Loyola-ICAM

College of Engineering and Technology (LICET)

(Autonomous)

Loyola Campus, Nungambakkam, Chennai – 600 034

Curriculum and Syllabi (R-2024)

B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

Loyola-ICAM
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CURRICULUM AND SYLLABI (R-2024)

CHOICE BASED CREDIT SYSTEM (CBCS)

B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

Vision of the Institution:

- To form responsible engineers, who would engineer a just society.

Mission of the Institution:

- To provide technical education in a Christian atmosphere to deserving students who are economically poor and socially marginalized.
- To train young men and women of quality to be leaders in all walks of life and serve their fellow men with justice, truth and love.
- To implement teaching learning processes that ensure guidance and mentoring for students throughout their period of study.
- To provide higher education through academic collaboration and pursue research in the international perspective of Engineering.

Vision of the Department:

- To facilitate the transformation of students into globally competent and socially committed engineers, innovators and entrepreneurs.

Mission of the Department:

M1: To develop skilled electronics engineers for providing innovative solutions through effective teaching learning practices.

M2: To inculcate ethical values, integrity, leadership qualities, and creativity to build entrepreneurial skills.

M3: To provide a holistic environment for the development of intellectual, social and personal abilities.

M4: To develop a centre of excellence in VLSI and Embedded system design.

M5: To provide international exposure to students through collaboration with universities abroad.

Programme Educational Objectives:

Graduates will be able to,

PEO1: Apply the acquired mathematical, scientific and engineering skills to meet the growing challenges of the industry, pursue higher education, and research.

PEO2: Provide solutions to contemporary engineering problems in the fields of Electronics and Communication engineering by employing modern techniques and tools.

PEO3: Exhibit leadership skills and work as team to provide solutions that address the societal, global, and environmental issues.

PEO4: Engage in lifelong learning and adapt to trending technologies for sustained career advancement.

Programme Outcomes:

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4).

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5).

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6).

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9).

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences.

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8).

Programme Specific Outcomes:

PSO1: Identify, analyze and design Electronics and Communication systems for providing solutions to societal problems by applying core engineering principles.

PSO2: Ideate and formulate solutions for engineering problems in real-time computing and embedded systems by adapting emerging technologies.

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CHOICE BASED CREDIT SYSTEM (CBCS)

B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

SEMESTER – I

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
Theory Courses								
1	MA24101	Calculus for Engineers	BSC	3	1	0	4	4
2	BE24103	Basic Electrical and Instrumentation Engineering	ESC	3	0	0	3	3
3	HS24101	English for Professional Communication	HSMC	3	0	0	3	3
4	PH24102	Engineering Physics	BSC	3	0	0	3	3
5	GE24101	Heritage of Tamils / தமிழர் மரபு	HSMC	1	0	0	1	1
Laboratory Integrated Theory Courses								
6	GE24111	Engineering Graphics	ESC	2	0	4	6	4
Laboratory Courses								
7	GE24122	Engineering Practices Laboratory - Electrical and Electronics	ESC	0	0	2	2	1
8	PH24121	Physics Laboratory	BSC	0	0	2	2	1
Formation Courses								
9	GE24123	Design Thinking[$]	HSMC	0	0	2	2	1
10	FC24102	Cultural Identities and Globalization	HSMC	2	0	0	2	0
Total				**17**	**1**	**10**	**28**	**21**

[$] Skill based courses

SEMESTER – II

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
Theory Courses								
1	MA24202	Laplace Transforms and Complex Variables	BSC	3	1	0	4	4
2	CY24201	Chemistry for Electronic Engineering	BSC	3	0	0	3	3
3	EC24201	C Programming and Data Structures	PCC	3	0	0	3	3
4	GE24201	Tamils and Technology / தமிழரும் தொழில்நுட்பமும்	HSMC	1	0	0	1	1
Laboratory Integrated Theory Courses								
5	EC24211	Circuit Analysis	PCC	3	0	2	5	4
Laboratory Courses								
6	CY24121	Engineering Chemistry Laboratory	BSC	0	0	2	2	1
7	EC24221	C Programming and Data Structures Laboratory	PCC	0	0	2	2	1
8	GE24121	Engineering Practices Laboratory - Civil & Mechanical	ESC	0	0	2	2	1
Formation Courses								
9	FC24101	Life Skills[$]	HSMC	2	0	0	2	1
Total				**15**	**1**	**8**	**24**	**19**

[$] Skill based courses

SEMESTER – III

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
Theory Courses								
1	EC24301	Signals and Systems	PCC	3	1	0	4	4
2	MA24303	Probability and Random Processes	BSC	3	1	0	4	4
3	EC24302	Electronic Circuits	PCC	3	0	0	3	3
4	EC24303	Theory and Design of Control Systems	PCC	3	0	0	3	3
Laboratory Integrated Theory Courses								
5	EC24311	Digital System Design	PCC	3	0	2	5	4
6	GE24112	Problem Solving using Python	ESC	2	0	4	6	4
Laboratory Courses								
7	EC24321	Devices and Circuits Laboratory	PCC	0	0	4	4	2
Formation Courses								
8	HS24321	Communication Skills Building Laboratory[$]	BSC	0	0	2	2	1
9	BS24321	System Discovery and Analysis	HSMC	0	0	2	2	0
Total				**14**	**1**	**14**	**29**	**25**

[$] Skill based courses

SEMESTER – IV

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
Theory Courses								
1	BS24301	Environmental Science and Sustainability	BSC	3	0	0	3	3
2	EC24401	Communication Theory	PCC	3	0	0	3	3
3	EC24402	Electromagnetic Fields and Waves	PCC	3	0	0	3	3
Laboratory Integrated Theory Courses								
4	EC24411	Digital Signal Processing	PCC	3	0	2	5	4
5	EC24412	Linear Integrated Circuits	PCC	3	0	2	5	4
6	CS24414	Object-Oriented Programming	ESC	2	0	2	4	3
Formation Courses								
7	EC24422	Project Driven Learning[$]	EEC	0	0	2	2	1
8	FC24301	Soft Skills[$]	HSMC	2	0	0	2	1
Total				**19**	**0**	**12**	**31**	**22**

[$] Skill based courses

Foreign language courses to be completed by the end of IV semester.

SEMESTER – V

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
Theory Courses								
1	EC24501	Digital Communication	PCC	3	0	0	3	3
2	EC24502	Transmission Lines and RF Systems	PCC	3	0	0	3	3
3		Professional Elective – I	PEC	3	0	0	3	3
Laboratory Integrated Theory Courses								
4	EC24511	VLSI and Chip Design	PCC	3	0	2	5	4
5	EC24512	Computer Networks	PCC	3	0	2	5	4
6	EC24513	Microprocessors and Microcontrollers	PCC	2	0	2	4	3
Laboratory Courses								
7	EC24521	Communication Systems Laboratory	PCC	0	0	4	4	2
8	EC24522	Mini Project	EEC	0	0	2	2	1
Formation Courses								
9	FC24501	Universal Human Values and Service Learning[$]	HSMC	1	0	1*	1	1
10	BS24502	Logical Reasoning and Aptitude Training	BSC	2	0	0	2	1[#]
Total				**19**	**0**	**15**	**33**	**24**

[$] Skill based courses

[#] Not included for GPA calculation

* Activities on non-working days/hours

SEMESTER – VI

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
Theory Courses								
1		Open Elective – I	OEC	3			3	3
2		Professional Elective – II	PEC	3			3	3
3		Professional Elective – III	PEC	3			3	3
4		Professional Elective – IV	PEC	3			3	3
5	GE24501	Project Management and Operations Management	HSMC	2	0	0	2	2
6	GE24502	Entrepreneurship and International Business Market	HSMC	2	0	0	2	2
Laboratory Integrated Theory Courses								
7	EC24611	Embedded Real Time Systems with ARM	PCC	3	0	2	5	4
8	CS24611	Fundamentals of ML and AI	ESC	2	0	2	4	3
Formation Courses								
9	GE24621	Interdisciplinary Project[$]	EEC	0	0	2	2	1
10	GE24622	Problem Solving Techniques	EEC	0	0	2	2	1[#]
11	GE24503	Financial Literacy	HSMC	2	0	0	2	0
Total				**21**	**0**	**6**	**27**	**24**

[$] Skill based courses

[#] Not included for GPA calculation

SEMESTER – VII

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
Theory Courses								
1		Open elective – II	OEC	3			3	3
2		Open Elective – III	OEC	3			3	3
3		Professional Elective – V	PEC	3			3	3
4		Professional Elective – VI	PEC	3			3	3
5	GE24701	Working to Engineer a Better World	HSMC	2	0	0	2	2
6		Audit Course	HSMC	2	0	0	2	0
Laboratory Integrated Theory Courses								
7	EC24711	Antennas and Microwave Engineering	PCC	3	0	2	5	4
Laboratory Courses								
8	EC24721	Professional Project – I	EEC	1	0	2	3	2
Formation Courses								
9	EC24722	Internship[$]	EEC	0	0	0	0	2
Total				**20**	**0**	**4**	**24**	**22**

[$] Skill Based Courses

SEMESTER – VIII

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
Laboratory Courses								
1	EC24821	Professional Project – II	EEC	0	0	20	20	10
Total				**0**	**0**	**20**	**20**	**10**

PROFESSIONAL ELECTIVE COURSES: VERTICALS

Communication Engineering	Signal Processing	RF Technologies	Semiconductor chip design and testing	Embedded and IoT	Biomedical and Robotics	Diversified
Optical Communication	Advanced Digital signal processing	Electromagnetic Interference and compatibility in electronic systems	Low Power IC design	Embedded C Programming	Biomedical Measurements and Instrumentation	Bio-Inspired Optimization Techniques
Wireless communication	Image Processing	Passive RF and Microwave Integrated Circuits	VLSI Testing & Design for Testability	Real Time Operating Systems	Medical Imaging Systems	Big data analytics
5G communication	Machine learning for signal processing	Electronic warfare	CMOS Analog IC Design	IoT Processors	MEMS Design	Database management systems
Satellite Communication	Computer Vision	Advanced Antennas	Mixed Signal IC Design	Wireless sensor network design	Sensors and Actuators	Cyber Security
Software Defined Radio	Speech Processing	Radar Technologies	SoC Design	IoT Based System Design	Robotics and automation	Devops
Ad Hoc and Sensor Networks	Natural language processing	RF Microelectronics	VLSI Signal Processing	Industry 5.0 and Technologies	Concepts in Mobile Robots	Electric vehicle technology

MINOR ELECTIVE COURSES: VERTICALS

Embedded Systems & IoT	Communication Systems and Engineering	VLSI and Signal Processing
Embedded System Design	Fundamentals of Communication Systems	VLSI Chip Design
Embedded Processors	Internet and Data Communication	FPGA based System Design
Embedded C Programming	Satellite and Optical Communication	Digital Signal Processing
Sensors and Actuators for Embedded Systems	Communication for IoT and Smart Systems	VLSI Signal Processing
IoT Systems and Applications	Signal Processing and Machine learning with applications	VLSI testing
Industrial IoT	Computer Vision and Image Processing	VLSI Physical Design

OPEN ELECTIVE COURSES

OPEN ELECTIVE COURSES
Wireless Sensors and Networks
Electronic System Design
IoT Concepts and Applications
Medical Electronics
Embedded Processors
VLSI design

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL 1: COMMUNICATION ENGINEERING

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
1	PEC2411	Optical Communication	PEC	2	0	2	4	3
2	PEC2412	Wireless Communication	PEC	2	0	2	4	3
3	PEC2413	5G Communication	PEC	2	0	2	4	3
4	PEC2414	Satellite Communication	PEC	3	0	0	3	3
5	PEC2415	Software Defined Radio	PEC	2	0	2	4	3
6	PEC2416	Adhoc and Sensor Networks	PEC	2	0	2	4	3

VERTICAL 2: SIGNAL PROCESSING

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
1	PEC2421	Advanced Digital Signal Processing	PEC	2	0	2	4	3
2	PEC2422	Image Processing	PEC	2	0	2	4	3
3	PEC2423	Machine Learning for Signal Processing	PEC	2	0	2	4	3
4	PEC2424	Computer Vision	PEC	2	0	2	4	3
5	PEC2425	Speech Processing	PEC	3	0	0	3	3
6	PEC2426	Natural Language Processing	PEC	2	0	2	4	3

VERTICAL 3: RF TECHNOLOGIES

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
1	PEC2431	Electromagnetic Interference and Compatibility in Electronic Systems	PEC	3	0	0	3	3
2	PEC2432	Passive RF and Microwave Integrated Circuits	PEC	2	0	2	4	3
3	PEC2433	Electronic Warfare	PEC	3	0	0	3	3
4	PEC2434	Advanced Antennas	PEC	3	0	0	3	3
5	PEC2435	Radar Technologies	PEC	3	0	0	3	3
6	PEC2436	RF Microelectronics	PEC	3	0	0	3	3

VERTICAL 4: SEMICONDUCTOR CHIP DESIGN AND TESTING

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
1	PEC2441	Low power IC design	PEC	2	0	2	4	3
2	PEC2442	VLSI Testing and Design for Testability	PEC	3	0	0	3	3
3	PEC2443	CMOS Analog IC Design	PEC	2	0	2	4	3
4	PEC2444	Mixed Signal IC Design	PEC	2	0	2	4	3
5	PEC2445	System On Chip Design	PEC	3	0	0	3	3
6	PEC2446	VLSI Signal Processing	PEC	3	0	0	3	3

VERTICAL 5: EMBEDDED AND IoT

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
1	PEC2451	Embedded C Programming	PEC	2	0	2	4	3
2	PEC2452	Real Time Operating Systems	PEC	3	0	0	3	3
3	PEC2453	IoT Processors	PEC	2	0	2	4	3
4	PEC2454	Wireless Sensor Network Design	PEC	3	0	0	3	3
5	PEC2455	IOT Based System Design	PEC	3	0	0	3	3
6	PEC2456	Industry 5.0 and Technologies	PEC	3	0	0	3	3

VERTICAL 6: BIOMEDICAL AND ROBOTICS

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
1	PEC2461	Biomedical Measurements and Instrumentation	PEC	3	0	0	3	3
2	PEC2462	Medical Imaging Systems	PEC	3	0	0	3	3
3	PEC2463	MEMS Design	PEC	2	0	2	4	3
4	PEC2464	Sensors and Actuators	PEC	3	0	0	3	3
5	PEC2465	Robotics and Automation	PEC	3	0	0	3	3
6	PEC2466	Concepts in Mobile Robots	PEC	3	0	0	3	3

VERTICAL 7: DIVERSIFIED

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
1	PEC2471	Bio-Inspired Optimization Techniques	PEC	3	0	0	3	3
2	PCS2408	Big data Analytics	PEC	3	0	0	3	3
3	PEC2473	Database Management Systems	PEC	2	0	2	4	3
4	PIT2407	Cyber Security	PEC	2	0	2	4	3
5	PCS2415	Devops	PEC	2	0	2	4	3
6	PEC2476	Electric Vehicle Technology	PEC	3	0	0	3	3

MINOR VERTICAL 1: EMBEDDED SYSTEMS & IoT

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
1	MEC2411	Embedded System Design	PEC	3	0	0	3	3
2	MEC2412	Embedded Processors	PEC	2	0	2	4	3
3	MEC2413	Embedded C Programming	PEC	2	0	2	4	3
4	MEC2414	Sensors and Actuators for Embedded Systems	PEC	3	0	0	3	3
5	MEC2415	IoT Systems and Applications	PEC	3	0	0	3	3
6	MEC2416	Industrial IoT	PEC	3	0	0	3	3

MINOR VERTICAL 2: COMMUNICATION SYSTEMS AND ENGINEERING

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
1	MEC2421	Fundamentals of Communication Systems	PEC	3	0	0	3	3
2	MEC2422	Internet and Data Communication	PEC	3	0	0	3	3
3	MEC2423	Satellite and Optical Communication	PEC	3	0	0	3	3
4	MEC2424	Communication for IoT and Smart Systems	PEC	3	0	0	3	3
5	MEC2425	Signal Processing and Machine learning with applications	PEC	2	0	2	4	3
6	MEC2426	Image Processing and Computer Vision	PEC	3	0	0	3	3

MINOR VERTICAL 3: VLSI AND SIGNAL PROCESSING

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
1	MEC2431	VLSI Chip Design	PEC	2	0	2	4	3
2	MEC2432	FPGA based System Design	PEC	2	0	2	4	3
3	MEC2433	Digital Signal Processing	PEC	2	0	2	4	3
4	PEC2446	VLSI Signal Processing	PEC	3	0	0	3	3
5	MEC2435	VLSI Testing	PEC	2	0	2	4	3
6	MEC2436	ASIC Design	PEC	2	0	2	4	3

OPEN ELECTIVES

S. No.	Course Code	Course Title	Category	Periods per week			Total Periods	Credits
				L	T	P		
1	OEC241	Wireless Sensors and Networks	OEC	3	0	0	3	3
2	OEC242	Electronic System Design	OEC	1	0	4	5	3
3	OEC243	IoT Concepts and Applications	OEC	2	0	2	4	3
4	OEC244	Medical Electronics	OEC	3	0	0	3	3
5	OEC245	Embedded Processors	OEC	3	0	0	3	3
6	OEC246	VLSI design	OEC	3	0	0	3	3

SEMESTER 1

MA24101	Calculus for Engineers	BSC	L	T	P	C
			3	1	0	4

Course Objectives:

- To develop the usage of matrix algebra techniques and its applications, which are essential for engineers.
- To provide the students with the rules of differentiation.
- To impart the students with the concepts of functions of several variables.
- To make the students understand various techniques of integration.
- To acquaint the students with mathematical knowledge in evaluating multiple integrals and their applications.

UNIT I TRANSFORMATIONS 12

Stretching of an elastic membrane - eigenvalues and eigenvectors of a real matrix – properties – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms - Cayley Hamilton Theorem

UNIT II DIFFERENTIAL CALCULUS 12

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Parametric differentiation- Maxima and Minima of functions of single variable

UNIT III FUNCTIONS OF SEVERAL VARIABLES 12

Partial differentiation – Total derivative – Partial differentiation of implicit functions – Jacobians – Taylor's series – Maxima and Minima of a function of two variables - Method of Lagrangian Multipliers - Evaluating extremum of single and two variable functions.

UNIT IV INTEGRAL CALCULUS 12

Techniques of Integration: Substitution rule, Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals - Moments and center of mass.

UNIT V MULTIPLE INTEGRALS 12

Double integrals in cartesian and polar coordinates – Area enclosed by plane curves - Change of order of integration – Change of variables in double integrals - Triple integrals in cartesian coordinates – Volume of solids - Change of variables from Cartesian to Spherical polar coordinates and Cylindrical polar coordinates.

Total Periods:60

Course Outcomes:

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

CO1: To identify the eigenvalues and eigenvectors of a matrix and to execute diagonalization.
CO2: Identify the limit of functions and apply the rules of differentiation to differentiate functions.
CO3: Apply differentiation to functions of several variables

CO4: Evaluate extreme values of functions
CO5: Evaluate integrals using various techniques of integration
CO6: Evaluate multiple integrals in various coordinate systems and applications of multiple integrals.

Suggested Activities:

- Evaluation of eigenvalues and eigenvectors using scientific tool
- Plotting and visualizing curves, and extreme values using a scientific tool 3. Plotting and visualizing surfaces, and extreme values using a scientific tool
- Evaluation of line integrals using scientific tool
- Evaluation of multiple integrals using a scientific tool
- Visualizing 2D and 3D functions using GeoGebra and Desmos

Text Books:

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal.B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2018.
3. James Stewart, " Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015.

References:

1. Anton. H, Bivens. I and Davis. S, "Calculus", Wiley, 10th Edition, 2016.
2. Bali.N., Goyal.M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009. 3.
3. Jain.R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5th Edition, 2016.
4. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
5. Kuldeep Singh, "Engineering Mathematics Through Applications", 2nd Edition, Bloomsbury Academic.
6. Thomas. G. B., Hass. J, and Weir. M.D, "Thomas Calculus", 14th Edition, Pearson India, 2018.
7. Amos Gilat, "MATLAB: An Introduction with Applications", 4th Edition, John Wiley.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	-	-	-	-	-	2	1	-
CO2	3	2	1	1	2	-	-	-	-	-	2	1	-
CO3	3	2	1	1	2	-	-	-	-	-	2	1	-
CO4	3	2	1	1	2	-	-	-	-	-	2	1	-
CO5	3	2	1	1	2	-	-	-	-	-	2	1	-
CO6	3	2	1	1	2	-	-	-	-	-	2	1	-
Avg.	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**

BE24103	Basic Electrical and Instrumentation Engineering	ESC	L	T	P	C
			3	0	0	3

Course Objectives:

- To familiarize the important laws of electromagnetism
- To understand the construction and working principle of Transformer and DC motors.
- To impart knowledge in basic solid-state devices.
- To understand different types of instruments, characteristics, and calibration.
- To familiarize different types of transducers and their working principle.

UNIT I BASIC CONCEPTS, LAWS AND PRINCIPLES 9

Electric Field and Magnetic Field, Electromagnetism and Electromagnetic Induction, Laws of Electromagnetic Induction, Induced EMF in a Coil Rotating in a Magnetic Field, EMF Induced in a Conductor, Dynamically Induced EMF and Statically Induced EMF, Self-induced EMF and Mutually Induced EMF, Self-inductance of a Coil, Mutual Inductance.

UNIT II ELECTRICAL MACHINES 9

Transformers: Basic principle and constructional details, Circuit Parameters and Equivalent Circuit, EMF Equation, Voltage Regulation, Ideal transformer, Efficiency. DC Motor: Working Principle, Changing the direction of Rotation, Energy Conversion Equation, Torque Equation, Starting a DC Motor. Applications of Stepper Motor, Servo Motor.

UNIT III SOLID STATE DEVICES 9

Semiconductor Devices: Introduction, Review of Atomic Theory, Binding Forces Between Atoms in Semiconductor Materials. Extrinsic Semiconductors, Semiconductor Diodes, Zener Diode, Bipolar Junction Transistors, Field Effect Transistors, MOSFET, Silicon-controlled Rectifier, DIAC, TRIAC, Optoelectronic Devices: Light-dependent Resistor, Light-emitting Diodes, Liquid Crystal Displays, Phototransistors

UNIT IV MEASUREMENT AND INSTRUMENTATION 9

Analog and Digital Instruments, Passive and Active Instruments, Static Characteristics of Instruments, Linear and Nonlinear Systems, Dynamic Characteristics of Instruments, Classification of the Instrument System, Measurement Error. Calibration of Instruments. Measurement of Power, Instrument Transformers, Multimeter, and Measurement of Resistance.

UNIT V TRANSDUCERS 9

Transducers: Classification of Transducers, Characteristics of a Transducer, Linear Variable Differential Transformer, Capacitive Transducers, Inductive Transducers, Potentiometric Transducer, Strain Gauge Transducer, Thermistors, Thermocouples, Hall Effect Transducers, Piezoelectric Transducer, Photoelectric Transducer, Selection of Transducers.

Total Periods:45

Course Outcomes:

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

CO1: Illustrate and interpret the significance of laws of electromagnetism.
CO2: Explain the main components and working principles of Transformers and DC motors.
CO3: Identify and describe the function of basic solid-state devices such as diodes, and transistors.
CO4: Identify various measuring instruments and their characteristics.
CO5: Interpret calibration data to ensure accurate measurements.
CO6: Identify and describe various types of transducers and their operating principles.

Suggested Activities:

- Simulation using virtual labs
- Design problems
- Transducer problem-solving
- Journal review on instrument calibration
- Presentation on transducers

Text Books:

1. Bhattacharya, S. K. (2011). *Basic Electrical Engineering*. Pearson.
2. A.K. Sawhney, Puneet Sawhney 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, New Delhi, 2015

References:

1. Hughes, E., Hiley, J., Brown, K., & Smith, I. M. (2008). *Hughes Electrical and Electronic Technology*. Pearson/Prentice Hall.
2. Kothari DP and I.J Nagrath, "Basic Electrical Engineering", Fourth Edition, McGraw Hill Education, 2019
3. C.L.Wadhwa, "Generation, Distribution and Utilisation of Electrical Energy", New Age International pvt.ltd.,2003
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
5. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw-Hill, New Delhi, 2010.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	-	-	-	2	-	-	-	-	-	-	-	-
CO2	3	-	2	-	3	-	-	-	-	-	-	-	-
CO3	3	-	-	-	3	-	-	-	-	-	-	-	-
CO4	3	-	2	-	3	-	-	-	-	-	-	-	-
CO5	3	-	-	-	3	-	-	-	1	-	-	-	-
CO6	3	-	-	3	3	-	-	-	-	-	2	-	-
Avg.	**3**	**-**	**2**	**2**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**1**	**-**

HS24101	English for Professional Communication	HSMC	L	T	P	C
			3	0	0	3

Course Objectives:

- To develop effective listening, speaking, reading, and writing skills for professional contexts.
- To cultivate formal correspondence skills for workplace communication.
- To analyze and apply rhetorical techniques in writing and speaking.
- To encourage self-expression through storytelling and reflective writing.
- To strengthen grammar and vocabulary for improved language proficiency.

UNIT I COMMUNICATION BASICS 9

Listening - Link verbal and nonverbal cues and listen to podcasts and news stories. Reading - Read brochures and running headlines. Social media messages and electronic correspondence relevant to professional advancement
Writing - Formal letters
Speaking - Self-introduction - Dialogues and role plays, discussing news stories, asking doubts (clarification, direction, inquiring details…)
Grammar - Noun, Pronoun, Articles
Vocabulary - one-word substitution, phrasal verbs

UNIT II PROFESSIONAL CORRESPONDENCE 9

Listening - Listen to voicemails, presentations, and panel discussions
Reading - MoM - minutes of the meeting, memos, business and economic articles
Writing - Respond to Business Emails
Speaking - Inaugural speech, Vote of thanks, and mini-presentation
Grammar - Verb, concord, wh questions, and Yes/no, question tag
Vocabulary - Word forms (Prefix & suffix)

UNIT III RHETORIC COMMUNICATION 9

Listening - Monologue from plays and movies, and sale pitches (marketing and promotions)
Reading - Looking for ambiguity - Ethos, pathos, and logos (poem or play)
Writing - Essays - problem solution, cause and effect essay
Speaking - Deliver a monologue - situational scenarios
Grammar - Conjunctions, prepositions, interjections
Vocabulary - Discourse markers for contextual essays, idioms, and phrases

UNIT IV EXTENDED NARRATION 9

Listening - Listen to documentaries, debates, discussions, and Toastmasters speech
Reading - Read professional resumes, LinkedIn profiles, newsletter
Writing - Blog writing, writing reviews
Speaking - Debate, group discussion
Grammar - Mixed tenses, Adverb
Vocabulary - Compound words, Collocation

UNIT V LANGUAGE AND SELF 9

Listening - Listen to tone, mood, and attitude. Find meanings based on the context, and listen to different accents.
Reading - An excerpt from an autobiography
Writing - Reflective journal and diary entries
Speaking - Narrate stories from personal experience
Grammar - Adjective, direct, and indirect speech
Vocabulary - Contextual meaning of words, Abbreviations, and acronyms

Total Periods:45

Course Outcomes:

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

CO1: Demonstrate enhanced listening, speaking, reading, and writing skills tailored for professional environments.
CO2: Compose clear formal emails and letters for workplace communication.
CO3: Analyze and use rhetorical techniques to engage and persuade audiences.
CO4: Develop storytelling and reflective writing skills to share personal experiences.
CO5: Improve grammar and vocabulary for effective communication.
CO6: Foster teamwork and discussion abilities through debates and group presentations.

Suggested Activities:

- Take a set of 15 messages and classify them into spam, alerts, scams, discount texts, news, cautionary, personnel, and informative.
- Reflective journal - write your own personal and learning experience so far at LICET. Page limit: 3 pages.
- Rhetoric Writing - Find a product or create a product and employ ethos, pathos, and logos to persuade the customers to buy your product. Write in 250 words.
- Creative writing - Create your account on Blogger and write reviews, articles, and stories.

Text Books:

1. English for Engineers and Technologists. Volume I by Orient Blackswan, 2022
2. English for Science & Technology - I by Cambridge University Press, 2023

References:

1. Interchange. Cambridge University Press. USA, 2022.
2. Embark. Cambridge University Press. USA, 2016.
3. A course in Technical English. Cambridge University Press. USA, 2023.
4. High School English Grammar & Composition. Wren & Martin's Regular & Multicolour Edition. S.Chand Publishing, 2016.
5. Interchange by Jack C. Richards, Fifth Edition, Cambridge University Press, 2017.
6. English for Academic Correspondence and Socializing. Adrian Wallwork, Springer, 2011.
7. The Study Skills Handbook. Stella Cortrell, Red Globe Press, 2019
8. www.uefap.com

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	1	1	3	-	2	3	-	3	-	1
CO2	-	-	-	1	1	3	-	2	3	-	3	-	1
CO3	-	-	-	1	1	3	-	3	3	1	3	-	1
CO4	-	-	-	1	1	3	1	1	1	2	3	-	1

CO5	-	-	-	1	1	3	-	2	3	-	3	-	1
CO6	-	-	-	1	1	3	-	3	3	1	3	-	1
Avg.	**-**	**-**	**-**	**1**	**1**	**3**	**1**	**2.1**	**2.6**	**1.3**	**3**	**-**	**1**

PH24102 Engineering Physics BSC L T P C

3 0 0 3

Course Objectives:

- To make the students understand the basics of crystallography and its importance in studying materials properties.
- To instill knowledge of oscillations and waves and make them able to apply this knowledge in engineering situations.
- To establish a sound grasp of foundational principles of quantum mechanics and enable them to perform basic quantum mechanical calculations.
- To introduce the basics principles of photonics and fibre optic communication to students
- To make students understand the applications of quantum mechanics in solid-state physics to decipher the electrical properties of materials.

UNIT I CRYSTAL PHYSICS 9

Crystal structures: Crystal lattice – basis - unit cell and lattice parameters – crystal systems and Bravais lattices – Structure and packing fractions of SC, BCC, FCC, diamond cubic & HCP systems– crystal planes, directions and Miller indices – distance between successive planes - imperfections in crystals-classification of defects.

UNIT II OSCILLATIONS AND WAVES 9

Simple harmonic motion - Torsional pendulum – Damped oscillations –Shock Absorber - Forced oscillations and Resonance (qualitative)–Applications of resonance - Electrical analogy of mechanical oscillators - waves on a string - progressive waves - stationary waves- Energy transfer of a wave.

UNIT III QUANTUM MECHANICS 9

Black body radiation – Planck's hypothesis and black body radiation formula (qualitative)- Wave-particle duality– de Broglie hypothesis– Uncertainty Principle – The Schrodinger Wave equation (time-dependent and time-independent) – Physical interpretation of wave function - Normalization - Particle in an infinite potential well - Energy values and wavefunctions Quantum mechanical tunneling. Scanning tunneling microscope.

UNIT IV PHOTONICS AND FIBRE OPTICS 9

Laser – characteristics – Spontaneous and Stimulated emission-Einstein's coefficients - population inversion - Metastable states - Basic components of a laser system - CO2 laser, Semiconductor laser - Industrial and medical applications - Optical Fibres – Total internal reflection – Numerical aperture and acceptance angle – Fibres optic communication system.

UNIT V QUANTUM THEORY OF SOLIDS 9

Particle in a three-dimensional box - Degenerate energy states. Electrons in metals - Classical free electron theory-quantum free electron theory Fermi- Dirac statistics – Density of energy states. Fermi energy and free electron

density. Drawbacks of quantum free electron theory- Electrons in a periodic potential- Kronig-Penney Model (qualitative) -Band theory. Classification of solids based on energy band structure.

Total Periods:45

Course Outcomes:

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

CO1: Describe the structural properties of semiconducting materials possessing cubic structure.
CO2: Estimate the vibrational stability of an engineering system which employs periodic motion.
CO3: Calculate basic measurable quantities of simple quantum mechanical models.
CO4: Apply the characteristics of lasers for material processing and in the medical field.
CO5: Outline the operational principle of fiber optic communication systems.
CO6: Apply quantum mechanical principles towards the formation of energy bands.

Text Books:

1. Avadhanulu M N, Kshirsagar P G, "A Textbook of Engineering Physics", S Chand & Co Ltd, Ninth Revised Edition, 2012.
2. Hitendra K Malik, A K Singh " Engineering Physics McGraw Hill Education; Second edition, 2017.
3. Gaur R K, Gupta S L, "Engineering Physics", Dhanpat Rai Publishers, 2012.

References:

1. Serway R A, Jewett J W, "Physics for Scientists and Engineers", Cengage Learning, 2010.
2. Halliday D, Resnick R, Walker J, "Principles of Physics", Wiley, 2015.
3. V. Raghavan, Materials Science and Engineering: A First Course, Prentice Hall India Learning Private Limited, 2015.
4. S.O.Kasap, Principles of Electronic Materials and Devices, Mc-Graw Hill, 20181.
5. K. Thyagarajan and A. Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.

MAPPING OF COs WITH POs AND PSOs

COs	Pos											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	1	1	1
CO2	2	2	1	1	-	-	-	-	-	-	1	1	1
CO3	2	1	1	1	-	-	-	-	-	-	1	1	1
CO4	2	1	1	1	-	-	-	-	-	-	1	1	1
CO5	2	2	1	1	-	-	-	-	-	-	1	1	1
CO6	2	2	1	1	-	-	-	-	-	-	1	1	1
Avg.	**2**	**1.66**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**

GE24101	HERITAGE OF TAMILS / தமிழர் மரபு	HSMC	L	T	P	C
			1	0	0	1

Course Objectives:

- Provide an insight to the students into the rich culture and heritage of the state
- Provide the students with detailed information on the engineering techniques to construct architectural marvels practiced in Tamil Nadu
- Make the students connect with their roots, appreciate, and preserve it.

UNIT I / அலகு I **LANGUAGE AND LITERATURE / மொழி மற்றும் இலக்கியம்** **3**

Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan/

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

UNIT II / அலகு II **HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE / மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக் கலை** **3**

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils/

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

UNIT III / அலகு III **FOLK AND MARTIAL ARTS / நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்** **3**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils/

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

UNIT IV / அலகு IV **THINAI CONCEPT OF TAMILS / தமிழர்களின் திணைக் கோட்பாடுகள்** **3**

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas/

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

UNIT V / அலகு V **CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE / இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குக் தமிழர்களின் பங்களிப்பு** **3**

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books/

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

Total Periods:15

Course Outcomes:

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

CO1: Understand the human values and rights in Tamil literature
CO2: Learn the art and culture being practiced by the people of Tamil Nadu
CO3: Understand various games and dance practices by the people of Tamil Nadu
CO4: Understand the Tamil Culture and Customs through Folklore
CO5: Learn the concepts of Sangam Literature and the bravery of Kings
CO6: Learn the life history of freedom fighters Vedic herbs and developments in lifestyle

Text Cum Reference Books

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

GE24111	ENGINEERING GRAPHICS	ESC	L	T	P	C
			2	0	4	4

Course Objectives:

- To draw engineering curves and freehand sketch of simple objects.
- To draw orthographic projection of solids and sections of solids.
- To draw development of solids
- To draw isometric and perspective projections of simple solids.

CONVENTIONS AND GEOMETRIC CONSTRUCTION (Not for examinations) **1**

Importance of graphics in engineering applications - Use of drafting instruments - BIS conventions and specifications - Size, layout and folding of drawing sheets - Lettering and dimensioning.

UNIT I PLANE CURVES AND FREEHAND SKETCHING **6+11**

Basic curves used in engineering practices: Construction of conic sections by eccentricity method - Construction of cycloidal curves - Construction of involutes of square and circle - Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles - Layout of views- Freehand sketching of multiple views from pictorial views of objects.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE **6+11**

Projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method and traces. Projection of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

UNIT III PROJECTION OF SOLIDS **6+12**

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV SECTION AND DEVELOPMENT OF SOLIDS **6+12**

Sectioning of simple solids like prisms, pyramids, cylinders, and cone in a simple vertical position when the cutting plane is inclined to one of the principal planes and perpendicular to the other - obtaining true shape of section. Development of lateral surfaces of simple and sectioned solids - Prisms, pyramids cylinders and cones.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS **6+12**

Principles of isometric projection - isometric scale - isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones - Perspective projection of simple solids - Prisms, pyramids and cylinders by visual ray method.

COMPUTER AIDED DRAFTING (Demonstration Only, Not for Exam) **3**

The Concepts of Computer Aided Drafting for Engineering drawing, Computer graphics & Geometrical modelling (2D Orthographic Views) and 3D drafting (Isometric Views) using design software.

Total Periods: 90

Course Outcomes:

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

CO1: Construct the conic curves, involutes and cycloids.
CO2: Visualize and construct multiple views of solid.
CO3: Solve practical problems involving projection of lines and planes.
CO4: Draw the projection of simple solids.
CO5: Draw the sectional views of simple solids, obtain true shape and develop sectioned solids.
CO6: Draw the isometric and perspective projections of simple solids.

Text Books:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2019.
2. Jayapoovan T, "Engineering Graphics using AUTOCAD", Vikas Publishing ,7 th Edition.
3. Natrajan K.V., "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, Chennai, 2018.

References:

1. Basant Agarwal and Agarwal C.M., "Engineering Drawing", McGraw Hill, 2nd Edition, 2019.
2. Gopalakrishna K.R., "Engineering Drawing" (Vol. I&II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3. Luzzader, Warren.J. and Duff, John M., "Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
4. Shah M.B., and Rana B.C., "Engineering Drawing", Pearson Education India, 2nd Edition, 2009.

Publication of Bureau of Indian Standards:

1. IS10711 — 2001: Technical products Documentation — Size and layout of drawing sheets.
2. IS 9609 (Parts 0 & 1) — 2001: Technical products Documentation —Lettering.
3. IS 10714 (Part 20) — 2001 & SP 46 — 2003: Lines for technical drawings.IS 11669 — 1986 & SP 46 —2003: Dimensioning of Technical Drawings.
4. IS 15021 (Parts 1 to 4) — 2001: Technical drawings — Projection Methods.

Special points applicable to Semester End Examinations on Engineering Graphics:

1. There will be five questions, each of either-or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1	2	-	2	-	-	-	2	-	2	-	-
CO2	3	1	2	-	2	-	-	-	2	-	2	-	-
CO3	3	1	2	-	2	-	-	-	2	-	2	-	-
CO4	3	1	2	-	2	-	-	-	2	-	2	-	-
CO5	3	1	2	-	2	-	-	-	2	-	2	-	-
CO6	3	1	2	-	2	-	-	-	2	-	2	-	-
Avg.	**3**	**1**	**2**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**2**	**-**	**-**

GE24122	Engineering Practices Laboratory - Electrical and Electronics	ESC	L	T	P	C
			0	0	2	1

Course Objectives:

- To learn the basics of electronic components.
- To understand the internal structure and working of the measuring instruments.
- To construct a prototype circuit on a breadboard and verify.
- To understand the process behind the PCB fabrication.
- To introduce the functionality of various electrical components namely switches, fuse, and meters to perform wiring various electrical joints in common household electrical wire work.
- To introduce the methods for measuring electrical quantities

LIST OF EXPERIMENTS:

Electrical

1. Introduction to Electrical Components switches, fuses, indicators, and lamps
2. Basic switchboard wiring with lamp, fan, three-pin socket, and energy meter
3. Staircase wiring
4. Fluorescent Lamp wiring with introduction to CFL and LED types
5. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit

Electronics

1. Study of electronic components resistor, capacitor, inductor, transistor and diode.
2. Introduction to CRO, DSO, MSO, FG and their working principles.
3. Circuit prototyping and verification.
4. Build a printed circuit board and verify the desired output.

Total Periods: 30

Course Outcomes:

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

CO1: Identify and describe the function of various electronic components, leading to successful application in circuit design.
CO2: Accurately interpret and apply measurement data in practical scenarios.
CO3: Build a prototype of a circuit and validate its output.
CO4: Gain knowledge of PCB fabrication processes, including design, etching, and assembly.
CO5: Understand the working of electrical switches, measuring instruments, and wiring layouts used in domestic applications and carry out basic electrical wiring work.
CO6: Comprehend the concepts of current, voltage, power, and power factor using various measuring instruments

Laboratory Requirements:

S. No.	Description of equipment	Required numbers (for a batch of 30 students)
1.	Resistors, Capacitors, Inductors – sufficient quantities, Bread Boards	15 nos.
2.	CRO, MSO, DSO, FG, Power Supply	5 Nos.

3.	PCB etching kit (Ferric Chloride, Drilling machine, Layout design)	15 kits
4.	Soldering iron, paste, lead, desoldering pump	15 nos. each
5.	Single-way switch, Two-way switch, fuses, indicators, 230 V -60W incandescent lamp	5 nos each
6.	Basic switchboard wiring kit and Energy meter	5 nos each
7.	Staircase wiring kit	5 nos each
8.	Fluorescent Lamp wiring kit, CFL, and LED lamps	5 nos each
9.	1φ Auto Transformer, Voltmeter, Ammeter, Rheostat, Capacitor, Choke	5 nos each
10.	Multimeters	6 nos

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1	1	1	1	2	1	2	1	-	-	1	1
CO2	2	1	1	2	1	-	-	2	1	-	-	1	1
CO3	2	1	1	1	1	-	-	2	1	-	-	1	1
CO4	2	1	1	1	1	-	-	2	1	-	-	1	1
CO5	2	1	1	1	1	-	1	2	1	-	-	-	1
CO6	2	1	1	2	1	2	-	2	1	-	-	-	1
Avg.	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**-**	**-**	**1**	**1**

PH24121 Physics Laboratory **BSC** **L T P C**

0 0 2 1

Course Objectives:

- To learn the measurements of various elastic moduli of materials
- To learn determination of thermal properties of materials.
- To study different optical phenomena involving ordinary light.
- To measure the characteristic properties of lasers.
- To understand the characteristics of oscillatory motion.
- To learn measurement of rigid body moment of inertia.

LIST OF EXPERIMENTS:

1. Non-uniform bending - Determination of Young's modulus
2. Uniform bending – Determination of Young's modulus
3. Lee's Disc Experiment - Determination of thermal conductivity of bad conductors.
4. Torsional pendulum - Determination moment of inertia of regular and irregular objects.
5. Simple harmonic oscillations of cantilever
6. Ultrasonic interferometer – determination of sound velocity and liquids compressibility
7. Viscosity of Liquids
8. Air wedge - Determination of thickness of a thin sheet/wire
9. Optical fibre -Determination of Numerical Aperture and acceptance angle
10. Spectrometer-Determination of the wavelength of light using grating

11. (a) Laser- Determination of the wavelength of the laser using grating
    (b) Compact disc- Determination of width of the groove using laser.

Total Periods: 30

Course Outcomes:

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

CO1: Determine various moduli of elasticity of materials
CO2: Determine thermal properties of solids
CO3: Analyze various optical phenomena involving ordinary light.
CO4: Determine the characteristic properties of lasers.
CO5: Measure characteristic properties of systems executing oscillatory motion.
CO6: Determine the moment of inertia of rigid bodies

References:

1. Engineering Physics Practicals by Dr. P. Mani, Dhanam Publications, 2023
2. Practical Physics by Gordon L Squires, Cambridge University Press; 4th edition, 2001

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	1	3	-	-	-	2	-	-	1	1	-
CO2	2	2	1	3	-	-	-	2	-	-	1	1	-
CO3	2	2	1	3	-	-	-	2	-	-	1	1	-
CO4	2	2	1	3	-	-	-	2	-	-	1	1	-
CO5	2	2	1	3	-	-	-	2	-	-	1	-	-
CO6	2	2	1	3	-	-	-	2	-	-	1	1	-
AVG	**2**	**2**	**1**	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**1**	**1**	**-**

GE24123 Design Thinking **HSMC** **L T P C**

0 0 2 1

Course Objectives:

- Students will understand the different learning methodologies
- Students will learn the art of observation and visualization
- Students will understand the need for empathy in problem-solving
- Students will learn how to work in a team
- Students will learn to use different design thinking tools to solve problems

Module 1 An Insight to Learning: Understanding the Learning Process and Kolb's Learning Styles 2

Module 2 Journey of my life: Visualization and Wheel of Life. Introduction to project 4

Module 3 Observation: Listening vs hearing, Beyond observations and Mind maps 2

Module 4	Teamwork: Divergent thinking and Brainstorming	2
Module 5	Customer Journey: Journey mapping	2
Module 6	Conflict management: Balancing priorities, Reacting and Responding, Constraints to opportunities	2
Module 7	Empathy: Persona and Empathy map	2
Module 8	Design Thinking Model: 5-step process: Empathize, define, ideate, prototype, and scale	2
Module 9	Appreciation: The wonder of recognition, Articulation and Influence	2
Module 10	Project presentation	10

Total Periods:30

Course Outcomes:

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

CO1: To understand various learning processes and stages
CO2: To observe and visualize different scenarios
CO3: To empathize with a customer
CO4: To develop a journey map based on experiences
CO5: To understand the art of conflict management
CO6: To use design thinking as a tool to solve problems

Suggested Activities:

Solve real-life problems using Design Thinking

Text Books:

1. Design Your Thinking: The Mindsets, Toolsets and Skill Sets for Creative Problem-solving, Pavan Soni, Penguin Random House India, Pvt. Ltd. 2020
2. Developing Thinking Skills (The Way to Success), E. Balagurusamy, 2024, Khanna Publishing House
3. The Design Thinking Toolbox: A Guide to Mastering the Most Popular and Valuable Innovation Methods, Michael Lewrick, Patrick Link, Larry Leifer, Wiley, March 2020

References:

1. Internet Reference: https://www.interaction-design.org/
2. Internet Reference: https://online.hbs.edu/
3. Internet Reference: https://dschool.stanford.edu/

MAPPING OF COs WITH POs AND PSOs

COs	**POs**											**PSOs**	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	-	-	-	-	-	2	1	1	-	-	3	-	-
CO2	-	-	-	-	-	2	-	-	-	-	3	-	-
CO3	-	-	-	-	-	2	2	2	2	-	3	-	-
CO4	-	-	-	-	-	2	-	-	-	-	3	-	-
CO5	-	-	-	-	-	2	2	2	2	-	3	-	-
CO6	-	-	-	-	-	3	2	3	2	2	3	-	-
Avg.	**-**	**-**	**-**	**-**	**-**	**2.1**	**1.7**	**2**	**2**	**2**	**3**	**-**	**-**

FC24102	Cultural Identities and Globalization	HSMC	L	T	P	C
			2	0	0	0

Course Objectives:

- To enable students to reflect on their own cultural identity in relation to their socialisation.
- To encourage cultural diversity that underpins the formation of identity and social behaviours.
- To give exposure to the varied cultural influences on the parent culture.
- To prepare to address the challenges and tensions in the globalised society.

UNIT I Exploring Social and Cultural Identity 5

Identity formation & environmental interaction

- Race/ethnicity
- Gender
- Language
- Religion
- Socialisation (contact with different cultures)

UNIT II Regional and Cultural Influence on Social Behaviour and Identity 6

- Assimilation, Amalgamation and Hybridisation
- Cultural Behaviour - dialect, traditions, social behaviour (customs), etiquette (work culture), habits, cuisine and regional variation

UNIT III Dissemination of Mass Culture Practices 6

- Cultural Imperialism
- Colonisation and Globalization - Cultural turn
- Manufacturing pop culture - Language, food, movies, music, fashion, cosmetics.

UNIT IV Socio-Cultural Changes via Globalisation 6

- Indian globalisation through trade liberalisation
- Increased migration flow with economic opportunities
- Cultural exchange, global networks
- Urbanisation - impact on family ideology and social structure

UNIT V Embracing Global Identities 7

- Challenges and tension
- Adaptable to changing society - etiquettes (in cross-cultural workspace) and social behaviours
- Building understanding and tolerance

Total Periods:30

Course Outcomes:

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

CO1: Engage in conversations with themselves in relation to their local culture and society.
CO2: Realise the nuances of identity formation through various means of socialisation.
CO3: Critically assess the countless social and cultural behaviours that influence their identity and behaviour.
CO4: Examine the role of globalisation and liberalisation in urbanisation and cultural imperialism.
CO5: Adapt to the cross-cultural changes and engage in global networking.
CO6: Respond appropriately in a multicultural space by building tolerance and understanding.

Suggested Activities:

- Exercise on identity formation - creation of mind maps / storyboards
- A mini presentation on "Identifying one's own culture amidst the influence of the diverse cultural environment" - expressing only one cultural aspect (language, attire, habits, food, …)
- Opinion piece speech - Deliver a short speech expressing personal opinions
- Survey report - Comparison chart (5 exchanges) by engaging conversations with a elderly stranger or grandparents
- Produce a 30-second reel showcasing their understanding of the social etiquette of a specific country.

References:

1. Brooks, Ann. Popular Culture: Global Intercultural Perspectives. United Kingdom, Bloomsbury Publishing, 2014.
2. Verkuyten, Maykel. Identity and Cultural Diversity: What Social Psychology Can Teach Us. United Kingdom, Taylor & Francis, 2013, pp. 1-27.
3. Savage, Michael, et al. Globalization and Belonging. United Kingdom, SAGE Publications, 2004.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	-	2	-	2	1	-	2	-	-
CO2	-	-	-	-	-	2	-	-	1	-	-	-	-
CO3	-	-	-	-	-	2	-	-	1	-	2	-	-
CO4	-	-	-	-	-	2	-	2	1	-	2	-	-
CO5	-	-	-	-	-	-	-	-	-	-	-	-	-
CO6	-	-	-	-	-	2	-	2	1	-	2	-	-
Avg.	-	-	-	-	-	**2**	-	**2**	**1**	-	**2**	-	-

SEMESTER 2

MA24202	Laplace Transforms and Complex Variables	BSC	L	T	P	C
			3	1	0	4

Course Objectives:

- Find the Laplace transforms of standard functions
- Find the inverse Laplace transform of a function and use it in solving differential equations
- To introduce vector differential operator and evaluation of sine, surface and volume integrals
- To introduce the basic understanding and application of the concepts of divergence and curl
- Enhance the understanding of Cauchy-Reimann equations and it's usage in the construction of analytic functions
- Familiarise the methods of complex integration, series expansion of functions

UNIT I ORDINARY DIFFERENTIAL EQUATIONS 12

Higher order linear differential equations with constant coefficients - Method of variation of parameters – Euler's and Legendre's Homogeneous equation – System of simultaneous linear differential equations with constant coefficients.

UNIT II LAPLACE TRANSFORMS 12

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Transform of periodic functions - Initial and final value theorems – Inverse Laplace transforms – Convolution theorem – Application to solution of linear second order ordinary differential equations with constant coefficients.

UNIT III VECTOR CALCULUS 12

Gradient and directional derivative – Divergence and curl – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems (no proof).

UNIT IV ANALYTIC FUNCTIONS 12

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions w=z+c, cz,1/z, z2, Bilinear transformation.

UNIT V COMPLEX INTEGRATION 12

Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals.

Total Periods:60

Course Outcomes:

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

CO1: Use Laplace transforms to compute transformations of functions
CO2: Solve higher-order linear differential equations with constant coefficients
CO3: Solve higher-order linear equations with variable coefficients

CO4: Compute vector differential quantities and vector integrals
CO5: To understand the standard techniques of complex variable theory in particular analytic function
CO6: To familiarise with complex integration techniques

Suggested Activities:

- Evaluation of Laplace transforms using scientific tool
- Evaluation of Inverse Laplace transforms using scientific tool
- Evaluation of higher order ODE using scientific tool
- Visualizing complex analytic function using scientific tool
- Visualizing complex line integrals using scientific tool

Text Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons Publishers, 10th Edition, 2014.
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, 2012.

References:

1. Churchill, R.V. and Brown, J.W, Complex Variables and Applications, Tata Mc Graw-Hill, 8th Edition, 2012.
2. Murray Spiegel, John Schiller, Probability and Statistics, Schaum's Outline Series, 3rd Edition, 2010.
3. Conway J.B., "Functions of one Complex variables", Springer International Student Edition, Second Edition, New York, 2000.
4. Lars V. Ahlfors, "Complex Analysis", McGraw Hill International, Indian Edition, 2017.
5. Kumaresan, S. A Pathway to Complex Analysis, Techno Wold Publication, Kolkata, 2022
6. Ponnusamy S., Foundations of Complex Analysis, Narosa Publishing House, Second Edition, New Delhi, 2018.
7. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2	-	-	-	-	-	2	1	-
CO2	3	2	2	2	2	-	-	-	-	-	2	1	-
CO3	3	2	2	2	2	-	-	-	-	-	2	1	-
CO4	3	2	2	2	2	-	-	-	-	-	2	1	-
CO5	3	2	2	2	2	-	-	-	-	-	2	1	-
CO6	3	2	2	2	2	-	-	-	-	-	2	1	-
Avg.	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	**2**	1	-

CY24201	Chemistry for Electronic Engineering	BSC	L	T	P	C
			3	0	0	3

Course Objectives:

- To understand the fundamental concepts of electrochemical cells, redox reactions, and their applications in various chemical processes.
- To introduce the principles of corrosion, including the types, factors influencing corrosion, and methods for corrosion control.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To learn the techniques of instrumental analysis for the characterization of materials.
- To explore the properties and applications of smart materials in engineering.

UNIT I ELECTROCHEMISTRY AND CORROSION 9

Electrochemical Cell, Redox Reaction, Electrode Potential - Oxidation and Reduction Potential. Nernst Equation and Applications. Emf series.
Introduction to Corrosion - Chemical and Electrochemical Corrosion (Galvanic Corrosion, Concentration Cell Corrosion), Galvanic series - Factors Influencing Corrosion. Corrosion Control - Material Selection and Design - Electrochemical Protection - Sacrificial Anodic Protection and Impressed Current Cathodic Protection. Protective Coatings – Metallic Coatings (Galvanizing, Tinning), Organic Coatings (Paints). Paints: Constituents and Functions.

UNIT II STORAGE DEVICES AND ENERGY SOURCES 9

Batteries - Characteristics - Types of Batteries – Primary Battery (Alkaline Battery), Secondary Battery (Lead Acid, Lithium - Ion - Battery) - Emerging Batteries – Nickel - Metal Hydride Battery, Aluminum Air Battery, Batteries for Automobiles and Satellites - Fuel Cells (Types) – H2-O2 Fuel Cell - Supercapacitors - Types and Applications, Nuclear Energy – Nuclear Fission, Fusion, Differences, Characteristics – Nuclear Chain Reactions – Light Water Nuclear Reactor – Breeder Reactor. Renewable Energy: Solar energy - Solar Cells, DSSC.

UNIT III NANOCHEMISTRY 9

Basics: Distinction Between Molecules, Nanomaterials and Bulk materials; Size - Dependent Properties (Optical, Electrical, Mechanical, Magnetic and Catalytic). Types of Nanomaterials: Definition, Properties and Uses of - Nanoparticle, Nanocluster, Nanorod, Nanowire, and Nanotube. Preparation of Nanomaterials: Sol-Gel, Solvothermal, Laser Ablation, Chemical Vapour Deposition, Electrochemical Deposition and Electro Spinning. Applications of Nanomaterials in Medicine, Agriculture, Energy, Electronics and Catalysis.

UNIT IV INSTRUMENTAL METHODS AND ANALYSIS 9

Introduction, Absorption of Radiation, Types of Spectra, UV-Visible and IR Spectrophotometer: Instrumentation and Applications, Cyclic Voltammetry for Redox System. Thermal Methods of Analysis TGA, DTA, DSC. Sensors: Oxygen, Pulse Oximeter, Biometrics, and Glucose Sensor.

UNIT V SMART MATERIALS FOR ENGINEERING APPLICATIONS 9

Polymers – Definition – Classification – Smart Polymeric Materials - Preparation, Properties and Applications of Piezoelectric Polymer - Polyvinylidene Fluoride (PVDF), Electroactive Polymer - Polyaniline (PANI) and Biodegradable Polymer - Polylactic acid (PLA). Polymer Composites: Definition, Classification – FRP's – Kevlar. Shape Memory Alloys: Introduction, Shape Memory Effect – Functional Properties of SMAs – Types of SMA - Nitinol (Ni-Ti) Alloys - Applications.
Chromogenic Materials: Introduction – Types - Applications.

Total Periods:45

Course Outcomes:

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

CO1: Explain the electrochemical cells, electrode potential and its applications.
CO2: Analyze the factors leading to corrosion for corrosion prevention and control in engineering materials.
CO3: Explain the operating principles, working processes and applications of energy conversion and storage devices.
CO4: Apply the basic concepts of nanochemistry in designing the synthesis of nanomaterials for engineering applications.
CO5: Analyze materials using various instrumental techniques and sensors.
CO6: Understand the characteristics of smart materials for advanced engineering applications.

Suggested Activities:

- Quiz
- Mind Mapping on Types of Nanomaterials
- Seminar
- Animated videos on Nuclear Power Plant
- Electroplating process by group of students
- Demonstration of sensors

Text Books:

1. Jain P. C. & Monica Jain., "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi,2012.
3. Dara S.S., "A Textbook of Engineering Chemistry", Chand Publications, 2004. 4. B.K.Sharma, "Instrumental Methods of Chemical Analysis", 28th Edition, Goel Publishing House. 2012.

References:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text Book of Nanoscience and Nanotechnology", Universities Press - IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4. ShikhaAgarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.
5. O.V. Roussak and H.D. Gesser, Applied Chemistry - A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013.
6. Gowariker V.R., Viswanathan N.V. and Jayadev Sreedhar, "Polymer Science", New AGE International Publishers, 2009.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	2	2	1	-	2	-	-	-	-	2	-	-
CO2	3	2	2	1	-	2	-	-	-	-	2	-	-
CO3	3	1	2	1	-	2	-	-	-	-	2	-	-
CO4	2	1	-	-	-	1	-	-	-	-	1	-	-
CO5	2	1	1	-	-	1	-	-	-	-	1	1	1
CO6	3	1	2	-	-	2	-	-	-	-	1	**1**	**1**
Avg.	**2.7**	**1.3**	**1.8**	**1**	**-**	**1.6**	**-**	**-**	**-**	**-**	**1.5**	1	1

EC24201	C PROGRAMMING AND DATA STRUCTURES	PCC	L	T	P	C
			3	0	0	3

Course Objectives:

- To understand the constructs of C Language.
- To develop C Programs using basic programming constructs
- To develop C programs using arrays and strings
- To develop modular applications in C using functions
- To develop applications in C using pointers and structures
- To Learn linear data structures – lists, stacks, and queues
- To understand sorting and searching techniques

UNIT I C PROGRAMMING BASICS 9

Compiler, Interpreter, Loader, Linker - Program Execution, Classification of Programming – Algorithms – Flowcharts - Basics of C: Introduction, Standardizations of C language - Developing Programs in C - Structure of C program - Variables, Data Types, Declaration – Token - Operators and Expressions - Type Conversion in C.

UNIT II INPUT AND OUTPUT 9

Basic screen and key board I/O in C , Non formatted input and output , Formatted Input and output. Control Statements: Specifying Test Condition for Selection and Iteration, Writing Test Expressions, Conditional Execution and Selection, Iterative and Repetitive Execution, GOTO Statement, Special Control statements, Nested loops.

UNIT III ARRAYS AND STRINGS 9

One dimensional Array, Strings: One-Dimensional Character Arrays, Multidimensional Arrays, Arrays of Strings. Functions: Concept of function, Call by Value Mechanism, passing arrays to Functions, Scope and extent, Storage classes, Inline function, Recursion, Searching and sorting.

UNIT IV POINTERS AND FILES 9

Pointers: Introduction, Understanding Memory Address, Address Operators, pointer, Void pointer, Null pointer, use of pointers, arrays and pointers, Pointer and strings, pointer arithmetic, pointers to pointers, pointer to arrays, Pointers to functions, Dynamic memory allocation, Pointer and const Qualifier. User-defined data types and variables: Structures, union, Enumerations types, Bitfields.
Files in C: Working with text files, Binary files, Random Access files, other file management functions, Command line arguments, C preprocessor, Type qualifier.

UNIT V DATA STRUCTURES 9

Linked Lists: Singly Linked Lists, Circular Linked lists, Doubly Linked list Applications of Linked Lists. Stacks and Applications, Queues, Other Variations of Queues, Applications, Tree-Binary tree, Traversals, Kinds of binary tress, Binary Search tree, Application of tree.

Total Periods: 45

Course Outcomes:

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

CO1: Develop simple applications in C using basic constructs
CO2: Develop simple applications in C using control flow constructs
CO3: Design and implement applications using arrays and strings
CO4: Develop and implement modular applications in C using functions
CO5: Develop applications in C using structures and pointers
CO6: Implement linear data structure operations.

Suggested Activities:

- Developing Pseudocodes and flowcharts for real life activities such as
- Flipped Learning - tkinter package
- Mini-project

Text Books:

1. Pradip Dey and Manas Ghosh, ―Programming in C, Second Edition, Oxford University Press, 2011.
2. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, ―Fundamentals of Data Structures in C, Second Edition, University Press, 2008.

References:

1. Mark Allen Weiss, ―Data Structures and Algorithm Analysis in C, Second Edition, Pearson Education, 1996
2. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, ―Data Structures and Algorithms, Pearson Education, 1983.
3. Robert Kruse, C.L.Tondo, Bruce Leung, Shashi Mogalla , ― Data Structures and Program Design in C, Second Edition, Pearson Education, 2007
4. Jean-Paul Tremblay and Paul G. Sorenson, ―An Introduction to Data Structures with Applications, Second Edition, Tata McGraw-Hill, 1991.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	-	-	3	1	-	-	-	1
CO2	3	2	1	-	-	-	-	3	1	-	-	-	1
CO3	3	2	1	-	-	-	-	3	1	-	-	-	1
CO4	3	2	2	-	-	-	-	3	1	-	-	-	1
CO5	3	2	2	1	-	-	-	3	1	-	-	-	1
CO6	3	2	2	1	-	-	-	3	1	-	-	-	1
Avg.	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**3**	**1**	**-**	**-**	**-**	**1**

GE24201	TAMILS AND TECHNOLOGY / தமிழரும் தொழில்நுட்பமும்	HSMC	L	T	P	C
			1	0	0	1

Course Objectives:

- Understand the art of making things and developments in the lifestyle of people
- Understand the various methods of constructing buildings
- Understand the techniques being used in Architecture by Tamils
- Understand and apply the concepts of Tamils with modern technology

UNIT I / அலகு I **WEAVING AND CERAMIC TECHNOLOGY / நெசவு மற்றும் பானைத் தொழில்நுட்பம்** **3**

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries/

சங்க காலத்தில் நெசவு தொழில் – பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் – பாண்டங்களில் கீறல் குறியீடுகள்.

UNIT II / அலகு II **DESIGN AND CONSTRUCTION TECHNOLOGY / வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்** **3**

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period/

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

UNIT III / அலகு III **MANUFACTURING TECHNOLOGY / உற்பத்தித் தொழில் நுட்பம்** **3**

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram/

கப்பல் கட்டும் கலை – உலோகவியல் – இரும்புத் தொழிற்சாலை – இரும்பை உருக்குதல், எஃகு – வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் – நாணயங்கள் அச்சடித்தல் – மணி உருவாக்கும் தொழிற்சாலைகள் – கல்மணிகள், கண்ணாடி மணிகள் – சுடுமண் மணிகள் – சங்கு மணிகள் – எலும்புத்துண்டுகள் – தொல்லியல் சான்றுகள் – சிலப்பதிகாரத்தில் மணிகளின் வகைகள்.

UNIT IV / அலகு IV **AGRICULTURE AND IRRIGATION TECHNOLOGY / வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்** **3**

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells

designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society/

அணை, ஏரி, குளங்கள், மதகு – சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மை சார்ந்த செயல்பாடுகள் – கடல்சார் அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு – அறிவுசார் சமூகம்.

UNIT V / அலகு V **SCIENTIFIC TAMIL & TAMIL COMPUTING / அறிவியல் தமிழ் மற்றும் கணித்தமிழ்** **3**

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project/

அறிவியல் தமிழின் வளர்ச்சி –கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் – தமிழ் மென்பொருட்கள் உருவாக்கம் – தமிழ் இணையக் கல்விக்கழகம் – தமிழ் மின் நூலகம் – இணையத்தில் தமிழ் அகராதிகள் – சொற்குவைத் திட்டம்.

Total Periods:15

Course Outcomes:

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

CO1: Know the gradual improvement in the life history of Tamils
CO2: Construct buildings with the impact of the past with the present
CO3: Learn to manufacture remarkable things with the help of technology
CO4: Apply new Concepts in agriculture to the upliftment of the future society
CO5: Apply the ancient skills to find out the measurements of oceans
CO6: Apply the concepts of Tamil with modern technology

Text Books:

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

EC24211	Circuit Analysis	PCC	L	T	P	C
			3	0	2	4

Course Objectives:

- To explore the fundamental concepts of electric circuits and the mesh and nodal methods for circuit analysis.
- To introduce circuit theorems and duality for analysing DC circuits.
- To introduce sinusoidal steady-state and power analysis for AC circuits.
- To explore the transient and resonant characteristics of RL, RC, and RLC circuits.
- To acquire the skills to analyse magnetically coupled circuits.
- To determine the parameters of two-port networks.

UNIT I FUNDAMENTALS OF CIRCUIT ANALYSIS 9

Fundamentals of electric Circuits: Charge, current, Voltage, Power, Energy, Voltage and Current Sources, Circuit elements - Resistor, Inductor and Capacitor
Voltage and Current laws: Ohms Law, Kirchhoff's Current Law and voltage law, Circuit elements connected in Series and Parallel, Voltage and Current Division
Methods of Analysis: Basic Mesh and Nodal analysis for DC circuits, Super mesh and Super node analysis, Dual circuits.

UNIT II CIRCUIT THEOREMS 9

Circuit theorems for DC circuits: Source transformation, Star-Delta Conversion, Superposition theorem, Thevenin and Norton Theorems, Maximum Power Transfer theorem, Reciprocity theorem, Millman's theorem

UNIT III AC CIRCUITS – SINUSOIDAL STEADY STATE ANALYSIS AND POWER ANALYSIS 9

Sinusoidal Steady State analysis: Sinusoids, Phasors, Impedance and Admittance, Mesh and Nodal analysis for AC circuits, Source transformation, Superposition and Thevenin theorems for AC circuits, Phasor diagrams
AC Circuit Power analysis: Instantaneous power, Average power, Maximum power transfer, Effective values of current and voltage, Apparent power and Power factor, Complex power.

UNIT IV CIRCUIT DYNAMICS: TRANSIENTS AND RESONANCE 9

Transients: Behaviour of circuit elements under switching condition, Evaluation of initial and final conditions, Transient analysis of RL, RC and RLC circuits under source-free conditions and DC excitations.
Resonance: Analysis of Series and Parallel RLC circuits under resonance

UNIT V MAGNETICALLY COUPLED CIRCUITS AND TWO PORT NETWORK PARAMETERS 9

Magnetically coupled circuits: Self Inductance and Mutual Inductance, Dot convention, Energy in a coupled circuit, Linear transformer
Two port networks: Determination of Admittance, Impedance, Hybrid, and Transmission parameters of a two-port network.

Periods: 45

List of Experiments:

1. Verification of Kirchhoff's laws.
2. Verification of Mesh analysis for DC circuits.
3. Verification of Node analysis for DC circuits.
4. Verification of Thevenin theorem for DC circuits.
5. Verification of Maximum Power Transfer theorem for DC circuits.

6. Determination of resonant frequency and bandwidth of series and parallel RLC circuits.
7. Verification of superposition theorem of AC circuits using EDA tools.
8. Simulation of DC transients in RL and RC circuits using EDA tools.
9. Determination of impedance parameters of two-port networks using EDA tools.

Periods: 30

Total Periods: 75

Course Outcomes:

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

CO1: Analyse electric circuits using fundamental concepts and mesh and nodal methods.
CO2: Apply network theorems to analyse DC circuits.
CO3: Perform steady state analysis and power analysis for AC circuits.
CO4: Analyze the transient and resonant characteristics of RL, RC, and RLC circuits.
CO5: Analyze magnetically coupled circuits.
CO6: Apply fundamental concepts of circuits to determine the parameters of two-port networks.

Suggested Activities:

- Circuit simulation using PSpice - Modern Tool Usage
- Fault Identification and Circuit Debugging (Group Activity) - Individual and Team Work

Text Books:

1. Hayt Jack Kemmerly, Steven Durbin, "Engineering Circuit Analysis",Mc Graw Hill education, 9th Edition, 2018.
2. Charles K. Alexander & Mathew N.O.Sadiku, "Fundamentals of Electric Circuits", Mc Graw- Hill, 2nd Edition, 2003.
3. Joseph Edminister and Mahmood Nahvi, ―Electric Circuits, Schaum‘s Outline Series, Tata McGraw Hill Publishing Company, New Delhi, Fifth Edition Reprint 2016

References:

1. Robert.L. Boylestead, "Introductory Circuit Analysis", Pearson Education India, 12th Edition, 2014.
2. David Bell, "Fundamentals of Electric Circuits", Oxford University press, 7thEdition, 2009.
3. John O Mallay, Schaum’s Outlines "Basic Circuit Analysis", The Mc Graw Hill companies, 2nd Edition, 2011
4. Allan H.Robbins, Wilhelm C.Miller, ―Circuit Analysis Theory and Practice, Cengage Learning, Fifth Edition, 1st Indian Reprint 2013

Laboratory Requirements: (for a batch of 30 students)

- Resistor, Inductor, Capacitor - sufficient quantities
- Bread boards: 15 Nos
- CRO (30MHz): 10 Nos
- Function Generator(3MHz): 10 Nos
- Dual Regulated power supplies(0-30V): 10 Nos
- Multimeter: 10 Nos
- EDA tool for circuit simulation – Orcad Pspice/Equivalent software

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	1	1	2	-	1	2	1	-	-	2	-
CO2	3	3	2	1	2	-	1	2	1	-	-	2	-
CO3	3	3	2	1	2	-	1	2	1	-	-	2	-

CO4	3	3	2	1	2	-	1	2	1	-	-	2	-
CO5	3	3	2	1	2	-	1	2	1	-	-	2	-
Avg.	**3**	**3**	**1.8**	**1**	**2**	**-**	**1**	**2**	1	**-**	**-**	**2**	**-**

EC24221	**C PROGRAMMING AND DATA STRUCTURES LABORATORY**	**PCC**	**L**	**T**	**P**	**C**
			0	**0**	**2**	**1**

Course Objectives:

- To familiarise with C programming constructs.
- To develop programs in C using basic constructs.
- To develop programs in C using arrays.
- To develop applications in C using strings, pointers, functions.
- To develop applications in C using structures.
- To demonstrate implementation of linear data structure algorithms.
- To implement Sorting and Searching techniques

LIST OF EXPERIMENTS

1. I/O statements, operators, expressions
2. decision-making constructs: if-else, goto, switch-case, break-continue
3. Loops: for, while, do-while
4. Arrays: 1D and 2D, Multi-dimensional arrays, traversal
5. Strings: operations
6. Functions: call, return, passing parameters by (value, reference), passing arrays to function.
7. Pointers: Pointers to functions, Arrays, Strings, Pointers to Pointers, Array of Pointers
8. Structures: Nested Structures, Pointers to Structures, Arrays of Structures and Unions.
9. Array implementation of Stack and Queue ADTs
10. Linked list implementation of Stack and Linear Queue ADTs
11. Implementation of Binary Search Trees
12. Implementation of Insertion Sort , Merge Sort and Quick sort.

Total Periods:30

Course Outcomes:

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

CO1: Develop simple applications in C using basic constructs
CO2: Develop simple applications in C using control flow constructs
CO3: Design and implement applications using arrays and strings
CO4: Develop and implement modular applications in C using functions
CO5: Develop applications in C using structures and pointers
CO6: Implement Linear data structure algorithms.
CO7: Develop the various searching and sorting algorithms

References:

1. Kernighan, B.W and Ritchie,D.M, “The C Programming language”, Second Edition, Pearson Education, 2015.
2. Anita Goel and Ajay Mittal, “Computer Fundamentals and Programming in C”, 1st Edition, Pearson Education, 2013.
3. Paul Deitel and Harvey Deitel, “C How to Program with an Introduction to C++”, Eighth edition, Pearson Education, 2018.
4. Yashwant Kanetkar, Let us C, 17th Edition, BPB Publications, 2020.

5. Byron S. Gottfried, "Schaum's Outline of Theory and Problems of Programming with C", McGraw-Hill Education, 1996.
6. Pradip Dey, Manas Ghosh, “Computer Fundamentals and Programming in C”, Second Edition, Oxford University Press, 2013.

Laboratory Requirements:

S.No	Description of Equipment	Required numbers (for batch of 30 students)
1.	INTEL based desktop PC with min. 8GB RAM and 500 GB HDD, 17” or higher TFT Monitor, Keyboard and mouse	30
2.	Windows 10 or higher operating system / Linux Ubuntu 20 or higher	30
3.	Dev C++ / Linux Operating System with GNU compiler / equivalent open source IDE	30

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	-	-	3	1	-	-	-	1
CO2	3	2	1	-	-	-	-	3	1	-	-	-	1
CO3	3	2	1	-	-	-	-	3	1	-	-	-	1
CO4	3	2	2	-	-	-	-	3	1	-	-	-	1
CO5	3	2	2	1	-	-	-	3	1	-	-	-	1
CO6	3	2	2	1	-	-	-	3	1	-	-	-	1
CO7	3	2	2	-	-	-	-	3	1	-	-	-	1
Avg.	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**3**	**1**	**-**	**-**	**-**	**1**

GE24121 Engineering Practices Laboratory - Civil and Mechanical ESC L T P C

0 0 2 1

Course Objectives:

- Familiarize students with basic tools and equipment used in engineering.
- Develop practical skills in Mechanical, Civil and 3D Printing practices.
- Encourage teamwork and collaboration in a lab environment.
- Foster an understanding of safety protocols and procedures.

INTRODUCTION AND SAFETY PRACTICES

Overview of lab rules, expectations, and safety protocols, Personal Protective Equipment (PPE), handling tools and equipment safely, emergency procedures.

MECHANICAL PRACTICES

Workshop Tools: Identification and usage of basic mechanical tools (hammers, wrenches, screwdrivers, etc.).
Basic Machining: Introduction to lathe and drilling machines. Practicing Facing, Turning, and Drilling.
Sheet Metal Works: Making a dustpan and funnel.

CIVIL PRACTICES

Plumbing: Exposure to different plumbing components. Exposure to plumbing repair methods and troubleshooting of existing connections. Practicing pipe connection to the wash basin from the water tank.
Carpentry: A study on carpentry procedure. Making joints like the Tee joint and the Dovetail joint. Exposure and usage of power tools.

ADDITIVE MANUFACTURING PRACTICES

Welding: Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding, CO2, gas, and MIG welding techniques.
Foundry: Introduction to the foundry process and tools. Mold preparation for solid and split patterns.
3D Printing: Basics of 3D printing and simple projects.

ASSEMBLING AND FITTING

Introduction to Systems - Dismantling and Assembling of Mixer/IC Engines/Refrigerator and Air Conditioner

Total Periods: 30

Course Outcomes:

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

CO1: To perform basic machining operations
CO2: To perform operations on the given sheet metal
CO3: To understand the concepts of additive manufacturing methods like Welding, Moulding and 3D Printing
CO4: To understand the rudimentary concepts of refrigeration and air conditioning systems
CO5: To do basic household works like Plumbing, Carpentry Joints
CO6: To identify the components of Mixer/IC Engines/Refrigerator/AC.

References:

1. Workshop Technology by W.A.J. Chapman
2. Electrical Engineering Fundamentals by Vincent Del Toro
3. Basic Civil Engineering by M.S. Palanichamy

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	-	-	-	-	-	-	2	-	-	-	-	-
CO2	2	-	-	-	-	-	-	2	-	-	-	-	-
CO3	2	-	-	-	2	-	-	2	-	-	-	1	1
CO4	2	-	-	-	1	-	-	2	-	-	-	-	-
CO5	1	-	-	-	-	-	-	2	-	-	-	1	1
CO6	1	-	-	-	-	-	-	2	-	-	-	-	-
Avg.	**1.6**	**-**	**-**	**-**	**1.6**	**-**	**-**	**2**	**-**	**-**	**-**	**1**	**1**

CY24121	Engineering Chemistry Laboratory	BSC	L	T	P	C
			0	0	2	1

Course Objectives:

- To inculcate experimental skills to test basic understanding of water quality parameters, such as acidity, alkalinity, hardness, DO, TDS, and Chloride.
- To demonstrate the synthesis of nanoparticles.
- To familiarize the students with the determination of the molecular weight of a polymer by a viscometer.
- To familiarize the students with electroanalytical techniques such as pH meter, Potentiometry, and Conductometry to determine impurities in aqueous solutions.
- To understand the factors influencing corrosion.

LIST OF EXPERIMENTS:

1. Estimation of HCl using Na2CO3 as primary standard
2. Determination of alkalinity in water sample.
3. Determination of total, temporary & permanent hardness of water by EDTA method.
4. Determination of DO content of water sample by Winkler's method.
5. Determination of chloride content of water sample by Argentometric method.
6. Estimation of copper content of the given solution by Iodometry.
7. Determination of strength of given hydrochloric acid using pH meter.
8. Conductometric titration of strong acid vs strong base.
9. Estimation of iron content of the given solution using potentiometer.
10. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline/thiocyanate method).
11. Estimation of sodium and potassium present in water using a flame photometer.
12. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
13. Preparation of nanoparticles (TiO2/ZnO/CuO) by Sol-Gel method.
14. Corrosion experiment-weight loss method.
15. Conductometric titration of barium chloride Vs Sodium Sulphate - Precipitation method.

Total Periods: 30

Course Outcomes:

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

CO1: Analyze the quality of water samples with respect to their acidity, alkalinity.
CO2: Determine the hardness and chloride content of the water sample.
CO3: Demonstrate precipitation method for synthesis of nanoparticles
CO4: Determine the molecular weight of the polymer.
CO5: Estimate the amount of analyte by conductometry.
CO6: Quantitatively analyze the impurities in solution by electroanalytical techniques.

References:

1. Engineering Chemistry Laboratory Manual – Department of SH-Chemistry, LICET, 2024.
2. Vogel's Textbook of Quantitative Chemical Analysis (8th edition, 2014).

Laboratory Requirements:

1. Conductivity meter – 15 Nos.
2. pH meter - 15 Nos.
3. Potentiometer - 15 Nos.
4. Viscometer - 35 Nos.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	2	-	-	-	-	2	-	-
CO2	3	2	1	-	-	2	-	-	-	-	2	-	-
CO3	2	1	2	-	-	2	-	-	-	-	-	-	-
CO4	2	1	2	-	-	1	-	-	-	-	1	-	-
CO5	3	1	2	-	1	2	-	-	-	-	2	-	-
CO6	3	1	2	-	1	2	-	-	-	-	2	-	-
AVG	2.7	1.3	1.7	-	1	1.8	-	-	-	-	1.8	-	-

FC24101 Life Skills **HSMC** **L T P C**

2 0 0 1

Course Objectives:

- To enhance self-awareness and understanding of personal strengths, weaknesses, and potential.
- To develop mechanisms to navigate through emotions and stress.
- To build effective interpersonal skills and maintain healthy social relationships.
- To foster and develop strategies for holistic well-being.
- To reflect on personal growth.

UNIT I Knowing Thyself **6**

- Knowing Thyself
  - Strengths, Limitations, Characteristics, Habits and Experiences
- Sense of SELF
  - Self Awareness, Self Image, Self-esteem, Self Love, Self Respect
- Three Dimensions of SELF
  - 1) Ideal Self, 2) Social Self, and 3) Real Self
- Personality Types
  - 1) Introvert, 2) Extrovert, and 3) Ambivert

UNIT II Emotional Competence **6**

- Understanding emotions
- Understanding the patterns of thoughts, feelings, and behaviors (Cognitive Behavior Theory)
- Handling stress, anxiety, and fear (flight mode) / anger (fright mode)
- Happy chemicals (4 chemicals - Dopamine, Oxytocin, etc)
- Positive Thinking

UNIT III Interpersonal Skills **6**

- Interpersonal relationships
- Communicating Positive Expressions
  - Empathy, Trust, Forgiveness, Gratitude, Compassion
- Personal and Social Associations - Family systems, Relationship management
- Building personal, social, and digital intelligence
- Sense of OTHERS
- Gender Equity

UNIT IV Dimensions of Well-being **6**

- Intellectual Well-being
- Emotional Well-being
- Spiritual Well-being
- Physical Well-being
- Social Well-being

UNIT V Life to the fullest **6**

- Happiness v/s Having fun
- Self-Retrospection and Positive Transformation
- Synthesis, Personal Reflection, and Way Forward

Total Periods: 30

Course Outcomes:

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

CO1: Identify their strengths and weaknesses and demonstrate self-awareness through reflective practices.
CO2: Demonstrate the ability to recognize emotions and handle stress.
CO3: Enhance interpersonal skills to build strong and positive relationships. 4. Adapt to a comprehensive understanding of well-being, and be able to implement strategies for maintaining mental health.
CO4: Develop a deeper understanding of personal and social relationships, and identify areas for growth.
CO5: Synthesize learning into a cohesive life plan for future growth.

Suggested Activities:

- Cognitive behavior therapy
- PLOT
- SLOT
- SWOT
- Johari Window

References:

1. Bradberry, Travis, and Jean Greaves. *Emotional Intelligence 2.0*. TalentSmart,2009.
2. Republic of Philippines, Department of Education. *K to 12 Senior High School Core Curriculum.* - Personal Development, May 2016.
3. US Department of Education, *Career Guidance and Counselling Programs.* Rich South High School Horizon Program: (Rich Town Park Illinois: Rich South High School, 1998)

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	-	-	3	-	-	-	-	2	-
CO2	-	-	-	-	-	2	3	-	-	-	-	2	-
CO3	-	-	-	-	-	3	3	3	3	-	-	2	-
CO4	-	-	-	-	-	3	3	-	3	-	3	2	-
CO5	-	-	-	-	-	3	3	-	-	-	3	2	-
CO6	-	-	-	-	-	-	3	-	-	-	-	-	-
Avg.	-	-	-	-	-	**2.8**	**3**	**3**	**3**	-	**3**	**2**	-

SEMESTER 3

EC24301	**Signals and Systems**	**PCC**	**L**	**T**	**P**	**C**
			3	**1**	**0**	**4**

Course Objectives:

- To understand the fundamental properties of signals and systems.
- To study Fourier and Laplace transforms and their properties for continuous-time signals.
- To learn the representation of discrete-time signals in the frequency domain using DTFT and Z-transform.
- To explore the response of continuous-time systems using convolution integrals, differential equations, and transform techniques.
- To examine the response of discrete-time systems using convolution sums, difference equations, and transform-domain methods.

UNIT I INTRODUCTION TO SIGNALS & SYSTEMS 12

Standard signals- Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids_Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Energy & Power signals - Classification of systems- CT systems and DT systems- – Linear & Nonlinear, Time-variant& Time-invariant,Causal & Non-causal, Stable & Unstable.

UNIT II CONTINUOUS-TIME SIGNAL ANALYSIS 12

Trigonometric & Exponential Fourier Series for periodic signals, Fourier transform of standard signals, Properties of Fourier transforms. Laplace transforms, Inverse Laplace transforms and properties.

UNIT III ANALYSIS OF DISCRETE TIME SIGNALS 12

Fourier Transform of discrete time signals (DTFT) — Properties of DTFT — Z Transform & Properties, Stability analysis, SAMPLING: Sampling theorem – Graphical and analytical proof for Band Limited Signals

UNIT IV LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 12

Impulse response — convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems

UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 12

Impulse response — Difference equations- Convolution sum- Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems

Total Periods:60

Course Outcomes:

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

CO1: Classify different types of signals and systems based on their properties and perform basic operations.
CO2: Examine the spectral characteristics of continuous-time signals using Fourier series, Fourier transform, and Laplace transform.
CO3: Apply Fourier and Z-transforms to represent discrete-time signals in the frequency domain.
CO4: Apply sampling concepts to signals and analyze the effects of sampling in practical scenarios
CO5: Determine the response of the continuous time systems using convolution and transform techniques.
CO6: Apply transform techniques to discrete time systems.

Suggested Activities:

- Concept Mapping
- Lab Experiments
- Journal review assignments
- Problem-Solving Workshops
- Hands-on Circuit Implementation / Code-based Implementation
- Simulation

Text Books:

1. Oppenheim, Willsky and Hamid, "Signals and Systems", 2nd Edition, Pearson Education, New Delhi, 2015.
2. Simon Haykin, Barry Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2002

References:

1. B. P. Lathi, "Principles of Linear Systems and Signals", 2nd Edition, Oxford, 2009.
2. M. J. Roberts, "Signals and Systems Analysis using Transform methods and MATLAB", McGraw- Hill Education, 2018.
3. John Alan Stuller, "An Introduction to Signals and Systems", Thomson, 2007.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	-	-	-	-	-	2	-	-	-	2	-
CO2	3	2	1	-	-	-	-	2	-	-	1	2	-
CO3	3	3	2	2	1	-	-	2	-	-	1	2	-
CO4	2	2	2	2	2	1	-	2	1	-	2	2	2
CO5	3	2	1	-	-	-	-	2	-	-	1	2	-
CO6	3	3	2	2	1	-	-	2	1	-	1	2	-
Avg.	2	2	-	-	-	-	-	2	-	-	-	2	-

MA24303 Probability and Random Processes **BSC** **L T P C**

3 1 0 4

Course Objectives:

- To introduce the fundamentals of probability and develop understanding of one dimensional random variables and some standard distributions applicable to engineering which can describe real-life phenomenon
- To enable the understanding of the basic concepts of two dimensional random variables and the relation between variables
- To enhance the understanding of the basic concept of random processes
- To facilitate the exploration of time-domain and frequency-domain characteristics of random processes using correlation functions and spectral densities
- To understand the significance of linear systems with random inputs

UNIT I ONE - DIMENSIONAL RANDOM VARIABLES **9+3**

Introduction to Probability - Random variables - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions.

UNIT II TWO - DIMENSIONAL RANDOM VARIABLES 9+3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (Application only).

UNIT III RANDOM PROCESSES 9+3

Classification – Stationary process – Markov process - Markov chain - Poisson process – Random telegraph process.

UNIT IV CORRELATION AND SPECTRAL DENSITIES 9+3

Auto correlation functions – Cross correlation functions – Properties – Power spectral density – Cross spectral density – Properties.

UNIT V LINEAR SYSTEMS WITH RANDOM INPUTS 9+3

Linear time invariant system – System transfer function – Linear systems with random inputs – Auto correlation and cross correlation functions of input and output.

Periods: 60

Course Outcomes:

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

CO1: Apply probability theory to analyse discrete random variables, continuous random variables
CO2: Apply standard distributions which can describe real life phenomenon
CO3: Analyse relation between random variables
CO4: Apply the concept of random processes in time dependent problems
CO5: Apply the concept of correlation and spectral densitiesAble to analyze the response of random inputs to linear time invariant systems.
CO6: Analyse the response of random inputs to linear time invariant systems.

Text Books:

1. Ibe, O.C.,& Fundamentals of Applied Probability and Random Processes ", 1st Indian Reprint, Elsevier, 2007.
2. Peebles, P.Z., & Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4th Edition, New Delhi, 2002.

References:

1. Cooper. G.R., McGillem. C.D., Probabilistic Methods of Signal and System Analysis, Oxford University Press, New Delhi, 3rd Indian Edition, 2012.
2. Hwei Hsu, Schaum's Outline of Theory and Problems of Probability, Random Variables and Random Processes, Tata McGraw Hill Edition, New Delhi, 2004.
3. Miller. S.L. and Childers. D.G., "Probability and Random Processes with Applications to Signal Processing and Communications, Academic Press, 2004.
4. Stark. H. and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing, Pearson Education, Asia, 3rd Edition, 2002.
5. Yates. R.D. and Goodman. D.J., "Probability and Stochastic Processes, Wiley India Pvt. Ltd., Bangalore, 2nd Edition, 2012.
6. Veerarajan. T., "Probability and Statistics, Random Process and Queueing Theory", Tata McGraw Hill, Second Reprint, 2025.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	-	-

CO2	3	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	3	2	2	-	-	-	-	-	-	-	-	-
CO5	3	3	2	2	-	-	-	-	-	-	-	-	-
CO6	3	3	2	2	-	-	-	-	-	-	-	-	-
AVG	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

EC24302 Electronic Circuits **PCC** **L T P C**

3 0 0 3

Course Objectives:

- To perform DC analysis of biasing circuits for transistors
- To perform AC analysis of BJT and MOSFET amplifiers.
- To determine the frequency response of amplifiers
- To design oscillator circuits using transistors
- To understand power amplifiers and DC-DC Converters

UNIT I BIASING OF TRANSISTORS 9

Construction, Working and V-I characteristics of BJT and MOSFET; DC Load line, operating point, biasing methods, and stability factor for BJT; Design of biasing circuits for MOSFET

UNIT II BJT AND MOSFET AMPLIFIERS 9

Small signal model based analysis: BJT - Common Emitter, Common Base, Common Collector configuration; MOSFET - Common Source, Common Drain, Common Gate configuration; Differential amplifier – Operating modes, DC and AC analysis, CMRR;

UNIT III FEEDBACK AMPLIFIERS AND FREQUENCY RESPONSE 9

Types of negative feedback, effects of negative feedback in amplifiers; frequency response of single stage BJT amplifiers; High frequency model based analysis and upper cut—off frequency for BJT and MOSFET.

UNIT IV TUNED AMPLIFIERS AND OSCILLATORS 9

Operation and frequency response of Single tuned amplifier; Positive feedback, condition for sustained oscillations, RC oscillators – RC phase shift and Wien Bridge; LC oscillators – Hartley and Colpitts

UNIT V POWER AMPLIFIERS AND DC-DC CONVERTERS 9

Working and efficiency of Class A, Class B and Class C power amplifiers; Working of Buck, Boost and Buck boost DC-DC converters

Total Periods:45

Course Outcomes:

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

CO1: On completion of the course, the students will be able to
CO2: Design biasing circuits for transistors
CO3: Derive small signal parameters of amplifiers

CO4: Analyze the effect of feedback in amplifiers
CO5: Analyze high frequency models of transistors
CO6: Determine resonant frequency of oscillators and tuned amplifiers
CO7: Analyze power amplifiers and DC-DC converters.

Suggested Activities:

- Crossword on introductory topics
- Video animations on oscillators
- Journal review on applications of electronic circuits
- Oral seminar on power amplifiers and converters
- Mini-projects on simple applications
- Circuit simulation using SPICE

Text Books:

1. Salivahanan and N. Suresh Kumar, Electronic Devices and Circuits, 5th Edition, Mc Graw Hill Education (India) Private Ltd., 2022.
2. Millman J, Halkias.C.and Sathyabrada Jit, Electronic Devices and Circuits, 4th Edition, Mc Graw Hill Education (India) Private Ltd., 2015
3. David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5th Edition, 2010

References:

1. Muhammad H.Rashid, "Power Electronics: Devices, Circuits and Applications", Pearson Education / PHI 4th Edition, 2023.
2. Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3rd Edition, 2010
3. Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	1		1	2		3	3	2	1	3	2
CO2	3	2	1	1							1	3	1
CO3	3	2	1	1		2		3	3	2	1	3	1
CO4	3	2	1	1							2	3	1
CO5	2	2	1	1	1	2		3	3	2	2	3	2
CO6	2	2	1		1	2		3	3	2	1	3	2
Avg.	**2.50**	**2.00**	**1.00**	**1.00**	**1.00**	**2.00**		**3.00**	**3.00**	**2.00**	**1.33**	**3.00**	**1.50**

EC24303 Theory and Design of Control Systems PCC L T P C

3 0 0 3

Course Objectives:

- To introduce the components and their representation of control systems
- To learn various methods for analyzing the time response, frequency response and stability of the systems.
- To learn the various approach for the state variable analysis.

UNIT I SYSTEM COMPONENTS AND THEIR REPRESENTATION 9

Control System: Terminology and Basic Structure- Feedforward and Feedback control theory. Electrical and Mechanical Transfer Function Models- Block diagram Models- Signal flow graphs models.

UNIT II TIME RESPONSE ANALYSIS 9

Transient response-steady state response-Measures of performance of the standard first order and second order system-steady state error constant and system-type number-PID control-Principle of PD, PI, PID controllers (Qualitative analysis).

UNIT III FREQUENCY RESPONSE AND SYSTEM ANALYSIS 9

Closed loop frequency response- Performance specification in frequency domain- Frequency response of standard second order system using Bode Plot and Polar plot - Gain margin and phase margin - Principle of compensators (Qualitative analysis).

UNIT IV CONCEPTS OF STABILITY ANALYSIS 9

Concept of stability- Bounded Input Bounded Output stability, Routh stability criterion- Relative stability - Root locus concept - Guidelines for sketching root locus.

UNIT V CONTROL SYSTEM ANALYSIS USING STATE VARIABLE METHODS 9

State variable representation- Conversion of state variable models to transfer functions- Conversion of transfer functions to state variable models- Solution of state equations- Concepts of Controllability and Observability- Stability of linear systems.

Total Periods:45

Course Outcomes:

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

CO1: Compute the transfer function of different physical systems.
CO2: Analyze the time domain specification and calculate the steady state error.
CO3: Illustrate the frequency response characteristics of open loop and closed loop system response.
CO4: Analyze the stability using Routh Hurwitz criterion and root locus techniques.
CO5: Analyze the stability using root locus techniques.
CO6: Illustrate the state space model of a physical system

Suggested Activities:

- Team-Based Problem Solving.
- Interactive quizzes.
- GATE-Centric Practice Questions.
- Troubleshooting Challenges.
- Simulation using MATLAB.

Text Books:

1. M.Gopal,"Control System – Principles and Design", Tata McGraw Hill, 4th Edition, 2012.

References:

1. J.Nagrath and M.Gopal, "Control System Engineering", New Age International Publishers, 5th Edition, 2007.
2. K.Ogata, "Modern Control Engineering", PHI, 5th Edition, 2012.
3. S.K.Bhattacharya, "Control System Engineering", Pearson, 3rd Edition, 2013.
4. Benjamin.C.Kuo, "Automatic Control Systems", Prentice Hall of India, 7th Edition,1995.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	-	-	1	1	-	1	3	1
CO2	3	3	1	1	2	-	-	1	1	-	1	3	1

CO3	3	3	1	1	2	-	-	1	1	-	1	3	2
CO4	3	3	2	2	2	-	-	1	1	-	1	3	2
CO5	3	3	2	2	2	-	-	1	1	-	1	3	2
CO6	3	2	2	1	2	-	-	1	1	-	1	3	2
Avg.	3	2.7	1.5	1.3	2	-	-	1	1	-	1	3	1.7

EC24311 Digital System Design **PCC** **L T P C**

3 0 2 4

Course Objectives:

- To introduce the basics of number systems, Boolean algebra, logic function representation, and simplification techniques using Karnaugh Maps.
- To understand the design and analysis of combinational logic circuits, including arithmetic circuits, data processing circuits, and code converters.
- To learn the design and analysis of synchronous and asynchronous sequential circuits
- To learn different logic families, memory types, and the implementation of combinational logic using ROM, PLA, and PAL.

UNIT I BASICS OF DIGITAL SYSTEM 9

Number systems, codes and Base conversions; Basic postulates and fundamental theorems of Boolean algebra; Standard representation of logic functions – Sum of Product (SOP) and Product Of Sum (POS) forms; NAND and NOR Implementation of logic functions; Simplification of switching functions using Karnaugh Maps; Verilog HDL models of simple logic functions.

UNIT II COMBINATIONAL LOGIC CIRCUITS 9

Analysis of combinational logic; Combinational logic design - Problem formulation and design of combinational circuits; Arithmetic Circuits - Adders , Subtractors, Carry look ahead Adder, BCD Adder, Magnitude Comparator; Data processing circuits - Decoder, Encoder, Priority Encoder, Multiplexer, Demultiplexer; Code Convertors; Verilog HDL models of simple combinational circuits- Adder, Subtractor, Decoder, Multiplexer.

UNIT III SEQUENTIAL CIRCUITS 9

Latches and Flip flops: SR, JK, T, D, Master/Slave FF, Triggering of FF; Analysis of clocked sequential circuits; Design of clocked sequential circuits – Counters: Ripple counter, Ring counter, modulo counters and Shift registers: SISO,SIPO,PISO,PIPO, Universal Shift register; Synthesizable HDL models of simple Sequential circuits-Ripple counter, Ring counter, Shift register (SISO,SIPO,PISO,PIPO)

UNIT IV SYNCHRONOUS FINITE STATE MACHINES AND ASYNCHRONOUS CIRCUITS 9

Synchronous : Moore/Mealy models of Finite State Machines; State reduction and state assignment; Algorithmic Sate Machine(ASM) : Sequence detector, up-down counter Asynchronous Circuits: Analysis - Transition table, Flow table, stable and unstable states, cycles, races ; Design of Fundamental mode asynchronous circuits; Hazards in combinational and sequential circuits.

UNIT V LOGIC FAMILIES AND PROGRAMMABLE LOGIC DEVICES 9

RTL, TTL,ECL and CMOS Logic families - Propagation Delay, Fan In and Fan Out, Noise Margin, Comparison of Logic families; Memory - RAM, ROM, PROM, PAL, PLA; Implementation of combinational logic design using ROM, PLA and PAL

Periods: 45

List of Experiments:

1. Design of one bit adders and subtractors
2. Design of Parallel adder/ subtractor using IC7483
3. Design of Multiplexers/Demultiplexers and Encoders/Decoders.
4. Design of Magnitude Comparators using IC.
5. Design and implementation of counters using flip-flops.
6. Design and implementation of shift registers using D flip flops.
7. Design and simulation of Finite State Machine – Sequence detector using Verilog HDL.
8. Design and simulation of RAM using Verilog HDL

Periods: 30

Total Periods: 75

Course Outcomes:

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

CO1: Implement Boolean algebra, and Karnaugh Map techniques to simplify and optimize logic functions.
CO2: Implement Combinational logic circuits.
CO3: Implement Synchronous Sequential logic circuits.
CO4: Design synchronous Finite State Machines and asynchronous sequential logic circuits.
CO5: Compare logic families and implement combinational logic using memory devices.
CO6: Implement digital circuits using Verilog HDL.

Suggested Activities:

- Verilog coding and simulation of digital circuits using Modelsim/equivalent simulators.
- GATE-Centric Practice Questions.

Text Books:

1. M. Morris Mano and Michael D. Ciletti, 'Digital Design', Pearson, 6th Edition, 2018.
2. Charles H. Roth, Jr, 'Fundamentals of Logic Design', Jaico Books, 7th Edition, 2014.

References:

1. John F. Wakerly, Digital Design Principles and Practices, Prentice Hall, Fifth Edition, 2018.
2. William I. Fletcher, "An Engineering Approach to Digital Design", Prentice- Hall of India, 1 st Edition, 2015.
3. Samir Palnitkar, "Verilog HDL", Pearson Education, 2nd Edition,2003.
4. Stephen Brown and Zvonko Vranesic, "Fundamentals of Logic Design with Verilog", TMH publications, 3 rd Edition, 2013.

Laboratory Requirements: (for a batch of 30 students)

- Power supply (5V) : 10 Nos
- Bread boards: 15 Nos
- Clock pulse generator : 10 Nos
- Digital IC's : IC 7486 (XOR), IC 7408 (AND), IC 7432 (OR), IC 7404 (NOT), IC 7483, IC 7485, IC 7476 (JK Flip-Flop), IC 7474 (D Flip-Flop) – Sufficient quantities
- Connecting wires – Sufficient quantities
- Software Requirements for Verilog HDL simulation : Quartus Prime / Xilinx Vivado / ModelSim
- Desktop Computers : 5 Nos.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	-	-	-	2	2	-	-	3	2
CO2	3	3	3	2	-	1	-	2	2	-	1	3	2

CO3	3	3	3	2	-	1	-	2	2	-	1	3	2
CO4	3	3	3	2	-	1	-	-	-	-	1	3	2
CO5	3	3	3	2	-	-	-	-	-	-	-	3	2
CO6	2	2	2	2	3	-	-	2	2	-	1	3	2
Avg.	**2.8**	**2.7**	**2.7**	**1.8**	**3**	**1**	**-**	**2**	**2**	**-**	**1**	**3**	**2**

GE24112 Problem Solving using Python **ESC** **L T P C**

2 0 4 4

Course Objectives:

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To define Python functions and use function calls to solve problems.
- Learn to manage file operations, handle exceptions, and apply object-oriented programming principles in Python
- To familiarize with Python's module system, packages, and essential scientific libraries

UNIT I PROBLEM SOLVING AND INTRODUCTION TO PYTHON PROGRAMMING 7

Fundamentals of computational thinking, algorithmic problem solving and logical thinking, problem solving and decomposition, notations (pseudo code, flowchart) - Introduction to Python – Literals – Variables and Identifiers - Comments- Reserved words – Data Types - Operators and Expressions - Input and Output: Working with user input, displaying output, and formatting - Conditional if - alternative if - chained conditional - Iteration: state, while, for, break, continue, pass

UNIT II DATA STRUCTURES AND MANIPULATION 5

Lists: List operations - List slices - List methods - List loop - Mutability - Aliasing - Cloning lists - List parameters - Lists as arrays-Advanced list processing-List Comprehension- Tuples: Tuple assignment - Tuple as return value. Dictionaries: Operations and Methods- Sets: Creating Sets – Operations and methods – Set comprehension

UNIT III STRINGS AND FUNCTIONS 6

Functions - definition and use - Flow of execution - Parameters and arguments - Fruitful functions: Return values - Parameters - Local and global scope -Function composition - Recursion - Strings: string slices, immutability, string functions and methods, string module

UNIT IV FILES, EXCEPTIONS, CLASSES AND OBJECTS 6

Files and exception: Text files - Reading and writing files - Command line arguments-Errors and exceptions - Handling exceptions - Classes and Objects: Defining classes - Creating Objects Data abstraction – Class variables and Object variables – Working with objects and Methods

UNIT V MODULES AND PACKAGES 6

Introduction to Modules and Packages- Basics of NumPy - N-dimensional Array in NumPy - Methods and Properties - Basics of SciPy - Broadcasting in NumPy Array Operations - Array Indexing in NumPy, Pandas - Introduction - Series - Data Frame - Matplotlib - Basics - Figures and Axes - Method subplot - Axis container

Periods: 30

List of Experiments:

1. Identification and solving of simple real life or technical problems related to applications to specific discipline and developing algorithms/flowcharts.
2. Python programming using simple statements and expressions.
3. Solving problems using conditional statements.
4. Solving problems using iterative loops (Palindrome, Factorial, Prime Numbers).
5. Implementing real-time/technical applications using List.
6. Implementing real-time/technical applications using Tuples.
7. Implementing real-time/technical applications using Dictionaries.
8. Implementing real-time/technical applications using sets.
9. Implementing programs using functions.
10. Implementing programs using strings.
11. Implementing programs using modules.
12. Implementing programs using command line arguments
13. Implementing real-time/technical applications using file handling (Word count- longest word - Copy file).
14. Implementing real-time/technical applications using exception handling.
15. Creating and Instantiating classes (Creating student class and object, Voter's age validation, Marks range validation (0-100)).
16. Implement programs using standard libraries (Pandas, Numpy, Scipy).
17. Generating basic plots using Matplotlib.
18. Developing a game activity using Pygame

Periods: 60

Total Periods: 90

Course Outcomes:

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

CO1: Develop algorithmic solutions to simple computational problems.
CO2: Develop solutions to problems using control structures.
CO3: Process compound data using Python data structures.
CO4: Structuring python program into functions and to implement String handling functions
CO5: Read and write data from/to files in Python programs and handle exceptions
CO6: Understand object-oriented programming concepts through classes and objects.
CO7: Utilize Python modules and packages for performing data analysis.

Suggested Activities:

- Developing Pseudocodes and flowcharts for real life activities such as railway ticket booking using IRCTC, admission process to undergraduate course, academic schedules during a semester etc.
- Assign a project to create a small application that uses various Python data structures (lists, tuples, dictionaries, and sets) to manage and process a dataset (e.g., a contact list or inventory system).
- Data Analysis and Visualization using NumPy, Pandas, and Matplotlib - Provide a dataset (e.g., weather data, sales records) and ask students to perform data analysis using NumPy and Pandas, followed by visualizing the results using Matplotlib.
- External Learning - Recursion vs. Iteration.
- Flipped Learning - tkinter package
- Mini-project

Text Books:

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.

References:

1. Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data”, Third Edition, MIT Press, 2021
4. Eric Matthes, “Python Crash Course, A Hands - on Project Based Introduction to Programming”, 2nd Edition, No Starch Press, 2019.
5. https://www.python.org/
6. Martin C. Brown, “Python: The Complete Reference”, 4th Edition, Mc-Graw Hill, 2018.

Laboratory Requirements: (for a batch of 30 students)

S.No.	Description of Equipment	Required numbers (for batch of 30 students)
1.	Desktop Computer (Windows/Linux) with Python 3 interpreter	30

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	-	-	2	-	-	-	-	1	1	-	-
CO2	2	2	1	-	2	-	-	-	-	1	1	-	-
CO3	2	2	-	-	2	-	-	-	-	1	1	-	-
CO4	2	2	2	2	2	-	-	-	-	1	1	-	-
CO5	2	2	-	-	2	-	-	-	-	1	1	-	-
CO6	2	2	2	2	2	-	-	1	-	1	1	-	-
CO7	2	2	2	2	2	-	-	1	-	1	1	-	-
Avg.	**2**	**2**	**2**	**2**	**2**	**-**	**-**	**1**	**-**	**1**	**1**	**-**	**-**

EC24321 Devices and Circuits Laboratory **PCC** **L T P C**

0 0 4 2

Course Objectives:

- To gain hands on experience in building electronic circuits.
- To learn simulation software used in circuit design.
- To obtain the V-I characteristics of active devices
- To understand the effect of positive and negative feedback in amplifiers.
- To plot frequency response of single and multi-stage amplifiers.

LIST OF EXPERIMENTS:

HARDWARE BASED EXPERIMENTS ON

1. V-I Characteristics of PN junction diode and its application as a full wave rectifier
2. V-I Characteristics of Zener diode and its application as a regulator
3. V-I Characteristics of BJT in Common Emitter Configuration
4. V-I Characteristics of MOSFET in Common Source Configuration
5. Measurement of CMRR for Differential Amplifier
6. Effect of series and shunt negative feedback in amplifiers on bandwidth
7. Frequency response of Single Tuned Amplifier
8. Sinusoidal waveform generation

SIMULATOR (SPICE) BASED EXPERIMENTS ON

1. Voltage divider biasing circuits of BJT and MOSFET
2. Frequency response of cascade and cascode amplifiers
3. Analysis of series fed and transformer coupled power amplifiers

Total Periods: 60

Course Outcomes:

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

CO1: Implement applications using basic diodes
CO2: Determine graphical parameters from V-I characteristics of active devices
CO3: Calculate AC parameters of Differential Amplifier
CO4: Analyse frequency responses of single and multi stage amplifiers
CO5: Design waveform generation circuits
CO6: Simulate the response of electronic circuits

References:

1. Datasheets of active devices and operating manuals of measuring instruments
2. Robert L. Boylestad and Louis Nasheresky, "Electronic Devices and Circuit Theory", 11th Edition, Pearson Education / PHI, 2017

Laboratory Requirements:

1. Bread Boards – 15 Nos
2. CRO (Min 30MHz) – 15 Nos.
3. Signal Generator /Function Generators (3 MHz) – 15 Nos
4. Dual Regulated Power Supplies (0 – 30V) – 15 Nos.
5. Digital Multimeter– 15 Nos
6. DRB, DCB, DIB – 5 Nos each
7. Desktop Computer – 10 Nos.
8. Transistor/MOSFET (BJT-NPN-PNP and NMOS/PMOS) – 50 Nos each
9. Diode (PN, Zener) – 25 Nos each
10. DC Ammeters and DC Voltmeters – As per design – 10 Nos in each range
11. Transformers – 12V – 0 – 12V – 10 Nos
12. Resistors, Capacitors
13. SPICE Circuit Simulation Software: (any public domain or commercial software)

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	3	-	-	-	3	3	-	1	3	1
CO2	3	2	1	3	2	-	-	3	3	-	1	3	2

CO3	3	2	1	3	-	-	-	3	3	-	1	3	1
CO4	3	2	1	3	2	-	-	3	3	-	1	3	2
CO5	3	2	1	3	-	-	-	3	3	-	1	3	1
CO6	3	2	1	3	2	-	-	3	3	-	1	3	2
AVG	**3**	**2**	**1**	**3**	**2**	**-**	**-**	**3**	**3**	**-**	**1**	**3**	**1.50**

HS24321 Communication Skills Building Laboratory[$] **HSMC** **L T P C**

0 0 2 1

Course Objectives:

- Develop the ability to construct grammatically correct and contextually appropriate sentences
- Enhance critical thinking skills for analyzing and interpreting texts, media, and experiences
- Strengthen comprehension, summarization, and documentation skills for professional contexts
- Improve verbal and non-verbal communication for effective interaction in diverse professional settings
- Equip learners with teamwork, networking, and interview skills essential for career advancement
- Enable the creation of a professional digital identity through resumes, LinkedIn profiles, and self-presentation techniques

UNIT I The Art of Discourse **6**

Listening: Listen to stand-up comedy, political commentaries, and campaigns for appreciative listening.
Reading: Read and evaluate business and economic news articles; determine tone (neutral, positive, negative) and fact-check.
Writing: Craft commentary and opinion pieces to persuade or provoke discussion.
Speaking: Explain satire comic strips (e.g., Amul advertisements, political cartoons)

UNIT II Professional Communication Essentials **6**

Listening: Listen to voicemail, messages, and fill out forms.
Reading: Compare products & services; analyze advertisements.
Writing: Draft meeting agendas and minutes.
Speaking: Engage in open-field group discussions.

UNIT III Documentation and Summation **6**

Listening: Listen to documentaries, book summaries, and movie summaries for comprehensive understanding.
Reading: Read and analyze reports on significant events (e.g., environmental disasters, economic downturns).
Writing: Write survey reports and paraphrase key information.
Speaking: Report news, weather forecasts, and predictions.

UNIT IV Refining Professional Competence **6**

Listening: Translate informal language into formal business communication (Contextual translation)
Reading: Read and interpret technical texts and industry-specific jargon.
Writing: Write cover letters and statements of purpose.
Speaking: Role-play professional etiquette in workplace scenarios (e.g., expressing empathy, kindness, courtesy).

UNIT V Developing a Professional Profile **6**

Listening: Listen to podcasts, Josh Talks, and professional interviews.

Reading: Analyze professional resumes and LinkedIn profiles.
Writing: Set up a LinkedIn profile and write engaging posts.
Speaking: Conduct mock interviews and deliver an effective elevator pitch.

Periods: 30

Course Outcomes:

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

CO1: Construct coherent and professional sentences tailored to various workplace scenarios
CO2: Analyze and critically interpret professional texts and multimedia content
CO3: Document, summarize, and report information effectively across multiple formats
CO4: Communicate effectively in professional and social interactions
CO5: Demonstrate teamwork, networking, and interview skills relevant to career development
CO6: Curate a professional online presence through resume development - LinkedIn, Indeed, .

Suggested Activities:

1. Documentation and Summation
   Assignment: Newsroom Simulation (20 Marks)
   - Students record a 2-minute news report on an environmental/economic issue.
   - Must include paraphrased content from real news reports (cite sources).
   - Submission: Video + written news script.
2. Group Discussion (30 Marks)
3. Refining Professional Competence
   Assignment: Corporate Dilemma Role play (20 Marks)
   - Scenario-based role play on professional etiquette (handling client complaints, rejecting proposals kindly, etc.).
   - Each student submits a formal email responding to the scenario professionally.
4. Developing a Professional Profile
   Assignment: LinkedIn Challenge (30 Marks)
   - Students create or optimize their LinkedIn profile and write a compelling post (e.g., career reflections, lessons from a recent project).
   - Submit a screenshot of updated profile + link to post.
   - Optional: Engage with at least three classmates' posts with meaningful comments.

Text Books:

1. English for Engineers and Technologists. Volume I by Orient Blackswan, 2022
2. English for Science & Technology - I by Cambridge University Press, 2023

References:

1. Seely, John. Oxford Guide to Effective Writing and Speaking: How to Communicate Clearly. Oxford University Press, 2013.
2. Cottrell, Stella. Critical Thinking Skills: Developing Effective Analysis and Argument. Bloomsbury Academic, 2017.
3. Bhatnagar, Nitin. Communicative English for Professional Courses. Pearson, 2010.
4. Guffey, Mary Ellen, and Dana Loewy. Essentials of Business Communication. Cengage Learning, 2021.
5. Collins, Patrick. Speak with Power and Confidence: Tested Ideas for Becoming a More Powerful Communicator. Prentice Hall, 2009.
6. Locker, Kitty O., and Stephen Kyo Kaczmarek. Business Communication: Building Critical Skills. McGraw-Hill, 2020.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	-	1	1	1	1	1	-	-	-

CO2	-	1	-	1	-	-	-	1	1	-	1	-	-
CO3	-	-	-	-	-	-	-	-	1	-	1	-	-
CO4	-	-	-	-	-	-	1	1	1	-		-	-
CO5	-	-	-	-	-	-	-	1	1	-	1	-	-
CO6	-	-	-	-	-	-	-	-	-	-	1	-	-
AVG	**-**	**1**	**-**	**1**	**-**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**

BS24321 System Discovery and Analysis HSMC L T P C

0 0 2 0

The purpose of the System discovery and analysis laboratory is to expose Electronics and Communication Engineering students to the practical aspects of analyzing and understanding electronic systems. This course focuses on reverse engineering as a method for discovering how a system's hardware and software components are organized and how they work together to perform key functions.

Course Objectives:

- To identify and prioritize the customer requirements in relation to the product functionality.
- To map the product's relationships with users, subsystems, and external elements.
- To perform systematic disassembly and understand the functional structure of a product.
- To apply insights from system analysis and propose alternative or improved design solutions.
- To enhance teamwork, technical documentation, and presentation skills through collaborative lab work.

List of Experiments:

1. Hardware disassembly and operating system installation for standalone machines.
2. Reverse engineering of a smart assistant device.
3. System breakdown and analysis of a BP Measurement device.
4. Study and functional decomposition of a Hearing Aid.
5. Functional analysis of a Walkie Talkie.
6. Analysis of an FM Transmitter and Receiver / Bluetooth speaker.
7. Sensor-to-Cloud system using IoT.
8. Team presentation on proposed design or redesign of an any existing product.

Total Periods: 30

Course Outcomes:

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

CO1. Interpret customer requirements relevant to product functionality.
CO2. Map system interactions among users, subsystems, and external elements.
CO3. Perform systematic product disassembly and document key components and functions.
CO4. Construct functional models (e.g., Bull, Octopus and FAST diagrams) to represent product operation and structure.
CO5. Propose alternative design concepts based on system analysis and benchmarking.
CO6. Demonstrate teamwork, documentation, and presentation skills through lab activities.

Laboratory Requirements:

- Laptop/PC/Raspberry Pi
- Smart assistant devices like amazon echo.
- Automatic BP monitor.
- Digital or analog hearing aid.

- Walkie Talkie units.
- FM Transmitter & Receiver Kits / Bluetooth Speaker.
- IoT device (e.g., Smart Thermometer, Fitness Tracker, Smart Plug)
- Disassembly Toolkit, Multimeter & Oscilloscope.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	3	2	-	-	-	-	-	-	-	-	-	-
CO2	-	2	3	2	-	-	-	-	-	-	-	-	-
CO3	-	-	-	3	2	-	-	-	-	-	-	-	-
CO4	-	-	3	-	2	-	-	-	-	-	-	-	-
CO5	-	-	3	3	2	-	-	-	-	-	-	-	-
CO6	-	-	-	-	-	-	-	3	3	-	-	-	-
Avg.	-	-	**2.5**	**2.8**	**2.7**	-	-	**3**	**3**	-	-	-	-

SEMESTER 4

BS24301	**Environmental Science and Sustainability**	**BSC**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:

- To introduce the basic concepts of environment, ecosystems.
- To emphasize on the biodiversity of India and its conservation.
- To familiarise with the causes and effects of different types of pollution in the environment.
- To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability.
- To impart knowledge about waste management and their recovery methods.
- To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles.

UNIT I ENVIRONMENT AND BIODIVERSITY 9

Definition, scope and importance of environment – need for public awareness. Ecosystem and Energy flow – food chain, food web, ecological pyramids-ecological succession. Types of biodiversity: genetic, species and ecosystem diversity – values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – endangered and endemic species of India, Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts, conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION 9

Causes, Effects and Preventive measures of Air, Water, Soil, Thermal and Noise Pollutions. Nuclear hazards and human health risks-case study. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection-Air act, Water act, Environmental protection act. Role of an individual in prevention of pollution.

UNIT III SUSTAINABILITY AND MANAGEMENT 9

Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals - intervention areas- Climate change-global warming, acid rain, Ozone layer depletion- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon credit, Carbon Footprint. Environmental management in industry-A case study.

UNIT IV WASTE MANAGEMENT AND RESOURCE RECOVERY 9

Biodegradable, non-biodegradable wastes, Solid, Hazardous and E-Waste management. Bio-medical waste management, Concept of waste to energy processes (WTE) - Combustion, Pyrolysis, Landfill gas (LFG) recovery. Recycling of spent batteries, end-of-life vehicle (ELV) recycling-Waste engine oil recycling-Solvent recovery, Barriers for material recycling-social, legal and economic factors-Environment impact of waste recycling.

UNIT V SUSTAINABILITY PRACTICES 9

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non- conventional Sources-Ocean energy sources, Geothermal energy, Energy Cycles- carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio- economical and technological change.

Periods: 45

Course Outcomes:

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

CO1: To understand the functions of the environment, ecosystems.
CO2: To analyse the threats of biodiversity and their conservation.
CO3: To explain the types of environmental pollution and environment protection acts.
CO4: To recognize the different goals of sustainable development and environmental standards.
CO5: To correlate the different types of waste management and possible resource recovery methods.
CO6: To explain the sustainability practices pertaining to sustainable energy, sustainable habitat and sustainable urbanization.

Suggested Activities:

- Quiz
- Mind Mapping
- Group discussion
- Seminar
- Animated videos

Text Books:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998

References:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38. edition 2010.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice Hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
5. Erach Bharucha "Text book of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	2	1	-	-	-	3	-	-	-	-	2	2	1
CO2	2	1	-	-	-	3	-	-	-	-	2	2	1
CO3	3	2	-	-	-	3	-	1	-	-	2	3	2
CO4	3	2	1	-	-	2	-	-	-	-	2	3	2
CO5	3	2	1	-	-	2	-	1	-	-	2	3	2
CO6	3	2	1	-	-	2	-	1	-	-	2	3	2
Avg.	**2.7**	**1.6**	**1**	**-**	**-**	**2.5**	**-**	**1**	**-**	**-**	**2**	**2.7**	**1.6**

EC24401	Communication Theory	PCC	L	T	P	C
			3	0	0	3

Course Objectives:

- To introduce the concepts of Amplitude modulation and demodulation with spectral characteristics
- To learn the concepts of Angle modulation
- To understand various pulse modulation techniques
- To impart the knowledge in random process.

UNIT I AMPLITUDE MODULATION 9

Amplitude Modulation- DSBSC, DSBFC, SSB, VSB - Modulation index, Spectra, Power relations and Bandwidth - AM Generation - Square law and Switching modulator, DSBSC Generation - Balanced and Ring Modulator, SSB Generation - Filter, Phase Shift and Third Methods, VSB Generation - Filter Method, Hilbert Transform, Pre-envelope and complex envelope -comparison of different AM techniques, Superheterodyne Receiver.

UNIT II ANGLE MODULATION 9

Phase and frequency modulation, Narrow Band and Wide band FM - Modulation index, Spectra, Power relations and Transmission Bandwidth - FM modulation -Direct and Indirect methods, FM Demodulation - FM to AM conversion, FM Discriminator - PLL as FM Demodulator.

UNIT III RANDOM PROCESS 9

Random variables, Random Process, Stationary Processes, Mean, Correlation and Covariance functions, Power Spectral Density, Ergodic Processes, Gaussian Process, Transmission of a Random Process through a LTI filter.

UNIT IV NOISE CHARACTERIZATION 9

Noise sources - Noise figure, noise temperature and noise bandwidth - Noise in cascaded systems. Representation of Narrow band noise -In-phase and quadrature, Envelope and Phase - Noise performance analysis in AM and FM systems - Threshold effect, Pre-emphasis and de-emphasis for FM.

UNIT V SAMPLING AND QUANTIZATION 9

Low pass sampling - Aliasing- Signal Reconstruction-Quantization – Uniform and non-uniform quantization - quantization noise - Logarithmic Companding -PAM, PPM, PWM, PCM - TDM, FDM.

Total Periods:45

Course Outcomes:

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

CO1: To explain and differentiate various amplitude modulation techniques such as in terms of modulation index, power relations, and bandwidth.
CO2: To analyze the methods of AM generation and demodulation including square law, switching, balanced and ring modulators, and understand the working of a superheterodyne receiver.
CO3: To analyze and evaluate narrowband and wideband Frequency modulation systems.
CO4: To understand the principles of random processes in communication system design.
CO5: To analyze the noise performance of AM and FM systems.
CO6: To evaluate different pulse modulation techniques.

Suggested Activities:

- MATLAB/Scilab Simulation
- Hardware Implementation

- Receiver Design Project
- Seminar
- Quiz

Text Books:

1. Simon Haykin, "Communication Systems", 5th Edition, Wiley, 2022
2. J.G.Proakis, M.Salehi, "Fundamentals of Communication Systems", Pearson Education 2014
3. Simon Haykins,"Digital Communication", Wiley standard Edition, 2006.

References:

1. B.P.Lathi, "Modern Digital and Analog Communication Systems", 4th Edition, Oxford University Press, 2017
2. H P Hsu, Schaum Outline Series - "Analog and Digital Communications" TMH 2006
3. B.Sklar, "Digital Communications Fundamentals and Applications", 2nd Edition Pearson Education 2007
4. D.Roody, J.Coolen, ―Electronic Communications, 4th edition PHI 2014.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	-	-	1	1	-	1	3	1
CO2	3	3	2	2	2	-	-	1	1	-	1	3	2
CO3	3	3	2	2	2	-	-	1	1	-	1	3	2
CO4	3	3	1	1	2	-	-	1	1	-	1	3	2
CO5	3	3	2	2	2	-	-	1	1	-	1	3	2
CO6	3	3	2	2	2	-	-	1	1	-	1	3	2
Avg.	3	2.83	1.7	1.7	2	-	-	1	1	-	1	3	1.83

EC24402 Electromagnetic Fields and Waves PCC L T P C

3 0 0 3

Course Objectives:

- To impart the knowledge on fundamental concepts of electromagnetic fields, and coordinate systems.
- To give insight into electrostatics principles, electric fields, potential, capacitance, and boundary conditions.
- To analyse magnetostatics, magnetic fields, inductance, and energy storage in magnetic materials.
- To derive and apply Maxwell's equations for electromagnetic wave propagation in different media.

UNIT I FUNDAMENTALS OF ELECTROMAGNETIC ANALYSIS 9

Electromagnetics and its importance, Vector Algebra, Rectangular, cylindrical and spherical coordinate systems, Gradient of a scalar field, Divergence of a vector field, Divergence theorem, Curl of a vector field, Stoke's theorem, Null identities, Helmholtz's theorem.

UNIT II ELECTROSTATICS 9

Electric field, Coulomb's law, Gauss's law and applications, Electric potential, Conductors in static electric field, Dielectrics in static electric field, Electric flux density and dielectric constant, Boundary conditions, Capacitance, Parallel, cylindrical and spherical, capacitors, Electrostatic energy, Poisson's and Laplace's equations.

UNIT III MAGNETOSTATICS 9

Lorentz force equation, Ampere's law, Vector magnetic potential, Biot-Savart law and applications, Magnetic field intensity and idea of relative permeability, Calculation of magnetic field intensity for various current distributions, Magnetic circuits, Behaviour of magnetic materials, Boundary conditions, Inductance and inductors, Magnetic energy, Magnetic forces and torques.

UNIT IV TIME-VARYING FIELDS AND MAXWELL's EQUATIONS 9

Faraday's law, Displacement current, Maxwell's Amperes law, Maxwell's equations, Potential functions, Electromagnetic boundary conditions, Wave equations and solutions, Time-harmonic fields, Observing the Phenomenon of wave propagation with the aid of Maxwell's equations.

UNIT V PLANE ELECTROMAGNETIC WAVES 9

Plane waves in lossy media (low-loss dielectrics and good conductors), Group velocity, Electromagnetic Power flow and Poynting vector, Normal incidence and oblique incidence at plane conducting boundary and at a plane dielectric boundary.

Total Periods:45

Course Outcomes:

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

CO1: Relate fundamental concepts of electromagnetic fields and coordinate systems.
CO2: Analyze the principles of electrostatics, including electric fields, potential, and field interactions.
CO3: Analyze capacitance, dielectric behavior, and boundary conditions in electrostatic fields.
CO4: Interpret magnetic field intensity, magnetic circuits, and forces in magnetostatics.
CO5: Apply Maxwell's equations for time-varying fields.
CO6: Analyze the plane wave propagation and power flow in different mediums.

Suggested Activities:

- 3D Animation Videos Screening
- Simulation based Assignment
- Seminars
- Article Reviews
- Peer Group Assignments
- Case study

Text Books:

1. W.H. Hayt and J.A. Buck, Engineering electromagnetics, 7th ed., McGraw-Hill (India), 2006
2. M.N.O.Sadiku and S.V. Kulkarni, Principles of electromagnetics, 6th ed., Oxford(Asian Edition), 2015.

References:

1. D.K. Cheng, Field and wave electromagnetics, 2nd ed., Pearson (India), 2002.
2. Kraus and Fleisch, Electromagnetics with applications, McGraw Hill Education; 5th edition, (1 July 2017).
3. Joseph A Edminister, Schaum's Outline of Electromagnetics, McGraw Hill Education; 2nd edition, July 2017
4. Edward C. Jordan and Keith G.Balmain, Electromagnetic Waves and Radiating Systems, Pearson Education, Second edition, 2015.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	1	2	-	-	1	1	-	2	2	1
CO2	3	3	1	2	2	-	-	1	1	-	2	3	1
CO3	3	3	1	2	2	-	-	1	1	-	2	3	1
CO4	3	3	1	2	2	-	-	1	1	-	2	3	2
CO5	3	3	1	2	3	-	-	1	1	1	2	3	2
CO6	3	3	1	2	3	-	-	1	1	1	2	3	2
Avg.	3	2.83	1	1.83	2.33	-	-	1	1	2	2	2.83	1.5

EC24411 Digital Signal Processing **PCC** **L T P C**

3 0 2 4

Course Objectives:

- To learn the Discrete Fourier Transform (DFT), its properties, and its application to linear filtering.
- To understand the characteristics of digital filters, design digital IIR and FIR filters, and apply them for filtering unwanted signals in different frequency bands.
- To study the effects of finite precision representation on digital filters.
- To understand the fundamental concepts of multirate signal processing and its applications.
- To implement and analyze DSP algorithms using simulation tools and hardware platforms.
- To Interpret the architecture and application of a digital signal processor.

UNIT I DISCRETE FOURIER TRANSFORM **9**

Discrete Fourier transform (DFT), properties of DFT - periodicity, symmetry, circular convolution, Linear filtering using DFT. Filtering long data sequences - overlap save and overlap add method, Fast computation of DFT - Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT),Radix-2 Decimation-in-frequency (DIF) Fast Fourier transform .

UNIT II DESIGN OF IIR FILTERS **9**

Design techniques for analog filter: Butterworth and Chebyshev approximations, Frequency transformation; IIR digital filter design (LPF and HPF): Approximation of derivatives, Bilinear transformation, Impulse Invariance method; Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.

UNIT III DESIGN OF FIR FILTERS **9**

Design of FIR filters: symmetric and Anti-symmetric FIR filters; Design of FIR filters using windowing techniques: Rectangular, Hamming, and Hanning, and frequency sampling method; FIR filter structures - linear phase structure, direct form realizations

UNIT IV FINITE WORD LENGTH EFFECT **9**

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

UNIT V MULTIRATE DIGITAL SIGNAL PROCESSING AND DSP ARCHITECTURE 9

Multirate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor, Fixed-Point and Floating-Point DSPs: Architecture, addressing modes, and instruction sets of TMS320C5X and TMS320C6X families.

Periods: 45

List of Experiments:

SIMULATION USING MATLAB / EQUIVALENT SOFTWARE PACKAGES

1. Frequency analysis using DFT
2. Linear and circular convolution
3. Design of Butterworth and Chebyshev IIR filter
4. Design of FIR filter using windowing techniques

DSP PROCESSOR BASED IMPLEMENTATION:

5. Perform MAC operation using various addressing modes
6. Generation of sine, square and triangular signals
7. Design IIR & FIR filter
8. Implementation of up-sampling and down-sampling

Periods: 30

Total Periods: 75

Course Outcomes:

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

CO1: Implement the Discrete Fourier Transform (DFT) of a given signal using Fast Fourier Transform (FFT) techniques.
CO2: Realize digital IIR filters using various transformation techniques and standard structures through simulation and DSP processors.
CO3: Implement FIR filters using different windowing and sampling techniques.
CO4: Examine the effect of quantization on digital filter coefficients and evaluate finite word-length effects in DSP system design.
CO5: Implement multirate filters for signal processing applications using DSP processors.
CO6: Analyze the DSP processor architectures.

Suggested Activities:

- Moodle quiz, Mini project , Group activity in problem solving,Simulation-Based Assignments,Hands-on Hardware Implementation, Journal Review

Text Books:

1. John G. Proakis, Dimitris G Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, 2022, 5th Edition, Pearson, USA
2. A.V.Oppenheim,R.W.Schafer and J.R.Buck,-Discrete time signal processing,8th Indian Reprint,Pearson,2010

References:

1. A textbook of Digital Signal Processing, R.S.Kaler, M.Kulkarni, Umesh Gupta, 1st edition, 2019, Dream tech Press, Wiley, India
2. James McClellan, Ronal Schaeffer, Mark Yoder, Digital Signal Processing first, 2016, 2nd edition, Pearson, USA
3. Lizhe Tan, Jean Jiang, Digital Signal Processing: Fundamentals and applications, 3rd edition, 2018, Academic Press, USA
4. S.K.Mitra, Digital Signal Processing, 2013, 4th edition, TMH, New Delhi, India.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	2	-	-	2	-	-	1	2	1
CO2	3	3	3	3	2	1	-	2	1	-	1	3	2
CO3	3	3	3	3	2	1	-	2	1	-	1	3	2
CO4	3	3	1	-	-	-	-	2	-	-	1	2	1
CO5	3	3	2	2	2	-	-	2	1	-	2	3	2
CO6	3	2	2	2	2	2	-	2	1	-	2	3	2
Avg.	3	3	3	3	2	-	-	2	-	-	1	2	1

EC24412 Linear Integrated Circuits **PCC** **L T P C**

3 0 2 4

Course Objectives:

- To familiarize students with the operational principles, characteristics, and design aspects of operational amplifiers and analog integrated circuits.
- To enable students to design and analyze both linear and non-linear applications of operational amplifiers.
- To introduce the principles and applications of data converters for signal processing.
- To expose students to the functionalities and practical applications of specialized integrated circuits such as timers, PLLs, and analog multipliers.
- To develop skills for designing waveform generation circuits and using IC voltage regulators for various real-time applications.

UNIT I OPERATIONAL AMPLIFIER PRINCIPLES AND CHARACTERISTICS 9

Op-Amp Basics: Block diagram and Pin configuration (IC 741); Ideal and Practical Op-Amp characteristics; General Op-Amp stages ;DC and AC performance characteristics ; Slew rate ; Open-loop and Closed-loop configurations

UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS 9

Linear applications : Voltage Follower, Summing, Scaling amplifiers - Instrumentation amplifier - Integrator and Differentiator - V-to-I and I-to-V convertors, Low pass and High pass First order and Second order active filters, Band Pass active filters

Non-linear applications: Comparators and Zero crossing detector – Schmitt trigger – Half wave and Full wave Precision rectifier – Peak detector – Sample and Hold circuits, Clipping circuits, Clamper circuits.

UNIT III DATA CONVERTERS 9

Digital-to-Analog Converters (DAC): Weighted Resistor, R-2R Ladder Networks, Analog-to-Digital Converters (ADC) : Successive Approximation, Flash, Dual Slope, Sigma-Delta.

UNIT IV SPECIAL FUNCTION ICs 9

Functional block, characteristics, modes & applications of 555 Timer IC; Phase Locked Loop (PLL) : Basic operation of PLL, 566 Voltage Controlled Oscillator IC, 565-Phase Locked Loop IC, Applications of PLL- FSK detection, Frequency multiplier; Analog Multiplier: Gilbert multiplier, AD 633 Analog multiplier IC

UNIT V WAVEFORM GENERATORS AND APPLICATION ICs 9

Waveform Generators : Sine wave generators, Multivibrators, Triangular wave generator; Application ICs: ICL8038 function generator ,IC Voltage regulators: Fixed voltage regulators LM78XX & LM79XX, Variable voltage regulators LM317 & IC723; LM 380 audio power amplifier.

Periods: 45

List of Experiments:

1. Inverting and Non-Inverting Amplifiers
2. Instrumentation Amplifier
3. Integrator and Differentiator Circuits
4. Active Filters (Low-Pass/High-Pass/Band-Pass)
5. Digital-to-Analog Converter (DAC) – R-2R Ladder.
6. Astable and Monostable Multivibrators using 555 Timer.
7. Sinusoidal RC Oscillators.
8. Fixed and Variable Voltage Regulators (LM78XX, LM317)

Periods: 30

Total Periods: 75

Course Outcomes:

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

CO1: Apply the basic principles and characteristics of operational amplifiers in practical circuit configurations.
CO2: Implement the designs of various linear and non-linear applications of op-amps.
CO3: Use data converters in practical applications for converting signals between analog and digital forms.
CO4: Apply the learnings of IC 555 timers, phase-locked loops, and multipliers in circuit designs.
CO5: Analyze waveform generators.
CO6: Analyze application ICs for voltage regulation and audio amplification.

Suggested Activities:

- Illustration of application of Op-amp using simulation tools
- Mini project implementation using Integrated Circuits
- Journal review on application of Integrated Circuits
- Oral seminar on data converters, PLL and regulators

Text Books:

1. D.Roy Choudhry, Shail Jain, “Linear Integrated Circuits”, New Age International Pvt. Ltd.,6th Edition, 2021.
2. Sergio Franco, “Design with Operational Amplifiers and Analog Integrated Circuits”, 4th Edition, Tata Mc Graw-Hill, 2016

References:

1. Ramakant A. Gayakwad, “OP-AMP and Linear ICs”, 4th Edition, Prentice Hall / Pearson Education, 2015
2. Robert F.Coughlin, Frederick F.Driscoll, “Operational Amplifiers and Linear Integrated Circuits”, Sixth Edition, PHI, 2001.
3. S.Salivahanan & V.S. Kanchana Bhaskaran, “Linear Integrated Circuits”, TMH, 3rd Edition, 2018.

Laboratory Requirements: (for a batch of 30 students)

- Breadboards, Regulated Power Supply (Dual DC, ±15V and ±5V), Multimeters , Function Generators, Oscilloscopes , Digital Storage Oscilloscope, Connecting wires ICs : IC741, IC555, LM78XX, LM317, DRB, Resistors and Capacitors.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	-	1	1	3	2	1	1	3	1
CO2	3	3	2	2	-	1	1	3	2	1	1	3	2
CO3	3	3	2	2	-	1	1	3	3	1	2	3	1
CO4	3	3	2	2	1	1	1	3	3	1	2	3	2
CO5	3	3	2	2	-	1	1	3	3	1	2	3	1
CO6	3	3	3	2	-	1	1	3	3	1	2	3	1
Avg.	3.00	3.00	2.17	2.00	0.17	1.00	1.00	3.00	2.67	1.00	1.67	3.00	1.33

CS24414 Object-Oriented Programming ESC L T P C

2 0 2 4

Course Objectives:

- To understand Object Oriented Programming concepts and basics of Java programming language
- To know the principles of classes and inheritance
- To define exceptions and interfaces and handle strings
- To develop a java application using I/O streams and generics classes
- To use packages and collections in java applications

UNIT I INTRODUCTION TO OOP AND JAVA 6

Overview of OOP – Object oriented programming paradigms – Features of Object-Oriented Programming –Overview of Java – Data Types, Variables and Arrays – Operators – Control Statements – Programming Structures in Java

UNIT II CLASSES AND INHERITANCE 6

Defining classes in Java – Constructors-Methods -Access specifiers - Overloading Methods – Objects as Parameters – Returning Objects –Static classes- Static members. Inheritance: Basics– Types of Inheritance -Super keyword -Method Overriding – Dynamic Method Dispatch –Abstract Classes – final with Inheritance.

UNIT III INTERFACE, EXCEPTION HANDLING AND STRINGS 6

Interfaces- defining an interface, implementing interface, difference between classes and interfaces and extending interface- Exceptions –- throwing and catching exceptions - built-in Exceptions – User defined Exception. String Manipulations

UNIT IV I/O AND GENERICS 6

I/O Basics – Reading and Writing Console I/O – Reading and Writing Files. Generics: Generic Programming – Generic classes – Generic

UNIT V PACKAGES AND COLLECTIONS 6

Packages – Packages and Member Access – Importing Packages - Collection Interfaces – Collection Classes.

Periods: 30

List of Experiments:

1. Solve problems by using sequential search, binary search, and quadratic sorting algorithms (selection, insertion)
2. Develop a java application with an Employee class with Emp_name, Emp_id, Address, Mail_id, Mobile_no as members. Inherit the classes, Programmer, Assistant Professor, Associate Professor and Professor from employee class. Add Basic Pay (BP) as the member of all the inherited classes with 97% of BP as DA, 10 % of BP as HRA, 12% of BP as PF, 0.1% of BP for staff club funds. Generate pay slips for the employees with their gross and net salary.
3. Write a Java Program to create an abstract class named Shape that contains two integers and an empty method named print Area(). Provide three classes named Rectangle, Triangle and Circle such that each one of the classes extends the class Shape. Each one of the classes contains only the method printArea ( ) that prints the area of the given shape.
4. Solve the above problem using an interface.
5. Implement exception handling and creation of user defined exceptions.
6. Implement Java programs to read and write programs using Files
7. Develop applications to demonstrate the features of generics classes.
8. Implement Java programs to use collections

Periods: 30

Total Periods: 60

Course Outcomes:

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

CO1: Apply the concepts of classes and objects to solve simple problems
CO2: Develop programs using concept of inheritance
CO3: Make use of interface, exception handling mechanisms and strings to solve real world problems
CO4: Build Java applications with I/O packages, generics and multithreading concepts
CO5: Integrate the concepts of using packages and collections

Text Books:

1. Herbert Schildt, “Java the Complete Reference”, 9th Edition, McGraw Hill Education, 2014
2. Cay S. Horstmann, Gary Cornell, “Core Java Volume –I Fundamentals”, 9th Edition, Prentice Hall, 2013.

References:

1. Cay S. Horstmann, “Core Java Fundamentals”, Volume 1, 11 th Edition, Prentice Hall, 2018.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	-	-	3	1	-	-	-	1
CO2	3	2	1	-	-	-	-	3	1	-	-	-	1
CO3	3	2	1	-	-	-	-	3	1	-	-	-	1
CO4	3	2	2	-	-	-	-	3	1	-	-	-	1
CO5	3	2	2	1	-	-	-	3	1	-	-	-	1
CO6	3	2	2	1	-	-	-	3	1	-	-	-	1
Avg.	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**3**	**1**	**-**	**-**	**-**	**1**

EC24422	Project Driven Learning[$]	EEC	L	T	P	C
			0	0	2	1

The Project-Driven Learning course in Electronics and Communication Engineering emphasizes applying core concepts through hands-on project. This pedagogical approach fosters a deeper engagement with the subject, empowering students to effectively integrate the acquired knowledge in project practices.

Through guided project:
A project that provides an integrated application of key concepts from Electronic circuits, Digital electronics, Linear integrated circuits, Signals and systems, Signal processing, Communication systems, Electromagnetic fields, and Control systems.

Course Objectives:

- To enable students to apply core concepts of Electronics and Communication Engineering in the design and execution of practical projects.
- To cultivate problem-solving and critical thinking skills through hands-on activities.
- To foster the integration of theoretical knowledge with real-world engineering practices.
- To encourage independent learning and teamwork through experiential learning activities.

UNIT I PROJECT ORIENTATION & PROBLEM STATEMENT 4

Focus:

- Understand project theme.
- Explore case studies and required domain knowledge.
- Define project scope and goals.

Key Activities:

- Introductory discussion
- Need Analysis
- Background research
- Problem statement writing
- Proposal development

Deliverables:

- Literature review
- Project proposal

UNIT II FOUNDATIONS & GUIDED DEVELOPMENT 4

Focus:

- Hands-on build of modules with guidance.
- Learn core tools, techniques, and frameworks.

Key Activities:

- Step-by-step guided builds
- Tutorials
- Peer demos

Deliverables:

- Working modules
- Progress

UNIT III SEMI-GUIDED CUSTOMIZATION & DESIGN 8

Focus:

- Modify or extend core project features.
- Apply design thinking, logic, and innovation.

Key Activities:

- Choose a feature

- Plan customization
- Peer feedback session

Deliverables:

- Mid-project report and presentation with modified feature
- New feature prototype or plan.

UNIT IV INDEPENDENT IMPLEMENTATION & TESTING 10

Focus:

- Autonomy in development.
- Troubleshooting and testing the project.

Key Activities:

- Feature implementation
- Testing and peer reviews
- Prepare final content

Deliverables:

- Partial demo of the project
- Testing results

UNIT V FINAL PRESENTATION & REFLECTION 4

Focus:

- Showcase project outcomes.
- Reflect on personal learning journey and project impact.

Key Activities:

- Presentation
- Self-assessment and peer feedback
- Discussion

Deliverables:

- Final project submission
- Presentation and demo

Total Periods: 30

Course Outcomes:

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

CO1: Apply fundamental concepts of electronics and communication to develop functional project solutions.
CO2: Demonstrate the ability to identify, analyze, and solve engineering problems through practical implementation.
CO3: Integrate theoretical knowledge with practical skills to address real-world challenges.
CO4: Effectively plan, design, and execute projects within defined technical and resource constraints.
CO5: Work independently and collaboratively in teams to complete project-based tasks.
CO6: Communicate technical ideas and project outcomes clearly through oral presentations, reports, and demonstrations.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	2	2	2
CO2	2	3	3	3	2	-	-	-	-	-	2	2	2
CO3	2	2	3	2	2	-	-	-	-	-	3	2	2

CO4	-	2	3	2	2	-	-	-	-	2	2		
CO5	-	-	-	-	-	-	-	3	2	2	2		
CO6	-	-	-	-	-	-	-	2	3	-	2		
AVG	**2.3**	**2.3**	**2.8**	**2.3**	**2.0**	**-**	**-**	**2.5**	**2.5**	**2.0**	**2.2**	**2**	**2**

FC24301 Soft Skills[$] **HSMC** **L T P C**

2 0 0 1

Course Objectives:

- Understand and apply proper etiquette in social, corporate, and online interactions
- Develop effective verbal and nonverbal communication skills, including body language and posture
- Enhance participation in group discussions and structured professional conversations
- Prepare for job interviews with appropriate etiquette, research, and response techniques
- Communicate professionally in written formats such as emails, inquiries, and job offer letters
- Deliver structured and engaging presentations using storytelling and persuasive techniques

UNIT I ETIQUETTE **6**

- Social
- Corporate/Business - Meeting
- Telephone
- Netiquette

UNIT II BODY LANGUAGE AND NONVERBAL COMMUNICATION **6**

- Posture
- Personal grooming
- Facial expression/ gesture/eye contact

UNIT III GROUP DISCUSSION **6**

- Etiquette - Rules of conduct
- GD flow
- Pestel - Political, economic, social, tech, legal, environmental
- Handling unpredictable situation

UNIT IV JOB INTERVIEW – ETIQUETTE **6**

- Pre-interview prep and research
- Responding to non technical questions (star model - situation/task/ action plan/ result)
- Speaking your resume
- Writing inquiries and responding to job offer letters

UNIT V PRESENTATION SKILLS **6**

- Setting the tone/ storytelling
- JAM/ Turn your Court

Total Periods: 30

Course Outcomes:

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

CO1: Demonstrate professionalism in meetings, telephone calls, and digital communication
CO2: Use appropriate body language, facial expressions, and gestures to enhance communication
CO3: Participate effectively in group discussions, debates, and structured dialogues
CO4: Apply job interview strategies, including answering behavioral questions using the STAR model
CO5: Write clear and professional business correspondence, including inquiries and job offers
CO6: Present ideas confidently with a structured approach, engaging tone, and strong delivery

Suggested Activities:

- **Role-Playing Business Meetings** – Students are assigned different corporate roles (CEO, Manager, Employee) and have them conduct a mock meeting with proper etiquette.
- Group Discussion
- **PESTEL Case Study** – Students analyze a real-world company using PESTEL factors and present their findings.
- **Resume Pitching** – Students present their resumes as a story, explaining their achievements in an engaging way.
- **Turn the Court Debate Organizer** – Students list arguments for and against a topic to prepare for persuasive speaking.

Work Sheets:

1. Business Meeting Etiquette Checklist – A checklist where students identify correct/incorrect meeting behaviors.
2. PESTEL Case Study Template – A table where students analyze a company using Political, Economic, Social, Technological, Environmental, and Legal factors.
3. STAR Method Interview Worksheet – Students write answers to common behavioral questions using the situation, Task, Action, Result format.

References:

1. Pachter, Barbara. The Essentials of Business Etiquette: How to Greet, Eat, and Tweet Your Way to Success. McGraw-Hill, 2013.
2. Pease, Allan, and Barbara Pease. The Definitive Book of Body Language. Bantam, 2004.
3. Gage, Martha. The Power of STAR Method: How to Succeed at Behavioral Job Interviews. Independently published, 2019.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	-	-	-	-	-	-	-	1	1	-	1	-	-
CO2	-	-	-	-	-	-	-	-	1	-	1	-	-
CO3	-	-	-	-	-	-	-	1	1	-	1	-	-
CO4	-	-	-	-	-	-	-	-	1	-	1	-	-
CO5	-	-	-	-	-	-	-	-	1	-	1	-	-
CO6	-	-	-	-	-	-	-	1	1	-	1	-	-
Avg.	-	-	-	-	-	-	-	**1**	-	-	**1**	-	-

SEMESTER 5

EC24501	Digital Communication	PCC	L	T	P	C
			3	0	0	3

Course Objectives:

- To analyze the performance limits of communication systems using Information Theory.
- To learn different waveform coding methods for digital signal representation.
- To grasp the basics of error control coding for reliable data transmission.
- To study common digital modulation and communication techniques.
- To gain knowledge of demodulation methods used for signal detection.

UNIT I INFORMATION THEORY AND SCHEMES FOR SOURCE CODING 9

Discrete Memory less source – Information - Uncertainty Information - Entropy: Basic Properties of Entropy - Conditional Entropy, Joint Entropy. Mutual Information - Discrete Memory Less Channels- Channel Capacity - Source Coding Theorem – Shannon-Fano & Huffman codes – Efficiency Calculations.

UNIT II WAVEFORM CODING & REPRESENTATION 9

Prediction filtering and DPCM - Delta Modulation - ADPCM & ADM principles-Linear Predictive Coding- Properties of Line codes- Power Spectral Density of Unipolar / Polar RZ & NRZ – Bipolar NRZ - Manchester Codes.

UNIT III ERROR CONTROL CODING 9

Channel Coding Theorem - Linear Block Codes - Hamming Codes - Cyclic Codes –Generator Polynomial, Parity Check Polynomial and Calculation of Syndrome - Convolutional Codes - Viterbi Decoder.

UNIT IV DIGITAL MODULATION AND DEMODULATION SCHEME 9

Coherent Binary and Quadrature Modulation Techniques-Noncoherent Binary Modulation Techniques- Comparison-M-ary Modulation Techniques-Power Spectra- Bandwidth efficiency-Effect of Intersymbol interference-Bit versus Symbol Error Probabilities-Synchronisation-Applications.

UNIT V MULTIPLEXING AND MULTIPLE ACCESS 9

Wireless Channels for passband transmission- Frequency Reuse- Channel Assignments- Time and Frequency-Division Multiplexing - Frequency Division Multiple Access- Time Division Multiple Access-Performance comparison of FDMA and TDMA- Code Division Channels-Space Division Multiple Access.

Periods: 45

Course Outcomes:

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

CO1: Apply the coding techniques in information theory.
CO2: Comprehend the characteristics of base band transmission schemes.
CO3: Design codes like linear block, cyclic, and convolutional for error detection and correction.
CO4: Assess the performance of error control codes in digital communication.
CO5: Analyze the working principle of various digital modulation schemes.
CO6: Analyze the effectiveness of various demodulation schemes.

Text Books:

1. Simon Haykins, "Digital Communications Systems", Wiley,5th Edition 2019.
2. Roberto Togneri, Christopher J.S DeSilva, "Fundamentals of Information Theory and Coding Design", CRC press,2003.

References:

1. Bernard Sklar, Pabitra Kumar Ray, "Digital Communications: Fundamentals and Applications", Pearson Education, 2nd Edition, 2009.
2. John G. Proakis, "Digital Communications", McGraw Hill International Edition, 4th Edition,2001.
3. Taub& Schilling, "Principles of Communication Systems", Tata McGraw Hill, 4th Edition,2013.
4. Thomas M. Cover and Joy A. Thomas, "Elements of Information Theory", John Wiley & Sons, 2nd Edition,2006.
5. Todd K.Moon, "Error Correction Coding: Mathematical Methods and Algorithms", John Wiley & Sons,2005.

MAPPING OF COs WITH POs AND PSOs

COs	Pos											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2	1	-	-	-	-	-	1	3	2
CO2	3	3	3	2	1	-	-	-	-	-	1	3	2
CO3	3	3	3	2	1	-	-	-	-	-	1	3	2
CO4	3	3	3	2	1	-	-	-	-	-	1	3	2
CO5	3	3	3	2	1	-	-	-	-	-	1	3	2
CO6	3	3	3	2	1	-	-	-	-	-	1	3	2
Avg.	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**2**

EC24502 Transmission Lines and RF Systems **PCC** **L T P C**

3 0 0 3

Course Objectives:

- To introduce the concepts of transmission lines and high-frequency behaviour in RF systems.
- To provide knowledge on impedance transformation and matching techniques.
- To impart the fundamentals of waveguides and optical fibre communication systems.
- To familiarize RF active and passive components and circuit design considerations.
- To introduce RF amplifier design concepts and MMIC technology for modern RF applications.

UNIT I TRANSMISSION LINE FUNDAMENTALS AND HIGH-FREQUENCY BEHAVIOUR 9

Lumped and distributed networks – Primary and secondary constants of transmission lines – Transmission line equations -Lossless and lossy lines -Distortion less line condition - Voltage and current on the dissipation less line – VSWR and Wavelength - Input impedance of the dissipation less line - Open and short circuited lines - Power and impedance measurement on lines - Introduction to planar transmission lines: Strip lines, and Microstrip line.

UNIT II IMPEDANCE MATCHING TECHNIQUES 9

Impedance Transformation with λ/4, λ/2 and λ/8 Line Sections - Impedance matching by stub: Single stub method - Double stub matching - Smith chart: Applications.

UNIT III WAVEGUIDES AND OPTICAL COMMUNICATION 9

Guided Waves Between Parallel Conducting Surfaces – TE and TM waves in Rectangular waveguides - Propagation Characteristics - Power transmission and attenuation in rectangular waveguides. TE and TM waves in circular waveguides -Transverse Electromagnetic waves. Optical fibre communication: Key elements - TIR - Mode theory for Circular waveguide.

UNIT IV RF COMPONENTS AND CIRCUIT DESIGN 9

RF active components: RF diodes, BJT, RF MOSFETs and High Electron Mobility Transistors (HEMT) – Biasing techniques and stability considerations
RF passive components: Inductors, capacitors, transmission line elements – Quality factor and losses. RF filters: Basic filter structures – Band pass and band stop filters

UNIT V RF AMPLIFIER DESIGN AND MMIC FUNDAMENTALS 9

RF Amplifier Design - Stability criteria, Rollett's stability factor, Amplifier power relations, Low noise amplifiers, Power amplifiers. Introduction to Monolithic Microwave Integrated Circuits (MMIC) - Integration of RF components in MMIC – Applications in modern RF systems.

Periods: 45

Course Outcomes:

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

CO1: Explain the fundamentals of transmission lines, high-frequency behaviour, and planar transmission line structures.
CO2: Apply impedance matching techniques and Smith chart methods for microwave circuits.
CO3: Analyze the propagation characteristics of waveguides and optical fibre communication systems.
CO4: Examine the operation and characteristics of RF active and passive components and RF filters.
CO5: Design RF amplifiers using stability criteria and power relations for high-frequency applications.
CO6: Explain the fundamentals and applications of MMIC technology in modern RF systems.

Suggested Activities:

- Group Discussion.
- Tutorials.
- Simulation.

Text Books:

1. John D Ryder, "Networks, lines and fields", 2nd Edition, Prentice Hall India, 2015.
2. Mathew M. Radmanesh, "Radio Frequency & Microwave Electronics", Pearson Education Asia, Second Edition, 2002.
3. Gred Keiser,"Optical Fiber Communication‖, McGraw Hill Education (India) Private Limited. Fifth Edition, Reprint 2013.

References:

1. Reinhold Ludwig & Gene Bogdanov, RF Circuit Design: Theory and Applications, 2nd Ed., Pearson, 2021.
2. Gupta, K.C., Microwave Engineering, New Age International, 2019.
3. Richard Chi-Hsi Li, "RF Circuit Design" – A John Wiley & Sons, Inc, Publications.
4. RF and Microwave Circuit Design for Wireless Communications-Lawrence E. Larson- Artech House, 2nd Edition, 2019.
5. T. L. Singh, Microwave and RF Engineering, PHI Learning, 2020.
6. 1.P Chakrabarti, "Optical Fiber Communication‖, McGraw Hill Education (India)Private Limited, 2016.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	-	-	-	-	-	-	3	-
CO2	3	3	2	2	3	-	-	-	-	-	-	3	-
CO3	3	3	2	2	2	-	-	-	-	-	-	3	-
CO4	3	2	3	2	3	-	-	-	-	-	-	3	-
CO5	3	3	3	3	3	-	-	-	-	-	-	3	-
CO6	2	2	2	1	2	-	-	-	-	-	-	3	-
Avg.	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**2**	**1**	**3**	**2**

EC24511 VLSI and Chip Design **PCC** **L T P C**

3 0 2 4

Course Objectives:

- To understand MOS transistor operation, CMOS logic families, and the basics of fabrication and layout.
- To learn combinational circuit design with emphasis on speed and power reduction
- To study sequential circuits, pipelining techniques, and timing analysis.
- To analyze and design datapath components such as adders, multipliers, and shifters.
- To understand memory organization, ASIC design flow, and basic VLSI testing methods.
- To develop practical skills in designing and implementing VLSI circuits and subsystems using CAD tools.

UNIT I MOS TRANSISTOR THEORY 9

MOS transistors (NMOS, PMOS) – Ideal IV Characteristics - Non-ideal IV effects - CV Characteristics - MOS transistor scaling - CMOS Logic – DC transfer characteristics - CMOS fabrication process - Stick diagram and Layout

UNIT II COMBINATIONAL CIRCUIT DESIGN 9

Performance parameters: RC delay model, Linear delay model, Logical effort of paths, Power dissipation, Dynamic Power, Static Power.
Circuit families: Static CMOS, Ratioed circuits, Cascode Voltage Switch Logic, Dynamic circuits, Domino logic, Dual-rail Domino logic, Pass transistor logic, Transmission gates, Trade-offs in speed, power, and area of circuit families.

UNIT III SEQUENTIAL CIRCUIT DESIGN 9

Static latches and registers - Dynamic latches and registers - Pulse registers - Sense amplifier based registers - Pipelining for optimization - Timing parameters and constraints in synchronous circuits.

UNIT IV DATAPATH SUB-SYSTEMS 9

Adders: Static CMOS full adder, Mirror adder, Ripple carry adder, Carry bypass adder, Carry select adder, Carry lookahead adder - Multipliers: Array multiplier, Carry save multiplier, Wallace tree multiplier, Booth multiplier – one

bit shifter - Barrel shifter.

UNIT V SEMICONDUCTOR MEMORIES, ASIC DESIGN AND TESTING 9

Semiconductor memories: Memory architectures, ROM cells, SRAM and DRAM cells - ASIC design flow – Types of ASICs - Manufacturing test principles: Test vectors, Fault models, Observability, Controllability, ATPG - Design for Testability : Scan design, Built-In Self Test - Boundary Scan testing.

Periods: 45

List of Experiments

1. Design a CMOS inverter and obtain the DC transfer characteristics using VLSI EDA tools. Generate Layout from the schematic.
2. Design and simulate a complex static CMOS gate using VLSI EDA tools.
3. Design and simulate a Latch/Register using VLSI EDA tools.
4. Design, simulate and implement a 8-bit Ripple carry adder on FPGA using HDL.
5. Design, simulate and implement a 4-bit Wallace tree multiplier on FPGA using HDL.
6. Design, simulate and implement a 4-bit Booth multiplier on FPGA using HDL .
7. Design a 6T-SRAM cell using Cadence EDA and analyze its read/write operations.
8. Design a 4-bit synchronous counter using HDL. Perform ASIC design flow steps to generate the GDSII file.
9. Mini Project

Periods: 30

Total Periods: 75

Laboratory Requirements: (for a batch of 30 students)

- Desktop Computers: 30 Nos
- Cadence EDA/Equivalent EDA tool: 10 Nos
- Quartus / Xilinx software: 20 Nos

Course Outcomes:

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

CO1: Analyze MOS transistor and CMOS characteristics.
CO2: Design combinational circuits for performance, power efficiency, and area using various circuit families.
CO3: Analyze sequential circuits with timing constraints.
CO4: Analyze adders, multipliers, and shifters in datapath subsystems.
CO5: Analyze memory architectures and VLSI testing techniques.
CO6: Implement arithmetic architectures in digital ASIC design flow.

Suggested Activities:

- Circuit design and debug challenges.
- Collaborative mini projects.
- Lab integrated activities.
- Seminars on emerging technologies and recent advancements.

Text Books:

1. Neil H.E.Weste & David Money Harris, “CMOS VLSI Design: A circuits and Systems perspective”, Fourth Edition, Pearson College Div, 2010
2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic “Digital Integrated Circuits: A Design Perspective”, Second Edition, Pearson Education,2016.

References:

1. A.Pucknell, Kamran Eshraghian, “BASIC VLSI Design”, Third Edition, Prentice Hall of India, 2007.
2. Samir Palnitkar,” Verilog HDL:A guide to Digital Design and Synthesis”, Second Edition, Pearson Education,2003

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	1	1	1	1	-	1	3	-
CO2	3	2	2	1	2	-	1	1	1	-	1	3	-
CO3	3	2	2	1	2	-	1	1	1	-	1	3	-
CO4	3	2	2	1	2	-	1	1	1	-	1	3	-
CO5	3	2	2	1	2	-	1	1	1	-	1	3	-
CO6	3	2	2	1	2	1	1	1	1	-	1	3	-
Avg.	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**-**	**1**	**3**	**-**

EC24512 Computer Networks **PCC** **L T P C**

3 0 2 4

Course Objectives:

- To introduce the foundational concepts of network architecture, protocols, and performance metrics.
- To explore the functionality of the link layer, media access control, and internetworking mechanisms.
- To develop a deep understanding of routing algorithms, IP addressing, and multicast communication.
- To examine transport layer protocols, congestion control techniques, and quality of service (QoS) mechanisms.
- To familiarize with application layer protocols, network services, and security fundamentals including firewalls and cryptography.

UNIT I NETWORKING FUNDAMENTALS & LINK LAYER 9

Overview of Data Communications - Networks – Building Network and its types–Network Models: Protocol Layering – TCP/IP Protocol Suite - OSI Model- Physical Layer : Overview of Data and Signals - Introduction to Data Link Layer : Link layer Addressing- Error Detection and Correction.

UNIT II MEDIA ACCESS & INTERNETWORKING 9

DLC: Services- HDLC- PPP-MAC: Random Access – Wired LAN: Ethernet (802.3) - Wireless LANs : 802.11 – Bluetooth - Zigbee - Network layer services – Packet Switching – IPV4 Address – Network layer protocols (IP, ICMP, Mobile IP).

UNIT III ROUTING 9

Routing - Unicast Routing :Algorithms – Protocols – Multicast Routing and its basics – Overview of Intradomain and Interdomain protocols – IPv6 Addressing –IPv6 Protocol– Transition from IPv4 to IPv6.

UNIT IV TRANSPORT LAYER 9

Introduction to Transport layer : Protocols - User Datagram Protocols (UDP) - Transmission Control Protocols (TCP) : Services – Features – TCP Connection – State Transition Diagram – Flow, Error and Congestion Control - Congestion avoidance (DECbit, RED) – QoS

UNIT V APPLICATION LAYER 9

Application Layer Paradigms – Client Server Programming – World Wide Web and HTTP - DNS - Electronic Mail

(SMTP, POP3, IMAP, MIME) – Introduction to Peer to Peer Networks – Need for Cryptography and Network Security – Firewalls - Introduction to Software Defined Networks - Network On Chip(NoC)

Periods: 45

List of Experiments

1. Implement the Data Link Layer framing methods
2. Implementation of Error Detection / Error Correction Techniques
3. Implementation of stop and wait and sliding window protocols
4. Study of socket programming and Client – Server model
5. Implementation of Distance vector and Link state routing algorithm
6. Encryption and Decryption.
7. Study of Network Simulator (NS) / Configuring network using Cisco Packet Tracer configure
8. Implement and realize the Network Topology - Bus and Ring using NS2.
9. Implement and perform the operation of CSMA/CD and CSMA/CA using NS2.

Periods: 30

Total Periods: 75

Laboratory Requirements for a batch of 30 students

- C / C++ / Java / Equivalent Compiler
- Network simulator like NS2/ Cisco Packet Tracer
- Desktop Computers – 30 Nos.

Course Outcomes:

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

CO1: Describe the fundamentals of data communication, network types, protocol layering, and the OSI model.
CO2: Explain the functions of the physical and data link layers, including link layer addressing and error detection / correction.
CO3: Analyze media access control techniques and evaluate the performance of wired and wireless networks
CO4: Demonstrate understanding of network layer using addressing and routing techniques.
CO5: Evaluate transport layer protocols and obtain its quality of service
CO6: Illustrate the functioning of application layer protocols and need of network security.

Suggested Activities:

- Quiz
- Mind map
- Peer Group Study
- Role Play

Text Books:

1. Behrouz.A.Forouzan, Data Communication and Networking, Fifth Edition, TMH, 2017.

References:

1. James.F.Kurose and Keith.W.Ross, Computer Networking – A Top – Down Approach, Sixth Edition, Pearson, 2017.
2. Doughlas .E.Comer, Computer Networks and Internets with Internet Applications, Fourth Edition, Pearson Education, 2008
3. Stallings.W., Data and Computer Communication, 9th Edition, Prentice Hall of India, 2011
4. Dimitrios Serpanos, Tilman Wolf, Chapter 13 - Networks on chips, 2011, Pages 239-248, https://doi.org/10.1016/B978-0-12-374494-4.00013-X.
5. Natalie Enright Jerger, Tushar Krishna, and Li-Shiuan Peh, On-Chip Networks, Second Edition, Synthesis Lectures on Computer Architecture, Springer, 2017. Cham. DOI: 10.1007/978-3-031-01755-1.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	3	3	2	-	-	1	1	-	2	3	2
CO2	3	2	2	3	2	-	-	1	1	-	2	3	2
CO3	2	3	2	2	3	-	-	1	1	-	2	3	2
CO4	3	3	3	2	3	-	-	1	1	-	2	3	2
CO5	3	2	3	2	2	-	-	-	-	-	2	3	2
CO6	2	2	3	3	2	-	-	1	1	-	2	3	2
Avg.	**2.5**	**2.3**	**2.7**	**2.5**	**2.3**	**-**	**-**	**1**	**1**	**-**	**2**	**3**	**2**

EC24513 Microprocessors and Microcontrollers PCC L T P C

2 0 2 3

Course Objectives:

- To introduce the fundamental concepts, architecture, and bus systems of microprocessors.
- To develop the ability to program 8086 using assembly language and understand its system configurations.
- To understand system bus timing and multiprocessor configurations for 8086.
- To provide insights into the architecture and programming of 8051 microcontrollers.
- To familiarize with the key features and interfaces of modern controllers like Node MCU and Raspberry Pi.
- To develop design skills for sensor interfacing and real-time control using ESP32.

UNIT I INTRODUCTION TO MICROPROCESSOR 6

Introduction to microprocessors, Memories, Basic architecture of a Microprocessor, 8086 – Microprocessor architecture, Bus signals.

UNIT II 8086 PROGRAMMING AND MULTIPROCESSOR CONFIGURATION 7

Addressing modes - Instruction set and assembler directives –Basic configurations, System bus timing, Multiprocessor configurations – Coprocessor, closely coupled and loosely Coupled configurations

UNIT III 8051 MICROCONTROLLER 7

Architecture of 8051 – Special Function Registers (SFRs) - I/O Pins Ports and Circuits - Instruction set - Addressing modes - Programming 8051 using SFRs- Timers - Serial Port and Interrupt Programming.

UNIT IV ADVANCED CONTROLLERS 5

Review of Arduino programming - Introduction to NodeMCU (ESP8266 / ESP32)- key features, GPIO structure, memory organization, and communication interfaces (UART, SPI, I2C, Wi-Fi). Raspberry Pi: The Raspberry Pi Boards - The Raspberry Pi Peripherals.

UNIT V CONTROLLERS AND APPLICATIONS 5

Interfacing and Controlling I/O devices by ESP32: LEDs - Push buttons - Light intensity sensor – Ultrasonic sensor –

Temperature sensor- Humidity sensor - Sensor and Actuator interactions

Periods: 30

List of Experiments

Experiments using 8086: (6 hrs)

1. Introduction to Assembly Language programming
2. Arithmetic and Logical operations
3. Code conversion
4. Sorting and String manipulation (Search the byte of number, Ascending and Descending)

Experiments using 8051: (4 hrs)

1. Introduction to Assembly Language programming
2. Arithmetic and logical operations
3. Square and cube for the given number
4. Unpacked BCD to ASCII

Interface Experiments using 8051: (4 Hrs)

1. ADC and DAC
2. Stepper motor

Experiments Using IDE: (6 Hrs)

1. Introduction to High level language programming
2. Port operation
3. Serial data transfer

Node MCU Experiments (6 Hrs)

1. Development environment setup – Installation and programming using Arduino IDE
2. Sensor and actuator interfacing – temperature, humidity, and IR sensors – Data communication using Wi-Fi and MQTT.
3. Cloud connectivity and data visualization using IoT platforms (ThingSpeak, Blynk, Firebase).

Mini Project: (4 hrs)

Design a mini project based on the ESP32 and Raspberry pi.

Periods: 30

Total Periods: 60

Laboratory Requirements: (for a batch of 30 students)

1. 8086 development kit – 20 numbers
2. 8051 Development kit – 20 numbers
3. Node MCU – 10 numbers
4. Sensors – Temperature, Humidity, IR sensors (Required numbers)
5. Desktop PCs – 30

Course Outcomes:

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

CO1: Explain the fundamental architecture, memory organization, and bus signals of microprocessors including 8086.

CO2: Apply the instruction set and assembler directives to program the 8086 microprocessor.

CO3: Analyze 8086 bus timings and multiprocessor configurations.

CO4: Demonstrate programming of 8051 microcontroller using SFRs, timers, interrupts, and serial communication in embedded applications.

CO5: Analyze the architecture, memory organization, and communication interfaces of ESP32 and Raspberry Pi for system design.

CO6: Implement ESP32 based real-time embedded applications through sensors and actuators interfacing.

Text Books:

1. R. S. Kaler, Microprocessors and Microcontrollers (2nd Edition, L.K. International) (UNIT I)
2. Krishna Kant, "Microprocessors and Microcontrollers Architecture, programming and system design using 8085, 8086, 8051 and 8096". PHI 2007 (UNIT II)
3. David A. Patterson and John L. Hennessey, ―Computer Organization and Design‖, Fifth edition, Morgan Kauffman / Elsevier, 2014. (UNIT II)
4. Mohammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D.McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Second Edition, Pearson Education, 2008.(UNIT III)
5. Sami S.H and Kisheen Rao G "The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers", CRC Press, 2022. (UNIT IV & V)

References:

1. Yu-Cheng Liu, Glenn A.Gibson, ―Microcomputer Systems: The 8086 / 8088 Family - Architecture, Programming and Design‖, Second Edition, Prentice Hall of India, 2007.
2. A.K. Ray, K.M. Bhurchandi, "Advanced Microprocessors and Peripherals" 3rd edition, Tata McGrawHill, 2012.
3. Bell C., "Beginning Sensor Networks with Arduino and Raspberry Pi", Apress, 2013.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	1	1	-	-	-	-	-	1	-	2	1
CO2	3	3	2	2	1	-	-	-	1	2	-	2	2
CO3	2	3	3	2	3	-	-	-	1	2	-	2	2
CO4	2	3	3	3	3	1	1	2	2	3	2	3	3
CO5	3	3	3	3	3	1	1	2	2	3	2	2	3
CO6	2	3	3	3	3	1	1	2	3	3	3	2	3
Avg.	2.50	3	2.50	2.33	2.60	1	1	2	1.80	2.33	2.33	2.17	2.33

EC24521 Communication Systems Laboratory **PCC** **L T P C**

0 0 4 2

Course Objectives:

- To visualize the effects of sampling and TDM
- To implement AM & FM modulation and demodulation
- To implement PCM & DM
- To simulate Digital Modulation schemes
- To simulate Error control coding schemes

List of Experiments:

1. AM Modulator and Demodulator.
2. FM Modulator and Demodulator.
3. Signal Sampling and reconstruction.
4. Time Division Multiplexing.
5. Pulse Code Modulation and Demodulation.

6. Line coding schemes.
7. Pulse Amplitude Modulation, Pulse Width Modulation and Pulse Position Modulation.
8. Delta Modulation and Demodulation.
9. ASK and FSK generation schemes.
10. Simulation of DPSK, QPSK and QAM generation schemes
11. Simulation of ASK, FSK and BPSK detection schemes
12. Simulation of Linear Block and Cyclic error control coding schemes.
13. Simulation of Convolutional coding scheme.
14. Design and simulation of digital modulation schemes using SDR

Total Periods: 60

Course Outcomes:

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

CO1: Analyze the process of signal sampling and reconstruction.
CO2: Implementation of Time Division Multiplexing (TDM).
CO3: Demonstrate the modulation and demodulation techniques in Analog communication (AM & FM).
CO4: Implement the Digital Modulation schemes (ASK, FSK, BPSK, DPSK, QPSK, QAM).
CO5: Realize the different line coding, pulse code modulation (PCM), and delta modulation (DM) techniques.
CO6: Simulate the error control coding schemes (Linear Block, Cyclic, Convolutional) and communication links.

Laboratory requirements for a batch of 30 students

1. Trainer kits for Signal Sampling, TDM, AM, FM, PCM, DM and Line Coding Schemes
2. CROs/DSOs – 15 Nos
3. Function Generators – 15 Nos
4. MATLAB or equivalent software package for simulation experiments
5. Desktop PCs - 15 Nos

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	2	-	-	1	-	-	1	2	1
CO2	3	3	2	2	2	-	-	1	-	-	1	2	1
CO3	3	3	2	2	2	-	-	1	-	-	1	2	1
CO4	3	3	2	2	2	-	-	1	-	-	1	2	1
CO5	3	3	2	2	2	-	-	1	-	-	1	2	1
CO6	3	3	2	2	2	-	-	1	-	-	1	2	1
Avg.	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**1**	**-**	**-**	**1**	**2**	**1**

EC24522	Mini Project	EEC	L	T	P	C
			0	0	2	1

Preamble:
Students gain practical experience in **solving real-world engineering problems** by working in teams. They identify needs, plan and manage the project using structured tools, create a working prototype, and present their results.

Prerequisite:
GE24123 – Design Thinking: Students were able to **discover user needs, ideate, visualize solutions**, and work in teams using the 5-step design thinking process.

BS24321 – System Discovery and Analysis: Students were able to **analyze how existing products** work, build functional models (Bull/Octopus/FAST), and document system interactions.

EC24422 – Project Driven Learning: Students were able to **apply core concepts through guidance by the faculty** and develop working modules and test.

Course Objectives:

- To enable students to identify and define a relevant problem.
- To apply project management tools for Need Analysis, Risk Analysis, Functional Analysis and plan to ensure systematic planning and execution.
- To design, implement, and validate a prototype addressing user needs.
- To foster teamwork, professional ethics, and technical communication through project execution and presentation.

WEEK 1&2: NEED IDENTIFICATION & PROPOSAL (4 hrs)
Students identify a real-world problem in core domain. They conduct a detailed need analysis using the Bull Diagram to define the project's purpose, users, and environment. Prepare a clear problem statement and project proposal.

Key Activities:
- Need Analysis
- Problem statement
- Proposal development

Deliverables:
- Problem statement and proposal

WEEK 3&4: PROJECT PLANNING & RISK MANAGEMENT (4 Hrs)
Students apply project management tools to plan their project timeline and manage potential challenges. They develop a Risk Analysis Matrix to identify and mitigate risks. Construct a PERT Chart to sequence tasks, estimate durations, and define dependencies.

Key Activities:
- Risk Analysis Matrix
- PERT Chart

Deliverables:
- Project plan
- Risk analysis

WEEK 5 to 7: FUNCTIONAL & SYSTEM DESIGN (6 Hrs)

Student teams perform functional and system-level analysis to model their proposed system. Using the Octopus Diagram, they identify system boundaries and external interactions. Through the FAST Diagram, they break down main functions into sub-functions and technical solutions.

Key Activities:

- Octopus Diagram
- FAST Diagram

Deliverables:

- Technical solution and Functional design
- Design documentation

WEEK 7 to 13: IMPLEMENTATION & TRACKING (14 Hrs)

Students transition from design to implementation. They use the Gantt Chart to schedule tasks and track progress.

Key Activities:

- Gantt Chart
- Budget proposal and tracking

Deliverables:

- Working prototype
- Project logbook submission

WEEK 14&15: TESTING, VALIDATION & MARKET STRATEGY (4 Hrs)

Students perform testing and validation to ensure their prototype meets the defined requirements. They do value proposition and pitch their idea through a demonstration and oral presentation.

Key Activities:

- Final demo preparation
- Value proposition canvas

Deliverables:

- Pitch
- Proof of concept (Demo)

Total Periods: 30

Course Outcomes:

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

CO1: Identify and define an engineering problem through structured need analysis.

CO2: Apply project management tools such as Risk Analysis, PERT, and Gantt charts to plan and organize project activities systematically.

CO3: Perform functional analysis using Bull, Octopus, and FAST diagrams to derive system requirements and specifications.

CO4: Design, develop, and validate a functional prototype that meets user-defined needs and technical constraints.

CO5: Work effectively as a team, demonstrating collaboration, responsibility, and ethical practices throughout the project lifecycle.

CO6: Communicate technical ideas, project outcomes, and reflections clearly through documentation, reports, and oral presentations.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	1	1	–	–	1	–	1	3	2

CO2	2	3	3	2	3	1	–	2	2	3	–	3	3
CO3	3	3	3	3	2	–	–	2	2	2	–	3	3
CO4	3	3	3	3	3	2	–	2	2	3	–	3	3
CO5	–	–	2	–	1	2	3	3	2	3	2	2	2
CO6	–	–	2	2	2	–	2	3	3	3	1	2	2
Avg.	**2.75**	**3.00**	**2.50**	**2.40**	**2.00**	**1.50**	**2.50**	**2.40**	**2.00**	**2.80**	**1.33**	**2.67**	**2.50**

FC24501	**Universal Human Values and Service Learning**	**HSMC**	**L**	**T**	**P**	**C**
			1	**0**	**1**	**2**

Course Objectives:

- To help the students appreciate the essential complementarity between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behaviour and mutually enriching interaction with Nature.

UNIT I	**INTRODUCTION-BASIC HUMAN ASPIRATION, ITS FULFILLMENT THROUGH ALL-ENCOMPASSING RESOLUTION**	**3**

The basic human aspirations and their fulfillment through Right understanding and Resolution, Right understanding and Resolution as the activities of the Self, Self being central to Human Existence; All-encompassing Resolution for a Human Being, its details and solution of problems in the light of Resolution

UNIT II	**RIGHT UNDERSTANDING (KNOWING)- KNOWER, KNOWN & THE PROCESS**	**3**

The domain of right understanding starting from understanding the human being (the knower, the experiencer and the doer) and extending up to understanding nature/existence – its interconnectedness and co-existence; and finally understanding the role of human being in existence (human conduct).

UNIT III	**UNDERSTANDING HUMAN BEING**	**3**

Understanding the human being comprehensively as the first step and the core theme of this course; human being as co-existence of the self and the body; the activities and potentialities of the self; Basis for harmony/contradiction in the self

UNIT IV	**UNDERSTANDING NATURE AND EXISTENCE**	**3**

A comprehensive understanding (knowledge) about the existence, Nature being included; the need and process of inner evolution (through self-exploration, selfawareness and self-evaluation), particularly awakening to activities of the Self: Realization, Understanding and Contemplation in the Self (Realization of Co-Existence, Understanding of Harmony in Nature and Contemplation of Participation of Human in this harmony/ order leading to comprehensive knowledge about the existence).

UNIT V	**UNDERSTANDING HUMAN CONDUCT, ALL-ENCOMPASSING RESOLUTION & HOLISTIC WAY OF LIVING**	**3**

Understanding Human Conduct, different aspects of All-encompassing Resolution (understanding, wisdom, science etc.), Holistic way of living for Human Being with Allencompassing Resolution covering all four dimensions of human endeavor viz., realization, thought, behavior and work (participation in the larger order) leading to harmony at all levels from Self to Nature and entire Existence

Periods: 15

Outreach Activities:

- Introduction to Service Learning (SL)-Concept- History & Dynamics of SL through Common, Classroom & Thematic Orientation. Understanding the Urban Poor.
- Understanding the process of Urbanization-Urban Social Problems-Slums, Types of Slums- Urban Poor-Understanding Urban Power Structure and identifying the resources of the community (Community Mapping) and Modules for the community Service.
- Identifying groups in the community such as women-children-youth-elders and persons with disabilities-Equipping with the skills to address issues such as Education, health, sanitation, Environment & livelihood issues.
- Community Program Planning: Orientation on community program – Event process (Identifying the issues, Need based analysis on specific issues, Invitation, Pamphlets, Inviting participants, Content designing, identifying & Selection of tools, venue arrangements, tapping the resources and etc). Identifying the stakeholders (hospitals, Civil Society Organizations) – Budgeting-Communication / liasoning (among learners, with community, support of experts / guests) and follow-ups - Implementation of the planned activity, reporting, reflection. Awareness / advocacy for an issue identified and build capacity to carry out that awareness and advocacy programme.

Periods: 15

Total Periods: 30

Course Outcomes:

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

CO1: Evaluate the significance of value inputs in formal education and start applying them in their life and profession

CO2: Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.

CO3: Analyze the value of harmonious relationship based on trust and respect in their life and profession

CO4: Examine the role of a human being in ensuring harmony in society and nature.

CO5: Apply the understanding of ethical conduct to formulate the strategy for ethical life and profession.

CO6: Categorize social skills

CO7: Develop networking skills.

CO8: Define the role and function of the civil society organisations in addressing the welfare needs of the deprived and disadvantaged sections of the society.

CO9: Recognize the socio-economic conditions of the urban poor and the importance of urbanization.

CO10: Identify the government response in terms of policies to address the needs of the urban poor.

CO11: Analyse the socio-economic conditions in the slums and comparing it to the larger state and national level realities.

Suggested Activities:

- Classroom discussions
- Self-assessment
- Peer assessment
- Socially relevant project
- Group Activities

Text Books:

1. R R Gaur, R Asthana, G P Bagaria, 2019 (2nd Revised Edition), A Foundation Course in Human Values and Professional Ethics. ISBN 978-93-87034-47-1, Excel Books, New Delhi.
2. Premvir Kapoor, Professional Ethics and Human Values, Khanna Book Publishing, New Delhi, 2022.

References:

1. Ivan Illich, 1974, Energy & Equity, The Trinity Press, Worcester, and Harper Collins, USA
2. E.F. Schumacher, 1973, Small is Beautiful: a study of economics as if people mattered, Blond & Briggs, Britain.
3. Sussan George, 1976, How the Other Half Dies, Penguin Press. Reprinted 1986.
4. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III, 1972, Limits to Growth – Club of Rome's report, Universe Books.
5. A Nagraj, 1998, Jeevan Vidya EkParichay, Divya Path Sansthan, Amarkantak.
6. P L Dhar, RR Gaur, 1990, Science and Humanism, Commonwealth Publishers.
7. A N Tripathy, 2003, Human Values, New Age International Publishers.
8. Subhas Palekar, 2000, How to practice Natural Farming, Pracheen (Vaidik) Krishi Tantra Shodh, Amravati.
9. E G Seebauer& Robert L. Berry, 2000, Fundamentals of Ethics for Scientists &Engineers, Oxford University Press
10. M Govindrajran, S Natrajan& V.S. Senthil Kumar, Engineering Ethics (including Human Values), Eastern Economy Edition, Prentice Hall of India Ltd.
11. B P Banerjee, 2005, Foundations of Ethics and Management, Excel Books.
12. B L Bajpai, 2004, Indian Ethos and Modern Management, New Royal Book Co., Lucknow. Reprinted 2008. Science & Humanism – towards a unified worldview, P. L. Dhar & R. R. Gaur (1990), Commonwealth Publishers, New Delhi

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	3	-	-	-				
CO2	-	-	-	-	-	-	3	3	-	-	-				
CO3	-	-	-	-	-	-	3	3	3	3	-				
CO4	-	-	-	-	-	-	3	3	-	3	-				
CO5	-	-	-	-	-	-	3	3	-	-	-				
CO6	-	-	-	-	-	-	-	3	-	-	-				
Avg.	-	-	-	-	-	-	3	3	3	3	-				

BS24502	Logical Reasoning and Aptitude Training	BSC	L	T	P	C
			2	0	0	1

Course Objectives:

- To develop foundational knowledge and skills in averages, percentages.
- To develop foundational knowledge and skills in problems on ages, ratios and proportions, time and work.
- To enable students to apply quantitative reasoning techniques to solve practical problems involving boats & streams, pipes & cisterns, trains, races.
- To enhance logical reasoning skills from series, venn diagrams, cubes and cuboids charts, tables and graphs.
- To enhance logical reasoning skills and critical thinking.

UNIT I	QUANTITATIVE APTITUDE I	6

- **Speed Maths:** Squaring numbers and multiplying numbers faster than the conventional methods - Finding Square roots of numbers faster - Finding Cube roots faster - Solving simultaneous equations faster than conventional methods .
- **Number system:** Remainder Theorem - Unit digits - Factor and Factorial Theorem - Divisibility Rule
- **Averages:** Basic Concepts of Averages - Properties of Averages- Weighted Averages - Problems on Averages - Averages of Averages
- **Percentage:** Basic Concepts of Percentages - Percentage Increase and Decrease - Finding Percentages - Percentage Change - Successive Percentage Changes - Percentage Comparisons

UNIT II	QUANTITATIVE APTITUDE II	6

- **Problems on Ages:** Basic Concepts of Age Problems - Formulating Equations Based on Age Statements - Solving Single-variable Age Problems - Solving Multi-variable Age Problems - Age Differences - Sum of Ages - Average Age - Age Ratios - Age Problems Involving Future and Past Scenarios - Age Problems in Competitive Exams - Age Puzzles and Riddles
- **Ratios & Proportions:** Basic Concepts of Ratios - Comparing Ratios - Proportions - Direct Proportion - Inverse Proportion - Compound Ratios - Ratio and Proportion in Real-life Applications - Ratio of Increase and Decrease - Advanced Problems on Ratios and Proportions
- **Time & Work:** Basic Concepts of Time and Work - Work and Time Relationship - Work Efficiency - Combined Work - Work Rate - Fractional Work - Work and Wages - Real-life Applications

UNIT III	QUANTITATIVE APTITUDE III	6

- **Boats & Streams:** Speed of Boat in Still Water - Speed of Stream or Current - Upstream and Downstream Concepts - Relative Speed - Calculating Efficiency - Advanced Problems with Multiple Boats or Streams
- **Pipes & Cisterns:** Inlet and Outlet Pipes - Individual Rates of Pipes - Combined Efficiency - Problems Involving Leakage or Partials - Alternative Filling Scenarios - Pipes with Different Capacities - Applications in Real-life Scenarios
- **Problems on Trains:** Basic Concepts - Relative Speed of Trains - Crossing and Overtaking Problems - Meetings and Passing - Time and Distance Problems - Platform and Bridge Problems - Average Speed of Trains.
- **Races:** Basic Concepts - Relative Speed - Average Speed - Uniform and Non-Uniform Motion - Problems Involving Trains and Platforms - Circular Track Problems.

UNIT IV	LOGICAL REASONING I	6

- **Series:** Alphabet and Number Series - Odd Man Out Series – Puzzles -Blood Relations - Seating Arrangement and Ordering - Directional Sense Test.
- **Venn Diagrams:** Basic Concepts of Venn Diagrams - Types of Venn Diagrams - Union and Intersection of Sets - Difference of Sets - Complement of a Set - Cardinality of Sets - Subset and Superset Relationships - Using Venn Diagrams for Logical Reasoning - Diagrammatic Representation of Data - Real-life Applications
- **Cubes & Cuboids:** Basic Concepts and Definitions - Surface Area of Cubes and Cuboids - Volume of Cubes and Cuboids - Diagonal of Cubes and Cuboids - Face Diagonal of Cubes and Cuboids - Relationship Between Edge Lengths and Dimensions - Construction of Cubes and Cuboids - Applications in Real-life Scenarios
- **Data-Interpretation and Data-Sufficiency:** Introduction to Data Interpretation - Types of Charts and Graphs - Calculations and Approximations - Percentage Calculations - Comparison and Analysis – Problem Solving Techniques

UNIT V	LOGICAL REASONING II	6

- **Non-verbal reasoning:** Pattern Recognition - Analogy and Classification - Series Completion - Spatial Orientation and Visualization - Cube and Dice Problems - Mirror and Water Image Problems - Analytical Reasoning with Diagrams
- **Syllogisms:** Basic Concepts of Syllogisms - Types of Syllogisms - Categorical Syllogisms - Venn Diagram Representation - Rules of Inference - Types of Validity - Formal vs Informal Fallacies - Conditional Syllogistic Reasoning
- **Critical Thinking:** Understanding Arguments - Argument Structure - Logical Fallacies - Evidence and Reasoning - Counterarguments and Rebuttal - Assumptions and Implications - Creative Thinking - Contextual Understanding - Practice and Application
- **Statement & Conclusion:** Understanding Statements - Types of Statements - Analyzing Premises - Identifying Conclusions - Logical Connectives - Validity of Conclusions – Assumptions - Negation of Statements - Strength and Weakness

Periods: 30

Course Outcomes:

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

CO1: Apply different techniques for faster calculations and also to solve, including averages.
CO2: Solve quantitative problems including ages, ratios and proportions, time and work.
CO3: Solve quantitative problems, including boats & streams, pipes & cisterns, trains, races.
CO4: Apply logical reasoning and draw conclusions from series, venn diagrams, cubes and cuboids, charts, tables and graphs.
CO5: Apply logical reasoning, analyse information and draw conclusions.

Suggested Activities:

- Mock test
- Skill Rack Practices
- Case Study Analysis.

Text Books:

1. Dr R S Aggarwal, “Quantitative Aptitude for Competitive Examinations”, S Chand and Company Ltd., 2025.
2. Dr R S Aggarwal, “A Modern Approach to Logical Reasoning”, S Chand and Company Ltd., 2022.
3. S. Sridhar, “Design and Analysis of Alogorithms”2nd Edition, Oxford University Press 2024.
4. Nishit K Sinha, “Quantitative Aptitude for the CAT” , 6th Edition, Pearson Publication 2024.
5. Abhijit Guha, “Quantitative Aptitude for all Competitive Examination”, 7th Edison, Mc Graw Hill Education 2020.
6. FACE, “ Aptipedia: Aptitude Encyclopaedia” 2nd Edition, Wiley India Pvt. Ltd., 2017.

References:

1. Arun Sharma, “Quantitative Aptitude for the CAT” 10th edition, Mc Graw-Hill Publishing, 2022.
2. Praveen R V, “Quantitative Aptitude and Reasoning”, 3rd edition, PHI Learning Pvt. Ltd., 2016.

MAPPING OF COs WITH POs AND PSOs

Cos	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2	
CO1	3	2	-	-	1	-	-	-	-	-	1				
CO2	3	3	1	-	-	-	-	-	1	-	2				
CO3	3	3	1	-	-	-	-	-	1	-	2				
CO4	2	3	-	2	2	-	-	-	1	-	1				

CO5	1	3	-	-	2	1	-	1	2	2	1				
Avg.	**2.4**	**2.8**	**1**	**2**	**1.6**	**1**		**1**	**1.25**	**2**	**1.4**				

SEMESTER 6

GE24501	**Project Management and Operations Management**	**HSMC**	**L**	**T**	**P**	**C**
			2	**0**	**2**	**3**

Course Objectives:

- To understand the fundamental concepts, roles, and lifecycle of project management
- To equip learners with planning, scheduling, and control techniques
- To introduce software project management methodologies and modern development frameworks
- To provide knowledge of operations management principles
- To familiarize students with quality management practices and sustainable operational strategies

UNIT I FUNDAMENTALS OF PROJECT MANAGEMENT 6

Understanding Project Management – Project Management Role – Classification of Projects – Product Vs Project Management – Project Lifecycle – Project Risk Management – Case Studies: LP Manning Corporation and Project Firecracker

UNIT II PROJECT PLANNING, SCHEDULING AND CONTROL 6

Project planning process and Work Breakdown Structure (WBS) – Project scheduling techniques: Gantt chart, PERT, CPM – Resource allocation – Project budgeting and cost estimation – Project Management Information Systems (PMIS) and software tools (MS Project, Primavera)

UNIT III SOFTWARE PROJECT MANAGEMENT AND PROCESS MODELS 6

Software Process Models : Waterfall Model, Prototyping Model, RAD Model, Incremental Model, Spiral Model, Agile Fundamentals - Scrum Framework

UNIT IV OPERATIONS MANAGEMENT AND INVENTORY CONTROL 6

Production systems, Classification of Production systems, Operations system, Operations Management - Definition, Objectives, Strategic role of operations, Strategic Planning, Inventory control or management - Inventory, Objectives of inventory control, benefits, techniques (EOQ, JIT, ABC analysis)

UNIT V QUALITY MANAGEMENT AND SUSTAINABLE OPERATIONS 6

Quality Management: Preventive Vs Breakdown maintenance for Quality – Techniques for measuring quality - Supply chain management – Lean operations and Six Sigma overview - Quality management concepts – TQM, ISO standards, Kaizen, 5S

Periods: 30

Laboratory Experiments:

Periods: 30

Total Periods: 60

Course Outcomes:

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

CO1: To comprehend the fundamental concepts of project management, including project lifecycle and risk management

CO2: Apply project planning and scheduling techniques such as WBS, Gantt charts, PERT, and CPM

CO3: Analyze and compare various software process models including Waterfall, Spiral, Agile, and Scrum frameworks.

CO4: Apply operations management principles and inventory control techniques such as EOQ, JIT, and ABC analysis in practical scenarios.

CO5: Evaluate quality management practices using tools such as TQM, Six Sigma, Kaizen, and ISO standards

CO6: Design and develop integrated solutions by combining project management, operations strategies, and quality frameworks

Suggested Activities:

- Interactive lectures and discussions
- Case studies from engineering and industrial projects
- Hands-on workshops on PERT/CPM using software tools
- Group projects on planning and evaluating an engineering project
- Industry expert talks on project execution and operations excellence

Text Books:

1. Kerzner, H. (2018). Project Management: A Systems Approach to Planning, Scheduling and Controlling. Wiley.
2. Chandra, Prasanna. (2017). Projects: Planning, Analysis, Selection, Financing, Implementation and Review. McGraw Hill Education.
3. Anil Kumar, S. & Suresh, N. (2018). Operations Management. New Age International Publishers.
4. Robert Hughes and Mike Cotterell (2009). Software Project Management. McGraw-Hill Higher Education.

References:

1. Dale H. Besterfiled, Carol B.Michna, Glen H. Bester field, MaryB.Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.
2. Gray, C. F., & Larson, E. W. (2020). Project Management: The Managerial Process. McGraw Hill Education.
3. Jack R. Meredith & Samuel J. Mantel. (2019). Project Management: A Managerial Approach. Wiley India.
4. Bhavesh. M Patel, Sandhya Rai, J.S Chandan, Dr. A. Nag, Project Management, Vikas Publishing House, New Delhi, 2020.

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2	
CO1	3	2	-	-	-	-	-	-	-	-	3				
CO2	3	3	2	2	-	-	-	-	-	-	3				
CO3	3	3	2	2	-	-	-	-	-	-	3				
CO4	3	3	2	2	-	-	-	-	-	-	3				
CO5	3	3	2	2	-	-	-	-	-	-	3				
CO6	3	3	3	2	-	-	-	-	-	-	3				
Avg.	3	3	2	2	-	-	-	-	-	-	3				

GE24502 Entrepreneurship And International Business Market HSMC L T P C

2 0 0 2

Course Objectives:

- Introduce the fundamental concepts of entrepreneurship, entrepreneurial traits, creativity and innovation.
- Develop the ability to generate, evaluate and transform innovative ideas into feasible business plans.
- Explain the legal forms of business organization and the importance of intellectual property rights for entrepreneurs.
- Impart knowledge on the nature of international entrepreneurship and strategies for entering and operating in global markets.
- Explain the principles of international entrepreneurship and the dynamics of international trade and foreign exchange markets.

UNIT I FUNDAMENTALS OF ENTREPRENEURSHIP 6

Concept and importance of entrepreneurship - Characteristics and types of entrepreneurs - Entrepreneurship vs. Intrapreneurship - Creativity and Entrepreneurship - Innovation - Types of Innovation - Entrepreneurial innovation. Entrepreneurial ecosystem – Components: Angels, Venture Capitalists, Maker Spaces, Incubators, Accelerators, Investors; Sources of finance – bootstrapping, venture capital, angel investors, government grants, crowdfunding; Stages of entrepreneurial process.

UNIT II IDEA TO BUSINESS PLAN 6

Sources of new ideas - Techniques for generating ideas - Steps involved in assessing the business potential of an idea - Preparing a Business Plan - Pitching a Business Plan - Steps in Setting up a Small Business Enterprise.

UNIT III LEGAL ASPECTS OF BUSINESS 6

Forms of Business Entity - Requirements for incorporation of a private or a public limited company - Introduction to Intellectual Property Rights: Patents, Trademarks, Copyright, Geographical Indication (GI), International Patents - IPRs and their importance - Importance of IP for start-ups. Patents - Types of Patents - Criteria for Patentability - Patent Process - Patent Infringement.

UNIT IV INTERNATIONAL ENTREPRENEURSHIP 6

Nature of International Entrepreneurship - International Vs Domestic Entrepreneurship - Foreign Market Selection - Entrepreneurial Entry Strategies - Barriers to International Trade.

UNIT V INTERNATIONAL TRADE AND FOREIGN EXCHANGE MARKETS 6

Interventionist and Free Trade Theories - Foreign Exchange - Aspects of Foreign Exchange Market - Major Foreign Exchange Markets - Foreign Exchange Trading Process.

Periods: 30

Course Outcomes:

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

CO1: Analyze entrepreneurial traits and apply creativity and innovation in entrepreneurial contexts.
CO2: Create viable business plans by generating, evaluating and developing entrepreneurial ideas.
CO3: Apply knowledge of business structures and protect innovations using intellectual property rights.
CO4: Analyze international business environments and formulate strategies for entering and sustaining in global markets.
CO5: Interpret trade theories, explain foreign exchange market operations and evaluate their impact on international business decisions.
CO6: Understand entrepreneurship concepts and apply them in domestic and international business contexts

Suggested Activities:

- Business Ideation using Design Thinking/ Brainstorming innovative product/service ideas using mind-mapping or SCAMPER technique.

- Develop a mini business plan and pitch the plan/ Review and critique of a real-world business plan (available from start-up incubators).
- Patent infringement case study/ Role-play on registering a company and selecting appropriate legal structure.
- Study of an Indian company's international expansion/ Market research exercise: Identify potential foreign markets for a product/service.
- Analysis of real-world trade agreements and their impact on a business (e.g., India–US trade relations)/ Study of a company affected by currency fluctuations in international operations.

Text Books:

1. Arya Kumar (2012). Entrepreneurship: Creating and leading an entrepreneurial organization. Pearson Education, Inc.
2. Khanka, S. S. (2026). Entrepreneurial development. S. Chand & Company Ltd.
3. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2020). Entrepreneurship. McGraw Hill Education.
4. Daniels, J. D., Radebaugh, L. H., & Sullivan, D. P. (2021). International Business: Environments and Operations. Pearson Education.
5. Kuratko, D. F. (2019). Entrepreneurship: Theory, Process and Practice. Cengage Learning.

References:

1. Rajeev Roy, Entrepreneurship, 3rd Edition Oxford.

EC24611	Embedded Real Time Systems with ARM	PCC	L	T	P	C
			2	0	2	3

Course Objectives:

- Understand Embedded System Design and Architecture
- Gain Proficiency in ARM Processor and Peripherals
- Master Embedded Programming and Optimization Techniques
- Master Embedded Programming and Optimization Techniques
- Understand Embedded Networks and Communication Protocols
- Apply Design Concepts to Real-World Embedded Systems

UNIT I INTRODUCTION TO EMBEDDED SYSTEM DESIGN 9

Complex systems and microprocessors– Embedded system design process –Design methodologies- Design flows - Requirement Analysis – Specifications-System analysis and architecture design – Quality Assurance techniques - Designing with computing platforms – consumer electronics architecture.

UNIT II ARM PROCESSOR AND PERIPHERALS 9

ARM Processor – Instruction Set Preliminaries – CPU – Programming Input and Output – Supervisor Mode – Exceptions and Trap, ARM Architecture – Instruction Set – Stacks and Subroutines – Features of the LPC 214X Family – Peripherals – The Timer Unit – Pulse Width Modulation Unit – UART – Block Diagram of ARM9 and ARM Cortex M3 MCU.

UNIT III EMBEDDED PROGRAMMING 9

Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.

UNIT IV REAL-TIME OPERATING SYSTEMS 9

GPOS VS RTOS, Task, process & threads, Multiprocessing and Multitasking, Scheduling Algorithm, Preemptive and non-preemptive scheduling , Task communication- shared memory, message passing- Interprocess Communication, Interrupt Routines in RTOS Environment. RTOS Example: Any one RTOS (FREE RTOS, µCos-II , Windows CE, PSOIX)

UNIT V NETWORKS FOR EMBEDDED SYSTEM AND DESIGN EXAMPLES 9

Distributed Embedded Architecture, Networks for Embedded systems and protocols, Internet Enabled systems, MPSOC , UML Notations. Case study : Cell Phones ,Video Accelerator.

Periods: 30

Laboratory Experiments:

Experiments using ARM7 – LPC2148

- PORT operation of LPC2148
- UART operation -LPC2148
- Interfacing ADC and DAC with LPC2148
- Interfacing EPROM with LPC2148
- PWM operation
- Interfacing Stepper motor
- Zigbee protocol interface with LPC2148

CORTEX M3

- Port operation in CORTEX M3
- UART operation in Cortex M3
- Mini project using ARM

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- Personal computer with supporting S/W-30 Nos.
- ARM 7 -LPC2148- 10 Nos
- Interfacing Kit: ADC kit, DAC kit, Stepper motor, Zigbee interface- 3 Nos Each
- ARM Cortex- M3&M4 -Each 1

Course Outcomes:

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

CO1: Analyze Embedded System Design Process
CO2: Implement ARM-Based Embedded Applications
CO3: Optimize Embedded Programs for Efficiency
CO4: Design and Implement RTOS-Based Systems
CO5: Integrate Networked Embedded Systems and Protocols
CO6: Design Real-Time Embedded Applications

Suggested Activities:

- Design example: Model train controller or equivalent model.
- Design Example : Soft Real time systems using ARM.
- Design Example: Digital Camera or equivalent model.
- Design Example: Smart home security systems or equivalent mode.
- Design Examples: Elevator Control or equivalent model.
- Design Examples: ECU Network in Modern Automobiles.

Text Books:

1. Marilyn Wolf, "Computers as Components - Principles of Embedded Computing System Design", Third Edition "Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.
2. David. E. Simon, "An Embedded Software Primer", 1st Edition, Fifth Impression, Addison-Wesley Professional, 2007.

References:

1. Lyla B.Das, ―Embedded Systems : An Integrated Approach‖ Pearson Education, 2013.
2. Jonathan W.Valvano, ―Embedded Microcomputer Systems Real Time Interfacing‖, Third Edition Cengage Learning, 2012.
3. Raymond J.A. Buhr, Donald L.Bailey, ―An Introduction to Real-Time Systems- From Design to Networking with C/C++‖, Prentice Hall, 1999.
4. C.M. Krishna, Kang G. Shin, ―Real-Time Systems‖, International Editions, Mc Graw Hill 1997

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	2	2	-	-	-	-	2	3	2
CO2	3	2	3	2	3	-	-	2	2	-	2	3	3
CO3	3	3	2	3	3	-	-	-	-	-	2	2	3
CO4	3	3	3	2	3	2	-	2	2	2	2	3	3
CO5	3	3	3	2	3	2	-	2	2	2	2	3	3
CO6	3	3	3	3	3	2	2	3	3	3	3	3	3

GE24621 Interdisciplinary Project **EEC** **L T P C**

2 0 2 3

Course Objectives:

- To encourage interdisciplinary teamwork to solve real world, SDG aligned problems.
- To guide students in identifying problems through research and user study.
- To enable idea generation, market analysis and product design.
- To develop practical skills in prototyping and testing.
- To promote validation, refinement and ethical analysis of solutions.
- To build pitching and presentation skills for innovation showcase.

UNIT I Problem Discovery and Ideation **9**

Formation of interdepartmental teams (4 members) ensuring diversity in domains and skills - Identify real world problems aligned with SDGs or industry needs - Conduct user research and background study - Define clear problem statements and objectives - Assign faculty mentors from relevant domains based on the problem area.
Deliverable: Problem Identification Canvas

UNIT II Conceptualization, Market Analysis and Product Design **9**

Brainstorm and shortlist solution ideas integrating multiple disciplines - Conduct market analysis: identify target users, analyze existing solutions and define product differentiation - Develop functional block diagrams, sketches and architecture combining hardware and software components - Define key features, materials and cost estimates with faculty mentor guidance.
Deliverable: Market Analysis Report and Design Blueprint

UNIT III Prototype/MVP Development **9**

Develop a working prototype integrating relevant hardware/software/mechanical/electronic systems - Apply rapid

prototyping techniques using lab tools - Collaborate with domain mentors for component integration and testing - Perform iterative improvements based on feedback.
Deliverable: Functional Prototype / MVP

UNIT IV Validation, Testing and Refinement 9

Test product performance, usability and sustainability - Gather user feedback and perform necessary refinements - Conduct cost, safety and ethical analysis - Seek mentor review for cross domain validation.
Deliverable: Validation Report

UNIT V Product Pitch 9

Prepare a Product Pitch Deck covering innovation, feasibility and impact - Demonstrate the product to an interdisciplinary evaluation panel - Highlight integration of hardware, software and design elements and cross functional team members contribution.
Deliverable: Product Demo and Pitch

Periods: 30

Course Outcomes:

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

CO1: Identify real-world problems through user research.
CO2: Analyze market needs and define feasible solutions.
CO3: Design and plan interdisciplinary product concepts.
CO4: Develop and test functional prototypes or MVPs.
CO5: Validate, refine, and assess product performance.
CO6: Pitch and demonstrate innovative products effectively.

Sample Interdisciplinary Products:

- Dynamic Solar Panel Cleaner with AI Scheduling
- Smart Carbon Footprint Analyzer for Industries
- AI Integrated Crop Pollination Drone
- AI Powered Structural Crack Detection Sensor Mesh
- AI Assisted Fire Detection & Suppression Drone
- Wearable Posture Correction Jacket
- Blockchain Based Product Authenticity Tagger
- Cognitive Traffic Signal System
- Smart Wheelchair with Gesture & Voice Control
- Microplastic Detection Device for Water Bodies

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2	PSO3
CO1	3	3	2	2	1	2	–	3	2	2	2				
CO2	2	3	3	2	2	3	1	2	2	2	2				
CO3	2	2	3	2	2	3	2	3	2	3	2				
CO4	3	2	3	3	3	2	1	3	2	3	2				
CO5	3	3	3	3	3	3	2	2	2	3	3				
CO6	2	2	3	2	2	3	2	3	3	3	2				
Avg.															

GE24503	Financial Literacy	PEC	L	T	P	C
			2	0	0	2

Course Objectives:

- Develop financial awareness among engineering students.
- Enable students to make informed decisions regarding personal finance, savings and investments.
- Equip learners with the skills to manage budgets, taxes, credit and debt efficiently.
- Provide knowledge on digital financial systems, fintech applications and entrepreneurship finance.
- Foster responsible financial behaviour and ethical decision-making.

UNIT I Introduction to Financial Literacy and Money Management 6

Meaning, need and importance of financial literacy - Basic financial concepts: income, expenses, assets, liabilities, cash flow - Financial goals and planning process - Budgeting for Skilled Money Management - Time value of money and inflation

UNIT II Banking and Digital Financial Systems 6

Process of Opening Bank Accounts - Types of bank accounts and their operation - Cheques, demand drafts, ATM, debit and credit cards - Digital banking: UPI, Internet banking, mobile banking, NEFT, RTGS, IMPS - Digital payment security and cyber safety - Role of RBI, NPCI and SEBI

UNIT III Saving and Investment Options 6

Difference between saving and investment - Risk and return concepts - Types of investment avenues: bank deposits, mutual funds, stocks, bonds, PPF, NPS, insurance, gold bonds, real estate - Government Schemes for Various Savings & Investment Options - Introduction to capital markets - Systematic Investment plan and portfolio diversification

UNIT IV Credit, Loans and Taxation 6

Concept of credit - Types of loans: education loan, vehicle loan, home loan, personal loan, Gold Loan - Understanding credit cards and managing debt - Credit score and its importance - Basics of taxation: income tax structure in India, PAN, TDS, filing IT returns - Tax Exemptions and Deductions

UNIT V Financial Planning, Entrepreneurship and Ethical Finance 6

Components of comprehensive financial planning - Retirement planning and insurance planning - Financial aspects of entrepreneurship and start-ups - Costing, pricing and break-even analysis for small businesses - Sustainable and ethical financial practices

Periods: 30

Course Outcomes:

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

CO1: Understand the fundamentals of personal and business finance.
CO2: Prepare personal budgets and financial plans.
CO3: Evaluate different saving and investment options.
CO4: Use digital tools and platforms for financial transactions and management.
CO5: Apply basic financial principles in entrepreneurial or career settings.
CO6: Effectively manage personal finances using financial literacy and planning skills.

Suggested Activities:

- Hands-on sessions on budgeting and investment planning using Excel or Google Sheets/ Create a Daily Spending Diary/ Conduct a Money Management SWOT Analysis
- Mock Account Opening Activity/ Digital Payment Demonstration: Hands-on demo of UPI, NEFT, IMPS and online payment apps (without real transactions)
- Analysis of the Government Schemes/ Create a mock investment portfolio/ Review on FinTech innovations and investment apps
- Demonstrate mock IT return filing using a sample Form 16 and income data/ Compare education, housing and vehicle loans from 2–3 banks, highlighting interest rates, EMIs and eligibility.
- Create a personal financial plan including budgeting, insurance, investments and retirement goals/ Mini Start-Up Simulation: Groups design a simple business idea and calculate costing, pricing and break-even point using realistic figures.

Text Books:

1. Shalu Garg, "Personal Financial Planning", Sultan Chand & Sons, Educational Publishers New Delhi, First Edition: 2024.
2. Jack R. Kapoor, Les R. Dlabay, Robert J. Hughes, Melissa M. Hart, "Personal Finance", 14th edition, McGraw Hill LLC, 2023.
3. Financial Education Booklet, Securities and Exchange Board of India (SEBI), Mumbai, November 2020.
4. Banking Theory and Practice, Mahesh Kumar Sarva, Excel Books Private Limited, New Delhi.

References:

1. "Principles and Practices of Banking" – Indian Institute of Banking & Finance (IIBF)
2. Financial Education Handbook For New Entrants at Workplace, National Centre for Financial Education (NCFE), First Edition September 2024.
3. Tulsi Bharatbhai Raval, "Financial Planning", Study Guide Educational Publication, December 2021.
4. National Finance Olympiad, "Personal Finance Handbook", Pockvue Solutions Pvt. Ltd., Ed. 1, 2024 - 2025

SEMESTER 7

EC24711	**Antennas and Microwave Engineering**	**PCC**	**L**	**T**	**P**	**C**
			3	**0**	**2**	**4**

Course Objectives:

- To introduce the fundamental principles of antennas and microwave systems
- To provide knowledge on various antenna structures and their radiation characteristics
- To familiarise the behavior of microwave devices in RF system applications
- To develop understanding of measurement techniques for microwave and antenna systems

UNIT I INTRODUCTION TO MICROWAVE THEORY AND ANTENNAS 9

Microwave frequency bands- Antenna parameters: Radiation pattern, Gain, efficiency, Directivity, Effective aperture, Radiation Resistance, Bandwidth, Beamwidth, Radiation from oscillating dipole and half wave dipole- Introduction to Microwave theory and components, Formulation of S Parameters, Properties of S parameters. Hazards and permitted levels of microwaves in practical applications.

UNIT II ARRAYS AND APERTURE ANTENNAS 9

Two element array, N-element linear array, Pattern multiplication, Broadside and end fire array, Array synthesis: Binomial array, Tschebyscheff array, planar array antennas. Huygens' principle, radiation from rectangular aperture, Babinet's principle, Radiation from sectoral and pyramidal horns, design concepts, parabolic reflector antennas, lens antennas.

UNIT III WIDEBAND AND SPECIAL ANTENNAS 9

Microstrip Patch Antennas: Radiation mechanism, Design and Feeding Techniques. Frequency Independent Antennas: Rumsey's principle, LPDA, Helical Antennas, Reconfigurability in Antennas, Antennas for Wearable, Automotive applications, Smart Antennas.

UNIT IV PASSIVE AND ACTIVE MICROWAVE DEVICES 9

Microwave Passive components: Directional Coupler, Power Divider, Magic Tee, attenuator, resonator, Principles of Microwave Semiconductor Devices: Gunn Diodes, IMPATT diodes, Schottky Barrier diodes, PIN diodes, Microwave tubes: Klystron, TWT, Magnetron.

UNIT V DESIGN PRINCIPLES AND MEASUREMENTS 9

Impedance transformation- Impedance matching, Microwave Filter design Microwave Mixers- Measuring Instruments – VSWR meter, Power meter, Spectrum Analyser, Network Analyser – principles- Measurement of Impedance, frequency, power, VSWR, Q factor, dielectric constant, S-Parameter- Antenna Measurements.

Periods: 30

Laboratory Experiments:

1. Characterization of Reflex Klystron Characteristics and Mode Behavior using Microwave Test Bench
2. Measurement of VSWR, Reflection Coefficient, and Impedance using Slotted Line Method
3. Characterization of Directional Coupler Parameters (Coupling, Directivity, and Isolation)
4. Performance Analysis of Microwave Isolator and Circulator
5. Measurement of V–I Characteristics of Gunn Diode and Study of Negative Resistance Region
6. Design and Simulation of Half-Wave Dipole Antenna and Analysis of Radiation Characteristics

7. Design and Simulation of Rectangular Microstrip Patch Antenna and Evaluation of Performance Parameters
8. Design and Simulation of Microstrip Components (Filters/Transmission Lines) and Analysis of Frequency Response

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- Desktop / Personal Computers
- MATLAB with Toolboxes
- Computer Simulation Technology (CST) Studio Software

Course Outcomes:

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

CO1: Interpret key antenna and microwave parameters and analyze fundamental radiation mechanisms.
CO2: Analyze the behavior of antenna arrays and aperture antennas for specified radiation characteristics.
CO3: Interpret the performance characteristics of wideband and special antennas for diverse applications.
CO4: Analyze the operating principles of passive and active microwave components and characterize microwave tubes used in RF systems.
CO5: Apply microwave measurement techniques using standard instruments to determine S-parameters, VSWR, Q-factor, and dielectric properties.
CO6: Evaluate antenna performance parameters using anechoic chambers and associated measurement systems.

Suggested Activities:

- Microwave radiation hazards & safety limits
- Case Study: Environmental impact of antenna systems (5G towers, radar, satellite)
- Discussion / Report: Ethical issues in RF exposure and spectrum usage
- Group Assignment: Design comparison of antennas (patch vs LPDA vs helical)
- Seminar

Text Books:

1. John D Krauss, Ronald J Marhefka and Ahmad S. Khan, "Antennas and Wave Propagation: Fourth Edition, Tata McGraw-Hill, 2006.
2. David M. Pozar, "Microwave Engineering", Fourth Edition, Wiley India, 2012.

References:

1. Constantine A.Balanis, "Antenna Theory Analysis and Design", Third edition, John Wiley India Pvt Ltd., 2005.
2. RE.Collin, "Foundations for Microwave Engineering", Second edition, IEEE Press, 2001

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	-	-	1	-	1	-	-	1	2	2
CO2	3	3	2	-	1	-	-	-	-	-	1	3	2
CO3	3	2	2	-	1	-	1	-	2	-	1	3	3
CO4	3	2	2	-	1	-	-	1	-	-	1	2	3
CO5	2	2	2	3	3	-	-	-	-	2	1	3	3

CO6	2	2	2	3	3	-	-	-	2	2	1	3	3
Avg.	**2.66**	**2.33**	**2**	**3**	**1.8**	**1**	**1**	**1**	**2**	**2**	**1**	**2.66**	**2.8**

EC24721	**Professional Project – I**	**PCC**	**L**	**T**	**P**	**C**
			1	**0**	**2**	**2**

Course Objectives:

- Identify and formulate a real-world engineering problem.
- Develop strong domain knowledge through literature survey.
- Analyze existing solutions and identify research gaps.
- Propose a feasible solution with proper methodology.
- Plan the project with milestones, tools, and ethical considerations.

UNIT I Project Initiation **5**

- Team formation and domain selection
- Identification of problem Statement aligned with targeted SDGs.
- Allocation of supervisor
- Preliminary study of existing systems

UNIT II Problem Definition and Feasibility **10**

- Finalization of problem statement and objectives
- Submission of title and abstract
- Feasibility analysis (technical, economic, societal)
- Identification of tools, platforms, and datasets

UNIT III Literature Survey, Methodology and Proof of Concept **10**

- Detailed literature survey (journals, patents, conferences)
- Gap identification and justification
- Proposed system architecture and workflow
- Project planning (milestones, Gantt chart)
- Block diagram , flowchart, Proof of concept (PoC)

UNIT IV Documentation and Proposal Presentation **5**

- Preparation of Phase 1 project report
- Preparation of conference paper and submission based on literature survey and PoC

Periods: 30

Course Outcomes:

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

CO1: Formulate engineering problems aligned with targeted SDGs
CO2: Perform literature survey and identify research gaps.
CO3: Propose innovative solutions with clear methodology.
CO4: Demonstrate project planning and teamwork.
CO5: Prepare and present a structured technical report.

EC24722	Internship	PEC	L	T	P	C
			0	0	0	2

Course Objectives:

- Establish exposure and interaction with industry, laboratories, or research institutes
- Acquire practical knowledge of production processes and develop problem-solving skills related to industrial applications
- Develop research skills through hands-on experience in laboratories and research environments

COURSE DESCRIPTION

Students are required to undergo individual internship training in reputed industries, research institutes, or laboratories for a specified duration.

- Physical (in-person) internship is mandatory.
- Online internships may be considered only if offered by reputed organizations, subject to approval.
- Internships obtained through payment by the student will not be considered valid.
- Paid internships are given additional value and recognition.
- Official feedback/evaluation from the company or organization is mandatory and must be submitted along with the report.

Upon completion of the training:

- A detailed internship report must be submitted within ten days from the commencement of the next semester
- Evaluation will be carried out as per the institutional regulations, including company feedback and report assessment

Course Outcomes:

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

CO1: Demonstrate understanding of system-level design, verification, validation, and industrial/research processes

CO2: Apply engineering knowledge to analyze real-world industrial or research problems and propose feasible solutions

CO3: Interpret and evaluate practical aspects such as process parameters, tools, and technologies used in the organization

CO4: Document internship activities, system specifications, methodologies, and results in a structured technical format

CO5: Present internship outcomes effectively and reflect on professional practices, ethics, and workplace learning

SEMESTER 8

EC24821	**Professional Project – II**	**PEC**	**L**	**T**	**P**	**C**
			0	**0**	**20**	**10**

Course Objectives:

- Design and implement a complete working system/prototype.
- Integrate modules and validate system performance.
- Conduct experiments and analyze results.
- Publish research findings in conferences/journals.
- Demonstrate professional presentation, documentation, and ethics

UNIT I Implementation and Integration **100**

- Module development and coding/design
- System integration
- Intermediate testing and debugging
- Performance metrics definition

UNIT II Testing, Validation and Optimization **80**

- Completion of implementation
- System validation and result analysis
- Optimization and refinement
- Verification of technical accuracy

UNIT III Report Preparation and Final Documentation **60**

- Preparation of complete project report (thesis format)
- Documentation of:
    - Problem statement
    - Literature survey
    - Methodology
    - Implementation details
    - Results and analysis
- Plagiarism check and formatting
- Draft report submission during third review
- Identification of patent scope (if applicable)
- Journal manuscript drafting and submission with supervisor approval

UNIT IV Research Dissemination and Final Demonstration **60**

- Registered patent / Journal Publication
- Product demonstration (hardware/software prototype)
- Final presentation and viva voce

Periods: 300

Course Outcomes:

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

CO1: Develop and integrate system modules effectively.
CO2: Conduct experiments and evaluate performance.
CO3: Demonstrate teamwork and project management skills.

CO4: Prepare comprehensive documentation and deliver professional presentations
CO5: Publish research work (conference/journal/patent).

PROFESSIONAL ELECTIVES

Communication Engineering

PEC2411	**Optical Communication**	**PEC**	**L**	**T**	**P**	**C**
			2	**0**	**2**	**3**

Course Objectives:

- To understand the fundamentals of optical fiber communication systems
- To analyze transmission characteristics such as attenuation and dispersion
- To explore optical sources and detectors.
- To examine optical receivers and measurement techniques.
- To design optical communication systems and networks

UNIT I INTRODUCTION TO OPTICAL FIBERS 6

Optical Fiber Communication System - Optical Laws and Definitions - Optical Fiber Modes and Configurations - Mode Theory for Circular Waveguides- Single Mode Fibers – Graded Index Fiber Structure

UNIT II TRANSMISSION CHARACTERISTICS OF OPTICAL FIBER 6

Attenuation: Absorption , Scattering , Bending Losses – Signal Dispersion in Fibers : Modal Delay , Factors Contributing to Dispersion , Group Delay , Material Dispersion , Waveguide Dispersion , Dispersion in Single Mode Fibers , Polarization Mode Dispersion

UNIT III OPTICAL SOURCES AND DETECTORS 6

Optical Sources: LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation of an LED, Laser Diode Modes and Threshold Conditions, Laser Diode Rate Equations, Laser Diode Structures and Radiation Patterns, Modulation of Laser Diodes.
Detectors: Physical Principles of Photodiodes - PIN Photodetector - Avalanche Photo Diodes -Photodetector Noise

UNIT IV OPTICAL RECEIVER, MEASUREMENTS AND COUPLING 6

Fundamental Receiver Operation - Digital Receiver Performance- Optical fiber measurements: Attenuation, Dispersion, Numerical Aperture, Diameter- LED Coupling to Single Mode Fibers - Fiber Splicing

UNIT V OPTICAL COMMUNICATION SYSTEMS AND NETWORKS 6

Digital Point-to-Point Links - Optical Networks: Network Concepts, Network Topologies, SONET/SDH, High Speed Light wave Links, Optical Ethernet.

Periods: 30

Laboratory Experiments:
1. Determination of Numerical Aperture for fibers
2. Measurement of attenuation and bending losses
3. Frequency response characteristics of fiber optic analog link.
4. BER characteristics of fiber optic digital link
5. DC Characteristics of LED
6. DC Characteristics of PIN Photo diode
7. Mode Characteristics of fibers

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- Trainer kits for
  - carrying out LED and PIN diode characteristics
  - determining the mode characteristics, losses in optical fiber
  - Analyzing Analog and Digital link performance
  - Numerical aperture and Attenuation of fiber
- 2 Mbps PRBS Data source, 10 MHz signal generator, 20 MHz Digital storage Oscilloscope.
- Digital multi meter, optical power meter.
- MM/SM Glass and plastic fiber patch chords with ST/SC/E2000 connectors
- LEDs with ST / SC / E2000 receptacles – 650 / 850 nm
- PIN PDs with ST / SC / E2000 receptacles – 650 / 850 nm

Course Outcomes:

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

CO1: Realize basic elements in optical fibers, different modes and configurations.
CO2: Derive the transmission characteristics associated with attenuation and dispersion techniques.
CO3: Analyze the structural, material, and efficiency aspects of LEDs and LASER diodes for optoelectronic applications.
CO4: Explain the physical principles and operational mechanisms of photodiodes, including PIN and avalanche structures.
CO5: Analyze fiber optic receiver systems, measurements and coupling techniques.
CO6: Design optical communication systems and its networks.

Suggested Activities:

- Quiz
- Mind map
- Peer Group Study
- Journal Review

Text Books:

1. Gred Keiser,"Optical Fiber Communication", McGraw Hill Education (India) Private Limited. Fifth Edition, Reprint 2013.
2. P Chakrabarti, "Optical Fiber Communication", McGraw Hill Education (India)Private Limited, 2016

References:

1. John M.Senior, "Optical fiber communication‖, Pearson Education", second edition.2007.
2. Rajiv Ramaswami, "Optical Networks", Second Edition, Elsevier , 2004.
3. J.Gower, "Optical Communication System", Prentice Hall of India, 2001.
4. Govind P. Agrawal, "Fiber-optic communication systems", third edition, John Wiley & sons, 2004.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2	1	1	-	1	1	-	2	3	1

CO2	3	3	3	2	1	1	-	1	1	-	2	3	1
CO3	3	3	2	2	1	1	-	1	1	-	2	3	1
CO4	3	3	2	2	1	1	-	1	1	-	2	3	1
CO5	3	3	3	2	-	1	-	-	-	-	2	3	1
CO6	3	3	3	2	-	1	-	-	-	-	2	3	1
Avg.	**3**	**3**	**2.7**	**2.0**	**1**	**1**	-	-	-	-	**2**	**3**	**1**

PEC2412 Wireless Communication **PEC** **L T P C**

2 0 2 3

Course Objectives:

- To introduce cellular concepts and wireless channel characteristics
- To provide knowledge on digital modulation techniques for communication over fading channels
- To examine diversity, equalization, and multiple access techniques in wireless communication systems
- To develop understanding of wireless communication models and performance evaluation using simulation tools

UNIT I CELLULAR CONCEPT **6**

Cellular System Design Fundamentals: Frequency Reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Improving coverage and capacity.

UNIT II WIRELESS CHANNELS **6**

Free Space Propagation Model -Link Budget design –Small scale fading-Large scale fading– Fading due to Multipath time delay spread :Flat fading ,Frequency selective fading –Fading due to Doppler spread :Fast fading ,Slow fading.

UNIT III DIGITAL SIGNALING FOR FADING CHANNELS **6**

Principles of Offset-QPSK, Pi/4-DQPSK, Minimum Shift Keying, Gaussian Minimum Shift Keying, Error performance in fading channels, OFDM principle –Cyclic prefix, Windowing, Peak Average Power Reduction (PAPR).

UNIT IV DIVERSITY, EQUALIZATION AND MULTIPLE ACCESS **6**

Diversity techniques,diversity combining techniques - Equalization: – Linear and Non-linear equalization-Adaptive Equalization- Multiple Access, FDMA, TDMA, CDMA, SDMA

UNIT V WIRELESS NETWORKING **6**

Introduction: Difference Between Wireless And Fixed Telephone Networks, Traffic Routing in wireless networks: Circuit Switching, Packet Switching- Personal Communication Services/ Networks (PCS/PCNs)- Packet Vs Circuit Switching for PCN, Packet Reservation Multiple Access(PRMA)- Universal Mobile Telecommunication Systems(UMTS).

Periods: 30

Laboratory Experiments:

1. Modeling of wireless communication systems using Matlab(Two ray channel and Okumura –Hata model)
2. Modeling and simulation of Multipath fading channel

3. Design, analyze and test Wireless standards and evaluate the performance measurements such as BER, PER, BLER, throughput, capacity, ACLR, EVM for 4G and 5G using Matlab
4. Modulation: Spread Spectrum – DSSS Modulation & Demodulation
5. Wireless Channel equalization: Zero-Forcing Equalizer (ZFE),MMSE Equalizer(MMSEE),Adaptive Equalizer (ADE),Decision Feedback Equalizer (DFE)
6. Modeling and simulation of TDMA, FDMA and CDMA for wireless communication

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- Personal/Desktop Computers
- MATLAB with toolboxes

Course Outcomes:

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

CO1: Analyse cellular system design principles.
CO2: Interpret wireless channel characteristics, model path loss and fading
CO3: Apply digital modulation techniques for reliable communication over fading channels
CO4: Evaluate OFDM system performance metrics BER and throughput
CO5: Apply diversity, equalization and multiple access techniques for improving wireless system performance
CO6: Assess wireless network architectures and end-to-end communication systems

Suggested Activities:

- Case Study: RF Exposure and Public Health (SAR Standards) CO1,CO6-PO6
- Energy-efficient wireless communication systems / spectrum usage CO2-PO7
- Professional Integrity in Standards Compliance:A case study on the consequences of falsifying interference or emission data during the product approval phase. CO4,CO6-PO8
- Simulation of channel models / OFDM / multiple access CO2, CO4,CO5 -PO9
- Seminars: Performance evaluation (BER, throughput, OFDM systems) CO4,CO6-PO 10

Text Books:

1. Theodore S. Rappaport, Wireless communication: Principles and Practice, 2/e, Pearson Education, 1990
2. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2005
3. Aditya Jagannatham, Principles of Modern Wireless Communication Systems, Mc Graw Hill, 2017.
4. Robert Collin, Antennas and Radiowave Propagation, McGraw Hill, 2016..

References:

1. B.P.Lathi, “Modern Digital and Analog Communication Systems”, 3rd Edition, Oxford University Press, 2007
2. H P Hsu, Schaum Outline Series - “Analog and Digital Communications” TMH 2006
3. B.Sklar, “Digital Communications Fundamentals and Applications”, 2nd Edition Pearson Education 2007
4. D.Roody, J.Coolen, ―Electronic Communications, 4th edition PHI 2006

CO PO PSO Mapping:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	-	-	-	1	-	-	-	-	1	2	1
CO2	3	2	1	-	2	-	1	-	1	-	1	2	2
CO3	2	2	2	-	2	-	-	-	1	-	1	2	2

CO4	2	2	2	1	3	-	-	1	2	2	1	2	3
CO5	2	2	2	-	2	-	-	-	1	-	1	2	2
CO6	2	2	2	1	2	1	-	1	1	2	2	2	3
Avg.	2.3	2.1	1.8	1	2.2	1	1	1	1.2	2	1.16	2	2.16

PEC2413 5G Communication **PEC** **L T P C**

2 0 2 3

Course Objectives:

- To familiarise the evolution of wireless networks and concepts
- To get acquainted with the fundamentals of 5G networks.
- To identify the challenges and modelling of 5G architecture and propagation channels
- To impart knowledge on the security features in 5G networks.
- To explore the benefit of 6G over 5G

UNIT I EVOLUTION OF WIRELESS NETWORKS 6

Introduction -Networks evolution: 2G, 3G, 4G – 4G vision – 4G features and challenges – Applications of 4G – 4G Technologies: Multicarrier Modulation, Smart antenna techniques, IMS Architecture, LTE, Advanced Broadband Wireless Access and Services, MVNO.

UNIT II 5G CONCEPTS AND CHALLENGES 6

Fundamentals of 5G technologies - Overview of 5G core network architecture - 5G new radio and cloud technologies - Radio Access Technologies (RATs) - EPC for 5G.

UNIT III NETWORK ARCHITECTURE AND THE PROCESSES 6

5G architecture and core, network slicing, Multi access Edge Computing(MEC) , visualization of 5G components, end-to-end system architecture, service continuity - Relation to EPC, and edge computing - 5G protocols: 5G NAS,NGAP, GTP-U, IPsec and GRE - Channel Models for mm Wave - MIMO Systems.

UNIT IV SECURITY IN 5G NETWORKS 6

Security features in 5G networks, - Network domain security - User domain security - Flow based QoS framework - Mitigating the threats in 5G.

UNIT V BEYOND 5G COMMUNICATION SYSTEM 6

Explaining 6G Spectrum THz, mm Wave - Sub -6 GHz and Low Band 5G- Requirements and use cases: Coverage, speed, capacity , power consumption, cost, latency, massive connectivity and sensing.

Periods: 30

Laboratory Experiments:

1. 5G-Compliant waveform generation and testing
2. Modeling of 5G Synchronization signal blocks and bursts
3. Channel modeling in 5G networks
4. Multiband OFDM demodulation
5. Perfect Channel estimation
6. Development of 5G New Radio Polar Coding technique

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- 30 Desktop Computers / Workstations
- MATLAB with Toolboxes

Course Outcomes:

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

CO1: Analyze the evolution of wireless networks and the need of 5G technology
CO2: Design 5G networks and integrates effectively 5G with cloud technology
CO3: Apply different communication protocols with 5G architecture to obtain effective communication.
CO4: Design 5G wireless propagation channels to transmit the message signal in the form of mm Wave.
CO5: Apply different security mechanisms in order to mitigate the threats in 5G..
CO6: Assess requirements and emerging use cases of 6G networks in terms of performance metrics.

Suggested Activities:

- Role Play
- Quiz
- Mindmap
- Journal Review

Text Books:

1. "5G Core networks: Powering Digitalization" , Stephen Rommer, Academic Press,2019
2. "An Introduction to 5G Wireless Networks : Technology, Concepts and Use cases", Saro Velrajan,First Edition, 2020.

References:

1. "5G Simplified: ABCs of Advanced Mobile Communications" Jyrki. T.J.Penttinen, Copyrighted Material.
2. "5G system Design: An end to end Perspective , Wan Lee Anthony, Springer Publications", 2019.
3. T. S. Rappaport et al., "Next-Generation Wireless: A Guide to the Fundamentals of 6G" Upper Saddle River, NJ, USA: Prentice Hall, 2024.
4. W. Saad, M. Bennis, and M. Chen, "Introduction to 6G". Hoboken, NJ, USA: Wiley, 2023.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3	1	-	-	2	-	-	-	-	2	-	2	1
CO2	3	2	1	1	2	-	-	-	-	2	-	2	1
CO3	3	2	2	1	2	-	-	-	1	2	-	2	1
CO4	3	2	2	2	3	-	-	-	1	1	-	2	1
CO5	3	2	2	2	3	2	-	2	1	1	-	2	1
CO6	3	2	2	2	1	3	2		2	1	3	1	1
Avg.	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**

PEC2414	Satellite Communication	PEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To learn the basics of satellite orbits.
- To study about satellite segment and earth segment
- To grasp the knowledge of Link Power budget calculation
- To analyse various satellite access and coding technology.
- To study the applications of satellites.

UNIT I SATELLITE ORBITS 9

Overview of satellite communications, frequency allocations of satellite services, design considerations of satellite communications, advantages & disadvantages of satellite communications.- Kepler's Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geo stationary and non-Geo-stationary orbits , Look Angle Determination, limits of visibility, eclipse Sub satellite point, elevation angle calculation, azimuth angle calculation, Sun transit outage-Launching Procedures , launch vehicles and propulsion.

UNIT II SPACE SEGMENT 9

Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion - communication Payload and supporting subsystems - Telemetry, Tracking and command-Transponders Antenna Subsystem.

UNIT III SATELLITE LINK DESIGN 9

Basic link analysis, Uplink and Downlink Design equation- Free space loss-Atmospheric effects, Ionospheric scintillation, Rain induced attenuation and interference, system noise temperature- Link Design with and without frequency reuse.

UNIT IV SATELLITE ACCESS AND CODING TECHNIQUES 9

Modulation and Multiplexing: Voice, Data, Video, Analog – digital transmission system, Digital video Broadcast, multiple access: FDMA, TDMA, CDMA, PAMA and DAMA Assignment Methods- compression – encryption, Coding Schemes.

UNIT V SATELLITE APPLICATIONS 9

INTELSAT Series: INSAT, VSAT,- Mobile satellite services: GSM, GPS, LEO, MEO, Satellite Navigational System, GPS-Position Location Principles, Differential GPS, GPS C/A code accuracy, differential GPS, selective availability - C-Band and Ku-Band Home Satellite TV, Direct Broadcast satellites (DBS/DTH).

Total Periods: 45

Course Outcomes:

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

CO1: Identify the satellite orbital parameter.
CO2: Analyse the satellite subsystems.
CO3: Comprehend the characteristics of satellite link power budget.
CO4: Access the performance of various access schemes for satellite services.
CO5: Apply different coding schemes, in satellite communication.
CO6: Analyse various satellite applications.

Text Books:

1. Dennis Roddy, “Satellite Communication”, 4th Edition, Mc Graw Hill International, 2017.
2. Timothy Pratt, Charles, W.Bostain,Jeremy E.Allnutt,"SatelliteCommunication”,3rd Edition, Wiley Publications,2021.

References:

1. Tri T. Ha, “Digital Satellite Communications”, 2nd edition, Mc Graw Hill education, 2017.
2. Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, “Satellite Communications Systems Engineering”, 2nd edition , Prentice Hall/Pearson , 2013.
3. M.Richharia, “Satellite Communication Systems-Design Principles”, Macmillan, 1999.
4. Brian Ackroyd, “World Satellite Communication and earth station Design”, BSP professional Books, 1990.
5. Bruce R. Elbert, “The Satellite Communication Applications”, Hand Book, Artech House Bostan London, 2003.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2	-	-	-	-	-	-	1	3	2
CO2	3	3	3	2	-	-	-	-	-	-	1	3	2
CO3	3	3	3	2	-	-	-	-	-	-	1	3	2
CO4	3	3	3	2	-	-	-	-	-	-	1	3	2
CO5	3	3	3	2	-	-	-	-	-	-	1	3	2
CO6	3	3	3	2	-	-	-	-	-	-	1	3	2
Avg.	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**2**

PEC2415 Software Defined Radio **PEC** **L T P C**

2 0 2 3

Course Objectives:

- To introduce the concepts of software radios.
- To know about RF implementation challenges for software defined radios.
- To understand the digital generation of signals.
- To learn the software and hardware requirements for software defined radios.

UNIT I INTRODUCTION TO SOFTWARE DEFINED RADIO 6

Evolution of Software Defined Radio-The Need for Software Radios- Characteristics and Benefits of a Software Radio- Design Principles of a Software Radio- Basics of Cognitive Radio- Comparison of SDR and CR.

UNIT II RF IMPLEMENTATION 6

Radio Frequency implementation: Purpose of RF front-end, Dynamic range, RF receiver front-end topologies, Enhanced flexibility of the RF chain with software radios, Importance of the components to overall performance, Transmitter architectures and their issues, Noise and distortion in the RF chain, Hybrid DDS-PLL systems.

UNIT III DIGITAL GENERATION OF SIGNALS 6

Comparison of direct digital synthesis with analog signal synthesis - Approaches to direct digital synthesis - Analysis of spurious signals - Performance of direct digital synthesis systems - Applications of direct digital synthesis.

UNIT IV SMART ANTENNAS 6

Benefits of smart antennas - Structures for beamforming systems - Smart antenna algorithms - Hardware implementation of smart antennas - Digital Hardware Choices-Key hardware elements.

UNIT V HARDWARE AND SOFTWARE FOR SDR & CASE STUDIES 6

DSP Processors: FPGA, ASICs- Trade-offs - Object oriented programming- Object Brokers - GNU Radio-USRP- Case Studies: SPEAK easy, JRTS, SDR-3000.

Periods: 30

List of experiments:

1. Study of SDR hardware kit
2. Design and Implementation of digital modulation schemes using SDR
3. Implementation of synchronization techniques using SDR
4. Channel Coding Techniques using SDR
5. Study of channel estimation techniques using SDR
6. Study of MIMO concepts using SDR

Periods: 30

Total Periods: 60

Course Outcomes:

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

CO1: Demonstrate an understanding in the evolving paradigm of Software defined radio and technologies for its implementation.
CO2: Compare various digital synthesis procedures.
CO3: Analyze RF front-end architectures considering noise, distortion, and dynamic range.
CO4: Evaluate software-defined radios and hybrid DDS-PLL techniques for RF applications.
CO5: Implement Smart antenna techniques for software defined radio.
CO6: Comprehend various hardware and software requirements for software defined radios.

Text Books:

1. Jeffrey Hugh Reed, “Software Radio: A Modern Approach to Radio Engineering,” Prentice Hall Professional, 2002.
2. Tony J Rouphael, “RF and DSP for SDR,” Elsevier Newnes Press, 2008.

References:

1. P. Kenington, “RF and Baseband Techniques for Software Defined Radio,” Artech House, 2005.
2. Paul Burns, “Software Defined Radio for 3G,” Artech House, 2002.
3. Behrouz. F. Bourjney“ Signal Processing for Software defined Radios”, Lulu 2008.

MAPPING OF COs WITH POs AND PSOs

Cos	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2	2	1	-	1	1	-	1	3	2
CO2	3	3	3	2	2	1	-	1	1	-	1	3	2
CO3	3	3	3	2	2	1	-	1	1	-	1	3	2

CO4	3	3	3	2	2	1	-	1	1	-	1	3	2
CO5	3	3	3	2	2	1	-	1	1	-	1	3	2
CO6	3	3	3	2	2	1	-	1	1	-	1	3	2
Avg.	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**1**	**1**	**-**	**1**	**3**	**2**

PEC2416 Adhoc and Sensor Networks **PEC** **L T P C**

2 0 2 3

Course Objectives:

- To introduce the MAC layer and routing protocols in ad hoc networks
- To provide exposure to sensor network architectures, MAC protocols, and routing strategies
- To familiarise transport protocols and QoS provisioning mechanisms in ad hoc and sensor networks
- To equip students with knowledge of security mechanisms, intrusion detection, and secure routing protocols in ad hoc and sensor networks.

UNIT I MAC AND ROUTING IN AD HOC NETWORKS 9

Introduction – Issues and challenges in ad hoc networks – MAC Layer Protocols for wireless ad hoc networks – Contention-Based MAC protocols – MAC Protocols Using Directional Antennas – Multiple-Channel MAC Protocols – Power-Aware MAC Protocols – Routing in Ad hoc Networks – Design Issues – Proactive, Reactive and Hybrid Routing Protocols

UNIT II TRANSPORT AND QOS IN AD HOC NETWORKS 9

TCP's challenges and Design Issues in Ad Hoc Networks – Transport protocols for ad hoc networks – Issues and Challenges in providing QoS – MAC Layer QoS solutions – Network Layer QoS solutions – QoS Model

UNIT III MAC AND ROUTING IN SENSOR NETWORKS 9

Introduction – Applications – Challenges – Sensor network architecture – MAC Protocols for wireless sensor networks – Low duty cycle protocols and wakeup concepts – Contention Based protocols – Schedule-Based protocols – IEEE 802.15.4 Zigbee – Topology Control – Routing Protocols

UNIT IV TRANSPORT AND QOS IN SENSOR NETWORKS 9

Data-Centric and Contention-Based Networking – Transport Layer and QoS in Wireless Sensor Networks – Congestion Control in network processing – Operating systems for wireless sensor networks – Examples

UNIT V SENSOR IN AD HOC AND SENSOR NETWORKS 9

Security Attacks – Key Distribution and Management – Intrusion Detection – Software based Anti-tamper techniques – Water marking techniques – Defense against routing attacks - Secure Ad hoc routing protocols – Broadcast authentication WSN protocols – TESLA – Biba – Sensor Network Security Protocols – SPINS

Periods: 45

Course Outcomes:

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

CO1: Analyze MAC layer protocols and routing strategies in ad hoc wireless networks

CO2: Examine transport protocols and QoS provisioning mechanisms in ad hoc networks
CO3: Apply MAC protocols and low-duty cycle mechanisms in wireless sensor networks
CO4: Analyze routing protocols and topology control techniques in wireless sensor networks
CO5: Assess transport layer performance and QoS mechanisms in wireless sensor networks
CO6: Apply security mechanisms and secure routing protocols in ad hoc and sensor networks

Suggested Activities:

- Ad hoc networks in emergency communication CO1, CO6, PO 6
- Energy-efficient MAC protocols and power-aware routing CO3, PO7
- Group Task: Identify vulnerabilities in a given network scenario and propose countermeasures.
- Compare routing protocols (AODV vs DSDV vs Hybrid) CO1,CO4 - PO9
- Seminars CO2, CO6-PO10

Text Books:

1. Pawan Singh, Sudesh Kumar, "Wireless Ad-hoc and Sensor Networks Architecture, Protocols, and Application", CNC Press, 2024
2. C.Siva Ram Murthy and B.S.Manoj, "Ad Hoc Wireless Networks – Architectures and Protocols", Pearson Education, 2006.

References:

1. Holger Karl, Andreas Willing, "Protocols and Architectures for Wireless Sensor Networks",John Wiley & Sons, Inc., 2007.
2. Subir Kumar Sarkar, T G Basavaraju, C Puttamadappa, "Ad Hoc Mobile Wireless Networks", Auerbach Publications, 2008.
3. Carlos De Morais Cordeiro, Dharma Prakash Agrawal, "Ad Hoc and Sensor Networks: Theory and Applications (2nd Edition)", World Scientific Publishing, 2011.
4. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks Theory and Practice", John Wiley and Sons, 2010

Signal Processing

PEC2421	**Advanced Digital Signal Processing**	**PEC**	**L**	**T**	**P**	**C**
			2	**0**	**2**	**3**

Course Objectives:

- To introduce the concepts of discrete time random signal processing
- To know about multirate signal processing and its applications
- To understand the spectrum estimation techniques
- To learn the concept of prediction theory and filtering
- To study the applications of adaptive and parametric signal processing

UNIT I MULTIRATE SIGNAL PROCESSING 6

Convolution – Correlation - Multirate Signal Processing: Decimation, Interpolation, Sampling Rate Conversion by a rational factor –Filter Design and Implementation for sampling rate Conversion-Applications of Multirate Signal Processing

UNIT II LINEAR PREDICTION AND FILTERING 6

Linear Prediction: Forward and Backward- Wiener filters for filtering and prediction –FIR Wiener Filter – IIR Wiener Filter.

UNIT III ADAPTIVE FILTERING 6

FIR adaptive filters – adaptive filters based on steepest descent method – LMS algorithm – Variants of LMS algorithm – adaptive echo cancellation – adaptive channel equalization – RLS Algorithm.

UNIT IV SPECTRUM ESTIMATION 6

Estimation of power spectra from finite duration observations of signals – Non parametric methods of spectrum estimation – the Bartlett and the Welch method – Parametric spectrum estimation – AR, MA and ARMA

UNIT V PARAMETRIC METHOD OF POWER SPECTRUM ESTIMATION 6

AR (Auto-Regressive) Process and Linear Prediction, Yule-Walker, Burg and Unconstrained Least Squares Methods, Piscaranko's Harmonic Decomposition Methods, MUSIC Method.

Periods: 30

List of experiments:

1. Study of autocorrelation and Cross Correlation of random signals
2. Design and Implementation of Multirate Systems.
3. Design and Implementation of Wiener Filter
4. Design and Implementation of FIR Linear Predictor
5. Design of adaptive filters using LMS algorithm
6. Spectrum Estimation using Bartlett and Welch Methods
7. Mini project

Periods: 30

Total Periods: 60

Laboratory Requirements: (for a batch of 30 students)

Desktop Computers: 30 Nos
Matlab /Equivalent tool: 30 users
DSP Processor – 10 Nos.

Course Outcomes:

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

CO1: Describe multirate signal processing and its applications.
CO2: Analyze discrete-time random signals and their properties.
CO3: Apply linear prediction and filtering techniques.
CO4: Design adaptive filters for signal processing applications.
CO5: Demonstrate spectrum estimation techniques.
CO6: Apply parametric methods for power spectrum estimation.

Suggested Activities

- Collaborative mini projects.
- Lab integrated activities.
- Review recent journal papers.

Text Books:

1. John G. Proakis & Dimitris G.Manolakis, Digital Signal Processing – Principles, Algorithms & Applications, Fifth Edition, Pearson Education / Prentice Hall, 2025.
2. P. Vaidyanathan, "Multirate systems and filter banks", Prentice Hall Inc. 1993.

References:

1. Monson H. Hayes, "Statistical digital signal processing and modeling", John Wiley and Sons Inc. New York, Indian reprint 2008.
2. Haykin, Adaptive Filter Theory, 4th Edition, Pearson Education, New Delhi, 2006.

3. Sophoncles J. Orfanidis, “Optimum Signal Processing “, McGraw Hill, 2000.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	2	2	-	-	1	1	-	1	2	2
CO2	3	3	-	1	2	-	-	1	1	-	1	2	2
CO3	3	3	2	2	2	-	--	1	1	-	2	3	2
CO4	3	3	3	3	2	-	-	1	1	-	2	3	2
CO5	3	3	2	3	2	-	-	1	1	-	1	2	2
CO6	3	3	2	2	2	-	-	1	1	-	1	2	2
Avg.	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**1**	**1**	**-**	**1**	**2**	**2**

PEC2422 Image Processing **PEC** **L T P C**

2 0 2 3

Course Objectives:

- To introduce the fundamental concepts of digital image acquisition, representation, and color models.
- To develop understanding of image enhancement and restoration techniques in spatial and frequency domains.
- To impart knowledge of segmentation methods for extracting meaningful structures from images.
- To familiarize students with feature extraction and image compression techniques for efficient image analysis and storage.
- To enable students to apply digital image processing algorithms to real-world problem scenarios.

UNIT I DIGITAL IMAGE FUNDAMENTALS 6

Steps in Digital Image Processing – Components - Elements of Visual Perception - Image Sensing and Acquisition - Image Sampling and Quantization - Relationships between pixels - Color image fundamentals – RGB and HSI models - 2D transforms fundamentals: DFT & DCT

UNIT II IMAGE ENHANCEMENT 6

Gray level transformations - Histogram processing - Smoothing and Sharpening filters in spatial domain and Frequency domains: Ideal, Butterworth and Gaussian filters - Effect of preprocessing on machine learning accuracy

UNIT III IMAGE RESTORATION 6

Degradation model - Noise models - Mean Filters - Order Statistics filters - Adaptive filters - Notch Filters - Inverse Filtering - Wiener filtering

UNIT IV IMAGE SEGMENTATION 6

Edge detection - Edge linking via Hough transform – Thresholding- Region based segmentation : Region growing, Region splitting and merging - Morphological processing: Erosion and Dilation, Segmentation by morphological watersheds - Segmentation for Machine learning based classification.

UNIT V FEATURE EXTRACTION AND IMAGE COMPRESSION 6

Feature extraction: Boundary Representation, Chain codes, Signatures, Boundary descriptors, Regional Descriptors, Topological descriptors - Features as inputs for Machine learning algorithms.
Image compression : Need for data compression, Huffman, Run Length Encoding, Arithmetic coding, JPEG standard

Periods: 30

List of experiments:
Use MATLAB/Equivalent Simulation tool, to perform

1. Contrast Enhancement using Gray-Scale Transformations
2. Image Restoration using Spatial Filtering Techniques
3. Edge Enhancement using Spatial Filters
4. Frequency Domain Processing using DFT and DCT for Denoising and Compression
5. Image Segmentation for Extracting Meaningful Regions
6. Mini Project: Application of Image Processing Techniques

Periods: 30

Total Periods: 60

Laboratory Requirements: (for a batch of 30 students)
Desktop Computers: 30 Nos
Matlab /Equivalent tool: 30 users

Course Outcomes:

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

CO1: Explain the fundamentals of digital image formation, color models, sampling, and quantization.
CO2: Apply image enhancement techniques in spatial and frequency domains to improve image quality.
CO3: Perform image restoration techniques to reduce noise and recover degraded images.
CO4: Implement image segmentation methods to extract meaningful regions and object boundaries.
CO5: Extract relevant image features and represent images using appropriate descriptor techniques.
CO6: Apply image compression methods to reduce storage while retaining image quality.

Suggested Activities

- Collaborative mini projects.
- Lab integrated activities.
- Review recent journal papers.

Text Books:

1. Rafael.C.Gonzalez, Richard.E. Woods and Steven L. Eddins, “Digital Image Processing using Matlab”, 4th Edition, Gatesmark Publishing, 2018.
2. Anil K. Jain, ‘Fundamentals of Digital Image Processing’, Pearson, 2015.

References:

1. William K. Pratt, “Introduction to Digital Image Processing”, CRC Press, 2013.
2. I Erik Cuevas , Alma Rodriguez, “Image Processing and Machine Learning: Advanced Topics in Image Analysis and Machine Learning” Volume 2,CRC Press, A Chapman & Hall Book, 2024
3. Oge Marques, “Practical Image and Video Processing using MATLAB”, Wiley-IEEE Press, 2011, ISBN: 978-0-470-04815-3.
4. Al.Bovik, “The Essential Guide to Image Processing”, Academic Press, 2009.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2

CO1	3	1	1	-	1	1	1	1	1	-	1	3	2
CO2	3	2	2	1	2	1	1	1	1	-	1	3	2
CO3	3	2	2	1	2	1	1	1	1	-	1	3	2
CO4	3	2	2	1	2	1	1	1	1	-	1	3	2
CO5	3	2	2	1	2	1	1	1	1	-	1	3	2
CO6	3	2	2	1	2	1	1	1	1	-	1	3	2
Avg.	**3**	**1.8**	**1.8**	**1**	**1.8**	**1**	**1**	**1**	**1**	**-**	**1**	**3**	**2**

PEC2423 Machine Learning for Signal Processing **PEC** **L T P C**

2 0 2 3

Course Objectives:

- To build a foundation in signal processing and data representation.
- To explain time-frequency analysis techniques for signal feature extraction.
- To present machine learning concepts for signal classification and recognition.
- To describe advanced machine learning models such as SVM, Neural Networks, and probabilistic models.
- To demonstrate the application of machine learning techniques in signal processing domains such as speech, audio, and radar.

UNIT I Signal Processing 6

Signals and systems overview- Convolution, Correlation-Statistical properties of signals: Auto Covariance, Coherence, Power Spectral Density (PSD)- Estimation and Detection- Central Limit Theorem- Sampling and Reconstruction of Signals- Data Representations- Fixed Point and Floating Point DSPs

UNIT II Signal Analysis and Feature Extraction 6

Short Time Fourier Transform- Wavelet Transform - Discrete Cosine Transform (DCT)- Windowing techniques- Feature extraction methods: MFCC(Mel-Frequency Cepstral Coefficients), spectral features

UNIT III Machine Learning Fundamentals 6

Introduction to Machine Learning – Feature Representation for ML – Supervised Learning – Unsupervised Learning – Classification concepts – Decision boundaries – Stochastic Processes in ML

UNIT IV Advanced Machine Learning Models 6

Support Vector Machines (SVM): Classification, Regression- Neural Networks-Probabilistic Models: Gaussian Models, Gaussian Mixture Models (GMM)-Expectation Maximization (EM) Algorithm-Sequence Models: Markov Models, Hidden Markov Models (HMM)

UNIT V Applications of ML in Signal Processing 6

Speech and Audio Signal Processing – Speech Recognition using HMM – Audio Classification – Noise Reduction using ML techniques – Radar Signal Processing – Intelligent Signal Processing Systems

Periods: 30

Laboratory Experiments:

1. Time-Frequency Analysis using STFT
2. Feature Extraction using MFCC
3. Signal Classification using k-NN and SVM
4. Neural Network based Signal Classification
5. Modeling Signal Data using Gaussian Mixture Model (GMM)
6. Signal Denoising using Machine Learning / Filtering Techniques.
7. Modeling Sequential Data using Hidden Markov Model (HMM)
8. Mini Project – Speech/Audio Classification system (End-to-end ML Implementation)

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- Personal Computers : 15 Nos
- Matlab/Equivalent tool: 15 Nos

Course Outcomes:

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

CO1: Apply basic concepts of signal processing for analysis and representation.
CO2: Perform feature extraction using time-frequency techniques.
CO3: Implement supervised and unsupervised learning methods for signal classification.
CO4: Evaluate machine learning models such as SVM, Neural Networks, and GMM
CO5: Analyze sequential data using Hidden Markov Models (HMM) for signal applications.
CO6: Design ML-based signal processing systems for real-world applications

Suggested Activities:

- Collaborative mini projects.
- Lab integrated activities.
- Review recent journal papers.

Text Books:

1. Michael M. Richter · Sheuli Paul , Veton Këpuska · Marius Silaghi ,"Signal Processing and Machine learning with application ",Springer 2022
2. Alan V. Oppenheim and Ronald W. Schafer, "Discrete time-signal Processing", Prentice Hall,2009

References:

1. Christopher M. Bishop," Pattern Recognition and Machine Learning",springer 2006.
2. Daniel Jurafsky and James H. Martin" Speech and Language Processing", Pearson 2023
3. Kevin P. Murphy," Machine Learning: A Probabilistic Perspective" MIT Press,2022
4. Max A. Little,"" Machine Learning for Signal Processing", Cambridge University Press,2019

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	-	2	-	-	1	2	2
CO2	3	3	-	1	2	-	-	2	-	-	1	2	2
CO3	3	3	2	1	2	-	-	2	-	-	1	2	2

CO4	3	3	2	1	2	-	-	2	-	-	1	2	2
CO5	3	3	2	1	2	-	-	2	-	-	1	2	2
CO6	3	3	3	2	2	2	2	2	2		2	2	2
Avg.	**3.0**	**2.8**	**2.3**	**1.2**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**-**	**1.2**	**2.0**	**2.0**

PEC2424	**Computer Vision**	**PEC**	**L**	**T**	**P**	**C**
			2	**0**	**2**	**3**

Course Objectives:

- To familiarize the fundamental concepts related to image formation and processing
- To explore feature detection, matching and segmentation
- To impart knowledge on feature-based alignment and motion estimation
- To develop skills on 3D reconstruction
- To provide exposure to image-based rendering and recognition

UNIT I INTRODUCTION TO IMAGE FORMATION AND PROCESSING 6

Computer vision – Geometric primitives and transformations – Photometric image formation – Digital camera – Point operators – Linear filtering – Neighbourhood operators – Fourier transforms – Pyramids and wavelets – Geometric transformations – Global optimization.

UNIT II FEATURE DETECTION, MATCHING AND SEGMENTATION 6

Points and patches – Edge detection – Line detection – Segmentation – Active contours – Split and merge – Mean shift and mode finding – Normalized cuts – Graph cuts – Energy-based methods.

UNIT III FEATURE-BASED ALIGNMENT AND MOTION ESTIMATION 6

2D and 3D feature-based alignment – Pose estimation – Camera calibration – Triangulation – Structure from motion – Factorization – Bundle adjustment – Optical flow – Parametric and layered motion.

UNIT IV 3D RECONSTRUCTION 6

Shape from X – Active range finding – Surface representations – Point-based representations – Volumetric representations – Model-based reconstruction – Texture mapping and albedo recovery.

UNIT V IMAGE-BASED RENDERING AND RECOGNITION 6

View interpolation – Layered depth images – Light fields and Lumigraphs – Environment mattes – Video-based rendering – Object detection – Face recognition – Instance and category recognition – Scene understanding – Recognition databases and datasets.

Periods: 30

Laboratory Experiments:

1. Basic Image Processing - loading images, Cropping, Contour analysis and Bolb detection.
2. Image Annotation – Drawing lines, text circle, rectangle, ellipse on images.
3. Image Enhancement - Histogram equalization, Convolution, Image smoothing, Gradients and Edge Detection.
4. Image transforms – Fourier transform and Hough transform.
5. Extract ORB Image features and Feature matching-based on image alignment.
6. Image segmentation using Graph cut.

7. 3D Reconstruction – Creating Depth map from stereo images.
8. Camera Calibration with circular grid.

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- Personal Computers
- Computer vision Library for OpenCV in Python / PyCharm or C++ / Visual Studio or equivalent

Course Outcomes:

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

CO1: Interpret image formation models and basic image processing operations.
CO2: Apply feature detection and matching techniques for image analysis.
CO3: Analyze image segmentation methods.
CO4: Analyze motion and estimate 3D structure from multiple images.
CO5: Implement different 3D reconstruction techniques and representations.
CO6: Design recognition and rendering systems for real-world vision applications.

Suggested Activities:

- Perform basic image processing operations such as point operations, linear filtering (smoothing, sharpening), and geometric transformations (scaling, rotation) using Python.
- Implement segmentation techniques like thresholding, region-based segmentation, or graph-based methods on real images.

Text Books:

1. Richard Szeliski, "Computer Vision: Algorithms and Applications", Springer- Texts in Computer Science, Second Edition, 2022.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, Second Edition, 2015.

References:

1. 1. Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
2. Christopher M. Bishop; Pattern Recognition and Machine Learning, Springer, 2006
3. E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	1	-	-	2	2	-	1		
CO2	3	2	2	1	2	-	-	2	2	-	1		
CO3	3	2	2	1	2	-	-	2	2	-	1		
CO4	3	2	2	1	2	-	-	2	2	-	1		
CO5	3	2	2	1	2	-	-	2	2	-	1		
CO6	3	2	2	1	2	-	-	2	2	-	1		
Avg.	3	2	2	1	1.83	-	-	2	2	-	1		

PEC2425	Speech Processing	PEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To provide a foundation in speech production mechanisms, phonetics, and the mathematical principles underlying speech processing.
- To develop an understanding of speech signal characteristics in time and frequency domains.
- To impart knowledge on Linear Predictive Coding (LPC) methods for efficient speech representation and analysis.
- To familiarize statistical models such as Markov processes and Hidden Markov Models (HMMs) for speech modelling.
- To present techniques for speech enhancement and noise reduction.

UNIT I INTRODUCTION TO SPEECH PROCESSING 9

Review of mathematics for speech processing: Discrete-time signals and systems, Filters, Probability and statistics - Articulatory Phonetics: Manner of articulation, Syllable, Voicing, Place of articulation - Acoustic Phonetics - Acoustics of speech production

UNIT II SPEECH ANALYSIS 9

Time-domain models for speech processing: Introduction to short-time speech analysis, windowing, short-time energy and average magnitude, short-time Zero Crossing Rate (ZCR), short-time autocorrelation function, short-time Average Magnitude Difference Function (AMDF) – Short-time Fourier analysis: Short-time Fourier transform (STFT), spectral displays, Filter bank analysis

UNIT III LINEAR PREDICTIVE CODING 9

Basic principles of Linear Predictive Coding (LPC) – LPC Analysis equations and examples - Autocorrelation method - Covariance method - LPC processor for speech recognition - LPC analysis parameters

UNIT IV SPEECH RECOGNITION MODELS 9

Discrete time Markov Processes-Extensions to Hidden Markov models(HMM): Coin toss models, The Urn and Ball model, Elements of HMM, HMM generator of observations - Types of HMMs - Comparison of HMMs

UNIT V SPEECH ENHANCEMENT 9

Common sources of speech degradation - Nature of interfering sounds - Speech Enhancement (SE) Techniques – Spectral Subtraction – Filtering and adaptive noise cancellation – Methods involving fundamental frequency tracking – Enhancement by resynthesis

Periods: 45

Course Outcomes:

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

CO1 : Explain the fundamentals of speech production, articulatory and acoustic phonetics.
CO2 : Apply time-domain analysis techniques for speech signal processing.
CO3 : Analyze speech signals in the frequency domain using Short-Time Fourier Transform and filter bank approaches.
CO4 : Explore Linear Predictive Coding techniques for speech analysis.
CO5 : Model speech signals using probabilistic approaches.
CO6 : Analyze basic speech enhancement techniques for improving speech quality.

Suggested Activities:

- Mini Project on Speech signal processing applications.

Text Books:

1. L. Rabiner, Biing-Hwang Juang and B. Yegnanarayana, 'Fundamentals of Speech Recognition', Pearson Education Inc.2009
2. Douglas O'Shaughnessy, Speech Communications - Human & Machine , 2nd Edition., Wiley India, 2000.

References:

1. Steven W. Smith, "The Scientist and Engineer's Guide to Digital Signal Processing", California Technical Publishing, 1997
2. Thomas F Quatieri, "Discrete-Time Speech Signal Processing – Principles and Practice", Pearson Education, 2003
3. Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", John Wiley and Sons, 1999.
4. Ben gold and Nelson Morgan, "Speech and audio signal processing", processing and perception of speech and music, Wiley- India Edition, 2006 Edition.
5. Frederick Jelinek, "Statistical Methods of Speech Recognition", MIT Press,1998

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1	1									2	3
CO2	3	2	1		1							2	3
CO3	3	2	1		1							2	3
CO4	3	2	1		1						1	2	3
CO5	2	3	1		1						1	2	3
CO6	2	2	2	2	2			1	1	1	2	2	3
Avg.	2.67	2	1.2	2	1			1	1	1	1.33	2	3

PEC2426 Natural Language Processing **PEC** **L T P C**

2 0 2 3

Course Objectives:

- To familiarize natural language processing basics
- To apply classification algorithms to text documents
- To introduce question answering and dialogue systems
- To impart knowledge on speech recognition system
- To introduce a speech synthesizer

UNIT I NATURAL LANGUAGE BASICS **6**

Introduction to Natural Language Processing – Language Syntax and Structure- Text Preprocessing and Wrangling – Text tokenization – Stemming – Lemmatization – Removing stop-words – Feature Engineering for Text representation – Bag of Words Model- Bag of N-Grams model – Term Frequency (TF) – Inverse Document Frequency model (IDF).

UNIT II TEXT CLASSIFICATION **6**

Vector Semantics and Embeddings -Word Embeddings - Word2Vec model – Glove model – Fast Text model – Overview of Deep Learning models: Recurrent Neural Network, Transformers – Text Summarization and Topic Modeling: Concepts, Techniques, and Applications.

UNIT III QUESTION ANSWERING AND DIALOGUE SYSTEMS 6

Introduction to Information Retrieval – IR based Question Answering – knowledge based question answering – Language models for QA – Classic QA models – Chatbots – Dialogue Systems:Design and Evaluation.

UNIT IV TEXT-TO-SPEECH SYNTHESIS 6

Introduction - Text normalization- Letter To Sound conversion - Prosody - Evaluation of TTS Systems - Signal Processing Approaches: Concatenative TTS, Parametric Approaches and Deep Learning based TTS systems.

UNIT V AUTOMATIC SPEECH RECOGNITION 6

Introduction to Automatic Speech Recognition - Convolutional NeuralNetworks - Encoder Decoder Architecture for ASR- Self Supervised models:HuBERT - CTC - ASR Evaluation:WordErrorRate .

Periods: 30

Laboratory Experiments:

1. Create Regular expressions in Python for detecting word patterns and tokenizing text
2. Getting started with Python and NLTK - Searching Text, Counting Vocabulary, Frequency Distribution, Collocations, Bigrams
3. Accessing Text Corpora using NLTK in Python
4. Write a function that finds the most frequently occurring words of a text that are not stop words.
5. Implement the Word2Vec model
6. Use a transformer for implementing classification
7. Design a chatbot with a simple dialog system
8. Convert text to speech and find accuracy
9. Design a speech recognition system and find the error rate.

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- Personal/Desktop Computers - 30
- Python / PyCharm or C++ / Visual Studio or equivalent

Course Outcomes:

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

CO7:

Suggested Activities:

- Quiz on natural language basics
- Assignment on Deep Learning Models
- Case study on speech recognition

Text Books:

1. Daniel Jurafsky and James H. Martin, “Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition”, Third Edition, 2022.

References:

1. Dipanjan Sarkar, “Text Analytics with Python: A Practical Real-World approach to Gaining Actionable insights from your data”, APress,2018.
2. Tanveer Siddiqui, Tiwary U S, “Natural Language Processing and Information Retrieval”, Oxford University Press, 2008.
3. Lawrence Rabiner, Biing-Hwang Juang, B. Yegnanarayana, “Fundamentals of Speech Recognition” 1st

Edition, Pearson, 2009. 4. Steven Bird, Ewan Klein, and Edward Loper, "Natural language processing with Python", O'REILLY.

MAPPING OF COs WITH POs AND PSOs

COs	Pos											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	1	2	2
CO2	3	3	2	-	2	-	-	-	-	-	1	2	2
CO3	3	3	2	2	1	-	-	-	-	-	1	2	2
CO4	3	3	3	2	2	-	-	-	-	-	1	2	2
CO5	3	3	3	3	2	-	-	-	-	-	1	2	2
CO6	3	3	3	2	3	-	-	-	-	-	1	2	2
Avg.	3	2.83	2.6	2.25	1.83	-	-	-	-	-	1	2	2

RF Technologies

PEC2431	**Electromagnetic Interference and Compatibility in Electronic Systems**	PEC	L	T	P	C
			3	**0**	**0**	**3**

Course Objectives:

- To develop an understanding of the fundamental principles of electromagnetic interference (EMI) and electromagnetic compatibility (EMC) in electronic systems.
- To enable analysis of interference mechanisms and signal integrity issues in high-speed electronic circuits.
- To equip students with the ability to implement effective EMI mitigation techniques such as grounding, shielding, and filtering.
- To provide knowledge of EMC standards, measurement techniques, and regulatory compliance requirements.
- To foster the ability to design and evaluate electronic systems for ensuring electromagnetic compatibility in real-world applications

UNIT I FUNDAMENTALS OF EMI/EMC 9

Introduction to EMI/EMC: Definitions, importance, and applications - Sources of EMI: Natural and man-made noise sources - Types of interference: Conducted and radiated EMI - Non-Ionizing Radiation: Sources, effects, exposure limits and safety considerations - Electromagnetic environment and compatibility requirements-Coupling mechanisms: Conductive coupling, Capacitive coupling, Inductive coupling, Radiative coupling - Basic EMC standards and regulatory bodies.

UNIT II TRANSMISSION LINES AND CROSSTALK 9

Transmission line theory basics - Reflection, impedance matching, and termination techniques - Signal integrity issues in high-speed circuits - Crosstalk: Near-end and far-end crosstalk, Causes and analysis - EMI in high-speed digital systems - PCB layout considerations for EMI control

UNIT III EMI CONTROL TECHNIQUES 9

Grounding and bonding techniques - Shielding effectiveness and materials - Filtering methods: Low-pass, high-pass, and band-pass filters, Power line filters - PCB design for EMI reduction - Decoupling and bypassing techniques - Cable shielding and routing

UNIT IV EMC TESTING AND STANDARDS 9

EMC standards and regulations (IEC, CISPR, FCC overview)- EMI measurement techniques - Conducted emission testing - Radiated emission testing - Immunity testing: ESD (Electrostatic Discharge) ,EFT (Electrical Fast Transients) ,Surge testing - Test setups and instrumentation

UNIT V ADVANCED EMC DESIGN AND APPLICATIONS 9

EMC issues in modern electronic systems -EMI in power electronics and communication systems -Signal integrity and EMI trade-offs - EMC in mixed-signal and RF systems - Case studies of EMC problems and solutions -Emerging trends in EMC (automotive, IoT, 5G systems)

Periods: 30

Course Outcomes:

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

CO1: Explain EMI sources, coupling mechanisms, and fundamental EMC concepts.
CO2: Analyze transmission line behavior, signal integrity, and crosstalk in electronic circuits.
CO3: Apply grounding, shielding, and filtering techniques to control electromagnetic interference.
CO4: Interpret EMC standards and perform EMI/EMC testing and measurement procedures.
CO5: Evaluate EMC issues in modern electronic systems such as power electronics, RF, and mixed-signal systems.
CO6: Design and recommend EMC-compliant solutions for advanced electronic applications.

Suggested Activities:

- EMI Analysis using EDA Tools (e.g., CST / HFSS / ADS)
  - Simulate radiated emissions and field distribution.
- EMC-Compliant PCB Design
  - Develop a PCB layout following EMC standards.

Text Books:

1. Electromagnetic Compatibility: Understanding, Design, and Testing with Practical Solutions M. Mardiguian, Electromagnetic Compatibility: Understanding, Design, and Testing with Practical Solutions, Cham, Switzerland: Springer, 2025.
2. Electromagnetic Compatibility: Principles and Applications, Y. Zhao, W. Yan, and Z. Zhao, Electromagnetic Compatibility: Principles and Applications, Singapore: Springer, 2021.
3. Electromagnetic Interference and Compatibility P. S. Crovetti, Ed., Electromagnetic Interference and Compatibility, Basel, Switzerland: MDPI, 2021.

References:

1. Electromagnetic Compatibility Engineering H. W. Ott, Electromagnetic Compatibility Engineering, Hoboken, NJ, USA: Wiley, 2009.
2. Introduction to Electromagnetic Compatibility C. R. Paul, Introduction to Electromagnetic Compatibility, 2nd ed., Hoboken, NJ, USA: Wiley, 2006.
3. EMC for Product Designers T. Williams, EMC for Product Designers, 5th ed., Oxford, U.K.: Newnes, 2016.
4. Noise Reduction Techniques in Electronic Systems H. W. Ott, Noise Reduction Techniques in Electronic Systems, 2nd ed., New York, NY, USA: Wiley, 1988.
5. High-Speed Digital Design: A Handbook of Black Magic, H. Johnson and M. Graham, High-Speed Digital Design: A Handbook of Black Magic, Upper Saddle River, NJ, USA: Prentice Hall, 1993.

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	–	–	–	–	–	–	–	–	–	2	1
CO2	3	2	1	1	1	–	–	–	–	–	–	2	-
CO3	3	3	2	1	1	–	–	–	–	–	–	3	-
CO4	3	2	3	1	2	–	–	–	–	-	–	3	-

CO / PO–PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO5	2	2	1	3	3	–	–	–	–	-	–	2	–
CO6	2	3	2	2	2	–	–	–	–	–	–	3	–

PEC2432 Passive RF and Microwave Integrated Circuits PEC L T P C

2 0 2 3

Course Objectives:

- To familiarize students with RF and microwave components and their characteristics
- To impart knowledge on impedance matching techniques using the Smith Chart
- To examine stability concepts for RF circuits and their implications in amplifier and oscillator design
- To explore RF control techniques for manipulation of signal properties
- To develop understanding of analysis and measurement of microwave components

UNIT I INTRODUCTION 6

Importance of Radio Frequency Design – Dimensions and Units – Frequency Spectrum - RF Behavior of Passive Components: Resistors at High Frequency, Capacitors at High Frequency, Inductors at High Frequency - Chip Components and Circuit Board Considerations - RF Circuit Manufacturing Processes.

UNIT II IMPEDANCE MATCHING NETWORKS 6

Impedance Matching Using Discrete Components - Circuit Representation of two port RF/Microwave Networks: Low Frequency Parameters, High Frequency Parameters –- Transmission Matrix, ZY Smith Chart.

UNIT III MICROWAVE AMPLIFIER AND OSCILLATOR DESIGN 6

Characteristics of microwave transistors – Stability considerations in active networks –
Gain consideration in Amplifiers – Noise consideration in active networks – Broadband Amplifier design – Design and stability considerations of Microwave Transistor Oscillators.

UNIT IV MIXERS AND CONTROL CIRCUITS 6

Mixer Types – Conversion Loss –Design of Mixers: SSB and DSB Mixers – Sub Harmonic Diode Mixers, Microwave Diodes, Phase Shifters – PIN Diode Attenuators

UNIT V MICROWAVE IC DESIGN AND MEASUREMENT TECHNIQUES 6

Microwave Integrated Circuits – MIC Materials- Hybrid versus Monolithic MICs – Multichip Module Technology – Measurement Techniques: Test fixture measurements, thermal and cryogenic measurements, and experimental field probing techniques.

Periods: 30

Laboratory Experiments:

1. Study of transmission line parameters – Impedance analysis
2. Design of impedance matching networks
3. Design of low pass and high pass filter
4. Design of band-pass and band-stop filters
5. Design of branch line couplers
6. Design of phase shifters
7. Design of Mixers
8. Design of Power dividers.

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

1.Microwave Test Benches
2.VSWR Meter
3.Computer Simulation Studio / Advanced Design System / Equivalent software
4.Desktop / Personal Computers
5.MATLAB with toolboxes

Course Outcomes:

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

CO1: Analyze Passive RF components at different frequency to design Microwave system.
CO2: Design Impedance Matching Networks using ZY Smith chart.
CO3: Perform stability analysis and be able to design amplifiers and oscillators at microwave frequencies
CO4: Design a mixer component to analyze and measure the input frequency in Microwave system
CO5: Design control circuits to manipulate signal properties such as amplitude and Phase.
CO6: Utilize modern CAD tools and Smith charts to solve complex RF engineering problems..

Suggested Activities:

- RF Component behavior analysis. CO1-PO4,PO5, PO6
- Study frequency-dependent behavior of: Resistors, capacitors, inductors using ADS or MATLAB
- Group Task: Solve Impedance matching problem using Smith Chart (Manual + Software) CO2-PO4,PO5,PO9
- Amplifier Stability- Ethical design to avoid unsafe oscillation . CO3- PO2, PO6, PO8
- Seminars CO6, PO10

Text Books:

1. 1. Jia Sheng Hong, M. J. Lancaster, “Microstrip Filters for RF/Microwave Applications”, John Wiley & Sons, 2001.
2. 2.David M. Pozar, “Microwave Engineering”, John Wiley & Sons, 4th edition 2012

References:

1. Reinhold Ludwig and Powel Bretchko, RF Circuit Design – Theory and Applications”,Pearson Education Asia, First Edition,2001.
2. Thomas H.Lee, “Planar Microwave Engineering”, Cambridge University Press, 2004
3. Matthew M. Radmanesh, “Radio Frequency and Microwave Electronics”, Pearson Education, 2002.

MAPPING OF COs WITH POs AND PSOs

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	–	–	–	–	–	–	–	1	2	1
CO2	3	2	3	1	–	–	–	–	–	–	2	2	1
CO3	3	2	1	–	1	–	–	–	–	–	1	3	2
CO4	3	2	2	1	1	–	–	–	–	–	1	3	2
CO5	3	3	2	2	1	–	–	–	–	–	1	3	1
CO6	3	3	3	2	2	–	–	–	-	-	2	3	1
Avg.	3	2.33	2.16	1.5	1.25	–	–	–	–	–	1.33	2.66	1.33

PEC2433	Electronic Warfare	PEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To explore the fundamental principles of Electronic Warfare, taxonomy and mission scenarios.
- To familiarise Electronic Counter Measures (ECM) techniques.
- To examine EW signal processing components and Radar Electronic Counter-Counter Measures
- To explore navigation and landing aid systems

UNIT I ELECTRONIC WARFARE PRINCIPLES 9

Electronic Warfare taxonomy- mission and scenarios- Introduction to Signals Intelligence (SIGINT)- Electronic Counter Measures (ECM)- Electronic Counter Countermeasures (ECCM)- Electronic Support Measure (ESM) receivers- Radar Warning Receivers (RWR)- current ESM receivers- Passive direction finding and emitter location

UNIT II ELECTRONIC COUNTER MEASURES 9

Noise jamming- Deception Electronic Counter Measures (DECM)- Range gate deception- Angle deception- ECM against conical scanning tracking radars- monopulse tracking radars and pulse compression- Velocity deception- Modern ECM systems- Expandable electronic counter measures

UNIT III RADAR ELECTRONIC COUNTER–COUNTER 9

Radar applications in weapon systems- Surveillance radars and their detection range – clear and jamming environments- Surveillance radars frequency tradeoffs and ECCM considerations- ECM jamming equations- Repeater jammer equations- EW receiver sensitivity.

UNIT IV EW SIGNAL PROCESSING 9

Signal environment – EM sensor subsystem- The receiver subsystem- The pre-processor- Data servo loop- Mile parameter tracking- Advanced pulley power- Managed jamming- EW technology and future trends

UNIT V NAVIGATION AND LANDING AIDS 9

Principles of automatic direction finders- DME- VOR- TACAN- Instrument landing system- Microwave landing system- GPS operation- 3D position determination- GPS based landing system.

Periods: 45

Course Outcomes:

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

CO1: Apply knowledge of engineering fundamentals to classify electronic warfare systems and their operational roles (Unit I)
CO2: Analyse noise jamming and deception ECM techniques against radar tracking systems. (Unit II)
CO3: Evaluate Electronic Counter Measures effectiveness and assess modern expandable ECM systems. (Unit II)
CO4: Solve ECM jamming and repeater jammer equations, and apply ECCM strategies for surveillance radars. (Unit III)
CO5: Analyse Electronic Warfare signal processing chains. (Unit IV)
CO6: Apply the working principles of VOR, TACAN, ILS, and GPS to determine 3D position and execute GPS-based landing approaches.(Unit V)

Suggested Activities:

- EW in Civil vs Defense systems
- GPS Spoofing & Public Safety
- EM spectrum usage & interference impact
- Ethics limits in Signal intelligence in EW
- Group Task on ECM vs ECCM strategy comparison.
- Seminars on Elecronic Warfare Systems.

Text Books:

1. Curtis Schleher. D. — 'Introduction to Electronic Warfare', Artech House Inc.,U.S.A., 1986
2. Skolnik, M.I. "Introduction to Radar System", Third Edition, McGrawHill, 2017.
3. Myron Kayton, Walter R. Fried, " Avionics Navigation Systems" John Wiley &Sons, 1997.
4. Nagaraja, N.S. "Elements of Electronic Navigation", Tata McGraw-Hill Pub.Co., New Delhi, 2nd edition, 2004.

References:

1. Col.K.Vishwanath. "Applications of Electronic Warfare", Global Press, 2025
2. Richard A. Poisel, "Electronic Warfare Target Location Methods",Artech House Publishers,2005

PEC2434	Advanced Antennas	PEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To introduce fundamental antenna concepts
- To develop knowledge on microstrip antennas
- To familiarize students with advanced antenna technologies
- To impart understanding of antennas used in various applications
- To provide insight into terahertz and nano-scale antennas

UNIT I ANTENNA PARAMETERS AND ARRAYS 6

Introduction –Types of Antennas – Radiation Mechanism – Current distribution on wire antennas – Maxwell's equations - Antenna fundamental parameters One Dimensional Arrays,Linear array –uniform array, end fire and broad side array, gain, beam width, side lobe level;Two dimensional uniform arrays;smart antennas,switched beam and adaptive arrays, phased arrays.

UNIT II MICROSTRIP ANTENNAS 6

Radiation Mechanism and Excitation techniques : Microstrip dipole; Patch, Rectangular patch, Circular patch, and Ring antenna – radiation analysis from cavity model; input impedance of rectangular and circular patch antenna; Microstrip array and feed network; Reconfiguration Mechanisms; Computer Aided Design of Microstrip Antennas, Microstrip Reflect array Antennas, Microstrip antenna for 5G mobile networks.

UNIT III ANTENNAS FOR 5G NETWORKS 6

Advanced antenna for 5G networks, digital and analog beam forming, Multi- antenna features, Multi user MIMO,cell-specific beam forming, UE-specific beam forming, advanced antenna system for network deployments, multi antenna performance in macro network deployments, deployment scenarios and considerations.

UNIT IV ANTENNAS FOR APPLICATIONS 6

Mobile phone antenna, base station, hand set antenna PIFA – Vivaldi Antennas – UWB Antennas - Antennas in Medicine – Leaky Wave Antennas – Plasma Antennas – Wearable Antennas – RFID Antennas - Automotive antennas, Reconfigurable antennas - Metamaterials.

UNIT V TETRAHERTZ AND NANO ANTENNAS 6

Material for Tera Hertz antennas. Tera Hertz sources, Tera Hertz antennas, Planar antenna and arrays, Reflect arrays, Lens antennas, Horn antennas, CNT antennas, Graphene antennas, applications of Tera Hertz antennas. Optical nano antennas and metamaterials.

Total Periods: 45

Course Outcomes:

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

CO1: Apply the operating principles, of different antennas to interpret their behavior and array configurations.
CO2: Design and analyze microstrip antennas and arrays using appropriate excitation techniques.
CO3: Evaluate advanced antenna technologies for 5G networks, including beamforming and multi-antenna systems.
CO4: Identify and compare antennas for practical applications such as mobile systems, medical devices, automotive, wearable and RFID.
CO5: Analyze the materials, design approaches, and performance characteristics of terahertz antennas, including planar arrays.
CO6: Interpret the principles of Nano-antennas and examine their applications with emphasis on metamaterial enhancements.

Suggested Activities

- 3D Animation videos Screening
- DIY Real time Experiments / Projects
- Seminars
- Article Reviews
- Peer Group Assignments

Text Books:

1. W.H. Hayt and J.A. Buck, Engineering electromagnetics, 7th ed., McGraw-Hill (India), 2006
2. M.N.O.Sadiku and S.V. Kulkarni, Principles of electromagnetics, 6th ed., Oxford(Asian Edition), 2015

References:

1. D.K. Cheng, Field and wave electromagnetics, 2nd ed., Pearson (India), 2002.
2. Kraus and Fleisch, Electromagnetics with applications, McGraw Hill Education; 5th edition, (1 July 2017).
3. Joseph A Edminister, Schaum's Outline of Electromagnetics, McGraw Hill Education; 2nd edition, July 2017
4. Edward C. Jordan and Keith G.Balmain, Electromagnetic Waves and Radiating Systems, Pearson Education, Second edition, 2015
5. David Morgan, A Handbook for EMC Testing and Measurement, IET Electrical Measurement Series 8, Paperback Edition 2007
6. Shoogo Ueno and Tsukasa Shigemitsu, Bioelectromagnetism History, Foundations and Applications, CRC Press, Taylor & Francis Group, 1st Edition, 2022

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	1	–	–	–	–	–	3	2
CO2	3	3	2	2	2	1	–	–	–	–	–	3	2

CO3	3	2	3	2	3	1	–	–	–	–	–	3	3
CO4	2	2	3	2	2	1	–	–	–	–	–	2	3
CO5	2	3	3	2	3	1	–	–	–	1	1	3	3
CO6	2	3	3	3	3	2	–	–	–	1	–	3	3
Avg.	**2.5**	**2.5**	**2.6**	**2**	**2.5**	**1.2**	**-**	**-**	**-**	**1**	**1**	**2.8**	**2.6**

PEC2435 Radar Technologies **PEC** **L T P C**

3 0 0 3

Course Objectives:

- To provide a strong foundation in radar principles and the influence of system parameters on radar performance.
- To develop analytical understanding of CW, MTI, and Pulse Doppler radar systems.
- To enable learners to examine tracking radar concepts and target state estimation for modern tracking applications.
- To impart knowledge of radar signal processing methods.

UNIT I INTRODUCTION TO RADAR SYSTEM 9

Radar fundamentals: The origin of Radar, Radar principles, Basic Block Diagram, Radar classifications based on Frequencies, Wave form and application, Detection, Range, velocity, Maximum Unambiguous Range - The simple form of the Radar equation, Pulsed radar equation - Detection of Signals in Noise - Receiver Noise, Signal-to-Noise Ratio- Probabilities of Detection and False Alarm - Integration of Radar Pulses, Radar Cross Section of Targets,- Transmitter Power, Pulse Repetition Frequency, Antenna Parameters, System losses.

UNIT II CW, MTI AND PULSE DOPPLER RADAR 9

CW and Frequency Modulated Radar - Airborne Doppler Navigation – Multiple Frequency CW Radar - Applications of CW-radar - MTI Radar: Delay Line Cancellers, Filter characteristics, Blind Speeds ,Staggered Pulse Repetition Frequencies - Doppler Filter Banks, Digital MTI Processing, Moving Target Detector, Limitations to MTI Performance - Pulse Doppler Radar.

UNIT III TRACKING RADAR 9

Tracking with Radar: Monopulse Tracking, Conical Scan, Sequential Lobing, Limitations to Tracking Accuracy, Low-Angle Tracking - Comparison of Trackers - Track while Scan (TWS) Radar- Comparison of Tracker- Target prediction, state estimation- Measurement models: alpha – beta tracker, Kalman Filtering, Extended Kalman filtering - Tracking with surveillance Radar:. Synthetic Aperture Radar (SAR), Drone based Synthetic Aperture Radar, Air Surveillance Radar, Height Finder and 3D Radar.

UNIT IV RADAR SIGNAL PROCESSING 9

Radar Signal Processing Fundamentals - Detection strategies: Optimal detection, Threshold detection, Constant False Alarm Rate detectors, Adaptive CFAR - Pulse compression waveforms, compression gain, LFM waveforms matched filtering, radar ambiguity functions, radar resolution - Detection of radar signals in Noise and clutter, types of clutters, methods to overcome the clutters - detection of non-fluctuating target in noise, Doppler spectrum of fluctuating targets, Range Doppler spectrum of stationary and moving radar.

UNIT V RADAR TRANSMITTERS AND RECEIVERS 9

Radar Transmitter: Linear Beam Power Tubes, Solid State RF Power Sources, Magnetron, Crossed Field Amplifiers,

Other RF Power Sources - Electronic Counter and Countermeasures - The Radar Receiver, Receiver noise power, Super heterodyne Receiver, Duplexers and Receiver Protectors - Radar Displays- Radar Antenna: Reflector Antennas , Electronically Steered Phased Array Antennas – Phase Shifters.

Total Periods: 45

Course Outcomes:

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

CO1: Identify the Radar parameters.
CO2: Differentiate various radar types.
CO3: Compare different tracking and filtering schemes
CO4: Apply signal processing in target detection.
CO5: List different types of clutter and methods to overcome the clutter & noise.
CO6: Design simple Radar transmitter and receiver blocks.

Suggested Activities

- Mini Project
- Journal Reviews

Text Books:

1. Habibur Rahman, Fundamental Principles of Radar, CRC press, Taylor and Francis, 2019.
2. M. R. Richards, J. A. Scheer, W. A. Holm, Editors "Principles of Modern Radar, Basic Principles", SciTech Publishing, 2012.

References:

1. Nathansan, "Radar design principles-Signal processing and environment", PHI, 2nd Edition,2007.
2. M.I.Skolnik , "Introduction to Radar Systems", Tata McGraw Hill 2006.
3. Mark A. Richards, "Fundamentals of Radar Signal Processing", McGraw-Hill, 2005.
4. A. Bekar, M. Antoniou and C. J. Baker, "High-Resolution Drone-Borne SAR using Off-the-Shelf High-Frequency Radars," 2021 IEEE Radar Conference (RadarConf21), 2021, pp. 1–6.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2	1	-	-	-	-	-	1	3	2
CO2	3	3	3	2	1	-	-	-	-	-	1	3	2
CO3	3	3	3	2	1	-	-	-	-	-	1	3	2
CO4	3	3	3	2	1	-	-	-	-	-	1	3	2
CO5	3	3	3	2	1	-	-	-	-	-	1	3	2
CO6	3	3	3	2	1	-	-	-	-	-	1	3	2
Avg.	**3**	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**2**

PEC2436	RF Microelectronics	PEC	L	T	P	C
			3	0	0	3

Course Objectives:

- Enable students to understand the fundamentals of RF systems.
- Develop the ability to model and evaluate RF passive components.
- Equip students with the knowledge to design and analyze RF amplifiers.
- Provide understanding of oscillator principles, including PLLs and VCOs.
- Enable students to analyze and design RF power amplifiers, considering efficiency, linearity, and practical design challenges.

UNIT I RF SYSTEMS & TRANSCEIVER ARCHITECTURES 9

Introduction to RF design and applications - Heterodyne and Homodyne receivers - Transmitter architectures - RF performance metrics: Noise figure, Linearity (IIP3, IP2), Dynamic range, blocking - Friis formula for cascaded systems -Impedance matching basics

UNIT II PASSIVE COMPONENTS & RF MODELING 9

Passive components in RF IC: Inductors, capacitors, resistors -CMOS implementation of RF components-Transmission line basics -S-parameters and Smith chart - Quality factor (Q) and losses - RF circuit modeling and parasitics

UNIT III RF AMPLIFIERS 9

Low Noise Amplifiers (LNA): Design considerations, Noise matching -RF amplifiers and gain stages -Mixers: Active and passive mixers, Conversion gain and non-linearity - Frequency translation principles.

UNIT IV OSCILLATORS & FREQUENCY SYNTHESIZERS 9

Basic oscillator theory -LC oscillators, Ring oscillators - Colpitts and Hartley oscillators - Negative resistance concept - Phase noise in oscillators - Voltage Controlled Oscillators (VCO) -PLL and frequency synthesizers

UNIT V RF POWER AMPLIFIERS 9

Power amplifier classifications: Class A, B, AB, C Switching amplifiers (Class D, E, F) -Efficiency vs linearity trade-off -Impedance matching in power amplifiers - Linearization techniques - RF power amplifier design issues

Periods: 30

Course Outcomes:

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

CO1: Understand RF system concepts and transceiver architectures
CO2: Analyze passive RF components and high-frequency models
CO3: Apply the concepts of LNAs, RF amplifiers, and mixers to determine gain, noise performance, and frequency translation.
CO4: Analyze oscillators and frequency synthesizers
CO5: Apply power amplifier classifications to determine efficiency and linearity characteristics.
CO6: Apply RF design concepts to real-world wireless systems

Suggested Activities:

- RF System Performance Analysis CO2-PO2,PO4,PO5
- Group Task: Evaluate Stability and Phase noise of RF LNA/Mixer/Oscillator CO4-PO9
- Seminar and Case Study: RF Amplifier Case Study

Text Books:

1. Behzad Razavi, RF Microelectronics, Pearson Education, 2nd Edition
2. Thomas H. Lee, The Design of CMOS Radio Frequency Integrated Circuits, Cambridge University Press

References:

1. Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGraw Hill
2. Ludwig & Bretchko, RF Circuit Design: Theory and Practice
3. David M. Pozar, Microwave Engineering
4. Gonzalez, Microwave Transistor Amplifiers

CO \ PO/PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	1	2	1
CO2	2	3	-	2	1	-	-	-	-	-	1	2	1
CO3	2	2	3	-	2	-	-	-	1	-	1	3	2
CO4	2	3	-	2	1	1	-	-	1	-	1	2	1
CO5	2	3	2	-	-	-	1	-	-	-	1	3	2
CO6	2	2	3	-	-	1	-	-	-	2	1	3	2
Avg.	2.16	2.5	2.66	2	1.33	1	1	v	1	2	1	2.5	1.5

Semiconductor chip design and testing

PEC2441	**Low power IC design**	**PEC**	**L**	**T**	**P**	**C**
			2	**0**	**2**	**3**

Course Objectives:

- Introduce the fundamental sources of power dissipation in CMOS circuits.
- Enable students to apply analytical and statistical techniques for estimating power consumption.
- Provide knowledge of various power optimization techniques at algorithm, logic, and circuit levels.
- To study voltage scaling, multiple supply voltage techniques, and methods to minimize switched capacitance for reducing power in digital circuits.
- Develop understanding of low-power arithmetic circuit architectures.
- Familiarize students with techniques for designing low-power SRAM architectures.

UNIT I BASICS OF LOW POWER DESIGN 6

Power dissipation in CMOS: Short circuit dissipation, Switching power dissipation, Leakage power dissipation, Load capacitance - Transistor leakage mechanisms: Reverse bias current, Weak inversion, Drain induced Barrier Lowering

effect, Gate induced drain leakage, punchthrough, Gate oxide tunnelling, Hot carrier injection

UNIT II POWER ESTIMATION 6

Signal Probability calculation - Probabilistic Techniques for signal activity estimation - Statistical Techniques - Estimation of Glitching power- Circuit level power estimation

UNIT III POWER OPTIMIZATION 6

Algorithm level, Logical level and Circuit level power optimization techniques - Power reduction techniques in digital circuits : Voltage scaling techniques, Multiple supply voltages and minimizing switched capacitance.

UNIT IV LOW VOLTAGE, LOW POWER ADDERS AND MULTIPLIERS 6

Parallel adders : Ripple carry adder, carry lookahead adder, carry select adder - Parallel multipliers: Braun multiplier, Baugh-Wooley multiplier, Modified Booth multiplier, Wallace tree multiplier

UNIT V LOW POWER STATIC RAM ARCHITECTURES 6

Organization of a static RAM - MOS Static RAM Memory cell - Banked organization of SRAMs - Reducing voltage swings on bit lines - Reducing power in write driver circuits - Reducing power in sense amplifier circuits - Method for achieving low core voltages from a single supply.

Periods: 30

List of experiments:

1. Power estimation and optimization at algorithmic level.
2. Power estimation and optimization at RTL level.
3. Power estimation and optimization at gate level.
4. Power estimation and optimization at circuit/ transistor levels
5. Mini Project

Periods: 30

Total Periods: 60

Laboratory requirements:

- Personal Computers
- Cadence EDA/Equivalent EDA tool
- Quartus / Xilinx software

Course Outcomes:

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

CO1: Explain the sources of power dissipation and leakage mechanisms in CMOS circuits.
CO2: Apply probabilistic and statistical techniques to estimate power consumption in digital circuits.
CO3: Compare algorithm-level, logic-level, and circuit-level power optimization strategies.
CO4: Apply suitable power reduction techniques to lower power dissipation in digital circuits.
CO5: Design low-power arithmetic units such as adders and multipliers for optimized performance.
CO6: Analyze SRAM architectures using low-voltage techniques to reduce memory subsystem power.

Suggested Activities

- Collaborative mini projects.
- Lab integrated activities.
- Review recent journal papers about low power.

Text Books:

1. Kaushik Roy, Sharat C. Prasad, "Low Power CMOS VLSI Circuit Design", John Wiley, & Sons, 2000.
2. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits – Analysis and Design",TMH, 2011.
3. Kiat-Seng Yeo, Kaushik Roy, "Low-Voltage, Low-Power VLSI Subsystems", TMH Professional Engineering, 2004.

References:

1. Ming-BO Lin, "Introduction to VLSI Systems: A Logic, Circuit and System Perspective", CRC Press, 2012.
2. Anantha Chandrakasan, "Low Power CMOS Design", IEEE Press, /Wiley International, 1998
3. Bellamour, M. I. Elamasri, "Low Power CMOS VLSI Circuit Design", A Kluwer Academic Press, 1995
4. Gary K. Yeap, "Practical Low Power Digital VLSI Design", Kluwer Academic Press, 2002

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2	1	1	1	1	-	1	3	3
CO2	3	2	2	1	2	-	-	1	1	-	1	3	3
CO3	3	2	2	1	2	-	1	1	1	-	1	3	3
CO4	3	2	2	1	2	-	1	1	1	-	1	3	3
CO5	3	2	2	1	2	1	1	1	1	-	1	3	3
CO6	3	2	2	1	2	1	-	1	1	-	1	3	3
Avg.	**3**	**2**	**2**	**1**	**2**	**1**	**1**	**1**	**1**	**-**	**1**	**3**	**3**

PEC2442 VLSI Testing and Design for Testability **PEC** **L T P C**

3 0 0 3

Course Objectives:

- To help students understand why testing is needed and learn basic fault models and test metrics.
- To teach scan design and BIST methods used to test digital circuits and SoCs.
- To introduce memory testing techniques and test interfaces like JTAG and boundary scan.
- To explain design and power-related issues that arise during testing.
- To provide an understanding of how analog and mixed-signal circuits are tested.

UNIT I TEST REQUIREMENTS AND METRICS **9**

Validation platforms : SOC design methodology, IP components, Integration, Clocking, I/Os and interfaces, Device modes, Logic, memories, analog, I/Os, power management - Test requirements : Test handoffs, Testers where DUT and DFT fit into design / framework – Test: ATPG, DFT, BIST,COF, TTR - Test cost metrics and test economics - Logic fault models : SAF, TDF, PDF, IDDQ, STBDG, Dy-BDG, SDD - Basics of test generation and fault simulation - Combinational circuits, Sequential - Specific algorithmic approaches - CAD framework - Optimisations.

UNIT II SCAN DESIGN AND BIST 9

Scan Design : Scan design requirements, Types of scan and control mechanisms, Test pattern construction for scan, Managing scan in IPs and SOCs, Scan design optimisations, Partitioning, Clocking requirements for scan and delay fault testing, Speed of operation – BIST: Framework, Controller configurations, FSMs, LFSRs, STUMPS architecture, Scan compression and bounds, Test per cycle, Test per scan, Self-testing and self-checking circuits, Online test

UNIT III MEMORY TEST AND TEST INTERFACES 9

Memory Test : Memory fault models, Functional architecture as applicable to test, Test of memories, Test of logic around memories, BIST controller configuration, Test of logic around memories, DFT and architecture enhancements, Algorithmic optimisations - Test Interfaces : Test control requirements, Test interfaces - 1500, JTAG, Hierarchical, serial control, Module / IP test, SOC test, Board test, System test, Boundary scan.

UNIT IV DESIGN CONSIDERATIONS AND POWER MANAGEMENT DURING TEST 9

Design considerations, Physical design congestion, Partitioning, Clocks, Test modes, Pins, Test scheduling, Embedded test, Architecture improvements, Test in the presence of security - Power management during test: Methods for low power test, ATPG methods, DFT methods, Scan methods, Low power compression, Test of power management, Implications of power excursions, Optimisations.

UNIT V ANALOG TEST 9

Test requirements - DFT methods - BIST methods - Test versus measurement - Defect tests versus performance tests - Tests for specific modules - PLL, I/Os, ADC, DAC, SerDes - RF test requirements.

Total Periods: 45

Course Outcomes:

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

CO1: Analyze the basic test requirements and fault models in digital systems.
CO2: Apply scan design techniques for testing sequential and combinational circuits.
CO3: Implement Built-In Self-Test (BIST) methods for logic and SoC components.
CO4: Explain memory testing strategies and use standard test interfaces such as JTAG.
CO5: Describe low-power test techniques.
CO6: Describe testing approaches for analog and mixed-signal circuits including PLLs, ADCs, DACs, and I/O modules.

Suggested Activities

- Journal/Article review.
- Seminars/Presentations
- Moodle interactive activities

Text Books:

1. M. L. Bushnell and V.D. Agrawal, “Essentials of Electronic Testing for Digital Memory and Mixed Signal VLSI Circuits”, Springer, 2006

References:

1. H. Fujiwara, Logic Testing and Design for Testability, MIT Press, 1985.
2. M. Abramovici, M. Breuer, and A. Friedman, Digital System Testing and Testable Design, IEEE Press, 1994
3. M. Huth and M. Ryan, Logic in Computer Science, Cambridge Univ. Press, 2004
4. T. Kropf, Introduction to Formal Hardware Verification, Springer Verlag, 2000.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	1	3	2
CO2	3	2	1	-	-	-	-	-	-	-	1	3	2
CO3	3	2	1	-	-	-	-	-	-	-	1	3	2
CO4	3	2	1	-	-	-	-	-	-	-	1	3	2
CO5	3	2	1	-	-	-	-	-	-	-	1	3	2
CO6	3	2	1	-	-	-	-	-	-	-	1	3	2
Avg.	**3**	**2**	**1**	-	-	-	-	-	-	-	**1**	**3**	**2**

PEC2443 CMOS Analog IC Design **PEC** **L T P C**

2 0 2 3

Course Objectives:

- To provide a foundation on MOS device characteristics.
- To develop an understanding of single-stage and differential amplifier configurations.
- To introduce frequency response, noise behaviour of single-stage and differential amplifiers.
- To familiarise with feedback concepts, operational amplifiers, and stability considerations.
- To discuss biasing techniques and bandgap reference circuits.

UNIT I BASICS OF MOS DEVICE AND ANALOG AMPLIFIER CIRCUITS 6

MOS I-V Characteristics - MOS Device models – Single stage amplifiers: Common Source (CS), Source follower, Common Gate (CG) and Cascode and Folded Cascode stages – Design of Differential amplifiers

UNIT II FREQUENCY RESPONSE AND NOISE CHARACTERISTICS OF AMPLIFIERS 6

Miller effect – Association of poles with nodes – Frequency response of CS, Source follower, CG, Cascode and Differential pair stages – Noise: Statistical characteristics, Noise in single stage amplifiers and differential amplifiers.

UNIT III FEEDBACK AND SINGLE STAGE OPERATIONAL AMPLIFIER 6

Properties of Feedback circuits – Feedback topologies – Effect of loading in feedback networks – Effect of feedback on noise – Single stage and two stage Operational Amplifiers – Slew rate – Power supply rejection

UNIT IV STABILITY AND FREQUENCY COMPENSATION 6

Multipole Systems, Phase Margin, Frequency Compensation, Compensation of Two Stage Op Amps, Slewing in Two Stage Op Amps, Other Compensation Techniques

UNIT V BANDGAP REFERENCES 6

Supply independent biasing – Temperature independent references : Negative and Positive TC voltage, Bandgap reference circuit

Periods: 30

Laboratory Experiments:

1. Design and performance analysis of Common source amplifier.
2. Design and performance analysis of Common drain amplifier.
3. Design and performance analysis of Common gate amplifier.
4. Design and performance analysis of a differential amplifier with a resistive load.
5. Frequency response analysis of Common Source amplifier.
6. Design three stage and five stage ring oscillator circuit and compare its frequencies
7. Design of a single-stage operational amplifier and measurement of Slew rate.
8. Design and analysis of Bandgap reference circuit.

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- Personal Computers : 15 Nos
- Cadence EDA/Equivalent EDA tool: 10 Nos

Course Outcomes:

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

CO1: Explore MOS devices and their characteristics.
CO2: Design single-stage amplifiers (CS, CG, CD, and Cascode) and differential amplifiers.
CO3: Analyze frequency response and noise characteristics of analog amplifier circuits
CO4: Design operational amplifiers considering feedback, slew rate, and stability.
CO5: Examine stability and frequency compensation techniques in 2-stage operational amplifiers.
CO6: Develop supply-independent biasing and temperature-independent reference circuits using bandgap principles.

Suggested Activities:

- Mini Project : Design and simulation of a simple analog system integrating amplifier stages, biasing circuits, and signal conditioning blocks.

Text Books:

1. Behzad Razavi, “Design Of Analog Cmos Integrated Circuits”, Tata Mcgraw Hill, Second edition, 2017.
2. Phillip E.Allen, Douglas R .Holberg, “Cmos Analog Circuit Design”, Oxford University Press, 2nd Edition, 2002

References:

1. Willey M.C. Sansen, “Analog Design Essentials”, Springer, 2006.
2. Grebene, “Bipolar And Mos Analog Integrated Circuit Design”, John Wiley & Sons,Inc.,2003.
3. Recorded Lecture available at http://www.ee.iitm.ac.in/vlsi/courses/ee5320_2021/start
4. Jacob Baker “CMOS: Circuit Design, Layout, And Simulation, Wiley IEEE Press, 3rd Edition,2010

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	2	-	-	2	2		1	3	3
CO2	3	3	2	2	2	-	-	2	2		1	3	3
CO3	3	3	2	2	2	-	-	2	2		1	3	3
CO4	3	3	2	2	2	-	-	2	2		1	3	3
CO5	3	3	2	2	1	-	-	-	-		1	3	3
CO6	3	3	2	2	2	-	-	2	2	1	1	3	3
Avg.	3	2	2	1	2	-	-	2	2	1	1	3	3

PEC2444	Mixed Signal IC Design	PEC	L	T	P	C
			2	0	2	3

Course Objectives:

- To introduce the fundamentals of sampling techniques and switched-capacitor circuits .
- To develop understanding of CMOS analog building blocks.
- To explain the principles and architectures of data converters.
- To impart knowledge on clocking mechanisms and oscillators used in mixed-signal circuits.
- To provide an overview of CMOS filters and their role in signal conditioning within mixed-signal systems.

UNIT I SAMPLING AND SWITCHED CAPACITOR FUNDAMENTALS 6

Impulse sampling – Sampling circuits - Performance metrics – CMOS Sampling switch – Open loop Sample and Hold architecture with miller capacitance - Switched capacitor amplifiers : Unity gain amplifier, Noninverting amplifier – Switched capacitor integrator – Switched capacitor common mode feedback

UNIT II ANALOG BUILDING BLOCKS 6

Open loop MOS Differential pair amplifier – Closed loop MOS amplifier – Operational Amplifiers : Two stage Op Amps, Cascode Op Amps – CMOS Comparators

UNIT III DATA CONVERTORS 6

R-2R DAC implementation – Op-amps in Data convertors – ADC implementation: Cyclic ADC, Pipeline ADC – Quantization and Performance metrics of ADC and DAC

UNIT IV OSCILLATORS AND CLOCKING 6

Ring Oscillator – LC Oscillator – Voltage controlled Oscillators - Clock generation and distribution - Clock skew – Jitter - duty cycle distortion - phase noise - Non-overlapping clocking in switched capacitor circuits - Introduction to PLL

UNIT V CMOS FILTERS 6

Lowpass filters – Active RC integrators – MOS-C Integrators – Transconductor C integrators – Discrete time integrators

Periods: 30

Laboratory Experiments:

1. Simulation of Sampling and Aliasing.
2. Design of CMOS Sampling Switch and Sample-and-Hold Circuit.
3. Design of Switched-Capacitor Amplifier.
4. Design of Switched-Capacitor Integrator.
5. Design and Simulation of R–2R Ladder DAC.
6. Design and Simulation of ADC
7. Design of CMOS Filter.

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- Personal Computers : 15 Nos

- Cadence EDA/Equivalent EDA tool: 10 Nos

Course Outcomes:

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

CO1: Explain the principles of sampling techniques and sample-and-hold circuits and switched-capacitor circuits.
CO2: Describe the operation of switched-capacitor circuits including amplifiers and integrators.
CO3: Analyze the characteristics and operation of CMOS analog building blocks.
CO4: Explore the architectures and performance of ADCs and DACs.
CO5: Analyze clock generation mechanisms and Oscillators deployed in mixed-signal systems.
CO6: Examine the operation of CMOS filters and discrete-time integrators in mixed-signal system.

Suggested Activities:

- Mini Project : Design and Simulation of a Mixed-Signal Sensor Interface System.

Text Books:

1. Jacob Baker "CMOS: Mixed Signal Circuit Design", Wiley IEEE Press, 3rd Edition,2010
2. Behzad Razavi, "Principles of Data Conversion System Design", Wiley, 1994

References:

1. Behzad Razavi, "Design Of Analog Cmos Integrated Circuits", Tata Mcgraw Hill, Second edition, 2017.
2. Phillip E.Allen, Douglas R .Holberg, "Cmos Analog Circuit Design", Oxford University Press, 2nd Edition, 2002
3. Willey M.C. Sansen, "Analog Design Essentials", Springer, 2006.
4. Grebene, "Bipolar And Mos Analog Integrated Circuit Design", John Wiley & Sons,Inc.,2003.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	2	-	-	2	2	1	1	3	3
CO2	3	3	2	2	2	-	-	2	2	1	1	3	3
CO3	3	3	2	2	2	-	-	2	2	1	1	3	3
CO4	3	3	2	2	2	-	-	2	2	1	1	3	3
CO5	3	3	2	2	1	-	-	1	1	1	1	3	3
CO6	3	3	2	2	2	-	-	2	2	1	1	3	3
Avg.	3	2	2	1	2	-	-	2	2	1	1	3	3

PEC2445 System On Chip Design **PEC** **L T P C**

3 0 0 3

Course Objectives:

- To introduce the fundamentals of System-on-Chip (SoC) design flow, architecture, and its key components.
- To develop understanding of processor architectures, instruction handling, and advanced processing techniques used in SoC systems.
- To provide knowledge of memory design principles, cache organization, and memory hierarchy in SoC environments.
- To familiarize students with bus-based and Network-on-Chip (NoC) interconnect architectures.

- To impart concepts of SoC implementation including design for testability, physical design flow, and verification techniques.

UNIT I INTRODUCTION TO SoC AND PROCESSORS 9

SoC Development life cycle- SoC Design flow – Components of SoC – Hardware and Software – Functional and architectural views of Processor - Processor Selection - Instruction set – Buffers - Branches – VLIW Processor – Superscalar Processor

UNIT II SoC MEMORY DESIGN 9

Outline for memory design – Flash memory – Cache memory and organization – Cache data and write policies – SoC memory systems – DRAM and memory array – Memory interaction

UNIT III SoC INTERCONNECT 9

Overview of Interconnect architecture – Bus architecture – SoC standard buses: AMBA, Coreconnect– Network on Chip(NoC) with switch interconnects – Layered architecture and Network Interface Unit – Evaluation of interconnect networks

UNIT IV SoC DESIGN FOR TESTABILITY 9

Need for testability – SoC design for testability guidelines – DFT logic insertion techniques: Scan insertion, Boundary scan, Boundary scan insertion flow, Memory Built-in Self-Test(BIST) , ROM Test algorithm, Power Aware Test Module Insertion (PATM), On SoC Clock Generation (OSCG) insertion – Memory clustering – DFT simulations – ATPG pattern generation – Automatic Test Equipment Testing – DFT tools

UNIT V SoC PHYSICAL DESIGN 9

Re-convergent model – File formats – Physical design : Stick diagrams, Design setup and floorplan, Floorplanning, Placement, Physical Design constraints, Clock tree synthesis, Routing, ECO implementation, Photolithography and mask pattern – Basics of SoC Physical design verification and Packaging

Periods: 45

Course Outcomes:

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

CO1: Explain the SoC design flow and its components.
CO2: Analyze processor architectures for SoC.
CO3: Analyze memory organization, cache mechanisms, and memory hierarchy in SoC design.
CO4: Describe interconnect architectures including standard bus protocols and Network-on-Chip (NoC) systems.
CO5: Apply design for testability (DFT) techniques in SoC design.
CO6: Demonstrate the physical design flow and basic verification in SoC implementation.

Suggested Activities:

- Mini Project : Simple SoC-based hardware–software integrated system.

Text Books:

1. Michael J.Flynn and Wayne Luk,“Computer System Design: System-on-Chip”, Wiley,2011.
2. Veena S. Chakravarthi, “A Practical Approach to VLSI System on Chip (SoC) Design”, 2020

References:

1. Rochi Rajsuman,“System-on-a-chip: Design and test”, Advantest America R&D Center, 2000.
2. Hubert Kaeslin,“Digital Integrated Circuit Design:From VLSI Architectures to CMOS Fabrication”, Cambridge University Press,2008.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	2	3	3
CO2	3	2	1	1	-	-	-	-	-	-	2	3	3
CO3	3	2	1	1	-	-	-	-	-	-	2	3	3
CO4	3	2	1	1	-	-	-	-	-	-	2	3	3
CO5	3	2	2	2	3	-	-	2	1	1	2	3	3
CO6	3	3	2	2	3	-	-	2	1	1	2	3	3
Avg.	3	2.66	1.33	1.33	3	-	-	2	1	1	2	3	3

PEC2446 VLSI Signal Processing **PEC** **L T P C**

3 0 0 3

Course Objectives:

- To understand how DSP algorithms are represented and implemented in hardware.
- To learn techniques like pipelining, parallel processing, retiming, folding, and unfolding for improving system performance.
- To study systolic array design for efficient realization of DSP systems.
- To understand fast convolution methods and bit-level arithmetic architectures used in DSP hardware design.

UNIT I DSP SYSTEMS AND ALGORITHMS 9

Introduction - Overview of typical DSP Algorithms - Representations of DSP algorithms: Block diagram - Signal flow graph - Data flow graph - Dependence graph - Pipelining and parallel processing: Introduction, Pipelining and parallel processing of FIR digital filters

UNIT II ITERATION BOUND AND RETIMING 9

Iteration Bound: loop bound and iteration bound, Longest path matrix algorithm for iteration bound computation - Introduction to Retiming - Definition and properties of retiming - Solving system of inequalities – Cutset retiming and pipelining techniques for retiming

UNIT III FOLDING AND UNFOLDING 9

Unfolding: Introduction, Algorithm for unfolding, Properties of unfolding – Folding: Introduction, Folding transformation, Register minimization techniques.

UNIT IV SYSTOLIC ARCHITECTURE DESIGN 9

Introduction - Systolic Array Design Methodology - FIR Systolic Arrays - Selection of Scheduling Vector - Matrix Multiplication and 2D Systolic Array Design

UNIT V CONVOLUTION AND BIT LEVEL ARITHMETIC ARCHITECTURES 9

Fast Convolution: Cook-Toom Algorithm, Winograd Algorithm, Iterated Convolution and Cyclic Convolution – Bit level arithmetic architectures: parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, design of Lyon's bit-serial multipliers using Horner's rule

Total Periods: 45

Course Outcomes:

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

CO1: Represent DSP algorithms using suitable graphical models.
CO2: Apply pipelining and parallel processing techniques to speed up DSP systems.
CO3: Use iteration bound and retiming concepts to optimize DSP hardware.
CO4: Perform folding and unfolding transformations to reduce hardware resources.
CO5: Design systolic array architectures for DSP applications.
CO6: Apply fast convolution and bit-level arithmetic methods in efficient hardware implementation.

Suggested Activities

- Problem solving sessions.
- Case study discussions.
- Journal/Article review.

Text Books:

1. R. Keshab K. Parhi, " VLSI Digital Signal Processing Systems, Design and implementation ", Wiley, Interscience, 2007.

References:

1. Mohammed Ismail, Terri, Fiez, Analog VLSI Signal and Information Processing, McGraw Hill, 1993.
2. U. Meyer – Baese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer, Second Edition, 2004
3. Kung. S.Y., H.J. While house T.Kailath, VLSI and Modern signal processing, Prentice Hall,1985 .

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	1	1	-	-	-	-	-	-	1	3	2
CO2	3	2	2	1	-	-	-	-	-	-	1	3	2
CO3	3	2	2	1	-	-	-	-	-	-	1	3	2
CO4	3	2	2	1	-	-	-	-	-	-	1	3	2
CO5	3	2	2	1	-	-	-	-	-	-	1	3	2
CO6	3	2	2	1	-	-	-	-	-	-	1	3	2
Avg.	**3**	**2**	**1.8**	**1**	-	-	-	-	-	-	**1**	**3**	**2**

Embedded and IoT

PEC2451	Embedded C Programming	PEC	L	T	P	C
			2	0	2	3

Course Objectives:

- To inculcate understanding of the fundamentals of Embedded C programming for microcontrollers
- To facilitate development of simple Embedded C programs for 8051 and ARM7
- To give key insights of Interfacing basic peripherals using Embedded C
- To apply programming concepts to build simple embedded applications
- To ensure gain of confidence in coding for embedded systems

UNIT I INTRODUCTION TO EMBEDDED C PROGRAMMING 6

Embedded C vs Standard C – Structure of Embedded C program – Data types and variables – Operators and expressions – Control statements (if, switch, loops) – Basic embedded programs – Development tools (Keil IDE for 8051 and ARM7)

UNIT II PROGRAMMING CONSTRUCTS IN EMBEDDED C 6

Functions and parameter passing – Arrays and strings – Introduction to pointers – Pointer operations – Pointer usage in embedded systems – Modular programming techniques – Simple program development using functions

UNIT III EMBEDDED C PROGRAMMING FOR 8051 6

I/O port programming using Embedded C – LED interfacing – Switch interfacing – Delay generation using software – Basic timer programming – Interrupt programming-UART communication – Simple application programs using 8051

UNIT IV EMBEDDED C PROGRAMMING FOR ARM7 6

Introduction to ARM7 (LPC2148) programming – GPIO programming using Embedded C – LED and switch interfacing – Delay generation – Basic UART communication – Comparison of 8051 and ARM7 programming approaches

UNIT V APPLICATIONS USING EMBEDDED C 6

Interfacing using Embedded C with 8051 and ARM 7: LCD,Sensor interfacing – Simple application development – Case studies: Home automation and simple control systems

Periods: 30

Laboratory Experiments:

1. **Introduction to Embedded C using 8051**
   - Develop and execute basic Embedded C programs (data types, operators, control statements) using Keil IDE
2. **I/O Port Programming – 8051**
   - LED interfacing with different patterns (blinking, running LED)
   - Switch interfacing for input detection
3. **Timer and Delay Programming – 8051**
   - Generate precise delays using software loops and hardware timers
   - Implement timer-based LED blinking
4. **UART Communication – 8051**
   - Serial transmission and reception using Embedded C
   - Display transmitted data patterns
5. **GPIO Programming – ARM7 (LPC2148)**

- LED interfacing and control using GPIO registers
- Switch interfacing and input handling

6. **Delay and Timer Programming – ARM7 (LPC2148)**
   - Generate delays using software and timers
   - Implement timing-based applications
7. **UART Communication – ARM7 (LPC2148)**
   - Serial communication using UART
   - Transmit and receive data between devices
8. **Interfacing Application using 8051 / ARM7**
   - Develop a mini project (e.g., LED control system or simple automation)
   - Implementation, testing, and debugging of the application

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- 30 -High end desktop systems
- KEIL 4 & 5 IDE software
- 8051 development board
- ARM 7/ Cortex Arm boards

Course Outcomes:

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

CO1: Interpret the fundamentals of Embedded C programming
CO2: Develop simple programs using Embedded C constructs
CO3: Implement peripheral interfacing using Embedded C
CO4: Apply Embedded C programming for 8051
CO5: Apply Embedded C programming for ARM7
CO6: Develop simple embedded applications using Embedded C

Suggested Activities:

- IDE simulation.
- Case study - Modelling of Embedded C concepts.
- Mini Project – Embedded System Application

Text Books:

1. Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin D. McKinlay, The 8051 Microcontroller and Embedded Systems Using Assembly and C, Pearson Education, Second Edition, 2008.
2. Richard H. Barnett, Larry O'Cull, and Sarah Cox, Embedded C Programming and the Microchip PIC, Pearson Education, 2007.

References:

1. Andrew N. Sloss, Dominic Symes, and Chris Wright, ARM System Developer's Guide, Elsevier, 2004.
2. Michael Barr and Anthony Massa, Programming Embedded Systems in C and C++, O'Reilly Media, Second Edition, 2006.

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	2	–	–	2	2	–	1	2	2
CO2	3	2	-	-	3	–	–	2	2	–	1	2	2
CO3	3	3	1	1	3	1	–	2	2	-	1	3	2
CO4	3	3	1	1	3	1	1	2	2	1	1	3	3
CO5	3	3	1	1	3	2	1	2	2	1	1	3	3
CO6	3	2	1	1	3	2	1	2	3	1	2	3	3

PEC2452	Real Time Operating Systems	PEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To inculcate the fundamentals of operating systems and embedded operating systems
- To enable learning of the concepts and working principles of RTOS.
- To develop the ability to analyze scheduling, synchronization, and inter-process communication mechanisms
- To build competency in understanding real-time system models and task management techniques
- To explore RTOS kernel design and implementation concepts
- To apply RTOS concepts in real-world embedded system applications

UNIT I INTRODUCTION TO OPERATING SYSTEMS AND EMBEDDED OS 9

Basic Principles of Operating Systems – OS Structures – System Calls – Files – Processes – Process Design and Implementation – Interprocess Communication – Introduction to Distributed OS – Embedded Operating Systems

UNIT II OVERVIEW OF REAL TIME OPERATING SYSTEMS 9

RTOS Concepts – Tasks and Task States – Multithreaded Preemptive Scheduling – Process Synchronization – Message Queues – Mailboxes – Pipes – Critical Section – Semaphores – Classical Synchronization Problems – Deadlocks

UNIT III REAL TIME MODELS AND SCHEDULING 9

Event-Based Models – Process-Based Models – Graph-Based Models – Real-Time Languages – RTOS Tasks – Scheduling Techniques – Interrupt Processing – Synchronization – Control Blocks – Memory Requirements

UNIT IV REAL TIME KERNEL DESIGN 9

RTOS Kernel Principles – Design Issues – Polled Loop Systems – RTOS Porting – Kernel Architecture – Comparison of RTOS: VxWorks, Linux-based RTOS, µC/OS, C Executive

UNIT V RTOS APPLICATIONS AND CASE STUDIES 9

Linux-based RTOS – µC/OS – C Executive – RTOS Application Development – Task Management – Inter-task Communication – Case Study: Automotive Systems and Embedded Application

Periods: 45

Course Outcomes:

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

CO1: Explain operating system concepts and embedded OS fundamentals.
CO2: Apply RTOS concepts such as scheduling and task management.
CO3: Analyze synchronization and inter-process communication mechanisms.
CO4: To examine real-time models and scheduling techniques.
CO5: Explain RTOS kernel design and implementation.
CO6: Design RTOS-based applications for real-world systems.

Suggested Activities:

- Case study
- Simulation
- Modelling using IDE

Text Books:

1. David. E. Simon, "An Embedded Software Primer", 1st Edition, Fifth Impression, Addison-Wesley Professional, 2007.
2. Jane.W.S .Liu, Real – Time Systems, Pearson Education, 2003
3. Raj Kamal, "Embedded Systems- Architecture, Programming and Design" Tata McGraw Hill,2006.

References:

1. Silberschatz,Galvin,Gagne" Operating System Concepts,6th ed,John Wiley,2003
2. Charles Crowley, "Operating Systems-A Design Oriented approach" McGraw Hill,1997
3. Lyla B.Das, Embedded Systems: An Integrated Approach, Pearson Education 2013.
4. Jane.W.S .Liu, Real – Time Systems, Pearson Education, 2003.
5. Karim Yaghmour,Building Embedded Linux System",O'reilly Pub,2003
6. MukeshSighal and N G Shi "Advanced Concepts in Operating System", McGraw Hill,2000

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	-	2	-	-	1	1	-	1	3	3
CO2	3	3	2	-	2	1	-	2	1	1	1	3	3
CO3	3	3	2	-	2	1	-	1	1	-	2	3	3
CO4	3	3	2	-	2	2	-	1	1	-	2	3	3
CO5	3	2	1	-	2	-	-	1	1	1	1	3	3
CO6	3	3	2	2	2	2	2	3	3	3	3	3	3

PEC2453 IoT Processors **PEC** **L T P C**

2 0 2 3

Course Objectives:

- Learn the architecture and features of ARM.
- Study the exception handling and interrupts in CORTEX M3
- Program the CORTEX M3
- Learn the architecture of STM 32L15XXX ARM CORTEX M3/M4 microcontroller.
- Understand the concepts of System – On – Chip (SoC)

UNIT I OVERVIEW OF ARM AND CORTEX-M3 **6**

ARM Architecture – Versions, Instruction Set Development, Thumb 2 and Instruction Set Architecture, Cortex M3 Basics: Registers, Stack Pointer, Link Register, Program Counter, Special Registers, Operation Mode, Exceptions and Interrupts, Vector Tables, Stack Memory Operations, Reset Sequence, CORTEX M3 Instruction Sets: Assembly Basics, Instruction List, Instruction Descriptions, CORTEX M3 – Implementation Overview: Pipeline, Block Diagram. Bus Interfaces, I – Code Bus, D – Code Bus, System Bus- External PPB and DAP Bus.

UNIT II CORTEX EXCEPTION HANDLING AND INTERRUPTS **6**

Exception Types, Priority, Vector Tables, Interrupt Inputs and Pending behaviour, Fault Exceptions, Supervisor Call and Pendable Service Call, NVIC: Nested Vector Interrupt Controller, Overview, Basic Interrupts, SYSTICK Time, Interrupt Behaviourm Interrupt/Exception Sequences, Exception Exits, Nested Interrupts, Tail – Chaining Interrupts, Late Arrivals and Interrupt Latency.

UNIT III CORTEX M3/M4 PROGRAMMING **6**

Cortex M3/M4 Programming: Overview, Typical Development Flow, Using C, CMSIS Using Assembly, Excepiton Programming Using Interrupts, Exception/Interrupt Handlers, Software Interrupts, Vector Table Relocation, Memory

Protection Unit and other CORTEX M3 Features, MPU Registers, Setting up the MPU, Power Management, Multiprocessor Configuration.

UNIT IV **STM32L15XXX ARMCORTEX M3/M4 MICROCONTROLLER AND DEBUGGING TOOLS** **6**

STM32L15XXX ARM CORTEX M3/M4 Microcontroller: Memory and Bus Architecture, Power Control, Reset and Clock Control, STM32L15XXX Peripherals: GPIOs, System Configuration Controller, NVIC, ADC, Comparators, GP Timers, USART Development and Debugging Tools: Software and Hardware tools like Cross Assemblerm Compiler, Debugger, Simulator, In – Circuit Emulator(ICE), Logic Analyser.

UNIT V **INTRODUCTION TO SYSTEM – ON – CHIP** **6**

System Architecture: An Overview, Components of the System Processors, Memories and Interconnects, Processor Architectures, Memory and Addressing, System Level Interconnection – An Approach for SOC Design – Chip basics – Cycle Time – Die Area – Power and Cost – Area, Power and Time Trade – Offs in Processor Design – Reliability and Configurability – SOC Design Approach – Application Studies – AES, 3D Graphics Processor. Image Compression and Video Compression.

Periods: 30

Laboratory Experiments:

ARM Assembly Programming

1. Write a program to add two 32-bit numbers stored in r0 and r1 registers and write the result to r2. The result is stored to a memory location. a) Run the program with breakpoint and verify the result b) Run the program with stepping and verify the content of registers at each stage.
2. Write ARM assembly to perform the function of division. Registers r1 and r2 contain the dividend and divisor, r3 contains the quotient, and r5 contains the remainder.

Embedded C Programming on ARM Cortex M3/M4 Microcontroller

1. Write a program to turn on green LED (Port B.6) and Blue LED (Port B.7) on STM32LDiscovery by configuring GPIO.
2. Transmit a string “Programming with ARM Cortex” to PC by configuring the registers of USART2. Use polling method.

ARM Cortex M3/M4 Programming with CMSIS

1. Write a program to toggle the LEDs at the rate of 1 sec using standard peripheral library. Use Timer3 for Delay.
2. Transmit a string “Programming with ARM Cortex” to PC by using standard peripheral library with the help of USART3. Use polling method.

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

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Course Outcomes:

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

CO1: Explain the architecture and features of ARM.
CO2: List the concepts of exception handling.
CO3: Write a program using ARM CORTEX M3/M4.
CO4: Learn the architecture of STM32L15XXX ARM CORTEX M3/M4.
CO5: Design an SoC for any application.

Suggested Activities:

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Text Books:

1. Joseph Yiu, The Definitive Guide to the ARM CORTEX M3/M4, Second Edition, Elsevier, 2010.(Unit – I, II)
2. Andrew N Sloss, Dominic Symes, Chris Wright, ARM System Developers Guide Designing and Optimising System Software, Elsevier, 2006 (Unit – III, IV)
3. Michael J Flynn and Wayne Luk, Computer System Design, System On Chip, Wiley India 2011.(Unit – V)

References:

1. Steve Furber, ARM System – on – Chip Architecture, 2nd Edition, Pearson, 2015.
2. CORTEX M Series ARM Reference Manual
3. CORTEX M3 Technical Reference Manual
4. STM32L152XX ARM CORTEX M3 Microcontroller Reference Manual 5/97

PEC2454	Wireless Sensor Network Design	PEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To understand the fundamentals of wireless sensor network
- To gain knowledge on the MAC, Routing Protocols of WSN
- To get exposed to 6LoWPAN technology
- To acquire knowledge on the protocols required for developing real time applications using WSN and 6LoWPAN.
- To gain knowledge about operating system related to WSN

UNIT I INTRODUCTION 9

Principle of Wireless Sensor Network - Introduction to wireless sensor networks: Challenges, Comparison with ad hoc network, Node architecture and Network architecture, design principles, Service interfaces, Gateway, Short range radio communication standards-IEEE 802.15.4 - Zigbee and Bluetooth - Physical layer characteristics and Communication considerations.

UNIT II MAC AND ROUTING PROTOCOLS 9

MAC protocols: Fundamentals, low duty cycle protocols and wakeup concepts - Contention and Schedule-based protocols: SMAC, BMAC- Routing protocols: Requirements- Classification: SPIN, Directed Diffusion, LEACH, PEGASIS.

UNIT III 6LoWPAN 9

6LoWPAN: Architecture, protocol stack, Adaptation Layer, Link layers – Addressing – Routing: Mesh-Under, Route-Over- Header Compression: Stateless header compression, Context- based header compression - Fragmentation and Reassembly- Mobility types: Mobile IPv6, Proxy MIPv6, NEMO- Routing: ROLL, Border routing.

UNIT IV APPLICATION LAYER PROTOCOLS 9

Design Issues - Protocol Paradigms: End-to-end, Real-time streaming and sessions, Publish/subscribe, Web service paradigms - Web service protocols: REST, MQ telemetry transport for sensor networks (MQTT-S) - Service discovery - Real-time transport and sessions.

UNIT V SENSOR NETWORK PLATFORMS AND TOOLS 9

Sensor Node Hardware: Berkeley Motes, Programming Challenges, Node-level software platforms: TinyOS, nesC, CONTIKI OS- Node-level Simulators: NS2 and its extension to sensor networks, COOJA, TOSSIM.

Total Periods: 45

Course Outcomes:

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

CO1: Comprehend the fundamentals of Wireless Sensor Network Design concepts
CO2: Analyze the frame formats of MAC and Routing Protocols
CO3: Interpret optimizations incorporated in 6LoWPAN
CO4: Analyze mobility management and routing mechanisms in WSN
CO5: Design protocol and web service paradigms
CO6: Decide a specific programming platform for programming interfaces in WSN

Suggested Activities

- Quiz assessments
- Expert Video lectures
- Hands-on Mini Projects
- Problem-Based Learning

References:

1. Holger Karl , Andreas Willig, "Protocol and Architecture for Wireless Sensor Networks", John Wiley Publication, 2007.
2. Anna Forster, "Introduction to Wireless Sensor Networks", Wiley, 2017.
3. Zach Shelby Sensinode and Carsten Bormann, "6LoWPAN: The Wireless Embedded Internet" John Wiley and Sons, Ltd, Publication, 2011.
4. Philip Levis, "TinyOS Programming", 2009.
5. Agus Kurniawan, "Practical Contiki-NG: Programming for Wireless Sensor Networks", Apress, 2018.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	1	-	1	-	-	-	-	1	2	1
CO2	2	2	1	1	-	-	-	-	-	-	1	2	1
CO3	2	2	1	1	-	-	-	-	-	-	2	2	1
CO4	2	2	1	1	-	-	-	-	-	-	1	2	1
CO5	2	2	1	1	-	-	-	-	-	-	1	2	1
CO6	3	3	3	3	3	-	-	-	-	-	2	2	3
Avg.	**2**	**2**	**1.33**	**1.33**	**3**	**1**	-	-	-	-	**1.33**	**2**	**1.33**

PEC2455	IOT Based System Design	PEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To understand the basics of IoT.
- To gain knowledge about the various services provided by IoT.
- To familiarize with various communication and networking methodologies in IoT.
- To learn about IoT implementation tools.
- To explore various applications of IoT.

UNIT I INTRODUCTION TO INTERNET OF THINGS 9

Rise of the machines – Evolution of IoT – Web 3.0 view of IoT – Definition and characteristics of IoT – IoT Enabling Technologies – IoT Architecture -– Fog, Edge and Cloud in IoT – Functional blocks of an IoT ecosystem – Sensors, Actuators, Smart Objects and Connecting Smart Objects - IoT levels and deployment templates – A panoramic view of IoT applications.

UNIT II MIDDLEWARE AND PROTOCOLS OF IOT 9

Middleware technologies for IoT system: IoT Ecosystem Overview, Horizontal Architecture Approach for IoT Systems, SOA based IoT Middleware- Middleware architecture of RFID, WSN, SCADA, M2M - Zigbee, KNX, BACNet, MODBUS - Challenges Introduced by 5G in IoT Middleware: Technological Requirements of 5G Systems, Perspectives, and a Middleware Approach towards 5G - COMPaaS Middleware.

UNIT III COMMUNICATION AND NETWORKING 9

IoT Access Technologies: Physical and MAC layers, Topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN – Network Layer: IP versions, Constrained Nodes and Constrained Networks – Optimizing IP for IoT: 6LoWPAN, Routing over Low Power and Lossy Networks – Transport mechanisms: Tunnelling, Protocol Translation –Application Layer Protocols: CoAP and MQTT- Data aggregation & dissemination.

UNIT IV IOT IMPLEMENTATION TOOLS 9

Introduction to Python- Introduction to different IoT tools- Developing applications through IoT tools - Developing sensor-based applications through embedded system platform- Implementing IoT concepts with python- Implementation of IoT with Raspberry pi.

UNIT V IOT APPLICATIONS 9

Case Studies: Home automation - Smart cities – Environment – Energy – Retail – Logistics – Agriculture – Industry - Health and life style

Total Periods: 45

Course Outcomes:

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

CO1: Articulate the main concepts, key technologies, strength and limitations of IoT.
CO2: Describe the middleware approaches for IoT and 5G systems
CO3: Compare the middleware architectures and protocols for IoT
CO4: Analyze the networking and inter-sensor communication in IoT.
CO5: Implement IoT concepts using python and Raspberry Pi
CO6: Analyze case studies on real time applications of IoT

Suggested Activities

- Crossword on introductory topics in IoT
- Blended learning using simulators for acquiring real time physical world data with a case example

- Mini-Project implementation considering safety / sustainability of the environment & society
- Oral Seminar on applications of IoT
- Journal review on applications of Sensors and Actuators involving IoT

Text Books:

1. Honbo Zhou, “Internet of Things in the cloud:A middleware perspective”, CRC press, 2012.
2. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on Approach)”, VPT, 1st Edition, 2015.

References:

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies,
2. Platforms, and Use Cases", CRC Press, 2017.
3. Constandinos X. Mavromoustakis, George Mastorakis, Jordi MongayBatalla, “Internet of
4. Things (IoT) in 5G Mobile Technologies” Springer International Publishing Switzerland 2016.
5. Dieter Uckelmann, Mark Harrison, Florian Michahelles, “Architecting the Internet of Things”, Springer-Verlag Berlin Heidelberg, 2011.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	1		3	1	3	2	3	2	2	2
CO2	2	2	1	1					1		3	2	1
CO3	2	2	1	1					1		2	2	1
CO4	2	2	1	1					1		2	2	1
CO5	3	3	3	3	3	3	1	3	3	3	3	2	2
CO6	3	3	3	3	3	3	1	3	3	3	3	2	3
Avg.	**2.17**	**2.17**	**1.67**	**1.67**	**3.00**	**3.00**	**1.00**	**3.00**	**1.83**	**3.00**	**2.50**	**2.00**	**1.67**

PEC2456 Industry 5.0 and Technologies **PEC** **L T P C**

3 0 0 3

Course Objectives:

- To explore the evolution of industrial revolutions and the fundamentals of Industry 5.0.
- To learn the concepts of digital transformation and Society 5.0.
- To acquire knowledge on smart systems, Industrial IoT and industrial applications.
- To introduce Cyber Physical Systems and cybersecurity in Industry 5.0.
- To explore AR/VR, Digital Twin and future trends in industrial systems.

UNIT I INTRODUCTION TO INDUSTRY 5.0 AND INDUSTRIAL IoT **9**

Industrial Revolutions: Evolution from Industry 1.0 to Industry 5.0 – Introduction to Industrial Internet of Things (IIoT) – Smart and Connected Businesses – Smart Factories – Globalization and Emerging Issues – Lean Production Systems – Big Data and Advanced Analytics.

UNIT II DIGITAL TRANSFORMATION AND INDUSTRY 5.0 9

Introduction to Industry 5.0: Human-centricity, Sustainability and Resilience – Digital Transformation – Digital Business Transformation – Causes of Disruption and Transformation – Digital Transformation Myths and Realities – Digital Transformation across Industries – Society 5.0 Concepts.

UNIT III SMART SYSTEMS AND INDUSTRIAL APPLICATIONS 9

Sensors and Actuators – Communication Technologies – 5G Technology – Communication Protocols – Human–Machine Interaction – Robotics and Artificial Intelligence – Industrial IoT Application Domains: Healthcare, Manufacturing, Power Plants, Inventory Management and Quality Control.

UNIT IV CYBER PHYSICAL SYSTEMS AND CYBER SECURITY 9

Introduction to Cyber Physical Systems (CPS) – CPS Architecture – Networking Systems for CPS Applications – Data Science and Technology for CPS – Wearable Cyber Physical Systems – Cyber Security in Industry 5.0 – Security and Privacy Issues – Domain Applications of CPS.

UNIT V AR/VR, DIGITAL TWIN AND FUTURE TRENDS 9

Augmented Reality (AR) and Virtual Reality (VR) – Digital Twin – Smart Healthcare and Human Computer Interactions – Collaborative Robots – Society 5.0 Applications – Future Trends towards Industry 6.0 – Case Studies.

Periods: 45

Course Outcomes:

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

CO1: Explain the concepts of Industry 5.0 and Industrial IoT.
CO2: Illustrate digital transformation in Industry 5.0
CO3: Apply smart systems and Industrial IoT technologies in industrial applications.
CO4: Analyze Cyber Physical Systems and cybersecurity issues in Industry 5.0.
CO5: Examine AR/VR, Digital Twin and future industrial trends.
CO6: Relate Industry 5.0 and Society 5.0 concepts.

Suggested Activities:

-

References:

1. S. Misra, C. Roy, and A. Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0. Boca Raton, CRC Press, 2021.
2. U. Elangovan, Industry 5.0: The Future of the Industrial Economy, CRC Press, 2021.
3. Industry 5.0: Key Technologies and Drivers, Springer, 2025.
4. Industry 5.0: The Human-Centric Future of Industry, Springer, 2025.

Biomedical and Robotics

PEC2461	Biomedical Measurements and Instrumentation	PEC	L	T	P	C
			3	0	0	3

Course Objectives:

- Gain a basic understanding of human physiology and the origin of bioelectric signals.
- Understand the principles of common electrophysiological measurement systems.
- Learn about the sensors and methods used to measure non-electrical physiological parameters.
- Understand biopotential electrodes and the basics of biomedical signal acquisition.
- Familiarize with the principles and clinical applications of major medical imaging modalities

UNIT I HUMAN PHYSIOLOGY AND BIOPOTENTIALS 9

Organization of the human body: cells, tissues, organs and systems – Overview of cardiovascular, nervous and respiratory systems – Origin of biopotentials: resting potential and action potential, Equivalent circuit models of excitable cells – Characteristics of biopotentials: ECG, EEG, EMG and EOG – Amplitude and frequency ranges of common biopotential signals.

UNIT II ELECTROPHYSIOLOGICAL MEASUREMENTS 9

Electrocardiography (ECG): Standard 12-lead system, electrode placement and waveform interpretation - ECG signal processing: amplification, filtering, and artefact rejection – Electroencephalography (EEG): 10-20 electrode placement, brain rhythms and clinical applications – Electromyography (EMG): surface and needle EMG, nerve conduction velocity – Electrooculography (EOG) – Holter monitoring and ambulatory ECG recording.

UNIT III MEASUREMENT OF NON-ELECTRICAL PARAMETERS 9

Blood pressure measurement: indirect sphygmomanometric and oscillometric methods – Blood flow measurement: Doppler ultrasound and plethysmography – Cardiac output measurement: Fick's principle and thermodilution – Respiratory measurements: spirometry and lung volume, SPo2– Temperature measurement: thermistors and infrared sensors – Pulse oximetry.

UNIT IV BIOPOTENTIAL ELECTRODES AND SIGNAL ACQUISITION 9

Biopotential electrodes: electrode-electrolyte interface and half-cell potential – Types of electrodes: surface, needle, and microelectrodes – Biomedical signal acquisition chain: transducer – amplifier – filter – ADC – display – Instrumentation amplifiers: CMRR and noise requirements – Isolation amplifiers and patient safety – Analog and digital filtering techniques for biomedical signals

UNIT V MEDICAL IMAGING 9

X-ray imaging: production, attenuation and image formation – Computed Tomography (CT): basic principles and reconstruction – Ultrasound imaging: A-mode, B-mode, M-mode and Doppler – Magnetic Resonance Imaging (MRI): principles of NMR and image formation – Nuclear medicine imaging: gamma camera, SPECT and PET – Comparison of imaging modalities: resolution, safety, and clinical applications.

Periods: 45

Course Outcomes:

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

CO1: Explain the origin and characteristics of common biopotential signals from major organ systems.
CO2: Describe the principles and instrumentation of ECG, EEG and EMG measurement systems.
CO3: Identify appropriate sensors and methods for measuring physiological parameters such as pressure, flow

and temperature.

CO4: Explain the function of biopotential electrodes and the basic biomedical signal acquisition chain.

CO5: Describe the working principles and clinical uses of major medical imaging modalities.

CO6: Correlate biomedical instrumentation concepts with real-world clinical diagnostic and patient monitoring applications.

Suggested Activities:

-

Text Books:

1. L. Cromwell, F. J. Weibell and E. A. Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson Education / Prentice Hall, 2011.
2. J. G. Webster (Ed.), "Medical Instrumentation: Application and Design", 4th Edition, John Wiley & Sons, 2010.

References:

1. R. S. Khandpur, "Handbook of Biomedical Instrumentation", 3rd Edition, Tata McGraw-Hill, 2014.
2. Joseph Bronzino (Ed.), "The Biomedical Engineering Handbook", 3rd Edition, CRC Press, 2006.
3. A. C. Guyton and J. E. Hall, "Textbook of Medical Physiology", 13th Edition, Elsevier, 2016.

PEC2462	Medical Imaging Systems	PEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To describe the generation of X-ray and its uses in medical imaging.
- To explain the principle of Computed Tomography.
- To discuss the techniques used for visualizing various sections of the body.
- To familiarize the principles of different radio diagnostic equipment in Imaging.
- To impart knowledge on the radiation therapy techniques and radiation safety

UNIT I X RAYS **9**

Nature of X-rays- X-Ray absorption – X-Ray Equipment : X-Ray Tube, Collimator, Bucky Grid, power supply - Digital Radiography : discrete digital detectors, storage phosphor and film scanning- X-ray Image Intensifier tubes – Digital Fluoroscopy- Angiography.

UNIT II COMPUTED TOMOGRAPHY **9**

Principle of tomography- CT Generations - X-Ray sources- collimation- X- Ray detectors – Viewing systems – spiral CT scanning – Ultra fast CT scanners- Image reconstruction techniques: back projection and iterative method.

UNIT III MAGNETIC RESONANCE IMAGING **9**

Fundamentals of magnetic resonance - properties of electromagnetic waves - Interaction of Nuclei with static magnetic field and Radio frequency wave- Rotation and precession – Induction of magnetic resonance signals –T1 and T2 Relaxation processes - Block Diagram of MRI system – system magnet : Permanent, Electromagnet and Superconductors - Generations of gradient magnetic fields - Radio Frequency coils - fMRI.

UNIT IV NUCLEAR IMAGING **9**

Radioisotopes-alpha, beta, and gamma radiations - Radiation detectors: Gas filled detectors, Proportional gas filled detector, Geiger Meuller counter and Scintillation Detectors - Gamma camera: Principle of operation, collimator, photomultiplier tube, X-Y positioning circuit, pulse height analyzer - Principle of SPECT and PET.

UNIT V RADIATION THERAPY AND RADIATION SAFETY 9

Radiation therapy – linear accelerator- Recent Techniques in radiation therapy – 3D CRT, SRS, SRT, Intensity Modulated Radiation Therapy (IMRT), Image Guided Radiation Therapy (IGRT) and Cyber knife – Radiation measuring instruments: Dosimeter, film badges, Thermo Luminescent dosimeters and electronic dosimeter – Radiation protection principles.

Periods: 45

Course Outcomes:

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

CO1: Describe the working principle of the X-ray machine and its application.
CO2: Illustrate the principle of computed tomography
CO3: Interpret the techniques used for visualizing various sections of the body using Magnetic Resonance Imaging.
CO4: Demonstrate the applications of radionuclide imaging.
CO5: Compare appropriate imaging equipment for efficient diagnosis
CO6: Recognize the methods of radiation safety.

Suggested Activities:

- Problem-solving on image reconstruction (back projection and iterative)
- Concept map on magnetic resonance principles
- Case study on SPECT and PET applications

Text Books:

1. Isaac Bankman, I. N. Bankman , "Handbook Of Medical Imaging: Processing and Analysis(Biomedical Engineering)",Academic Press,2000
2. Jacob Beutel (Editor), M. Sonka (Editor), "Handbook of Medical Imaging, Volume 2. Medical Image Processing and Analysis", SPIE Press 2000
3. Khin Wee Lai, DyahEkashantiOctorinaDewi "Medical Imaging Technology", Springer Singapore, 2015

References:

1. Khandpur R.S, "Handbook of Biomedical Instrumentation", Tata McGraw – Hill, New Delhi, 2003.
2. Dougherty, Geoff (Ed.), "Medical Image Processing -Techniques and Applications ",Springer-Verlag New York, 2011

MAPPING OF COs WITH POs AND PSOs

COs	POs												PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	1		2	1
CO2	3	2	1	-	-	-	-	-	-	-	1		2	1
CO3	3	2	1	-	-	-	-	-	-	-	1		2	1
CO4	3	2	1	-	-	-	-	-	-	-	1		2	1
CO5	3	2	1	-	-	-	-	-	-	-	1		2	1
CO6	3	2	1	-	-	-	-	-	-	-	1		2	1
Avg.	3	2	1	-	-	-	-	-	-	-	1		2	1

PEC2463	MEMS Design	PEC	L	T	P	C
			2	0	2	3

Course Objectives:

- To introduce MEMS device principles using analytical and virtual modeling tools.
- To familiarize students with microsystem fabrication processes
- To enable students to analyze electromechanical behavior of microstructures
- To develop design for thermal, electrostatic, and piezoelectric MEMS devices.
- To expose students to real-world MEMS applications

UNIT I MICROSYSTEM AND FABRICATION TECHNIQUES 6

Overview: MEMS and Microsystem, Evolution of Microfabrication, Microsystems and Microelectronics, Microsystems and Miniaturization, Scaling Law - Microsystems Fabrication Processes: Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapor Deposition, Physical Vapor Deposition, Sputtering, Deposition by Epitaxy, Etching.

UNIT II ELECTRIC AND MECHANICAL CONCEPTS 6

Conductivity of semiconductors - Crystal planes and orientations - stress and strain - flexural beam bending analysis under simple loading conditions - Dynamic system - resonant frequency and quality factor.

UNIT III ELECTRO STATIC SENSING AND ACTUATION 6

Parallel plate capacitor: Capacitance of Parallel Plates, Equilibrium position of electrostatic actuator under bias, Pull-In Effect of Parallel-Plate Actuators - Interdigitated finger capacitors.

UNIT IV THERMAL AND PIEZOELECTRIC PRINCIPLES 6

Thermal Sensing and Actuation: Fundamentals of thermal transfer, Sensors and actuators based on thermal expansion, Thermal couples, Thermal resistors - Piezo electric sensing and actuation: Mathematical description of piezoelectric effects, Cantilever piezoelectric actuator model, properties of piezoelectric materials – Quartz, PZT,PVDF, ZnO.

UNIT V CASE STUDIES OF MEMS PRODUCTS 6

Comb drive actuator - Infrared Sensor - Piezo electric Tactile Sensor - Blood Pressure (BP) sensor – Microphone - Acceleration sensors – Gyros – RF MEMS.

Periods: 30

List of experiments:

1. Calculation of beam deflection under static load
2. Calculation of free vibration of a micro-beam
3. Model a parallel plate sensor/actuator
4. Design of comb drive actuator
5. Design of thermal bimorph actuator
6. Design and Simulation of piezo electric sensor under stress
7. Film Deposition / Wet Etching

Periods: 30

Total Periods: 60

Laboratory Requirements:

- MEMS Simulation Software
- Desktop Computers

Course Outcomes:

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

CO1: Explain the fundamental principles of Micro systems and devices.
CO2: Demonstrate understanding of microsystem fabrication techniques such as lithography, deposition, and etching.
CO3: Analyze the electromechanical characteristics of microstructures such as beams, capacitive plates, and comb drives.
CO4: Design and simulate electrostatic MEMS devices to meet specified performance parameters.
CO5: Design and simulate thermal and piezoelectric MEMS devices to meet specified performance parameters.
CO6: Evaluate the influence of material properties, geometry, and scaling effects on MEMS device.

Text Books:

1. Tai Ran Hsu, MEMS and Microsystems Design and Manufacture, Tata Mcgraw Hill, 2017.
2. Chang Liu, "Foundations of MEMS", Pearson education India limited, 2011.

References:

1. Murty B.S, Shankar P, Raj B, Rath, B.B, Murday J, Textbook of Nanoscience and Nanotechnology, Springer publishing, 2013.
2. Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures", CRC Press, 2002
3. Vinod Kumar Khanna Nanosensors: Physical, Chemical, and Biological, CRC press,2012.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	-	-	2	3	2
CO2	3	2	-	2	3	-	-	-	-	-	2	3	2
CO3	3	3	2	2	3	-	-	-	-	-	2	3	3
CO4	3	2	3	2	3	-	-	-	-	-	2	3	3
CO5	3	2	3	2	3	2	-	-	-	-	2	3	3
CO6	3	3	2	3	3	-	-	-	-	-	3	3	3
Avg.	**3.0**	**2.3**	**2.5**	**2.2**	**2.8**	**2.0**	-	-	-	-	**2.2**	**3.0**	**2.7**

PEC2464 Sensors and Actuators **PEC** **L T P C**

3 0 0 3

Course Objectives:

- To understand the characteristics of the measurement system
- To gain knowledge about the variable resistance sensors, variable inductance sensors and special sensors
- To design the actuator for automotive application
- To design temperature control actuators and controllers for automotive application

UNIT I INTRODUCTION TO MEASUREMENTS AND TRANSDUCERS 9

Principle of transduction: Classification of transducers - Sensors and Actuators: Functions, Classifications, Main technical requirement and trends - Need for Calibration - Classification of errors- Error analysis- Limiting error- Probable error - Propagation of error- Odds and uncertainty- Static characteristics and Dynamic characteristics.

UNIT II VARIABLE RESISTANCE AND INDUCTANCE SENSORS 9

Principle of operation- Construction details- Characteristics and applications of Resistive potentiometer: Strain gauges, Resistive thermometers, Thermistors and Piezoresistive sensors- Inductive potentiometer: Variable reluctance transducers and LVDT.

UNIT III SPECIAL SENSORS 9

Principle of operation- Construction details- Characteristics of Variable air gap type, variable area type and variable permittivity type capacitive transducer: Application: Capacitive Microphone - Piezoelectric, Magneto-strictive, Hall Effect, Digital Encoding and Optical displacement transducer – Automotive climate control: Humidity. Rain, Solar, Light and Antiglare sensor.

UNIT IV AUTOMOTIVE ACTUATORS 9

Principle of operation - Construction details - Characteristics of Electromechanical actuators and Fluid-mechanical actuators - Electrical machines: DC and AC machines, Duty-type ratings – Location and operation of Solenoid, Relay and Stepper motor in Automotives.

UNIT V AUTOMATIC TEMPERATURE CONTROL ACTUATORS 9

Fundamentals of HVAC system- Different types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Controller for Fixed and variable displacement type air conditioning system

Total Periods: 45

Course Outcomes:

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

CO1: Comprehend the characteristics and errors in measurements using sensors
CO2: Design measurement equipment system using variable resistance and inductance sensors
CO3: Analyze the variable capacitance transducer
CO4: Design measurement equipment system using special sensors
CO5: Generate new ideas in designing the actuators for automotive application
CO6: Design temperature control actuators and controllers for vehicles and air conditioning system

Suggested Activities:

- Crossword on introductory topics in measurement
- Blended learning using simulators for acquiring real time physical world data with a case example
- Mini-Project implementation considering safety / sustainability of the environment & society
- Oral Seminar on working principles of sensors and actuators
- Journal review on applications of Sensors and Actuators

Text Books:

1. Doebelin's Measurement Systems: 7th Edition (SIE), Ernest O. Doebelin Dhanesh N.Manik McGraw Hill Publishers, 2019.
2. Robert Brandy, “Automotive Electronics and Computer System”, Prentice Hall,2001
3. William Kimberley,” Bosch Automotive Handbook”, 11th Edition, Robert Bosch GmbH, 2022.
4. Bosch Automotive Electrics and Automotive Electronics Systems and Components, Networking and Hybrid Drive, 5th Edition, 2014, ISBN No: 978-3-658-01783-5.

References:

1. James D Halderman, “Automotive Electrical and Electronics” , Prentice Hall, USA, 6th Edition,2020

2. Tom Denton, “Automotive Electrical and Electronics Systems,” 5th Edition, 2017, SAE International.
3. Patranabis.D, “Sensors and Transducers”, 2nd Edition, Prentice Hall India Ltd,2003
4. William Ribbens, "Understanding Automotive Electronics -An Engineering Perspective," 7th Edition, Elsevier Butterworth-Heinemann Publishers, 2012.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1		2	1	-	-	3	3	-	1	2	-
CO2	3	1	1	2	1	2	-	3	3	1	1	2	1
CO3	3	1	1	2	1	2	-	3	3	1	1	2	1
CO4	3	1	1	2	1	2	-	3	3	1	1	2	1
CO5	3	2	1	1	-	2	-	3	3	1	1	2	1
CO6	3	2	1	1	-	2	-	3	3	1	1	2	1
Avg.	2.83	1.33	1.00	1.67	1.00	2	-	3	3	1.00	1	2.00	1

PEC2465 Robotics and Automation **PEC** **L T P C**

3 0 0 3

Course Objectives:

- To introduce the fundamental concepts, components, and classifications of robotic systems.
- To provide knowledge on kinematics, coordinate transformations, and trajectory planning of robots.
- To discuss various actuators, drive systems, and their selection for robotic applications.
- To familiarize students with different types of sensors and their role in robotic perception.
- To expose students to intelligent robotics, communication technologies, and real-world robotic applications.

UNIT I FUNDAMENTALS **9**

Introduction: Definition of robotics, Classification of Robots, Evolution of Robotics, Robot Components - Degrees of freedom - Robot Joints - Robot coordinates - Reference frames – Characteristics - Robot Workspace - Programming Modes - Robot Languages - Robot Applications, collaborative robots - social issues.

UNIT II KINEMATICS OF SERIAL ROBOTS AND TRAJECTORY PLANNING **9**

Matrix Representation - Homogeneous Transformation Matrices - Forward and Inverse Kinematics of Robots – Position – Orientation - Denavit-Hartenberg Representation - Inverse Kinematics - Degeneracy and Dexterity - Importance of Jacobian matrix and Lagrangian Mechanics - Trajectory Planning – Path vs Trajectory - Trajectory Planning.

UNIT III ACTUATORS **9**

Characteristics of Actuating Systems - Comparison of Actuating Systems - Hydraulic Actuators - Pneumatic Devices - Electric Motors - Microprocessor Control of Electric Motors - Magneto strictive Actuators - Shape-Memory Type Metals - Electroactive Polymer Actuators (EAPs) - Speed Reduction - Selection of Actuators – Case Studies.

UNIT IV SENSORS **9**

Classification of Sensors - Position Sensors - Velocity Sensors - Acceleration Sensors - Force and Pressure Sensors - Torque Sensors – Microswitches - Visible Light and Infrared Sensors - Touch and Tactile Sensors - Proximity Sensors - Range Finders - Sniff Sensors - Vision Systems - Voice-Recognition Devices - Remote Center Compliance (RCC) Device - Selection of Sensors – Case Study

UNIT V CASE STUDIES 9

Introduction to Intelligent Robotics – Artificial Intelligence in Robotics – Machine Learning and Deep Learning Concepts for Robotics – Robot Operating System (ROS) – Human-Robot Interaction (HRI) – Wireless Communication in Robotics (Wi-Fi, Bluetooth, Zigbee, 5G) – IoT-enabled Robotics – Edge and Cloud Robotics - Ethical and Safety Considerations in Robotics.

Periods: 45

Course Outcomes:

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

CO1: Explain the fundamentals of robotics, including robot classification, components, workspace, and applications.
CO2: Apply kinematic principles and transformation techniques to analyze forward and inverse kinematics of robotic manipulators.
CO3: Analyze and select appropriate actuators and drive systems for different robotic applications.
CO4: To select sensor and justify their selection for robotic sensing and perception systems.
CO5: Illustrate the role of embedded systems, communication protocols, and IoT in modern robotic systems.
CO6: Analyze case studies of intelligent robotic systems integrating AI, machine learning, and communication technologies for real-world applications.

Suggested Activities:

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Text Books:

1. Saeed B. Niku, Introduction to Robotics: Analysis, Control, Applications, 3rd Edition, Indian Adaptation, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2022.

References:

1. John J. Craig, Introduction to Robotics: Mechanics and Control, 4th Edition, Pearson Education, 2023.
2. S K. Saha, Introduction to Robotics, 3rd Edition,2024 McGraw Hill.

PEC2466	Concepts in Mobile Robots	PEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To introduce mobile robotic technology and its types in detail.
- To learn the kinematics of wheeled and legged robot.
- To familiarize the intelligence into the mobile robots using various sensors.
- To acquaint the localization strategies and mapping technique for mobile robot.
- To aware the collaborative mobile robotics in task planning, navigation and intelligence.

UNIT I INTRODUCTION TO MOBILE ROBOTICS 9

Introduction – Locomotion of the Robots – Key Issues on Locomotion – Legged Mobile Roots – Configurations and Stability – Wheeled Mobile Robots – Design Space and Mobility Issues – Unmanned Aerial and Underwater Vehicles.

UNIT II KINEMATICS 9

Kinematic Models – Representation of Robot – Forward Kinematics – Wheel and Robot Constraints – Degree of Mobility and Steerability – Manoeuvrability – Workspace – Degrees of Freedom – Path and Trajectory Considerations – Motion Controls - Holonomic Robots.

UNIT III PERCEPTION 9

Sensor for Mobile Robots – Classification and Performance Characterization – Wheel/Motor Sensors – Heading Sensors - Ground-Based Beacons - Active Ranging - Motion/Speed Sensors – Camera - Visual Appearance based Feature Extraction.

UNIT IV LOCALIZATION 9

Localization Based Navigation Versus Programmed Solutions - Map Representation -Continuous Representations - Decomposition Strategies - Probabilistic Map-Based Localization - Landmark-Based Navigation - Globally Unique Localization - Positioning Beacon Systems - Route-Based Localization - Autonomous Map Building - Simultaneous Localization And Mapping (SLAM).

UNIT V PLANNING, NAVIGATION AND COLLABORATIVE ROBOTS 9

Introduction - Competences for Navigation: Planning and Reacting - Path Planning - Obstacle Avoidance - Navigation Architectures – Control Localization - Techniques for Decomposition -Case Studies – Collaborative Robots – Swarm Robots.

Total Periods: 45

Course Outcomes:

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

CO1: Analyze the appropriate mobile robotic technology for a desired application.
CO2: Analyse kinematic models for both wheeled and legged robotic systems
CO3: Apply sensor data to enhance decision-making in mobile robots
CO4: Optimize localization and mapping frameworks for autonomous mobile robot
CO5: Implement collaborative planning techniques in mobile robots for specific tasks
CO6: Develop advanced collaborative mobile robots capable of autonomous navigation and intelligent task execution in targeted domains.

Text Books:

1. Roland Siegwart and IllahR.Nourbakish, “Introduction to Autonomous Mobile Robots” MIT Press, Cambridge, 2004.

References:

1. Dragomir N. Nenchev, Atsushi Konno, TeppeiTsujita, “Humanoid Robots: Modelling and Control”, Butterworth-Heinemann, 2018
2. MohantaJagadish Chandra, “Introduction to Mobile Robots Navigation”, LAP Lambert Academic Publishing, 2015.
3. Peter Corke, “Robotics, Vision and Control”, Springer, 2017.
4. Ulrich Nehmzow, “Mobile Robotics: A Practical Introduction”, Springer, 2003.
5. Xiao Qi Chen, Y.Q. Chen and J.G. Chase, “Mobile Robots - State of the Art in Land, Sea, Air, and Collaborative Missions”, Intec Press, 2009.
6. Alonzo Kelly, Mobile Robotics: Mathematics, Models, and Methods, Cambridge University Press, 2013, ISBN: 978-1107031159

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	1	1	-	-	-	1	1	3	2

CO2	3	3	3	2	2	1	-	-	-	2	1	3	3
CO3	2	3	2	2	3	1	-	-	-	2	1	3	2
CO4	2	3	3	3	3	1	-	-	-	2	1	3	3
CO5	2	3	3	3	3	1	-	-	-	3	1	3	3
CO6	2	2	3	3	3	2	-	-	-	3	2	3	3
Avg.	**2**	**3**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**2**	**1**	**3**	**3**

Diversified

PEC2471 Bio-Inspired Optimization Techniques **PEC** **L T P C**

3 0 0 3

Course Objectives:

- To understand fundamental topics in bio-inspired optimization techniques
- To learn the collective systems such as ACO, PSO, and BCO
- To develop skills in biologically inspired algorithm design with an emphasis on solving real world problems
- To understand the most appropriate types of algorithms for different data analysis problems and to introduce some of the most appropriate implementation strategies.
- To implement the Bio-inspired technique with other traditional algorithms.

UNIT I INTRODUCTION **9**

Optimization Techniques: Introduction to Optimization Problems – Single and Muti- objective Optimization – Classical Techniques – Overview of various Optimization methods – Evolutionary Computing: Genetic Algorithm and Genetic Programming: Basic concept – encoding – representation – fitness function – Reproduction – differences between GA and Traditional optimization methods – Applications – Bio- inspired Computing (BIC): Motivation – Overview of BIC – usage of BIC – merits and demerits of BIC.

UNIT II SWARM INTELLIGENCE **9**

Introduction – Biological foundations of Swarm Intelligence – Swarm Intelligence in Optimization – Ant Colonies: Ant Foraging Behavior – Towards Artificial Ants – Ant Colony Optimization (ACO) – S-ACO – Ant Colony Optimization Metaheuristic: Combinatorial Optimization – ACO Metaheuristic – Problem solving using ACO – Other Metaheuristics – Simulated annealing – Tabu Search – Local search methods – Scope of ACO algorithms.

UNIT III NATURAL TO ARTIFICIAL SYSTEMS **9**

Biological Nervous Systems – artificial neural networks – architecture – Learning Paradigms – unsupervised learning – supervised learning – reinforcement learning – evolution of neural networks – hybrid neural systems – Biological Inspirations in problem solving – Behaviour of Social Insects: Foraging –Division of Labor – Task Allocation – Cemetery Organization and Brood Sorting – Nest Building – Cooperative transport.

UNIT IV SWARM ROBOTICS **9**

Foraging for food – Clustering of objects – Collective Prey retrieval – Scope of Swarm Robotics – Social Adaptation of Knowledge: Particle Swarm – Particle Swarm Optimization (PSO) – Particle Swarms for Dynamic Optimization Problems – Artificial Bee Colony (ABC) Optimization biologically inspired algorithms in engineering.

UNIT V CASE STUDIES 9

Other Swarm Intelligence algorithms: Fish Swarm – Bacteria foraging – Intelligent Water Drop Algorithms – Applications of biologically inspired algorithms in engineering. Case Studies: ACO and PSO for NP-hard problems – Routing problems – Assignment problems – Scheduling problems – Subset problems – Machine Learning Problems – Travelling Salesman problem.

Periods: 45

Course Outcomes:

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

CO1: Understand the fundamental principles of evolutionary computing and bio inspired computing methods
CO2: Analyze swarm intelligence techniques and other metaheuristics for various optimization scenarios.
CO3: Compare biological systems and artificial neural learning paradigms to design hybrid and biologically inspired problem-solving models.
CO4: Implement swarm robotics and bio-inspired algorithms for real-time tasks such as foraging, clustering, and collective decision making.
CO5: Evaluate and apply bio-inspired optimization algorithms to engineering case studies including routing, scheduling, assignment, and NP-hard problems.
CO6: Design and develop innovative optimization solutions by integrating multiple bio-inspired algorithms to address complex real-world engineering problems.

Suggested Activities:

- Flipped classroom - GA vs Traditional Optimization
- Simulation of Art Foraging Behaviour
- Implementation of Ant Colony Optimization
- Implementation of Artificial Bee Colony Optimization
- Comparative study of Swarm Algorithms
- Case Study/Seminar Paper Presentation

Text Books:

1. A. E. Elben and J. E. Smith, “Introduction to Evolutionary Computing”, Springer, 2010.
2. Floreano D. and Mattiussi C., "Bio-Inspired Artificial Intelligence: Theories, Methods, and Technologies", MIT Press, Cambridge, MA, 2008.
3. Leandro Nunes de Castro, " Fundamentals of Natural Computing, Basic Concepts, Algorithms and Applications", Chapman & Hall/ CRC, Taylor and Francis Group, 2007

References:

1. Eric Bonabeau, Marco Dorigo, Guy Theraulaz, “Swarm Intelligence: From Natural to Artificial Systems”, Oxford University press, 2000.
2. Christian Blum, Daniel Merkle (Eds.), “Swarm Intelligence: Introduction and Applications”, Springer Verlag, 2008.
3. Leandro N De Castro, Fernando J Von Zuben, Inspired Computing”, Idea Group Inc., 2005. “Recent Developments in Biologically
4. Albert Y.Zomaya, "Handbook of Nature-Inspired and Innovative Computing", Springer, 2006.
5. C. Ebelhart et al., “Swarm Intelligence”, Morgan Kaufmann, 2001.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	-	-	-	-	-	-	-	-	-
CO2	2	3	2	2	3	-	-	-	-	-	-	-	-	-
CO3	3	2	3	3	3	-	-	-	-	-	-	-	-	-
CO4	2	2	3	2	2	-	-	-	-	-	-	-	-	-
CO5	2	3	3	3	3	-	-	-	-	-	-	-	-	-

CO6	3	3	3	2	3	-	-	-	-	-	-	-	-	-
Avg.	**2.5**	**2.5**	**2.5**	**2.16**	**2.67**	-	-	-	-	-	-	-	-	-

PCS2408 Big data Analytics **PEC** **L T P C**

2 0 2 3

Course Objectives:

- To understand big data.
- To learn and use NoSQL big data management.
- To learn map reduce analytics using Hadoop and related tools.
- To work with map reduce applications
- To understand the usage of Hadoop related tools for Big Data Analytics

UNIT I UNDERSTANDING BIG DATA 6

Introduction to big data – convergence of key trends – unstructured data – industry examples of big data – web analytics – big data applications– big data technologies – introduction to Hadoop – open source technologies – cloud and big data – mobile business intelligence – Crowd sourcing analytics – inter and trans firewall analytics

UNIT II NOSQL DATA MANAGEMENT 6

Introduction to NoSQL – aggregate data models – key-value and document data models – relationships – graph databases – schema less databases – materialized views – distribution models – master-slave replication – consistency - Cassandra – Cassandra data model – Cassandra examples – Cassandra clients

UNIT III MAP REDUCE APPLICATIONS 6

MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats.

UNIT IV BASICS OF HADOOP 6

Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes – design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow – Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures - Cassandra – Hadoop integration.

UNIT V HADOOP RELATED TOOLS 6

Hbase – data model and implementations – Hbase clients – Hbase examples – praxis. Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts. Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation – HiveQL queries.

Periods: 30

Laboratory Experiments:

1. Downloading and installing Hadoop; Understanding different Hadoop modes. Startup scripts, Configuration files.
2. Hadoop Implementation of file management tasks, such as Adding files and directories,
3. retrieving files and Deleting files
4. Implement of Matrix Multiplication with Hadoop Map Reduce
5. Run a basic Word Count Map Reduce program to understand Map Reduce Paradigm.
6. Installation of Hive along with practice examples.

7. Installation of HBase, Installing thrift along with Practice examples
8. Practice importing and exporting data from various databases.

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

-

Course Outcomes:

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

CO1: Describe big data and use cases from selected business domains
CO2: Explain NoSQL big data management.
CO3: Install, configure, and run Hadoop and HDFS.
CO4: Perform map-reduce analytics using Hadoop
CO5: Use Hadoop-related tools such as HBase, Cassandra, Pig, and Hive for big data analytics.
CO6: Apply big data technologies to solve real-world data analytics problems.

Suggested Activities:

- Hands-on / Lab Activities
- Mini Projects
- Case Studies

Text Books:

1. Michael Minelli, Michelle Chambers, and AmbigaDhiraj, "Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses", Wiley, 2013.
2. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.
3. Sadalage, Pramod J. “NoSQL distilled”, 2013

References:

1. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012. 126
2. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
3. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
4. Alan Gates, "Programming Pig", O'Reilley, 2011.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	-	-	-	2	2	3			
CO2	3	3	2	3	2	-	-	-	2	2	3			
CO3	3	3	3	2	3	-	-	-	2	2	1			
CO4	2	3	3	3	3	-	-	-	2	2	3			
CO5	3	3	3	3	3	-	-	-	3	1	3			
CO6	3	3	3	3	3	-	-	-	2	2	3			
Avg.	2.8	3	2.8	2.8	2.8	-	-	-	2.2	1.8	2.7			

PEC2473	Database Management Systems	PEC	L	T	P	C
			2	0	2	3

Course Objectives:

- To understand the fundamentals of database systems and data models
- To design and develop relational databases for engineering applications
- To apply SQL for data manipulation and querying
- To explore database concepts in embedded systems, IoT, and real-time applications
- To introduce transaction management and database security

UNIT I INTRODUCTION TO DATABASE SYSTEMS 6

Overview of Database Systems - File System vs Database System-Database System Architecture-Data Models: Hierarchical, Network, Relational-Three-Schema Architecture-Database Users and Roles-DBMS Applications in ECE (IoT data logging, sensor data storage, communication systems)

UNIT II RELATIONAL MODEL AND DATABASE DESIGN 6

Relational Model Concepts-Keys: Primary, Candidate, Foreign-Relational Algebra and Operations Functional Dependencies -Normalization (1NF, 2NF, 3NF, BCNF)-ER Model and ER Diagram Design-Mapping ER Model to Relational Schema-Case Study: Designing database for sensor networks / embedded applications

UNIT III STRUCTURED QUERY LANGUAGE (SQL) 6

Introduction to SQL-Data Definition Language (DDL)-Data Manipulation Language (DML)-Data Control Language (DCL)-Queries: Selection, Projection, Joins, Nested Queries-Aggregate Functions and Grouping-Views and Indexing-Embedded SQL concepts for application integration

UNIT IV TRANSACTION MANAGEMENT AND CONCURRENCY CONTROL 6

Transaction Concepts and Properties (ACID)-Serializability-Concurrency Control Techniques (2PL)-Locking Protocols-Deadlock Handling-Recovery Techniques-Introduction to Real-Time Databases in Embedded Systems

UNIT V ADVANCED TOPICS AND APPLICATIONS IN ECE 6

NoSQL Databases (Introduction)-Distributed Databases-Database Security and Authorization-Data Storage for IoT and Sensor Networks-Cloud Databases and Edge Computing-Case Study: Database usage in communication systems / smart devices

Periods: 30

Laboratory Experiments:

1. Introduction to SQL: DDL, DML, DCL, TCL. SQL clause: SELECT FROM WHERE GROUPBY, HAVING, ORDERBY Using SQLite/MySQL/Oracle
2. Creation of Views, Synonyms, Sequence, Indexes, Save point.
3. Creating an Employee database to set various constraints and subqueries.
4. Implementation of PL/SQL Procedure (IN, OUT, INOUT) with Exception Handling.
5. Implementation of PL/SQL Function.
6. Implementation of PL/SQL Cursor.
7. MINI PROJECT
   Database Connectivity with Front End Tools (Python/C/C++/JAVA) and Back End Tools (MySQL/SQLite/Oracle)
   For any problem selected, write the ER Diagram, apply ER mapping rules, normalize the relations, and follow the application development process.
   Make sure that the application should have five or more tables, at least one trigger and one stored procedure, using suitable frontend tool.
   Indicative areas include

a) Inventory Control System.
b) Material Requirement Processing.
c) Hospital Management System.
d) Railway Reservation System.
e) Personal Information System.
f) Web Based User Identification System.
g) Timetable Management System.
h) Hotel Management System
i) Library Management System.

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

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Course Outcomes:

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

CO1: Understand database concepts and architecture
CO2: Design relational databases using normalization techniques
CO3: Apply SQL for data definition, manipulation, and retrieval operations
CO4: Analyze transaction management and concurrency control mechanisms
CO5: Implement database solutions for ECE applications
CO6: Evaluate modern database systems including NoSQL and distributed databases

Suggested Activities:

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Text Books:

1. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, McGraw-Hill, 2019.
2. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, Pearson, 2016.

References:

1. Raghu Ramakrishnan, Johannes Gehrke, Database Management Systems, McGraw-Hill, 2003.
2. Carlos Coronel, Steven Morris, Database Systems: Design, Implementation, and Management, Cengage Learning, 2018.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	-	-	-	-	-	-			
CO2	3	3	2	-	2	-	-	-	-	-	-			
CO3	2	2	3	-	3	-	-	-	-	-	-			
CO4	2	3	-	2	-	-	-	-	-	-	-			
CO5	2	2	3	2	3	-	-	-	2	-	-			
CO6	2	3	2	2	2	-	-	-	-	-	-			

PIT2407	Cyber Security	PEC	L	T	P	C
			2	0	2	3

Course Objectives:

- To learn cybercrime and cyberlaw.
- To understand the cyber-attacks and tools for mitigating them.
- To understand information gathering.
- To learn how to detect a cyber-attack.
- To learn how to prevent a cyber-attack.

UNIT I INTRODUCTION 6

Cyber Security – History of Internet – Impact of Internet – CIA Triad; Reason for Cyber Crime – Need for Cyber Security – History of Cyber Crime; Cybercriminals – Classification of Cybercrimes – A Global Perspective on Cyber Crimes; Cyber Laws – The Indian IT Act – Cybercrime and Punishment.

UNIT II ATTACKS AND COUNTERMEASURES 6

OSWAP; Malicious Attack Threats and Vulnerabilities: Scope of Cyber-Attacks – Security Breach – Types of Malicious Attacks – Malicious Software – Common Attack Vectors – Social engineering Attack – Wireless Network Attack – Web Application Attack – Attack Tools – Countermeasures.

UNIT III RECONNAISSANCE 6

Harvester – Whois – Netcraft – Host – Extracting Information from DNS – Extracting Information from E-mail Servers – Social Engineering Reconnaissance; Scanning – Port Scanning – Network Scanning and Vulnerability Scanning – Scanning Methodology – Ping Sweer Techniques – Nmap Command Switches – SYN – Stealth – XMAS – NULL – IDLE – FIN Scans – Banner Grabbing and OS Finger printing Techniques.

UNIT IV INTRUSION DETECTION 6

Host -Based Intrusion Detection – Network -Based Intrusion Detection – Distributed or Hybrid Intrusion Detection – Intrusion Detection Exchange Format – Honeypots – Example System Snort.

UNIT V INTRUSION PREVENTION 6

Firewalls and Intrusion Prevention Systems: Need for Firewalls – Firewall Characteristics and Access Policy – Types of Firewalls – Firewall Basing – Firewall Location and Configurations –Intrusion Prevention Systems – Example Unified Threat Management Products.

Periods: 30

Laboratory Experiments:

1. Install Kali Linux on Virtual box
2. Explore Kali Linux and bash scripting
3. Perform open-source intelligence gathering using Netcraft, Whois Lookups, DNS Reconnaissance, Harvester and Maltego
4. Understand the nmap command d and scan a target using nmap
5. Install metasploitable2 on the virtual box and search for unpatched vulnerabilities
6. Use Metasploit to exploit an unpatched vulnerability
7. Install Linus server on the virtual box and install ssh
8. Use Fail2banto scan log files and ban Ips that show the malicious signs
9. Launch brute-force attacks on the Linux server using Hydra.
10. Perform real-time network traffic analysis and data pocket logging using Snort

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

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Course Outcomes:

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

CO1: Apply fundamental concepts of cyber security, cybercrime, and cyber laws to analyze security requirements.
CO2: Apply knowledge of cyber attacks, threats, and vulnerabilities to identify system weaknesses.
CO3: Apply reconnaissance and information gathering techniques using appropriate tools.
CO4: Apply scanning and enumeration techniques to assess network and system security.
CO5: Apply intrusion detection mechanisms using IDS tools and techniques.
CO6: Apply intrusion prevention and firewall techniques to secure systems and networks.

Suggested Activities:

- Hands-on demonstration on tools like Nmap, Wireshark, Metasploit, and Snort.
- Basic ethical hacking challenges could be conducted on Password cracking, SQL injection simulation and Network scanning tasks
- Presentation of case studies on cybercrime laws and legal actions in India.
- Poster / Infographic Presentation on Topics like Cyber hygiene, Social engineering awareness, OWASP Top 10 vulnerabilities

Text Books:

1. Anand Shinde, "Introduction to Cyber Security Guide to the World of Cyber Security", Notion Press, 2021
2. Nina Godbole, Sunit Belapure, "Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives", Wiley Publishers, 2011
3. https://owasp.org/www-project-top-ten/

References:

1. David Kim, Michael G. Solomon, "Fundamentals of Information Systems Security", Jones & Bartlett Learning Publishers, 2013
2. Patrick Engebretson, "The Basics of Hacking and Penetration Testing: Ethical Hacking and Penetration Testing Made easy", Elsevier, 2011
3. Kimberly Graves, "CEH Official Certified Ethical hacker Review Guide", Wiley Publishers, 2007

MAPPING OF COs WITH POs AND PSO's

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	-	-	-	2	-	2	-	-	-	2	-	-
CO2	3	3	-	2	2	2	-	-	-	-	-	3	2	-
CO3	2	3	-	3	3	-	-	-	-	-	-	3	2	-
CO4	2	3	-	3	3	-	-	-	-	-	-	3	2	-
CO5	2	3	-	3	3	2	-	-	-	-	-	3	3	-
CO6	2	3	2	2	3	3	-	2	-	-	2	3	3	2
Avg.	2.3	2.8	2	2.6	2.8	2.3		2			2	2.8	2.4	2

PCS2415	Devops	PEC	L	T	P	C
			2	0	2	3

Course Objectives:

- To introduce DevOps terminology, definition & concepts
- To understand the different Version control tools like Git, Mercurial
- To understand the concepts of Continuous Integration/ Continuous Testing/ Continuous Deployment)
- To understand Configuration management using Ansible
- Illustrate the benefits and drive the adoption of cloud-based Devops tools to solve real world problems

UNIT I INTRODUCTION TO DEVOPS 6

Devops Essentials - Introduction To AWS, GCP, Azure - Version control systems: Git and Github.

UNIT II COMPILE AND BUILD USING MAVEN & GRADLE 6

Introduction, Installation of Maven, POM files, Maven Build lifecycle, Build phases (compile build, test, package) Maven Profiles, Maven repositories (local, central, global), Maven plugins, Maven create and build Artificats, Dependency management, Installation of Gradle, Understand build using Gradle.

UNIT III CONTINUOUS INTEGRATION USING JENKINS 6

Install & Configure Jenkins, Jenkins Architecture Overview, Creating and Running a Simple Jenkins Job, Essential Plugins (Git and Maven Plugin), Configuring Jenkins with Git and Maven - Introduction to SonarQube - Integrating Jenkins with SonarQube for a Basic Code Quality Scan.

UNIT IV CONFIGURATION MANAGEMENT USING ANSIBLE 6

Ansible Introduction, Installation, Ansible master/slave configuration, YAML basics, Ansible modules, Ansible Inventory files, Ansible playbooks, Ansible Roles, adhoc commands in ansible

UNIT V BUILDING DEVOPS PIPELINES USING AZURE 6

Create Github Account, Create Repository, Create Azure Organization, Create a new pipeline, Build a sample code, Modify azure-pipelines.yaml file

Periods: 30

Laboratory Experiments:

1. Problem Identification and Software Requirement Specification (SRS) Development.
2. Web Application Development using MVC Architecture and Spring Boot Framework
3. Install Git version control system and configure with GitHub
4. Installation and build using Maven
5. Installation and build using Gradle
6. Create a Maven build pipeline in Azure
7. Run regression test using Maven build pipeline in Azure
8. Installation and Configuration of Jenkins and creating a workspace
9. Install Jenkins in cloud and create CI/CD pipeline and deploy in cloud
10. Install and configure Ansible
11. Create an Ansible playbook for a simple web application infrastructure

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- Java JDK 21 or above, Maven v3.9 or above, Gradle v8 or above.

- Jenkins (latest LTS version).
- SonarQube Server (Community Edition) and SonarScanner CLI.
- Azure DevOps Organization (Student / Free Tier) with Pipeline Access.
- Ansible v2.15 or above with YAML support.
- Visual Studio Code and Git Version Control System

Course Outcomes:

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

CO1: Understand different actions performed through Version control tools like Git.
CO2: Perform Continuous Integration and Continuous Testing and Continuous Deployment using Jenkins by building and automating test cases using Maven & Gradle
CO3: Ability to Install, configure, and manage Jenkins with Java, Git, and Maven for CI/CD automation
CO4: Perform integration and use key Jenkins plugins to enhance job execution and reporting
CO5: Ability to do configuration management using Ansible
CO6: Understand to leverage Cloud-based DevOps tools using Azure DevOps

Suggested Activities:

- Hand-on activities
- Case Studies
- In-Class activities
- Project

Text Books:

1. Roberto Vormittag, "A Practical Guide to Git and GitHub for Windows Users: From Beginner to Expert in Easy Step-By-Step Exercises", Second Edition, Kindle Edition, 2016.
2. Jason Cannon, "Linux for Beginners: An Introduction to the Linux Operating System and Command Line", Kindle Edition, 2014

References:

1. Mitesh Soni, "Hands-On Azure Devops: Cicd Implementation for Mobile, Hybrid, And Web Applications Using Azure Devops and Microsoft Azure: CICD Implementation for ... DevOps and Microsoft Azure (English Edition) Paperback", 2020.
2. Jeff Geerling, "Ansible for DevOps: Server and configuration management for humans", First Edition, 2015.
3. David Johnson, "Ansible for DevOps: Everything You Need to Know to Use Ansible for DevOps", Second Edition, 2016.
4. Mariot Tsitoara, "Ansible 6. Beginning Git and GitHub: A Comprehensive Guide to Version Control, Project Management, and Teamwork for the New Developer", Second Edition, 2019.
5. https://www.jenkins.io/user-handbook.pdf
6. https://maven.apache.org/guides/getting-started/

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	-	-	-	-	-	-			
CO2	3	3	3	2	3	-	-	-	-	-	-			
CO3	3	3	3	2	3	-	-	-	-	-	-			
CO4	3	3	3	2	3	-	-	-	-	-	-			
CO5	3	3	3	2	3	-	-	-	-	-	-			
CO6	3	3	3	2	3	-	-	-	-	-	-			
Avg.	3.0	3.0	3.0	2.0	3.0	-	-	-	-	-	-			

PEC2476	Electric Vehicle Technology	PEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To provide a comprehensive understanding of the evolution of electric vehicles and their comparison with conventional internal combustion engine vehicles.
- To study different hybrid electric vehicle (HEV) architectures and their applications in various terrains and vehicle types.
- To analyze the working principles, control strategies, and selection criteria of electric motors used in electric vehicles.
- To understand the design and sizing of EV powertrain components, including transmission systems and braking mechanisms.
- To explore advanced battery technologies, including their chemistry, performance characteristics, and degradation mechanisms.
- To familiarize students with control strategies, charging systems, and operational aspects of electric and hybrid vehicles.

UNIT I EV HISTORY AND ITS EVOLUTION 9

Electric Vehicle History - IC Engines, BMEP and BSFC, Vehicle Fuel Economy, Emission Control Systems, Treatment of Diesel Exhaust Emissions, Evolution of Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs) - Construction and working of PHEV - Block diagram and Components - Charging Mechanisms - Advantages of PHEVs - Comparison of electric, hybrid electric and plugin hybrid Vehicles

UNIT II HEV ARCHITECTURE 9

Architecture of HEVs - Series, Parallel and Series Parallel Architecture, Micro and Mild architectures. HEVs in Hilly terrains - Mountain Bike - Motorcycle - Electric Cars and Heavy Duty EVs. - Details and Specifications - Solar-assisted Hybrid Vehicles and Solar EV concepts.

UNIT III MOTORS FOR ELECTRIC VEHICLES 9

Introduction – Speed and Torque control of above and below rated speed-Speed control of EV in the constant power region of electric motors. DC Motors, Induction Motor, Permanent Magnet Synchronous Motors (PMSM), Brushless DC Motors, Switched Reluctance Motors (SRMs). Synchronous Reluctance Machines-Choice of electric machines for EVs.

UNIT IV POWER COMPONENTS, BRAKES AND SOLAR CHARGING SYSTEMS 9

Power train Component sizing- Motors, Gears, Clutches, Differential, Transmission and Vehicle Brakes. EV power train sizing, HEV Powertrain sizing, Example. EV Wiring Harness - Hybrid vehicle control strategy: Vehicle supervisory control, Mode selection strategy, Modal Control strategies - Solar photovoltaic cell fundamentals, characteristics of solar cells, MPPT techniques, solar-powered EV charging systems and onboard/offboard solar charging infrastructure.

UNIT V BATTERIES 9

Li-ion batteries: types, formats, chemistry, safe operating area, efficiency and aging; battery characteristics – State of Charge (SOC), Depth of Discharge (DOD), State of Health (SOH); cell balancing techniques – passive and active balancing; advanced batteries – Solid state, NCM and NCA batteries; specifications of cylindrical cells (e.g., NCR18650B) - – Battery storage integration with solar charging systems in EV applications.

Periods: 45

Course Outcomes:

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

CO1: Explain the evolution of electric vehicles and evaluate their advantages over conventional vehicles in terms of efficiency and emissions.

CO2: Describe and compare different HEV architectures and select suitable configurations for specific applications.

CO3: Analyze the performance characteristics and control methods of various electric motors used in EVs.

CO4: Design and evaluate EV powertrain components, including motor sizing, transmission, and braking systems.

CO5: Assess battery technologies by analyzing parameters such as State of Charge (SOC), State of Health (SOH), and degradation behavior.

CO6: Apply knowledge of EV systems to select appropriate components and develop basic control strategies for electric and hybrid vehicles.

Suggested Activities:

-

Text Books:

1. Iqbal Hussain, “Electric and Hybrid Vehicles: Design Fundamentals, ”CRC Press, Taylor & Francis Group, Third Edition 2021.
2. Mehrdad Ehsani, YiminGao, Sebastian E. Gay, Ali Emadi, 'Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design', CRC Press, 2004.
3. Chris Mi & M. Abul Masrur, Hybrid Electric Vehicles: Principles and Applications, 3rd Edition, Wiley, 2025.

References:

1. Christopher H. T. Lee (Ed.), Emerging Technologies for Electric and Hybrid Vehicles, Springer, 1st Edition, 2024.
2. Smart Electric and Hybrid Vehicles: Design, Modeling and Assessment, Wiley/CRC Press, 1st Edition, 2024.
3. Nil Patel, Akash Kumar Bhoi, Sanjeevikumar Padmanaban, Jens Bo Holm-Nielsen, Electric Vehicles: Modern Technologies and Trends, Springer, 1st Edition, 2021.

MINOR ELECTIVES

Embedded Systems & IoT

MEC2411	**Embedded System Design**	**MEC**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:

- To provide knowledge of microcontrollers and their role in embedded systems
- To introduce the architecture and programming of the 8051 microcontroller
- To familiarize students with embedded system concepts, design process, and constraints
- To develop skills in embedded program design, analysis, and optimization techniques
- To introduce real-time operating systems and their role in embedded applications
- To expose students to embedded networking, communication protocols, and real-world design examples

UNIT I 8051 MICROCONTROLLER 9

Microcontrollers for an Embedded System – 8051 – Architecture – Addressing Modes – Instruction Set – Program and Data Memory – Stacks – Interrupts – Timers/Counters – Serial Ports – Programming.

UNIT II INTRODUCTION TO EMBEDDED SYSTEM 9

Introduction to embedded system – Characteristics- Constraints- Challenges of Embedded system- Embedded system components – Classification of Embedded system- Constraints in choosing the processor- Real time system- Design process in Embedded system – Skills Required for Embedded system designer.

UNIT III EMBEDDED PROGRAM DESIGN AND ANALYSIS 9

Components for embedded programs- Models of programs- Assembly, linking and loading – compilation techniques- Performance analysis –Analysis and optimization of program size- Program validation and testing.

UNIT IV REAL TIME OPERATING SYSTEMS 9

GPOS VS RTOS, Task, process & threads, Multiprocessing and Multitasking, Scheduling Algorithm, Preemptive and non-preemptive scheduling , Task communication- shared memory, message passing- Interprocess Communication.

UNIT V NETWORKS FOR EMBEDDED SYSTEM AND DESIGN EXAMPLES 9

Distributed Embedded Architecture, Networks for Embedded systems and protocols, Internet Enabled systems,UML Notations. Case study : Cell Phones, Elevator Control.

Periods: 45

Course Outcomes:

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

CO1: Explain the architecture, features, and programming concepts of the 8051 Microcontroller.
CO2: Analyze embedded system characteristics, design requirements, and constraints.
CO3: Design and optimize embedded programs considering performance, power, and memory constraints.
CO4: Apply real-time operating system concepts such as scheduling, task management, and interprocess communication.
CO5: Apply embedded system communication networks and protocols used in distributed systems.
CO6: Design and analyze real-world embedded applications using appropriate hardware and software techniques.

Suggested Activities:

- Case study

- Flipped Class room
- Quiz
- Mini Project

Text Books:

1. Marilyn Wolf, "Computers as Components - Principles of Embedded Computing System Design", Third Edition "Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.
2. David. E. Simon, "An Embedded Software Primer", 1st Edition, Fifth Impression, Addison-Wesley Professional, 2007.

References:

1. Lyla B.Das, Embedded Systems: An Integrated Approach, Pearson Education 2013.
2. Jane.W.S .Liu, Real – Time Systems, Pearson Education, 2003.

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2	-	-	-	-	-	2	3	2
CO2	3	3	2	2	2	2	-	-	-	-	2	3	2
CO3	3	3	3	3	3	-	-	1	1	-	2	3	3
CO4	3	3	3	2	3	2	-	2	2	2	2	3	3
CO5	3	3	3	2	3	2	-	2	2	2	2	3	3
CO6	3	3	3	3	3	2	2	3	3	3	3	3	3

MEC2412 Embedded Processors **MEC** **L T P C**

2 0 2 3

Course Objectives:

- To familiarize with the architecture and features of ARM processors.
- To develop programming skills for ARM-based systems.
- To apply techniques to interface peripherals and communication modules.
- To examine modern processor architectures.
- To design embedded applications using processors
- To gain hands-on exposure to single-board embedded systems

UNIT I ARM ARCHITECTURE **6**

ARM Architecture – Memory Organization – Addressing Modes – Programmer's Model – Registers – Pipeline – Interrupts – Coprocessors – Interrupt Structure

UNIT II ARM PROGRAMMING AND PERIPHERALS **6**

ARM Instruction Set – Thumb Instruction Set – Basic Programming – I/O Memory – EEPROM – I/O Ports – SRAM – Timer – UART – Serial Communication with PC – ADC/DAC Interfacing – Introduction to DSP on ARM

UNIT III ARM COMMUNICATION AND INTERFACING **6**

Communication Protocols – CAN, I2C, SPI – Serial Communication – Peripheral Interfacing – Sensor Interfacing – Motor Control – PWM Generation

UNIT IV MODERN PROCESSOR ARCHITECTURES 6

RISC-V Architecture – Features and Significance – Instruction Formats – Addressing Modes – Programming Concepts – Development Tools – Introduction to GPU and TPU – Parallel Processing Applications

UNIT V SINGLE BOARD EMBEDDED SYSTEMS AND APPLICATIONS 6

Raspberry Pi Architecture – Booting Process – Operating System and Linux Commands – GPIO Programming – Interfacing Peripherals – Python-based Data Acquisition – Embedded Application Development – Mini Project

Periods: 30

Laboratory Experiments:
Laboratory Exercises:
Programming using IDE for ARM microcontroller
Timer and PWM generation
RTC interfacing using serial communication
Stepper motor control
Sensor interfacing and data acquisition
UART, I2C, SPI programming
Seminar Topics:
ARM with GSM/GPS interfacing
Introduction to ARM Cortex processors
Mini Project:
ARM or Raspberry Pi-based embedded system

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

-

Course Outcomes:

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

CO1: Explain ARM processor architecture and functional units
CO2: Develop programs using ARM instruction sets
CO3: Interface peripherals and communication protocols
CO4: Analyze modern processor architectures such as RISC-V, GPU, and TPU
CO5: Design embedded applications using ARM-based systems
CO6: Implement applications using single-board embedded processors

Suggested Activities:

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Text Books:

1. S. Furber, ARM System-on-Chip Architecture. Harlow, Addison-Wesley, 2nd ed., 2015.A. N.
2. Sloss, D. Symes, and C. Wright, ARM System Developer's Guide: Designing and Optimizing System Software. Burlington, Elsevier (Morgan Kaufmann), 2004.

References:

1. W. Hohl and C. Hinds, ARM Assembly Language: Fundamentals and Techniques. Boca Raton, CRC Press, 2nd ed., 2014. (Unit II, III)
2. R. Kamal, Microcontrollers: Architecture, Programming, Interfacing and System Design. New Delhi, Pearson,

3rd ed., 2017. (Unit III, IV)
3. J. Yiu, The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors. Oxford, Newnes (Elsevier), 3rd ed., 2013. (Unit I, II, III)
4. D. Patterson and A. Waterman, The RISC-V Reader: An Open Architecture Atlas. Strawberry Canyon LLC, 2017. (Unit IV)
5. D. Patterson and J. L. Hennessy, Computer Organization and Design RISC-V Edition. Cambridge, Morgan Kaufmann, 2nd ed., 2021. (Unit IV)

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	–	2	–	–	–	–	–	2	2	2
CO2	3	3	2	1	3	–	–	1	–	–	2	2	3
CO3	3	3	3	2	3	1	–	1	1	–	2	3	3
CO4	3	3	2	2	2	1	–	–	1	–	2	2	3
CO5	3	3	3	2	3	2	1	2	2	2	3	3	3
CO6	3	3	3	3	3	2	1	2	2	2	3	3	3

MEC2413 Embedded C Programming **MEC** **L T P C**

2 0 2 3

Course Objectives:

- To provide a strong foundation in C programming concepts for structured program development
- To introduce Embedded C programming concepts and their differences from standard C
- To develop skills in modular programming using functions, arrays, and pointers
- To enable programming and interfacing of the 8051 microcontroller using Embedded C
- To familiarize students with basic communication and interfacing techniques in embedded systems

UNIT I BASIC C PROGRAMMING **6**

Typical C Program Development Environment – Introduction to C Programming – Structured Program Development in C – Data Types and Operators – C Program Control Structures – Functions in C

UNIT II INTRODUCTION TO EMBEDDED C PROGRAMMING **6**

Embedded C vs Standard C – Structure of Embedded C program – Data types and variables – Operators and expressions – Control statements (if, switch, loops) – Basic embedded programs – Development tools using Keil IDE for 8051

UNIT III FUNCTIONS, ARRAYS AND POINTERS **6**

Functions and parameter passing – Arrays and strings – Introduction to pointers – Pointer operations – Pointer usage in embedded systems – Modular programming techniques – Simple program development using functions

UNIT IV 8051 PROGRAMMING IN C **6**

Introduction to 8051 Microcontroller – Embedded C programming for 8051 – Data types and variables – Delay generation using simple loops – I/O port programming – LED and switch interfacing – Basic logic operations – Simple data manipulation programs

UNIT V 8051 COMMUNICATION AND INTERFACING IN C 6

Basics of serial communication – Introduction to 8051 serial port programming – Basic timer programming – Introduction to interrupts (concept only) – LCD interfacing using Embedded C – Simple application programs using 8051

Periods: 30

Laboratory Experiments:

1. Embedded C Program Development for 8051
2. Write and execute simple Embedded C programs using Keil IDE
3. Demonstrate structure of Embedded C program and basic operations
4. I/O Port Programming using 8051
5. LED interfacing (blinking and pattern generation)
6. Switch interfacing for input detection
7. Delay and Timer Programming using 8051
8. Generate delays using software loops
9. Implement basic timer-based applications
10. Serial Communication using 8051
11. UART-based data transmission and reception
12. Display or verify transmitted data
13. Interfacing using 8051
14. LCD interfacing to display messages
15. Develop a simple application (e.g., display/control system)

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

1.

Course Outcomes:

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

CO1: Understand and apply fundamental C programming concepts for structured program development
CO2: Explain Embedded C concepts and differentiate them from standard C programming
CO3: Develop modular programs using functions, arrays, and pointers
CO4: Implement Embedded C programs for the 8051 Microcontroller involving I/O operations and basic logic
CO5: Design simple communication and interfacing programs using serial communication, timers, and LCD
CO6: Analyze and develop basic embedded applications using Embedded C programming techniques

Suggested Activities:

- IDE simulation.
- Case study - Modelling of Embedded C concepts.
- Mini Project – Embedded System Application

Text Books:

1. C How to Program – Paul Deitel and Harvey Deitel, 9th Edition, Pearson Education Limited, 2022.
2. Embedded C, Addison-Wesley, Pearson Education, 2002.
3. The 8051 Microcontroller and Embedded Systems – Muhammad Ali Mazidi, Janice G. Mazidi, Rolin D. McKinlay, Prentice Hall, 2nd Edition, 2007.

References:

1. Learn to Program with C, Apress Inc., 2015.
2. Practical C Programming, O'Reilly Media, 3rd Edition, 1997.

MEC2414	Sensors and Actuators for Embedded Systems	MEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To impart knowledge on the characteristics of measurements.
- To give an exposure to various sensors and their application.
- To foster familiarization with various actuators.
- To gain insight into interfacing sensors and actuators with processors.
- To explore the usage of sensors and actuators in climate control of automotives.

UNIT I QUALITY OF MEASUREMENT 9

Classification of transducers - Sensors and Actuators: Functions, Classifications, Technical requirement – Performance characteristics of measurement: Static characteristics, Dynamic characteristics of First order System - Need for Calibration - Errors in measurement.

UNIT II SENSORS 9

Construction, Operation, Characteristics and Applications: Thermistors, Photodiode, Phototransistor, Linear Variable Differential Transformer, Resistive and Optical Encoders, Piezo-electric transducer, Hall effect transducer, Hygrometer.

UNIT III ACTUATORS 9

Construction and Operation of Actuators: Magnetic voice-coil, Acoustic, Pneumatic, Hydraulic, MEMS, Stepper motor, DC Motor, Solenoid, Relay, LED – Thermal Actuation - Chemical actuation.

UNIT IV INTERFACING TO MICROPROCESSORS 9

Introduction – The microprocessor as a general-purpose controller – General requirements for interfacing sensors and actuators – Errors - Interfacing examples: Automatic light on upon entry, Power generator frequency control, Battery operated keypad lock.

UNIT V AUTOMOTIVE COMFORT, SAFETY AND CLIMATE CONTROL 9

Introduction – Sun-roof – Central locking – Cruise control – In-car multimedia – Security – Airbags – Obstacle avoidance – Auto-dimming mirror - Fundamentals of HVAC system- Different types of actuators used in automatic temperature control - Fixed and variable displacement temperature control.

Periods: 30

Course Outcomes:

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

CO1: Infer the characteristics and errors in measurements.
CO2: Specify the appropriate sensor for real-time system requirements.
CO3: Select an actuator for a timely system response.
CO4: Analyze the challenges in interfacing sensors and actuators with processors.
CO5: Implement interfacing applications using intelligent devices.
CO6: Interpret comfort, safety and temperature control features in Automotives.

Suggested Activities:

- Quiz assessments on introduction to measurement and sensors
- Journal review on applications of Sensors and Actuators
- Hands-on Mini Projects considering safety / sustainability of the environment & society
- Blended learning using simulators by acquiring real time physical world data using sensors for a case example

Text Books:

1. Ernest O. Doebelin, "Doeblin's Measurement Systems", 7th Edition (SIE), McGraw Hill Publishers, 2019.
2. A.K. Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", 19th Edition, Dhanpat Rai & Co, 2022.
3. Nathan Ida, "Sensors, Actuators and their Interfaces: A multidisciplinary Introduction", 2nd Edition, SciTech Publishers, The Institution of Engineering and Technology, London, United Kingdom, 2020.
4. Tom Denton, "Automobile Electrical and Electronics Systems," 4th Edition, 2012, Routledge, Taylor & Francis Group.

References:

1. Clarence W.de Silva, "Sensors and Actuators", CRC Press, Taylor & Francis Group, 2007.
2. William Kimberley, "Bosch Automotive Handbook", 11th Edition, Robert Bosch GmbH, 2022.
3. James D Halderman, "Automotive Electrical and Electronics" , Prentice Hall, USA, 6th Edition,2020

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	2	1
CO2	3	1	-	-	-	-	-	-	-	-	-	2	1
CO3	2	1	-	-	-	-	-	-	1	-	-	2	1
CO4	3	2	2		2	1	1	1	1	1	1	2	2
CO5	3	2	2	2	2	1	1	1	1	1	1	2	2
CO6	3	2	-	-	-	-	-	-	1	-	1	2	2
Avg.	2.83	1.50	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	1.50

MEC2415 IoT Systems and Applications **MEC** **L T P C**

3 0 0 3

Course Objectives:

- To impart knowledge on the fundamentals of IoT.
- To explore about the various services provided by IoT.
- To enable familiarization with various communication and networking methodologies in IoT.
- To facilitate the learning about IoT implementation tools.
- To give an exposure to various applications of IoT.

UNIT I INTRODUCTION TO IoT **9**

Definition and characteristics of IoT – Physical and Logical design of IoT – IoT enabling technologies- IoT Architecture: Simplified and Standardized, Comparison of Fog / Edge / Cloud computing - IoT levels and deployment templates – IoT Sensing and Actuation.

UNIT II COMMUNICATION FRAMEWORKS OF IoT **9**

Communication Middleware for IoT: M2M, SCADA, RFID, WSN – Zigbee: Architecture, Association, Network and APS Layer, Device Object and Device Profile - KNX: Technology overview, Device Configuration – BACNet: Technology, Security – MODBUS: Message framing and Transmission modes - Challenges Introduced by 5G in IoT Middleware: Technological Requirements of 5G Systems, Perspectives, and a Middleware Approach towards 5G.

UNIT III COMMUNICATION PROTOCOLS AND ACCESS TECHNOLOGIES FOR IoT 9

IoT Access Technologies: Physical, MAC layers, Topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a and LoRaWAN – Network Layer: Key advantages of Internet Protocol for IoT, 6LoWPAN, Routing over Low Power and Lossy Networks – Transport mechanisms: Tunnelling, Protocol Translation –Application Layer Protocols: CoAP and MQTT.

UNIT IV IoT IMPLEMENTATION PLATFORMS 9

IoT Design Methodology- Introduction to Python - Introduction to Arduino Boards - LED interface with Arduino – Interfacing with NodeMCU: LED, DHT, MQ-2, Ultrasonic sensor and Relay- Introduction to Raspberry Pi Boards – LED and PiCamera interfacing with Raspberry Pi.

UNIT V IoT APPLICATIONS 9

Case Studies: Home automation - Smart cities – Environment – Energy – Retail – Logistics – Agriculture – Industry - Health and life style

Periods: 45

Course Outcomes:

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

CO1: Articulate the main concepts, key technologies, strength and limitations of IoT.
CO2: Describe the middleware approaches for IoT and 5G systems
CO3: Compare the middleware architectures and protocols for IoT
CO4: Analyze the networking and communication in IoT.
CO5: Implement simple applications using Arduino, NodeMCU and Raspberry Pi
CO6: Analyze case studies on real time applications of IoT

Suggested Activities:

- Quiz assessment on IoT introductory topics
- Journal review on applications of Sensors and Actuators involving IoT
- Hands-on Mini Projects using sensors / actuators considering safety / sustainability of the environment & society
- Blended learning using simulators by acquiring real time physical world data for a case example

Text Books:

1. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on Approach)”, VPT, 1st Edition, 2015 (Paperback Edition).
2. Honbo Zhou, “Internet of Things in the cloud: A middleware perspective”, CRC press, 2012.
3. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things”, Cisco Press, 2017.
4. Sudip Misra, Anandarup Mukherjee, Arijit Roy, “Introduction to IoT”, Cambridge University Press, 2021.

References:

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies,
2. Platforms, and Use Cases", CRC Press, 2017.
3. Constandinos X. Mavromoustakis, George Mastorakis, Jordi MongayBatalla, “Internet of
4. Things (IoT) in 5G Mobile Technologies” Springer International Publishing Switzerland 2016.
5. Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things: Key Applications and Protocols”, John Wiley & Sons Ltd, 2012.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	1	-	3	1	3	2	3	2	2	2

CO2	2	2	1	1	-	-	-	-	1	-	3	2	1
CO3	2	2	1	1	-	-	-	-	1	-	2	2	1
CO4	2	2	1	1	-	-	-	-	1	-	2	2	1
CO5	3	3	3	3	3	3	1	3	3	3	3	2	2
CO6	3	3	3	3	3	3	1	3	3	3	3	2	3
Avg.	**2.2**	**2.2**	**1.7**	**1.7**	**3.0**	**3.0**	**1**	**3**	**2**	**3**	**3**	**2**	**2**

MEC2416 Industrial IoT **PEC** **L T P C**

3 0 0 3

Course Objectives:

- To explore the evolution of industrial revolutions and the fundamentals of Industry 5.0.
- To learn the concepts of digital transformation and Society 5.0.
- To acquire knowledge on smart systems, Industrial IoT and industrial applications.
- To introduce Cyber Physical Systems and cybersecurity in Industry 5.0.
- To explore AR/VR, Digital Twin and future trends in industrial systems.

UNIT I INTRODUCTION TO INDUSTRY 5.0 AND INDUSTRIAL IoT 9

Industrial Revolutions: Evolution from Industry 1.0 to Industry 5.0 – Introduction to Industrial Internet of Things (IIoT) – Smart and Connected Businesses – Smart Factories – Globalization and Emerging Issues – Lean Production Systems – Big Data and Advanced Analytics.

UNIT II DIGITAL TRANSFORMATION AND INDUSTRY 5.0 9

Introduction to Industry 5.0: Human-centricity, Sustainability and Resilience – Digital Transformation – Digital Business Transformation – Causes of Disruption and Transformation – Digital Transformation Myths and Realities – Digital Transformation across Industries – Society 5.0 Concepts.

UNIT III SMART SYSTEMS AND INDUSTRIAL APPLICATIONS 9

Sensors and Actuators – Communication Technologies – 5G Technology – Communication Protocols – Human–Machine Interaction – Robotics and Artificial Intelligence – Industrial IoT Application Domains: Healthcare, Manufacturing, Power Plants, Inventory Management and Quality Control.

UNIT IV CYBER PHYSICAL SYSTEMS AND CYBER SECURITY 9

Introduction to Cyber Physical Systems (CPS) – CPS Architecture – Networking Systems for CPS Applications – Data Science and Technology for CPS – Wearable Cyber Physical Systems – Cyber Security in Industry 5.0 – Security and Privacy Issues – Domain Applications of CPS.

UNIT V AR/VR, DIGITAL TWIN AND FUTURE TRENDS 9

Augmented Reality (AR) and Virtual Reality (VR) – Digital Twin – Smart Healthcare and Human Computer Interactions – Collaborative Robots – Society 5.0 Applications – Future Trends towards Industry 6.0 – Case Studies.

Periods: 45

Course Outcomes:

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

CO1: Explain the concepts of Industry 5.0 and Industrial IoT.
CO2: Illustrate digital transformation in Industry 5.0
CO3: Apply smart systems and Industrial IoT technologies in industrial applications.

CO4: Analyze Cyber Physical Systems and cybersecurity issues in Industry 5.0.
CO5: Examine AR/VR, Digital Twin and future industrial trends.
CO6: Relate Industry 5.0 and Society 5.0 concepts.

Suggested Activities:

-

References:

1. S. Misra, C. Roy, and A. Mukherjee, Introduction to Industrial Internet of Things and Industry 4.0. Boca Raton, CRC Press, 2021.
2. U. Elangovan, Industry 5.0: The Future of the Industrial Economy, CRC Press, 2021.
3. Industry 5.0: Key Technologies and Drivers, Springer, 2025.
4. Industry 5.0: The Human-Centric Future of Industry, Springer, 2025.

Communication Systems and Engineering

MEC2421	**Fundamentals of Communication Systems**	**MEC**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:

- To introduce the fundamental concepts of analog communication systems and modulation techniques.
- To provide knowledge on pulse and data communication methods, standards, codes and interfaces.
- To enable understanding of digital communication techniques and their performance comparison.
- To impart knowledge on source coding, information theory concepts, and error control coding techniques for reliable communication.
- To familiarize multi-user communication systems and modern wireless technologies.

UNIT I ANALOG COMMUNICATION 6

Introduction to Communication Systems – Modulation – Types – Need for Modulation. T
heory of Amplitude Modulation – Evolution and Description of SSB Techniques – Theory of Frequency and Phase Modulation – Comparison of Analog Communication Systems (AM – FM – PM).

UNIT II PULSE AND DATA COMMUNICATION 6

Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Width Modulation (PWM) – Pulse code Modulation (PCM) – Comparison of various Pulse Communication Systems. Data Communication: History of Data Communication – Standards Organizations for Data Communication- Data Communication Circuits – Data Communication Codes – Data communication Hardware – serial and parallel interfaces.

UNIT III DIGITAL COMMUNICATION 6

Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK)–Phase Shift Keying (PSK) – BPSK – QPSK – Quadrature Amplitude Modulation (QAM) – 8 QAM – Bandwidth Efficiency– Comparison of Digital Communication Systems.

UNIT IV SOURCE AND ERROR CONTROL CODING 6

Entropy- Source encoding theorem - Shannon-fano coding - Huffman coding - mutual information- channel capacity- Error Control Coding: linear block codes, cyclic codes.

UNIT V MULTI USER RADIO COMMUNICATION 6

Cellular Concept and Frequency Reuse – Channel Assignment and Handover Techniques –Multiple Access Schemes:

TDMA, FDMA and CDMA - GSM – Satellite Communication – Bluetooth.

Periods: 45

Course Outcomes:

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

CO1: Explain the fundamentals of analog communication systems and modulation techniques.
CO2: Compare various pulse communication techniques and their performance.
CO3: Describe data communication methods, standards, codes and interfaces.
CO4: Analyze digital modulation schemes with respect to bandwidth efficiency and performance.
CO5: CO5: Explore source and error control coding techniques for efficient data transmission.
CO6: Explain multi-user communication, satellite communication and Bluetooth.

Suggested Activities:

-

Text Books:

1. Simon Haykin, Communication Systems, Wiley, 2001 (4th Edition).
2. B.P. Lathi, Modern Digital and Analog Communication Systems, Oxford University Press.2011
3. Behrouz A. Forouzan, Data Communications and Networking, McGraw-Hill, 2006 (4th Edition)

References:

1. Simon Haykin, 'Digital Communication Systems', Wiley, 2013.
2. Dennis Roddy and John Coolen, 'Electronic Communications', Prentice Hall of India ,4th Edition ,2006
3. George Kennedy and Bernard Davis , 'Electronic Communication Systems' Pearson Education 5th Edition, 2008.
4. Bernard Sklar, 'Digital Communications Fundamentals and Applications' Pearson Education 2nd Edition, 2007
5. Hwei P. Hsu, 'Analog and Digital Communications', Tata McGraw Hill, 2006.

MEC2422	Internet and Data Communication	MEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To impart knowledge on the fundamentals of data communication systems and network models.
- To introduce the concepts of data link layer protocols, error detection/correction, and LAN technologies.
- To familiarise network layer functions such as addressing, routing, and IP protocols.
- To explore transport layer mechanisms including TCP/UDP, congestion control, and QoS.
- To interpret application layer protocols, client-server models, and basics of network security.

UNIT I DATA COMMUNICATION & NETWORK MODELS 9

Overview of Data Communications, Networks and Internet-Protocol Layering :TCP/IP Protocol suite, OSI Model-Physical Layer: Data And Signals, Periodic Analog Signals, Digital Signals-Transmission Media- Circuit and Packet Switching.

UNIT II DATA LINK LAYER 9

Introduction to Data Link Layer - Link layer Addressing- Error Detection and Correction- Ethernet (802.3) - Wireless LANs:IEEE802.11, Bluetooth

UNIT III NETWORK LAYER 9

Network layer services - IPv4 Address - Routing : Unicast Routing, Algorithms, Protocols , Multicast Routing and its basics - IPv6 Addressing – Transition from IPv4 to IPv6

UNIT IV TRANSPORT LAYER 9

Transport layer –Protocols- UDP, TCP : Services, Features , TCP Connection , State Transition Diagram , Flow, Error and Congestion Control - Congestion avoidance (DECbit, RED) –QoS

UNIT V APPLICATION LAYER 9

Application Layer Paradigms – Client Server Programming-Standard Client Server Protocols :WWW and HTTP, FTP, Electronic Mail, DNS- Introduction to Peer to Peer Networks - Need for Cryptography and Network Security - Firewalls.

Periods: 45

Course Outcomes:

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

CO1: Interpret the basic concepts of data communication, network models, and protocol layering
CO2: Analyze data link layer functionalities and LAN technologies
CO3: Apply network layer concepts for IP addressing and routing algorithms
CO4: Examine transport layer protocols and transmission control mechanisms
CO5: Analyze the application layer protocols.
CO6: Examine basic principles of network security systems.

Suggested Activities:

- Quiz
- Case Study
- Role Play
- Simulation
- Literature review

Text Books:

1. Behrouz.A.Forouzan, " Data Communication and Networking", Fifth Edition, TMH, 2017.

References:

1. James.F.Kurose and Keith.W.Ross, "Computer Networking – A Top – Down Approach", Sixth Edition, Pearson, 2017.
2. Doughlas .E.Comer, "Computer Networks and Internets with Internet Applications", Fourth Edition, Pearson Education, 2008
3. Behrouz.A.Forouzan, " Data Communication and Networking", Sixth Edition, TMH, 2022.

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	1	1	3
CO2	2	2	-	2	3	-	-	-	-	-	-	1	3
CO3	3	2	3	1	3	-	-	-	-	-	-	1	3
CO4	2	2	-	1	2	-	-	-	1	-	-	1	3
CO5	2	1	-	-	-	-	-	-	2	-	-	1	3

CO6	1	1	-	-	-	3	3	1	1	-	1	1	3
Avg.	**2**	**2**	**3**	**1**	**3**	**3**	**3**	**1**	**1**	**-**	**1**	**1**	**3**

MEC2423 Satellite and Optical Communication **MEC** **L T P C**

3 0 0 3

Course Objectives:

- To introduce the basic principles of satellite communication, orbital mechanics and operation of satellite systems.
- To provide knowledge on the fundamentals and transmission characteristics of optical fibers.
- To familiarize students with optical sources and detectors used in communication systems.
- To impart understanding of optical receivers and system design considerations, including link budget and performance analysis

UNIT I SATELLITE COMMUNICATION **9**

Overview - Frequency allocations of satellite services – Kepler's Laws - Newton's Laws - Orbital Parameters - Orbital Perturbations - Station Keeping-Geo Stationary and Non Geo Stationary Orbits – Look Angle Determination - Limits of Visibility- Launch Vehicles and Propulsion.

UNIT II SATELLITE SYSTEMS **9**

Attitude and orbit control system – Telemetry, Tracking and Command subsystems - Power system- Communication subsystems -Transponders-The Uplink - Downlink - Effects of Rain on fade margin.

UNIT III FUNDAMENTALS OF OPTICAL FIBER COMMUNICATION **9**

Introduction - Optical fiber communication system- Basic optical laws - Optical modes and configurations: Single mode fiber , Graded index fiber - Attenuation: absorption , scattering losses , bending losses , core and cladding losses - Signal dispersion: Intra model dispersion, Intermodal dispersion.

UNIT IV OPTICAL SOURCES AND DETECTORS **9**

Intrinsic and extrinsic material - Direct and indirect band gaps- LED structures: Surface emitting LED, Edge emitting LED-Quantum efficiency and LED power- Light source materials-Modulation of LED-LASER diodes : Modes and threshold conditions, Rate equations- PIN photo detector-Avalanche photo diodes

UNIT V OPTICAL FIBER RECEIVERS AND SYSTEM DESIGN **9**

Fundamental receiver operation: Digital signal transmission, Error sources, Front end amplifiers - Digital receiver performance: Probability of error, Receiver sensitivity, Quantum limit - Digital Link - Point to Point link design: System design consideration, Link power budget, Rise time budget.

Periods: 45

Course Outcomes:

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

CO1: Interpret the basic concepts of satellite communication.
CO2: Analyze the significance of satellite orbits and orbital parameters in communication.
CO3: Illustrate the working of uplink, downlink systems and transponders.
CO4: Examine the fundamentals of optical fibers and its transmission characteristics.
CO5: Analyze optical sources and detectors in optical communication system.
CO6: Assess digital optical receiver and point-to-point optical links.

Suggested Activities:

- Quiz
- Simulation Activity
- Case Study
- Literature Review

Text Books:

1. Dennis Roddy, “Satellite Communications”,Tata McGraw-Hill Education, 4th Edition, 2011.
2. Gerd Keiser, “Optical Fiber Communications”,McGraw-Hill Education, 5th Edition, 2013.

References:

1. Madhavendra Richharia, “Satellite Communication Systems”, McGraw-Hill, 2nd Edition, 2003.
2. Timothy Pratt, Jeremy Allnutt, “Satellite Communications”, 3ed, An Indian Adaptation, 2021.
3. John M. Senior, Optical Fiber Communications: Principles and Practice, Pearson Education, 3rd Edition, 2009.
4. Joseph C. Palais, Fiber Optic Communications, Pearson Education, 5th Edition, 2005.
5. I. B. Djordjevic, Advanced Optical and Wireless Communications Systems. Springer International Publishing, 2022.

MAPPING OF COs WITH POs AND PSOs

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	1	2	1
CO2	3	3	-	-	-	-	-	-	-	-	1	3	1
CO3	2	2	1	-	-	-	-	-	-	-	1	2	1
CO4	3	2	-	-	-	-	-	-	-	-	1	2	1
CO5	3	3	1	-	-	-	-	-	-	-	1	3	2
CO6	2	3	2	1	1	-	-	-	-	2	1	3	2
Avg.	2.66	2.5	1.33	1	1	-	-	-	-	2	1	2.5	1.33

MEC2424 Communication for IoT and Smart Systems **MEC** **L T P C**

3 0 0 3

Course Objectives:

- To apply communication principles in IoT-based systems
- To analyze IoT architectures and communication requirements
- To develop knowledge of IoT communication protocols across layers
- To utilize networking technologies for IoT applications
- To integrate IoT communication technologies in real-world scenarios

UNIT I IoT COMMUNICATION BASICS 9

IoT overview- Machine-to-Machine and IoT- IoT architecture and components- Sensors- Actuators- Gateways – Communication requirements in IoT- Basic communication concepts: Signal- Bandwidth- Modulation- Overview of IoT applications.

UNIT II PHYSICAL AND LINK LAYER TECHNOLOGIES 9

IoT Physical layer concepts- Wired vs Wireless communication- IEEE 802.11- IEEE 802.15.4- Bluetooth Low Energy (BLE)- NFC- Low-power communication techniques- MAC layer basics

UNIT III NETWORK AND TRANSPORT LAYER 9

IPv6 for IoT- 6LoWPAN- Addressing and header compression- Routing fundamentals- Introduction to RPL- Transport Layer Concepts- UDP in IoT systems

UNIT IV APPLICATION LAYER PROTOCOLS 9

REST architecture- HTTP basics- CoAP protocol- MQTT protocol- AMQP – Publish–Subscribe model- IoT data communication frameworks

UNIT V ADVANCED IoT COMMUNICATION TECHNOLOGIES AND APPLICATIONS 9

Low Power Wide Area Networks (LPWAN): LoRa, NB-IoT, SigFox- IoT architectures (Thread)- Communication security basics- Integration of IoT communication technologies- Case studies in smart systems: healthcare, smart cities, industrial IoT

Periods: 45

Course Outcomes:

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

CO1: Analyze IoT system architecture and communication requirements (UNIT I)
CO2: Apply physical and link layer technologies for IoT communication (UNIT II)
CO3: Analyze network and transport layer mechanisms in IoT systems (UNIT III)
CO4: Implement IoT application layer protocols for data communication (UNIT IV)
CO5: Explore IoT communication technologies for real-world applications (UNIT V)
CO6: Develop simple IoT communication models for practical scenarios (UNIT V)

Suggested Activities:

- Mini Project
- Seminar / Demo: Present IoT solution / project

Text Books:

1. Ronaldo Herrero- “Fundamentals of IoT Communication Technologies”- Springer- 2020.
2. Arshdeep Bahga, Vijay Madisetti, “Internet – of- Things – A Hands on Approach”, Universities Press, 2015.

References:

1. Mayur Ramgir, “Internet- of-Things, Architecture, Implementation and Security”, First Edition, Pearson Education, 2020.
2. Arjun K P, Abel Jopaul, Tegil John, Internet of things: Concepts, Technologies and Applications, Scientific International Publishing House, 2025.

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	1	**2**	**1**
CO2	3	2	1	-	3	-	-	-	-	-	1	**3**	**2**
CO3	2	3	1	-	2	-	-	-	-	-	1	**3**	**2**
CO4	2	2	2	-	3	-	-	1	-	-	1	**2**	**3**
CO5	2	3	2	1	2	2	2	1	-	2	1	**3**	**3**
CO6	2	2	3	1	2	-	-	-	2	2	2	**3**	**3**
AVG	2.33	2.33	1.8	1	2.4	2	2	1	2	2	1.16	2.66	2.2

MEC2425 Signal Processing and Machine learning with applications MEC L T P C

2 0 2 3

Course Objectives:

- To apply signal representations and processing techniques for real-world data.
- To analyze signal transformation and filtering methods.
- To develop approaches for extracting meaningful features from signals.
- To utilize machine learning techniques for pattern recognition tasks.
- To integrate signal processing and machine learning concepts in practical applications

UNIT I SIGNAL REPRESENTATION AND TRANSFORMATION 9

Signals: Types and classification-Signal representation- Basic operations on signals- Sampling and Quantization-Noise and Signal-to-noise ratio. Concept of frequency domain representation- Discrete Fourier Transform (DFT)- Fast Fourier Transform (FFT).

UNIT II SIGNAL FILTERING 9

Convolution and Correlation- Digital filters: Finite Impulse Response Filter and Infinite Impulse Response Filter-Signal Processing Applications.

UNIT III FEATURE EXTRACTION AND ANALYSIS 9

Feature extraction fundamentals- Time domain and frequency domain features- Spectral analysis- Dimensionality reduction- Principal Component Analysis (PCA)- Introduction to Pattern recognition.

UNIT IV MACHINE LEARNING TECHNIQUES 9

Introduction to Machine learning- Supervised and Unsupervised learning- Clustering techniques (K-means)-Probabilistic models- Basics of neural networks – Learning from signal data.

UNIT V APPLICATIONS OF SIGNAL PROCESSING AND ML 9

Speech processing and recognition using ML models- Image and Multimedia signals with feature based classification-Biomedical signals (ECG,EEG) and pattern recognition techniques- Noise handling and signal enhancement- Case Studies in real-world application.

Periods: 45

Course Outcomes:

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

CO1: Interpret different types of signals and their transformations.
CO2: Analyse filtering techniques and signal processing applications.
CO3: Extract relevant features from signals for analysis.
CO4: Implement basic machine learning algorithms for signal-based problems.
CO5: Analyze real-world applications using signal processing and ML techniques.
CO6: Develop simple models integrating signal processing and machine learning.

Suggested Activities:

- Mini Project
- Seminar- Presentation

Text Books:

1. Michael M. Richter- Sheuli Paul- Veton Kepuska- Marius Silaghi- "Signal Processing and Machine Learning with Applications"- Springer- 2022.
2. John G. Proakis and Dimitris G. Manolakis- Digital Signal Processing – Principles- Algorithms and Applications- Fourth Edition- Pearson Education / Prentice Hall- 2007.

References:

1. Ethem Alpaydin- “Introduction to Machine Learning”- MIT Press- Fourth Edition- 2020.
2. A. V. Oppenheim- R. W. Schafer and J. R. Buck- Discrete-Time Signal Processing- 8th Indian Reprint- Pearson- 2004.
3. Monson H. Hayes- "Statistical digital signal processing and modeling"- John Wiley and Sons Inc. New York- Indian reprint 2008.

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	1	2	1
CO2	3	2	1	-	2	-	-	-	-	-	1	2	2
CO3	2	3	1	-	2	-	-	-	-	-	1	2	2
CO4	2	2	2	-	3	-	-	1	-	-	1	2	3
CO5	2	3	2	1	2	2	2	1	-	1	1	3	2
CO6	2	2	3	1	2	-	-	-	1	1	2	3	3
Avg.	2.33	2.33	1.80	1.00	2.20	2.00	2.00	1.00	1.00	1.00	1.17	2.33	2.17

MEC2426	Image Processing and Computer Vision	MEC	L	T	P	C
			3	0	0	3

Course Objectives:

- Learn the basic concepts of image processing and computer vision.
- Explore the use of computer vision for object detection and image segmentation problems.
- Understand the ideas about image Recognition and Restoration
- Explore the ideas of object detection and Segmentation using Vision Datasets.
- Demonstrate the model prediction and to solve a variety of problems

UNIT I INTRODUCTION 9

Introduction to Image Processing and Computer Vision-Features-Applications- Image formation –Geometric primitives and Photometric image formation - The digital camera and Image processing - Point operators - Linear filtering ,Fourier transforms - Pyramids and wavelets - Geometric transformations - Global optimization – Feature detection and matching Points and patches - Edges – Lines

UNIT II IMAGE SEGMENTATION AND ALIGNMENT 9

Segmentation: Active contours - Split and merge - Mean shift and mode finding - Normalized cuts – Graphcuts - Feature-based alignment - 2D and 3D feature-based alignment - -Geometric intrinsic calibration.

UNIT III OBJECT DETECTION, RECOGNITION, AND 3D RECONSTRUCTION 9

Object detection -Face recognition -Instance recognition - Category recognition -Context and scene understanding- Recognition databases and test set, 3D reconstruction: Shape from X - Active range finding - Surface representations- Point-based representations - Volumetric representations - Model-based reconstruction -Recovering texture maps and albedos

UNIT IV VISION DATASETS AND MODEL PREDICTIONS 9

Object Detection – Segmentation. Creating Vision Datasets: Collecting Images – Data types – Manual Labeling – Labeling at Scale – Automated Labeling – Bias – Creating a Dataset -Model Predictions: Making Predictions

UNIT V OBJECT MEASUREMENT, POSE ESTIMATION, AND IMAGE UNDERSTANDING 9

Object Measurement – Counting – No-Code Computer Vision - Pose estimation- Image Search, Image and Text Generations: Image Understanding – Image Generation –Image Captioning.

Periods: 30

Laboratory Experiments:

1 Installation of Open CV & To perform the basic image handling processing operation on the image
2 Implement Edge Detection, Line Detection and Corner Detection
3 Demonstrate Camera Calibration using python
4 Implement Image Histogram and Histogram Equalization
5 Develop a python program for Skin color Detection
6 Create a python program for Warping and Estimation
7 Develop a python program for Motion Tracking
8 Design a program for Object Detection using YOLO
9 Develop a python program for Stereo Vision and Depth Estimation
10 Demonstrate Augmented reality using feature matching

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

-

Course Outcomes:

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

CO1: Explain the fundamentals of image processing and computer vision.
CO2: Implement 2D and 3D feature-based alignment methods for real-world computer vision applications.
CO3: Compare various surface, point-based, and volumetric representations used in 3D modeling.
CO4: Demonstrate the complete pipeline for creating a vision dataset suitable for training machine learning models.
CO5: Analyze pose estimation methods for detecting and tracking object or human posture..
CO6: Implement image captioning and text generation methods for semantic interpretation of visual data.

Suggested Activities:

-

Text Books:

1. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", 4th Edition, Pearson Education, 2018.
2. Richard Szeliski, "Computer Vision: Algorithms and Applications", 2nd Edition, Springer, 2020.
3. Adrian Kaehler and Gary Bradski, "Learning OpenCV 3: Computer Vision in C++ with the OpenCVLibrary", 2nd Edition, O'Reilly Media, 2016.

References:

1. Rajalingappaa Shanmugamani, "Deep Learning for Computer Vision", Packt Publishing, 2018.
2. Himanshu Singh, "Practical Machine Learning and Image Processing", Apress, 2019.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	1	1	3	–	–	–	–	–	–	2	–
CO2	2	2	2	2	3	–	–	–	–	–	–	2	–
CO3	2	3	2	2	3	–	–	–	–	–	–	2	–
CO4	2	3	2	2	1	–	–	–	–	–	–	2	–
CO5	2	2	3	2	1	–	–	–	–	–	–	2	–
CO6	2	2	2	2	1	–	–	–	–	–	–	2	–
Avg.	2	2.3	2.3	1.83	2	–	–	–	–	–	–	2	–

VLSI and Signal Processing

MEC2431	VLSI Chip Design	MEC	L	T	P	C
			2	0	2	3

Course Objectives:

- To impart knowledge on MOS transistor operation, CMOS logic families, and the basics of fabrication and layout.
- To educate students on combinational circuit design with emphasis on speed and power reduction
- To familiarize students with sequential circuits, pipelining techniques, and timing analysis.
- To facilitate analysis of datapath components such as adders, multipliers, and shifters.
- To explain memory organization and ASIC design flow.

UNIT I MOS TRANSISTOR THEORY 9

MOS transistors (NMOS, PMOS) – Ideal IV Characteristics - Non-ideal IV effects - CV Characteristics - CMOS Logic – DC transfer characteristics

UNIT II COMBINATIONAL CIRCUIT DESIGN 9

Performance parameters: RC delay model, Linear delay model, Logical effort of paths, Power dissipation, Dynamic Power, Static Power.
Circuit families: Static CMOS, Ratioed circuits, Dynamic circuits, Domino logic, Pass transistor logic, Transmission gates.

UNIT III SEQUENTIAL CIRCUIT DESIGN 9

Static latches and registers - Dynamic latches and registers - Pulse registers - Pipelining for optimization - Timing parameters and constraints in synchronous circuits.

UNIT IV DATAPATH SUB-SYSTEMS 9

Adders: Static CMOS full adder, Mirror adder, Ripple carry adder, Carry bypass adder, Carry select adder, Carry lookahead adder - Multipliers: Array multiplier, Carry save multiplier, Wallace tree multiplier – 1-bit shifter - Barrel shifter

UNIT V SEMICONDUCTOR MEMORIES AND ASIC DESIGN 9

Semiconductor memories: Memory architectures, ROM cells, SRAM and DRAM cells - ASIC design flow – Types of ASICs

Periods: 45

Course Outcomes:

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

CO1: Explain MOS transistor and CMOS characteristics.
CO2: Design combinational circuits using various circuit families.
CO3: Analyze sequential circuits with timing constraints.
CO4: Construct adders, multipliers, and shifters in datapath subsystems.
CO5: Describe semiconductor RAM and ROM memory architectures.
CO6: Explore ASIC types and digital ASIC design flow.

Suggested Activities:

- Journal review/Case study: Review of state of art circuit topologies.

- Design and simulation of simple combinational circuits using Verilog HDL.

Text Books:

1. Neil H.E.Weste & David Money Harris, "CMOS VLSI Design: A circuits and Systems perspective", Fourth Edition, Pearson College Div, 2016
2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic "Digital Integrated Circuits: A Design Perspective", Second Edition, Pearson Education,2016.

References:

1. A.Pucknell, Kamran Eshraghian, "BASIC VLSI Design", Third Edition, Prentice Hall of India, 2007.
2. NPTEL Course, "CMOS Digital VLSI Design", https://onlinecourses.nptel.ac.in/noc26_ee85/preview

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	3	2
CO2	3	2	1	-	-	-	-	-	-	-	-	3	2
CO3	3	2	1	-	-	-	-	-	-	-	-	3	2
CO4	3	2	2	1	1	-	-	-	1	-	1	3	2
CO5	3	2	-	-	-	-	-	-	-	-	-	3	2
CO6	3	2	-	-	-	-	-	-	-	-	-	3	2
Avg.	2	2	1	1	1	-	-	-	1	-	1	3	2

MEC2432 FPGA based System Design **MEC** **L T P C**

2 0 2 3

Course Objectives:

- To introduce the fundamentals of FPGA-based systems.
- To provide understanding of FPGA architectures, logic elements, and interconnect structures.
- To develop knowledge of logic implementation and physical design processes for FPGAs.
- To familiarize students with Verilog HDL for gate-level and dataflow modeling.
- To enable behavioural modelling and simulation of combinational and sequential circuits using HDL.

UNIT I INTRODUCTION TO FPGA BASED SYSTEMS 9

Role of FPGAs – FPGA types - FPGA vs Custom VLSI – Hierarchical design – Design Abstraction – Methodologies - FPGA vs DSP – DSPs on FPGA

UNIT II FPGA FABRIC 9

SRAM based FPGAs – Permanently programmed FPGAs – Chip I/O – Circuit Design of FPGA Fabrics : Logic elements, Interconnects – Architecture of FPGA

UNIT III LOGIC IMPLEMENTATION AND PHYSICAL DESIGN FOR FPGAs 9

Logic implementation for FPGAs : Syntax directed translation, Macro, Logic synthesis and optimization
Physical Design for FPGAs : Placement, Routing

UNIT IV GATE LEVEL AND DATAFLOW MODELING 9

Introduction to Verilog : Introduction to HDL, Typical design flow, lexical conventions, Data types, System tasks and

directives, Verilog modules and ports - Gate level modeling : Primitive gates - buffers - multiple input gates - Gate delays: Rise,Fall and turn off delays, Min/Typ/Max values – Structural modelling of combinational circuits
Dataflow modelling : Continuous assignments – Delays: Regular assignment delay, Net Declaration delay – Expressions – Operators – Operands - Operator types – Dataflow modeling of combinational circuits.

UNIT V BEHAVIORAL MODELING 9

Structured procedures – Procedural assignments – Blocking assignments – Non blocking assignments – Timing controls: Delay based control ,Event based timing control ,Level sensitive timing control – Conditional statements – Multiway branching – Loops – Sequential and Parallel blocks - Behavioral modelling of sequential circuits.

Periods: 30

Laboratory Experiments:

1. Study and implementation of FPGA design flow
2. Implementation of Boolean expressions on FPGA.
3. Implementation of combinational circuits on FPGA.
4. Implementation of sequential circuits on FPGA.
5. Implementation of Moore Finite State Machines on FPGA.
6. Implementation of Mealey Finite State Machines on FPGA.

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- Personal Computers : 15 Nos
- Quartus/Xilinx/Equivalent software : 15 Nos
- FPGA (Altera/Spartan/Equivalent) Board : 10 Nos

Course Outcomes:

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

CO1: Explain FPGA architectures, design methodologies, and their comparison with custom VLSI and DSP systems..
CO2: Describe FPGA fabric components.
CO3: Explain logic synthesis and optimization techniques for FPGA implementation.
CO4: Demonstrate placement and routing processes in FPGA physical design.
CO5: Implement Verilog models using gate-level and dataflow modelling techniques for combinational circuits.
CO6: Apply behavioral modeling concepts in Verilog for designing and simulating sequential circuits.

Suggested Activities:

- Mini Project – Design and implement a complete Digital System design on FPGA.

Text Books:

1. Wayne Wolf," FPGA Based System Design", Pearson Education, 2004
2. Samir Palnitkar," Verilog HDL:A guide to Digital Design and Synthesis", Second Edition, Pearson Education,2003 .

References:

1. NPTEL Course : FPGA based Signal processing Systems: https://onlinecourses.nptel.ac.in/noc26_ee09
2. S. B. Zvonko Vranesic,"Fundamentals of Digital Logic with Verilog Design", 2016, McGraw Hill .

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	3	3
CO2	3	2	-	-	-	-	-	-	-	-	-	3	3
CO3	3	2	-	-	-	-	-	-	-	-	-	3	3
CO4	3	2	-	-	-	-	-	-	-	-	-	3	3
CO5	3	2	2	2	3	-	-	2	2	1	2	3	3
CO6	3	3	2	2	3	-	-	2	2	1	2	3	3
Avg.	3	2.16	2	2	3	-	-	2	2	1	2	3	3

MEC2433 Digital Signal Processing **MEC** **L T P C**

2 0 2 3

Course Objectives:

- To understand the fundamental concepts of Digital Signal Processing including discrete-time signals and systems
- To learn discrete Fourier transform, properties of DFT and its application to linear filtering
- To understand the characteristics of digital filters, design digital IIR and FIR filters, and apply them for filtering unwanted signals in different frequency bands
- To explain multirate signal processing techniques and the architecture of DSP processors, including fixed-point and floating-point implementations.

UNIT I SIGNALS AND SYSTEMS 6

Basic elements of DSP — Discrete time signals and systems – Analysis of discrete time LTI systems-Fourier transform – Z transform – Convolution (linear and circular) - concepts of frequency in Analog and Digital Signals–sampling theorem

UNIT II FREQUENCY TRANSFORMATIONS 6

Introduction to Discrete Fourier transform (DFT) – Properties of DFT: periodicity, symmetry, circular convolution - Fast computation of DFT: Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT), Radix-2 Decimation-in-frequency (DIF) Fast Fourier transform.

UNIT III IIR FILTER DESIGN 6

Structures of IIR – Design techniques for analog filter: Butterworth and Chebyshev approximations, Frequency transformation-IIR digital filter design (LPF and HPF):Bilinear transformation, Impulse Invariance method.

UNIT IV FIR FILTER DESIGN 6

Structures of FIR – Design of FIR filters: symmetric and Anti-symmetric FIR filters – Filter design: Using windowing techniques(Rectangular, Hamming, and Hanning) ,Frequency sampling method

UNIT V MULTIRATE DIGITAL SIGNAL PROCESSING AND DSP ARCHITECTURE 6

Multirate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor
Fixed-Point and Floating-Point DSPs: Architecture, addressing modes, and instruction sets of TMS320C5X and TMS320C6X families.

Periods: 30

Laboratory Experiments:
SIMULATION USING MATLAB
1.Generation of signals
2. Linear and circular convolution
3.UpSampling and down sampling
4.Frequency analysis using DFT
5.Design of Butterworth and Chebyshev IIR filter
6.Design of FIR filter using windowing techniques

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

-

Course Outcomes:

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

CO1: Implement different operation of signals.
CO2: Implement the Discrete Fourier Transform (DFT) of a given signal using Fast Fourier Transform (FFT) techniques.
CO3: Analyze IIR filters using Butterworth and Chebyshev methods along with transformations such as Bilinear Transformation and impulse invariance.
CO4: Implement FIR filters using different windowing and sampling techniques.
CO5: Explain multirate signal processing methods such as decimation, interpolation, and sampling rate conversion
CO6: Describe DSP processor architectures like TMS320C5x and TMS320C6x in terms of addressing modes and instruction sets.

Suggested Activities:

- Simulation using MATLAB
- Group activity in problem solving
- Journal review

Text Books:

1. Oppenheim, Willsky and Hamid, “Signals and Systems”, 2nd Edition, Pearson Education, New Delhi, 2015.
2. John G. Proakis, Dimitris G Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, 2022, 5th Edition, Pearson, USA

References:

1. A textbook of Digital Signal Processing, R.S.Kaler, M.Kulkarni, Umesh Gupta, 1st edition, 2019, Dream tech Press, Wiley, India
2. James McClellan, Ronal Schaeffer, Mark Yoder, Digital Signal Processing first, 2016, 2nd edition, Pearson, USA
3. Lizhe Tan, Jean Jiang, Digital Signal Processing: Fundamentals and applications, 3rd edition, 2018, Academic Press, USA
4. S.K.Mitra, Digital Signal Processing, 2013, 4th edition, TMH, New Delhi, India.
5. B. P. Lathi, “Principles of Linear Systems and Signals”, 2nd Edition, Oxford, 2009.
6. M. J. Roberts, “Signals and Systems Analysis using Transform methods and MATLAB”, McGraw- Hill Education, 2018.
7. A.V. Oppenheim,R.W.Schafer and J.R.Buck,-Discrete time signal processing,8th Indian Reprint,Pearson,2010

CO PO PSO Mapping:

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	3	-	-	-	1	-	1	-	-
CO2	3	3	-	-	3	-	-	-	1	-	1	-	-
CO3	3	3	2	-	3	-	-	-	1	-	1	-	-
CO4	3	3	2	-	3	-	-	-	1	-	1	-	-
CO5	3	2	2	-	3	-	-	-	1	-	1	-	-
CO6	2	2	2	-	-	-	-	-	1	-	1	-	-

PEC2446 VLSI Signal Processing **PEC** **L T P C**

3 0 0 3

Course Objectives:

- To understand how DSP algorithms are represented and implemented in hardware.
- To learn techniques like pipelining, parallel processing, retiming, folding, and unfolding for improving system performance.
- To study systolic array design for efficient realization of DSP systems.
- To understand fast convolution methods and bit-level arithmetic architectures used in DSP hardware design.

UNIT I DSP SYSTEMS AND ALGORITHMS 9

Introduction - Overview of typical DSP Algorithms - Representations of DSP algorithms: Block diagram - Signal flow graph - Data flow graph - Dependence graph - Pipelining and parallel processing: Introduction, Pipelining and parallel processing of FIR digital filters

UNIT II ITERATION BOUND AND RETIMING 9

Iteration Bound: loop bound and iteration bound, Longest path matrix algorithm for iteration bound computation - Introduction to Retiming - Definition and properties of retiming - Solving system of inequalities – Cutset retiming and pipelining techniques for retiming

UNIT III FOLDING AND UNFOLDING 9

Unfolding: Introduction, Algorithm for unfolding, Properties of unfolding – Folding: Introduction, Folding transformation, Register minimization techniques.

UNIT IV SYSTOLIC ARCHITECTURE DESIGN 9

Introduction - Systolic Array Design Methodology - FIR Systolic Arrays - Selection of Scheduling Vector - Matrix Multiplication and 2D Systolic Array Design

UNIT V CONVOLUTION AND BIT LEVEL ARITHMETIC ARCHITECTURES 9

Fast Convolution: Cook-Toom Algorithm, Winograd Algorithm, Iterated Convolution and Cyclic Convolution – Bit level arithmetic architectures: parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers,

design of Lyon's bit-serial multipliers using Horner's rule

Total Periods: 45

Course Outcomes:

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

CO7: Represent DSP algorithms using suitable graphical models.
CO8: Apply pipelining and parallel processing techniques to speed up DSP systems.
CO9: Use iteration bound and retiming concepts to optimize DSP hardware.
CO10: Perform folding and unfolding transformations to reduce hardware resources.
CO11: Design systolic array architectures for DSP applications.
CO12: Apply fast convolution and bit-level arithmetic methods in efficient hardware implementation.

Suggested Activities

- Problem solving sessions.
- Case study discussions.
- Journal/Article review.

Text Books:

1. R. Keshab K. Parhi, " VLSI Digital Signal Processing Systems, Design and implementation ", Wiley, Interscience, 2007.

References:

1. Mohammed Ismail, Terri, Fiez, Analog VLSI Signal and Information Processing, McGraw Hill, 1993.
2. U. Meyer – Baese, "Digital Signal Processing with Field Programmable Gate Arrays", Springer, Second Edition, 2004
3. Kung. S.Y., H.J. While house T.Kailath, VLSI and Modern signal processing, Prentice Hall,1985 .

MEC2435	VLSI Testing	MEC	L	T	P	C
			2	0	2	3

Course Objectives:

- To introduce the fundamentals of testing and fault modeling in digital integrated circuits.
- To develop the ability to generate test patterns for combinational and sequential circuits.
- To provide knowledge of design-for-testability (DFT) techniques.
- To explain built-in self-test (BIST) architectures and memory testing algorithms.
- To familiarize students with fault diagnosis techniques and self-checking circuit design

UNIT I FAULT MODELING 9

Introduction to Testing - Faults in digital circuits - Modelling of faults - Logical Fault Models - Fault detection - Fault location - Fault dominance - Logic Simulation - Types of simulation - Delay models - Gate level Event-driven simulation.

UNIT II TEST GENERATION FOR COMBINATIONAL AND SEQUENTIAL CIRCUITS 9

Test generation for combinational logic circuits - Testable combinational logic circuit design - Test generation for sequential circuits - design of testable sequential circuits.

UNIT III DESIGN FOR TESTABILITY (DFT) 9

Design for Testability - Ad-hoc design - Generic scan based design - Classical scan based design – System level DFT approaches.

UNIT IV SELF TEST AND TEST ALGORITHMS 9

Built-In Self Test - Test pattern generation for BIST - Circular BIST - BIST Architectures - Testable Memory Design - Test algorithms - Test generation for Embedded RAMs.

UNIT V FAULT DIAGNOSIS LOGIC 9

Level Diagnosis - Diagnosis by UUT reduction - Fault Diagnosis for Combinational Circuits - Self-checking design - System Level Diagnosis.

Periods: 45

Course Outcomes:

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

CO1: Explain different fault models, fault detection techniques, and simulation methods .
CO2: Apply test generation techniques for combinational logic circuits.
CO3: Analyze test generation methods for sequential circuits.
CO4: Explain design-for-testability techniques.
CO5: Describe built-in self-test (BIST) architectures.
CO6: Explore fault diagnosis techniques and self-checking circuits for reliable system operation.

Suggested Activities:

- Mini Project : Design and test a small digital system with Fault injection, test pattern generation and Basic DFT.

Text Books:

1. M. Abramovici, M.A. Breuer and A.D. Friedman, "Digital Systems and Testable Design", Jaico Publishing House.
2. M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers.

References:

1. 1.P.K. Lala, "Digital Circuit Testing and Testability", Academic Press, 2002.
2. A.L. Crouch, "Design Test for Digital IC's and Embedded Core Systems", Prentice Hall International.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	1	3	3
CO2	3	2	1	1	-	-	-	-	-	-	1	3	3
CO3	3	2	1	1	-	-	-	-	-	-	1	3	3
CO4	3	2	1	-	-	-	-	-	-	-	-	3	3
CO5	3	2	1	-	-	-	-	-	-	-	-	3	3
CO6	3	3	2	1	2	-	-	2	2	2	1	3	3
Avg.	3	2.16	1.16	1	2	-	-	2	2	2	1	3	3

MEC2436	ASIC Design	MEC	L	T	P	C
			2	0	2	3

Course Objectives:

- To provide knowledge of ASIC design flow from RTL to GDSII.
- To understand standard cell–based design, partitioning, and floor planning techniques.
- To develop skills in placement, routing, and clock tree synthesis.
- To impart knowledge of static timing analysis and timing closure.
- To introduce physical verification and sign-off methodologies used in ASIC design.

UNIT I INTRODUCTION TO ASICS 6

Types of ASICs - Design flow - CMOS transistors - Combinational Logic Cell – Sequential logic cell - Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical effort.

UNIT II FLOORPLANNING AND PLACEMENT 6

Floor Planning Goals - Floor planning tools - I/O and Power planning - Clock planning - Placement Algorithms - Pin Assignment Objectives - Measurement of Delay in floor planning

UNIT III ROUTING, CLOCK DESIGN AND PHYSICAL VERIFICATION 6

Routing: Global routing, Detailed routing, Special routing, Clock Design, Clock Network Synthesis. Power and Ground Routing, Watchdog Timer, DRC, RC Extraction, Antenna Effect.
Physical verification: Packaging- Layout Issues-Preventing electrical overstress, Static verification techniques-Post-layout design verification

UNIT IV STATIC TIMING ANALYSIS 6

Timing Paths - Time borrowing - Basic concepts of Setup Time and Hold Time - Setup and Hold Violation - Delay: Timing path delay, Interconnect Delay models, Wire load model - Maximum clock frequency - Timing Models: SDF , SDC - Design Constraints: Transition Time, Fanout, Process Variation, Parasitic Extraction

UNIT V SYSTEM-ON-CHIP DESIGN 6

SoC Design Flow - Platform-based and IP based SoC Designs - Basic Concepts of Bus Based Communication Architectures

Periods: 30

Laboratory Experiments:

1. RTL Synthesis and Analysis of Area, Timing, and Power Reports
   Floor planning and Placement:
2. Design Partitioning and Floorplanning with I/O Pin Assignment
3. Power Planning and Placement Optimization in ASIC Design
   Clock and Routing :
4. Clock Tree Synthesis and Clock Skew Analysis
5. Global and Detailed Routing with Congestion Analysis
   Timing analysis :
6. Static Timing Analysis for Setup and Hold Time Violations
7. Timing Closure Using Design Constraints and Optimization Techniques
   Post layout and verification:
8. Parasitic Extraction and Post-Layout Timing Analysis
9. Physical Verification using DRC and LVS Checks

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

- Personal Computers : 30 Nos
- Cadence EDA/Equivalent EDA tool: 10 Nos

Course Outcomes:

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

CO1: Explain ASIC design flow and standard cell–based design methodology.
CO2: Apply floorplanning, placement, and power planning techniques for ASIC implementation.
CO3: Analyze routing and clock tree synthesis to optimize performance and timing.
CO4: Perform static timing analysis and identify/setup and hold violations.
CO5: Analyze the impact of design constraints such as transition time, fanout, process variations, and parasitic effects on circuit performance.
CO6: Apply physical verification techniques such as DRC and LVS for design sign-off.

Suggested Activities:

- Mini project: RTL-to-GDSII Implementation of a Digital Design Block

Text Books:

1. M.J.S.Smith, " Application - Specific Integrated Circuits", Pearson, 2003.

References:

1. Ming-BO Lin, “Introduction to VLSI Systems: A Logic, Circuit and System Perspective”, CRC Press, 2012.
2. Anantha Chandrakasan, “Low Power CMOS Design”, IEEE Press, /Wiley International, 1998
3. Douglas J. Smith, “HDL Chip Design”, Madison, AL, USA: Doone Publications, 1996.

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-		2	3	3
CO2	3	3	2	2	2	-	-	2	2	1	2	3	3
CO3	3	3	2	2	2	-	-	2	2	1	2	3	3
CO4	3	3	2	2	2	-	-	2	2	1	2	3	3
CO5	3	3	2	2	2	-	-	2	2	1	2	3	3
CO6	3	3	2	2	2	-	-	2	2	1	2	3	3
Avg.	3	2.66	2	2	2	-	-	2	2	1	2	3	3

OPEN ELECTIVES

OEC241	**Wireless Sensors and Networks**	**OEC**	**L**	**T**	**P**	**C**
			3	**0**	**0**	**3**

Course Objectives:

- To provide knowledge of the fundamentals, challenges, and architecture of wireless sensor networks.
- To develop understanding of physical layer components and network architecture for efficient communication.
- To familiarize with various MAC protocols used in wireless sensor networks.
- To impart knowledge on routing techniques and protocols in sensor networks.
- To enable students to apply node and network management techniques, including power optimization and programming models.

UNIT I INTRODUCTION AND NODE ARCHITECTURE 9

Motivation for a Network of Wireless Sensor Nodes: Definitions and Background, Challenges and Constraints- Node Architecture: The Sensing Subsystem, The Processor Subsystem, Communication Interfaces, Prototypes - Operating Systems: Functional Aspects, Non-functional Aspects, Prototypes

UNIT II PHYSICAL LAYER AND NETWORK ARCHITECTURE 9

Physical Layer : Basic Components, Source Encoding, Channel Encoding, Modulation- Network Architecture : Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

UNIT III MEDIUM ACCESS CONTROL 9

Wireless MAC Protocols- Characteristics of MAC Protocols in Sensor Networks- Contention-Free MAC Protocols- Contention-Based MAC Protocols - Hybrid MAC Protocols.

UNIT IV NETWORK LAYER 9

Routing Metrics - Flooding and Gossiping- Data Centric Routing- Proactive Routing- On-Demand Routing- Hierarchical Routing- Location-Based Routing- QoS-Based Routing Protocols

UNIT V NODE AND NETWORK MANAGEMENT 9

Power Management: Local Power Management aspects, Dynamic Power Management, Conceptual Architecture- Sensor Network Programming: Challenges in Sensor Network Programming, Node-Centric Programming, Macro programming

Periods: 45

Course Outcomes:

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

CO1: Describe the concepts, challenges, and architecture of wireless sensor networks and sensor nodes.
CO2: Analyze physical layer functionalities and network architectures for efficient data transmission.
CO3: Compare different MAC protocols used in wireless sensor networks.
CO4: Analyze routing protocols based on network requirements and constraints.
CO5: Apply power management strategies and programming approaches for efficient sensor network operation.
CO6: Design wireless sensor network solutions considering performance metrics and constraints.

Suggested Activities:

- Case study on wireless protocols
- Mini Project on sensor nodes and networks

Text Books:

1. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", 2nd edition, Wiley publications, 2010.

References:

1. S. Sen, Wireless sensor networks. I K International Pvt Ltd, 2023.
2. Holger Karl, Andreas willig, "Protocol and Architecture for Wireless Sensor Networks",John Wiley Publication, 2006.
3. Anna Forster, "Introduction to Wireless Sensor Networks", Wiley, 2017.
4. H. Karl and A. Willig, "Protocols and Architectures for Wireless Sensor Networks", 1st edition, John Wiley & Sons, India, 2012.

MAPPING OF COs WITH POs AND PSOs

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1	1	1	1	-	3	1	3	2	3	2	2	2
CO2	2	2	1	1	-	-	-	-	1	-	3	2	1
CO3	2	2	1	1	-	-	-	-	1	-	2	2	1
CO4	2	2	1	1	-	-	-	-	1	-	2	2	1
CO5	3	3	3	3	3	3	1	3	3	3	3	2	2
CO6	3	3	3	3	3	3	1	3	3	3	3	2	3
Avg.	**2.2**	**2.2**	**1.7**	**1.7**	**3.0**	**3.0**	**1**	**3**	**2**	**3**	**3**	**2**	**2**

OEC242 Electronic System Design **OEC** **L T P C**

1 0 4 3

Course Objectives:

- To enable students to understand the electronics product development lifecycle.
- To select appropriate electronic components and prepare Bill of Materials (BOM).
- To design and analyze basic electronic circuits.
- To develop PCB layouts and fabricate electronic circuits.
- To implement embedded design and integrate hardware systems.
- To test and validate electronics products based on industry standards.

UNIT I COMPONENT SELECTION **3**

- Electronics product lifecycle — Idea to Product stages, Types of electronic products — consumer, industrial, medical, IoT
- Passive components — Resistor, Capacitor, Inductor — ratings & selection, Active components — Diode, Transistor, MOSFET, Op-Amp — application-based selection
- Integrated Circuits — voltage regulators, logic ICs, timers
- Microcontroller selection — Arduino, ESP32 — criteria: I/O, power, cost Datasheet reading — key parameters, absolute maximum ratings
- Bill of Materials (BOM) — preparation, component sourcing, cost estimation

UNIT II CIRCUIT DESIGN & SCHEMATIC CAPTURE 3

- Power supply circuit design — linear regulator (7805), buck converter, Resistor network design — voltage divider, current limiting, pull-up/pull-down,
- RC filter design — low pass, high pass — noise reduction in sensor circuits
- Transistor as switch — driving relay, motor, buzzer from microcontroller output
- Op-Amp circuits — comparator and amplifier for sensor signal conditioning
- Schematic capture using EasyEDA/KiCad — symbols, nets, power flags, Electrical Rules Check (ERC) — identifying and correcting schematic errors, Netlist generation from schematic for PCB design

UNIT III PCB DESIGN & FABRICATION 3

- PCB basics — layers, substrate, copper traces, vias, pads, solder mask, silkscreen, Single layer vs double layer — selection criteria for product design,
- PCB design flow — Schematic, Netlist, Layout, Gerber, Fabrication, Identifying and fixing layout errors, Gerber file generation
- PCB fabrication process — etching, drilling, plating
- Soldering techniques — through-hole, SMD soldering, solder paste and reflow basics.

UNIT IV EMBEDDED PROGRAMMING & SYSTEM INTEGRATION 3

- Embedded C basics — GPIO, ADC, PWM, UART, I2C, SPI protocols
- Sensor interfacing — temperature, humidity, motion, gas sensors
- Actuator control — motor, relay, display, buzzer
- Interrupt handling and timer-based scheduling
- Debugging techniques — serial monitor, logic analyser
- Wireless integration — ESP32 WiFi/Bluetooth for IoT-enabled products.

UNIT V PRODUCT TESTING, STANDARDS & FABRICATION 3

- Product testing — functional, performance, stress, environmental testing,
- Test plan preparation — test cases, pass/fail criteria, test report,
- Electronics standards — BIS, CE Marking, FCC, RoHS, PCB assembly quality — IPC-A-610 inspection standards,
- IP Rating — enclosure selection for product protection,
- EMI/EMC basics — electromagnetic interference in product design
- Enclosure design — plastic, metal, 3D printed — thermal and IP considerations
- Case studies — Smart Air Quality Monitor, Portable Health Monitor, Industrial Sensor Node.

Periods: 15

Laboratory Experiments:

1. Read three datasheets and extract key parameters into a component selection sheet.
2. Compare two microcontrollers (Arduino vs ESP32) — tabulate specifications.
3. Define a product idea and prepare complete BOM with part numbers and cost estimate.
4. Design and test 5V regulated power supply and measure output using multimeter and CRO.
5. Build and test voltage divider and RC low-pass/high-pass filters.
6. Build transistor switch to control LED/buzzer/relay from GPIO.
7. Design Op-Amp based comparator/amplifier circuit for sensor signal conditioning.
8. Draw complete product schematic in EasyEDA, identify and fix all errors
9. Import netlist into KiCad, place components on PCB, route all traces, define trace width per current requirement, add ground plane, run DRC, fix all errors, Generate Gerber files
10. Fabricate PCB using perfboard or prototype PCB and Solder a practice through-hole kit
11. Interface sensors with Arduino/ESP32 and read data.
12. Interface actuators such as motor, relay, display and buzzer.
13. Implement UART/I2C/SPI communication.
14. Implement interrupt-based and timer-based control.

15. Develop an IoT-based prototype using ESP32 WiFi/Bluetooth.

Periods: 60

Total Periods: 60

Laboratory requirement for a batch of 30 students

- Passive Components – Resistors, Capacitors, Inductors, Potentiometers - Adequate quantity
- Active Components – Diodes, Transistors (BC547, 2N2222), MOSFETs, Voltage Regulators (7805), Operational Amplifiers (LM358/LM741) - Adequate quantity
- Sensors & Actuators - Temperature & Humidity Sensors (DHT11/DHT22), IR / Motion Sensors, Gas Sensors (MQ series), DC Motors, Buzzers, LEDs - Adequate quantity
- Development Boards & Interfaces - Arduino Uno / Nano, ESP32 Development Boards – each 15 nos.
- Testing & Measurement Equipment - Digital Multimeters, Regulated DC Power Supplies, Digital Storage Oscilloscopes (≥50 MHz), Function Generators – each 15 nos.
- PCB Design Software: EasyEDA / KiCad
- Embedded IDE: Arduino IDE / PlatformIO
- Simulation Tools: Wokwi / Tinkercad
- Gerber Viewer Software
- Soldering & Fabrication Tools, Solder iron, desoldering Pumps, Soldering Wire & Flux – Adequate quantity
- General-purpose PCB / Perfboards – 30 Nos.
- Breadboards – 20 Nos.
- Computer Systems – 10 Nos.

Course Outcomes:

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

CO1: Select appropriate components and prepare BOM based on product specifications
CO2: Design basic circuits like regulator, amplifier and filter.
CO3: Draw and capture schematics using EDA tools
CO4: Design a PCB layout and generate fabrication-ready Gerber files
CO5: Develop and integrate embedded firmware with hardware for a working prototype
CO6: Test and validate an electronics product against relevant industry standards

Suggested Activities:

-

Text Books:

1. Paul Scherz and Simon Monk, Practical Electronics for Inventors, 4th Edition, McGraw-Hill Education, 2016.
2. David L. Jones, PCB Design Tutorial, Revision A, June 29, 2004

References:

1. Robert L. Boylestad and Louis Nashelsky, Electronic Devices and Circuit Theory, 11th Edition, Pearson Education, 2015.
2. Ramakant A. Gayakwad, Op-Amps and Linear Integrated Circuits, 4th Edition, Pearson Education, 2015.
3. Bruce Archambeault, PCB Design for Real-World EMI Control, 1st Edition, Springer, 2002.
4. Jonathan W. Valvano, Embedded Systems: Introduction to ARM Cortex-M Microcontrollers, 5th Edition, CreateSpace / Self-published, 2014.
5. John Catsoulis, Designing Embedded Hardware, 2nd Edition, O'Reilly Media, 2005.

OEC243	IoT Concepts and Applications	OEC	L	T	P	C
			2	0	2	3

Course Objectives:

- To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT
- To teach a student how to analyse requirements of various communication models and protocols for cost-effective design of IoT applications on different IoT platforms.
- To introduce the technologies behind Internet of Things(IoT).
- To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.
- To apply the concept of Internet of Things in real world scenario.

UNIT I INTRODUCTION TO INTERNET OF THINGS 6

Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT

UNIT II COMPONENTS IN INTERNET OF THINGS 6

Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee,Wifi, GPS, GSM Modules)

UNIT III PROTOCOLS AND TECHNOLOGIES BEHIND IOT 6

IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, BigData Analytics, Cloud Computing, Embedded Systems.

UNIT IV OPEN PLATFORMS AND PROGRAMMING 6

IOT deployment for Raspberry Pi /Arduino platform-Architecture –Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

UNIT V IOT APPLICATIONS 6

Business models for the internet of things, Smart city, Smart mobility and transport, Industrial IoT, Smart health, Environment monitoring and surveillance – Home Automation – Smart Agriculture

Periods: 30

Laboratory Experiments:

1. Introduction to Arduino platform and programming
2. Interfacing Arduino to Zigbee module
3. Interfacing Arduino to GSM module
4. Interfacing Arduino to Bluetooth Module
5 Introduction to Raspberry PI platform and python programming
6. Interfacing sensors to Raspberry PI
7. Communicate between Arduino and Raspberry PI using any wireless medium
8. Setup a cloud platform to log the data
9. Log Data using Raspberry PI and upload to the cloud platform
10.Design an IOT based system

Periods: 30

Total Periods: 60

Laboratory requirement for a batch of 30 students

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Course Outcomes:

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

CO1: Explain the concept of IoT.
CO2: Understand the communication models and various protocols for IoT.
CO3: Design portable IoT using Arduino/Raspberry Pi /open platform
CO4: Apply data analytics and use cloud offerings related to IoT.
CO5: Analyze applications of IoT in real time scenario.

Suggested Activities:

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Text Books:

1. 1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017
2. Samuel Greengard, The Internet of Things, The MIT Press, 2015

References:

1. Perry Lea, "Internet of things for architects", Packt, 2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012
3. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.
4. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
5. ArshdeepBahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015
6. https://www.arduino.cc/
7. https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet

OEC244	Medical Electronics	OEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To introduce the basic concepts of human physiological systems relevant to engineering.
- To familiarize students with medical electronic instruments and measurement systems.
- To understand the sensors used for physiological parameter measurement.
- To provide knowledge on biomedical signal acquisition and safety aspects.
- To expose students to modern medical devices and imaging techniques.

UNIT I BASICS OF HUMAN PHYSIOLOGY AND BIO-SIGNALS 9

Physiology of human body – Overview of cardiovascular, nervous and respiratory systems – Concept of bioelectric signals – Origin of ECG, EEG and EMG – Characteristics of bio-signals – Engineering relevance of physiological signals – Applications of medical electronics in healthcare.

UNIT II MEDICAL ELECTRONIC INSTRUMENTATION 9

Basic measurement system – Sensors, signal conditioning and display – Block diagram of ECG, EEG and EMG instruments – Amplification and noise reduction – Patient monitoring systems – Wearable health monitoring devices.

UNIT III SENSORS AND MEASUREMENT OF PHYSIOLOGICAL PARAMETERS 9

Measurement of temperature, blood pressure, heart rate and pulse – Blood oxygen measurement, pulse oximetry – Respiratory measurement – Introduction to biosensors – Applications in healthcare and fitness systems.

UNIT IV BIOMEDICAL SIGNAL ACQUISITION AND SAFETY 9

Basic biomedical signal acquisition system – Electrodes and transducers – Signal conditioning: amplification and filtering – Data acquisition and display – Electrical safety in medical equipment – Patient isolation – Safety standards.

UNIT V MEDICAL DEVICES AND IMAGING SYSTEMS 9

Overview of medical devices: Defibrillator, pacemaker, ventilator and infusion pump – Introduction to medical imaging: X-ray, CT, Ultrasound and MRI – Comparison of imaging techniques – Role of medical electronics in telemedicine and IoT-based healthcare systems.

Periods: 45

Course Outcomes:

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

CO1: Explain the basic physiological systems and bio-signals.
CO2: Describe the working of common medical electronic instruments.
CO3: Identify sensors used for measuring physiological parameters.
CO4: Explain biomedical signal acquisition and safety considerations.
CO5: Describe the working principles of medical devices and imaging systems.
CO6: Apply medical electronics concepts to real-world healthcare applications.

Suggested Activities:

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Text Books:

1. L. Cromwell, F. J. Weibell and E. A. Pfeiffer, "Biomedical Instrumentation and Measurements", 2nd Edition, Pearson Education / Prentice Hall, 2011.
2. J. G. Webster (Ed.), "Medical Instrumentation: Application and Design", 4th Edition, John Wiley & Sons, 2010.

References:

1. R. S. Khandpur, "Handbook of Biomedical Instrumentation", 3rd Edition, Tata McGraw-Hill, 2014.
2. Joseph Bronzino (Ed.), "The Biomedical Engineering Handbook", 3rd Edition, CRC Press, 2006.
3. A. C. Guyton and J. E. Hall, "Textbook of Medical Physiology", 13th Edition, Elsevier, 2016.

OEC245	Embedded Processors	OEC	L	T	P	C
			3	0	0	3

Course Objectives:

- To provide knowledge of embedded systems and processor platforms
- To introduce RISC-based architectures and microcontroller concepts
- To develop understanding of modern embedded platforms such as Arduino and NodeMCU
- To explain ARM architecture and its peripheral subsystems
- To familiarize students with single board computers and operating system concepts
- To enable understanding of interfacing, sensing, and embedded applications

UNIT I INTRODUCTION TO EMBEDDED SYSTEMS AND PROCESSOR PLATFORMS 9

Embedded systems: overview and applications – single-chip microcontroller systems – single-board microcontroller systems – single-board computer systems – embedded system peripherals – software considerations – embedded processors: selection criteria, constraints, and classification of processor types.

UNIT II INTRODUCTION TO RISC-BASED ARCHITECTURE 9

Overview of RISC architecture – architecture of PIC16/PIC18 – memory organization – addressing modes – instruction set concepts – timers – I/O ports – interrupt mechanism.

UNIT III ARDUINO AND NODEMCU ARCHITECTURE AND INTERFACING 9

Overview and architecture of Arduino boards – peripherals and development environment – architecture and features of ESP8266 NodeMCU – NodeMCU peripherals and Wi-Fi capabilities – comparison of Arduino and NodeMCU – interfacing concepts for I/O devices: LEDs, push buttons, light sensors, ultrasonic sensors, temperature and humidity sensors – fundamentals of sensor and actuator interaction.

UNIT IV ARM ARCHITECTURE AND PERIPHERALS 9

Overview of ARM architecture – register organization – memory organization and addressing modes – pipeline concept – interrupt structure – ARM and Thumb instruction sets – overview of peripherals: GPIO, timers, and UART communication.

UNIT V SINGLE BOARD COMPUTERS AND EMBEDDED PROCESSORS 9

Introduction to single board computers – architecture of Raspberry Pi – processor, memory, and peripheral organization – booting process and operating system concepts – basics of Linux – GPIO and interfacing concepts – sensing and control fundamentals – introduction to BeagleBone Black and NVIDIA Jetson Nano – comparison and applications of SBC platforms.

Periods: 30

Course Outcomes:

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

CO1: Explain the fundamentals of embedded systems and processor selection criteria
CO2: Describe RISC architecture and the features of PIC microcontrollers
CO3: Illustrate the architecture and interfacing concepts of Arduino and NodeMCU
CO4: Explain ARM architecture and its peripheral functionalities
CO5: Analyze the architecture and working of single board computers
CO6: Apply embedded system concepts for basic sensing and control applications

Suggested Activities:

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Text Books:

1. Sami S.H and Kisheen Rao G "The Internet of Mechanical Things: The IoT Framework for Mechanical Engineers", CRC Press, 2022.
2. Muhammad Ali Mazidi & Janice Gilli Mazidi, 'The PIC Micro Controller and Embedded Systems', 2010
3. Steve Furber, ARM System-on-Chip Architecture, Addison-Wesley, 2nd Edition, 2015

References:

1. Rajkamal, 'Embedded system-Architecture, Programming, Design, McGraw-Hill Edu, 3rd edition 2017
2. Wayne Wolf, "Computers as Components: Principles of Embedded Computer System Design", Elsevier, 2006.
3. David Patterson and Andrew Waterman,The RISC-V Reader: An Open Architecture Atlas, 2017.

COs \ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	–	–	–	–	–	–	–	–	1	2	1
CO2	3	2	–	–	–	–	–	–	–	–	1	2	2
CO3	2	2	1	–	2	–	–	–	–	–	1	2	3
CO4	3	2	–	–	2	–	–	–	–	–	1	2	2
CO5	2	2	1	–	1	–	–	–	–	–	1	2	3
CO6	2	2	2	1	2	1	–	–	–	–	1	3	3

OEC246 VLSI design **OEC** **L T P C**

3 0 0 3

Course Objectives:

- To provide an understanding of MOS transistor operation and CMOS inverter characteristics.
- To develop the ability to analyze combinational logic circuits using static and dynamic CMOS techniques.
- To introduce the principles of sequential logic circuits and timing considerations..
- To explain arithmetic building blocks and memory architectures used in digital integrated circuits.
- To familiarize students with Verilog HDL for modeling and simulation of digital systems.

UNIT I MOS TRANSISTOR AND CMOS INVERTER 9

MOSFET Transistor Characteristic under Static and Dynamic Conditions - MOS Transistor Secondary Effects - CMOS Inverter: Static Characteristic, Dynamic Characteristic – Power dissipation – Stick diagram and Layout

UNIT II COMBINATIONAL LOGIC CIRCUITS 9

Static CMOS Design – Complementary CMOS, Ratioed Logic – Pass Transistor Logic - Dynamic CMOS Design – Dynamic Logic: Basic Principles, Speed and Power Dissipation of Dynamic Logic, Issues in Dynamic Design, Cascading Dynamic Gates.

UNIT III SEQUENTIAL LOGIC CIRCUITS 9

Timing metrics for sequential circuits - Static Latches and Registers - Dynamic Latches and Registers – Pipelines - Pulse and sense amplifier based Registers - Non-Bistable Sequential Circuits.

UNIT IV ARITHMETIC BUILDING BLOCKS AND MEMORY ARCHITECTURES 9

Data path circuits - Architectures for Adders, Multipliers and Shifters - Speed and Area Tradeoffs - Array Subsystems: SRAM, DRAM, ROM.

UNIT V VERILOG HDL 9

Verilog HDL : Basic constructs, Behavioral, Dataflow, Structural and gate level modelling – Verilog Testbenches – Modelling of combinational and Sequential circuits using Verilog HDL.

Periods: 45

Course Outcomes:

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

CO1: Explain MOS transistor characteristics, secondary effects, and CMOS inverter operation.
CO2: Design combinational logic circuits using static and dynamic CMOS techniques.
CO3: Analyze the operation and timing behavior of sequential logic circuits.
CO4: Realize architectures of arithmetic building blocks such as adders, multipliers, and shifters.
CO5: Describe the organization and operation of memory architectures such as SRAM, DRAM, and ROM.
CO6: Apply Verilog HDL to model combinational and sequential digital circuits.

Suggested Activities:

- Journal review/Case study: Review of state of art circuit topologies.
- Design and simulation of datapath architectures using Verilog HDL.

Text Books:

1. Neil H.E.Weste & David Money Harris, "CMOS VLSI Design: A circuits and Systems perspective", Fourth Edition, Pearson College Div, 2016
2. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic "Digital Integrated Circuits: A Design Perspective", Second Edition, Pearson Education,2016

References:

1. A.Pucknell, Kamran Eshraghian, "BASIC VLSI Design", Third Edition, Prentice Hall of India, 2007.
2. Samir Palnitkar," Verilog HDL:A guide to Digital Design and Synthesis", Second Edition, Pearson Education,2003 .

MAPPING OF COs WITH POs AND PSOs

COs	POs											PSOs	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	3	3
CO2	3	2	2	1	-	-	-	-	-	-	1	3	3
CO3	3	2	-	-	-	-	-	-	-	-	-	3	3
CO4	3	2	-	-	-	-	-	-	-	-	-	3	3
CO5	3	2	2	1	1	-	-	-	-	-	1	3	3
CO6	3	3	2	1	1	-	-	-	-	-	1	3	3
Avg.	3	2.16	2	1	1	-	-	-	-	-	1	3	3