (DSA) with AI; Signal classification and modulation recognition using AI techniques; Resource allocation in wireless networks using optimization algorithms; Introduction to Reinforcement Learning (RL) for radio decision-making.

Module 3: AI-Driven Cognitive Radio Systems [10L]

Basics of cognitive radios: Architecture and functionality; AI-enhanced spectrum sensing and sharing; Decision-making in cognitive radios using RL and neural networks; AI in network slicing and 5G/6G integration; Practical implementation: Simulating cognitive radio systems using AI frameworks.

Module 4: Advanced Applications and Future Trends [8L]

AI for MIMO systems: Beam forming and spatial multiplexing optimization; Principles of beam-forming: Interference management and predictive analytics for congestion control; AI in 6G and beyond: Intelligent reflecting surfaces and terahertz communication; Security and privacy in AI-driven radio systems; Ethical considerations and challenges in deploying AI for communication.

Text Books

1. Artificial Intelligence in Wireless Communications-By Rondeau, Thomas W; Bostian, Charles W, Artech House, 2009.
2. Cognitive Radio Techniques : Spectrum Sensing, Interference Mitigation and Localization- By Sithamparanathan, Kandeepan; Giorgetti, Andrea, Artech House, 2012.
3. Cognitive Radio Technology-By Bates, Martin; Fettee, Bruce A, Elsevier Science & Technology.
4. Artificial intelligence Artificial Intelligence: A Modern Approach
By Peter Norvig and Stuart J. Russell.
5. Kwang-Cheng Chen, Eamjee Prasad Cognitive Radio Networks. Germany:Wiley,2009, ISBN:9780470742013
6. Cognitive Radio Architecture: The Engineering Foundations of Radio XML By-[Joseph Mitola III](#).
7. Cognitive Radio Technology Edited by Bruce A. Fettee.

Course Name: Fundamentals of RDBMS

Course Code: CSE3221

Contact Hours per week:

L

T

P

Total

Credit Points

3

0

0

3

3

Course Outcomes

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

CSE3221.1. Identify the basic concepts used in database design and be able to model an application's data requirements using conceptual modelling tools like ER diagrams.

CSE3221.2. Formulate relational algebra expression for queries and evaluate it using the concept of query processing and optimization.

CSE3221.3. Create RDBMS schema mapping various business validations and formulate queries based on that schema using SQL to satisfy business requirements.

CSE3221.4. Apply normalization and various types of dependencies for evaluating a relational database design.

CSE3221.5. Apply and relate the concept of transaction, concurrency control and recovery in database.

CSE3221.6. Understand with basic database storage structures and access techniques: file and page organizations, indexing methods including B tree, and hashing.

II. Detailed Syllabus

Module 1 [8L]

Introduction: Concept & Overview of DBMS, Data Models, Database Languages, Role of database administrator and database Users, Three Tier architecture of DBMS.

Entity-Relationship Model: Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.

Module 2 [10L]

Relational Model: Structure of relational Databases, Relational Algebra, Extended Relational Algebra Operations, Views, Modifications of the Database.

Relational Database Design: Functional Dependency, Different anomalies in designing a Database, Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Multi-valued dependencies -definition.

Module 3 [8L]

SQL and Integrity Constraints: Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, views, Nested Subqueries, Stored procedures and triggers.

Module 4 [10L]

Internals of RDBMS: Transaction processing, Concurrency control and Recovery Management: transaction model properties, state serializability, lock base protocols, two phase locking.

File Organization & Index Structures: File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree.

III. Textbooks

1. Database System Concepts, Henry F. Korth and Silberschatz Abraham, Mc.Graw Hill.
2. Fundamentals of Database Systems, Elmasri Ramez and Novathe Shamkant, Benjamin Cummings Publishing Company.
3. Database Management System, Ramakrishnan, McGraw-Hill.
4. Transaction Processing: Concepts and Techniques, Gray Jim and Reuter Address, Moragan Kauffman Publishers.
5. Advanced Database Management System, Jain, CyberTech.
6. Introduction to Database Management, Vol. I, II, III, Date C. J., Addison Wesley.
7. Principles of Database Systems, Ullman JD., Galgottia Publication.

IV. Reference Books

1. Principles of Database Management Systems, James Martin, 1985, Prentice Hall of India, New Delhi.

2. Fundamentals of Database Systems, Ramez Elmasri, Shamkant B.Navathe, Addison Wesley Publishing Edition.

3. Database Management Systems, Arun K.Majumdar, Pritimay Bhattacharya, Tata McGraw Hill.

Course Name : Introduction to Biology					
Course Code: BTC3223					
Contact hrs per week:	L	T	P	Total	Credit points
	3	0	0	3	3

Course Outcomes:

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

BTC3223.1 Understand the basic structure and function of cells and cellular organelles.

BTC3223.2 Understand the fundamental concepts of DNA, RNA and central dogma of cells.

BTC3223.3 Characterize the different types of proteins, lipids and carbohydrates.

BTC3223.4 Analyze the mechanism of inheritance of characters through generations.

BTC3223.5 Understand and implement the working principles of enzymes and their applications in biological systems and industry.

BTC3223.6 Design and evaluate different environmental engineering projects with respect to background knowledge about bioresources, biosafety and bioremediation.

Module-I: Basic Cell Biology

Prokaryotic and Eukaryotic cells, Cell theory; Cell structure and function, Cell organelles, Structure and function of DNA and RNA, Central Dogma; Genetic code and protein synthesis.

Module -II: Biochemistry and Cellular Aspects of Life

Biochemistry of carbohydrates, proteins and lipids; Fermentation; Cell cycle; Basics of Mendelian Genetics.

Module -III: Enzymes and Industrial Applications

Enzymes – significance, co-factors and co-enzymes, classification of enzymes; models for enzyme action; Restriction enzymes; industrial applications of enzymes.

Module -Iv: Biodiversity and Bioengineering Innovations

Basic concepts of environmental biosafety, bioresources, biodiversity, bioprospecting, bioremediation, biosensors; recent advances in engineering designs inspired by examples in biology.

Text Books:

1. Wiley Editorial, "*Biology for Engineers: As per Latest AICTE Curriculum*," Wiley-India, 2018.
2. S. ThyagaRajan, N. Selvamurugan, M. P. Rajesh, R. A. Nazeer, Richard W. Thilagaraj, S. Barathi, and M. K. Jaganathan, "*Biology for Engineers*," Tata McGraw-Hill, New Delhi, 2012.

Reference Books:

1. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, "*Biochemistry*," W.H. Freeman and Co. Ltd., 6th Ed., 2006.
2. Robert Weaver, "*Molecular Biology*," MCGraw-Hill, 5th Edition, 2012.
3. Jon Cooper, "*Biosensors A Practical Approach*" Bellwether Books, 2004.
4. Martin Alexander, "*Biodegradation and Bioremediation*," Academic Press, 1994.
5. Kenneth Murphy, "*Janeway's Immunobiology*," Garland Science; 8th edition, 2011.

Course Title: Fundamentals of Cloud Computing					
Course Code: INF3221					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

After successfully completing this course the students will be able to:

INF3221.1: Articulate the main concepts, key technologies, strengths, and limitations of cloud computing.

INF3221.2: Identify the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS. Public cloud, Private cloud, hybrid cloud and Community cloud.

INF3221.3: Explain the core issues of cloud computing such as security, privacy, and interoperability. Identify Cost components in Cloud Computing.

INF3221.4: Discuss server, network and storage virtualization and outline their role in enabling the cloud computing system model.

INF3221.5: Explain AWS, Google App Engine, and Microsoft Azure.

INF3221.6: Understand different web services techniques to provide SaaS and SLA.

Module-I [7L]

Overview of Computing Paradigm: Recent trends in Computing, Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing.

Introduction to Cloud Computing: Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers, Characteristics of Cloud Computing, Pros and Cons of Cloud Computing, Applications of Cloud Computing, Cloud computing vs. Cluster computing vs. Grid computing.

Module-II [11L]

Cloud Computing Architecture: Cloud computing stack, Comparison with traditional computing architecture (client/server), Services provided at various levels, How Cloud Computing Works, Role of Networks in Cloud computing, protocols used, Role of Web services

Service Models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS)

Deployment Models: Public cloud, Private cloud, Hybrid cloud, Community cloud

Infrastructure as a Service (IaaS): Introduction to IaaS, Introduction to virtualization, Different approaches to virtualization, Hypervisors, Machine Image, and Virtual Machine (VM)

Resource Virtualization: Server, Storage, Network, Virtual Machine (resource) provisioning and manageability, storage as a service, Data storage in cloud computing (storage as a service)

Examples: Amazon EC2, Renting, EC2 Compute Unit, Platform and Storage, pricing, customers

Module-III [10L]

Platform as a Service (PaaS): Introduction to PaaS, Service Oriented Architecture (SOA)

Cloud Platform and Management: Computation, Storage

Examples: Google App Engine, Microsoft Azure

Software as a Service (SaaS): Introduction to SaaS, Web services, Web 2.0, Web OS

Module-IV [10L]

Service Management in Cloud Computing: Service Level Agreements (SLAs), Billing & Accounting, Comparing Scaling Hardware: Traditional vs. Cloud, Economics of scaling: Benefitting enormously

Managing Data: Looking at Data, Scalability & Cloud Services, Database & Data Stores in Cloud, Large Scale Data Processing

Cloud Security: Infrastructure Security, Network level security, Host level security, Application level security, Data security and Storage, Data privacy and security Issues, Identity & Access Management, Access Control, Trust, Reputation, Risk, Authentication in cloud computing, Client access in cloud, Cloud contracting Model, Commercial and business considerations

Books

1. Cloud Computing Black Book, Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr. Deven Shah, Dreamtech Press.
2. Cloud Computing, A practical approach for learning and implementation, A. Srinivasan, J. Suresh, Pearson.
3. Cloud Computing Bible, Barrie Sosinsky, Wiley-India.
4. Cloud Computing: Principles and Paradigms, Rajkumar Buyya, James Broberg, Andrzej M. Goscinski Wiley, 2011.
5. Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley-India, 2010

Course Title: Instrumentation and Telemetry

Course Code: AEI3222

Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

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

AEI3222.1: Understand the working principles and characteristics of various sensors and transducers.

AEI3222.2: Analyse different temperature measurement to evaluate their suitability for specific industrial applications.

AEI3222.3: Apply appropriate pressure, flow, and level measurement instruments in real-world scenarios.

AEI3222.4: Evaluate different telemetry systems and their transmission techniques for effective data communication.

AEI3222.5: Design a basic digital telemetry system using quantization and coding.

AEI3222.6: Explain the role of IoT and wireless technologies in modern telemetry applications, including telemedicine.

Detailed Syllabus:

Module I – [10L]

Sensors and transducers: definition and differentiation, classifications, characteristics, types: resistive, capacitive, inductive and piezoelectric

Temperature measurement: thermocouple, RTD, thermistors, pyrometer.

Module II – [10L]

Measurement of pressure and vacuum: Introduction, diaphragm, capsule, bellows, bourdon tube, DP transmitters, McLeod gauge.

Flow measurement: primary and secondary flow meters – orifice, pitot tube, venturi meter, rotameter; electromagnetic flow meters; ultrasonic flow meters.

Level measurement: float and displacer type instruments, capacitive type level instrument; D/P type sensors; ultrasonic level instruments.

Module III – [8L]

Introduction to telemetry principles: Basic systems, classifications, non-electrical telemetry systems, voltage and current telemetry systems.

Digital transmission techniques: quantization, data conversion, coding.

Multiplexing in Telemetry Systems - TDM systems (architecture), synchronization, FDM systems – architecture & standards.

Module IV – [8L]

Fundamentals of wireless systems – WiMAX, ZigBee and Bluetooth, Wi-Fi.

Digital modulation techniques: ASK, FSK, PSK, QPSK, MPSK, and QAM.

Introduction to IoT, Architecture of IoT system, MQTT protocol.

References:

1. A. K. Sawhney, “A Course in Electrical Measurements and Measuring Instruments”, Dhanpat Rai & Co. (Pvt.) Ltd.
2. D. Patranabis, “Principles of industrial Instrumentation”; Tata McGraw-Hill
3. D. Patranabis, “Telemetry Principles”, Tata McGraw-Hill
4. B. P. Lathi, “Modern Digital and Analog Communication Systems”, Oxford University Press.
5. Alberto Leon-Garcia and Indra Widjaja, “Communication Networks: Fundamental Concepts and Key Architectures”, McGraw-Hill.
6. Behrouz A. Forouzan & Sophia Chung Fegan, “Data Communications and Networking”, McGraw-Hill.
7. Jeeva Jose, “Internet of Things”, Khanna Publishing House

Laboratory Course

Course Title :Embedded System Laboratory					
Course Code :ECE3253					
Contact hours per week :	L	T	P	Total	Credit Points
	1	0	2	3	2

Course Outcomes:

After completing the following experiments, students will be able to:

ECE3253.1. Identify basic controller unit requirements for a given situation

ECE3253.2. Design a basic control unit using Micro controller board and Single board Computer

ECE3253.3. Design application interface with multiple Sensors and Actuators

ECE3253.4. Design basic embedded applications for IOT

List of Design Problems: (Suggest choosing 4 from first 6 experiments and next 4 from last 6)

1. Experiments using Relay

In a four story flat building there are four switches with one on each floor that individually control the lights of the entire stair case and gate. Design and show the control logic circuit of the switch settings and with relays to turn on the lights.

2. Experiment with LDR

In an apartment complex the parking and the street lights need to be turned on before dusk sets in and again turned off in the morning. Design the set up with using LDR sensors and relays. Use Arduino Uno micro-controller board.

3. Distance Measure with Ultrasound sensors with LCD

Often in engineering short gaps between two structures are difficult to measure by manual access, but which can be easily measured by ultrasound sensors with LCD readout. Design a short distance measurement tool within the range of the ultra sound sensor to design a measurement system. A warning LED should light up on exceeding range threshold. Use Arduino Uno micro-controller board.

4. Sound alarm along with visible flashing LED display for a fire alarm with Heat sensors

Design a simple fire alarm using appropriate heat sensors which will cover a certain region and raise both audio and visual alarms as soon the temperature or heat is sensed above normal threshold. Use Arduino Uno micro-controller board.

5. Counting parking lot cars entry and exit with infra-red sensors with updated count on LCD display

Design a system which will count the number of cars entering and exiting a parking lot using IR sensors and update the current status of available parking slots using LCD screen. Use Arduino Uno micro-controller board.

6. Use motion sensor for security.

In a selected area use motion sensor to detect unauthorized entry from individuals and in case of a unauthorized entry detection raise alarm. Use Arduino Uno as micro-controller board.

7. Window left open in case of Storm

If a window shutter is left open or loose during a storm, and window may be in motion gets wet and rain water gets in to the room then sensors shall automatically sense the situation by sensors and send appropriate signal to proper persons mobile. Use Raspberry PI as Single Board Computer (SBC).

8. Use a camera and color coded path to track a path of an automatic car

Use camera and system to identify five colors Red, Blue, yellow, Green and White, then take appropriate actions of the car engine based on combinations of the color codes identified. (32 combinations). Use Raspberry PI as SBC

9. Security with IR and Motion sensors

In a house or an apartment, If any of the closed doors and windows are opened without prior permission then an alarm will be set out to the respective persons mobile as unauthorized entry has occurred. Use Raspberry PI as SBC.

10. Water controller system

In an apartment complex the pump is turned off as soon the overhead tank is filled up and the pump is turned on when the water level in over head tank is below threshold. The pump is only turned on when the water level in the ground floor reservoir is above a threshold. Design the water level controller system using water level sensors and simple circuitry. Use LED based monitoring to see the water levels in overhead tank and the reservoir. Use Raspberry SBC.

11. Design and implement a 4 bit ripple carry Adder/Subtractor unit, on FPGA (ARTIX 7) using XILINX Simulator.

12. Design and implement an 8 bit unsigned multiplier unit on FPGA (ARTIX 7) using XILINX Simulator.

Sessional Course

Course Title: Mini Project: Fundamental System Design and Development Laboratory					
Course Code: ECE3294					
Contact Hours per week	L	T	P	Total	Credit Points
	0	0	3	3	1.5

Course Outcomes:

After completing the following experiments, students will be able to:

ECE3294.1. Design fundamental analog electronic circuits using electronic devices.

ECE3294.2. Design application specific analog electronic systems using analog ICs.

ECE3294.3. Design application specific electronic systems which can process digital signals.

ECE3294.4. Design flexible single purpose electronic systems using microcontroller.

List of Design Problem statements:

(At least one problem should be done from each domain)

Domain 1: Fundamental Analog Circuits using electronic devices:

1. Design an audio amplifier circuit using basic electronic device like BJT or FET with a voltage gain of 100. Consider the load resistance of 4Ω due to practical speaker. Study the frequency response of the same.
2. Design of Series and shunt Voltage regulator circuits using basic electronic device like BJT or FET to provide a specific regulated output voltage in the range of 6 to 9 volt and study the line and load regulations of the designed circuit.

Domain 2: Analog Systems using Analog ICs:

3. Design of a variable power supply of 12V using voltage regulator IC and study the line and load regulations of the designed circuit.
4. Design a basic function generator circuit using analog ICs to generate sinusoidal, square and triangular waves in the audio frequency range with variable frequency.
5. Design an active band pass filter circuit using analog IC with lower and upper cut off frequencies specified in the audio frequency range. Study the frequency response of the same.

Domain 3: Electronic systems to process Digital Signals:

6. Design a basic police siren system by feeding two different signals with frequencies of 1 KHz and 3 KHz alternatively to the speaker. Each tone should have duration of 1 second. Study the timing diagram of the same.
7. Design of a basic traffic signaling system with three LEDs of red, yellow and green colours using simple hardware. The signal timing will be specified between 1 to 4 seconds for each light. Study the timing diagram of the same.

Domain 4: Flexible Electronic systems using Microcontroller:

8. Design a traffic signaling system for a 4 way crossing using microcontroller module like Arduino or ESP 32. The signal timing will be specified between 1 to 4 seconds for each light. Study the timing diagram of the same.
9. Design a water level controller circuit for water tank using microcontroller module like Arduino or ESP 32.

Open Elective course -2 (to be offered by ECE Department)

Course Title : Artificial Intelligence in Radio Communication					
Course Code: ECE3221					
Contact hrs per week	L	T	P	Total	Total Credits
	3	0	0	3	3

Course Outcomes:

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

ECE3221.1. Understand the fundamentals of radio communication and AI techniques.

ECE3221.2. Apply AI methods to optimize wireless communication performance and spectrum management.

ECE3221.3. Understand the concepts of different methods of learning in an AI based radio.

ECE3221.4. Develop intelligent cognitive radio systems leveraging AI frameworks.

ECE3221.5. Explore advanced applications and trends in AI-driven radio communication.

ECE3221.6. Explain the security requirement in AI-driven Radios.

Module 1: Fundamentals of Radio Communication and AI [10L]

Overview of radio communication systems: Components, modulation techniques, and performance metrics; Introduction to Artificial Intelligence (AI): Machine Learning (ML), Deep Learning (DL), and Neural Networks; Role of AI in modern communication systems; Overview of software tools: Python, MATLAB, Tensor Flow, and Scikit-learn; Applications of AI in wireless networks: Monitoring of network performance, Cognitive radios, interference management, and spectrum optimization.

Module 2: AI Techniques for Wireless Communication [8L]

Spectrum sensing using ML: Supervised and unsupervised learning approaches; Dynamic Spectrum Access (DSA) with AI; Signal classification and modulation recognition using AI techniques; Resource allocation in wireless networks using optimization algorithms; Introduction to Reinforcement Learning (RL) for radio decision-making.

Module 3: AI-Driven Cognitive Radio Systems [10L]

Basics of cognitive radios: Architecture and functionality; AI-enhanced spectrum sensing and sharing; Decision-making in cognitive radios using RL and neural networks; AI in network slicing and 5G/6G integration; Practical implementation: Simulating cognitive radio systems using AI frameworks.

Module 4: Advanced Applications and Future Trends [8L]

AI for MIMO systems: Beam forming and spatial multiplexing optimization; Principles of beam-forming: Interference management and predictive analytics for congestion control; AI in 6G and beyond: Intelligent reflecting surfaces and terahertz communication; Security and privacy in AI-driven radio systems; Ethical considerations and challenges in deploying AI for communication.

Text Books

1. Artificial Intelligence in Wireless Communications-By Rondeau, Thomas W; Bostian, Charles W, Artech House, 2009.
2. Cognitive Radio Techniques : Spectrum Sensing, Interference Mitigation and Localization- By Sithamparanathan, Kandeepan; Giorgetti, Andrea, Artech House, 2012.
3. Cognitive Radio Technology-By Bates, Martin; Fettee, Bruce A, Elsevier Science & Technology.
4. Artificial intelligence Artificial Intelligence: A Modern Approach
By Peter Norvig and Stuart J. Russell.
5. Kwang-Cheng Chen, Eamjee Prasad Cognitive Radio Networks. Germany:Wiley,2009, ISBN:9780470742013
6. Cognitive Radio Architecture: The Engineering Foundations of Radio XML By-[Joseph Mitola III](#).
7. Cognitive Radio Technology Edited by Bruce A. Fette.

Course Name:Designing With Processors And Controllers
Course Code :ECE3222

Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing the course, the students will be able to:

ECE3222.1 Understand microprocessors and microcontrollers – their operation and programming.

ECE3222.2 Identify RISC processors from CISC processors and apply them in circuits.

ECE3222.3 Analyse operations of different serial and parallel buses and interrupts.

ECE3222.4 Evaluate different hardware designs and memory configurations.

ECE3222.5 Write RTOS for complex processor-based designs.

ECE3222.6 Design processor and controller based intelligent systems for real life problems.

Module I [8L]:

Designing with microprocessors and microcontrollers- the issues and solutions, Embedded systems VS General computing systems, Purpose of Embedded systems, optimizing design metrics, prominent processor and controller technology, RISC vs CISC.

Module II [10L]:

Devices and Communication Buses: I/O types, serial and parallel communication devices, wireless communication devices, timer and counting devices, watchdog timer, real time clock, serial bus communication protocols UART RS232/RS85, parallel communication network using ISA, PCI, PCT-X, Internet embedded system network protocols, USB, Bluetooth. Different types of I/O devices and interfacing: Keypad, LCD, VGA. Introduction to I/O interfaces: Interrupts, Interrupt hardware, Enabling and disabling interrupts, Concepts of handshaking, Polled I/O, Memory mapped I/O, Priorities, Stack and Queues. Vectored interrupts, Direct memory access, few types of Sensors and actuators.

Module III [10L]:

Memory: SRAM, DRAM, EEPROM, FLASH, CACHE memory organizations, (direct, associative, set associative mapping), Virtual memory, organization, mapping and management techniques, Fundamental issues in Hardware software co-design, Unified Modeling Language (UML), Hardware Software trade-offs DFG model, state machine programming model, model for multiprocessor system. Introduction to ARM architecture, Processor design, ARM organization and implementation.

Module IV [8L]:

Real Time Operating Systems: Operating system basics, Tasks, Process and Threads, Multiprocessing and multitasking, task communication, task synchronization, qualities of good RTOS. Resource Management/scheduling paradigms: static priorities, static schedules, dynamic scheduling, best effort

current best practice in scheduling (e.g. Rate Monotonic vs. static schedules), Real-world issues: blocking, unpredictability, interrupts, caching, Examples of OSs for embedded systems - RT Linux, VRTX, Mobile phones, RFID.

Books:

Text Books:

1. David Simon, "An Embedded Software Primer", (Addison Wesley), 2000.
2. Jack Ganssle, "The Art of Designing Embedded Systems", (Newnes), 1999.
3. G. Osborn, "Embedded microcontroller and processor design", (Pearson)
4. S. Heath, "Embedded System design ", (Elsevier)
5. Steve Furber, ARM System-on-Chip Architecture, (Pearson)

Reference Books:

1. Shibu, "Introduction to Embedded Systems" K. V. (TMH)
2. Frank Vahid, Tony Givargis, "Embedded System Design – A unified hardware and software introduction:" (John Wiley)
3. Rajkamal "Embedded Systems": (TMH)
4. L. B. Das "Embedded Systems" (Pearson)
5. RTS: Real-Time Systems, by C.M. Krishna and Kang G. Shin, McGraw-Hill, 1997, ISBN 0-07-057043.
6. J. A. Stankovic and K. Ramamritham, Advances in Hard Real-Time Systems, IEEE Computer Society Press, Washington DC, September 1993, 777 pages. Selected papers and references

Course Name: Analog And Digital Communication					
Course Code:ECE3223					
Contact Hours	L	T	P	Total	Credit Points
per week	3	0	0	3	3

Course Outcomes:

After completing the course the students will be able to:

ECE3223.1 Explain the necessity of communication, its history, evolution, the role of efficient communication in the present day.

ECE3223.2 Understand & apply the concepts of various types of signals, techniques for signal transmission and signal modulation from the knowledge gathered earlier.

ECE3223.3 Identify various parameters associated with Amplitude and frequency Modulation, time and frequency domain representations, side band frequencies etc and apply these knowledge to solve numerical problems.

ECE3223.4 Apply sampling theorem to sample analog signal properly and differentiate among pulse modulation & demodulation techniques and understand PCM, DPCM.

ECE3223.5 Analyze performance of various digital modulation & demodulation techniques and understand concept of OFDM and Spread Spectrum Modulation system.

ECE3223.6 Analyze various multiplexing and Multiple access techniques and compare modern multiple access schemes, explain the concept of frequency reuse, channel assignment strategies and make use of wireless communication tools

Module I –[10L]

Introduction-Signal Analysis and Transmission: Overview of communication- base-band transmission, various types of signals, analog signal, digital signal, fundamental limitations in communication system- noise, power and bandwidth. Fourier series and Fourier Transformation representations, ; Modulation and its need and types; Time domain and frequency domain analysis. **AMPLITUDE MODULATION**: Modulation principle and definitions, spectrum and power considerations, DSB,SSB, VSB and AM principles. Different type of modulator circuits.

DEMODULATOR Basic principle of coherent detections, envelope detectors.

FREQUENCY AND PHASE MODULATION Principles and definitions, Relationship between frequency and phase modulations. Phase and frequency deviations, Spectrum of FM signal, bandwidth considerations. Effect of modulation index on bandwidth, Narrow band and sideband FM and PM principles, **RADIO RECEIVER** Basic block diagram of TRF, Superhetrodyne principle,

Module II –[10L]

Digital Transmission: Sampling theorem, sampling rate, aliasing and aperture effect; analog pulse modulation -PAM (ideal, natural & flat topped sampling),PWM, PPM; basic concept of pulse code modulation, block diagram of PCM; quantizer; non-uniform quantizer, conceptual idea of A-law & μ -law companding; encoding, coding efficiency, source, line coding channel coding & properties, NRZ & RZ, AMI, manchester coding PCM, DPCM, Delta modulation, adaptive delta modulation (basic

concept and applications); baseband pulse transmission, matched filter (its importance and basic concept), error rate due to noise;, nyquist criterion for distortion-less transmission.

Module III –[8L]

Digital Modulation Techniques: Types of Digital Modulation, coherent and non-coherent Binary Modulation Techniques, Bit rate, baud rate; information capacity generation and detection, digital carrier modulation techniques: ASK, PSK and FSK, DPSK . Concept of QAM and M-ary Communication, M-ary phase shift keying, (QPSK), Generation, detection, , Offset Quadrature Phase shift Queuing (OQPSK), Minimum Shift Keying (MSK), Basic Concept of OFDM and Spread Spectrum Modulation.

Module IV –[8L]

Multiplexing -TDM, FDM. Multiple Access Techniques and Radio Communication: Multiple access techniques, TDMA, FDMA and CDMA in wireless communication systems, advanced mobile phone system (AMPS), global system for mobile communications (GSM), cellular concept and frequency reuse, channel assignment and handoff, Bluetooth, introduction to satellite communication.

Text Books:

7. Taub and Schilling , “Principles of Communication Systems”, 2nd ed., Mc-Graw Hill
8. B.P.Lathi -Communication Systems- BS Publications
2. V Chandra Sekar – Analog Communication- Oxford University Press

References:

9. Carlson—Communication System,4/e , Mc-Graw Hill
10. Proakis&Salehi Fundamentals of Communication Systems- Pearson
11. Singh & Sapre—Communication Systems: 2/e, TMH
12. P K Ghosh- Principles of Electrical Communications- University Press
13. L.W.CouchIi, “Digital and Analog Communication Systems”, 2/e, Macmillan Publishing
14. Blake, Electronic Communication Systems- Cengage Learning
15. S Sharma, Analog Communication Systems- Katson Books

Course Name: Optical Fiber Communication					
Course Code :ECE3224					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing the course the student will be able to:

ECE3224.1 Apply the basic idea of electronics, physics and solid state devices and explain the operation of different components in an optical communication system.

ECE3224.2 Understand the properties of optical fiber and categorize the transmission characteristics of a wave through the optical fiber.

ECE3224.3 Analyze the structure of various optical sources and can classify them according to the performance, efficiency and application.

ECE3224.4 Explain the operation of optical detectors and can analyze the performance parameters of a detector.

ECE3224.5 Recognize the current optical technologies used for long distance communication and their application in optical networks.

ECE3224.6 Solve the problems related to optical fiber communication and can justify the physical significance of the solutions.

Module I [8L]: Optical Fiber

- Introduction to communication systems:
Principles, Components; Different Forms of Communications, Advantages Of Optical Fiber Communication, Spectral Characteristics.
- Optical Fiber
Cylindrical Wave Guide Structure, Fabrication and Related Parameters, Single and Multimode Operation; Attenuation & losses, Material and Wave Guide Dispersion. Dispersion Compensation and Management. Nonlinear effects in propagation of optical signal through fiber: Self phase modulation, Cross Phase Modulation, Four wave mixing, Fiber Splices, Fiber Optic Connectors, OTDR.

Module II [10L]: Optical Sources

- Light Emitting Diode:
Principle, Structures, Power And Efficiency, Surface Emitting LED And Edge Emitting LED, Super Luminescent Diode (SLD), Coupling of LEDs to Fibers. Modulation Response of an LED.
- Laser diodes:
Principle, Coherence, Significance Of Modes, Double Heterostructure, Gain and Index

Guiding, Distributed Lasers. Quantum Well Lasers and Narrow Line Width Lasers. Modulation; Bandwidth for Modulation, Optical Transmitters: Components.

Module III [12L]: Detectors & Other Network Components

- Photo Detectors:
Photo Diodes, Photo Conducting Detectors, Photo Transistors, Optical Detection Principles, PIN Photo Detector, Avalanche Photo Detector: Efficiency, Responsivity, Bandwidth.
- WDM System:
Preamplifiers; Noise Sources, Signal To Noise Ratio. WDM Link Analysis And Bit-Error-Rate Calculation. Point-To-Point Link, Wavelength Division Multiplexing and Demultiplexing: Building Blocks; Multiplexing; Intensity Modulation/Direct Detection System; Principle Of Regeneration.
- Optical amplifiers & Filters
EDFA, SOA, Raman Amplifier, Fabry-Perot Filters.

Module IV [6L]: Optical Network

- Network Topologies:
LAN, MAN, WAN; Topologies: Bus, Star, Ring; Ethernet; FDDI, PON (Passive Optical Network), FSO: The concept & Challenges
- Telecom Networking:
SDH/SONET, SONET/SDH Layers, SONET Frame Structure, SONET/SDH Physical Layer

Text Books:

1. Fiber Optics and Optoelectronics, R. P. Khare, Oxford University Press
2. Optical Fiber Communication : John M. Senior (Pearson)
3. Optical Networks – A Practical Perspective: Rajiv Ramaswami, K. N. Sivarajan, Galen H. Sasaki (Morgan-Kaufman)
4. Optical Communication Systems : John Gawarek (PHI)

Reference Book:

1. Optical Fiber Communication: Gerd Kaiser (TMH)

Course Title: Introduction to MEMS					
Course Code: ECE 4131					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

4th Year, 1st semester

Program Elective Course-4

Course Outcomes:

After completing this course, the students will be able to:

- ECE4131.1. Understanding material properties and their importance in the field of MEMS.
- ECE4131.2. To develop the knowledge of fluid motion in microchannel.
- ECE4131.3. Understanding crystal structure and associated imperfections in order to identify their role in determining material properties.
- ECE4131.4. Understanding the aspects of MEMS fabrication.
- ECE4131.5. Identification of specific materials for MEMS application and the scope of their use.
- ECE4131.6. Understanding the concept of sensing and actuation and development of wide range of MEMS structure.

Module I: Overview of physical phenomena for MEMS [8L]

Stress and strain analysis, Hooke's Law, Young's modulus, Bulk modulus, Modulus of rigidity, Poisson's Ratio, Flexural beam bending, Torsional deflection.

Kinematics of moving fluids, Equation of continuity, Idea of Streamline and turbulent flow, Reynold's number, Poiseuille's equation for the flow of viscous liquid.

Electrostatics, Electromagnetic Induction, Thermal properties of materials, Heat Transport

Module II: Crystal Structure [8L]

Crystal structure of materials, crystal systems, unit cells and space lattices, determination of structures of simple crystals, miller indices of planes and directions, concept of amorphous, single and

polycrystalline structures and their effect on properties of materials, imperfections in crystalline solids and their role in influencing various properties.

Module III: MEMS Fabrication[8L]

Introduction to Micro fabrication, Optical Lithography. Wet and Dry etching, PVD and CVD of semiconductors, metals and insulators, nanofabrication techniques.

Bulk & Surface Micromachining, Silicon based MEMS processes, Silicon and other materials(Quartz, GaAs, SiN, Polymer) for MEMS, Etching methods, Non-lithographic micro- fabrication techniques, SOI MEMS.

Module IV: MEMS Structures and Systems for sensors and actuators [8L]

Electrostatic sensors, Parallel plate capacitors – Applications, Interdigitated Finger capacitor, Comb drive devices, Micro Motors, Magnetic Actuators.

Piezoresistive sensors, Piezoresistive sensor materials, Stress analysis of mechanical elements – Applications to Inertia, Pressure, Flow sensors. Piezoelectric effects, Piezoelectric materials, Piezoelectric sensors and actuators – Applications to Inertia, 3D Accelerometer, Energy harvesters and scavengers.

Microfluidics, Pumping in Microfluidic systems- Electroosmotic & Electrophoretic flow, Mixing in microfluidics.

References:

1. Nadim Maluf, Kirt William, “An Introduction to Microelectromechanical System Engineering”, Artech House.
2. C Chatterjee, S Sengupta, “A Treatise on General Properties of Matter”, New Central Book Agency.
3. S.O Pillai, “Solid State Physics”, New Age International Publishers.

Course Title: Application of Green Energy					
Course Code: ECE 4132					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcome:

After completing this course, the students will be able to:

ECE4132.1. Apply the previous knowledge gathered from the course on Environmental Studies.

ECE4132.2. Analyze and categorize the different environment friendly green energy.

ECE4132.3. Evaluate and calculate the solar radiation and designing of solar thermal collectors.

ECE4132.4. Analyze and design of different type of solar cells and array.

ECE4132.5. Categorize the different type of PV Plant.

ECE4132.6. Understand and identify the different fabrication techniques pertaining to solar cell fabrication.

Module I: Overview of green energy sources [8L]

Classification of Green Energy Sources and Impact on Environment, Solar Energy, Wind Energy, Hydel Energy: Electricity generation from micro hydel plants, Fuel Cell. Bio Energy: biogas conversion, biomass energy, Bio diesel Principle of Tidal Energy; Principle of wave Energy, Principle of geothermal Energy.

Module II: Solar Energy [8L]

Spectrum of electromagnetic radiation, Solar radiation data requirements, Sun structure and characteristics, Solar constant, Spectral distribution, Sun earth geometric relationship, Solar angles, Sun's trajectories in different seasons, Zenith solar time, Air mass, Solar radiation: beam, diffuse and global radiation, extra-terrestrial radiation. Attenuation of solar radiation by the atmosphere, Beam and diffuse components of hourly and daily radiation, Clearness index, Earth sun energy flux diagram, Solar thermal collectors, Solar heater, Solar pumps & refrigeration, Solar inverters, concentrating collectors, Overview of photovoltaic energy conversion, role of AI and IoT in optimizing solar energy systems.

Module III: Physics of Solar Cell [8L]

Introduction to the physics of semiconductor: Nanomaterials and nanotechnology including semiconductor materials and its properties suitable for solar cells, Photovoltaic Effect, Basics of solar cells, Solar cell efficiency, I-V characteristic and solar cell parameters, Solar cell efficiency, Solar PV module and array, Shading effect, Bypass diode, Blocking diode.

Module IV: Different type of solar cell & basic concept of fabrication technology[8L]

Crystalline and amorphous Silicon Solar cell; PIN Solar Cell, Tandem Solar cell, HIT Solar Cell, Dye Sensitised solar cell, **Quantum dot solar cells**, Maximum power point tracking (MPPT).

Classification of PV System: Direct coupled, Grid connected, Stand alone, Hybrid system, Estimating Power and Energy demand. Energy storage Technology: Classification and principle, Super capacitors and Battery.

Text Books:

1. Renewable Energy Engineering and Technology – A Knowledge Compendium, ed. VVN Kishore (TERI Press) HITK/ECE 148
2. VLSI Fabrication Principles Silicon and Gallium Arsenide – SorabK.Gandhi. (John Willey & Sons, Inc.)
3. CS Solanki: Solar Photovoltaics – Fundamentals, Technologies and Applications, (PHI Learning)
4. Renewable energy resources – 2nd Edition- John Twidell and Tony Weir (Taylor & Francis)

Reference Books:

1. DYE-SENSITIZED SOLAR CELLS - K. Kalyanasundaram, (EPFL Press A Swiss academic publisher distributed by CRC Press)
2. Carbon nanotubes and related structures: New material for twenty-first century, P.J.F. Harris, Cambridge University Press, 1999

Course Title: Network Security					
Course Code: ECE 4133					
Contact	L	T	P	Total	Credit Points
Hours per week	3	0	0	3	3

Course Outcome:

After completing this course, the students will be able to:

ECE4133.1. Understand and Apply Foundational Cryptographic Principles

ECE4133.2. Describe the principles of Symmetric-Key Cryptosystems and Block cipher Techniques

ECE4133.3. Implement and Analyze Asymmetric Cryptographic Algorithms and Authentication Mechanisms

ECE4133.4. Evaluate and Implement Network Security Protocols

ECE4133.5. Analyze Security Risks and Formulate Security Policies

ECE4133.6. Analyzing the design principles of a secure system, encompassing the different layers of network.

Module I: Foundations of Network Security & Cryptography

Introduction: Security goals (CIA triad), Types of attacks (passive, active), Security services and mechanisms, OSI and TCP/IP security models, Basic Cryptography, Symmetric vs. asymmetric cryptography, Basic terminology, Classical cryptography (substitution, transposition),

Symmetric Key Cryptography: DES, AES algorithms, Block cipher modes of operation

Module II: Public Key Cryptography & Authentication

Asymmetric Key Cryptography: RSA algorithm, Diffie-Hellman key exchange, Elliptic Curve Cryptography (ECC),

Authentication: User authentication mechanisms (HASH Function and MAC), Digital signature standards (DSS), Key Management

Module -III: Network Security Protocols & Implementation

Transport Layer and Application Layer Security Protocols, Secure Sockets Layer/Transport Layer Security, Application Layer Security: Secure Electronic Transaction, Password management, IPsec , Email Security (PGP/SMIME),

Network Security Systems: Firewalls (packet filtering, stateful inspection), Intrusion Detection/Prevention Systems (IDS/IPS)

Module IV: Systems Security & Management

Malware: Different types of Malwares,

Viruses: Viruses and Related Threats, Virus Countermeasures, Trusted Systems,

Security Management & Legal Aspects: Security policies and risk assessment,

Privacy: Types of Privacy, Information Privacy, Data Privacy, Online Privacy, Ethical hacking concepts.

Text Books:

1. William Stallings, "Cryptography and Network Security", 6th Edition, Pearson Education,
2. Charlie Kaufman, Radia Perlman and Mike Speciner, "Network Security, Private communication in a public world", 2nd Edition, Prentice Hall of India.
3. Douglas R. Simson, "Cryptography - Theory and Practice", CRC Press.

References:

1. Behrouz A. Ferouzan, "Cryptography & Network Security", Tata Mc Graw Hill.
2. Bruce Schneier, Niels Ferguson, "Practical Cryptography", Wiley Dreamtech India Pvt Ltd.

3. Charles Pfleeger, “Security in Computing”, 4th Edition, Prentice Hall of India.

Course Title: Nanoelectronics & Nanophotonics					
Course Code: ECE4134					
Contact hrs per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing the course, the student will be able to:

- ECE4134. 1. Understand the quantum mechanical properties and phenomena for low-dimensional systems
- ECE4134. 2. Apply the concept of band gap engineering, novel electronic transport & optical interaction properties of nanostructures for diverse practical applications
- ECE4134. 3. Understand the fundamentals of nanophotonics, and photonic crystals
- ECE4134. 4. Identify the application areas of nanophotonics and photonic crystals
- ECE4134. 5. Understand the basic concepts of plasmonics as a developing field from nanophotonics
- ECE4134. 6. Identify and analyze the latest research trends & challenges in the real-life applications of nanoelectronics and nanophotonics

Module I: Fundamentals of Low-Dimensional Systems [12L]

Introduction to Quantum Mechanics; Schrodinger equation and expectation values, Solutions of the Schrodinger equation for free particle, particle in a box, Angular momentum and its operators, Eigen values and Eigen functions of the angular momentum operators; Heterostructures : Band gap engineering, Layered structures : quantum wells & barriers, superlattice and minibands ; Strained layers : structural aspects, effect of strain on band structure, Si-Ge heterostructures; Tunneling Transport Phenomenon, resonant tunneling diode, transistor.

Module II: Semiconducting Nanostructures and Applications [8L]

Nanostructures: Quantum well, wire, dot; Optical Properties: Interband, inter-subband transition, optical gain & laser, excitons, Quantum Confined Stark Effect (QCSE), optical absorption : Fermi Golden rule; Applications : Infra-Red Photodetectors, solar cells; Quantum Dot Cellular Automata (QCA): logic gates design using QCA.

Module III: Carbon Nano Tubes and Applications [6L]

Carbon Nanotubes & Graphene: Graphene vs. Carbon Nano Tube (CNT), basic structure, chirality, SWNT, DWNT, and MWNT, strain-induced band gap changes, piezo resistance property; Metallic CNT: Ballistic transport, resonant tunneling, current carrying capacity,

currentsaturation; Semiconducting CNT: switching behavior of CNTFET, Schottky barrier, ambipolar transistor; Applications: Logic gates with CNTFET, infra-red emitters, photo detectors, solar cell, Nano-antenna, NEMS.

Module IV: Nano Photonics and plasmonics [10L]

Foundations for Nanophotonics: Photons and electrons, similarities and differences, free space propagation. Confinement of photons and electrons. Propagation through a classically forbidden zone: tunneling. Nanoscale optical interactions; Photonic Crystals: Basics Concepts, Features of Photonic Crystals, wave propagation, photonic band gaps, Photonic crystal fiber, photonic crystal sensors; Applications of Nanophotonics: Bioimaging, nanoparticles for optical diagnostics & targeted therapy; Applications of Nanophotonics in Plasmonics: Basic of plasmonics, Metallic nanoparticles, nanorods and nanoshells, local field enhancement, plasmonic waveguiding. Applications of Metallic Nanostructures, radiative decay engineering.

Textbooks:

1. "Quantum Mechanics: Theory & Applications", byAjoy K. Ghatak, S. Loknathan, McMillan publishing
- 2."The Physics of Low-Dimensional Semiconductors", by John H. Davies, Cambridge University Press
3. "Nanophotonics", by Paras N. Prasad, Wiley Interscience
4. "Carbon Nanotubes Properties and Applications", Edited by Michael J. O'Connell, Taylor & Francis

Reference Books:

1. "Theory of Optical Processes in Semiconductors: Bulk and Microstructures", byPrasanta K. Basu, Clarendon Press
2. "Design & Test of Digital Circuits by Quantum-Dot Cellular Automata", by Jing Huang,Fabrizio Lombardi, Artech publisher

Course Title: Electromagnetic Interference and Compatibility					
Course Code: ECE4135					
Contact hrs per week	L	T	P	Total	Total Credits
	3	0	0	3	3

Course Outcome:

After completing the course, the student will be able to:

- ECE4135. 1. identify sources of EMI
- ECE4135. 2. understand coupling of electromagnetic signals leading to interference
- ECE4135. 3. develop an ability to design EMI mitigation techniques
- ECE4135. 4. demonstrate EMI test method and its capabilities
- ECE4135. 5. identify EMC requirements for electronic systems
- ECE4135. 6. understand EMC standards and its application

Module I: Introduction To EMI and EMC [10L]

Definitions, Different Sources of EMI (Electro-magnetic Interference), Victims of EMI, Inter Source and Intra Source s EMI, Electro-static discharge (ESD), Electro-magnetic pulse (EMP).

Coupling Mechanism: Coupling paths, coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Radiative coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients. Categorization of electromagnetic interference: emission, susceptibility, transients, crosstalk, shielding and compatibility, signal integrity.

Module II: EMC requirements for electronic systems [8L]

World regulatory bodies- FCC, CISPR etc. Class- A devices, class-B devices, Regulations of the bodies on EMC issues.

Standards And Regulation: Need for Standards, EMI Standardizing for different application. IEC, ANSI, FCC, ICNIRP, CISPR, UN-ECR10, BSI, CENELEC, ACEC, MIL461E, SAE and ASIL qualification metrics, MIL-STD-461. Indian perspective on EMI standards.

Module III: EMI Mitigation Techniques [10L]

Working principle of Shielding, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketing and sealing, PCB Level shielding, Principle of Grounding.

Module IV:EMI Test Methods and Instrumentation[10L]

Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, shielded chamber, shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Antennas, Current probes, Effect of ambient noise on home appliances.

References:

- 1) W. Ott Henry, "Electromagnetic Compatibility Engineering", John Wiley & Sons Inc, New York, 2009.
- 2) W. Scott Bennett, "Control and Measurement of Unintentional Electromagnetic Radiation", John Wiley & Sons Inc., (Wiley Interscience Series) 1997.
- 3) Dr Kenneth L Kaiser, "The Electromagnetic Compatibility Handbook", CRC Press 2005.
- 4) C.R. Paul, "Introduction to Electromagnetic Compatibility", 2nd ed., Wiley (2010).

Course Title: Introduction to RF Biosensors					
Course Code: ECE4136					
Contact hrs per week	L	T	P	Total	Total Credits
	3	0	0	3	3

Course Outcome:

After completing the course, the student will be able to:

- ECE4136. 1. Select a proper antenna design to be used in the RF spectral region.
- ECE4136. 2. Model and evaluate specific radiation pattern in different operational domains.
- ECE4136. 3. Understand principles of radar systems and their application across industries.
- ECE4136. 4. Demonstrate a sound understanding of RFID technology and its standards.
- ECE4136. 5. Gain a comprehensive understanding of biosensors, their components, and real world applications.

Prerequisites:

Basics of Electromagnetic Theory, and Communication Systems

Module I [10L]:

Introduction to Microwave Antenna: Types and fundamental parameters of antennas (gain, directivity, efficiency, beamwidth, polarization). Radiation mechanism and analysis of Fresnel and Fraunhofer regions. Concepts of Printed Antennas, Broadband Microstrip Patch Antennas.

Antenna as sensor: Antennas for Wearable Devices, Design Requirements. Modeling and Characterization of Wearable Antennas. Human-body interaction and operational challenges.

Module II [10L]:

Radar: Introduction to radar, radar range equation, Different types of radar: MTI and pulse Doppler radar, Tracking radar, SAR pulse radar, CW radar.

Applications of Radar in: Remote sensing, agriculture, medicine, detection of buried objects, NDT, defense factors affecting the performance of radar, radar transmitters, Receivers.

Module III [10L]:

Microwave power Sensors: Diode Sensors: Principles, dynamic range and waveform effects.

Thermocouple Sensors: Working principles and power measurement methods.

RFID Sensors: Components of RFID systems (tags, readers, antenna). Hardware and software standards, including ISO/IEC standards. Applications: Logistics, healthcare, retail and IoT integration.

Module IV [10L]:

Introduction to Biosensors: Advantages, limitations and components (bioreceptor, transducer, signal processor). Categories of biosensors: Bio affinity, biocatalytic and microorganisms based.

Transducers in Biosensors and Applications: Various types of transducers; Calorimetric, Optical, Potentiometric / Amperometric, Conductometric / Resistometric, Piezoelectric, Semiconductor based. Biosensors in clinical chemistry, medicine and health care. Low cost - biosensor for resource constrained environments.

References:

1. Finkenzeuer Klaus, "RFID Handbook", 2011, 3rd edition, John Wiley and Sons, New Jersey.
2. Constantine A. Balanis, "Antenna Theory Analysis and Design", 2016, 4th edition, John Wiley and Sons, New Jersey.
3. Brian R Eggins - Biosensors an Introduction , First edition, John Wiley & Sons Publishers, 1996.
4. Loic J Blum, Pierre R Coulet - Biosensors Principles and Applications, First edition, Marcel Dekker, Inc., 1991.
5. Merrill Skolnik, Introduction to Radar Systems, 3rd Edition, McGraw-Hill, 2001.

Open Elective course- 3

Course Title: Principles of Radar					
Course Code: ECE 4121					
Contact Hours per week	L	T	P	Total	Total Credits
	3	0	0	3	3

Course Outcome:

After completing the course, the student will be able to:

- ECE4121. 1. Understand the concept and characteristics of Radar operation.
- ECE4121. 2. Know the role of probability in the Radar communication.
- ECE4121. 3. Understand the importance of shape and material for Radar targets.
- ECE4121. 4. Develop the idea of Radar Transmission and Reception and in what aspects it is different from data communication.
- ECE4121. 5. Classify between different types of Radars and their distinct areas of application.
- ECE4121. 6. Have the concept of the specific design considerations of the antennas under the use for Radar communication.

Module I: [8L]

Introduction to radar: Basic radar equation and block diagram, Types of radar, Information available from a radar, Effects of operating frequency on radar, Applications of radar, Detection of signals in noise, Receiver noise and Signal-to-Noise Ratio, Probability Density Functions, Probabilities of Detection and False Alarm.

Module II: [8L]

Atmospheric attenuation and refraction of radar waves, Attenuation, back scatter and Doppler effects in rain, clouds and snow, Radar Cross Section (RCS) of targets, Control of RCS, Body shaping, Radar absorbing materials, Enhancement of RCS by multiple scattering, RCS prediction techniques, RCS measurement techniques, Radar echo suppression, Signal processing-Pulse compression, Ambiguity dgm, Blind zone, Matched filter

Module III:[8L]

Types of radar transmitters, Gyrotrons, Modulators, Choice of RF power source, Radar receiver configurations, Bandwidth considerations, Receiver front end, Digital receivers, Automatic detection, Practical detectors, Optimal detectors, Automatic tracking, Range and velocity tracking.

Module IV:[8L]

MTI radar, Adaptive MTI radar, Air-borne MTI radar, Pulse Doppler radar, Detection algorithm, Radar reflector antennas, Reflector feed design considerations, Phased Array antennas, Beam formers, Beam steering, Mutual coupling, Phase shifters.

Textbook:

- 1) M Skolnik, "Introduction to Radar Systems", McGraw Hill.3rd Edition

References:

- 1) George W Stimson, "Introduction to Airborne Radar", SciTech Publishing Inc.3rd Edition

Course Title: Bio-Sustainable Solar Energy

Course Code: ECE 4122

Contact Hours per week	L	T	P	Total	Total Credits
	3	0	0	3	3

Course Outcome:

After completing the course, the student will be able to:

- ECE4122. 1. understand the principles of solar energy and its role in achieving sustainability.
- ECE4122. 2. evaluate bio-sourced and bio-inspired technologies and their potential for scalable solar energy systems.
- ECE4122. 3. design sustainable solar systems and assess their environmental and social impact.
- ECE4122. 4. develop insights into future trends and policy frameworks supporting bio-sustainable solar energy innovation.
- ECE4122. 5. Analyze bio-inspired and bio-sourced technologies for solar energy applications.
- ECE4122. 6. Evaluate policy frameworks and their implications for solar energy adoption globally.

Module I: Fundamentals of Solar Energy [8L]

Overview of renewable energy sources and their global significance. Solar radiation: Properties, measurement, and Earth's solar energy potential. Basic photovoltaic principles: Semiconductor physics, solar cell working principles. Types of solar cells: Silicon-based, thin-film, and emerging bio-inspired technologies. Environmental and economic benefits of solar energy. Sustainability principles in the context of solar energy systems.

Module II: Bio-Inspired and Bio-Sourced Solar Technologies[8L]

Bio-photovoltaics: Imitate natural photosynthesis for energy conversion. Organic photovoltaics: Role of polymers and biomaterials. Dye-sensitized solar cells (DSSCs): Working, bio-sourced dyes, and advancements. Integration of bio-sourced materials like natural pigments, cellulose in solar panels. Challenges in the adoption of bio-sustainable solar technologies.

Module III: Design and Implementation of Solar Systems [8L]

Solar panel design and material selection. Energy storage integration: Batteries and sustainable alternatives (e.g., bio-batteries). System design, installation and maintenance for residential, industrial, and agricultural applications. Life Cycle Assessment (LCA) for solar systems: Environmental impact evaluation. Smart grids and solar energy integration. Socio-economic considerations in solar energy adoption.

Module IV: Policy, Future Trends, and Innovations in Bio-Solar Energy [8L]

Global policies promoting solar energy and bio-sustainability. Role of AI and IoT in optimizing solar energy systems. Advances in bio-hybrid solar technologies. Future trends: Perovskite solar cells, bio-waste-based photovoltaic materials. Recycling of Solar PV panels. Climate change mitigation through bio-sustainable solar energy.

Textbooks:

1. Biomass and Solar-Powered Sustainable Digital Cities – Edited by Md. Akhtaruzzaman, Neeraj Priyadarshi, and Prashant Kumar Soori – Scrivener Publishing
2. Sustainable Solar Energy Systems: Challenges and Economics for Application – By Jasmi Hafizan, Abu Bakar, and others – Bentham Books
3. Electricity from Sunlight: Photovoltaic-Systems Integration and Sustainability – By Vasilis Fthenakis – Wiley

References:

1. Renewable Energy: Challenges and Solutions – By Peter Yang – Springer
2. Sustainable Solar Electricity – By Roberto Aguiar, Jan Dirk Jansen, and others – Springer

Course Title : DevOps					
Course Code: CSE4121					
Contact hrs per week:	L	T	P	Total	Credit points
	2	0	2	4	3

Course Outcomes:

After completing the course, students will be able to:

CSE4121.1. Understand the fundamentals of DevOps and its relevance in modern software development and delivery.

CSE4121.2. Recognize the importance and application of different DevOps stages.

CSE4121.3. Implement virtualization or configuration management for DevOps-based software development.

CSE4121.4. Analyze the performance of each stage of the DevOps life cycle.

CSE4121.5. Evaluate the development and delivery process across all DevOps stages.

CSE4121.6. Establish a Continuous Integration (CI) / Continuous Delivery (CD) pipeline for automated integration and delivery of cohesive software releases that are fast, reliable, and scalable.

Detailed Syllabus

Module 1 [8L]

Introduction to DevOps: [4L]

Waterfall Model· Agile Model· Lean Model· Waterfall vs Agile vs Lean· Why DevOps· What is DevOps, DevOps Lifecycle· DevOps tools· DevOps Technical Challenges.

Version Control with Git: [4L]

What is Version Control· Types of Version Control System· Introduction to Git· Git Lifecycle· Common Git Commands· Recording Changes to the Repository· Working with Remotes· Branching and Merging in Git· Resolving Merge Conflicts· Git Workflow.

Module 2 [8L]

CI/CD with Jenkins: [8L]

Essentials of Continuous Integration· An example scenario where CI is used · Jenkins and its architecture · Jenkins tool Management · User management in Jenkins · Authentication· Authorization· Overview of Maven· Creating jobs and automatic build settings· Adding a slave node to Jenkins · Building Delivery Pipeline · Notification settings in Jenkins · Plugin management in Jenkins.

Module 3 [12L]

Containerization Using Docker: [6L]

What is Virtualization · What is Containerization · Containerization Tools · Components of Docker · Installing Docker · Common Docker Commands · Introduction to Docker Networking · Creating a Docker Hub Account · Docker Swarm.

Kubernetes: [6L]

Introduction to Kubernetes · Kubernetes Cluster Architecture — An overview · Understanding concepts of Pods, Replica sets, deployments and namespaces · Understanding the concepts of services and networking · Persistent volumes and persistent volume claims —an overview · Design of Pods · Understanding labels, selectors, jobs, and schedulers.

Module 4 [8L]

Ansible: [8L]

Introducing Ansible – A configuration management tool · Inventory · Ansible modules · Adhoc commands, Introduction to YAML script · Playbook · Including and Importing · Setting up Master Slave · Ansible Playbooks · Ansible Roles.

Text Books:

1. Emily Freeman, “DevOps For Dummies”, Oreilly
2. Gene Kim, Jez Humble, Patrick Debois, John Willis, “The DevOps Handbook”, Oreilly

Course Title: Introduction to Software Engineering					
Course Code: CBS4121					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After successfully completing this course, the students will be able to:

CBS4121.1 Understand the basic concept of SDLC stages and different SDLC models

CBS4121.2 Explain software engineering process by identifying the requirements and system modeling.

CBS4121.3 Develop object-oriented software design.

CBS4121.4 Illustrate the evolution process, reuse and testing for developing quality software for customer.

CBS4121.5 Estimate size, effort, cost and time related to a software project.

CBS4121.6 Work out software project schedule and staffing plan.

Detailed Syllabus:

Module I [10L]

Introduction: Professional software development, software engineering ethics.

Socio-technical systems: Complex systems, System engineering, System procurement, System development, System operation.

Dependability and Security: Dependability properties, Availability and reliability, Safety, Security.

Software Process: Software process model, process activities, coping with change, The rational unified process.

Product Life Cycle: Product life cycle stages, SDLC Models: waterfall, RAD, Prototyping, Incremental, Iterative, Spiral, Agile ,Product life cycle case study.

Structured Analysis Modeling Techniques : Data Dictionary, Decision Tree, Decision Table with examples, Data Model using Entity Relationship Diagram (ERD).

Module II [10L]

Requirements Engineering , Functional and Non Functional requirements, the software requirements document, Requirements specification, Requirements engineering processes, Requirements elicitation and analysis. Requirements validation, Requirements management.

Estimation and Scheduling of Software Projects: Software Sizing, LOC and FP based Estimations; Estimating Cost and Effort, Estimation Models, Constructive Cost Model (COCOMO), Project scheduling and Staffing; Time-line Charts.

System Modeling: Context models, Interaction models, Structural models, Behavioral models, Model

Module III [10L]

Software Design and Development:

Architectural Design: Architectural design decisions, Architectural views, Architectural patterns, Application architectures.

Design and implementation: Object oriented design using UML, Design patterns, implementation issues, Open source development. Agile software development: Agile methods, Plan driven and agile development.

Module IV [10L]

Software Testing: Verification and Validation; Error, Fault, Bug and Failure, Unit and Integration Testing, White-box and Black-box Testing, Basis Path Testing, Control Structure Testing, CFG and Cyclomatic Complexity, Deriving Test Cases, Alpha and Beta Testing; Regression Testing, Performance Testing, Stress Testing.

Software Configuration Management: Change Control and Version Control; Software Reuse, Software Re-engineering, Reverse Engineering

Software Quality: McCall's Quality Factors, ISO 9126 Quality Factors, Quality Control, Quality Assurance. Risk Management, Risk Mitigation, Monitoring and Management (RMMM), Software Reliability.

Text / Reference Books:

1. Software Engineering: A Practitioner's Approach - Roger S. Pressman, McGraw Hill.
2. Software Engineering - Ian Sommerville, Pearson.
3. Software Engineering Theory and Practice - Shari Lawrence Pfleeger, Joanne M. Atlee, Pearson Education.
4. Software Engineering Fundamentals - Ali Behforooz, Frederick J. Hudson, Oxford University Press.
5. An Integrated approach to Software Engineering - P. Jalote, Narosa Publications.
6. The unified modeling language User guide-Grady Booch, James Rumbaugh, Ivar Jacobson, Pearson education, New York.

Course Title: Medical Instrumentation

Course Code: AEI4121

Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

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

AEI4121.1: Familiarization of methods of measurement of different clinical parameters.

AEI4121.2: Understand the generation of bioelectric-potentials basic and its measurement.

AEI4121.3: Apply the knowledge of different sensors and transducers used in medical instruments.

AEI4143.4: Analyze different methods of medical imaging techniques and instruments.

AEI4143.5: Learn about the therapeutic and diagnostic medical instruments.

AEI4143.6: Aware of the importance of electrical safety and apply it in the design of different assisting devices.

Course Contents:

Module I-[8L]

Transducers in clinical parameter measurements:

Basic of Sensors and Transducers: Definition, principles of sensing and transduction, characteristics, classification, concept of signal conditioning; Measurement of Clinical Parameters: Temperature and Blood Pressure measurement; Blood flow measurement using Electromagnetic and Ultrasonic transducers, Indicator dilution methods; Plethysmography, Heart sound measurement, Measurements of blood pH, pCO₂, pO₂.

Module II-[10L]

Bio-potentials and Bio-electrodes: Bio-potentials- Origin and electrical activity of cells, resting and action potentials of cells; Electrodes- Electrode theory and half-cell potential, Polarizable and Non-polarizable electrodes, Electrode-Electrolyte-skin interface, types of electrodes: surface, needle and micro electrodes and respective applications. Electrode impedance, electrode gellies and creams; Measurement of electrical activities in Cardiovascular system- ECG, Einthoven's triangle, 12 lead electrodes, amplifiers; Measurement of electrical activities in muscles and brain: EMG, EEG.

Module III-[10L]

Biomedical Imaging and Assisting-Therapeutic instruments: Ultrasound imaging, radiography, CT scan, MRI and applications; Pacemakers, defibrillators, Hearing aids, Ventilators.

Module IV-[8L]

Philosophy of Biotelemetry and Patient Safety: Transmission and reception aspects of biological signals via long distances, Bio telemetry and patient monitoring, IoT-enabled patient monitoring and cloud-based health data management; Patient Safety: Physiological Effect of Electricity, Macro-Micro Shock, Electrical safety of patients. NFPA 99 (IEC 60601, and FDA guidelines).

References:

1. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, Second edition, Prentice-Hall India, 1997.
2. R.S. Khandpur, Handbook of Biomedical Instrumentation, 2 Edition, Tata McGraw Hill New Delhi, 1987.
3. John G. Webster, Medical Instrumentation application and design, Third edition, Wiley, 1997.
4. S. K. Venkata Ram, Biomedical Electronics and Instrumentation, Galgotia Publication Pvt. Ltd., New Delhi.
5. Geddes L.A and Baker L.E, Principles of Applied Biomedical Instrumentation, Third edition, Wiley-Interscience, 1989.

Open Elective course- 4

❖ To be opted from MOOCs courses

Open Elective course3 (to be offered by ECE Department)

Course Title: Principles of Radar					
Course Code: ECE 4121					
Contact Hours per week	L	T	P	Total	Total Credits
	3	0	0	3	3

Course Outcome:

After completing the course, the student will be able to:

- ECE4121. 1. Understand the concept and characteristics of Radar operation.
- ECE4121. 2. Know the role of probability in the Radar communication.
- ECE4121. 3. Understand the importance of shape and material for Radar targets.
- ECE4121. 4. Develop the idea of Radar Transmission and Reception and in what aspects it is different from data communication.
- ECE4121. 5. Classify between different types of Radars and their distinct areas of application.
- ECE4121. 6. Have the concept of the specific design considerations of the antennas under the use for Radar communication.

Module I: [8L]

Introduction to radar: Basic radar equation and block diagram, Types of radar, Information available from a radar, Effects of operating frequency on radar, Applications of radar, Detection of signals in noise, Receiver noise and Signal-to-Noise Ratio, Probability Density Functions, Probabilities of Detection and False Alarm.

Module II: [8L]

Atmospheric attenuation and refraction of radar waves, Attenuation, back scatter and Doppler effects in rain, clouds and snow, Radar Cross Section (RCS) of targets, Control of RCS, Body shaping, Radar absorbing materials, Enhancement of RCS by multiple scattering, RCS prediction techniques, RCS measurement techniques, Radar echo suppression, Signal processing-Pulse compression, Ambiguity dgm, Blind zone, Matched filter

Module III:[8L]

Types of radar transmitters, Gyrotrons, Modulators, Choice of RF power source, Radar receiver configurations, Bandwidth considerations, Receiver front end, Digital receivers, Automatic detection, Practical detectors, Optimal detectors, Automatic tracking, Range and velocity tracking.

Module IV:[8L]

MTI radar, Adaptive MTI radar, Air-borne MTI radar, Pulse Doppler radar, Detection algorithm, Radar reflector antennas, Reflector feed design considerations, Phased Array antennas, Beam formers, Beam steering, Mutual coupling, Phase shifters.

Text Book:

1. M Skolnik, "Introduction to Radar Systems", McGraw Hill.3rd Edition

References:

1. George W Stimson, "Introduction to Airborne Radar", SciTech Publishing Inc.3rd Edition

Course Name:		Evolution of Mobile Communication: 1G to 5G			
Course Code :		ECE4123			
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing the course the students will be able to:

ECE4123.1 Recapitulate cellular communication systems, architecture, functioning, and various standards.

ECE4123.2 Understand evolution of mobile communication generations 1G, 2G, 2.5G.

ECE4123.3 Analyse various Gs with their characteristics and limitations.

ECE4123.4 Understand emerging technologies required for fourth generation mobile systems such as SDR, MIMO etc.

ECE4123.5 Understand the concept of LTE-advanced, 4G features and challenges, 5G vision.

ECE4123.6 Analyze and compare architecture, functioning, protocols, capabilities and application of various mobile communication networks.

Module I [10 L]:

Introduction:

The cellular fundamentals: cellular communication and frequency reuse, general architecture of a cellular system, channel assignment strategies, hand-off in a cellular system. Evolution of mobile cellular communication: different generations of mobile cellular communication (1G/GSM, 2G, 2.5G). Need for 3G cellular network.

Module II [12 L]:

Third-Generation (3G) Wireless System:

GSM Evolution for Data, UMTS Core Network Architecture, Channel Structure in UMTS Terrestrial Radio Access Network, UMTS Bearer Service, High-Speed Downlink Packet Access (HSDPA).

Evolution of CDMA-One (IS-95) to CDMA-2000, CDMA-2000 Layering Structure, Physical Channels of CDMA-2000 , CDMA-2000 1X EV-DO , CDMA-2000 1X EV-DV, WCDMA : Differences between CDMA-2000 and WCDMA

Module III [8 L]:

Fourth Generation Systems:

4G Vision, 4G Features and Challenges, Applications of 4G, 4G Technologies: Multicarrier Modulation, OFDM-MIMO Systems, Bell Labs Layered Space Time (BLAST) System

Long Term Evolution (LTE):

System Architecture – Radio interface and channels – Resource mapping – Session, mobility and security procedures, VoLTE.

Module IV [6 L]:

Over view of LTE Advanced – Heterogeneous Networks – Internetworking – IP based coupling Architecture - Multimode terminals and intersystem handover. Relays, HetNets& Other Features of LTE-Advanced, Introduction to 5G.

Text Books:

1. Wireless Communications: Principles and Practice, T.S. Rappaport, Pearson Education
2. Wireless Communication, Andrews F. Molisch, Wiley
3. Wireless Communications and Networking, V.K. Garg, Morgan Kaufmann Publishers
4. Wireless Communication and Networks: 3G and Beyond, I.SahaMisra, TMH Education.

Reference Book:

1. From GSM to LTE-Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband, Martin Sauter, Wiley

Course Title: Introduction to Software Defined Radio					
Course Code : ECE4124					
Contact Hours per week	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcomes:

After completing the course, the students will be able to:

ECE4124.1 Understand the technological differences between families of radios.

ECE4124.2 Explain the function of reconfigurable hardware.

ECE4124.3. Analyze the processing techniques required for software defined radio.

ECE4124.4 Evaluate the effects of probability in communication reliability.

ECE4124.5 Analyze the synchronization requirements in SDR and SDR based networks.

ECE4124.6 Analyze functioning of different families of radios.

Module – I [10 L]

Introduction to SDR, Brief history of development of SDR, RF architectures applied in SDR, Processing architectures suitable for SDR, Software environment for SDR. SDR- benefits, problems, GNU radio design.

Module – II [12 L]

Signals and Systems in relation to SDR, Probability in Communications- the effects on reliability, Understanding SDR hardware, Timing and Carrier synchronization, Frame synchronization, Channel coding.

Receive techniques for SDR, Transmit Power, Bandwidth, Spectral Efficiency, Interference.

Module – III [8 L]

OFDM, introduction and implementation of the general model, Channel estimation, Equalization, Power allocation techniques for bits.

Module – IV [6 L]

SDR – some applications, future directions.

SDR-3000 series Software Defined Radio Transceiver Systems

Smart Antenna API for SDR

Networking and SDR- some case histories, Vehicular networking.

Text Books:

- 1) Software Defined Radio for Engineers , T.Collins, Robin Getz, Di Pu, and Alexander M. Wyglinski, Artech House, 2015
- 2) Cognitive Radio Techniques : Spectrum Sensing, Interference Mitigation and Localization- Sithamparanathan, Kandeepan; Giorgetti, Andrea, Artech House, 2012

Reference Books:

- 1) Cognitive Radio Technology, Bates, Martin; Fettee, Bruce A, Elsevier Science & Technology
- 2) Software Defined Radios : From Smart(er) to Cognitive, Liesbet Van Der Perre, Michael Timmers and SofiePollin, Springer

Course Title : Ad Hoc Wireless Networks					
Course Code : ECE4125					
Contact hours per week :	L	T	P	Total	Credit Points
	3	0	0	3	3

Course Outcome:

After completing the course the students will be able to:

ECE4125.1 Understand the underlying technologies of wireless communication networks.

ECE4125.2 Analyze the various design issues and challenges of Ad hoc Networks.

ECE4125.3 Different routing protocols and their operations will be clear to them.

ECE4125.4 Learn about the contention in MAC layer and ways to solve them.

ECE4125.5 Students will be familiar with the network design strategies to assure adequate QoS.

ECE4125.6 Apply their knowledge to develop new and improved applications.

Module I: [10L]

Introduction [2L]

Ad hoc wireless networks, Applications of Ad hoc wireless networks. Issues in Ad hoc wireless networks, Static and mobile Ad hoc network, Indoor Outdoor network model.

Mac Protocols [8L]

Issues in designing a MAC protocol for Ad hoc wireless Networks, Hidden and Exposed terminal problem, Contention based protocols with reservation mechanisms and scheduling mechanisms, MAC protocols using directional antennas, IEEE802.11 in Ad hoc mode.

Module II: [8L]

Routing Protocols [8L]

Issues in designing a routing protocol for Ad hoc wireless Networks, Classification of routing protocols, Proactive & Reactive routing protocol, Unicast & Multicast routing algorithm. Location aided routing, Link reversal routing, Hybrid routing algorithm, Energy aware routing algorithm, Hierarchical routing, QoS aware routing.

Module III [6L]

Transport Layer Protocols [6L]

Issues in designing a transport layer protocol for Ad hoc wireless Networks, Design goals of a transport layer protocol for Ad hoc wireless Networks, Classification of transport layer solutions, TCP over Ad hoc wireless Networks.

Module IV [12L]

QoS in Ad hoc wireless network [8L]

Issues and challenges in providing QoS in Ad hoc wireless networks, Classification of QoS solutions, QoS in wireless ad hoc network – analysis of degradation of receiver sensitivity, practical solutions.

Energy Management Schemes [4L]

Battery management, transmission power management, System power management schemes.

Text Books:

1. “Ad Hoc Wireless Networks – Architectures and Protocols” - C.Siva Ram Murthy and B.S. Manoj –Pearson Education.

Reference Books:

- 1) “Ad Hoc Mobile Wireless Networks – Protocols and Systems” - Chai K. Toh – Prentice Hall.
- 2) “Ad hoc wireless Networking”, Xiuzhen Cheng, Xiao Hung, DingZhu Du, Kluwer Academic publishers.
- 3) “Mobile Ad Hoc Networking” – Stefano Basagni, Marco Conti, Silvia Giardano, Ivan Stojmenovic –Wiley India

4th Year 2nd Semester

Dedicated to projects & internships.

APPENDIX – A

Updated Guidelines of Massive Open Online Courses (MOOCs) Scheme

(With Effect from 2023-2024 Academic Sessions)

MOOCs for B.Tech Honours Degree

For B.Tech. honours degree, a 4 - year B.Tech. student will have to earn 20 credits from MOOCs from any established MOOCs platform in addition to 160 credits for B.Tech. degree. B.Tech. lateral entry students should earn 16 credit points from MOOCs in addition to the required credit for B.Tech degree. Student should submit all the certificates before the last date of submission of MOOCs for the B.Tech. Honours degree, through the department declared by the office of the Controller of the Examinations.

Credit points from MOOCs Courses

All of the MOOCs courses are to be taken any MOOCs platform as per following scheme of credit points. Students should be advised to avoid the courses taught/offered through the curriculum in the offline/ class room mode.

1. For MOOCs courses are available in hours

- i) For every 8 – 15 hours of course: 1 credit point.
- ii) For the courses with duration less than 8 hours, multiple courses could be taken together (preferably in the same area) to consider 1 credit point. But where duration is available in weeks, count of hours will not be applicable.

The above structure is indicative only. Departmental Committee concerned may propose credit points of the courses offered through MOOCs platform based on the content and level (beginner/intermediate/advanced) of the courses. However, for any critical judgment the matter will be referred to the Departmental Committee.

Department will submit the list of the students who have successfully completed the MOOCs course along with the details in the prescribed format to the Controller of Examinations as and when notified.

APPENDIX – B

Point Description for Mandatory Additional Requirement (MAR)

Sl. No.	Name of the Activity	Points	Maximum Points allowed
1	MOOCS (SWAYAM/NPTEL/Spoken Tutorial) (per course)	20	40
2	Tech Fest / Teachers Day / Freshers Welcome		
	(i) Organizer	05	10
	(ii) Participants	03	06
3	Rural Reporting	05	10
4	Tree Plantation (per tree)	01	10
5	Participation in Relief Camps	20	40
6	Participation in Debate/Group Discussion/ Tech quiz	10	20
7	Publication of Wall magazine at Institutional level (magazine/article/internet)	10	20
8	Publication in News paper, Magazine & Blogs	10	20
9	Research Publication (per publication)	15	30
10	Innovative Projects (other than course curriculum)	30	60
11	Blood donation camp		
	(i) Donor	08	16
	(ii) Camp Organizer	10	20
12	Participation in Sports/Games		
	(i) College Level	05	10
	(ii) University Level	10	20
	(iii) District Level	12	24
	(iv) State Level	15	30
	(v) National / International Level	20	40
13	Cultural programme (Dance, Drama, Elocution, Music etc.)	10	20
14	Member of Professional Society	10	20
15	Student Chapter Activities / Seminars		
	(i) Participant	05	20
	(ii) Presentation	10	20
	(iii) Organizer	10	20
16	Relevant industry visit & report	10	20
17	Activities in different clubs at HIT (Photography Club, Cine Club etc.)	05	10
18	Participation in Yoga Camp	05	10
19	Self-Entrepreneurship programme	20	20
20	Adventure sports	10	20
21	Training to under privileged / Physically challenged	15	30
22	Community Service & Allied Activities	10	20
23	Hackathon (State / National Level)		
	(i) Participation in Hackathon	10	20
	(ii) Qualifier for final round (not prize winner) in Hackathon	20	40
	(iii) Prize Winners of Hackathon	30	60

Format for Report Submission

Name :

Department :

Year/Semester :

Title of the Activity :

Date :

Name of the organization :

Report :

Signature
(Coordinator / Competent Authority)

Points earned:

Signature of the Mentor

APPENDIX – C

