CARE COLLEGE OF ENGINEERING
(An Autonomous Institution)

Approved AICTE New Delhi | Affiliated to Anna University Chennai
No 27, Thayanur, Tiruchirappalli 620 009

Regulations 2024
Undergraduate Degree
B.E. Electronics and Communication Engineering
Full Time Programmes
Curriculum and Syllabus

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Chairperson
Board of Studies
Dr. SELVAKUMAR .P
HEAD
DEPARTMENT OF ECE
CARE COLLEGE OF ENGINEERING,
TRICHY-09.

Principal
Principal
CARE College of Engineering (Autonomous)
No. 27, Thayanur, Trichy - 620 009.

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Department of Electronics and Communication Engineering

Institute Vision

Transform Lives through Education and Research.

Institute Mission

To impart quality education to students through critical thinking, creativity, leadership and spirit of entrepreneurship**.**

Institute Values

We develop in each member the ability and passion to work effectively for the betterment of humanity with cultural awareness, high ethical and moral values and a sense of social responsibility.

Department Vision

To produce globally competent Electronics and Communication Engineers.

Department Mission

M1	To impart value-based technical education with a state of art technologies to meet industry standards
M2	To foster critical thinking and creativity through research and experimentation
M3	To prepare our students to be a lifetime professional with creativity and leadership

CARE COLLEGE OF ENGINEERING, TIRUCHIRAPPALLI 620 009
(AN AUTONOMOUS INSTITUTION)

CURRICULUM AND SYLLABUS

CHOICE BASED CREDIT SYSTEM

B.E. ELECTRONICS AND COMMUNICATION ENGINEERING

Program Educational Objectives (PEOs)

PEO 1 - Shall pursue higher education and research, or have a successful career in industries or as entrepreneurs.
PEO 2 - Shall have the ability and attitude to adapt to emerging technological changes.
PEO 3 -Shall exhibit leadership abilities, professional ethics, communication skills, interpersonal skills and Students of the Electronics and Communication Engineering Program

Knowledge and Attitude Profile (WK)

WK1 (**Natural Science):** A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2 (Mathematics and Modelling): Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3 (Engineering Fundamentals): A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4 (Engineering Specialization): Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5 (Environmental impact on design and practice): Knowledge, including efficient resource use, environmental impacts, whole-life cost, reuse of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6 (Newer Practical Knowledge): Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7 (Engineer role and responsibility in Society): Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8 (Critical Thinking and Creativity): Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9 (Ethics and Diversity): Ethics, inclusive behaviour and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Program Outcomes: On completion of the program, the graduates will be able to

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).

Program Specific Outcomes (PSOs)

PSO 1 - Shall have Potential to analyze, design, synthesize and provide technical solutions in the field of VLSI, Embedded Systems, Communication, Networking and Real Time Processing.
PSO 2 - Shall exhibit leadership skills and pursue entrepreneurship and contribute in the field of Electronics

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CURRICULUM AND SYLLABI FOR I TO VIII SEMESTERS

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MA111	Matrices and Calculus	BSC	3	1	0	4	4	40	60
2	U24GE111	Problem solving using Python	ESC	3	0	0	3	3	40	60
3	U24HS111	Heritage of Tamils	HSMC	1	0	0	1	1	40	60
THEORY CUM PRACTICAL COURSES										
4	U24PH113	Engineering Physics	BSC	3	0	2	5	4	50	50
5	U24CY113	Engineering Chemistry	BSC	3	0	2	5	4	50	50
6	U24HS123	Communicative English for Engineers	HSMC	3	0	2	5	4	50	50
PRACTICAL COURSES										
7	U24GE122	Problem solving using Python Lab	ESC	0	0	4	4	2	60	40
				16	**1**	**10**	**27**	**22**		

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MA231	Transforms and Complex Analysis	BSC	3	1	0	4	4	40	60
2	U24HS211	Tamils and Technology	HSMC	1	0	0	1	1	40	60
THEORY CUM PRACTICAL COURSES										
3	U24PH233	Physics for Electronics Engineering	BSC	3	0	2	5	4	50	50
4	U24EC213	Circuit Analysis	ESC	3	0	2	5	4	50	50
5	U24CS233	Data Structures using C	ESC	3	0	2	5	4	50	50
6	U24HS223	Technical English for Engineers	HSMC	2	0	2	4	3	50	50
PRACTICAL COURSES										
7	U24EE232	Engineering Practices Laboratory for Circuit Branches	ESC	0	0	4	4	2	60	40
8	U24EM212	Professional Development	EEC	0	0	2	2	1	100	-
			Total	**15**	**1**	**14**	**30**	**23**		

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MA331	Probability and Random Processes	BSC	3	1	0	4	4	40	60
2	U24EC311	Electromagnetic Fields	PCC	3	1	0	4	4	40	60
THEORY CUM PRACTICAL COURSES										
3	U24EC323	Signals and Systems	PCC	2	1	2	5	4	50	50
4	U24EC333	Electronic Devices and Circuits	PCC	3	0	2	5	4	50	50
5	U24EC343	Digital System Design	PCC	3	0	2	5	4	50	50
			Total	**14**	**3**	**6**	**23**	**20**		

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24EC411	Analog Integrated Circuits	PCC	3	0	0	3	3	40	60
2	U24EC421	Transmission Lines and Waveguides	PCC	3	1	0	4	4	40	60
3	U24EC431	Communication Systems	PCC	3	0	0	3	3	40	60
4	U24EM411	Aptitude and Reasoning - I	EEC	1	0	0	1	1	100	-
THEORY CUM PRACTICAL COURSES										
5	U24EC443	Digital Signal Processing	PCC	3	0	2	5	4	50	50
6	U24EC453	Internet of Things	PCC	1	0	4	3	3	50	50
PRACTICAL COURSES										
7	U24EC462	Analog Integrated Circuits Lab	PCC	0	0	4	4	2	60	40
8	U24EC472	Communication Systems Lab	PCC	0	0	4	4	2	60	40
9	U24EM422	Soft skill and Personality Development - 1	EEC	0	0	2	2	1	100	-
				14	**1**	**16**	**31**	**23**		

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24EC511	Antenna and Wave Propagation	PCC	3	1	0	4	4	40	60
2	U24EC521	Data Communication and Networks	PCC	3	0	0	3	3	40	60
3	U24EC531	Digital VLSI Design	PCC	3	0	0	3	3	40	60
4	U24EM511	Aptitude and Reasoning - II	EEC	1	0	0	1	2	100	-
5	U24MG511	Leadership and Team Management	EEC	2	0	0	2	2	100	-
6		Professional Elective-I	PEC					3		
7		Professional Elective-II	PEC					3		
PRACTICAL COURSES										
8	U24EC542	VLSI Design Laboratory	PCC	0	0	4	4	2	60	40
9	U24EM312	Design Thinking and Innovation	EEC	0	0	2	2	1	100	-
10	U24EM522	Soft skill and Personality Development - II	EEC	0	0	2	2	1	100	-
								24		

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24EC611	Wireless Communication	PCC	3	0	0	3	3	40	60
2	U24EC621	Microwave and Optical Communication	PCC	3	0	0	3	3	40	60
3	U24MG611	Project Management	HSMC	2	0	0	2	2	40	60
4	U24MG621	Entrepreneurship	EEC	2	0	0	2	2	40	60
5		Professional Elective 3	PEC					3		
6		Professional Elective 4	PEC					3		
7		Open Elective 1	OEC					3		
8		Mandatory Course-I*	MC	3	0	0	3	0	100	-
PRACTICAL COURSES										
9	U24EC632	Advanced Communication Systems Laboratory	PCC	0	0	4	4	2	60	40
10	U24EC642	Mini Project	EEC	0	0	4	4	2	60	40
								23		

*Mandatory Course-I is a Non-credit Course

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MG711	Human Values and Ethics	HSMC	2	0	0	3	2	40	60
2	U24MG721	Total Quality Management	HSMC	3	0	0	2	3	40	60
3		Professional Elective 5	PEC					3		
4		Professional Elective 6	PEC					3		
5		Open Elective 2	OEC					3		
6		Mandatory Course-II**	MC	2	0	0	2	0	100	-
THEORY CUM PRACTICAL COURSES										
7	U24EC713	Embedded and Real Time Systems	PCC	3	0	2	5	4	50	50
PRACTICAL COURSES										
8	U24EC722	Summer Internship*	EEC	0	0	4	4	2	100	-
								20		

* During sixth semester holidays

** Mandatory Course-II is a Non-credit Course

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
PRACTICAL COURSES										
1	U24EC812	Capstone Project /Industry Internship	EEC	0	0	16	16	8	60	40
				0	**0**	**16**	**16**	**8**		

PROFESSIONAL ELECTIVES

VERTICAL 1: SYSTEM DESIGN WITH IOT

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24ECSD01	Sensors and Actuators	PEC	3	0	0	3	3	40	60
2	U24ECSD02	IoT Architecture and Protocols	PEC	3	0	0	3	3	40	60
3	U24ECSD03	Wearable Technologies	PEC	3	0	0	3	3	40	60
4	U24ECSD04	MEMS Design	PEC	3	0	0	3	3	40	60
5	U24ECSD05	Industrial IoT and Industry 4.0	PEC	3	0	0	3	3	40	60
6	U24ECSD06	Nano Electronics	PEC	3	0	0	3	3	40	60

VERTICAL 2: COMMUNICATION AND SIGNAL PROCESSING

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24ECCS01	Next Generation Networks	PEC	3	0	0	3	3	40	60
2	U24ECCS02	Digital Image Processing	PEC	2	0	2	3	3	50	50
3	U24ECCS03	Speech Information Processing	PEC	3	0	0	3	3	40	60
4	U24ECCS04	Multimedia Communication Systems	PEC	3	0	0	3	3	40	60
5	U24ECCS05	Wireless and Adhoc Networks	PEC	3	0	0	3	3	40	60
6	U24ECCS06	Optical Signal Processing	PEC	3	0	0	3	3	40	60
7	U24ECCS07	Millimetre Wave Technology	PEC	3	0	0	3	3	40	60
8	U24ECCS08	Computer Vision	PEC	2	0	2	3	3	50	50

VERTICAL 3: BIOMEDICAL TECHNOLOGIES

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24ECBT01	Medical Imaging Systems	PEC	3	0	0	3	3	40	60
2	U24ECBT02	Therapeutic Equipments	PEC	3	0	0	3	3	40	60
3	U24ECBT03	Human Assist Devices	PEC	3	0	0	3	3	40	60
4	U24ECBT04	Brain Computer Interface and Applications	PEC	3	0	0	3	3	40	60
5	U24ECBT05	Body Area Networks	PEC	3	0	0	3	3	40	60
6	U24ECBT06	Medical Informatics	PEC	3	0	0	3	3	40	60
7	U24ECBT07	Wearable Devices	PEC	3	0	0	3	3	40	60
8	U24ECBT08	Human Computer Interaction	PEC	3	0	0	3	3	40	60



VERTICAL 4: SEMICONDUCTOR CHIP DESIGN AND TESTING

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24ECST01	Analog IC Design	PEC	3	0	0	3	3	40	60
2	U24ECST02	Mixed Signal IC Design	PEC	3	0	0	3	3	40	60
3	U24ECST03	ASIC Design	PEC	3	0	0	3	3	40	60
4	U24ECST04	Low Power IC Design	PEC	3	0	0	3	3	40	60
5	U24ECST05	RFIC Design	PEC	3	0	0	3	3	40	60
6	U24ECST06	VLSI Testing and Testability	PEC	3	0	0	3	3	40	60
7	U24ECST07	EMI/EMC Concepts	PEC	3	0	0	3	3	40	60
8	U24ECST08	Electronic Packaging and Testing	PEC	3	0	0	3	3	40	60

OPEN ELECTIVES

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24OEEC01	Smart Agricultural Systems	OEC	3	0	0	3	3	40	60
2	U24OEEC02	Electric and Hybrid Vehicles	OEC	3	0	0	3	3	40	60
3	U24OEEC03	Internet of Things Principles and Practices	OEC	1	0	4	3	3	50	50
4	U24OEEC04	Electronic Circuits for Smart Technologies	OEC	3	0	0	3	3	40	60
5	U24OEEC05	Mechatronics	OEC	3	0	0	3	3	40	60

MANDATORY COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MC11	Disaster Risk Reduction and Management	MC	3	0	0	3	0	100	-
2	U24MC21	Environmental Science	MC	3	0	0	3	0	100	-
3	U24MC31	History of Science and Technology in India	MC	3	0	0	3	0	100	-
4	U24MC41	Personal Finance	MC	3	0	0	3	0	100	-
5	U24MC51	Well-Being with Traditional Practices- Yoga, Ayurveda and Siddha	MC	3	0	0	3	0	100	-

Category VS Semester Credit Distribution Summary

B.E.: Electronics and Communication Engineering									
Category/Semester	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**Total**
HSMC: Humanity, Science and Management Courses	5	4				2	5		**16**
BSC: Basic Science Courses	12	8	4						**24**
ESC: Engineering Science Courses	5	10							**15**
PCC: Professional Core Courses			16	21	12	8	4		**61**
PEC: Professional Elective Courses					6	6	6		**18**
OEC: Open Elective Courses						3	3		**6**
EEC: Employability Enhancement Courses		1		2	5	4	2	8	**22**
TOTAL	**22**	**23**	**20**	**23**	**23**	**23**	**20**	**8**	**162**

MINOR COURSES

Vertical 1: Business Data Analytics

SL. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MI401	Statistics for Management	MC	3	0	0	3	3	40	60
2	U24MI402	Datamining for Business Intelligence	MC	3	0	0	3	3	40	60
3	U24MI403	Human Resource Analytics	MC	3	0	0	3	3	40	60
4	U24MI404	Marketing and Social Media Web Analytics	MC	3	0	0	3	3	40	60
5	U24MI405	Operation and Supply Chain Analytics	MC	3	0	0	3	3	40	60
6	U24MI406	Financial Analytics	MC	3	0	0	3	3	40	60

Vertical 2: Public Administration

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MI301	Principles of Public Administration	MC	3	0	0	3	3	40	60
2	U24MI302	Constitution of India	MC	3	0	0	3	3	40	60
3	U24MI303	Public Personnel Administration	MC	3	0	0	3	3	40	60
4	U24MI304	Administrative Theories	MC	3	0	0	3	3	40	60
5	U24MI305	Indian Administrative System	MC	3	0	0	3	3	40	60
6	U24MI306	Public Policy Administration	MC	3	0	0	3	3	40	60

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SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MA111	Matrices and Calculus	BSC	3	1	0	4	4	40	60
2	U24GE111	Problem Solving using Python	ESC	3	0	0	3	3	40	60
3	U24HS111	Heritage of Tamils	HSMC	1	0	0	1	1	40	60
THEORY CUM PRACTICAL COURSES										
4	U24PH113	Engineering Physics	BSC	3	0	2	5	4	50	50
5	U24CY113	Engineering Chemistry	BSC	3	0	2	5	4	50	50
6	U24HS123	Communicative English for Engineers	HSMC	3	0	2	5	4	50	50
PRACTICAL COURSES										
7	U24GE122	Problem Solving using Python Laboratory	ESC	0	0	4	4	2	60	40
				16	**1**	**10**	**27**	**22**		

ASSESSMENT SCHEME

Sl. No	Course Type	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24MA111	3	1	0	4	60	40	60	40	-	100		40	60	45	50
2	U24GE111	3	0	0	3	60	40	60	40	-	100		40	60	45	50
3	U24HS111	1	0	0	1	60	40	60	40	-	100		40	60	45	50
4	U24HS123	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
5	U24PH113	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
6	U24CY113	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
7	U24GE122	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50

(W) – Weightage

U24MA111	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

Course Objective:

After completing this course, the students will be ,

- To develop the use of matrix algebra techniques those are needed to engineers for practical applications.
- To familiarize the students with differential calculus.
- To introduce the methods of solving linear and nonlinear ordinary differential equations.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.
- To acquaint the student with the concepts of vector calculus needed for problems in all engineering disciplines.

Detailed Syllabus

UNIT I MATRICES **9+3**

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications : Stretching of an elastic membrane.

UNIT II DIFFERENTIAL CALCULUS **9+3**

Functions of single variable – Limit of the function- Continuity and Differentiability - Mean value Theorems - Partial derivatives - Total derivative - Taylor series (in one and two variables) - Maxima and Minima (in one and two variables).

UNIT III ORDINARY DIFFERENTIAL EQUATION **9+3**

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

UNIT IV INTEGRAL CALCULUS **9+3**

Evaluation of definite and improper integrals - Change of order of integration - Double integrals in polar coordinates - Area enclosed by plane curves - Triple integrals.

UNIT V VECTOR CALCULUS **9+3**

Gradient and directional derivative – Divergence and curl - Vector identities – 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 – Verification and application in evaluating line, surface and volume integrals.

Total Periods:60

Learning Resources

1	Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 44th Edition, New Delhi, 2015.
2	Erwin Kreyszig. E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016

3	Anton. H, Bivens. I and Davis. S, " Calculus ", Wiley, 10th Edition, 2016
4	Jain. R.K. and Iyengar. S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 5th Edition, 2016.
5	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the matrix algebra methods for solving practical problems.	Apply
CO2	Apply differential calculus tools in solving various Engineering problems.	Apply
CO3	Apply various techniques in solving differential equations.	Apply
CO4	Apply double and triple integration techniques in solving areas and volumes.	Apply
CO5	Evaluate of line, surface and volume integrals using Gauss, Stokes and Green's Theorems.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3						2	2		3	
CO2	3	3	3						2	2		3	
CO3	3	3	3						2	2		3	
CO4	3	3	3						2	2		3	
CO5	3	3	3						2	2		3	
Avg.	**3**	**2**	**3**						**2**	**2**		**3**	

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24GE111	**PROBLEM SOLVING USING PYTHON**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able ,

- To understand the basics of algorithmic problem solving.
- To learn to solve problems using Python conditionals and loops.
- To define Python functions and use function calls to solve problems.
- To use Python data structures - lists, tuples, dictionaries to represent complex data.
- To do input/output with files in Python.

Detailed Syllabus

UNIT-I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT-II DATA TYPES, EXPRESSIONS, STATEMENTS	**9**
Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.	
UNIT-III CONTROL FLOW, FUNCTIONS, STRINGS	**9**
Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.	
UNIT-IV LISTS, TUPLES, DICTIONARIES	**9**
Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.	
UNIT-V FILES, MODULES, PACKAGES	**9**
Files and exceptions: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).	
	Total Periods:45

Learning Resources

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

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Develop algorithmic solutions to simple computational problems	Apply

CO2	Write simple python programs using the basic data types, expressions and Statements.	Apply
CO3	Write simple Python programs using conditionals and loops for solving problems and decompose a Python program into functions.	Apply
CO4	Represent compound data types using Python lists, tuples, dictionaries etc.	Apply
CO5	Read and write data from/to files in Python programs.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24HS111	தமிழர் மரபு / HERITAGE OF TAMILS	L	T	P	C
		1	0	0	1

Course Objective:

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

- Recognize Tamil literature and its significance in Tamil culture.
- Introduce the Tamils' rich artistic and cultural legacy.
- Familiarize the different types of folk and martial arts that are unique to Tamil Nadu.
- Acquaint the concept of Thinai in Tamil literature and culture.
- Comprehend the significance of Tamil in developing Indian culture.

Detailed Syllabus

UNIT I LANGUAGE AND LITERATURE **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.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE **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.

UNIT III FOLK AND MARTIAL ARTS **3**

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS **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.	
UNIT V CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE **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.	
Total Periods:15	

Learning Resources

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

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Describe the various types of Tamil Literature.	Understand
CO2	Discuss about Tamil Arts and Sculpture.	Understand
CO3	Explain the Tamil Folks and Martial Arts.	Understand
CO4	Summarize the Thinai Concepts of Tamil.	Understand
CO5	Review the contribution of Tamil Culture to Indian Culture and National Movements.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1						2		2	2	3			
CO2						2		2	2	3			
CO3						2		2	2	3			
CO4						2		2	2	3			
CO5						2		2	2	3			
Avg.						**2**		**2**	**2**	**3**			

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24PH113	ENGINEERING PHYSICS	L	T	P	C
		3	0	2	4

Course Objective:

After completing this course, the students will be able,

- To make the students effectively to achieve an understanding of mechanics.
- To enable the students to gain knowledge of electromagnetic waves, optics and its applications.
- To introduce the basics knowledge of lasers and fibre optics.
- Equipping the students to successfully understand the importance of quantum mechanics.
- To make the students understand the basics of crystal structure and its importance in studying materials properties.

Detailed Syllabus

UNIT I MECHANICS **9**

Multi-particle dynamics: Center of mass (CM) – CM of continuous bodies – motion of the CM Rotation of rigid bodies: Rotational kinematics – Theorems of M .I –moment of inertia of continuous bodies – torque – rotational dynamics of rigid bodies —- gyroscope - torsional pendulum – double pendulum.

UNIT II ELECTROMAGNETIC WAVES AND OPTICS **9**

Maxwell's equations - wave equation; Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - Producing electromagnetic waves - Cell-phone reception. Reflection and refraction of light waves - interference –Michelson interferometer –Theory of air wedge and experiment.

UNIT III LASERS AND FIBRE OPTICS **9**

Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein’s coefficients - population inversion - Nd-YAG laser, CO2 laser, semiconductor laser –Basic applications of lasers in industry.

Fiber optics: Principle, Numerical aperture and acceptance angle –types of optical fibers (material, refractive index, mode)- fibre optic communication- losses associated with optical fibers- fibre optic sensors: pressure and displacement- medical endoscope.

UNIT IV QUANTUM MECHANICS **9**

Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization – particle in a infinite potential well: 1D- particle in a infinite potential well:2D and 3D Boxes (Qualitative).

UNIT V CRYSTAL PHYSICS	**9**
Crystal structures: Crystal structures: BCC, FCC and HCP – crystal imperfections- edge and screw dislocations – grain and twin boundaries - Burgers vector and elastic strain energy- Slip systems, plastic deformation of materials and Miller indices –distance between successive planes – crystalline and non-crystalline material.	
	Total Periods:45

PRACTICAL – LIST OF EXPERIMENTS

Sl. No.	Practical – List of experiments (Any Seven experiments)
1	Determination of rigidity modulus – Torsion pendulum
2	Determination of Young's modulus by non-uniform bending method
3	Determination of wavelength using Laser.
4	Determination of Numerical aperture and acceptance angle in an optical fiber.
5	Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
6	Determination of thickness of a thin wire – Air wedge method
7	Determination of band gap of a semiconductor
8	Determination of Young's modulus by uniform bending method.
9	Compact disc- Determination of width of the groove using laser.
10	Simple harmonic oscillations of cantilever.
11	Spectrometer - Determination of wavelength of Mercury Spectrum using diffraction grating.
12	Michelson's interferometer -Determine the wave length of monochromatic light.
13	Melde's Experiment - Determine the Frequency of a tuning fork.
	Total Periods:30

Learning Resources

1	D. Kleppner and R. Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2	E.M. Purcell and D.J. Morin, Electricity and Magnetism, Cambridge University Press, 2013.
3	Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw-Hill (Indian Edition), 2017.
4	Gaur R K and Gupta S L, "Engineering Physics", Dhanpat Rai Publications, 2018.
5	Charles Kittel, "Introduction to Solid State Physics", Wiley India Pvt. Ltd, 7th ed., 2017.
6	D. K. Mynbaev and Lowell L. Scheiner, Fiber Optic Communication Technology, 2011,1st Edition, Pearson, USA.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the principles of mechanics to solve problems.	Apply
CO2	Apply the knowledge of the Maxwell's equations for electromagnetic waves and optics.	Apply
CO3	Apply the knowledge on the concepts of laser and their applications in fiber optics.	Apply

CO4	Apply quantum mechanical principles towards the formation of energy bands.	Apply
CO5	Describe the basics of crystals, their structures and defects.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24CY113	ENGINEERING CHEMISTRY	L	T	P	C
		3	0	2	4

Course Objective:

After completing this course, the students will be able ,

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

Detailed Syllabus

UNIT I WATER AND ITS TREATMENT **9**

Water: Sources and impurities, Water quality parameters - color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, fluoride and arsenic.

Municipal water treatment: primary treatment and disinfection (UV, Ozonation, break-point chlorination). Desalination of brackish water-Reverse Osmosis.

Boiler troubles - Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming & foaming.

Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process.

UNIT II NANOCHEMISTRY **9**

Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); 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 III PHASE RULE AND COMPOSITES	**9**
Phase rule: Introduction, definition of terms with examples. One component system - water system; Reduced phase rule; Construction of a simple eutectic phase diagram - Thermal analysis; Two component system: lead-silver system - Pattinson process. **Composites:** Introduction: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). **Nano Composites:** Properties and applications of Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.	
UNIT IV FUELS AND COMBUSTION	**9**
Fuels: Introduction: Classification of fuels; Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel. **Combustion of fuels:** Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method.	
UNIT V ENERGY SOURCES AND STORAGE DEVICES	**9**
Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of Silicon (si) Solar cell, Wind energy, Geo thermal energy. **Batteries:** Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium- ion battery; Electric vehicles - working principles; Fuel cells: H_2-O_2 fuel cell, microbial fuel cell; Super capacitors: Storage principle, types and examples.	
	Total Periods:45

PRACTICAL – LIST OF EXPERIMENTS

Sl. No.	Practical – List of experiments (Any Seven experiments)
1	Determination of types and amount of alkalinity in a water sample. - Split the first experiment into two.
2	Determination of total, temporary & permanent hardness of water by EDTA method.
3	Determination of DO content of water sample by Winkler's method.
4	Determination of chloride content of water sample by Argentometric method.
5	Determination of strength of given hydrochloric acid using pH meter.
6	Determination of strength of acids in a mixture of acids using conductivity meter.
7	Conductometric titration of barium chloride against sodium sulphate (precipitation titration)
8	Conductometric titration of strong acid vs strong base.
9	Estimation of iron content of the given solution using potentiometer.
10	Estimation of sodium /potassium present in water using a flame photometer.
	Total Periods:30

Learning Resources

1	P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2018.
2	Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3	Mary Francisca.L.J, Engineering Chemistry-I, 1, 2004.
4	O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Describe the water treatment processes and calculate the quality parameters of different types in Water Samples and Apply the appropriate method to find the PH, conductance and potential values of various solutions	Understand
CO2	Apply the concepts of nano science in Engineering Applications.	Apply
CO3	Apply the knowledge of phase rule and composites for material selection requirements	Apply
CO4	Identify the types of fuels and calculate the calorific value, explosive range for engineering processes.	Understand
CO5	Apply suitable energy resources for Engineering sectors.	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24HS123	**COMMUNICATIVE ENGLISH FOR ENGINEERS**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Course Objective:

After completing this course, the students will be able ,

- To learn to use basic grammatical structures in suitable contexts.
- To acquire lexical competence and use them appropriately in a sentence and understand their meaning in a text.
- To help learners use language effectively in both informal and professional contexts.
- To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions, essays and user manuals.

Detailed Syllabus

UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 1 What is effective communication? (Explain using activities) Why is communication critical for excellence during study, research and work? What are the seven C's of effective communication? What are key language skills? What is effective listening? What does it involve? What is effective speaking? What does it mean to be an excellent reader? What should you be able to do? What is effective writing? How does one develop language and communication skills? What does the course focus on? How are communication and language skills going to be enhanced during this course? What do you as a learner need to do to enhance your English language and communication skills to get the best out of this course?
UNIT I INTRODUCTION TO FUNDAMENTALS OF COMMUNICATION 8 Reading - Reading brochures (technical context), telephone messages / social media messages relevant to technical contexts and emails. Writing - Writing emails / letters introducing oneself. Grammar - Present Tense (simple and progressive); Question types: Why / Yes or No / and Tags. Vocabulary - Synonyms; One word substitution; Abbreviations & Acronyms (as used in technical contexts).
UNIT II NARRATION AND SUMMATION 9 Reading - Reading biographies, travelogues, newspaper reports, Excerpts from literature, and travel & technical blogs. Writing - Guided writing-- Paragraph writing; Short Report on an event (field trip etc.) Grammar –Past tense (simple); Subject-Verb Agreement; and Prepositions. Vocabulary - Word forms (prefixes& suffixes); Synonyms and Antonyms. Phrasal verbs.
UNIT III DESCRIPTION OF A PROCESS / PRODUCT 9 Reading – Reading advertisements, gadget reviews; user manuals. Writing - Writing definitions; instructions; and Product /Process description. Grammar - Imperatives; Adjectives; Degrees of comparison; Present & Past Perfect Tenses. Vocabulary - Compound Nouns, Homonyms; and Homophones, discourse markers (connectives & sequence words).
UNIT IV CLASSIFICATION AND RECOMMENDATIONS 9 Reading – Newspaper articles; Journal reports –and Non-Verbal Communication (tables, pie charts etc.). Writing – Note-making / Note-taking (*Study skills to be taught, not tested); Writing recommendations; Transferring information from non-verbal (chart, graph etc., to verbal mode) Grammar – Articles; Pronouns - Possessive & Relative pronouns. Vocabulary - Collocations; Fixed / Semi fixed expressions.
UNIT V EXPRESSION 9 Reading – Reading editorials; and Opinion Blogs; Writing – Essay Writing (Descriptive or narrative), Dialogue-writing. Grammar – Future Tenses, Punctuation; Negation (Statements & Questions); and Simple, Compound & Complex Sentences. Vocabulary - Cause & Effect Expressions – Content vs Function words.
Total Periods:45

PRACTICAL – LIST OF EXPERIMENTS

Sl. No.	Practical – List of experiments:
1	Listening comprehension
2	Telephone conversation & Introductions (listening & speaking)
3	Mock Interviews
4	Narrating personal experiences

Sl. No.	Practical – List of experiments:
5	Short Oral Presentations
6	Advertising a product
7	Situational conversation – 3 in a team
8	Creating educational videos
9	Group discussion
10	ICT based presentations
	Total Periods:30

Learning Resources

1	Communication Book, Portfolio Penguin, 2018. Authored by Mikael Krogerus, Roman Tschäppeler. ISBN-13 : 978-0241982280.
2	English for Science & Technology, Cambridge University Press, 2021. Authored by Dr.Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
3	Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
4	English For Technical Communication (With CD) By Aysha Viswamohan, McGraw Hill Education, ISBN : 0070264244, 2008.
5	How to win at Interviews & Group Discussions, Abhishek Publications, 2014. Authored by D.S. Cheema, ISBN: 9788182475175, 8182475171.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain different points of view during discussions.	Apply
CO2	Prepare for formal ICT based presentations and video creation.	Apply
CO3	Construct English sentences in both formal and informal contexts.	Apply
CO4	Interpret technical texts, audio materials and visual representation.	Understand
CO5	Write letters, definitions, descriptions, narrations and essays on various topics.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1								1	2	3		3	
CO2								1	2	3		3	
CO3								1	2	3		3	
CO4								1	2	3		3	
CO5								1	2	3		3	
Avg								**1**	**2**	**3**		**3**	

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24GE122	PROBLEM SOLVING USING PYTHON LABORATORY	L	T	P	C
		0	0	4	2

Course Objective:

After completing this course, the students will be able ,

- To learn about Variables, Operators available and how to write loops and decision statements in Python.
- To learn and Implement programs using non recursive and recursive functions.
- To Learn and execute a program using different Data Types - String, List, advance List, Dictionary, Tuple, Sets, Python Modules and packages.
- To learn how to read and write files in Python and also learn to use exception handling in Python applications for error handling.
- To build a mini project using fundamental programming constructs like variables, conditional logic, looping, and function and other required modules.

List of Experiments

1	Environment Setup and execute Basic Exercise to learn about Variables, Operators available in python.
2	Execute programs using Python Control Flow -Python Loops and Control Statements
3	Implement programs using String and array in python.
4	Write functions and pass arguments [Non Recursive, Recursive] in Python
5	Execute program to learn different Data Types in python- String, List, advance List, Dictionary, Tuple, Sets
6	Learn and execute programs using Python Modules and packages.
7	Execute program using Python Directory and Files Management.
8	Implement program to learn about python exception handling
9	Mini project [Group project- demo and presentation]
	Total Periods: 60

Learning Resources

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.
3	Paul Deitel and Harvey Deitel, “Python for Programmers”, Pearson Education, 1st Edition, 2021.
4	G Venkatesh and Madhavan Mukund, “Computational Thinking: A Primer for Programmers and Data Scientists”, 1st Edition, Notion Press, 2021.
5	Reema Thareja, “Python Programming using problem solving approach”, 2019, Oxford University Press.

6	John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021
7	Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019. https://www.python.org/
8	Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Write loops and decision statements in Python using variables and operators.	Apply
CO2	Execute programs to implement non recursive and recursive functions in Python.	Apply
CO3	Write Python Programs using core data structures like array, string, Lists, Set, Dictionaries and use Tuples.	Apply
CO4	Use and carry out examples to handle File Systems and exception handling in Python.	Apply
CO5	Deconstruct exemplary applications in Python.	Analyse

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MA231	Transforms and Complex Analysis	BSC	3	1	0	4	4	40	60
2	U24HS211	Tamils and Technology	HSMC	1	0	0	1	1	40	60
THEORY CUM PRACTICAL COURSES										
3	U24PH233	Physics for Electronics Engineering	BSC	3	0	2	5	4	50	50
4	U24EC213	Circuit Analysis	ESC	3	0	2	5	4	50	50
5	U24CS233	Data Structures using C	ESC	3	0	2	5	4	50	50
6	U24HS223	Technical English for Engineers	HSMC	2	0	2	4	3	50	50
PRACTICAL COURSES										
7	U24EE232	Engineering Practices Laboratory for Circuit branches	ESC	0	0	4	4	2	60	40
8	U24EM212	Professional Development	EEC	0	0	2	2	1	100	-
				15	**1**	**14**	**30**	**23**		

ASSESSMENT SCHEME

Sl. No	Course Type	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24MA231	3	1	0	4	60	40	60	40	-	100		40	60	45	50
2	U24HS211	1	0	0	1	60	40	60	40	-	100		40	60	45	50
3	U24PH233	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
4	U24EC213	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
5	U24CS233	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
6	U24HS223	2	0	2	3	60	40	60	40	100	50	50	50	50	45	50
7	U24EE232	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50
8	U24EM212	0	0	2	1	-	-	-	-	-	-	-	100	-	-	50

(W) – Weightage

U24MA231	TRANSFORMS AND COMPLEX ANALYSIS	L	T	P	C
		3	1	0	4

Course Objective:

After completing this course, the students will be able :

- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier transform techniques used in a wide variety of situations.
- To make the student appreciate the purpose of using transforms to create a new domain which makes it easier to handle the problem that is being investigated.
- To develop Z transform techniques for discrete time Systems.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence in application areas.

Detailed Syllabus

UNIT I FOURIER SERIES	**9+3**
Dirichlet's conditions - General Fourier series - Odd and even functions - Half range sine series - Half range cosine series - Complex form of Fourier series - Parseval's identity - Harmonic analysis.	
UNIT II FOURIER TRANSFORMS	**9+3**
Statement of Fourier integral theorem - Fourier transform pair - Fourier sine and cosine transforms - Properties - Transforms of simple functions - Convolution theorem - Parseval's identity.	
UNIT III LAPLACE TRANSFORM	**9+3**
Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems -Transforms of derivatives and integrals – Initial and final value theorems – Inverse transforms – Convolution theorem – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.	
UNIT IV Z — TRANSFORMS AND DIFFERENCE EQUATIONS	**9+3**
Z-transforms - Elementary properties – Convergence of Z-transforms – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.	
UNIT V COMPLEX ANALYSIS	**9+3**
Analytic functions - Cauchy's integral theorem - Cauchy's integral formula - Taylor and Laurent series - residue theorem.	
	TOTAL: 60 PERIODS

Learning Resources

1	Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
2	Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2018
3	Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.
4	Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S. Viswanathan Publishers Pvt. Ltd, Chennai, 1998.

5	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Determine periodic function using Fourier series analysis which plays a vital role in engineering applications.	Apply
CO2	Calculate the Fourier Sine and Cosine transform.	Apply
CO3	Apply the Laplace and inverse Laplace transformations for different types of functions.	Apply
CO4	Apply Z-transforms for solving linear ODEs.	Apply
CO5	Apply residue theorem to integrate complex functions.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3						2	2		3	
CO2	3	3	3						2	2		3	
CO3	3	3	3						2	2		3	
CO4	3	3	3						2	2		3	
CO5	3	3	3						2	2		3	
Avg.	**3**	**3**	**3**						**2**	**2**		**3**	

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24HS211	**தமிழரும் தொழில்நுட்பமும் / TAMILS AND TECHNOLOGY**	**L**	**T**	**P**	**C**
		1	**0**	**0**	**1**

Course Objective:

After completing this course, the students will be able :

- To facilitate the student to understand weaving and technology of sangam age.
- To create an awareness on structural design of Tamils during sangam age.
- To help students to distinguish between all the levels of manufacturing technology in ancient period.
- To understand the ancient knowledge of agriculture and irrigation technology.
- To enable the students to understand the digitalization of Tamil Language.

Detailed Syllabus

UNIT I WEAVING AND CERAMIC TECHNOLOGY **3**

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

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY	**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.	
UNIT III MANUFACTURING TECHNOLOGY	**3**
Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and goldCoins 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.	
UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY	**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.	
UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING	**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.	
Total Periods:15	

Learning Resources

1	Social Life of Tamils (Dr. K.K. Pillay) A joint publication of TNTB & ESC and RMRL
2	Social Life of the Tamils - The Classical Period (Dr. S. Singaravelu) (Published by: International Institute of Tamil Studies.
3	Historical Heritage of the Tamils (Dr. S.V. Subatamanian, Dr. K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4	The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi) (Published by: International Institute of Tamil Studies).
5	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).
6	Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author).
7	Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu).

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Review the Weaving and Ceramic Technology during Tamil Sangam Age.	Understand

CO2	Describe the Construction Technology and various Architecture during Tamil Sangam Age.	Understand
CO3	Discuss the Manufacturing Technology with Archaeological Evidences.	Understand
CO4	Explain the Agriculture and Irrigation Technology during Tamil Sangam Age.	Understand
CO5	Describe Tamil Software and Digitalization Tamil Literatures.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24PH233	Physics for Electronics Engineering	L	T	P	C
		3	0	2	4

Course Objective:

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

- Ascertain about the basic of semiconductor physics.
- Illustrate concepts of semiconductor devices and applications of diodes.
- Analyzing and creating ideas about transistors and applying advanced circuit analysis techniques to solve complex electrical circuits.
- Apply optical properties of materials to the optoelectronic devices.
- Interpret the quantum physics and its applications in Nano devices.

Detailed Syllabus

UNIT I SEMICONDUCTOR PHYSICS **9**

Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors – Carrier concentration in P-type semiconductors – Variation of carrier concentration with temperature — Carrier transport in Semiconductor: drift and diffusion.

UNIT II SEMICONDUCTORS **9**

Semiconductor Basics – PN Junction Diodes – Forward and Reverse Biasing – Reverse Saturation Current – Diode current components – Cut-in voltage – VI Characteristics. Rectification – Half-wave – Full-wave and Bridge – Filters. Zener Diodes -Shunt voltage regulator – Regulator Design.

UNIT III TRANSISTORS **9**

Transistors – BJTs – PNP and NPN transistors – Effects – Transistor Currents – Amplifying action of a transistor. Transistor Characteristics – CE configuration – Biasing – Quiescent point – Load line – Biasing – Fixed base bias – Small Signal Model of BJT.

Field Effect Transistors – MOSFET – Enhancement and Depletion Modes – Regions of Operation. MOSFET Characteristics – MOSFET Amplifier – MOSFET as a switch.
UNIT IV OPTOELECTRONIC DEVICES 9 Classification of optical materials –light detectors and solar cells – light emitting diode – laser diode - optical processes in organic semiconductor devices –LCD - excitonic state – Varactor Diodes – Schottky Diodes.
UNIT V NANO DEVICES 9 Introduction - quantum confinement – quantum structures: quantum wells, wires and dots — band gap of nanomaterials. Tunneling – Single electron phenomena: Coulomb blockade – resonant tunnelling diode – single electron transistor – Optics in quantum structures – quantum well laser.
TOTAL: 45 PERIODS

Sl. No.	Practical – List of experiments
1	Characteristics of PN Junction Diode
2	Zener diode characteristics
3	FET Characteristics
4	Transistor - Common Base input - output Characteristics
5	Transistor - Common Emitter input - output Characteristics.
6	Compact disc- Determination of width of the narrow beam using laser.
7	Determination of particle size using laser source.
	TOTAL: 30 PERIODS

Learning Resources

1	Charles K. Alexander & Mathew N.O. Sadiku, "Fundamentals of Electric Circuits", McGraw-Hill, 2nd Edition, 2003.
2	S.O. Kasap. Principles of Electronic Materials and Devices, McGraw Hill Education (Indian Edition), 2020.
3	Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, McGraw-Hill Education (Indian Edition), 2019.
4	G.W. Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009.
5	Robert. L. Boylestead, "Introductory Circuit Analysis", Pearson Education India, 12th Edition, 2014.
6	David Bell, "Fundamentals of Electric Circuits", Oxford University press, 7thEdition, 2009.
7	Allan H.Robbins, Wilhelm C.Miller, “Circuit Analysis Theory and Practice", Cengage Learning, Fifth Edition, 1st Indian Reprint 2013.
8	R.F.Pierret. Semiconductor Device Fundamentals. Pearson (Indian Edition), 2006.

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Acquire knowledge on the concepts of semiconductor physics	Understand
CO2	Apply the knowledge of semiconductor devices and diodes.	Apply

CO3	Apply knowledge of the transistor devices and its applications.	Apply
CO4	Apply knowledge of the optoelectronic devices	Apply
CO5	Apply knowledge about the optical properties and its application in finding the thickness of the particles.	Apply

Course Articulation Matrix

CO	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	
Avg.	**3**	**1**			**2**				**2**	**2**		**2**	

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC213	**Circuit Analysis**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Course Objective:

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

- Apply the basic concepts of circuit analysis in Kirchoff's laws for the DC and AC circuits.
- Compute suitable network theorems and analyze AC and DC circuits
- Design steady state response of any R, L and C circuits
- Analyze the transient response for any RC, RL and RLC circuits and frequency response of Parallel and series resonance circuits.
- Determine relationship of various two port network

Detailed Syllabus

UNIT I: DC CIRCUIT ANALYSIS **9**

Basic Components of electric Circuits, Charge, current, Voltage and Power, Voltage and Current Sources, Ohms Law, Kirchoff's Current Law, Kirchoff's voltage law, The single Node – Pair Circuit, series and Parallel Connected Independent Sources, Resistors in Series and Parallel, voltage and current division, Nodal analysis, Mesh analysis.

UNIT II: NETWORK THEOREM AND DUALITY 9

Useful Circuit Analysis techniques – Linearity and superposition, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer, Reciprocity Theorems, Delta-Wye Conversion. Duals, Dual circuits. Analysis using dependent current sources and voltage sources.

UNIT III : SINUSOIDAL STEADY STATE ANALYSIS **9**

Sinusoidal Steady – State analysis , Characteristics of Sinusoids, The Complex Forcing Function, The Phasor, Phasor relationship for R, L, and C, impedance and Admittance, Nodal and Mesh Analysis, Phasor Diagrams, AC Circuit Power Analysis, Instantaneous Power, Average Power, apparent Power and Power Factor, Complex Power.

UNIT IV: TRANSIENTS AND RESONANCE IN RLC CIRCUITS 9 Basic RL and RC Circuits, The Source- Free RL Circuit, The Source-Free RC Circuit, The Unit-Step Function, Driven RL Circuits, Driven RC Circuits, RLC Circuits, Frequency Response, Parallel Resonance, Series Resonance, Quality Factor.
UNIT V: TWO PORT NETWOK 9 Two Port Networks, terminal pairs, relationship of two port variables, impedance parameters, admittance parameters, transmission parameters and hybrid parameters, interconnections of two port networks
TOTAL: 45 PERIODS

Sl. No.	Practical – List of experiments
1	Verification of KVL and KCL
2	Verification of Thevenin Theorems.
3	Verification of Norton's Theorems.
4	Verification of Superposition Theorem
5	Verification of Maximum Power Transfer
6	Verification of Maximum Power Transfer
7	Verification of reciprocity Theorems
8	Frequency response of series & parallel resonance circuits.
9	Transient analysis of RL and RC circuits
	TOTAL: 30 PERIODS

Learning Resources

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

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the basic concepts of circuit analysis in Kirchoff's laws for the DC and AC circuits.	Apply
CO2	Compute suitable network theorems and analyze AC and DC circuits	Apply
CO3	Design steady state response of any R, L and C circuits	Apply
CO4	Analyze the transient response for any RC, RL and RLC circuits and frequency response of parallel and series resonance circuits.	Apply
CO5	Determine relationship of various two port network	Apply

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24CS233	**Data Structures using C**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Course Objective:

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

- To introduce the basics of C programming language.
- To learn the concepts of advanced features of C.
- To understand the concepts of ADTs and linear data structures.
- To know the concepts of non-linear data structure and hashing.
- To familiarize the concepts of sorting and searching techniques.

Detailed Syllabus

UNIT I : C PROGRAMMING FUNDAMENTALS **9**

Data Types – Variables – Operations – Expressions and Statements – Conditional Statements – Functions – Recursive Functions – Arrays – Single and Multi-Dimensional Arrays.

UNIT II: C PROGRAMMING - ADVANCED FEATURES **9**

Enumerated Data Types – Pointers: Pointers to Variables, Arrays and Functions – Structures – Union – File Handling – Preprocessor Directives.

UNIT III : LINEAR DATA STRUCTURES **9**

Abstract Data Types (ADTs) – List ADT – Array-Based Implementation – Linked List – Doubly Linked Lists – Circular Linked List – Stack ADT – Implementation of Stack – Applications – Queue ADT – Priority Queues – Queue Implementation – Applications.

UNIT IV: NON-LINEAR DATA STRUCTURES	**9**
Trees – Binary Trees – Tree Traversals – Expression Trees – Binary Search Tree – Hashing - Hash Functions – Separate Chaining – Open Addressing – Linear Probing– Quadratic Probing – Double Hashing – Rehashing.	
UNIT V: SORTING AND SEARCHING TECHNIQUES	**9**
Insertion Sort – Quick Sort – Heap Sort – Merge Sort –Linear Search – Binary Search.	
TOTAL: 45 PERIODS	

Sl. No.	Practical – List of experiments
1	Practice of C programming using statements, expressions, decision making and iterative statements.
2	Practice of C programming using Functions and Arrays
3	Implement C programs using Pointers and Structures
4	Implement C programs using Files
5	Array implementation of List ADT
6	Array implementation of Stack and Queue ADTs
7	Linked list implementation of List, Stack and Queue ADTs
8	Implementation of Binary Trees and operations of Binary Trees
9	Implementation of Binary Search Trees
10	Implementation of searching techniques
11	Implementation of Sorting algorithms: Insertion Sort, Quick Sort, Merge Sort
12	Implementation of Hashing – any two collision techniques
	TOTAL: 30 PERIODS

Learning Resources

1	Mark Allen Weiss, “Data Structures and Algorithm Analysis in C”, Second Edition, Pearson Education, 1997.
2	Reema Thareja, “Programming in C”, Second Edition, Oxford University Press, 2016.
3	Brian W. Kernighan, Rob Pike, “The Practice of Programming”, Pearson Education, 1999.
4	Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, “Data Structures and Algorithms”, Pearson Education,1983.
5	Ellis Horowitz, Sartaj Sahni and Susan Anderson, “Fundamentals of Data Structures”, Galgotia, 2008.
6	Paul J. Deitel, Harvey Deitel, “C How to Program”, Seventh Edition, Pearson Education, 2013.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Develop C programs for any real world/technical application	Apply
CO2	Apply advanced features of C in solving problems	Apply
CO3	Write functions to implement linear and non–linear data structure operations	Apply
CO4	Suggest and use appropriate linear/non–linear data structure operations for solving a given problem	Apply
CO5	Appropriately use sort and search algorithms for a given application	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	1	2	2	1	1		1	2	1	3	
CO2	1	2	1	2	2				1	1	1	2	
CO3	2	3	1	2	3				1	1	1	2	
CO4	2	1		1	1				2	1	1	2	
CO5	1	2	1	2	2	1	1		1	2	1	3	
Avg.	**1.6**	**2.2**	**1**	**1.8**	**2**	**1**	**1**		**1.2**	**1.4**	**1**	**2.4**	

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24HS223	**Technical English for Engineers**	**L**	**T**	**P**	**C**
		2	**0**	**2**	**3**

Course Objective:

After completing this course, the students will be able :

- To engage learners in meaningful language activities to improve their LSRW skills.
- To enhance learners' awareness of general rules of writing for specific audiences.
- To help learners understand the purpose, audience, contexts of different types of writing.
- To develop analytical thinking skills for problem solving in communicative contexts.
- To demonstrate an understanding of job applications and interviews for internship and placements.

Detailed Syllabus

UNIT I : MAKING COMPARISONS **6**

Reading - Reading advertisements, user manuals, brochures; Writing – Professional emails, Email etiquette - Compare and Contrast Essay; Grammar – Mixed Tenses, Prepositional phrases.

UNIT II EXPRESSING CAUSAL RELATIONS IN SPEAKING AND WRITING **6**

Reading - Reading longer technical texts– Cause and Effect Essays, and Letters / emails of complaint, Writing - Writing responses to complaints. Grammar - Active Passive Voice transformations, Infinitive and Gerunds

UNIT III PROBLEM SOLVING **6**

Reading - Case Studies, excerpts from literary texts, news reports etc. Writing – Letter to the Editor, Checklists, Problem solution essay / Argumentative Essay. Grammar – Error correction; If conditional sentences

UNIT IV REPORTING OF EVENTS AND RESEARCH	**6**
Reading –Newspaper articles; Writing – Proposal writing - Picture description - Accident Report, Survey Report. Grammar – Reported Speech, Modals Vocabulary – Conjunctions- use of prepositions.	
UNIT V THE ABILITY TO PUT IDEAS OR INFORMATION COGENTLY	**6**
Reading – Company profiles, Statement of Purpose, (SOP), an excerpt of interview with professionals; Writing – Job / Internship application – Cover letter & Resume; Grammar – Numerical adjectives, Relative Clauses.	
TOTAL: 30 PERIODS	

Sl. No.	Practical – List of experiments
1	Role Play Exercises Based on Workplace Contexts
2	Understanding lexical items via movie clippings – Individual task
3	Discussing news stories
4	Dialogues (with cue cards)-Understanding common technology terms
5	Pronunciation, Intonation, Stress and Rhythm (Level 1)
6	Pronunciation, Intonation, Stress and Rhythm (Level 2)
7	Public Speech: Talking about self in a Professional Setting, Introduction of Speakers, Vote of thanks - 3 in a team
8	Writing a short article (Can be compiled as a magazine)
9	Verbal ability exercises for competitive examinations
10	Visume
	TOTAL: 30 PERIODS

Learning Resources

1	English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2	English for Science & Technology Cambridge University Press 2021 Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
3	Better English Pronunciation, (2005), J.D.O'Connor, Second Edition, ISBN-13:978-0521682589.
4	Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
5	Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.
6	A Modern Approach to Verbal & Non-Verbal Reasoning - Includes Latest Questions and their Solutions, Revised Edition , R.S. Aggarwal, January 2018.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Articulate English with proper pronunciation, intonation, stress and rhythm.	Apply

CO2	Develop verbal ability skills for attending competitive examinations.	Apply
CO3	Employ speaking and writing skills in professional contexts.	Apply
CO4	Write effective resumes in the context of job search.	Apply
CO5	Interpret the denotative and connotative meanings of technical texts.	Understand

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EE232	ENGINEERING PRACTICES LABORATORY FOR CIRCUIT BRANCHES	L	T	P	C
		0	0	4	2

Course Objective:

- To gain practical experience in characterizing electronic devices
- To solder and test simple electronic circuits on PCB
- To verify KVL and KCL using series and parallel circuits
- To perform various electrical joints in common household electrical wire work.
- To measure of electrical quantities in different electrical circuits

List of Experiments

Sl. No.	List of Experiments
	Electronic Engineering Practices
1	Study of Electronic Components and Equipment.
2	Resistor Value using Colour coding.
3	Generation of AC signal using Function Generator and Measurement of its parameter using CRO / DSO.
4	Study of logic gates - AND, OR, NOT, NOR, NAND and XOR.
5	Soldering simple electronic circuits and checking continuity.
6	Verification of KVL and KCL using series and parallel circuits.
7	Controlling smart devices using Mobile phone.
8	Study of troubleshooting steps in Mobile Repairing.
	Electrical Engineering Practices
1	Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2	Fluorescent lamp wiring.
3	Stair case wiring.

4	Measurement of electrical quantities – voltage, current, power and power factor in RLC circuit.
5	Measurement of energy using a single-phase energy meter.
6	Measurement of resistance to earth of electrical equipment.
	Total Periods: 60

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Analyze the characteristics of basic electronic devices	Analyze
CO2	Perform simple electronic circuits on PCB	Apply
CO3	Solve KVL and KCL using series and parallel circuits	Apply
CO4	Perform various electrical joints in common household electrical wire work.	Apply
CO5	Calculate electrical quantities in different electrical circuits	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3						2	3	2		2	
CO2	3	2	2					2	3	2		2	
CO3	3	3	3					2	3	2			
CO4	3	2				2		2	3	2		3	
CO5	3	2	2			2		2	3	2		3	
Avg.	**3**	**2.4**	**2.3**			**2**		**2**	**3**	**2**		**2.5**	

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EM212	**PROFESSIONAL DEVELOPMENT**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Course Objective:

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

- To be proficient in important Microsoft Office tools: MS WORD, EXCEL, and POWERPOINT.
- To be proficient in using MS WORD to create quality technical documents, by using standard templates, widely acceptable styles and formats, variety of features to enhance the presentability and overall utility value of content.
- To be proficient in using MS EXCEL for all data manipulation tasks including the common statistical, logical, mathematical etc., operations, conversion, analytics, search and explore, visualize, interlink, and utilizing many more critical features offered
- To be able to create and share quality presentations by using the features of MS PowerPoint, including: organization of content, presentability, aesthetics, using media elements and enhance the overall quality of presentations.

List of Experiments

S. No.	List of experiments:
1	**MS WORD: (10 Periods)** Create and format a document Working with tables Working with Bullets and Lists Working with styles, shapes, smart art, charts Inserting objects, charts and importing objects from other office tools Creating and Using document templates Inserting equations, symbols and special characters Working with Table of contents and References, citations Insert and review comments Create bookmarks, hyperlinks, endnotes footnote Viewing document in different modes Working with document protection and security Inspect document for accessibility
2	**MS EXCEL: 10 Periods** Create worksheets, insert and format data Work with different types of data: text, currency, date, numeric etc. Split, validate, consolidate, Convert data Sort and filter data Perform calculations and use functions: (Statistical, Logical, Mathematical, date, Time etc.,) Work with Lookup and reference formulae Create and Work with different types of charts Use pivot tables to summarize and analyse data Perform data analysis using own formulae and functions Combine data from multiple worksheets using own formulae and built-in functions to generate results Export data and sheets to other file formats Working with macros Protecting data and Securing the workbook
3	**MS POWERPOINT: 10 Periods** Select slide templates, layout and themes Formatting slide content and using bullets and numbering Insert and format images, smart art, tables, charts Using Slide master, notes and handout master Working with animation and transitions Organize and Group slides Import or create and use media objects: audio, video, animation Perform slideshow recording and Record narration and create presentable videos
	TOTAL: 30 PERIODS

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Create quality documents, by structuring and organizing content for their day to day technical and academic requirements using MS Word.	Apply
CO2	Perform data operations and analytics, record, retrieve data as per requirements and visualize data for ease of understanding using MS Excel.	Apply
CO3	Create high quality academic presentations by including common tables, charts, graphs, interlinking other elements, and using media objects using MS Power Point.	Apply
CO4	Prepare an effective report using MS Word and MS Excel on any subject content.	Apply
CO5	Present the report using MS Power Point.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1									2	2		2	
CO2									2	2		2	
CO3									2	2		2	
CO4									2	2		2	
CO5									2	2		2	
Avg.									**2**	**2**		**2**	

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MA331	Probability and Random Processes	BSC	3	1	0	4	4	40	60
2	U24EC311	Electromagnetic Fields	PCC	3	1	0	4	4	40	60
THEORY CUM PRACTICAL COURSES										
3	U24EC323	Signals and Systems	PCC	2	1	2	5	4	50	50
4	U24EC333	Electronic Devices and Circuits	PCC	3	0	2	5	4	50	50
5	U24EC343	Digital System Design	PCC	3	0	2	5	4	50	50
				14	**3**	**6**	**23**	**20**		

ASSESSMENT SCHEME

Sl. No	Course Type	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24MA331	3	1	0	4	60	40	60	40	-	100	-	40	60	45	50
2	U24EC311	3	1	0	4	60	40	60	40	-	100	-	40	60	45	50
3	U24EC323	2	1	2	4	60	40	60	40	100	70	30	50	50	45	50
4	U24EC333	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
5	U24EC343	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50

(W) - Weightage

U24MA331	PROBABILITY AND RANDOM PROCESSES	L	T	P	C
		3	1	0	4

Course Objective:

After completing this course, the students will be able :

- To provide necessary basic concepts in probability and random processes with applications to random signals, linear systems in communication engineering.
- To understand the basic concepts of probability, one- and two-dimensional random variables and to introduce some standard distributions commonly used in engineering to real life phenomenon.
- To understand the basic concepts of random processes which are widely used in IT fields.
- To understand the concept of correlation and spectral densities.
- To understand the significance of linear systems with random inputs.

Detailed Syllabus

UNIT I : PROBABILITY AND RANDOM VARIABLES	**9+3**
Probability – Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions- Functions of a random variable.	
UNIT II TWO - DIMENSIONAL RANDOM VARIABLES	**9+3**
Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables.	
UNIT III RANDOM PROCESSES	**9+3**
Classification – Stationary process: SSS process and WSS process – Markov process - Markov chain - Poisson 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	
	TOTAL: 30 PERIODS

Learning Resources

1	Ibe, O.C.," Fundamentals of Applied Probability and Random Processes ", 1st Indian Reprint, Elsevier, 2010.
2	Peebles, P.Z., "Probability, Random Variables and Random Signal Principles ", Tata McGraw Hill, 4th Edition, New Delhi, 2002.
3	M.B.K .Moorthy, K. Subramani, A. Santha, "Probability and Random Processes", 7thEdition, Scitech Publications (INDIA) Pvt.Ltd.,2015.
4	Stark. H. and Woods. J.W., "Probability and Random Processes with Applications to Signal Processing ", Pearson Education, Asia, 3rdEdition, 2002.

5	Yates. R.D. and Goodman. D.J., “Probability and Stochastic Processes", Wiley India Pvt. Ltd., Bangalore, 2nd Edition, 2012.
6	Cooper. G.R., McGillem. C.D., "Probabilistic Methods of Signal and System Analysis", Oxford University Press, New Delhi, 3rd Indian Edition, 2012.
7	Miller. S.L. and Childers. D.G., “Probability and Random Processes with Applications to Signal Processing and Communications ", Academic Press, 2004.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the basic knowledge of the probability concepts.	Apply
CO2	Apply the basic concepts on two dimensional random variables.	Apply
CO3	Apply the concept random processes in engineering disciplines.	Apply
CO4	Apply the concept of correlation and spectral densities in engineering fields.	Apply
CO5	Apply the appropriate formula for the input system of a transfer function to get the auto correlation function and mean square value of the output.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3					2	2		3		
CO2	3	3	3					2	2		3		
CO3	3	3	3					2	2		3		
CO4	3	3	3					2	2		3		
CO5	3	3	3					2	2		3		
Avg.	**3**	**3**	**3**					**2**	**2**		**3**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC311	ELECTROMAGNETIC FIELDS	L	T	P	C
		3	1	0	4

Course Objective:

After completing this course, the students will be able :

- To develop Proficiency in Vector Analysis for Electromagnetic Applications
- To gain a Comprehensive Understanding of Electrostatics and Electric Fields
- To explore the Fundamentals of Magnetostatics and Magnetic Fields
- To examine the Role of Time-Varying Fields and Maxwell’s Equations in Electromagnetics
- To analyze Wave Propagation and Electromagnetic Power in Different Media

Detailed Syllabus

UNIT I : INTRODUCTION TO VECTOR ANALYSIS 9+3 The Electromagnetic Model, Units and constants, Review of vector algebra- Cartesian Coordinates, Cylindrical Coordinates and Spherical Coordinates-Line, surface and volume integrals, Gradient of a Scalar Field, Divergence of a Vector Field, Divergence Theorem, Curl of a Vector Field, Stokes's Theorem, Two Null Identities, Helmholtz's Theorem
UNIT II STATIC ELECTRIC FIELDS 9+3 Electrostatics in Free Space, 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 for Electrostatic Fields, Capacitance and Parallel, cylindrical and spherical capacitors, Electrostatic Energy and Forces, Poisson's and Laplace's equations, Current Density and Ohm's Law, Electromotive Force and Kirchhoff's Voltage Law, Equation of Continuity and Kirchhoff's Current Law
UNIT III STATIC MAGNETIC FIELDS 9+3 Fundamental Postulates of Magnetostatics in Free Space, Lorentz force equation, Ampere's law, Vector Magnetic Potential, The Biot-Savart Law and Applications, The Magnetic Dipole, Magnetic Field Intensity and Relative Permeability, Magnetic Circuits, Behavior of Magnetic Materials, Boundary Conditions for Magnetostatic Fields, Inductances and Inductors, Magnetic Energy, Magnetic Forces and Torques
UNIT IV TIME-VARYING FIELDS AND MAXWELL'S EQUATIONS 9+3 Faraday's Law of Electromagnetic Induction, Maxwell's Equations – Differential and Integral Form of Maxwell's Equations, Potential Functions, Electromagnetic Boundary Conditions, Wave Equations and Their Solutions, Time-Harmonic Fields.
UNIT V PLANE ELECTROMAGNETIC WAVES 9+3 Plane Waves in Lossless Media, Plane Waves in Lossy Media, Group Velocity, Flow of Electromagnetic Power and the Poynting Vector, Normal Incidence at a Plane Conducting Boundary, Oblique Incidence at a Plane Conducting Boundary, Normal Incidence at a Plane Dielectric Boundary
TOTAL: 60 PERIODS

Learning Resources

1	David K. Cheng, “Field and Wave Electromagnetics”, Second Edition, Pearson New International Edition, 2014
2	John Kraus and Daniel Fleisch, “Electromagnetics with Applications”, Fifth Edition, McGraw Hill Education (India Edition),July 2017.
3	M.N.O. Sadiku and S.V. Kulkarni, Principles of electromagnetics, 6th ed., Oxford(Asian Edition), 2015
4	Edward C. Jordon (Author), Keith G. Balmain (Author), Electromagnetic Waves and Radiating Systems, Second Edition, Pearson Education, 2015
5	W.H. Hayt and J.A. Buck, “Engineering electromagnetics”, 9th ed., McGraw-Hill (India), 2020

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply vector calculus operations and related theorems to solve problems in electromagnetic theory.	Apply
CO2	Analyze the behavior of electrostatic fields and their interactions with materials in static conditions.	Analyze
CO3	Evaluate magnetic fields and energy using fundamental postulates of magnetostatics and related laws.	Evaluate
CO4	Explain Maxwell's equations and their applications in solving electromagnetic wave equations.	Apply
CO5	Infer the behavior of electromagnetic waves during propagation and interaction with various boundaries	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	3	2		2	2	2		2	2	2
CO2	3	3	2	3	2		2	2	2		2	2	2
CO3	3	3	2	3	2		2	2	2		2	2	2
CO4	3	3	2	3	2		2	2	2		2	2	2
CO5	3	3	2	3	2		2	2	2		2	2	2
Avg.	**3**	**3**	**2**	**3**	**2**		**2**	**2**	**2**		**2**	**2**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC323	**SIGNALS AND SYSTEMS**	**L**	**T**	**P**	**C**
		2	**1**	**2**	**4**

Course Objective:

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

- Understanding the fundamental characteristics of signals and systems.
- Analysis of Continuous Time Signals using Fourier Representation.
- Analysis of discrete time signals using Z Transform and Fourier Transform.
- Understanding the Characteristics of LTI-CT Systems
- Understanding the Characteristics of LTI-DT Systems

Detailed Syllabus

UNIT I : CLASSIFICATION OF SIGNALS AND SYSTEMS **9**

Standard signals-Step, Ramp, Impulse, Real and complex exponentials and Sinusoids-Classification of signals-Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals. Classification of systems-CT systems and DT systems-Static and Dynamic Systems, Time-variant & Time-invariant, Linear & Nonlinear, Causal & Non-causal, Stable & Unstable systems, Invertible and Invertible systems.

UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 9 Fourier series-Continuous Time Fourier series-Trigonometric or Quadrature Fourier series – Fourier series and properties-Fourier Transform and properties-Laplace Transforms and properties.
UNIT III ANALYSIS OF DISCRETE TIME SIGNALS 9 Fourier Transform of discrete time signals (DTFT)-Properties of DTFT-Z Transform and Properties.
UNIT IV LINEAR TIME INVARIANT - CONTINUOUS TIME SYSTEMS 9 Convolution integrals-Impulse Response and Properties of Systems-Differential Equation- Fourier and Laplace transforms in Analysis of CT systems.
UNIT V LINEAR TIME INVARIANT - DISCRETE TIME SYSTEMS 9 Convolution sum-Impulse response-Difference equations-Discrete Fourier Transform-Z Transform Analysis DT systems-Recursive & Non-Recursive systems.
TOTAL: 45 PERIODS

Sl.No.	Practical – List of experiments
1	Study of MATLAB and Its Features
2	Study of Basic MATLAB Commands and Functions
3	Basic MATLAB Programming
4	Simulation of Various Real-Time Signal Generations for Communication
5	Simulation and Fourier Series Analysis of Square Waves for Signal Processing and
6	Communication Systems
7	Simulation of Fourier Transform and Spectral Analysis for Signal Processing:
8	Magnitude and Phase Spectrum Visualization
9	Simulation of Z-Transform for Discrete-Time System Analysis and Digital Control
	TOTAL: 30 PERIODS

Learning Resources

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, 2020
3	M. J. Roberts, “Signals and Systems Analysis using Transform methods and MATLAB”, McGraw- Hill Education, 2018.
4	B. P. Lathi, “Principles of Linear Systems and Signals”, 2nd Edition, Oxford, 2009.
5	John Alan Stuller, “An Introduction to Signals and Systems”, Thomson, 2007

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Estimate the basic elementary signals & determine the Fourier series for Continuous Time Signals.	Apply
CO2	Calculate Fourier Transform and Laplace Transform in continuous Time Signals	Apply
CO3	Determine Fourier Transform and Z Transform in Discrete Time Signals	Apply
CO4	Solve Linear Time Invariant Continuous Signals using Fourier Transform and Laplace Transform	Apply
CO5	Solve Linear Time Invariant Discrete Signals using Z Transform	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO 2
CO1	3	3	3	3	3		2	2	2		2	2	2
CO2	3	3	3	3	3		2	2	2		2	2	2
CO3	3	3	3	3	3		2	2	2		2	2	2
CO4	3	3	3	3	3		2	2	2		2	2	2
CO5	3	2	3	3	3		2	2	2		2	2	2
Avg.	**3**	**3**	**3**	**3**	**3**		**2**	**2**	**2**		**2**	**2**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC333	**ELECTRONIC DEVICES & CIRCUITS**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Course Objective:

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

- Describe a strong basis for building the Analog Electronic Circuits.
- Analyze the Low Frequency and High frequency Small Signal amplifier.
- Provide insights into multistage amplifiers and Differential amplifiers.
- Equip students with the ability to analyze and design feedback amplifiers & Oscillators
- Explain Photo Electronic Devices and Regulated Power Supplies..

Detailed Syllabus

UNIT I : SPECIAL DIODES & APPLICATIONS **9**

Special Diodes: Backward Diode, p-i-n photo Diode, Tunnel diode, Gunn Diode, IMPATT Diode-Avalanche Photodiode - Applications: Clipper, Clamper & Voltage Multipliers.

UNIT II AMPLIFIERS **9**

BJT small signal model: Analysis of CE, CB, CC amplifiers- Gain and frequency response – MOSFET small signal model: Analysis of CS, CG and Source follower – Gain and frequency response.

UNIT III MULTISTAGE AMPLIFIERS & DIFFERENTIAL AMPLIFIER **9**	
Cascade Amplifier, Cascode Amplifier, Differential Amplifier - Common mode and Differential Mode analysis -Tuned Amplifier -Neutralization Methods- Power Amplifier - Class A, Class B, Class AB & Class C.	
UNIT IV FEEDBACK AMPLIFIER & OSCILLATOR **9**	
Advantages of negative feedback – Voltage / Current, Series / Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators	
UNIT V PHOTOELECTRIC DEVICES **9**	
Photo emissivity - Photoelectric Theory - Photo Tubes - Applications of Photo devices – Multiplier Phototubes - Photoconductivity - The Semiconductor Photodiode- Multiple Junction Photodiodes - The Photovoltaic Effect.	
TOTAL: 45 PERIODS	

Sl.No.	**Practical – List of experiments**
1	Characteristics of Voltage Multipliers.
2	MOSFET Drain Current and Transfer Characteristics
3	Characteristics of Diode-Clipper Circuits.
Simulation using Multisim NS 12	
4	Gain & Frequency response of CE Amplifier
5	Gain & Frequency response of CS Amplifier
6	Cascade Amplifier Frequency response.
7	Wien bridge oscillator Frequency response
8	Current shunt Feedback Amplifier-Feedback on frequency response.
9	Simulation of Photo-Diode characteristics using MULTISIM 12
TOTAL: 30 PERIODS	

Learning Resources

1	Jacob Millman & Christos C. Halkias, “Electronic Devices and Circuits” ,4th Edition, October 2022.
2	David A. Bell, “Electronic Devices and Circuits”, Oxford Higher Education Press, 5th Edition, 2022.
3	Robert L. Boylestad and Louis Nasheresky, “ Electronic Devices and Circuit Theory”, 11th Edition , Person Education, 2018.
4	Adel.S. Sedra , Kenneth C.Smith, “Microelectronic Circuits: Theory and Applications”, oxford university, Pearson Education, 6th Edition, 2017.
5	Donald A. Neamen, “Electronic circuit Analysis and Design”, Tata McGraw Hill, 3rd Edition, 2010.



Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Experiment the structure and working operation of basic electronic devices.	Apply
CO2	Design and Analysis of Low frequency & High frequency small signal amplifiers.	Analyze
CO3	Analyze the response of Multistage Amplifiers and Differential amplifiers.	Analyze
CO4	Examine the behaviour of feedback amplifiers and oscillators.	Analyze
CO5	Develop photo electronic devices.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	2		2	2			2	2	2
CO2	3	2	2	3	2		2	2			2	2	2
CO3	3	3	3	2	2		2	2			2	2	2
CO4	3	3	2	3	2		2	2			2	2	2
CO5	3	2	3	2	2		2	2			2	2	2
Avg.	**3**	**2.6**	**2.6**	**2.6**	**2**		**2**	**2**			**2**	**2**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC343	**DIGITAL SYSTEMS DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**2**	**4**

Course Objective:

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

- Develop a strong foundation in number systems and Boolean algebra
- Enable students to design and implement combinational logic circuits
- Provide insights into synchronous sequential circuits
- Equip students with the ability to analyze and design asynchronous sequential circuits
- Explore logic families and programmable logic devices.

Detailed Syllabus

UNIT I : NUMBER SYSTEMS AND BOOLEAN ALGEBRA **9**

Boolean algebra- theorems, Logic expression minimization, sum of product and product of sum simplification, canonical forms min term and max term, Simplification of Boolean expressions using Karnaugh map, Implementation of Boolean expressions using universal gates.

UNIT II COMBINATIONAL LOGIC CIRCUITS **9**

Combinational circuits Introduction, Half and Full Adders, Binary Adder – Carry look ahead Adder, BCD Adder, Magnitude Comparator, Decoder, Encoder, Priority Encoder, Multiplexer, Demultiplexer, Implementation of logic functions using multiplexer, Parity Generator/Checker, Code-Converters.

UNIT III SYNCHRONOUS SEQUENTIAL CIRCUITS 9 Latches, Flip flops – SR, T, D, JK, Master Slave FF, Triggering of FF, Analysis and design of clocked sequential circuits – Design of Moore and Mealy models, state minimization, state assignment – Design of synchronous Counters, Ripple Counters, Ring Counters, Shift registers
UNIT IV ASYNCHRONOUS SEQUENTIAL CIRCUITS 9 Introduction to Asynchronous Sequential Circuits - Fundamental mode and pulse mode sequential circuits, Stable and Unstable States, State Reduction, Races and Cycles, Race-Free State Assignments, Hazards in Asynchronous Circuits - Design of hazard-free circuits, Essential Hazards.
UNIT V LOGIC FAMILIES AND PROGRAMMABLE LOGIC DEVICES 9 Introduction to Logic Families, Key Characteristics of Logic Families, Logic Family Types- RTL, TTL,ECL, CMOS, Comparison of Logic families, Low power Design considerations in logic families, Applications of Logic Families in Automotive and IoT. Implementation of Logic Circuits - Combinational logic and sequential logic design using standard ICs, Introduction to Programmable Logic Devices - Types and applications: PROM, PLA, and PAL, Basic Memory Concepts - Static ROM, PROM, EPROM and EEPROM, Introduction to HDL.
TOTAL: 45 PERIODS

Sl. No.	Practical – List of experiments
1	Verification of Boolean theorems
2	Design of adders.
3	Design of subtractors.
4	Design of code converters.
5	Design of Multiplexers.
6	Design of Demultiplexers.
7	Design of Encoders.
8	Design of Decoders.
9	Design of Magnitude Comparators
10	Parity Checker and Generator
11	Design and implementation of counters using flip-flops
12	Design and implementation of shift registers
13	Simulation of Half adder using Verilog HDL
14	Simulation of Full adder using Verilog HDL
	TOTAL: 30 PERIODS

Learning Resources

1	M. Morris Mano and Michael D. Ciletti, ‘Digital Design’, Pearson, 7th Edition, 2024
2	M. Morris Mano, ‘"Digital Logic and Computer Design", 2024
3	William Kleitz, "Digital Electronics: A Practical Approach with VHDL", (8th Edition) 2024

4	"Digital Systems: Principles and Applications" (13th Edition) by Ronald J. Tocci, Neal S. Widmer, and Gregory L. Moss 2024

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Experiment the conversion of number systems and Boolean algebra theorems	Apply
CO2	Design combinational logic circuits, including adders, multiplexers, and encoders	Apply
CO3	Construct synchronous sequential circuits and State machines using Moore and Mealy models	Apply
CO4	Examine the behavior of asynchronous sequential circuits to identify races, hazards, and stable states	Apply
CO5	Evaluate different logic families and programmable logic devices for circuit design	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2	2		2	2	2		2	3	2
CO2	3	2	3	2	2		2	2	2		2	3	2
CO3	3	2	2	2	2		2	2	2		2	3	2
CO4	3	2	2	2	2		2	2	2		2	3	2
CO5	3	2	2	2	2		2	2	2		2	3	2
Avg.	**3**	**2.2**	**2.4**	**2**	**2**		**2**	**2**	**2**		**2**	**3**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24EC411	Analog Integrated Circuits	PCC	3	0	0	3	3	40	60
2	U24EC421	Transmission Lines and Waveguides	PCC	3	1	0	4	4	40	60
3	U24EC431	Communication Systems	PCC	3	0	0	3	3	40	60
4	U24EM411	Aptitude and Reasoning - I	EEC	1	0	0	1	1	100	-
THEORY CUM PRACTICAL COURSES										
5	U24EC443	Digital Signal Processing	PCC	3	0	2	5	4	50	50
6	U24EC453	Internet of Things	PCC	1	0	4	3	3	50	50
PRACTICAL COURSES										
7	U24EC462	Analog Integrated Circuits Lab	PCC	0	0	4	4	2	60	40
8	U24EC472	Communication Systems Lab	PCC	0	0	4	4	2	60	40
9	U24EM422	Soft skill and Personality Development-1	EEC	0	0	2	2	1	100	-
				14	**1**	**16**	**31**	**23**		

ASSESSMENT SCHEME

Sl. No	Course Type	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24EC411	3	0	0	3	60	40	60	40	-	100		40	60	45	50
2	U24EC421	3	1	0	4	60	40	60	40	-	100		40	60	45	50
3	U24EC431	3	0	0	3	60	40	60	40	-	100		40	60	45	50
4	U24EM411	1	0	0	1	-	-	-	-	-	-	-	100	-	-	50
5	U24EC443	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
6	U24EC453	1	0	4	3	-	-	60	40	100	-	100	50	50	45	50
7	U24EC462	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50
8	U24EC472	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50
9	U24EM422	0	0	2	1	-	-	-	-	-	-	-	100	-	-	50

(W) - Weightage

U24EC411	ANALOG INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

Course Objective:

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

- Apply the basic concepts of operational amplifiers to analyze their functional characteristics.
- Demonstrate the practical applications of operational amplifiers in analog circuits.
- Analyze the operation of analog multipliers and phase-locked loops (PLLs) in system design.
- Implement the applications of A/D and D/A converters in signal processing.
- Analyze the performance of special function ICs for various electronic applications.

Detailed Syllabus

UNIT I BASICS OF OPERATIONAL AMPLIFIERS	**9**
Basic information about Op-amps: Symbol, Power Supply Connection - Ideal Operational Amplifier - Inverting Amplifier - Non-Inverting Amplifier - Voltage Follower - Differential Amplifier - Op-amp: Block Diagram, DC characteristics : Input Bias Current –Input offset current – input offset voltage, AC characteristics: Frequency response, Frequency Compensation, Slew rate - open and closed loop configurations.	
UNIT II APPLICATIONS OF OPERATIONAL AMPLIFIERS	**9**
Basic Op-amp Applications - Scale Changer/Inverter, Summing Amplifier, Subtractor, Differentiator, Integrator, Comparators, Instrumentation amplifier, Log and Antilog amplifier. V-to-I and I-to-V converters, Op-amp Circuit using diode: HWR- FWR – Peak Detector – clipper - Sample and Hold circuit, Schmitt trigger	
UNIT III ANALOG MULTIPLIER AND PLL	**9**
Analog Multiplier using Emitter Coupled Transistor Pair - Gilbert Multiplier cell – Variable transconductance technique, Operational Transconductance Amplifier (OTA), Analog multiplier ICs and their applications, PLL: basic principles, analysis, Voltage controlled oscillator, Monolithic PLL IC 565, PLL Application	
UNIT IV ANALOG TO DIGITAL AND DIGITAL TO ANALOG CONVERTERS	**9**
Basic DAC techniques - weighted resistor type, R-2R Ladder type, inverted R-2R Ladder DAC, A/D Converter - Flash type, Counter Type A/D converter, Servo Tracking A/D Converter, Successive Approximation type – Integrated type of ADC -Single Slope type, Dual Slope type, DAC/ADC Specifications.	
UNIT V SPECIAL FUNCTION ICS	**9**
Timer IC 555 - Functional Description, Monostable operation, Astable Multivibrator, IC Voltage regulators: fixed voltage series regulator - IC 723 general purpose regulator - Switching regulator, Frequency to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier, Isolation Amplifier, Opto-couplers and fibre optic IC.	
	TOTAL: 45 PERIODS

Learning Resources

1	Roy Choudhry D and Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 4th Edition, 2018.
2	Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", Tata McGraw-Hill, 4th Edition, 2015.
3	Ramakant A Gayakwad, "Op-Amp and Linear ICs", Prentice Hall I Pearson Education, 4th Edition, 2021

4	Salivahanan S and Kanchana Bhaskaran VS, "Linear Integrated Circuits", Tata McGraw Hill, 3rd Edition, 2018
5	IIT Madras, Prof. Aniruddhan S & Nagendra Krishnapura, "Analog IC Design" ,https://nptel.ac.in/courses/108106105?utm_source
6	IIT Madras, Prof. Shanti Pavan, "Analog Electronic Circuits" , https://nptel.ac.in/courses/108106188?utm_source

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the basic concepts of operational amplifiers to analyze their functional characteristics.	Apply
CO2	Demonstrate the practical applications of operational amplifiers in analog circuits.	Apply
CO3	Analyze the operation of analog multipliers and phase-locked loops (PLLs) in system design.	Analyze
CO4	Implement the applications of A/D and D/A converters in signal processing.	Apply
CO5	Analyze the performance of special function ICs for various electronic applications.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3				2	2			3	3
CO2	3	3	3	3	3			2	2		2	3	3
CO3	3	3	3	3				2	2			3	3
CO4	3	3	3	3				2	2			3	3
CO5	3	3	3	3				2	2			3	3
Avg.	**3**	**3**	**3**	**3**	**3**			**2**	**2**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC421	**TRANSMISSION LINES AND WAVEGUIDES**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Objective:

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

- Analyze the transmission line equations and their solutions to study propagation, reflection, and distortion phenomena.
- Evaluate high-frequency transmission line characteristics such as standing waves, VSWR, and input impedance under various terminations.

- Analyze impedance matching networks using quarter-wave transformers, stubs, and Smith chart methods for maximum power transfer.
- Analyze passive filter networks (constant-k and m-derived) to achieve desired frequency-selective characteristics.
- Analyze electromagnetic wave propagation in waveguides and develop solutions for TE, TM and TEM modes

Detailed Syllabus

UNIT I TRANSMISSION LINE THEORY	**12**
General theory of Transmission lines – the transmission line – general solution – The infinite line – Wavelength, velocity of propagation – Waveform distortion – the distortion-less line – Loading and different methods of loading – Line not terminated in Z0 – Reflection coefficient – calculation of current, voltage, power delivered and efficiency of transmission – Input and transfer impedance – Open and short circuited lines – reflection factor and reflection loss.	
UNIT II HIGH FREQUENCY TRANSMISSION LINES	**12**
Transmission line equations at radio frequencies – Line of Zero dissipation – Voltage and current on the dissipation-less line, Standing Waves, Nodes, Standing Wave Ratio – Input impedance of the dissipation-less line – Open and short circuited lines – Power and impedance measurement on lines – Reflection losses – Measurement of VSWR and wavelength.	
UNIT III IMPEDANCE MATCHING IN HIGH FREQUENCY LINES	**12**
Impedance matching: Quarter wave transformer – Impedance matching by stubs – Single stub and double stub matching – Smith chart – Solutions of problems using Smith chart – Single and double stub matching using Smith chart.	
UNIT IV PASSIVE FILTERS	**12**
Characteristic impedance of symmetrical networks – filter fundamentals, Design of filters: Constant K – Low Pass, High Pass, Band Pass, Band Elimination, m- derived sections – low pass, high pass composite filters.	
UNIT V WAVE GUIDES	**12**
General Wave behaviours along uniform Guiding structures, Transverse Electromagnetic waves, Transverse Magnetic waves, Transverse Electric waves, TM and TE waves between parallel plates, TM and TE waves in Rectangular wave guides, Bessel's differential equation and Bessel function, TM and TE waves in Circular wave guides, Rectangular and circular cavity Resonators.	
	TOTAL: 60 PERIODS

Learning Resources

1	David M. Pozar, "Microwave Engineering",4th Edition (2011).
2	Constantine A. Balanis, "Advanced Engineering Electromagnetics",3rd Edition (2024).
3	Robert E. Collin, "Foundations for Microwave Engineering",2nd Edition (1992).
4	G. L. Matthaei, Leo Young, E. M. T. Jones, Microwave Filters, Impedance-Matching Networks, and Coupling Structures, Reprint of 1964 / 1980 editions (Artech House).
5	NPTEL: Advances in UHV Transmission and Distribution,- https://onlinecourses.nptel.ac.in/noc25_ee141/preview
6	NPTEL: Microwave Engineering & Transmission Line Theory-Introduction to Electromagnetic Theory-https://onlinecourses.nptel.ac.in/noc25_ph41/preview

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Analyze the behavior of transmission lines under matched and mismatched conditions, including reflection losses and efficiency.	Analyze
CO2	Evaluate input impedance, power transfer, and VSWR in high-frequency transmission lines.	Evaluate
CO3	Analyze the impedance matching networks using single/double stub techniques and Smith chart.	Analyze
CO4	Analyze the passive filters (low-pass, high-pass, band-pass, band-stop) and composite filters.	Analyze
CO5	Analyze the TE, TM, and TEM wave propagation in rectangular and circular waveguides and cavity resonators for microwave applications.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3					2	2		2	3	3
CO2	3	3	3					2	2		2	3	3
CO3	3	3	3	3				2	2		2	3	3
CO4	3	3	3					2	2		2	3	3
CO5	3	3	3					2	2		2	3	3
Avg.	**3**	**3**	**3**	**3**				**2**	**2**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC431	COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

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

- Apply various modulation techniques to generate analog signals.
- Implement noise models for communication systems and their effects on signal transmission and reception.
- Illustrate pulse modulation techniques and their performance in digital communication systems.
- Analyze various digital modulation schemes for the effectiveness under varying channel conditions
- Evaluate various source and error control coding methods to enhance reliability and efficiency in digital communication systems

Detailed Syllabus

Unit I: ANALOG MODULATION **9**

Amplitude Modulation Systems-Switching modulator, Envelop detector, DSB- Ring modulator , Coherent detection, Costas Receiver, Quadrature carrier multiplexing , SSB and VSB modulations. Super heterodyne Receiver, Practical AM communication systems Angle Modulation, Representation of FM and PM signals, Generation of FM Signals – Direct method, indirect method, Demodulation of FM Signals.

Unit II: SAMPLING & NOISE MODELLING	**9**
Gaussian and white noise characteristics, Noise in amplitude modulation systems, Noise in Frequency modulation systems. Pre-emphasis and De-emphasis, Threshold effect in angle modulation. Low pass sampling – Aliasing- Signal Reconstruction-Quantization - Uniform & non-uniform quantization - quantization noise - Nyquist criterion- Logarithmic Companding.	
Unit III: PULSE MODULATION AND LINE CODING TECHNIQUES	**9**
Pulse Modulation Techniques - PAM, PPM, PWM, Pulse code Modulation, Noise considerations in PCM ,Differential pulse code modulation, Adaptive Differential Pulse Code Modulation, Delta modulation, Adaptive Delta Modulation, Line Coding Techniques.	
Unit IV: DIGITAL MODULATION SCHEME	**9**
Generation, detection and BER analysis of coherent BPSK, BFSK, QPSK, QAM - Carrier Synchronization - Structure of Non coherent Receivers - Generation and detection of BFSK and DPSK.	
Unit V: SOURCE AND ERROR CONTROL CODING	**9**
Entropy, Source encoding theorem, Shannon fano coding, Huffman coding, mutual information, channel capacity, Channel coding theorem - Linear Block Codes - Hamming codes - Cyclic codes - Convolutional codes and Viterbi decoding.	
TOTAL: 45 PERIODS	

Learning Resources

1	Simon Haykin; Michael Moher; Ganesh Prasad; Kiran Kumar Gurrala; Sateesh Kumar Awasthi; Shravan Kuma, “Introduction to Analog and Digital Communications, 2nd Edition, An Indian Adaptation Paperback- 6 January 2023.
2	B.P.Lathi, “Modern Digital and Analog Communication Systems”, 6th Edition, Oxford
3	George Kennedy, Bernard Davis, “Kennedy’s Electronic Communication Systems (SIE)”, 6th
4	B.Sklar, “Digital Communications Fundamentals and Applications”, 3rd Edition Pearson Education 2021.
5	IIT Kanpur- Prof. Aditya Jagannatham, “Principles of Communication Systems”, https://nptel.ac.in/courses/108104091
6	IIT Guwahati- “Simulation of communication Systems using MATLAB”- https://nptel.ac.in/courses/108103191

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply various modulation techniques to generate analog signals.	Apply
CO2	Implement noise models for communication systems and their effects on signal transmission and reception.	Evaluate
CO3	Illustrate pulse modulation techniques and their performance in digital communication systems.	Apply
CO4	Analyze various digital modulation schemes for the effectiveness under varying channel conditions	Analyze
CO5	Evaluate various source and error control coding methods to enhance reliability and efficiency in digital communication systems	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3					2	2		2	3	3
CO2	3	3	3					2	2		2	3	3
CO3	3	3	3					2	2		2	3	3
CO4	3	3	3					2	2		2	3	3
CO5	3	3	3					2	2		2	3	3
Avg.	**3**	**3**	**3**					**2**	**2**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EM411	APTITUDE AND REASONING – I	L	T	P	C
		1	0	0	1

Course Objective:

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

- Enhance analytical and logical reasoning skills to solve problems efficiently.
- Strengthen understanding of basic arithmetic, algebra, geometry, and data interpretation.
- Train students to approach problems systematically and apply suitable techniques.
- Foster quick thinking and reduce error rates through practice and time-bound exercises.

Detailed Syllabus

Topic titles
Quantitative aptitude 20 • Numbers: Number series, arithmetic progression, geometric progression • HCF and LCM: Highest common factor – split method, division method, Least Common Multiples – prime factor method, division method. • Simplification – BODMAS rule • Average and Percentage • Simple and Compound Interest • Profit, loss and discounts • Ratio and proportion: Ratio – compound ratio, inverse ratio. Proportion – direct proportion, inverse proportion • Mixture and alligation: Mixture, alligation, mean concentration • Problems based on ages • Partnerships: Simple partnership, compound partnership
Reasoning: 10 • Number series and letter series • Odd one out • Coding and decoding • Missing characters/numbers and analogies • Blood relations problems • Direction sense tests • Sequencing and ranking test
TOTAL: 30 PERIODS

Learning Resources

1	R.V. Praveen, “Quantitative Aptitude and Reasoning”, 3rd Edition , Eastern Economy Edition, PHI Learning, New Delhi, 2016
2	Dr. R.S. Aggarwal, “ Quantitative Aptitude”, S Chand Publishing, New Delhi 2017

3	Dr. R.S. Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", S Chand Publishing, New Delhi 2017
4	https://www.indiabix.com/
5	https://www.geeksforgeeks.org/
6	https://faceprep.in/
7	https://prepinsta.com/
8	https://www.javatpoint.com/

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Solve quantitative aptitude problems involving arithmetic, algebra, percentages, ratios, etc., using logical approaches.	Apply
CO2	Analyze problems and apply reasoning strategies such as deduction, inference, and pattern recognition.	Analyze
CO3	Solve problems in simple and compound interest, profit, loss and discount	Apply
CO4	Solve problems based on ages and partnership	Apply
CO5	Demonstrate improved performance in time-bound aptitude tests through consistent practice.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1								2	1		2		
CO2								2	1		2		
CO3								2	1		2		
CO4								2	1		2		
CO5								2	1		2		
Avg.								**2**	**1**		**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC443	DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	2	4

Course Objective:

After completing this course, the students will be able :

- Apply the Discrete Fourier Transform (DFT), analyze its properties, and implement its application to linear filtering.
- Examine the characteristics of digital filters, design and implement digital IIR filters, and apply them to suppress undesirable signals in specified frequency bands.
- Analyze the characteristics of digital filters, design and implement digital FIR filters, and apply them to remove unwanted signals across various frequency bands.
- Evaluate the effects of finite precision representation on the performance of digital filters.
- Analyze adaptive filters and apply them in communication engineering scenarios for noise cancellation and signal enhancement.

Detailed Syllabus

Unit I:DISCRETE FOURIER TRANSFORM	**9**
Review of Signals & Systems-Discrete Fourier transform (DFT) - deriving DFT from DTFT-Fast computation of DFT - Radix-2 Decimation-in-time (DIT) Fast Fourier transform (FFT), Decimation-in-frequency (DIF) Fast Fourier transform (FFT).Linear filtering using DFT. Filtering long data sequences – overlap save and overlap-add method.	
Unit II:INFINITE IMPULSE RESPONSE FILTERS	**9**
Characteristics of commonly used analog filters - Butterworth filters, Chebyshev Type-I filters. Design of IIR filters from analog filters (LPF, HPF, BPF, BRF) - Approximation of derivatives, Impulse invariance method, Bilinear transformation. Frequency transformation in the analog domain. Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations.	
Unit III:FINITE IMPULSE RESPONSE FILTERS	**9**
Analyze FIR filters - FIR filter design using windows (Rectangular, Hamming and Hanning window), Frequency sampling method. FIR filter structures - linear phase structure, direct form realizations.	
Unit IV:FINITE WORD LENGTH EFFECTS	**9**
Fixed point 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.	
Unit V:DSP PROCESSORS	9
Multirate signal processing: Decimation, Interpolation, Sampling rate conversion by a rational factor-DSP Architecture Fixed and Floating point architecture - principles, Instruction Set, Addressing Modes.	
	TOTAL: 45 PERIODS

List of Experiments

Sl. No	List of Experiments
	Using MATLAB :
1	Apply the Discrete Fourier Transform (DFT) to analyze Decimation-In-Time FFT and Decimation-In-Frequency FFT.
2	Compute the spectrum of the signal for the following techniques using the FFT method. i) Spectrum of single Sinusoid



	ii) Sum of two Sinusoid iii) Resolution iv) Picket Fence effect and v) Spectral Leakage
3	Implement the program for computing block convolution using overlap save method and overlap Add method.
4	Analyze signals using Auto correlation and cross correlation techniques to detect the stability test.
5	Design and evaluate FIR filter realizations using Butterworth and Chebhyshev types and widowing methods.
6	Design and implement IIR filters using Butterworth and Chebhyshev types.
7	Explore and apply multirate signal processing through convolution and m-fold decimation by polyphase decomposition.
8	Implement and assess PSD Estimator and Periodogram Estimation.
	TMS320C54X Processor Experiments:
9	Analyze DSP processor architecture to evaluate its role in accelerating real-time audio and video processing applications, such as mobile communication and multimedia devices.
10	Synthesize and apply standard test signals to simulate biomedical, speech, and radar environments, enabling validation of DSP system performance under practical conditions.
11	Implement and evaluate multiply–accumulate (MAC) operations with addressing techniques.

Learning Resources

1	John G. Proakis & Dimitris G.Manolakis, —Digital Signal Processing – Principles, Algorithms & Applications, Fifth Edition, Pearson Education / Prentice Hall, 2021.
2	Maurice Bellanger-Digital Signal Processing: Theory and Practice, Tenth Edition, Wiley Publications,2024
3	P. P. Vaidyanathan-Signals, Systems, and Signal Processing-1st Edition (2024),Cambridge University Press.
4	Andreas Antoniou- Digital Filters: Analysis, Design, and Signal Processing Applications,2nd Revised Edition,Mcgraw-Hill,2018.
5	IIT Delhi- Prof. S.C. Dutta Roy, “Digital Signal Processing Introduction”- https://nptel.ac.in/courses/117102060
6	IIT Bombay- Prof. V. M. Gadre, “Digital Signal Processing and its Applications”- https://onlinecourses.nptel.ac.in/noc24_ee16/preview

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply DFT for the analysis of digital signals and systems.	Apply
CO2	Examine the characteristics of IIR Filters.	Analyze
CO3	Analyze FIR Filter structures.	Analyze
CO4	Compute the effects of finite representation on digital filters.	Apply
CO5	Estimate Multi-Rate Signal Processing.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3			2	2	2	2	2	3	3
CO2	3	3	3	3			2	2	2	2	2	3	3
CO3	3	3	3	3			2	2	2	2	2	3	3
CO4	3	3	3	3			2	2	2	2	2	3	3
CO5	3	3	3	3	3		2	2	2	2	2	3	3
Avg.	**3**	**3**	**3**	**3**	**3**		**2**	**2**	**2**	**2**	**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC453	INTERNET OF THINGS	L	T	P	C
		1	0	4	3

Course Objective:

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

- Analyze the architecture, components, and characteristics of IoT systems and their applications.
- Examine the hardware and software features of Arduino and Raspberry Pi for IoT-based implementations.
- Evaluate the operation and interfacing of various sensors used in IoT environments.
- Analyze and implement sensor integration using Arduino and Raspberry Pi with appropriate communication protocols.
- Analyze real-time IoT case studies and assess the potential of IoT solutions in various application domains

Detailed Syllabus

Unit I: INTRODUCTION TO IOT & ARDUINO **3**

Introduction to IoT – Fundamentals and characteristics of IoT - IoT architecture and components - Applications and challenges of IoT - Introduction to Arduino board and features - Arduino programming environment and basic syntax.

Unit II: RASPBERRY PI	**3**
Introduction to Raspberry Pi board and models - Hardware architecture and GPIO pins - Installing and configuring Raspbian OS - Basics of Python programming for Raspberry Pi - Interfacing input/output devices with Raspberry Pi.	
Unit III: SENSORS	**3**
Introduction and need for sensors in IoT - Classification of sensors – active and passive - - Analog and digital sensors – working principles - Ultrasonic sensor: operation and interfacing - Temperature and humidity sensor: operation and interfacing.	
Unit IV: SENSOR INTEGRATION AND CLOUD PLATFORM	**3**
Sensor data acquisition using Arduino & Raspberry Pi - Data communication protocols – MQTT & HTTP - IoT cloud platforms Overview: ThingSpeak, Blynk, AWS IoT - Uploading sensor data to cloud - Real-time monitoring and data visualization.	
Unit V: CASE STUDIES	**3**
Smart home automation using IoT - Smart city applications and traffic monitoring - IoT-based environmental monitoring system - Smart agriculture and irrigation system - Industrial IoT applications - Future trends and challenges in IoT.	
TOTAL: 15 PERIODS	

List of Experiments

Sl. No	List of Experiments
1	Develop a program on the Arduino platform to control an LED.
2	Control an LED or relay using Python on Raspberry Pi.
3	Interfacing sensors with Arduino.
4	Interfacing sensors with Raspberry Pi.
5	Setup a cloud platform to log the data.
6	**Mini Projects: Design an IOT based system.** 1. Smart Home Automation using IoT 2. IoT-based Smart Agriculture System 3. IoT-based Environmental Monitoring System 4. IoT-based Smart Parking System 5. IoT-based Industrial Application System 6. IoT-based EV Charging & Fleet Monitoring System
	Total Periods: 60

Learning Resources

1	Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A Hands-On Approach”, Universities Press / VPT Publication, 2nd Edition, 2021.
2	Bharat Bhushan, “Internet of Things: Technologies and Applications for a New Age of Intelligence”, Elsevier Publication,2nd Edition, 2024
3	Peter Waher, “ Mastering the Internet of Things: Design and Deploy Solutions Using IoT Platforms” ,Packt Publishing,2nd Edition, 2023

4	David Hanes et al., "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, First Edition 2022.
5	IIT Kharagpur- Prof. Sudip Misra, " Introduction to Internet of Things"- https://nptel.ac.in/courses/106105166
6	IIT Patna- Prof. Sanjoy Kumar Parida , "Components and Applications of Internet of Things" - https://onlinecourses.swayam2.ac.in/arp19_ap52/preview

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Analyze an IoT system architecture by integrating hardware and software components for real-world applications.	Analyze
CO2	Create IoT devices with Raspberry Pi and Python Programming.	Create
CO3	Integrate multiple sensors with Arduino and Raspberry Pi using appropriate communication protocols to create functional IoT prototypes.	Evaluate
CO4	Develop cloud-enabled IoT systems for real-time data monitoring and visualization.	Create
CO5	Design IoT-based solutions for domains such as smart homes, agriculture, industries, and environment monitoring.	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3			2	3	3		2	3	3
CO2	3	3	3	3		3	2	3	3	3	2	3	3
CO3	3	3	3	3		3	2	3	3	3	2	3	3
CO4	3	3	3	3		3	2	3	3	3	2	3	3
CO5	3	3	3	3	3	3	2	3	3	3	2	3	3
Avg.	**3**	**3**	**3**	**3**	**3**	3	**2**	**3**	**3**	**3**	**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC462	ANALOG INTEGRATED CIRCUITS LABORATORY	L	T	P	C
		0	0	4	2

Course Objective:

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

- Demonstrate the characteristics of amplifiers and filters using operational amplifiers.
- Analyze the characteristics of multivibrators through circuit evaluation.
- Implement wave-shaping circuits using ICs for practical applications.
- Evaluate the functionality of special function ICs in electronic systems.
- Apply PSPICE software for circuit design and verification

List of Experiments

Sl. No	List of Experiments
1	Design and test Inverting, Non-Inverting and Differential Amplifiers.
2	Develop an instrumentation amplifier to measure the output.
3	Implement an integrator circuit to generate a triangular wave from a square wave, and a differentiator to detect sharp edges in pulse signals.
4	Design a low-pass filter to remove high-frequency noise from an audio input, and a high-pass filter to pass only treble sounds.
5	Design and implement Astable and Monostable Multivibrators.
6	Apply a Schmitt Trigger to convert a noisy sine wave into a clean digital square wave
7	Design a regulated 5V DC power supply to operate digital ICs.
8	Construct an R-2R ladder DAC to generate a staircase waveform for simple digital-to-analog conversion.
Simulation Experiments:	
1	Measurement and verification of Inverting, Non-Inverting and Differential Amplifiers.
2	Implementation of Integrator and Differentiator
3	Determine the cutoff frequency by measuring output amplitude at different input frequencies.
4	Measure the output frequency of Astable and Monostable Multivibrators.
5	Record the Output voltage of Schmitt Trigger and note the hysteresis effect.
	Total Periods: 60

Learning Resources

1	Roy Choudhry D and Shail Jain, "Linear Integrated Circuits", New Age International Pvt. Ltd., 4th Edition, 2018.
2	Sergio Franco, "Design with Operational Amplifiers and Analog Integrated Circuits", Tata McGraw-Hill, 4th Edition, 2015.
3	Ramakant A Gayakwad, "Op-Amp and Linear ICs", Prentice Hall I Pearson Education, 4th Edition, 2015

4	Salivahanan S and Kanchana Bhaskaran VS, "Linear Integrated Circuits", Tata McGraw Hill, 2nd Edition, 61h Reprint, 2010.
5	IIT Madras- Prof. Nagendra Krishnapura- "Analog Integrated Circuit Design" - - http://www.digimat.in/nptel/courses/video/117106030/L28.html

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Analyze the characteristics of amplifiers and filters using operational amplifiers.	Analysing
CO2	Analyze the characteristics of multivibrators through circuit evaluation.	Analysing
CO3	Implement wave-shaping circuits using ICs for practical applications.	Applying
CO4	Evaluate the functionality of special function ICs in electronic systems.	Evaluating
CO5	Apply PSPICE software for circuit design and verification.	Applying

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3			2	2	2			3	3
CO2	3	3	3	3			2	2	2			3	3
CO3	3	3	3	3			2	2	2		2	3	3
CO4	3	3	3	3			2	2	2		2	3	3
CO5	3	3	3	3	2	2	2	2	2	2	2	3	3
Avg.	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC472	**COMMUNICATION SYSTEMS LABORATORY**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Course Objective:

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

- Demonstrate AM and FM modulation and demodulation techniques.
- Illustrate the effects of sampling and Time Division Multiplexing (TDM).
- Apply the concepts of Pulse Code Modulation (PCM) and digital modulation.
- Simulate various digital modulation schemes using appropriate tools.
- Implement equalization algorithms and error control coding schemes.

List of Experiments

Sl. No	List of Experiments
1	Apply the concept of Amplitude modulation and process by using envelope detection for recovering the original message.

2	Apply the FM modulation and demodulation technique to transmit and retrieve the information signal.
3	Implementing the pre-emphasis and de-emphasis circuit to improve the signal-to-noise ratio.
4	Apply the sampling theorem for continuous-time signals.
5	Demonstrate the multiplexing of multiple signals using TDM technique.
6	Demonstrate the encoding and decoding of an analog signal using PCM.
7	Apply a modulation and demodulation method using PAM.
8	Apply a modulation and demodulation method using PWM and PPM.
	Simulation Experiments:
1	Implement ASK, PSK and FSK modulation and demodulation schemes for digital data transmission.
2	Demonstrate the simulation of DPSK, QPSK, and QAM modulated signals.
3	Implement a linear block coding scheme and its error detection capability.
4	Apply cyclic coding techniques for error correction in a digital system
	Total Periods: 60

Learning Resources

1	Simon Haykin; Michael Moher; Ganesh Prasad; Kiran Kumar Gurrala; Sateesh Kumar Awasthi; Shravan Kuma, “Introduction to Analog and Digital Communications, 2nd Edition, An Indian Adaptation Paperback- 6 January 2023.
2	B.P. Lathi, “Modern Digital and Analog Communication Systems”, 6th Edition, Oxford University Press, 2025.
3	George Kennedy, Bernard Davis, “Kennedy’s Electronic Communication Systems (SIE)”, 6th edition, 2017.
4	B. Sklar, “Digital Communications Fundamentals and Applications”, 3rd Edition Pearson Education 2021.
5	IIT Kanpur- Prof. Aditya Jagannatham, “Principles of Communication Systems”, https://nptel.ac.in/courses/108104091
6	IIT Guwahati- “Simulation of communication Systems using MATLAB”- https://nptel.ac.in/courses/108103191

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Demonstrate the process of AM and FM modulation and demodulation in communication systems.	Apply
CO2	Illustrate the practical effects of sampling and Time Division Multiplexing.	Apply

CO3	Apply the principles of Pulse Code Modulation and digital modulation techniques.	Apply
CO4	Simulate digital modulation schemes using appropriate simulation tools.	Apply
CO5	Implement equalization algorithms and error control coding schemes in digital communication systems.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3				2	2	2		3	3	3
CO2	3	3	3				2	2	2			3	3
CO3	3	3	3				2	2	2			3	3
CO4	3	3	3		3		2	2	2			3	3
CO5	3	3	3	3		2	2	2	2	3		3	3
Avg.	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**3**	**3**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EM422	SOFT SKILLS AND PERSONALITY DEVELOPMENT – I	L	T	P	C
		0	0	2	1

Course Objective:

After completing this course, the students will be able :

- To understand and interpret human perception and behavior, enhancing interpersonal awareness.
- To enhance self-management, including habit formation, stress regulation, and personal productivity
- Develop conflict-resolution skills, aiming for win-win outcomes through structured strategies.
- Strengthen communication abilities—active listening, telephone etiquette, and overcoming listening barriers

List of Experiments

Sl. No	List of Experiments
1	Introduction: A New Approach to Learning, Planning and Goal-Setting
2	Human Perceptions: Understanding People
3	Aiming for Excellence: Developing Potential and Self-Actualisation
4	Self-Management Skills- Time management & Self-motivation
5	Self-Management Skills- Stress management & Adaptability
6	Conflict Resolution Skills

7	Using The Zeigarnik Effect for Productivity and Personal Growth, Forming Habits of Success
8	Communication: Significance of Listening, Active Listening, Barriers to Active Listening
9	Telephone Communication: Basic Telephone Skills, Advanced Telephone Skills , Essential Telephone Skills
10	Profile Building
	Total Periods: 30

Learning Resources

1	Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2	Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3	Klaus, Peggy, Jane Rohman & Molly Hamaker. The Hard Truth about Soft Skills. London: HarperCollins E-books, 2007.
4	Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Develop an actionable growth plan aligning self-development with objectives.	Apply
CO2	Analyze the habit loop; design personal interventions to break bad habits.	Analyze
CO3	Analyze examples of interpersonal conflict, propose dual solutions using conflict-model frameworks.	Analyze
CO4	Apply stress-management strategies: reframing, planning, relaxation exercises.	Apply
CO5	Apply techniques to rectify the barriers in active listening	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1								1	2		2		
CO2								1	2		2		
CO3								1	2		2		
CO4								1	2		2		
CO5								1	2		2		
Avg.								**2**	**2**		**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24EC511	Antenna and Wave Propagation	PCC	3	1	0	4	4	40	60
2	U24EC521	Data Communication and Networks	PCC	3	0	0	3	3	40	60
3	U24EC531	Digital VLSI Design	PCC	3	0	0	3	3	40	60
4	U24EM511	Aptitude and Reasoning - II	EEC	1	0	0	1	2	100	-
5	U24MG511	Leadership and Team Management	EEC	2	0	0	2	2	100	-
6		Professional Elective-I	PEC					3		
7		Professional Elective-II	PEC					3		
PRACTICAL COURSES										
8	U24EC542	VLSI Design Laboratory	PCC	0	0	4	4	2	60	40
9	U24EM312	Design Thinking and Innovation	EEC	0	0	2	2	1	100	-
10	U24EM522	Soft skill and Personality Development - II	EEC	0	0	2	2	1	100	-
				12	**1**	**8**		**24**		

ASSESSMENT SCHEME

Sl. No	Course Type	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24EC511	3	1	0	4	60	40	60	40	-	100	-	40	60	45	50
2	U24EC521	3	0	0	3	60	40	60	40	-	100	-	40	60	45	50
3	U24EC531	3	0	0	3	60	40	60	40	-	100	-	40	60	45	50
4	U24EM511	1	0	0	1	-	-	-	-	-	-	-	100	-	-	50
5	U24MG511	2	0	0	2	60	40	60	40	-	100	-	40	60	45	50
6	PEC 1															
7	PEC 2															
8	U24EC542	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50
9	U24EM312	0	0	2	1	-	-	-	-	-	-	-	100	-	-	50
10	U24EM522	0	0	2	1	-	-	-	-	-	-	-	100	-	-	50

(W) - Weightage

U24EC511	ANTENNA AND WAVE PROPAGATION	L	T	P	C
		3	1	0	4

Course Objective:

After completing this course, the students will be able,

- To understand the physical concepts of antenna radiation, near and far-field regions, radiation patterns, and the influence of antenna parameters such as gain, efficiency, and impedance matching on performance.
- To apply the principles of antenna arrays, including linear, binomial, and phased arrays, for beam shaping and directional communication applications.
- To comprehend and interpret the operation, design, and characteristics of aperture, horn, reflector, slot, and micro strip antennas using analytical and numerical methods.
- To compare the structure, radiation mechanisms, and applications of special antennas such as, Helical, and ,Franklin Antenna, MIMO Antenna for various frequency bands.
- To explain and apply the concepts of radio wave propagation through different modes-ground, sky, and duct.

Detailed Syllabus

Unit I ANTENNA BASICS	**12**
Physical concept of radiation, Near- and far-field regions, Fields and Power Radiated by an Antenna, Antenna Pattern Characteristics, Antenna Gain and Efficiency, Aperture and Effective Area, Antenna Noise Temperature and G/T, Impedance matching, VSWR.	
Unit II ANTENNA ARRAYS	**12**
Two-point Element Antenna array, Horizontal patterns in broadcast array, Linear array, Multiplication of patterns array, Concept of Phased arrays, Adaptive array, Binomial array	
Unit III APERTURE AND SLOT ANTENNAS	**12**
Radiation from rectangular apertures, Uniform and Tapered aperture, Horn antenna , Reflector antenna, Slot antennas , Numerical tool for antenna analysis	
Unit IV SPECIAL ANTENNAS	**12**
Turnstile Antenna, Helical Antenna- Axial mode helix, Normal mode helix, Spiral Antenna, Microstrip Patch Antennas, Franklin Antenna, MIMO Antenna.	
Unit V PROPAGATION OF RADIO WAVES	**12**
Modes of propagation, Structure of the atmosphere, Ground wave propagation, Tropospheric propagation, Duct propagation, Troposcatter propagation, Sky wave propagation – Critical frequency, Maximum usable frequency (MUF), propagation. Case study: Analysis of radio wave propagation effects in 4G/5G mobile communication networks	
	Total Periods: 60

Learning Resources

1	Constantine A. Balanis, “Antenna Theory: Analysis and Design”, 4th Edition, Wiley, 2016.
2	E. C. Jordan and K. G. Balmain, “Electromagnetic Waves and Radiating Systems”, Pearson Education / PHI, 2006.

3	John D. Kraus, Ronald J. Marhefka and Ahmad S. Khan, "Antennas for All Applications", 3rd Edition, McGraw-Hill, 2007.
4	K. D. Prasad and Satya Prakash, "Antenna and Wave Propagation", 4th Edition, Tech-Max, Publications, 2018.
5	NPTEL Course : Antenna Theory -https://nptel.ac.in/courses/108105116
6	NPTEL Course :Electromagnetic Waves -https://nptel.ac.in/courses/117101056

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the fundamentals of antenna radiation concepts, field regions, parameters and impedance matching	Apply
CO2	Apply the principles of antenna arrays for pattern formation and beam control	Apply
CO3	Apply the design and applications of aperture, slot, and microstrip antennas	Apply
CO4	Compare characteristics and uses of special antennas for various communication needs.	Understand
CO5	Analyze modes of radio wave propagation and their effects on signal transmission	Analyze

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC521	DATA COMMUNICATION AND NETWORKS	L	T	P	C
		3	0	0	3

Course Objective:

The student should be made:

- To apply the fundamental networking concepts and architectures in designing and understand computer communication systems.
- To analyze the Data Link Layer functions such as framing, error control, and flow control using standard protocols.
- To analyze Network Layer protocols and routing algorithms for efficient data delivery across networks.
- To demonstrate the working principles of Transport Layer protocols (UDP and TCP) and compare their performance in various network scenarios.
- To apply the network security techniques and mechanisms to safeguard the data integrity, confidentiality, and authentication in communication networks

Detailed Syllabus

Unit I DATA COMMUNICATIONS	**9**
Components, Direction of data flow, Networks, Types of connections, Topologies, Protocols and standards, OSI and TCP/IP models. Introduction to modern networking concepts: Software Defined Networking (SDN) and Cloud networking basics.	
Unit II DATA-LINK LAYER & MEDIA ACCESS	**9**
Introduction, Link-layer addressing, DLC services, Data-link layer protocols: HDLC, PPP, Media access control, Wired LANs: Ethernet, Wireless LANs: IEEE 802.11, Bluetooth, Connecting devices. Basics of IoT communication protocols: MQTT and CoAP.	
Unit III NETWORK LAYER	**9**
Network layer services, Packet switching, Performance, IPv4 addresses, Forwarding of IP packets, Network layer protocols: IP, ICMPv4, Unicast routing algorithms. Overview of 5G core networking architecture and its role in next-generation networks.	
Unit IV TRANSPORT LAYER	**9**
Introduction to transport layer protocols, User Datagram Protocol (UDP) and Transmission Control Protocol (TCP), Services and features, TCP connection, State transition diagram, Flow control, Error control, Congestion control, Congestion avoidance techniques (DECbit, RED), Quality of Service (QoS), Application requirements	
Unit V SECURITY LAYER	**9**
Network layer security: IPSec, Emerging security mechanisms; Transport layer security: SSL/TLS, SSH; Application layer security: PGP; Firewall concepts – Architecture, Packet filtering, Proxy services; Blockchain in networking (basic concepts) and basic cyber-attack case studies.	
	Total Periods:45

Learning Resources

1	Behrouz A. Forouzan, Data Communications and Networking, 6th Edition, McGraw-Hill, 2022.
2	William Stallings, Network Security Essentials: Applications and Standards, 5th Edition, Pearson Education, 2014.
3	Andrew S. Tanenbaum, Computer Networks, 6th Edition, Pearson Education / PHI, 2022.
4	W. A. Shay, Understand Communications and Networks, 3rd Edition, Cengage Learning.
5	NPTEL Course : Computer Networks -https://nptel.ac.in/courses/106101160
6	NPTEL Course : Computer Networks and Internet Protocol -https://nptel.ac.in/courses/106105183

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Analyze and explain the fundamental concepts of data communications	Analyze
CO2	Develop and implement data link layer protocols for reliable communication.	Apply

CO3	Design and implement network layer protocols for efficient data transmission.	Apply
CO4	Analyze the functioning and performance of TCP and UDP transport protocols.	Analyze
CO5	Apply the principles and mechanisms of network security.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	1					1		2	2
CO2	3	2	3	2	2				1	1		3	2
CO3	3	2	3	3	2				1	1		3	3
CO4	2	3	3	3	2				1	1		3	3
CO5	2	2	3	3	3	1	2	1		1		3	3
Avg.	**2.6**	**2.2**	**2.2**	**2.4**	**2**	**1**	**2**	**1**	**1**	**1**		**2.8**	**2.6**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC531	DIGITAL VLSI DESIGN	L	T	P	C
		3	0	0	3

Course Objective:

The student should be able to,

- Analyze MOS transistor characteristics and CMOS logic behavior to understand the impact of device structure, non-ideal effects, and technology scaling on circuit performance.
- Design efficient combinational logic circuits by Apply delay models, layout rules, power optimization techniques, and logic implementation styles.
- Analyze sequential circuits and clocking strategies to meet timing requirements in synchronous and self-timed digital systems.
- Develop data path and memory subsystems by modeling interconnect effects and Apply optimized arithmetic and storage architectures.
- Apply ASIC design flow and testing methods to verify functionality and ensure testability using scan, BIST, and boundary scan techniques.

Detailed Syllabus

UNIT I MOS TRANSISTOR PRINCIPLES **9**

MOS Transistor Theory–Structure, Long Channel IV Characteristics, Non-ideal IV effects, C-V Characteristics, Pass Transistor Logic, CMOS Logic Design, CMOS DC characteristics, CMOS Transmission Gates, Technology Scaling and FinFETs – Structure & operation.

UNIT II COMBINATIONAL LOGIC DESIGN **9**

Propagation Delay – RC Delay model, Linear Delay model and Logic Effort, Layout Design Rules –Stick diagram and Layouts, Combinational Circuit design – Static Logic, Ratioed Logic, Cascode Voltage Switch Logic, Dynamic Circuits, Power Consumption in CMOS circuits, Low Power Architectures.

UNIT III SEQUENTIAL LOGIC DESIGN AND CLOCKING STRATEGIES **9** Static Latches and Registers, Dynamic Latches and Registers, Pulse Registers, Sense-Amplifier Based Registers, Pipelines, Non-bistable Sequential Circuits, Timing Classification of Digital Systems, Synchronous Interconnect, Synchronous Design, Self-Timed Circuit Design.
UNIT IV INTERCONNECT,DATAPATH SUBSYSTEMS AND MEMORY ARCHITECTURE **9** Interconnect – Wire Modelling, Interconnect modelling - Capacitance, Resistance, and Inductance, Adders – Single bit adder, Ripple Carry Adder, Carry Generation and Propagation - Carry Look ahead adder, Carry-Skip Adder, Multiplier – Array multiplication comparators, Shifters, FPGA, Memory Architectures and Building Blocks, Memory Peripheral Circuitry.
UNIT V ASIC DESIGN, VERIFICATION AND TESTING **9** ASIC Design Flow, Introduction to ASICs – Types, Introduction to System on Chip Design, Introduction to test benches - Writing test benches in Verilog HDL, Manufacturing Test Principles, Design for Testability – Ad Hoc, Scan design, Built-In Self-Test, IDDQ Test, Boundary Scan.
Total Periods:45

Learning Resources

1	Neil H.E Weste, David Money Harris “CMOS VLSI Design: A Circuits and Systems perspective”, Pearson, 2020
2	Samir Palnitkar, Verilog HDL - “A Guide to Digital Design and Synthesis IEEE 1364-2001 Compliant”, Pearson, 2020
3	R. Jacob Baker, “CMOS: Circuit Design, Layout, and Simulation”, 4th Edition, Wiley–IEEE Press, 2019.
4	Sung-Mo, Kang and Yusuf Leblebici, “CMOS Digital Integrated Circuits: Analysis and Design”, 4th Edition, McGraw Hill Education, 2014.
5	John P. Uyemura, “Introduction to VLSI Circuits and Systems”, Wiley India, 2002.
6	CMOS Digital VLSI Design : https://onlinecourses.nptel.ac.in/noc26_ee85/
7	Digital IC Design : https://onlinecourses.nptel.ac.in/noc26_ee70/

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Apply the characteristics and operation of MOS transistors and apply MOS principles in CMOS logic design.	Apply
CO2	Explain CMOS combinational logic circuits using static, dynamic, and low power design techniques.	Understand
CO3	Analyze sequential logic circuits and clocking strategies for synchronous and asynchronous systems	Analyze
CO4	Illustrate data path components and memory architectures and peripheral circuits.	Apply
CO5	Analyze ASIC design methodologies and testing strategies for ensuring design reliability.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	2	1					1	3	1
CO2	2	2	2	2	1	1					1	3	1
CO3	3	2	2	2	2	2					2	3	1
CO4	3	3	2	3	2	1					1	1	1
CO5	3	3	3	3	2	2					3	2	3
Avg.	**2.8**	**2.6**	**2.4**	**2.6**	**1.8**	**1.4**					**1.6**	**2.4**	**1.4**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EM511	Aptitude and Reasoning – II	L	T	P	C
		2	0	0	2

Course Objective:

- Enhance analytical and logical reasoning skills to solve problems efficiently.
- Strengthen Understand of basic arithmetic, algebra, geometry, and data interpretation.
- Train students to approach problems systematically and apply suitable techniques.
- Foster quick thinking and reduce error rates through practice and time-bound exercises**.**
- Understand data interpretation using bar chart, pie chart and table chart.

Syllabus topics

Topic titles	No of periods
• Quantitative aptitude • Time and work • Pipes and Cistern • Chain Rule and wages • Time speed and distance • Train problems • Boats and streams • Races and games • Permutations and Combinations • Probability • Heights and distance • Logarithms • Surds and indices • Mensuration – 2D, 3D • Date interpretation – pie chart, bar chart, table chart. Data sufficiency in logical reasoning	20

Reasoning: • Symbols and notations • Mathematical operators and Venn diagrams • Puzzles • Cubes and Dice • Clocks and Calendars • Critical Reasoning • Non-verbal reasoning • Verbal Ability	10

Learning Resources

1	R.V. Praveen, "Quantitative Aptitude and Reasoning", 3rd Edition , Eastern Economy Edition, PHI Learning, New Delhi, 2016
2	Dr. R.S. Aggarwal, " Quantitative Aptitude", S Chand Publishing, New Delhi 2017
3	Dr. R.S. Aggarwal, "A Modern Approach to Verbal & Non-Verbal Reasoning", S Chand Publishing, New Delhi 2017
4	https://www.indiabix.com/
5	https://www.geeksforgeeks.org/
6	https://faceprep.in/
7	https://prepinsta.com/
8	https://www.javatpoint.com/

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Solve quantitative aptitude problems involving time & work, chain rule and wages etc., using logical approaches.	Apply
CO2	Analyze problems and apply reasoning strategies such as deduction, inference, and pattern recognition.	Analyze
CO3	Solve problems on data interpretation, including bar charts, pie charts, tables, and graphs.	Apply
CO4	Solve problems in probability, height and distance and logarithms logically	Apply
CO5	Demonstrate improved performance in time-bound aptitude tests through consistent practice.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1								2	1		2		
CO2								2	1		2		
CO3								2	1		2		
CO4								2	1		2		
CO5								2	1		2		
Avg.								**2**	**1**		**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MG511	LEADERSHIP AND TEAM MANAGEMENT	L	T	P	C
		2	0	0	2

Course Objective:

After completing this course, the students will be able ,

- To introduce students to fundamental leadership theories, models, and frameworks for understanding leadership effectiveness.
- To develop the ability to analyze leadership styles, personality traits, emotional intelligence, and ethical values in organizational contexts.
- To enhance students' competence in evaluating leadership behavior, decision-making, and crisis management in diverse environments.
- To equip students with skills to lead groups and teams through effective communication, delegation, conflict management, and motivation.
- To enable students to design and apply strategies for developing high-performance, multicultural, and virtual teams using contemporary leadership practices.

Detailed Syllabus

UNIT I INTRODUCTION TO LEADERSHIP & TEAM MANAGEMENT **6**

Leadership Myths; Interactional Framework for analyzing leadership; Leadership Development: The First 90 Days as a Leader; Leader Development- The Action-Observation-Reflection Model. LMX Theory and Normative Decision Model; Situational Leadership Model; Contingency Model and Path Goal Theory.

UNIT II LEADERSHIP TYPES AND ATTRIBUTES **6**

Emotional Approach Charismatic and Transformational Leadership; Leadership for Tomorrow, Leadership Attributes; Personality Traits and Leadership; Personality Types and Leadership; Intelligence and Leadership; Emotional Intelligence and Leadership. Power and Leadership; The art of influence in leadership; Leadership and "Doing the Right Things; Character-Based Approach to Leadership; Role of Ethics and Values in Organisational Leadership

UNIT III LEADERSHIP BEHAVIOUR **6**

Leadership Behaviour, Assessing Leadership Behaviour: Multi-rater feedback instruments, The Dark Side of Leadership -Destructive Leadership, Managerial Incompetence and Derailment, Negotiation and Leadership, Leadership in Crisis Situation, The Situation and The Environment, Culture and Leadership, Global Leadership, Motivation and Leadership

UNIT IV INTRODUCTION TO GROUPS AND TEAMS **6**

Characteristics of Leaders, Followers and Situation, Group Dynamics, Team Formation, Delegation and Empowerment, Leading Teams: Enhancing Teamwork Within a Group, The Leader's Role in Team-Based Organizations, Leader Actions That Foster Team Effectiveness, Offsite Training and Team Development, Understanding Team Processes and Team Coaching, Team Decision Making and Conflict Management, Virtual Teams

UNIT V MANAGING MULTICULTURAL TEAMS **6**
Building Great Teams, Experiential Learning, Action Learning, Developmental Planning: Gaps Analysis, Coaching and Mentoring, Women in Leadership Roles, Building Effective Relationship with Subordinates and Peers, Fostering Followers Satisfaction, The Art of Communication, Setting Goals and Providing Constructive Feedback, Enhancing Creativity Problem Solving Skill, Building High-Performance Teams: The Rocket Model, Building Credibility and Trust, Skills for Developing others.
Total Periods:30

Learning Resources

1	Peter G. Northouse, “Leadership: Theory and Practice”, 8th Edition, Sage Publications, 2019.
2	Stephen P. Robbins and Timothy A. Judge, “Organizational Behavior”, 18th Edition, Pearson Education, 2019.
3	Robert N. Lussier and Christopher F. Achua, “Leadership: Theory, Application, and Skill Development”, 6th Edition, Cengage Learning, 2016.
4	Jon R. Katzenbach and Douglas K. Smith, “The Wisdom of Teams”, Harvard Business School Press, 2005.
5	Daniel Goleman, “Emotional Intelligence”, Bantam Books, 2006.
6	Leadership and Team Effectiveness, Dr. Santosh Rangnekar, IIT Roorkee (NPTEL Course) https://onlinecourses.nptel.ac.in/noc22_mg39/preview

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain and compare major leadership theories, models, and frameworks.	Understand
CO2	Describe leadership styles, attributes, personality, and emotional intelligence in organizational situations.	Understand
CO3	Discuss leadership behavior, ethics, power, and decision-making in complex and crisis situations.	Understand
CO4	Illustrate leadership principles to manage groups, teams, conflicts, and motivation effectively.	Understand
CO5	Explain leadership development and team-building strategies for high-performance, multicultural, and virtual teams.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	1							2	2	2	2		
CO2	1							2	2	2	2		
CO3	1							2	2	2	2		
CO4	1							2	2	2	2		
CO5	1							2	2	2	2		
Avg.	**1**							**2**	**2**	**2**	**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC542	VLSI DESIGN LABORATORY	L	T	P	C
		0	0	4	2

Course Objective:

The student should be made to,

- Introduce the fundamentals of digital circuit design using Hardware Description Language (HDL) for modeling and simulation.
- Develop the ability to design and simulate combinational circuits such as adders, multiplexers, encoders, decoders, and comparators.
- Enable students to model and analyze sequential circuits including flip-flops, shift registers, and counters.
- Familiarize students with the design of arithmetic and logic modules like adders, multipliers, and ALUs using HDL.
- Provide exposure to memory design and control applications through finite state machine–based systems such as traffic light, elevator, vending machine, and digital lock controllers.

List of Experiments

Sl. No	List of Experiments
1	Design of basic combinational circuits 8 bit Adder, 4 bit Multiplier, Encoder and Multiplexer using HDL. Simulate it using Xilinx/Altera Software and implement by Xilinx/Altera FPGA.
2	Design of Flip-flops circuits using HDL. Simulate it using Xilinx/Altera Software and implement it by Xilinx/Altera FPGA.
3	Design 4-bit ALU (Arithmetic Logic Unit) using HDL. Simulate it using Xilinx/Altera Software.
4	Design and implement Universal Shift Register using HDL. Simulate it using Xilinx/Altera Software.
5	Design Memories using HDL. Simulate it using Xilinx/Altera Software.
6	Design Finite State Machine (Moore and Mealy) using HDL. Simulate it using Xilinx/Altera Software.
7	Design of Synchronous and Asynchronous using HDL. Simulate it using Xilinx/Altera Software.
8	Design a simple Traffic Light Controller system using HDL. Simulate it using Xilinx/Altera Software.
9	Design a simple Elevator Controller using HDL. Simulate it using Xilinx/Altera Software.
10	Mini Project
	Total Periods: 60

Learning Resources

1	M. Morris Mano and Michael D. Ciletti, “Digital Design: With an Introduction to the Verilog HDL, VHDL, and SystemVerilog”, Sixth Edition, Pearson Education, 2018.
2	Stephen Brown and Zvonko Vranesic, “Fundamentals of Digital Logic with Verilog Design Third Edition, McGraw-Hill Education, 2014.
3	Douglas L. Perry, “Verilog HDL”, Fifth Edition, McGraw-Hill Education, 2008
4	Douglas L. Perry, “Verilog HDL”, Fifth Edition, McGraw-Hill Education, 2008
5	VLSI Virtual Lab : https://vlsi-iitg.vlabs.ac.in/
6	VLSI Design Virtual Labs: https://cse14-iiith.vlabs.ac.in/

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Simulate basic combinational logic circuits (adders, multiplexers, encoders, decoders, comparators) using HDL.	Apply
CO2	Model, simulate, and verify sequential circuits such as flip-flops, shift registers, and counters using HDL	Apply
CO3	Develop arithmetic and logic modules such as adders, multipliers, and ALUs using HDL and analyze their performance.	Apply
CO4	Develop HDL models for memory elements and finite state machines (Moore	Apply
	and Mealy types).	
CO5	Simulate real-time digital control systems such as traffic light controller, elevator controller, vending machine controller, and digital lock system using HDL.	Apply

CO-PO/PSO Mapping

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EM312	DESIGN THINKING AND INNOVATION	L	T	P	C
		0	0	2	1

Course Objective:

The student should be made to,

- Empathizing with users to uncover their real problems and desires.
- Promoting out-of-the-box thinking to develop unique and effective solutions.
- Using prototyping, testing, and refining ideas to ensure the best outcome.
- Testing assumptions early to prevent costly mistakes and enhance decision-making.
- Creating innovative products, services, or processes that improve market competitiveness.

Sl No	List of Exercises	No of periods
1	Design Thinking – models – Why design thinking? Case Studies. Innovation – 7Cs of Innovation. Identify a case study.	4

2	Empathize – tools - customer Journey map – case studies – Empathize the identified case study	4
3	Analyze – tools, multi-whys, case study, conflict of interest. Analyze the identified case study	4
4	Ideate and solve – brainstorming – TRIZ method, trial and error method – Solve the identified case study	4
5	Prototype/process and test – tools and methods – create a prototype for the identified case study	4
6	Iterate to improve the prototype/process – revisit the methods to improve the prototype.	8
7	Submit the report and final prototype/process of the case study.	2
	Total Periods	**30**

Learning Resources

1	Pavan Soni, Design your thinking, Penguin Random House India Pvt, Ltd., India, 2022
2	Don Norman, The Desing of everyday things, Basic Books, New York, 2013
3	B.K. Chakravarthy, Janaki Krishnamoorthi, Innovation by Design Lessons from Post Box Design & Development, Springer, New Delhi 2013
4	Balaramadurai, Karmic Design Thinking, 2020
5	Design by Innovation NPTEL Course B.K. Chakravarthy IIT Bombay https:/ /npt el.ac.in/ courses/107 101086
6	Design Thinking and Innovation NPTEL Cours Ravi Poovaiah, IIT Bombay https:/ /onlinecourses.swa yam2.ac.in/ aic23_g e17/preview
7	Design Thinking A Premier NPTEL Course, Prof. Ashwin Mahalingam, Prof. Bala Ramadurai, IIT Madras https:/ /onlinecourses.npt el.a c.in/ noc22 mg32/ preview

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Apply the tools to empathize the identified case study	Apply
CO2	Analyze the data and information to conceptualize the solution for the case study	Analyze
CO3	Ideate and solve the case study using appropriate tools	Apply
CO4	Create a prototype/process of the case study	Creating
CO5	Iterate to improvise the prototype/process of the case study	Analyze

CO-PO/PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	2	-	-	2	2	2	2	2	2	2	2	-
CO2	2	2	-	-	2	2	2	2	2	2	2	2	-
CO3	2	2	-	-	2	2	2	2	2	2	2	2	-
CO4	2	2	-	-	2	2	2	2	2	2	2	-	3
CO5	2	2	-	-	2	2	2	2	2	2	2	-	3
Avg.	**2.0**	**2.0**	-	-	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**2.0**	**3.0**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EM522	Soft Skills and Personality Development – II	L	T	P	C
		0	0	2	1

Course Objective:

- To improve written communication etiquette, covering email principles, netiquette, and proper messaging practices.
- To communicate effectively with clarity, active listening, and overcoming sender–receiver barriers.
- To develop non-verbal awareness, interpreting body language and cues, especially in high-stakes contexts (interviews, presentations).
- To enhance public speaking and presentation skills using visuals, confidence building, and anxiety management.
- To cultivate integrity-driven human relations, emphasizing listening, trust, and ethical communication

List of Exercises

Sl. No.	List of Exercises
1	Technology and Communication: Technological Personality, Mobile Personality?
2	Communication Skills: Effective Communication
3	Barriers to Communication: Arising out of Sender/Receiver's Personality, Interpersonal Transactions, Miscommunication
4	Nonverbal Communication: Introduction And Importance, Issues and Types, Basics and Universals
5	Body Language: For Interviews, For Group Discussions
6	Presentation Skills: Overcoming Fear, Becoming A Professional, The Role of Body Language
7	Presentation Skills: Using Visuals
8	Reading Skills: Effective Reading
9	Human Relations: Developing Trust and Integrity
10	Visume
	Total Periods: 30

Learning Resources

1	Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2	Kamin, Maxine. Soft Skills Revolution: A Guide for Connecting with Compassion for Trainers, Teams, and Leaders. Washington, DC: Pfeiffer & Company, 2013.
3	Klaus, Peggy, Jane Rohman & Molly Hamaker. The Hard Truth about Soft Skills. London: HarperCollins E-books, 2007.
4	Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.
5	Enhancing Soft Skills and Personality, Dr. T. Ravichandran, IIT Kanpur NPTEL Course: https://onlinecourses.nptel.ac.in/noc26_hs47/preview
6	Developing Soft Skills and Personality, Dr. T. Ravichandran, IIT Kanpur NPTEL Course: https://nptel.ac.in/courses/109104107

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Write effective emails using email principles and etiquette	Apply
CO2	Design visuals using principles of clarity, readability, and relevance (graphs, slides, props).	Apply
CO3	Apply the communication model to real-world situations, accounting for tone, style, barriers	Apply
CO4	Compare self-assessed nonverbal behaviors to standardized benchmarks.	Understand
CO5	Apply confident body language techniques in interviews and group discussion simulations.	Apply

CO-PO/PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1								1	2		2		
CO2								1	2		2		
CO3								1	2		2		
CO4								1	2		2		
CO5								1	2		2		
Avg.								**1**	**2**		**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24EC611	Wireless Communication	PCC	3	0	0	3	3	40	60
2	U24EC621	Microwave and Optical Communication	PCC	3	0	0	3	3	40	60
3	U24MG611	Project Management	HSMC	2	0	0	2	2	40	60
4	U24MG621	Entrepreneurship	EEC	2	0	0	2	2	40	60
5		Professional Elective 3	PEC					3		
6		Professional Elective 4	PEC					3		
7		Open Elective 1	OEC					3		
8		Mandatory Course-I*	MC	3	0	0	3	0	100	-
PRACTICAL COURSES										
9	U24EC632	Advanced Communication Systems Laboratory	PCC	0	0	4	4	2	60	40
10	U24EC642	Mini Project	EEC	0	0	4	4	2	60	40
								23		

*Mandatory Course-I is a Non-Credit Course

Sl. No	Course Type	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24EC611	3	0	0	3	60	40	60	40	-	100	-	40	60	45	50
2	U24EC621	3	0	0	3	60	40	60	40	-	100	-	40	60	45	50
3	U24MG611	2	0	0	2	60	40	60	40	-	100	-	40	60	45	50
4	U24MG621	2	0	0	2	60	40	60	40	-	100	-	40	60	45	50
5	PEC 3														45	50
6	PEC 4														45	50
7	OEC 1														45	50
8	MC 1	3	0	0	0	-	-	-	-	-	-	-	100	-	-	50
9	U24EC632	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50
10	U24EC642	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50

(W) – Weightage

U24EC611	WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3

Course Objective:

The student should be made:

- Identify different handoff strategies and their importance in maintaining call quality and continuity in cellular networks.
- Apply the knowledge of basic propagation mechanisms for mobile radio environments and predict path loss in different scenarios
- Analyze the impact of various modulation schemes on system performance, including data rate, bandwidth efficiency, and interference resistance
- Evaluate the performance of different diversity techniques, with a focus on Rake receivers, in combating multipath interference and improving overall system reliability and throughput.
- Analyze security mechanisms, protocols, and countermeasures such as SNEP and μTESLA for securing resource-constrained sensor networks.

Detailed Syllabus

Unit I CELLULAR ARCHITECTURE **9**

Frequency reuse - Channel assignment strategies - Hand off strategies- interference & system capacity- Trunking & grade of service –Improving Coverage and capacity in cellular systems-Evolution of cellular communication systems and modern cellular technologies such as LTE and 5G and Beyond.

Unit II MOBILE RADIO PROPAGATION **9**

Large Scale Path Loss: Introduction to radio wave propagation - Free Space propagation models - Three Basic propagation mechanism - small scale fading and Multipath:- factor Influencing small scale fading - Doppler shift -Parameters of mobile multipath channels – Time dispersion parameters- Coherence bandwidth – Doppler spread & Coherence time-Types of small scale fading.

Unit III MODULATION TECHNIQUE FOR MOBILE RADIO **9**

Structure of a wireless communication link, Digital Modulation – An Overview: Factors That Influence the Choice of Digital Modulation, Linear Modulation Techniques: Minimum Shift Keying (MSK), Gaussian Minimum Shift Keying (GMSK), Spread Spectrum Modulation Techniques: Pseudo- Noise (PN) Sequences, Direct Sequence Spread Spectrum (DS-SS)-Frequency Hopping Spread Spectrum-Orthogonal Frequency Division Multiplexing (OFDM).

Unit IV MULTIPATH MITIGATION TECHNIQUES **9**

Fundamentals of Equalization – Linear equalizer and Non-Linear equalization,- Algorithms for Adaptive equalization: zero forcing algorithm-Least Mean square Algorithm-Recursive least square algorithm, Diversity Techniques:-Practical Space Diversity Consideration-Polarization Diversity-Frequency Diversity , Rake receiver-Beamforming basics-Massive MIMO systems.

Unit V AD HOC AND SENSOR NETWORK **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-Low Power Wide Area Network (LPWAN) technologies: LoRaWAN and NB-IoT- Physical layer and transceiver design considerations-Future wireless communication trends.

Total Periods:45

Learning Resources

1	Rappaport. T. S, "Wireless Communications: Principles and Practice", Second Edition, Pearson Education, Reprint 2011.
2	Hakima Chaouchi, Maryline Laurent-Maknavicius, "Wireless and Mobile Network Security-Security Basics, Security in On-the-shelf and Emerging Technologies", John Wiley & Sons Inc, 2013
3	David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press, 2005.
4	Van Nee, R. and Ramji Prasad, "OFDM for wireless multimedia communications", Artech House, 2000
5	Wireless and Cellular Communications-https://onlinecourses.nptel.ac.in/noc25_ee109
6	Wireless Ad Hoc and Sensor -Networks-https://onlinecourses.nptel.ac.in/noc25_cs74

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply various channel assignment strategies to design efficient cellular networks and optimize system capacity.	Apply
CO2	Apply the Understand of small-scale fading and multipath to analyze mobile radio channels in terms of time dispersion, Doppler spread, and coherence time.	Apply
CO3	Analyze the characteristics and performance of Minimum Shift Keying (MSK) and Gaussian Minimum Shift Keying (GMSK) in terms of bandwidth efficiency, spectral characteristics, and resistance to noise.	Analyze
CO4	Apply linear and non-linear equalization techniques to mitigate the effects of multipath fading in communication channels.	Apply
CO5	Analyze various attacks on Ad Hoc network routing protocols and identify vulnerabilities associated with network topology and mobility.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2				2	2		2	3	2
CO2	3	3	3	2				2	2		2	3	2
CO3	3	3	3	2				2	2		2	3	2
CO4	3	3	3	2				2	2		2	3	2
CO5	3	3	3	2				2	2		2	3	2
Avg.	**3**	**3**	**3**	**2**				**2**	**2**		**2**	**3**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC621	MICROWAVE AND OPTICAL COMMUNICATION	L	T	P	C
		3	0	0	3

Course Objective:

The student should be able to,

- Apply the fundamental principles of microwave engineering to know microwave transmission and sources.
- Apply the concept of S-parameters to characterize different N-port microwave devices.
- Evaluate the accuracy and reliability of microwave measurements obtained from network analyzers and signal analyzers.
- Evaluate different optical sources (LED, LASER) and detectors (PIN, APD) for various communication system requirements.
- Evaluate wavelength division multiplexing (WDM) systems and passive optical devices based on their impact on link capacity and signal quality.

Detailed Syllabus

Unit I INTRODUCTION TO MICROWAVES AND SOURCES	**9**
History of Microwave Engineering, Microwave transmission and Applications, Microwave Tubes, Klystron amplifier, Reflex Klystron oscillators, Magnetron oscillators, TRAPATT.	
Unit II S PARAMETERS ANALYSIS FOR N-PORT MICROWAVE DEVICES	**9**
Scattering parameter, Directional coupler, E plane, H plane and Magic Tee Junctions, Microwave Circulators, Isolators, Phase shifters, Attenuators and Power dividers.	
Unit III MICROWAVE MEASUREMENTS	**9**
Impedance and Power measurement, Measurement of Frequency, Attenuation, Scattering parameters, Vector Network Analyzer, Signal Analyzer and Spectrum Analyzer.	
Unit IV OPTICAL FIBER COMMUNICATION SYSTEMS	**9**
Introduction to Optical fiber communication, Ray theory transmission, Optical fiber modes and configurations, Fiber attenuation and dispersion mechanisms, Optical sources-LED and LASER Diode, Optical detectors- PIN and Avalanche photo diode.	
Unit V OPTICAL LINK POWER BUDGET ANALYSIS	**9**
Digital link-Point-to-Point link –System considerations, Link power budget and Rise time budget, Analog link and analysis, WDM and Passive devices.	
	Total Periods:45

Learning Resources

1	Samuel Y. Liao, “Microwave Devices and Circuits”, 3rd Edition, Pearson Education, 2013
2	Keiser G, “Optical Fiber Communication Systems”, 5th Edition, 6th Reprint, McGraw Hill Education (India), 2015.
3	David M. Pozar, “Microwave Engineering”, 4th Edition, John Wiley & Sons, 2012
4	John M. Senior, “Optical fiber Communications: Principles and Practice”, Pearson Education, 3rd Edition, 2009.
5	Microwave Engineering By Prof. Ratnajit Bhattacharjee | IIT Guwahati- https://onlinecourses.nptel.ac.in/noc20_ee91/



6	Fiber Optic Communication Technology — Preview: https://onlinecourses.nptel.ac.in/noc25_ee90

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Analyze microwave tube behavior (klystron, reflex klystron, magnetron, TRAPATT) and their applications and limitations.	Analyze
CO2	Analyze the characteristics and performance of microwave components such as directional couplers, magic tees, circulators, isolators, phase shifters, and attenuators.	Analyze
CO3	Apply microwave measurement methods to measure impedance, attenuation, frequency, and power using VNA, signal analyzer, and spectrum analyzer	Apply
CO4	Apply optical fiber concepts such as ray theory, fiber modes, attenuation, dispersion, and operation of optical sources & detectors	Apply
CO5	Analyze analog and digital optical communication system performance, including WDM and passive device effects	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2				2	2		2	3	2
CO2	3	3	3	2				2	2		2	3	2
CO3	3	3	3	2				2	2		2	3	2
CO4	3	3	3	2				2	2		2	3	2
CO5	3	3	3	2				2	2		2	3	2
Avg.	**3**	**3**	**3**	**2**				**2**	**2**		**2**	**3**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MG611	PROJECT MANAGEMENT	L	T	P	C
		2	0	0	2

Course Objective:

The student should be made to

- Understand the fundamentals of project management including project characteristics, life cycle phases, and key managerial issues involved in projects.
- Identify, screen, and evaluate projects using qualitative techniques and quantitative financial appraisal methods under certainty and uncertainty conditions.
- Understand project organizational structures and leadership concepts and analyze the roles and responsibilities of a project manager in different organizational settings.
- Apply project planning and control techniques for effective scope, time, and cost management using tools such as WBS, network diagrams, CPM, PERT, and earned value analysis.
- Recognize the importance of quality management in projects and apply quality assurance, quality control, and continuous improvement techniques for successful project execution.

Detailed Syllabus

UNIT I INTRODUCTION TO PROJECT MANAGEMENT	**9**
Concept of project management - project definition and key features of projects - project life cycle phases - typical project management issues - basic project activities.	
UNIT II PROJECT IDENTIFICATION AND SELECTION	**9**
Identification and screening (brainstorming, strength and weakness in the system, Environmental opportunities and threats) - Project evaluation methods - Payback period - Net present value - internal rate of return and project evaluation under uncertainty.	
UNIT III PROJECT ORGANIZATION	**9**
Roles and responsibilities of a project manager, Project Organization- The project as Part of the Functional Organization - Pure Project Organization - The Matrix organization - leadership styles	
UNIT IV SCOPE, TIME AND COST MANAGEMENT	**9**
Scope Management-define the project-SOW, WBS - Time Management-Network diagram-forward and backward pass - critical path - PERT and CPM - AOA and AON methods - tools for project network - Cost management - earned value method.	
UNIT V QUALITY MANAGEMENT	**9**
Quality assurance and quality control - quality audit- methods of enhancing quality.	
	Total Periods: 45

Learning Resources

1	R. Panneerselvam and P. Senthil Kumar (2013), Project Management, PHI Learning Private Limited
2	Prasanna Chandra (2014), Projects: Planning, Analysis, Selection, Financing, implementation and Review
3	A Guide to the Project Management Body of Knowledge: (PMBOK Guide) by Project Management Institute, 2013.
4	Gopala Krishnan & Rama Murthy, A Text book of Project Management, McMillan India
5	S. Choudhary (2004), Project Management, Tata McGraw Hill Publication.
6	Clifford F Gray (2014), Project Management: The Managerial Process, (Special Indian Edit.), Oregon State University.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the concepts, characteristics, life cycle phases, and managerial issues of projects.	Understand
CO2	Identify, screen, and evaluate projects using financial appraisal techniques such as Payback Period, NPV, IRR, and evaluation under uncertainty.	Apply
CO3	Analyze different project organizational structures and leadership styles and assess the role of a project manager in achieving project objectives.	Understand



CO4	Develop project plans by defining scope, scheduling activities, identifying critical paths, and controlling cost using CPM, PERT, and earned value techniques.	Analyze
CO5	Apply quality management principles, quality assurance, quality control, and auditing techniques to enhance project performance and outcomes.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3							2	2	2	2		
CO2	3	2	2					2	2	2	2		
CO3	3							2	2	2	2		
CO4	3	2	2					2	2	2	2		
CO5	3	2	2					2	2	2	2		
Avg.	**3**	**2**	**2**					**2**	**2**	**2**	**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MG621	ENTREPRENEURSHIP	L	T	P	C
		2	0	0	2

Course Objective:

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

- Understand the fundamentals of entrepreneurship including motivation, leadership, social entrepreneurship, and the role of women entrepreneurs in economic development.
- Analyze the entrepreneurial process involved in identifying, Evaluate, and selecting viable business opportunities through market research.
- Formulate innovative business ideas using creative problem-solving techniques and understand legal and ownership structures of business organizations.
- Develop and evaluate comprehensive business plans incorporating marketing, financial, organizational, and implementation strategies.
- Acquire knowledge of MSMEs and institutional support systems including government policies, incentives, subsidies, and industrial infrastructure for entrepreneurship development.

Detailed Syllabus

UNIT I INTRODUCTION 9

Understand entrepreneurship- need for entrepreneurship development - Theory of Entrepreneurial Motivation - Barriers to entrepreneurship - Qualities of a successful entrepreneur - Types of entrepreneurs, Entrepreneurial Leadership- Development of women entrepreneurs and the Future of entrepreneurship- Social Entrepreneurship.

UNIT II ENTREPRENEURIAL PROCESS 9

Identification – Selection of a good Business opportunity - Market survey and Research – developing a business plan -Entrepreneurship Development Programme- Meaning - Objectives - Phases of EDP - Course contents, Target groups.

UNIT III FORMULATION OF BUSINESS IDEA 9

Sources for new ideas & evaluation of new idea for doing business - Creative problem-solving techniques used in entrepreneurial decision making. Formalities for registration of business units - Types of ownership in Business- merits and demerits - business incubators - types by valuation.

UNIT IV THE BUSINESS PLAN 9 Nature and scope of Business plan - Writing Business Plan - Evaluate Business plans - sing and implementing business plans. Application BMC - Marketing plan - financial plan and the organizational plan - Launching formalities
UNIT V MICRO SMALL MEDIUM ENTERPRISE (MSME) 9 Procedures and formalities for registration of business units and its benefits. Types of ownership in Business & its merits and demerits - Reason for business failures - causes and preventive measures. Institutional support to Entrepreneurship - Central and State Level Institutional support for business units. Industrial Estates & Special Economic Zones in India. Incentives and subsidies & bounties for businesses - Policy initiatives.
Total Periods: 45

Learning Resources

1	Anshuja Tiwari, (2015), Entrepreneurship Development in India, Himalaya Publishing House, New Delhi.
2	Nagaraja Prakasam, (2025) Back to Bharath in search of sustainable future, Penguin Business Published, New Delhi.
3	Vasant Desai, Dynamics of Entrepreneurial Development and Management Principles. Projects, Policies, Programmes – 2005, Himalaya Publishing House, New Delhi.
4	Poornima M Charantimath, (2016), Entrepreneurship Development Small Business Enterprises, Dorling Kindersley India Pvt. Ltd, New Delhi.
5	Anshuja Tiwari, (2015), Women Entrepreneurship and Economic Development, Himalaya Publishing House, New Delhi.
6	S. Anil Kumar, (2015), Small Businesses and Entrepreneurship, International Publishing House Private Ltd, New Delhi.
7	Dr. S.S. Khanka, (2012), Entrepreneurial Development, S.Chand, New Delhi.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the concepts, theories, and motivation behind entrepreneurship, including social and women entrepreneurship, and assess the qualities required for successful entrepreneurs.	Understand
CO2	Explain and evaluate business opportunities using market survey and research techniques and outline the stages of the entrepreneurial process	Understand
CO3	Describe innovative business ideas, apply creative problem-solving tools, and select appropriate ownership and registration procedures for business ventures.	Apply
CO4	Discuss a viable business plan using tools such as the Business Model Canvas, marketing, financial, and organizational plans.	Understand
CO5	Examine MSME policies, institutional support mechanisms, incentives, and causes of business failure to recommend strategies for sustainable entrepreneurial growth.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3							2	2	2	2		
CO2	3							2	2	2	2		
CO3	3	2	2					2	2	2	2		
CO4	3							2	2	2	2		
CO5	3							2	2	2	2		
Avg.	**3**	**2**	**2**					**2**	**2**	**2**	**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC632	ADVANCED COMMUNICATION SYSTEMS LABORATORY	L	T	P	C
		0	0	4	2

Course Objective:

After completing this course, the students will be able ,

- To simulate multipath fading channels and multiple access schemes.
- To analyze various channel equalization techniques.
- To evaluate microwave devices such as Reflex Klystron and Gunn Diode.
- To simulate the characteristics of optical components such as LEDs and PIN photodiodes through DC characterization experiments.
- To determine important optical fiber parameters including Numerical Aperture, Attenuation, and Mode Characteristics for Understand fiber propagation behavior.

List of Experiments

Sl. No.	List of Experiments
Wireless Experiments:	
1	Modeling and simulation of Multipath fading channel.
2	Modeling and simulation of TDMA, FDMA and CDMA for wireless communication
3	Wireless Channel equalization: Zero-Forcing Equalizer (ZFE),Adaptive Equalizer (ADE),
4	Modulation: Spread Spectrum – DSSS Modulation & Demodulation
Microwave Experiments:	
5	Reflex Klystron Characteristics.
6	Gunn Diode Characteristics.
7	Measurement of low VSWR and high VSWR
8	Coupling and directivity of a directional coupler.
Optical Experiments:	
9	Mode Characteristics of Fibers
10	Attenuation Measurement in Fibers
11	Numerical Aperture determination for Fibers
12	Measurement of connector and bending losses
	Total Periods: 60

Learning Resources

1	https://www.vlab.co.in/ → Search for **"Fading Channels & Mobile Communications"**
2	**Optical Communication Virtual Lab:** https://oc-iitr.vlabs.ac.in
3	**Microwave Engineering Virtual Lab:** https://me-iitr.vlabs.ac.in/

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Simulate multipath fading channels and multiple access techniques (TDMA, FDMA, CDMA) for Analyze wireless communication performance.	Apply
CO2	Evaluate various channel equalization techniques	Evaluate
CO3	Interpret the characteristics of microwave sources (Reflex Klystron, Gunn Diode) and determine key parameters such as VSWR, frequency, and wavelength	Analyze
CO4	Evaluate the DC characteristics of optical sources and detectors (LED, PIN Photodiode)	Evaluate
CO5	Analyze microwave, wireless, and optical communication measurements through simulation	Analyze

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC642	MINI PROJECT	L	T	P	C
		0	0	4	2

Course Objective:

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

- To provide hands-on experience in the design and fabrication of mechanical components or systems.
- To enable students to apply theoretical knowledge to develop a complete working model.
- To enhance problem-solving skills through real-time project planning, execution, and troubleshooting.
- To develop teamwork, project management, and communication skills through group-based project work.
- To expose students to industry-relevant fabrication practices, documentation, and evaluation procedures.

Guideline for Batch Formation, Review and Evaluation:

1. The students may be grouped with minimum one student to maximum 4 students and work under a project supervisor.
2. The device/system/component/ product to be fabricated may be decided in consultation with the supervisor and if possible, with an industry.
3. The mini project report to be submitted by the Batch with the fabricated model at the end of the semester/time of final Viva-Voce.
4. During the allotted periods the mini project work to be reviewed (Maximum of 4 reviews including Zeroth Review) and evaluated for internal assessment by a committee constituted by the Head of the Department.
5. At the end of the semester examination the mini project work evaluated based on oral presentation and the project report jointly by internal and External Examiner appointed by Controller of Examination

Total Periods: 60

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Identify and define a suitable mechanical design problem based on practical or industry requirements.	Understand
CO2	Design mechanical elements or systems using appropriate engineering principles and tools.	Apply
CO3	Fabricate and assemble the designed components into a functional working model.	Analyze
CO4	Analyze and evaluate the performance of the fabricated model through testing and validation.	Analyze
CO5	Prepare a comprehensive project report and effectively present the project work.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3						2	2	2		2	3	3
CO2	3	2	2		3		2	2	2		2	3	3
CO3	3	2	2		3		2	2	2		2	3	3
CO4	3	2	2		3		2	2	2		2	3	3
CO5	3	2					2	2	2		2	3	3
Avg.	**3**	**2**	**2**		**3**		**2**	**2**	**2**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
THEORY COURSES										
1	U24MG711	Human Values and Ethics	HSMC	2	0	0	2	2	40	60
2	U24MG721	Total Quality Management	HSMC	3	0	0	3	3	40	60
3		Professional Elective 5	PEC					3		
4		Professional Elective 6	PEC					3		
5		Open Elective 2	OEC					3		
6		Mandatory Course-II**	MC	3	0	0	3	0	100	-
THEORY CUM PRACTICAL COURSES										
7	U24EC713	Embedded and Real Time Systems	PCC	3	0	2	5	4	50	50
PRACTICAL COURSES										
8	U24EC722	Summer Internship*	EEC	0	0	4	4	2	100	-
								20		

* During Sixth Semester Holidays: 4 Weeks

** Mandatory Course-II is a Non-credit Course

Sl. No	Course Code	L	T	P	C	CIA Weightage (Theory)				CIA	ESE		CIA (W)	ESE (W)	Min. Marks to Pass for 100	
						T1	A1	T2	A2	Prac	Th	Prac			ESE	Total
1	U24MG711	2	0	0	2	60	40	60	40	-	100		40	60	45	50
2	U24MG721	3	0	0	3	60	40	60	40	-	100		40	60	45	50
3	PEC 5				3										45	50
4	PEC 6				3										45	50
5	OEC 2				3										45	50
6	MC – II	3	0	0	0	-	-	-	-	-	-	-	100	-	-	50
7	U24EC713	3	0	2	4	60	40	60	40	100	70	30	50	50	45	50
8	U24EC722	0	0	4	2	-	-	-	-	100	-	100	60	40	45	50

(W) – Weightage

U24MG711	HUMAN VALUES AND ETHICS	L	T	P	C
		2	0	0	2

Course Objective:

After completing this course, the students will be able ,

- To create awareness about values and ethics enshrined in the Constitution of India
- To sensitize students about the democratic values to be upheld in the modern society.
- To inculcate respect for all people irrespective of their religion or other affiliations.
- To install the scientific temper in the students' minds and develop their critical thinking.
- To promote sense of responsibility and Understand of the duties of citizen.

Detailed Syllabus

UNIT I DEMOCRATIC VALUES	**6**
Understand Democratic values: Equality, Liberty, Fraternity, Freedom, Justice, Pluralism, Tolerance, Respect for All, Freedom of Expression, Citizen Participation in Governance – World Democracies: French Revolution, American Independence, Indian Freedom Movement.	
UNIT II SECULAR VALUES	**6**
Understand Secular values – Interpretation of secularism in Indian context - Disassociation of state from religion – Acceptance of all faiths – Encouraging non-discriminatory practices.	
UNIT III SCIENTIFIC VALUES	**6**
Scientific thinking and method: Inductive and Deductive thinking, Proposing and testing Hypothesis, validating facts using evidence-based approach – Skepticism and Empiricism –Rationalism and Scientific Temper.	
UNIT IV SOCIAL ETHICS	**6**
Application of ethical reasoning to social problems – Gender bias and issues – Gender violence – Social discrimination – Constitutional protection and policies – Inclusive practices.	
UNIT V SCIENTIFIC ETHICS	**6**
Transparency and Fairness in scientific pursuits – Scientific inventions for the betterment of society - Unfair application of scientific inventions – Role and Responsibility of Scientist in the modern society.	
	Total Periods: 30

Learning Resources

1	The Nonreligious: Understand Secular People and Societies, Luke W. Galen Oxford University Press, 2016.
2	Secularism: A Dictionary of Atheism, Bullivant, Stephen; Lee, Lois, Oxford University Press, 2016.
3	The Oxford Handbook of Secularism, John R. Shook, Oxford University Press, 2017.
4	The Civic Culture: Political Attitudes and Democracy in Five Nations by Gabriel A. Almond and Sidney Verba, Princeton University Press,
5	Research Methodology for Natural Sciences by Soumitro Banerjee, IISc Press, January 2022

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the importance of democratic, secular, and scientific values for the harmonious functioning of social life.	Understand
CO2	Describe the role of democratic and scientific values in shaping responsible personal and professional behaviour.	Understand
CO3	Interpret social problems using rational and logical thinking approaches.	Understand
CO4	Explain the principles of ethical behaviour in societal contexts.	Understand
CO5	Discuss the significance of critical thinking and the pursuit of truth in decision-making.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1							3	2	2		2		
CO2							3	2	2		2		
CO3							3	2	2		2		
CO4							3	2	2		2		
CO5							3	2	2		2		
Avg.							**3**	**2**	**2**		**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24MG721	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able ,

- To create awareness about values and ethics enshrined in the Constitution of India
- To sensitize students about the democratic values to be upheld in the modern society.
- To inculcate respect for all people irrespective of their religion or other affiliations.
- To install the scientific temper in the students' minds and develop their critical thinking.
- To promote sense of responsibility and Understand of the duties of citizen.

Detailed Syllabus

UNIT I INTRODUCTION TO TOTAL QUALITY MANAGEMENT **9**

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of product and service quality –Definition of TQM-- Basic concepts of TQM - Gurus of TQM (Brief introduction) -- TQM Framework- Barriers to TQM –Benefits of TQM.

UNIT II TQM PRINCIPLES **9**

Leadership - Deming Philosophy, Quality Council, Quality statements and Strategic planning- Customer Satisfaction –Customer Perception of Quality, Feedback, Customer complaints, Service Quality, Kano Model and Customer retention – Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition & Reward and Performance Appraisal--Continuous process improvement –Juran Trilogy, PDSA cycle, 5S and Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating and Relationship development.

UNIT III TQM TOOLS & TECHNIQUES I	**9**
The seven traditional tools of quality - New management tools - Six-sigma Process Capability-Bench marking - Reasons to benchmark, Benchmarking process, What to Bench Mark, Understand Current Performance, Planning, Studying Others, learning from the data, Using the findings, Pitfalls and Criticisms of Benchmarking - FMEA - Intent, Documentation, Stages: Design FMEA and Process FMEA.	
UNIT IV TQM TOOLS & TECHNIQUES II	**9**
Quality circles – Quality Function Deployment (QFD) - Taguchi quality loss function – TPM –Concepts, improvement needs – Performance measures- Cost of Quality - BPR.	
UNIT V QUALITY MANAGEMENT SYSTEM	**9**
Introduction-Benefits of ISO Registration-ISO 9000 Series of Standards-Sector-Specific Standards - AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements-Implementation-Documentation- Internal Audits-Registration-ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001-Benefits of EMS.	
	Total Periods: 45

Learning Resources

1	Dale H. Besterfiled, Carol B. Michna, Glen H. Bester field, Mary B. Sacre, Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression,2013.
2	James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 6th Edition, South-Western (Thomson Learning), 2005.
3	Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.
4	Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd.,2006.
5	Janakiraman,B and Gopal, R.K, “Total Quality Management – Text and Cases”, Prentice Hall (India) Pvt. Ltd., 2006.

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Explain the concepts of quality, Total Quality Management, quality dimensions, frameworks, benefits, and barriers.	Understand
CO2	Explain the principles of TQM including leadership, customer satisfaction models, employee involvement, continuous improvement, and supplier partnership.	Understand
CO3	Describe various TQM tools and techniques including Seven QC tools, Six Sigma, Benchmarking, FMEA, QFD, and TPM	Understand
CO4	Explain quality improvement strategies including cost of quality, Business Process Re-engineering (BPR), Taguchi loss function, and performance measurement systems.	Understand
CO5	Describe Quality Management Systems and Environmental Management Systems, including the implementation and audit requirements of ISO 9001 and ISO 14001 standards.	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3					2		2	2		2		
CO2	3					2		2	2		2		
CO3	3					2		2	2		2		
CO4	3					2		2	2	2	2		
CO5	3					2		2	2		2		
Avg.	**3**					**2**		**2**	**2**	**2**	**2**		

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC713	EMBEDDED AND REAL TIME SYSTEMS	L	T	P	C
		3	0	2	4

Course Objective:

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

- Develop skills in programming parallel ports, timers, and serial ports on the 8051 microcontroller.
- Analyze various design methodologies and design flows used in embedded system development.
- Develop practical skills in managing memory, especially stacks and subroutines, for system-level programming and interrupt handling in ARM-based systems.
- Analyze different program models used in embedded systems, such as interrupt-driven, time- driven, and event-driven models, and their relevance in system design and performance optimization.
- Analyze real-time system design through practical examples, such as audio players,
- engine control units.

Detailed Syllabus

Unit I 8051-MICRO CONTROLLER **9**

Introduction to Microprocessor -Microcontrollers for an Embedded System – 8051 – Architecture – Addressing Modes – Instruction Set – Program and Data Memory – Stacks – Interrupts – Timers/Counters – Serial Ports – Programming

Unit II EMBEDDED SYSTEM DESIGN **9**

Embedded system design process – Design example: Model train controller- Design methodologies- Design flows - Requirement. Analysis — Quality Assurance techniques - Consumer electronics architecture-Overview of modern embedded development platforms: STM32, NXP LPC and TI Launchpad.

Unit III ARM PROCESSOR AND PERIPHERALS **9**

ARM Architecture Versions – ARM 7 Architecture – Instruction Set – Stacks and Subroutines –Features of the LPC 214X Family – Peripherals – Timer Unit – Pulse Width Modulation – UART – Architecture of ARM Cortex-M processors.

Unit IV EMBEDDED PROGRAMMING **9**

Components for embedded programs- Models of programs- Assembly, linking and loading–compilation techniques- Program level performance analysis – Software performance optimization –Program validation and testing-Embedded programming using ARM Cortex-M / ESP32 development boards.

Unit V REAL TIME SYSTEMS **9**

Structure of a Real Time System – Task Assignment and Scheduling- Multiple tasks and multiple processes- Multirate systems- Preemptive real- time operating systems- Priority based scheduling- Distributed embedded systems – MPSoCs and shared memory multiprocessors. –Design Example - Audio player, Engine control unit – Video accelerator.

TOTAL PERIODS: 45

List of Experiments

Sl. No	List of Experiments
	Experiments using 8051
1	Programming Arithmetic and Logical Operations in 8051.
2	Generation of Square waveform using 8051
3	Design of a Digital Clock using Timers/Counters in 8051.
	Experiments using ARM
4	Interfacing ADC and DAC.
5	Interfacing LED and LCD.
	Mini project
6	Plant Watering System
7	Solar-Powered Auto Irrigation System
8	Voice-Control Home Automation System
9	Gesture Controlled Robot
10	Smart Phone Security System
	Total Periods: 30
	Total Periods: 75

Learning Resources

1	Muhammed Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, "The 8051 Microcontroller and Embedded Systems", Pearson Education, Second Edition, 2014
2	Marilyn Wolf, "Computers as Components - Principles of Embedded Computing System Design", Third Edition, Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.
3	Michael J. Pont Embedded Cll, Pearson Education, 2007.
4	Qing Li, Caroline Yao, "Real-Time Concepts for Embedded Systems", First Edition, 2003.
5	Introduction to Embedded systems-**https://nptel.ac.in/courses/108102045**
6	Embedded systems Design-https://onlinecourses.nptel.ac.in/noc26_cs54/

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Write assembly programs using the 8051-instruction set, and understand how different instructions affect registers, memory, and peripheral interfaces.	Apply
CO2	Compare different design methodologies and flows used in embedded system development and choose the most appropriate methodology for a given application.	Analyze
CO3	Solve real-world problems using ARM architecture by integrating various peripherals and efficiently programming microcontrollers for embedded systems.	Apply
CO4	Analyze the key components that make up an embedded program, including hardware interactions, software layers, and peripheral control.	Analyze
CO5	Evaluate the timeliness, predictability, and reliability of real-time systems, ensuring they meet deadlines under varying load conditions.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	2		2	2	2		2	3	2
CO2	3	3	3	3	2		2	2	2		2	3	2
CO3	3	3	3	3	2		2	2	2		2	3	2
CO4	3	3	3	3	2		2	2	2		2	3	2
CO5	3	3	3	3	2		2	2	2		2	3	2
Avg.	**3**	**3**	**3**	**3**	**2**		**2**	**2**	**2**		**2**	**3**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24EC722	SUMMER INTERNSHIP	L	T	P	C
		0	0	4	2

Course Objective:

- To provide practical exposure to real-world engineering practices and industrial environments.
- To apply theoretical knowledge gained in academics to solve practical problems in the workplace.
- To develop professional skills such as communication, teamwork, time management, and workplace ethics.
- To understand industrial processes, tools, and technologies relevant to the student's discipline.
- To enhance documentation and reporting abilities through systematic recording and presentation of internship activities.

Description:

- The 4-week summer internship for B.E./B.Tech. students is implemented through a well-defined process to ensure both academic relevance and meaningful industry exposure.
- Internships may be secured through the institution's placement cell, faculty references, or by students themselves, subject to departmental approval. Prior to the internship, the department issues detailed guidelines specifying eligibility, duration, expected outcomes, and documentation formats.
- Students submit their internship details, including offer letters, which are reviewed and approved, and faculty mentors are assigned to guide and monitor their progress.
- A structured orientation program is conducted to familiarize students with internship objectives, professional ethics, workplace conduct, and reporting requirements.
- During the internship, students actively engage in assigned technical tasks, apply theoretical knowledge to practical situations, and develop professional skills.
- They are required to maintain a daily or weekly logbook and submit periodic progress updates.
- Faculty mentors track student performance through regular interactions, while industry supervisors oversee daily activities, provide technical guidance, and evaluate the student's learning and overall contribution.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply engineering concepts and technical knowledge to perform assigned industrial tasks.	Apply
CO2	Analyze real-time problems, processes, and systems encountered during the internship.	Analyze
CO3	Demonstrate professional skills including teamwork, communication, and ethical practices.	Apply
CO4	Evaluate industrial practices, personal performance, and learning outcomes through structured reporting.	Evaluate
CO5	Create detailed internship reports, logbooks, and presentations summarizing their work and learning experience.	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2		2			2	2		3	3	2
CO2	2	3	2		2			2	2		3	2	2
CO3	2	2	2		2			2	2		2	3	3
CO4	2	2	2		2			2	2		2	2	2
CO5	2	2	2		2			2	2		2	2	3
Avg.	2.2	2.4	2		2			2	2		2.4	2.4	2.4

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
PRACTICAL COURSES										
1	U24EC812	Capstone Project/ Industry Internship	EEC	0	0	16	16	8	60	40
				0	**0**	**16**	**16**	**8**		

U24EC812	CAPSTONE PROJECT / INDUSTRY INTERNSHIP	L	T	P	C
		0	0	16	8

Course Objective:

- To identify and define real-world problems in computing domains and develop appropriate solutions.
- To apply engineering and software development principles for designing and implementing systems or applications.
- To develop research, analytical, and problem-solving skills through project-based learning.
- To enhance professional competencies such as teamwork, communication, project management, and ethical practices.
- To strengthen documentation and presentation skills through systematic reporting and project demonstration.

Description:

- The Capstone Project/Industry Internship in the final semester is designed as a comprehensive learning experience that integrates theoretical knowledge with practical application.
- Students may undertake the capstone either internally within the institution under faculty supervision or externally in an industry, research organization, or startup.
- The external project/internship may be secured through the institution's placement cell, faculty references, or by students themselves, subject to departmental approval.
- At the beginning, the department issues detailed guidelines covering project scope, duration, expected outcomes, and evaluation criteria.
- Students are required to identify a problem statement, submit a project proposal, and obtain approval.
- Faculty guides are assigned for internal projects, while external projects involve both a faculty mentor and an industry supervisor.
- During execution, students carry out design, development, analysis, or implementation work, with periodic reviews to monitor progress.
- For industry-based projects, regular interaction with the organization ensures alignment with real-world requirements.
- Students must maintain proper documentation, including progress reports and logs.
- Upon completion, they submit a detailed project report and present their work through a final review and viva voce evaluation.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply computing and engineering knowledge to design and develop solutions for real-world problems.	Apply
CO2	Analyze problem requirements, system constraints, and data to propose effective solutions.	Analyze
CO3	Design and develop software systems, components, or processes to meet specified needs.	Create
CO4	Evaluate system performance, project outcomes, and alternative solutions considering technical and societal factors.	Evaluate
CO5	Create comprehensive project reports and deliver effective presentations demonstrating their work.	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2		2			2	2		3	3	2
CO2	2	3	2		2			2	2		3	3	2
CO3	2	2	3		3			2	2		2	3	3
CO4	2	2	2		2			2	2		2	2	2
CO5	2	2	2		3			2	2		2	2	3
Avg.	2.2	2.4	2.2		2.4			2	2		2.4	2.6	2.4

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

PROFESSIONAL ELECTIVES

VERTICAL 1: SYSTEM DESIGN WITH IOT

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24ECSD01	Sensors and Actuators	PEC	3	0	0	3	3	40	60
2	U24ECSD02	IoT Architecture and Protocols	PEC	3	0	0	3	3	40	60
3	U24ECSD03	Wearable Technologies	PEC	3	0	0	3	3	40	60
4	U24ECSD04	MEMS Design	PEC	3	0	0	3	3	40	60
5	U24ECSD05	Industrial IoT and Industry 4.0	PEC	3	0	0	3	3	40	60
6	U24ECSD06	Nano Electronics	PEC	3	0	0	3	3	40	60

U24ECSD01	SENSORS AND ACTUATORS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able,

- To outline the principles of measurement systems, sensor classifications, and signal characteristics used in sensing applications.
- To examine displacement, proximity, and ranging sensors used for position and distance measurement.
- To analyze force, magnetic, and heading sensors used in engineering measurement systems.
- To study optical, pressure, temperature, and other advanced sensors used in modern sensing applications.
- To explore data acquisition systems and actuator mechanisms used for automatic control applications.

Detailed Syllabus

Unit I SENSOR CLASSIFICATION, CHARACTERISTICS AND SIGNAL TYPES 9

Basics of Measurement – Classification of Errors – Error Analysis – Static and Dynamic Characteristics of Transducers – Performance Measures of Sensors – Classification of Sensors – Sensor Calibration Techniques – Sensor Outputs - Signal Types - Analog and Digital Signals, PWM and PPM.

Unit II DISPLACEMENT, PROXIMITY AND RANGING SENSORS 9

Displacement Sensors – Brush Encoders - Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer – Range Sensors - Ultrasonic Ranging - Reflective Beacons - Laser Range Sensor (LIDAR) – GPS - RF Beacons.

Unit III FORCE, MAGNETIC AND HEADING SENSORS 9

Strain Gage – Types, Working, Advantage, Limitation, and Applications: Load Measurement –Force and Torque Measurement - Magnetic Sensors – Types, Principle, Advantage, Limitation, and Applications - Magneto Resistive – Hall Effect, Eddy Current Sensor - Heading Sensors –Compass, Gyroscope and Inclinometers.

Unit IV OPTICAL, PRESSURE, TEMPERATURE AND OTHER SENSORS	**9**
Photo Conductive Cell, Photo Voltaic, Photo Resistive, LDR – Fiber Optic Sensors – Pressure – Diaphragm – Bellows - Piezoelectric - Piezo-resistive - Acoustic, Temperature – IC, Thermistor, RTD, Thermocouple – Non-Contact Sensor - Chemical Sensors - MEMS Sensors -Smart Sensors.	
UNIT V DATA ACQUISITION AND ACTUATORS	**9**
Fundamentals of Data Acquisition System- Working principles, construction and location of actuators viz. Solenoid, relay, stepper motor - Types of actuators used in automatic temperature control- Fixed and variable displacement temperature control- Semi Automatic- Controller design for air conditioning systems.	
TOTAL PERIODS: 45	

Learning Resources

1	Bolton W., “Mechatronics”, Pearson Education, 2015.
2	Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
3	William Ribbens, "Understand Automotive Electronics -An Engineering Perspective," Elsevier Butterworth-Heinemann Publishers, 2012.
4	K.M. Letherman, “Automatic Controls for Heating and Air Conditioning: Principles and Applications” Elsevier, 2014
5	Sensors and Actuators, IISc Bangalore- nptel.ac.in/courses/108108147
6	Sensor Technologies: Physics, Fabrication, and Circuits - https://onlinecourses.nptel.ac.in/noc23_ee95/preview

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Illustrate principles of measurement systems, sensor characteristics, and signal types in sensing applications.	Apply
CO2	Analyze displacement, proximity, and ranging sensors used for position and distance measurement.	Analyze
CO3	Apply force, magnetic, and heading sensors for measurement of physical parameters.	Apply
CO4	Analyze optical, pressure, temperature, and MEMS sensors used in modern instrumentation systems.	Analyze
CO5	Evaluate data acquisition systems and actuator mechanisms used in automatic control applications.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2	2			2	2		2	3	3
CO2	3	3	3	2	2			2	2		2	3	3
CO3	3	3	2	2	2			2	2		2	3	3
CO4	3	3	3	3	2			2	2		2	3	3
CO5	3	3	2	2	2			2	2	3	2	3	3
Avg.	**3**	**3**	**2.4**	**2.2**	**2**			**2**	**2**	**3**	**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECSD02	IOT ARCHITECTURE AND PROTOCOLS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able,

- To apply the concepts, architecture, and functional blocks of IoT.
- To analyze the enabling technologies and communication protocols used in IoT systems.
- To apply programming and interfacing techniques using microcontrollers for IoT development.
- To explore networking, cloud integration, and data management in IoT environments.
- To analyze the applications and business models of IoT in various domains.

Detailed Syllabus

Unit I FUNDAMENTALS OF IoT ARCHITECTURE	**9**
Definition and Characteristics of Internet of Things (IoT) - Challenges and Issues - Physical Design of IoT - Logical Design of IoT - IoT Functional Blocks.	
Unit II IoT PROTOCOLS	**9**
Control Units – Communication modules – Bluetooth – Zigbee – WiFi – GPS - IoT Protocols (IPv6, 6LoWPAN, RPL, CoAP) – MQTT - Wired Communication - Power Sources.	
Unit III IoT TECHNOLOGIES	**9**
Four pillars of the IoT paradigm: RFID, Wireless Sensor Networks, Supervisory Control and Data Acquisition (SCADA) - M2M - IoT Enabling Technologies: Big Data Analytics, Cloud Computing, Embedded Systems.	
Unit IV NETWORKING, DATA MANAGEMENT AND WEB OF THINGS	**9**
Scalability: Network Configuration Protocol, Open vSwitch Database Management Protocol - Routing and Protocols: Collection Tree, LOADng.	
Unit V WoT SCOPE	**9**
Scope of Web of Things (WoT) – IoT Data Management: Set up cloud environment, Cloud access from sensors, Data Analytics Platforms for IOT- Resource Identification: Richardson Maturity Model - REST API.	
	TOTAL PERIODS: 45

Learning Resources

1	Simone Cirani, Gianluigi Ferrari, Marco Picone, Luca Veltri, “Internet of Things: Architectures, Protocols and Standards”,Wiley Publications, USA, 2019.
2	Bahga, Arshdeep, and Vijay Madisetti, “Internet of Things: A Hands-on Approach” Universities press, India, 2014
3	Vlasios Tsiatsis, Jan Holler, Catherine Mulligan, Stamatis Karnourskos and David Boyle, “Internet of Things: Technologies and Applications for a New Age of Intelligence” Academic Press, USA, 2018.
4	Rajkumar Buyya, Amir Vahid Dastjerdi, “Internet of Things: Principle and Paradigms”, Elsevier, 2016.
5	Olivier Hersent, David Boswarthick, Omar Elloumi, “The Internet of Things: Key Applications and Protocols” 2011, Wiley
6	Introduction to Internet of Things “ Introduction to Internet of Things - Course “

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Interpret the fundamental concepts, architecture, and functional blocks of IoT.	Apply
CO2	Explain the role of enabling technologies and communication protocols in IoT systems.	Apply
CO3	Develop microcontroller programming and interfacing techniques for IoT applications.	Apply
CO4	Illustrate the networking, data management, and cloud integration aspects of IoT.	Apply
CO5	Analyze IoT-based business models and applications in real-world scenarios.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	2				2	2		2	3	3
CO2	3	3	3	2				2	2		2	3	3
CO3	3	3	3	2				2	2		2	3	3
CO4	3	2	2	2				2	2	2	2	3	3
CO5	3	3	3	2				2	2		2	3	3
Avg.	**3**	**2.8**	**2.6**	**2**				**2**	**2**	**2**	**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECSD03	**WEARABLE TECHNOLOGIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able,

- To outline the evolution, core concepts, and technology components that enable modern wearable systems.
- To explore innovation processes, prototyping approaches, and performance considerations in wearable device development.
- To examine key cybernetics concepts, including augmented, virtual, and mixed reality used in wearable computing.
- To study Body Area Network (BAN/BSN) architectures, communication standards, sensor platforms, and development frameworks.
- To evaluate real-world wearable computing case studies and identify critical design challenges and implementation issues.

Detailed Syllabus

Unit I INTRODUCTION TO WEARABLE TECHNOLOGIES **9**

Introduction - History - Building Blocks: Bluetooth Low Energy (BLE), Embedded Software Programming, Sensors for Wearables, Data from Wearable Device: Android Wear, Apple WatchKit, Cloud Services, Google Fit, Apple Health Kit

Unit II INNOVATION WITH WEARABLES	**9**
Process for Lifestyle Innovation, Prototyping and Modelling, Working with a Wearable Device, Three-Tier Architecture for Wearables, Useful Design Patterns and Methods, Multi threading and Concurrency for Wearables, Performance Tuning Retrieval and Analysis of Sensor Data	
Unit III CYBERNETICS	**9**
Wearables - Augmented Reality – Mixed Reality. Case studies, Oculus Rift (2012, 2013), AR versus VR - IoT and Wearables: Smart Cities and Wearable Computing as a form of urban design - Advanced I/O – open Frameworks: Live Network feeds (push and pull), Data persistence (saving data and preferences)	
Unit IV BODY AREA NETWORKS	**9**
Typical m-Health System Architecture- Hardware Architecture of a Sensor Node-Communication Medium, Power Consumption Considerations, Communication Standards-Network Topologies-Commercial Sensor Node Platforms- Bio-physiological Signals and Sensors, BSN Application Domains- Developing BSN Applications- Programming Abstractions-Requirements for BSN Frameworks- BSN Programming Frameworks	
Unit V CASE STUDIES	**9**
Soft Skin simulation for Wearable Haptic Rendering - Design Challenges for real wearable computers - E-Textiles in the Apparel Factory - Garment Devices - Collaboration with wearable computers.	
TOTAL PERIODS: 45	

Learning Resources

1	Fortino, Giancarlo, Raffaele Gravina, and Stefano Galzarano, “Wearable computing: from modeling to implementation of wearable systems based on body sensor networks”, John Wiley & Sons, 2018.
2	Linowes Jonathan, “Augmented Reality for Developers” Packt Publishing Limited, 2017
3	Simon Monk, “Programming the Raspberry Pi: Getting Started with Python” McGraw Hill LLC, 2021
4	Barfield, Woodrow, “Fundamentals of wearable computers and augmented reality” CRC press, 2015.
5	Wearable Technologies and Sports Analytics - Wearable Technologies and Sports Analytics | Coursera
6	Introduction to Augmented Reality and ARCore - Introduction to Augmented Reality and ARCore | Coursera

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Apply the key building blocks of wearable technologies	Apply
CO2	Illustrate innovation processes, prototyping methods, and performance factors involved in developing wearable devices.	Apply
CO3	Develop interaction and data-handling mechanisms in AR, VR, and mixed-reality based wearable applications.	Apply

CO4	Develop Body Area Network (BAN/BSN) applications using sensor nodes, communication standards, and suitable frameworks.	Apply
CO5	Analyze wearable computing case studies to identify major design challenges, architectural issues, and practical constraints.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2							2	3	3
CO2	3	3	3	2		2				2	2	3	3
CO3	3	3	3	3		2				2	2	3	3
CO4	3	2	2	2					2		2	3	3
CO5	3	3	3	2		2	3	3	3	2	2	3	3
Avg.	**3**	**2.6**	**2.6**	**2.2**		**2**	**3**	**3**	**2.5**	**2**	**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECSD04	MEMS DESIGN	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able,

- To outline the fundamental electrical and mechanical concepts relevant to MEMS devices.
- To examine electrostatic sensing and actuation mechanisms used in micro sensors and actuators.
- To study thermal sensing and actuation principles and their applications in MEMS devices.
- To analyze the working principles and material properties of piezoelectric sensors and actuators.
- To explore magnetic sensing and actuation techniques used in MEMS-based systems

Detailed Syllabus

Unit I ESSENTIAL ELECTRIC AND MECHANICAL CONCEPTS **9**

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 II ELECTRO STATIC SENSING AND ACTUATION **9**

Parallel plate capacitor, Applications of parallel plate capacitors- inertial sensor, pressure sensor, flow sensor, tactile sensor, parallel plate actuators, inter digitated finger capacitors, applications of comb drive devices.

Unit III THERMAL SENSING AND ACTUATION **9**

Fundamentals of thermal transfer, Sensors and actuators based on thermal expansion, Thermal couples, Thermal resistors, Applications- Infrared sensors, flow sensors, Inertial sensors, other sensors

Unit IV PIEZOELECTRIC SENSING AND ACTUATION **9**

Mathematical description of piezoelectric effects, Cantilever piezoelectric actuator model, properties of piezoelectric materials –Quartz, PZT,PVDF, ZnO , Applications – Acoustic sensors, Tactile sensors

Unit V MAGNETIC SENSING AND ACTUATION	**9**
Concepts and principles- magnetization and nomenclatures, principles of micro magnetic actuators, fabrication of micro magnetic components- deposition, design and fabrication of magnetic coil, MEMS magnetic actuators	
	Total Periods: 45

Learning Resources

1	Murty B.S, Shankar P, Raj B, Rath, B.B, Murday J, "Textbook of Nano science and Nanotechnology" Springer, 2013.
2	Chang Liu, "Foundations of MEMS", Pearson education India limited, 2011
3	Sergey Edward Lyshevski, "MEMS and NEMS: Systems, Devices, and Structures", CRC Press, 2018
4	Vinod Kumar Khanna, "Nanosensors: Physical, Chemical, and Biological" CRC press, 2021.
5	Introduction to MEMS and Microsystems - nptel.ac.in/courses/117105082
6	Fabrication Techniques for MEMs-based sensors: Clinical Perspective - nptel.ac.in/courses/108108113

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Illustrate electrical and mechanical concepts such as semiconductor conductivity, stress–strain, and resonant frequency in MEMS systems.	Apply
CO2	Analyze electrostatic sensing and actuation mechanisms used in MEMS devices such as capacitive sensors and comb drive actuators.	Analyze
CO3	Apply thermal sensing and actuation principles for MEMS-based sensors such as infrared and flow sensors.	Apply
CO4	Analyze piezoelectric sensing and actuation mechanisms using materials such as PZT, Quartz, and ZnO.	Analyze
CO5	Evaluate magnetic sensing and actuation techniques used in MEMS devices and micro magnetic components.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2		2	2	2			3	3
CO2	3	3	2	2	2		2	2	2			3	3
CO3	3	2	2	2	2		2	2	2			3	3
CO4	3	3	2	3	2		2	2	2			3	3
CO5	3	3	2	2	2	2	2	2	2			3	3
Avg.	**3.0**	**2.6**	**2**	**2**	**2**	**2**	**2**	**2**	**2**			**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECSD05	INDUSTRIAL IOT AND INDUSTRY 4.0	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able,

- To outline the fundamentals of Industry 4.0 and IIoT, including IT–OT convergence and industrial control systems.
- To examine technological aspects, industrial networks, and architectural models used in IIoT systems.
- To study enabling technologies such as sensing, communication, and industrial data acquisition in IIoT.
- To analyze data analytics, machine learning, and security mechanisms in industrial IoT environments.
- To evaluate real-time IIoT applications and case studies in smart industries and Industry 5.0.

Detailed Syllabus

Unit I INTRODUCTION TO IIoT AND INDUSTRY 4.0	**9**
Basics of Industry 4.0 and Industrial Internet of Things (IIoT) - Evolution of IIoT – Understand the IT & OT (Operational Technology) convergence - OT components like Industrial control systems, PLC, SCADA and DCS - Industrial Edge - Open loop and Closed loop controls -Components of IIOT - Role of IIOT in Manufacturing Processes - Challenges & Benefits in implementing IIOT, Adoption of IIoT - Market trends and opportunities in IIoT	
Unit II TECHNOLOGICAL ASPECTS OF IIOT	**9**
Technological Aspects of Industry 4.0 and IIoT - Industrial processes - Industrial sensing and actuation - Industrial networks - Machine-to-machine networks - Business Models and Reference Architecture of IIoT - IIoT design considerations - Key Technologies, Off-site Technologies, On-site Technologies	
Unit III ENABLING TECHNOLOGIES OF IIOT	**9**
Enabling Technologies of IIoT - IIoT Layers - Sensing - Processing - Communication and Networking in IIoT - Sensors, Actuators, Industrial Data Transmission - Industrial Data Acquisition	
Unit IV IIoT ANALYTICS AND SECURITY	**9**
IIoT Analytics - Big Data Analytics and Software Defined Networks - Machine Learning and Data Science in Industries - Security and Fog computing in IIoT	
Unit V IIoT APPLICATIONS AND CASE STUDIES	**9**
Applications of IIoT and Case Studies - Healthcare Applications in Industries - Inventory Management and Quality Control - Plant Safety and Security - Oil, chemical and pharmaceutical industry - Integration of products, processes, and people - Smart factories and cyber physical systems - Case Studies used in building IIoT applications - Industry 5.0 - Introduction, Features.	
	Total Periods: 45

List of Experiments

1	Image Negative Transformation
2	Image Histogram and Histogram Equalization
3	Edge Detection using Sobel Operator
4	Image Noise Addition and Removal
5	Image Thresholding for Image Segmentation



6	Introduction to Industry 4.0 and Industrial Internet of Things - https://onlinecourses.nptel.ac.in/noc24_cs95/preview?utm
	Total Periods:30

Learning Resources

1	Sudip Misra Chandana Roy, Anandarup Mukherjee, “Introduction to Industrial Internet of Things and Industry 4.0” CRC Press, 2020
2	Simon Monk, O'Reilly (SPD), “Raspberry Pi Cookbook, Software and Hardware Problems and solutions” 2016, ISBN 7989352133895
3	N. Ida, “Sensors, Actuators and Their Interfaces” SciTech Publishers, 2014.
4	Vinod Kumar Khanna, “Nanosensors: Physical, Chemical, and Biological” CRC press, 2021.
5	Diego Galar Pascual, Pasquale Daponte, UdayKumar, “Handbook of Industry 4.0 and Smart Systems”, CRC Press, 2019
6	Introduction to Industry 4.0 and Industrial Internet of Things - https://onlinecourses.nptel.ac.in/noc24_cs95/preview?utm

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Illustrate IIoT concepts, industrial architectures, and control systems in industrial environments.	Apply
CO2	Analyze technological frameworks, industrial networks, and design considerations in IIoT systems.	Analyze
CO3	Interpret enabling technologies such as sensors, actuators, and data acquisition in IIoT applications.	Apply
CO4	Analyze big data analytics, machine learning, and security mechanisms in IIoT systems..	Analyze
CO5	Evaluate IIoT applications, smart factories, and industrial case studies for real-world implementation.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3		2	2			2	3	3
CO2	3	3	3	3	3		2	2			2	3	3
CO3	3	3	3	3	3		2	2			2	3	3
CO4	3	3	3	3	3		2	2			3	3	3
CO5	3	3	3	3	3		3	3	3		3	3	3
Avg.	**3**	**3**	**3**	**3**	**3**		**2.2**	**2.2**	**3**		**2.4**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECSD06	NANO ELECTRONICS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able,

- To outline the principles of nano-scale physics including quantum mechanics and electron confinement.
- To examine quantum electronic devices and their operation in nano-scale transistor technologies.
- To study nano-electronic transistor structures such as single electron transistors and nanowire FETs.
- To analyze tunneling phenomena and superconducting nano-electronic devices.
- To explore carbon nanotubes and nano-structured devices for future electronic applications.

Detailed Syllabus

Unit I INTRODUCTION TO NANO ELECTRONICS	**9**
Scaling to nano - Light as a wave and particle- Electrons as waves and particles- origin of quantum mechanics - General postulates of quantum mechanics - Time independent Schrodinger wave equation- Electron confinement - Quantum dots, wires and well-Spin and angular momentum	
Unit II QUANTUM ELECTRONICS	**9**
Quantum electronic devices - Short channel MOS transistor - Split gate transistor - Electron wave transistor - Electron wave transistor - Electron spin transistor - Quantum cellular automata Quantum dot array, Quantum memory.	
Unit III NANO ELECTRONIC TRANSISTORS	**9**
Coulomb blockade - Coulomb blockade in Nano capacitors - Coulomb blockade in tunnel junctions - Single electron transistors, Semiconductor nanowire FETs and SETs, Molecular SETs and molecular electronics - Memory cell.	
Unit IV NANO ELECTRONIC TUNNELING AND SUPER CONDUCTING DEVICES	**9**
Tunnel effect -Tunneling element -Tunneling diode - Resonant tunneling diode - Three terminal resonant tunneling devices- Superconducting switching devices- Cryotron- Josephson tunneling device.	
Unit V NANOTUBES AND NANOSTRUCTURE DEVICES	**9**
Carbon Nanotube - Fullerenes - Types of nanotubes – Formation of nanotubes –Assemblies –Purification of carbon nanotubes – Electronic properties – Synthesis of carbon nanotubes –Carbon nanotube interconnects – Carbon nanotube FETs and SETs –Nanotube for memory applications- Nano structures and nano structured devices.	
	Total Periods: 45

Learning Resources

1	Hassan Raza, “Nanoelectronics Fundamentals: Materials, Devices and Technology” Springer, 2019
2	Seng Ghee Tan, Mansoor B. A. Jalil, “Introduction to the Physics of Nanoelectronics” Elsevier, 2018
3	Mircea Dragoman and Daniela Dragoman, “2D Nanoelectronics: Physics and Devices of Atomically Thin Materials” Springer, 2017
4	Robert Puers, Livio Baldi, Marcel Van de Voorde and Sebastiaan E. Van Nooten, “Nanoelectronics: Materials, Devices, Applications” Wiley, 2017.

5	Brajesh Kumar Kaushik, “Nanoelectronics: Devices, Circuits and Systems” Elsevier science, 2018
6	Introduction to Nanoelectronics - nptel.ac.in/courses/117108047

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Illustrate principles of quantum mechanics and electron confinement in nano-electronic systems.	Apply
CO2	Analyze the operation and characteristics of quantum electronic devices and nano MOS transistors.	Analyze
CO3	Develop concepts of Coulomb blockade and single electron transistors in nano-electronic circuits.	Apply
CO4	Analyze tunneling mechanisms and superconducting switching devices in nano-electronics.	Analyze
CO5	Evaluate carbon nanotubes and nano-structured devices for advanced electronic applications.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2			2	2		2	3	2
CO2	3	3	2	2	2			2	2		2	3	2
CO3	3	3	3	2	2			2	2		2	3	3
CO4	3	3	2	3	2			2	2		2	3	2
CO5	3	3	2	2	2		2	2	2		2	3	3
Avg.	**3**	**2.8**	**2.2**	**2.2**	**2**		**2**	**2**	**2**		**2**	**3**	**2.4**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

VERTICAL 2: COMMUNICATION AND SIGNAL PROCESSING

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24ECCS01	Next Generation Networks	PEC	3	0	0	3	3	40	60
2	U24ECCS02	Digital Image Processing	PEC	2	0	2	3	3	50	50
3	U24ECCS03	Speech Information Processing	PEC	3	0	0	3	3	40	60
4	U24ECCS04	Multimedia Communication Systems	PEC	3	0	0	3	3	40	60
5	U24ECCS05	Wireless and Adhoc Networks	PEC	3	0	0	3	3	40	60
6	U24ECCS06	Optical Signal Processing	PEC	3	0	0	3	3	40	60
7	U24ECCS07	Millimeter Wave Technology	PEC	3	0	0	3	3	40	60
8	U24ECCS08	Computer Vision	PEC	2	0	2	3	3	50	50

U24ECCS01	NEXT GENERATION NETWORKS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able,

- To understand the concepts of network convergence and the evolution of communication networks towards Next Generation Networks (NGN).
- To explain the architecture and functional components of NGN and IP Multimedia Subsystem (IMS).
- Apply NGN protocols and signaling mechanisms used in multimedia communication and VoIP networks.
- Analyze the technologies used in next generation access networks and core networks including fiber, wireless broadband and mobile networks.
- Evaluate modern networking paradigms such as Software Defined Networking (SDN), network virtualization and intelligent future networks.

Detailed Syllabus

UNIT I Network Convergence and Next Generation Networking Fundamentals 9

Concept of convergence: network convergence, service convergence, device convergence and content convergence- Evolution from technology push to service pull- Introduction to Next Generation Networks (NGN)- Evolution trends in ICT networks towards NGN- Differences between traditional telecommunication networks and converged networks- Drivers for NGN: economic, technological and social factors- NGN services, challenges and opportunities

UNIT II NGN Architecture and IP Multimedia Subsystem (IMS) 9

Conceptual model of NGN: access layer, transport layer, control layer and service layer- NGN architecture: soft-switch based architecture and IMS-based architecture- IMS architecture: nodes and functional entities – P-CSCF, S-CSCF, I-CSCF, application servers, BGCF, gateways and

media resource functions- Advantages of IMS architecture- Numbering, naming and addressing in NGN- IMS based service delivery and integration.
UNIT III NGN Protocols and Multimedia Communication 9 NGN protocol stack and signaling protocols-Fundamental protocols: SIP, SDP, RTP, RTCP, H.248 (Megaco)- Authentication and security protocols: AAA frameworks- Supporting protocols: XCAP, SOAP and REST-based APIs- Voice over IP (VoIP) principles and telephony over IP networks- Fixed Mobile Convergence (FMC) and multimedia service delivery- Case study: IMS-based IPTV architecture
UNIT IV Next Generation Access and Core Networks 9 Wire line access: Fiber to the Premises (FTTP), Passive Optical Networks (PON), Carrier Ethernet-Broadband wireless access: Wi-Fi 6/6E, WiMAX (overview), Emerging 6G concepts-Next generation core networks: role of core networks in service control and reconfigurability-Cloud-based network infrastructure and edge computing- NGN applications: e-commerce, unified communications, IoT connectivity and multimedia services.
UNIT V Software Defined Networking and Future Intelligent Networks 9 Software Defined Networking (SDN) concepts and architecture-SDN control plane and data plane separation-SDN software stack and controllers-Network virtualization and Network Function Virtualization (NFV)-Applications: data center networking, traffic engineering and wide area network optimization-SDN challenges: scalability, security and reliability-Future trends: AI-driven networks, self-healing networks, intent-based networking and programmable networks
Total Periods: 45

Learning Resources

1	Jingming Li Salina & Pascal Salina, **"**Next Generation Networks: Perspectives and Potentials", Wiley Publications, 1st Edition (2008).
2	Thomas Plevyak, "Next Generation Telecommunications Networks, Services, and Management", Wiley-IEEE Press, 1st Edition (2010).
3	Erik Dahlman, Stefan Parkvall, Johan Skold, "5G NR: The Next Generation Wireless Access Technology", Academic Press, 2nd Edition (2020).
4	NPTEL: Advanced 3G and 4G Wireless Mobile Communications- https://nptel.ac.in/courses/117104099
5	NPTEL: Computer Networks and Internet Protocol -https://onlinecourses.nptel.ac.in/noc26_cs35

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the principles of network convergence and the evolution of communication networks towards NGN.	Understand
CO2	Describe the architecture, functional entities and services of NGN and IMS based networks	Understand
CO3	Apply NGN protocols such as SIP, RTP and related signaling mechanisms for multimedia communication and VoIP services.	Apply

CO4	Analyze next generation access and core network technologies including fiber networks, wireless broadband and mobile communication systems.	Analyze
CO5	Evaluate the role of Software Defined Networking (SDN), network virtualization and emerging intelligent networking technologies.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3				2	2		2	3	3
CO2	3	3	3	3				2	2		2	3	3
CO3	3	3	3	3				2	2		2	3	3
CO4	3	3	3	3				2	2		2	3	3
CO5	3	3	3	3				2	2		2	3	3
Avg.	**3**	**3**	**3**	**3**				**2**	**2**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECCS02	DIGITAL IMAGE PROCESSING	L	T	P	C
		2	0	2	3

Course Objective:

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

- Explain the fundamental concepts and mathematical representations of digital images.
- Apply image enhancement techniques in both spatial and frequency domains to improve image quality.
- Analyze the effects of degradation functions and suitable restoration techniques.
- Analyze the image segmentation and representation methods for efficient image analysis.
- Analyze the image compression and recognition techniques for real-world applications.

Detailed Syllabus

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, HSI models

UNIT II IMAGE ENHANCEMENT **6**

Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement

UNIT III IMAGE RESTORATION **6**

Image Restoration - degradation model, Properties, Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass 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 – basic concepts – Dam construction – Watershed segmentation algorithm.	
UNIT V IMAGE COMPRESSION AND RECOGNITION	**6**
Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors – Topological feature, Texture - Patterns and Pattern classes - Recognition based on matching.	
Total Periods: 30	

List of Experiments

1	Image Negative Transformation
2	Image Histogram and Histogram Equalization
3	Edge Detection using Sobel Operator
4	Image Noise Addition and Removal
5	Image Thresholding for Image Segmentation
6	Object Counting in an Image
	Total Periods:30

Learning Resources

1	Gonzalez, Woods & Steven L. Eddins, “Digital Image Processing Using MATLAB, 3rd Edition, (2020).
2	Anil K. Jain, “Fundamentals of Digital Image Processing”, Pearson, 2nd Edition, 2016.
3	Scott E. Umbaugh, “Digital Image Processing & Analysis (Enhancement, etc.), 4th Edition 2022.
4	Hang Chen & Zhengjun Liu, “Artificial Intelligence in Digital Image Processing”, 1st Edition 2026, Springer.
5	Digital Image Processing - https://nptel.ac.in/courses/117105079
6	Virtual lab- Digital Image Processing Virtual Lab-https://cse20-iiith.vlabs.ac.in/

Course Outcomes

At the end of the course, the students will be able to

CO	Course Outcome Statement	Knowledge Level
CO1	Analyze the fundamental principles of digital image formation, sampling, and quantization to interpret image structures effectively.	Analyze
CO2	Apply spatial and frequency domain enhancement techniques to select suitable methods for specific image improvement tasks.	Apply
CO3	Analyze image degradation models and restoration algorithms to reconstruct high-quality images.	Analyze

CO4	Analyze the various image segmentation and representation techniques for efficient object recognition and scene Understand	Analyze
CO5	Analyze the effective image compression and recognition systems for practical and real-time image processing applications.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2				2	2	2		2	3	3
CO2	3	3	2				2	2	2		2	3	3
CO3	3	3	2				2	2	2		2	3	3
CO4	3	3	2				2	2	2		2	3	3
CO5	3	3	2				2	2	2		2	3	3
Avg.	**3**	**3**	**2**				**2**	**2**	**2**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECCS03	SPEECH INFORMATION PROCESSING	L	T	P	C
		3	0	0	3

Course Objective:

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

- Illustrate the mechanism of human speech production using block diagrams and models.
- Analyze time domain models for speech signals.
- Analyze linear predictive coding techniques.
- Illustrate the homomorphic speech processing.
- Analyze the speech enhancement techniques.

Detailed Syllabus

UNIT I FUNDAMENTALS OF SPEECH **9**

The Human speech production mechanism, Discrete-Time model of speech production, Speech perception - human auditory system, Phonetics - articulatory phonetics, acoustic phonetics, and auditory phonetics, Categorization of speech sounds, Spectrographic analysis of speech sounds

UNIT II SPEECH FEATURES **9**

Significance of speech features in speech-based applications, Speech Features – Cepstral Coefficients, Mel Frequency Cepstral Coefficients (MFCCs), Perceptual Linear Prediction (PLP), Log Frequency Power Coefficients (LFPCs).

UNIT III SPEECH CODING **9**

Need for speech coding, Waveform coding of speech – PCM, Adaptive PCM, DPCM, ADPCM, Delta Modulation, Adaptive Delta Modulation, G.726 Standard for ADPCM, Parametric Speech Coding – Channel Vocoders, Linear Prediction Based Vocoders, Code Excited Linear Prediction (CELP) based Vocoders.

UNIT IV SPEECH ENHANCEMENT **9**

Classes of Speech Enhancement Algorithms, Spectral-Subtractive Algorithms - Multiband Spectral Subtraction, MMSE Spectral Subtraction Algorithm, Spectral Subtraction Based on Perceptual Properties, Wiener Filtering - Wiener Filters in the Time Domain, Wiener Filters in the Frequency Domain.

UNIT V SPEECH SYNTHESIS AND APPLICATION **9**

Text-to-Speech systems (TTS), Synthesizers technologies – Concatenative synthesis, Use of

Formants for concatenative synthesis, Use of LPC for concatenative synthesis, HMM-based synthesis, Sine wave synthesis, Speech transformations.
Total Periods: 45

Learning Resources

1	Steve Young, Gerrit Bloothooft, **"**Corpus-Based Methods in Language and Speech Processing: 2" (Text, Speech and Language Technology)-Dec, 2010.
2	Dr. Shaila D. Apte, "Speech and audio Processing', Wiley Publications, 2nd Edition (2019/2021),
3	Daniel Jurafsky, James H. Martin, " Speech and Language Processing" , 2nd Edition (2009).
4	Lawrence R. Rabiner, Ronald W. Schafer, "Theory and Applications of Digital Speech Processing", Pearson, 2011.
5	Speech Signal Processing-https://nptel.ac.in/courses/117106056
6	Digital Speech Processing- https://nptel.ac.in/courses/117105145

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Illustrate the process of human speech production using appropriate models	Apply
CO2	Analyze time domain models for speech signals.	Analyze
CO3	Analyze linear predictive coding techniques.	Analyze
CO4	Illustrate the homomorphic speech processing.	Apply
CO5	Analyze the speech enhancement techniques	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3				2	2		2	3	3
CO2	3	3	3	3				2	2		2	3	3
CO3	3	3	3	3				2	2		2	3	3
CO4	3	3	3	3				2	2		2	3	3
CO5	3	3	3	3				2	2		2	3	3
Avg.	**3**	**3**	**3**	**3**				**2**	**2**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECCS04	MULTIMEDIA COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

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

- Understand the fundamental concepts of multimedia communication systems and multimedia terminals.
- Explain digital media processing techniques including audio, image, and video signal processing.
- Apply multimedia compression techniques for efficient storage and transmission of multimedia data.
- Analyze the architecture and resource management of distributed multimedia systems and multimedia networking.
- Evaluate multimedia communication standards and protocols used for multimedia transmission across networks.

Detailed Syllabus

UNIT I FUNDAMENTALS OF MULTIMEDIA COMMUNICATION	**9**
Network requirements for multimedia communication –Multimedia terminals and system components- Multimedia requirements for ATM networks - Audio–visual integration in multimedia systems- Audio-to-visual mapping techniques.	
UNIT II DIGITAL MULTIMEDIA PROCESSING	**9**
Digital media representation- Signal processing elements in multimedia systems- Challenges in multimedia information processing- Perceptual coding of digital audio signals- Transform audio coding techniques	
UNIT III IMAGE AND VIDEO CODING TECHNIQUES	**9**
Image coding principles-Video coding fundamentals-Compression techniques for multimedia data-JPEG image compression-MPEG video compression standards	
UNIT IV DISTRIBUTED MULTIMEDIA SYSTEMS	**9**
Distributed multimedia systems (DMS) architecture- Resource management in distributed multimedia systems- Multimedia IP networking- Multimedia operating systems- Distributed multimedia servers and applications- Multimedia file formats.	
UNIT V MULTIMEDIA COMMUNICATION STANDARDS AND APPLICATIONS	**9**
Multimedia communication standards- MPEG standards: MPEG-1, MPEG-2 and MPEG-4-MPEG-4 visual texture coding (VTC)- Multimedia communication across networks- Emerging multimedia services and applications.	
	Total Periods: 45

Learning Resources

1	Fred Halsall, “Multimedia Communications: Applications, Networks, Protocols, and Standards”, Pearson Education, 2020.
2	Ze-Nian Li, Mark S. Drew, Jiangchuan Liu, **“**Fundamentals of Multimedia**”,** 3rd Edition 2021.
3	Khalid Sayood, “Introduction to Data Compression”, 4th Edition (2012).
4	K. R. Rao, Zoran S. Bojkovic, Dragorad A. Milovanovic, “Multimedia Communication Systems: Techniques, Standards and Networks, Prentice Hall, 2002.

5	NPTEL: Introduction to Multimedia Systems and Processing- https://nptel.ac.in/courses/117105083
6	Virtual Lab: Graphics and Visualization Virtual Lab-https://vgl.csa.iisc.ac.in/

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the principles of multimedia communication systems, multimedia terminals, and network requirements.	Understand
CO2	Illustrate multimedia signal processing techniques used for digital audio, image, and video data.	Apply
CO3	Apply multimedia compression methods for efficient coding of audio, image, and video signals.	Apply
CO4	Analyze distributed multimedia system architectures and multimedia networking concepts.	Analyze
CO5	Evaluate multimedia communication standards and protocols used for multimedia transmission across networks.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3			2		2	2		2	3	3
CO2	3	3	3			2		2	2		2	3	3
CO3	3	3	3			3		2	2		2	3	3
CO4	3	3	3			3		2	2		2	3	3
CO5	3	3	3			3		2	2		2	3	3
Avg.	**3**	**3**	**3**			**2.6**		**2**	**2**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECCS05	**WIRELESS AND ADHOC NETWORKS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

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

- Understand the fundamental concepts, characteristics, mobility models, and applications of wireless ad hoc networks.
- Explain the design issues and working principles of MAC protocols and IEEE wireless standards used in ad hoc networks.
- Apply different routing protocols and algorithms for efficient communication in ad hoc networks.
- Analyze transport layer protocols and security issues associated with wireless ad hoc networks.
- Evaluate cross-layer design techniques and the integration of ad hoc networks with mobile IP networks.

Detailed Syllabus

UNIT I FUNDAMENTALS OF WIRELESS ADHOC NETWORKS	**9**
Introduction to adhoc networks: definition, characteristics and features-Applications of adhoc networks-Characteristics of wireless channels-Adhoc mobility models: indoor and outdoor mobility models-Challenges in wireless adhoc networking.	
UNIT II MEDIUM ACCESS CONTROL PROTOCOLS FOR ADHOC NETWORKS	**9**
MAC protocols: design issues, goals and classification- Contention-based MAC protocols with reservation- Scheduling algorithms for MAC protocols- Protocols using directional antennas-IEEE wireless standards.	
UNIT III ROUTING PROTOCOLS IN ADHOC NETWORKS	**9**
Routing design issues and goals-Classification of routing protocols-Proactive vs reactive routing protocols-Unicast routing algorithms- Multicast routing algorithms- Hybrid routing algorithms-Energy-aware routing protocols- Hierarchical routing- QoS-aware routing protocols.	
UNIT IV TRANSPORT LAYER AND SECURITY IN ADHOC NETWORKS	**9**
Transport layer issues in adhoc networks- Classification of adhoc transport protocols- Security challenges in adhoc networks- Network security attacks- Secure routing protocols and security mechanisms	
UNIT V CROSS LAYER DESIGN AND NETWORK INTEGRATION	**9**
Need for cross-layer design in adhoc networks- Cross-layer optimization techniques- Parameter optimization methods- Cross-layer design challenges and cautionary perspective- Integration of adhoc networks with Mobile IP networks- Emerging applications and future trends.	
	Total Periods: 45

Learning Resources

1	Feng Zhao and Leonidas J. Guibas, “Wireless Sensor Networks: An Information Processing Approach”, Elsevier, Morgan Kaufmann Publishers, 2004.
2	Charles E. Perkins, “Ad Hoc Networking, Addison”,Wesley Publishers, 2007.
3	Stefano Basagni, “Mobile Ad Hoc Networking: Cutting Edge Directions”, Wiley publishers, Second Edition, 2004.
4	Holger Karl and Andreas Willig. Protocols and Architectures for Wireless Sensor Networks,-Wiley Publishers, 2005.
5	NPTEL: Wireless Ad Hoc and Sensor Networks- https://onlinecourses.nptel.ac.in/noc25_cs74
6	NPTEL: Computer Networks And Internet Protocol- https://onlinecourses.nptel.ac.in/noc26_cs35/

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the basic concepts, characteristics, and mobility models of wireless ad hoc networks.	Understand

CO2	Describe MAC protocols, scheduling mechanisms, and IEEE wireless standards used in ad hoc networks.	Understand
CO3	Apply routing algorithms such as proactive, reactive, multicast, hybrid, and energy-aware routing in ad hoc networks.	Apply
CO4	Analyze transport layer protocols and security challenges in wireless ad hoc networks.	Analyze
CO5	Evaluate cross-layer design strategies and integration techniques for improving performance in mobile ad hoc networks.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	2				2	2		2	3	3
CO2	3	3	3	2				2	2		2	3	3
CO3	3	3	3	2				2	2		2	3	3
CO4	3	3	3	2				2	2		2	3	3
CO5	3	3	3	2				2	2		2	3	3
Avg.	**3**	**3**	**3**	**2**				**2**	**2**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECCS06	OPTICAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able ,

- To understand the fundamental concepts of optical signals, spatial signals, and geometrical optics.
- To explain Fourier transforms techniques and their applications in optical signal processing.
- To apply spectrum analysis and spatial filtering methods in optical systems.
- To analyze optical signal processors and spatial filtering techniques used in optical information processing.
- To evaluate the performance of acousto-optic devices and heterodyne optical systems

Detailed Syllabus

UNIT I FUNDAMENTALS OF OPTICAL SIGNALS AND GEOMETRICAL OPTICS 9

Characterization of a general signal - Examples of signals and spatial signals-Basic laws of geometrical optics-Refraction by mirrors and lenses-Lens formula and general imaging conditions-Optical invariant-Optical aberrations.

UNIT II PHYSICAL OPTICS AND FOURIER TRANSFORM TECHNIQUES 9

Physical optics concepts: Fresnel Transform-Fourier Transform and inverse Fourier transform-Examples of Fourier transforms-Extended Fourier transform analysis- Maximum information capacity and optimum packing density- System coherence.

UNIT III Spectrum Analysis and Spatial Filtering	**9**
Spectrum analysis in optical systems-Light sources used in optical signal processing-Spatial light modulators-Detection process in the Fourier domain- System performance parameters and dynamic range-Fundamentals of signal processing- Spatial filtering techniques.	
UNIT IV BINARY SPATIAL FILTERS AND OPTICAL SIGNAL PROCESSING	**9**
Binary spatial filters-Magnitude spatial filters-Phase spatial filters-Real-valued spatial filters-Interferometry techniques for constructing spatial filters- Optical signal processors and filter generators- Applications of optical signal processing	
UNIT V ACOUSTO-OPTIC DEVICES AND HETERODYNE SYSTEMS	**9**
Acousto-optic cell spatial light modulators- Applications of acousto-optic devices- Basic acousto-optic power spectrum analyzer- Heterodyne systems- Interference between two waves- Optical radio concepts.	
Total Periods: 45	

Learning Resources

1	Anthony VanderLugt, “Optical Signal Processing”, Ist Edition, 2005.
2	Bahaa E. A. Saleh and Malvin C. Teich., “Fundamentals of Photonics”, Second Edition, 2007.
3	David Casasent., “Optical Data Processing Applications”, Springer-Verlag (Topics in Applied Physics, Vol. 23), 1st Edition 1975.
4	Joseph L. Horner, “Optical Signal Processing”, Academia Press,1987.
5	NPTEL: Optical Engineering-https://onlinecourses.nptel.ac.in/noc21_ee81
6	NPTEL: Fiber Optic Communication Technology-https://nptel.ac.in/courses/108106167

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the principles of optical signals, geometrical optics, and imaging systems.	Understand
CO2	Illustrate Fourier transform techniques used in optical signal processing systems.	Apply
CO3	Apply spatial filtering and spectrum analysis methods for processing optical signals.	Apply
CO4	Analyze optical signal processors and spatial filter designs used in optical information processing.	Analyze
CO5	Evaluate the applications of acousto-optic devices and heterodyne optical systems.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3		2		3	3		2	3	3
CO2	3	3	3	3		2		3	3		2	3	3
CO3	3	3	3	3		2		3	3		2	3	3
CO4	3	3	3	3		2		3	3		2	3	3
CO5	3	3	3	3		2		3	3		2	3	3
Avg.	**3**	**3**	**3**	**3**		**2**		**3**	**3**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECCS07	MILLIMETER WAVE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

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

- Understand the fundamentals of microwave waveguides, resonators, and propagation modes in rectangular and circular waveguides.
- Explain the working principles of microwave passive components such as hybrid couplers, ferrite devices and transmission line circuits.
- Describe the operating principles of microwave tubes and quantum devices including klystrons, travelling wave tubes, and masers.
- Analyze microwave semiconductor amplifier configurations using devices such as MESFETs, tunnel diodes and parametric amplifiers.
- Analyze the performance of the microwave oscillators and mixers.

Detailed Syllabus

UNIT I MICROWAVE WAVEGUIDES AND RESONATORS	**9**
Analysis of rectangular and circular waveguides - Resonators and cavity resonators - TE and TM modes - Quality factor (Q) of the cavity - Loss mechanisms in cavities.	
UNIT II MICROWAVE PASSIVE COMPONENTS AND CIRCUITS	**9**
Hybrid couplers - Faraday rotation in ferrites - Passive microwave circuits: Microstrip and stripline - Filter implementation using transmission lines and striplines.	
UNIT III MICROWAVE TUBES AND QUANTUM DEVICES	**9**
Klystron: velocity modulation and electron bunching - Travelling Wave Tube (TWT): slow wave structure and Brillouin diagram - Maser: population inversion, pumping and stimulated emission.	
UNIT IV MICROWAVE SEMICONDUCTOR AMPLIFIERS	**9**
Microwave semiconductor devices: MESFETs, tunnel diode, parametric amplifiers - Principles of amplifier configurations - Amplifier parameters: gain, bandwidth, noise figure, dynamic range - Single-stage and broadband transistor amplifier design - Amplifier stability analysis.	
UNIT V MICROWAVE OSCILLATORS AND MIXERS	**9**
RF oscillators - Microwave Oscillators - Oscillator Phase Noise - Frequency Multipliers - Mixers.	
	Total Periods: 45

Learning Resources

1	David M. Pozar, “Microwave Engineering”, McGraw-Hill Education, 4th Edition, 2012.
2	Robert E. Collin, “Foundations for Microwave Engineering”, Wiley India, 2007.
3	Samuel Y. Liao, “Microwave Devices and Circuits”, Pearson Education, 1996.
4	Ludwig Reinhold, Pavel Bretchko, “RF Circuit Design: Theory and Applications”, Pearson, 2nd Edition, 2009.
5	NPTEL: Millimeter Wave Technology- http://digimat.in/nptel/courses/video/117105139/L13.html
6	MIT Opencourseware:https://ocw.mit.edu/search/?q=Microwave+and+RF+Engineering

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the propagation characteristics, resonant behavior, and modes of operation in rectangular and circular microwave waveguides and resonators.	Understand
CO2	Illustrate the working principles and applications of microwave passive components such as hybrid couplers, ferrite devices, and transmission line circuits.	Understand
CO3	Describe the operation and performance characteristics of microwave tubes and quantum devices including klystrons, travelling wave tubes, and masers.	Understand
CO4	Analyze microwave semiconductor amplifier configurations using devices such as MESFETs, tunnel diodes, and parametric amplifiers.	Analyze
CO5	Analyze the performance of microwave oscillators and mixers used in microwave communication systems.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3		2		3	3		2	3	3
CO2	3	3	3	3		2		3	3		2	3	3
CO3	3	3	3	3		2		3	3		2	3	3
CO4	3	3	3	3		2		3	3		2	3	3
CO5	3	3	3	3		2		3	3		2	3	3
Avg.	**3**	**3**	**3**	**3**		**2**		**3**	**3**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECCS08	COMPUTER VISION	L	T	P	C
		2	0	2	3

Course Objective:

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

- Understand the fundamental concepts related to Image formation and processing.
- Explain the principles of feature detection, matching, and object detection techniques.
- Apply feature-based alignment and motion estimation methods for Analyze image sequences.
- Analyze techniques used for three-dimensional (3D) reconstruction from images.
- Evaluate image-based rendering and recognition methods used in computer vision applications.

Detailed Syllabus

UNIT I INTRODUCTION TO IMAGE FORMATION AND PROCESSING	**6**
Computer Vision - Geometric primitives and transformations - Photometric image formation - The digital camera - Point operators - Linear filtering - More neighborhood operators - Fourier transforms - Pyramids and wavelets - Geometric transformations - Global optimization.	
UNIT II FEATURE DETECTION, MATCHING AND SEGMENTATION	**6**
Points and patches - Edges - Lines - Segmentation - Active contours - Split and merge - Mean shift and mode finding - Normalized cuts - Graph cuts and energy-based methods.	
UNIT III FEATURE-BASED ALIGNMENT & MOTION ESTIMATION	**6**
2D and 3D feature-based alignment - Pose estimation - Geometric intrinsic calibration - Triangulation - Two-frame structure from motion - Factorization - Bundle adjustment - Constrained structure and motion - Translational alignment - Parametric motion - Spline-based motion - Optical flow - Layered motion	
UNIT IV 3D RECONSTRUCTION	**6**
Shape from X - Active range finding - Surface representations - Point-based representations Volumetric representations - Model-based reconstruction - Recovering texture maps and albedosos.	
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 recognition - Category recognition - Context and scene Understand- Recognition databases and test sets	
Total Periods: 30	

Practical exercises:

Laboratory Experiments:
Software needed:
OpenCV computer vision Library for OpenCV in Python/Pycharm or C++/Visual Studio or equivalent
• OpenCV Installation and working with Python
• Basic Image Processing- loading images, cropping, resizing, Thresolding, Contour analy Bolb detection.

• Image annotation – Drawing lines, text circle, rectangle, ellipse on images • Image Enhancement - Understand Color spaces, color space conversion, Histog equalization, Convolution, Image smoothing, Gradients, Edge Detection • Image Features and Image Alignment – Image transforms – Fourier, Hough, Extract C Image features, Feature matching, cloning, Feature matching based image alignment • Image Segmentation using Graphcut/ Grabcut • Camera Calibration with circular grid • Pose Estimation • 3D Reconstruction – Creating Depth map from stereo images • Object Detection and Tracking using Kalman Filter, Camshift 1. docs.opencv.org 2. https://opencv.org/opencv-free-course/
Total periods: 30

Learning Resources

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.
3	Richard Hartley and Andrew Zisserman, Multiple View Geometry in Computer Vision, Second Edition, Cambridge University Press, March 2004.
4	E. R. Davies, Computer and Machine Vision, Fourth Edition, Academic Press, 2012.
5	NPTEL: Modern Computer Vision - https://onlinecourses.nptel.ac.in/noc23_ee78/preview
6	Virtual Lab (IIT Kharagpur/IIT Delhi): http://vlabs.iitkgp.ac.in/ (Includes image processing and computer vision modules)

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain basic knowledge, theories and methods in image processing and computer vision	Understand
CO2	Illustrate basic and some advanced image processing techniques in OpenCV.	Understand
CO3	Apply 2D a feature-based based image alignment, segmentation and motion estimations.	Apply
CO4	Apply 3D image reconstruction techniques	Apply
CO5	Develop innovative image processing and computer vision applications	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	2		2	2	3		2	3	3
CO2	3	3	3	3	2		2	2	3		2	3	3
CO3	3	3	3	3	2		2	2	3		2	3	3
CO4	3	3	3	3	2		2	2	3		2	3	3
CO5	3	3	3	3	2		2	2	3		2	3	3
Avg.	**3**	**3**	**3**	**3**	**2**		**2**	**2**	**3**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

VERTICAL 3: BIOMEDICAL TECHNOLOGIES

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24ECBT01	Medical Imaging Systems	PEC	3	0	0	3	3	40	60
2	U24ECBT02	Therapeutic Equipments	PEC	3	0	0	3	3	40	60
3	U24ECBT03	Human Assist Devices	PEC	3	0	0	3	3	40	60
4	U24ECBT04	Brain Computer Interface and Applications	PEC	3	0	0	3	3	40	60
5	U24ECBT05	Body Area Networks	PEC	3	0	0	3	3	40	60
6	U24ECBT06	Medical Informatics	PEC	3	0	0	3	3	40	60
7	U24ECBT07	Wearable Devices	PEC	3	0	0	3	3	40	60
8	U24ECBT08	Human Computer Interaction	PEC	3	0	0	3	3	40	60

U24ECBT01	MEDICAL IMAGING SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able,

- To explain the basic principles and operation of X-ray imaging systems.
- To describe the working concept and clinical use of Computed Tomography (CT).
- To understand the imaging technique and diagnostic applications of Magnetic Resonance Imaging (MRI).
- To outline the principles and uses of Radionuclide Imaging in medical diagnosis.
- To provide knowledge on selecting suitable medical imaging equipment and practicing radiation safety.

Detailed Syllabus

Unit I X RAYS **9**

Nature of X-rays- X-Ray absorption – Tissue contrast. X- Ray Equipment (Block Diagram) –Xray Tube, the collimator, Bucky Grid, power supply, Digital Radiography - discrete digital detectors, storage phosphor and film scanning, X-ray Image Intensifier tubes – Fluoroscopy –Digital Fluoroscopy. Angiography, cine Angiography. Digital subtraction Angiography-Mammography.

Unit II COMPUTED TOMOGRAPHY **9**

Principles 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 : speed , amplitude, phase, orientation and waves in matter - Interaction of Nuclei with static magnetic field and Radio frequency wave- rotation and precession – Induction of magnetic resonance signals –bulk magnetization – Relaxation processes T1 and T2. Block Diagram approach of MRI system –system magnet (Permanent, Electromagnet and Superconductors), generations of gradient magnetic fields, Radio Frequency coils (sending and receiving), shim coils, Electronic components, fMRI.

Unit IV NUCLEAR IMAGING	**9**
Radioisotopes- alpha, beta, and gamma radiations. Radio Pharmaceuticals. Radiation detectors – gas filled, ionization chambers, proportional counter, GM counter and scintillation Detectors, Gamma camera – Principle of operation, collimator, photomultiplier tube, X-Y positioning circuit, pulse height analyzer. Principles of SPECT and PET	
Unit V RADIATION THERAPY AND RADIATION SAFETY	**9**
Radiation therapy – linear accelerator, Telegamma Machine. SRS – SRT – Recent Techniques in radiation therapy – 3D CRT – IMRT – IGRT and Cyber knife – radiation measuring instruments Dosimeter, film badges, Thermo Luminescent dosimeters – electronic dosimeter –Radiation protection in medicine – radiation protection principles	
Total Periods:45	

Learning Resources

1	Isaac Bankman, I. N. Bankman , Handbook Of Medical Imaging: Processing and Analysis(Biomedical Engineering),Academic Press,2nd Edition, 2009
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, Dyah Ekashanti Octorina Dewi “Medical Imaging Technology”, Springer Singapore, 2015
4	Khandpur R.S, “Handbook of Biomedical Instrumentation”, Tata McGraw – Hill, New Delhi,3rd Edition, 2024.
5	Medical Image Analysis - https://nptel.ac.in/courses/112107243
6	Biomedical Image Processing - https://nptel.ac.in/courses/108106058

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Describe the working principle of X-ray machines and their applications.	Understand
CO2	Explain the principle of Computed Tomography.	Understand
CO3	Interpret the technique used for visualizing body sections using Magnetic Resonance Imaging.	Understand
CO4	Demonstrate the applications of Radionuclide Imaging.	Apply
CO5	Analyze different medical imaging techniques and select appropriate imaging equipment for accurate diagnosis, including basic radiation safety considerations.	Analyze

Course Articulation Matrix

CO	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	2	1	2				2			3	2
CO3	3	3	2	2	2				2			3	2
CO4	2	2	2	2	2				2			3	2
CO5	2	2	2	1	2		1	1	2		1	3	3
Avg.	**2.6**	**2.4**	**2.0**	**1.4**	**2**		**1**	**1**	**2**		**1**	**3**	**2.2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECBT02	THERAPEUTIC EQUIPMENTS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able,

- To apply the principles and operation of cardiac and respiratory therapy equipment such as pacemakers, defibrillators, and ventilators used in clinical care.
- To apply the concepts of biomechanical therapeutic equipment for muscle stimulation, pain relief, and rehabilitation.
- To analyze the operation and applications of various body care and fitness equipment used in therapy and wellness.
- To examine the design, functionality, and components of dental care equipment and accessories for clinical applications.
- To evaluate the effectiveness and safety of heat and photonic (laser) therapy
- equipment used in medical treatments.

Detailed Syllabus

Unit I CARDIAC AND RESPIRATORY THERAPY EQUIPMENT **9**

Cardiac Pacemaker: Internal and External Pacemaker– Programmable pacemakers. Cardiac Defibrillators: AC and DC Defibrillator- Internal and External Defibrillators - Protection Circuit, Defibrillator analyzers. Cardiac ablation catheter.

Types of Ventilators – Pressure, Volume, and Time controlled. Basic principles of electromechanical, pneumatic and electronic ventilators, Patient Cycle Ventilators, Ventilator Testing. Humidifiers, Nebulizers, Inhalators.

Unit II BIOMECHANICAL THERAPEUTIC EQUIPMENT **9**

Electro diagnosis, Therapeutic radiation, Electrotherapy, Electrodes, Stimulators for Nerve and Muscle, Functional Electrical Stimulation. Peripheral nerve stimulator, ultrasonic stimulators, Stimulators for pain and relief - Inferential Therapy Unit, TENS. GAIT Assessment and Therapy. Continuous Passive Motion unit, Cervical / Lumber Traction Machine -Traction Table.

Unit III BODY CARE EQUIPMENT **9**

Skin Treatment: Ultrasonic spot remove, vacuum therapy unit, Skin tightening, Wrinkle Reduction, Facial and Rejuvenation. Laser hair therapy machine. Body Slimmer/Shaper – Deep Heat Therapy, Massager, Fitness – Treadmill, Bike.

Unit IV DENTAL CARE EQUIPMENT **9**

Dental Chair - Dental Hand pieces and Accessories: Evolution of rotary equipment, Low-speed hand piece, High-speed hand piece, Hand piece maintenance. Vacuum and Pneumatic techniques: Vacuum techniques, Oral evacuation systems, Vacuum pump, Pneumatic techniques, Dental compressor. Decontamination Unit and constant fumigation unit. Dental Radiography: Dental X-ray Machine.

Unit V HEAT & PHOTON THERAPY EQUIPMENT **9**

High frequency heat therapy, Principle, Short wave diathermy, Microwave diathermy, Ultrasonic therapy, Lithotripsy. Therapeutic UV and IR Lamps. Basic principles of Biomedical LASERS: Applications of lasers in medicine, CO2laser, He-Ne laser, Nd-YAG and Ruby laser.

Total Periods:45

Learning Resources

1	Khandpur, R. S., Handbook of Biomedical Instrumentation, 3rd Edition, McGraw-Hill Education, New Delhi, 2014 (reprint available 2024).
2	Webster, J. G., and Nimunkar, A. J., Medical Instrumentation: Application and Design, 5th Edition, Wiley, 2020 (Indian adaptation published 2021).
3	Cromwell, L., Weibell, F. J., and Pfeiffer, E. A., Biomedical Instrumentation and Measurements, 2nd Edition, Prentice-Hall, 2000
4	Low, J., and Reed, A., Electrotherapy Explained: Principles and Practice, 4th Edition, Elsevier / Butterworth-Heinemann, 2008.
5	Carr, J. J., and Brown, J. M., Introduction to Biomedical Equipment Technology, 4th Edition, Prentice Hall, 2008.
6	Bio micro electromechanical Systems (BioMEMS) – https://nptel.ac.in/courses/112104029
	Bioinformatics: Algorithms and Applications - https://nptel.ac.in/courses/102106065

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the principles and operation of cardiac and respiratory therapy equipment such as pacemakers, defibrillators, and ventilators used in clinical care.	Apply
CO2	Apply the concepts of biomechanical therapeutic equipment for muscle stimulation, pain relief, and rehabilitation.	Apply
CO3	Analyze the operation and applications of various body care and fitness equipment used in therapy.	Analyze
CO4	Examine the design and functionality of dental care equipment and accessories for clinical applications	Analyze
CO5	Evaluate the effectiveness and safety of heat and photonic (laser) therapy equipment used in medical treatments.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	1	2				2			3	3
CO2	3	3	2	1	2				2			3	3
CO3	3	2	2	2	2				2			3	3
CO4	3	2	2	2	2				2			3	3
CO5	2	2	2	1	2	2	1	1	2		1	3	3
Avg.	**2.8**	**2.4**	**2**	**1.4**	**2**	**2**	**1**	**1**	**2**		**1**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECBT03	HUMAN ASSIST DEVICES	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able,

- To apply the principles and operation of machines that performs the functions of the heart and lungs in clinical care.
- To apply various mechanical and therapeutic techniques that assists or replaces a non-functioning heart.
- To analyze the working principles of biomedical equipment used for blood purification, such as hemodialysis and filtration units.
- To analyze the diagnostic tests used to assess hearing loss and the development of electronic assistive hearing devices.
- To evaluate the recent advancements and emerging technologies used in modern
- clinical and therapeutic applications.

Detailed Syllabus

Unit I HEART LUNG MACHINE AND ARTIFICIAL HEART	**9**
Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Schematic for temporary bypass of left ventricle.	
Unit II CARDIAC ASSIST DEVICES	**9**
Assisted through Respiration, Right and left Ventricular Bypass Pump, Auxiliary ventricle, Open Chest and Closed Chest type, Intra-Aortic Balloon Pumping, Prosthetic Cardiac valves, Principle of External Counter pulsation techniques.	
Unit III ARTIFICIAL KIDNEY	**9**
Indication and Principle of Hemodialysis, Membrane, Dialysate, types of filter and membranes, Different types of hemodialysis, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.	
Unit IV RESPIRATORY AND HEARING AIDS	**9**
Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, SISI, masking techniques, wearable devices for hearing correction.	
Unit V RECENT TRENDS	**9**
Transcutaneous electrical nerve stimulator, bio-feedback, Diagnostic and point-of-care platforms.	
	Total Periods:45

Learning Resources

1	Wnek, G. E., & Bowlin, G. L., Encyclopedia of Biomaterials and Biomedical Engineering, 2nd Edition, CRC Press / Taylor & Francis, 2008
2	John. G . Webster – Bioinstrumentation - John Wiley & Sons (Asia) Pvt Ltd - 2004
3	Bronzino, J. D., & Peterson, D. R., The Biomedical Engineering Handbook, 4th Edition (Four-Volume Set), CRC Press, 2015.
4	Sunder, S., Textbook of Rehabilitation, 4th Edition, Jaypee Medical Publishers, 2024.

5	Carr, J. J., and Brown, J. M., Introduction to Biomedical Equipment Technology, 4th Edition, Prentice Hall, 2008.
6	Mechanics of Human Movement -http://www.digimat.in/nptel/courses/video/112106248/L46.html
7	Biomedical Signal Processing - https://nptel.ac.in/courses/108106105

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the principles and operation of cardiac and respiratory therapy equipment such as pacemakers, defibrillators, and ventilators used in clinical care.	Apply
CO2	Apply the concepts of biomechanical therapeutic equipment for muscle stimulation, pain relief, and rehabilitation.	Apply
CO3	Analyze the functioning and applications of various body care and fitness equipment used in therapy and wellness.	Analyze
CO4	Examine the design and functionality of dental care equipment and accessories for clinical applications.	Analyze
CO5	Evaluate the effectiveness and safety of heat and photonic (laser) therapy equipment used in medical treatments.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	1	2				2			3	3
CO2	3	3	2	1	2				2			3	3
CO3	3	2	2	2	2				2			3	3
CO4	3	2	2	2	2				2			3	3
CO5	2	2	2	1	2	2	1	1	2		1	3	3
Avg.	**2.8**	**2.4**	**2**	**1.4**	**2**	**2**	**1**	**1**	**2**		**1**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECBT04	**BRAIN COMPUTER INTERFACE AND APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able,

- To explain the basic concepts and components of Brain–Computer Interface (BCI) systems.
- To understand brain signals such as event-related potentials and sensory motor rhythms used in BCI.
- To introduce various feature extraction techniques suitable for BCI applications.
- To provide knowledge on classifier design methods for developing BCI systems.
- To familiarize students with implementing BCI systems for real-world applications.

Detailed Syllabus

UNIT I INTRODUCTION TO BCI	**9**
Fundamentals of BCI – Structure of BCI system – Classification of BCI – Invasive, Non-invasive and Partially invasive BCI – EEG signal acquisition - Signal Preprocessing – Artifacts removal.	
UNIT II ELECTROPHYSIOLOGICAL SOURCES	**9**
Sensorimotor activity – Mu rhythm, Movement Related Potentials – Slow Cortical Potentials- P300 - Visual Evoked Potential - Activity of Neural Cells - Multiple Neuromechanisms.	
UNIT III FEATURE EXTRACTION METHODS	**9**
Time/Space Methods – Fourier Transform, PSD – Wavelets – Parametric Methods – AR,MA, ARMA models – PCA – Linear and Non-Linear Features.	
UNIT IV FEATURE TRANSLATION METHODS	**9**
Linear Discriminant Analysis – Support Vector Machines - Regression – Vector Quantization Gaussian Mixture Modeling – Hidden Markov Modeling – Neural Networks.	
UNIT V APPLICATIONS OF BCI	**9**
Functional restoration using Neuroprosthesis - Functional Electrical Stimulation, Visual Feedback and control - External device control, Case study: Brain actuated control of mobile Robot.	
Total Periods:45	

Learning Resources

1	Bernhard Graimann, Brendan Allison, Gert Pfurtscheller, “Brain-Computer Interfaces: Revolutionizing Human-Computer Interaction”, Springer, 2010
2	Fisch, B. J., Fisch and Spehlmann’s, “EEG Primer: Basic Principles of Digital and Analog EEG”, 3rd Edition, Elsevier, 1999.
3	Arnon Kohen, “Biomedical Signal Processing”, Vol I and II, CRC Press Inc, Boca Rato, Florida, 1986.
4	Bishop C.M., “Neural Networks for Pattern Recognition”, Oxford, Clarendon Press, 1995
5	Brain-Computer Interface Courses and Certifications - https://www.classcentral.com/subject/brain-computer-interface
6	How Brain-Computer Interfaces Work -https://training.incf.org/lesson/how-brain-computer-interfaces-work

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the Brain–Computer Interface (BCI) system and its potential applications.	Understand
CO2	Apply suitable techniques for analyzing event-related potentials and sensory motor rhythms in BCI systems	Apply
CO3	Analyze relevant features for BCI applications using appropriate feature extraction techniques	Analyze

CO4	Evaluate the performance of classifiers used in BCI systems based on suitable criteria	Analyze
CO5	Evaluate BCI techniques for various real-world applications based on their suitability and performance	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2		2	2	2		2	3	2
CO2	3	3	2	2	2		2	2	2		2	3	3
CO3	3	3	2	2	2		2	2	2		2	3	3
CO4	3	3	3	2	2		2	2	2		2	3	3
CO5	2	2	3	2	2		2	2	2		2	3	3
Avg.	**2.8**	**2.6**	**2.4**	**1.8**	**2**		**2**	**2**	**2**		**2**	**3**	**2.8**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECBT05	BODY AREA NETWORKS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able,

- To apply the fundamental principles of Body Area Networks (BAN) and their role in healthcare and medical monitoring systems.
- To apply suitable network architectures, components, and communication techniques for designing effective BAN systems.
- To analyze the performance, efficiency, and security parameters involved in BAN communication.
- To analyze the importance of medical device regulations and compare the regulatory practices followed in different regions.
- To evaluate the advanced applications and future developments of BAN technology
- in healthcare and clinical environments

Detailed Syllabus

UNIT I INTRODUCTION TO BAN **9**

Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BAN Architecture – Introduction.

UNIT II HARDWARE FOR BAN **9**

Processor-Low Power MCUs, Mobile Computing MCUs ,Integrated processor with radio transceiver, Memory ,Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes.

UNIT III WIRELESS COMMUNICATION AND NETWORK **9**

RF communication in Body, Antenna design and testing, Propagation, Base Station-Network topology-Stand –Alone BAN, Wireless personal Area Network Technologies-IEEE 802.15.1,IEEE P802.15.13, IEEE 802.15.14, Zigbee.

UNIT IV COEXISTENCE ISSUES WITH BAN **9**

Interferences – Intrinsic - Extrinsic, Effect on transmission, Counter measures- on physical layer and data link layer, Regulatory issues-Medical Device regulation in USA and Asia, Security and Self-

protection-Bacterial attacks, Virus infection, Secured protocols, Self-protection.
UNIT V APPLICATIONS OF BAN 9 Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrhythmias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill.
Total Periods:45

Learning Resources

1	Sandeep K.S. Gupta,Tridib Mukherjee, Krishna Kumar Venkata Subramanian, "Body Area Networks Safety, Security, and Sustainability'', Cambridge University Press, 2013.
2	Mehmet R. Yuce, Jamil Y.Khan, "Wireless Body Area Networks Technology, Implementation, and Applications", Pan Stanford Publishing Pte. Ltd., Singapore, 2012.
3	Zhang, Yuan-Ting, "Wearable Medical Sensors and Systems'', Springer, 2013.
4	Guang-Zhong Yang (Ed.), "Body Sensor Networks'',2nd Edition, Springer, 2014.
5	Body Area Networks an overview - https://www.youtube.com/watch?v=EJswuJd523M
6	Body Sensor Network –https://www.sciencedirect.com/topics/engineering/body-sensor-network

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply the fundamental concepts of Body Area Networks (BAN) and their significance in modern healthcare applications.	Apply
CO2	Analyze suitable Body Area Network architecture suitable for specific medical and healthcare applications.	Analyze
CO3	Evaluate the efficiency of communication protocols and security mechanisms used in BAN systems.	Evaluate
CO4	Analyze the importance of medical device regulations and compare regulatory practices across different regions.	Analyze
CO5	Evaluate the potential extensions and applications of BAN concepts for advanced medical and clinical systems.	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	2				2		2	3	3
CO2	3	3	3	2	2				2		2	3	3
CO3	3	3	2	2	2				2		2	3	3
CO4	2	2	2	2	2	2	1	1	2		2	2	3
CO5	2	2	3	2	2	2	1	1	2		2	3	3
Avg.	**2.6**	**2.6**	**2.4**	**1.8**	**2**	**2**	**1**	**1**	**2**		**2**	**2.8**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECBT06	MEDICAL INFORMATICS	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able,

- To understand the fundamental concepts of Medical Informatics and its role in healthcare information management
- To apply suitable techniques for managing, processing and retrieving medical data using healthcare information system
- To analyze electronic health records, medical databases, and healthcare data for effective clinical decision-making
- To analyze computer assisted medical decision-making techniques including artificial neural network, expert systems, and clinical decision support systems for healthcare applications
- To evaluate emerging trends in medical informatics including virtual reality, computer assisted surgery, telemedicine, telesurgery and computer assisted medical education.

Detailed Syllabus

Unit I INTRODUCTION TO MEDICAL INFORMATICS	**9**
Introduction - Structure of Medical Informatics –Internet and Medicine -Security issues , Computer based medical information retrieval, Hospital management and information system, Functional capabilities of a computerized HIS, Health Informatics – Medical Informatics, Bioinformatics	
Unit II COMPUTERS IN CLINICAL LABORATORY AND MEDICAL IMAGING	**9**
Automated clinical Laboratories-Automated methods in hematology, cytology and histology, Intelligent Laboratory Information System - Computerized ECG, EEG and EMG, Computer assisted medical imaging- nuclear medicine, ultrasound imaging, computed X ray tomography, Radiation therapy and planning, Nuclear Magnetic Resonance.	
Unit III COMPUTERISED PATIENT RECORD	**9**
Introduction – History taking by computer, Dialogue with the computer- Components and functionality of CPR, Development tools, Intranet, CPR in Radiology- Application server provider, Clinical information system, Computerized prescriptions for patients.	
Unit IV COMPUTER ASSISTED MEDICAL DECISION-MAKING	**9**
Neurocomputers and Artificial Neural Networks application, Expert System-General model of CMD, Computer–assisted decision support system-production rule system Cognitive model, semantic networks, decisions analysis in clinical medicine-computers in the care of critically ill patients, Computer aids for the handicapped.	
Unit V RECENT TRENDS IN MEDICAL INFORMATICS	**9**
Virtual reality applications in medicine, Virtual endoscopy, Computer Assisted surgery, Surgical simulation, Telemedicine - Tele surgery, Computer assisted Patient education and health-Medical education and health care information, computer assisted instruction in medicine.	
	Total Periods:45

Learning Resources

1	Mohan Bansal, “Medical informatics”, Tata McGraw Hill Publishing Ltd, 2003.
2	R.D.Lele, “Computers in medicine progress in medical informatics”, Tata McGraw Hill,2005

3	Kathryn J. Hannah, Marion J Ball, “Health Informatics”, 3rd Edition, Springer, 2006.
4	Guang-Zhong Yang (Ed.), “Body Sensor Networks”,2nd Edition, Springer, 2014.
5	Health Research Fundamentals - https://nptel.ac.in/courses/110104095
6	Health Informatics Specialization - https://www.coursera.org/specializations/health-informatics

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the fundamental concepts and structure of medical informatics and healthcare information systems	Understand
CO2	Apply computer-based techniques for managing clinical laboratory, medical imaging and healthcare information	Apply
CO3	Analyze the components and functionality of computerized patient records and clinical information systems	Analyze
CO4	Analyze computer assisted medical decision-making methods used in clinical applications	Analyze
CO5	Evaluate recent trends in medical informatics, including telemedicine, virtual reality and computer assisted healthcare application	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	1	3	2	1	2	2	2	1	3	2
CO2	3	3	2	3	3	2	1	2	2	2	1	3	3
CO3	3	3	2	3	3	2	1	2	2	2	1	3	3
CO4	3	3	3	3	3	2	1	2	2	2	2	3	3
CO5	3	3	3	3	3	3	2	3	2	3	2	3	3
Avg.	**3.0**	**2.8**	**2.4**	**2.6**	**3.0**	**2.2**	**1.2**	**2.2**	**2.0**	**2.2**	**1.4**	**3.0**	**2.8**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECBT07	**WEARABLE DEVICES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able,

- To understand the fundamentals of wearable systems, their components, types, and applications in healthcare and monitoring systems.
- To study the sensors used in wearable devices for measuring physiological and motion parameters.
- To learn signal processing techniques, wearability issues, and energy harvesting methods used for efficient operation of wearable devices.
- To understand wireless health systems and Body Area Networks (BAN) used for communication in wearable healthcare systems.
- To analyze smart textiles and wearable technologies used for monitoring biological parameters and healthcare applications.

Detailed Syllabus

UNIT I INTRODUCTION TO WEARABLE SYSTEMS AND SENSORS	**9**
Wearable Systems- Introduction, Need for Wearable Systems, Drawbacks of Conventional Systems for Wearable Monitoring, Applications of Wearable Systems, Types of Wearable Systems, Components of wearable Systems. Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor	
UNIT II SIGNAL PROCESSING AND ENERGY HARVESTING FOR WEARABLE DEVICES	**9**
Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, sampling frequency for reduced energy consumption, Rejection of irrelevant information. Power Requirements- Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.	
UNIT III WIRELESS HEALTH SYSTEMS	**9**
Need for wireless monitoring, Definition of Body area network, BAN and Healthcare, Technical Challenges- System security and reliability, BAN Architecture – Introduction, Wireless communication Techniques	
UNIT IV SMART TEXTILE	**9**
Introduction to smart textile- Passive smart textile, active smart textile. Fabrication Techniques, Conductive Fibres, Treated Conductive Fibres, Conductive Fabrics, Conductive Inks. Case study-smart fabric for monitoring biological parameters - ECG, respiration	
UNIT V APPLICATIONS OF WEARABLE SYSTEMS	**9**
Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, neural recording, Gait analysis, Sports Medicine.	
Total Periods:45	

Learning Resources

1	Annalisa Bonfiglo and Danilo De Rossi, Wearable Monitoring Systems, Springer, 2011
2	Zhang and Yuan-Ting, Wearable Medical Sensors and Systems,Springer, 2013
3	Edward Sazonov and Micheal R Neuman, Wearable Sensors: Fundamentals, Implementation and Applications, Elsevier, 2014
4	Mehmet R. Yuce and JamilY.Khan, Wireless Body Area Networks Technology, Implementation applications,Pan Stanford Publishing Pte.Ltd, Singapore, 2012
5	Sandeep K.S, Gupta, Tridib Mukherjee and Krishna Kumar Venkatasubramanian, Body Area Networks Safety, Security, and Sustainability, Cambridge University Press, 2013.
6	NPTEL – Biosensors: Fundamentals and Applications https://nptel.ac.in/courses/102106065

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain wearable systems, components, and sensors	Understand
CO2	Apply signal processing and energy harvesting methods	Apply

CO3	Analyze wireless health systems and BAN architecture	Analyze
CO4	Analyze smart textile fabrication and monitoring techniques	Analyze
CO5	Evaluate wearable device applications in healthcare	Evaluate

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	1	1	2				2		2	3	2
CO2	3	3	2	2	2				2		2	3	3
CO3	3	3	2	2	2	1			2		2	3	3
CO4	2	3	2	2	2				2		2	3	3
CO5	2	2	2	1	2	2	1	1	2		2	3	3
Avg.	**2.6**	**2.6**	**1.8**	**1.6**	**2**	**1.5**	**1**	**1**	**2**		**2**	**3**	**2.8**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECBT08	HUMAN COMPUTER INTERACTION	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able,

- To understand the basic concepts of Human Computer Interaction and human factors in system design.
- To learn interactive design principles, usability engineering, and prototyping techniques
- To study interaction design models and usability evaluation methods.
- To understand the design of mobile and web interfaces for interactive applications.
- To learn communication and collaboration techniques used in human–machine systems

Detailed Syllabus

UNIT I FOUNDATIONS OF HCI **9**

Input–output channels, Human memory, thinking reasoning and problem solving, Emotion, 143 Individual differences, Psychology and the design of interactive systems, Text entry devices, Positioning, pointing and drawing, Display devices, Devices for virtual reality and 3D interaction, Physical controls, sensors and special devices, Paper: printing and scanning.

UNIT II DESIGN SOFTWARE PROCESS **9**

Interactive Design: Basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process: Software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules: principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.

UNIT III INTERACTION DESIGN MODELS **9**

GOMS - CMN-GOMS Analysis, Modeling Structure, State Transition Networks - Three-State Model, Glimpse Model, Physical Models,– Shneideman's eight golden rules, Norman's Sever principles, Norman's model of interaction, Nielsen's ten heuristics, Heuristic evaluation, contextual evaluation, Cognitive walk-through.

UNIT IV MOBILE HCI AND WEB INTERFACE DESIGN 9 Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools. - Case Studies. Designing Web Interfaces – Drag Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow - Case Studies.
UNIT V COLLABORATION AND COMMUNICATION 9 Face-to-face Communication, Conversation, Text-based Communication, Group working, Dialog design notations, Diagrammatic notations, Textual dialog notations, Dialog semantics, Dialog analysis and design: Groupware, Meeting and decision support systems, Shared applications and artifacts, Frameworks for groupware Implementing synchronous groupware, Mixed, Augmented and Virtual Reality
Total Periods:45

Learning Resources

1	A Dix, Janet Finlay, G D Abowd, R Beale., “Human-Computer Interaction”, 3rd Edition, Pearson Publishers, 2008
2	Brian Fling, “Mobile Design and Development”, First Edition, O‘Reilly Media Inc., 2009
3	Bill Scott and Theresa Neil, “Designing Web Interfaces”, First Edition, O‘Reilly, 2009
4	Shneiderman, Plaisant, Cohen and Jacobs, “Designing the User Interface: Strategies for Effective Human Computer Interaction”, 5th Edition, Pearson Publishers, 2010
5	Human Computer Interaction - https://nptel.ac.in/courses/106106223
6	Design and Analysis of Algorithms (for interaction models and problem-solving concepts) https://nptel.ac.in/courses/106105085

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain fundamentals of HCI and interaction devices	Understand
CO2	Apply interactive design and usability engineering methods	Apply
CO3	Analyze interaction design models and usability principles	Analyze
CO4	Analyze mobile and web interfaces using HCI principles	Analyze
CO5	Evaluate collaborative systems and communication interfaces	Evaluate

Course Articulation Matrix

CO	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	3	2					2		2	3	3
CO3	3	3	2	2				1	2		2	3	3
CO4	2	3	3	2					2		2	3	3
CO5	2	2	2	1		1		1	2	1	2	3	3
Avg.	**2.6**	**2.6**	**2.2**	**1.6**		**1**		**1**	**2**	**1**	**2**	**3**	**2.8**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

VERTICAL 4: SEMICONDUCTOR CHIP DESIGN AND TESTING

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24ECST01	Analog IC Design	PEC	3	0	0	3	3	40	60
2	U24ECST02	Mixed Signal IC Design	PEC	3	0	0	3	3	40	60
3	U24ECST03	ASIC Design	PEC	3	0	0	3	3	40	60
4	U24ECST04	Low Power IC Design	PEC	3	0	0	3	3	40	60
5	U24ECST05	RFIC Design	PEC	3	0	0	3	3	40	60
6	U24ECST06	VLSI Testing and Testability	PEC	3	0	0	3	3	40	60
7	U24ECST07	EMI/EMC Concepts	PEC	3	0	0	3	3	40	60
8	U24ECST08	Electronic Packaging and Testing	PEC	3	0	0	3	3	40	60

U24ECST01	ANALOG IC DESIGN	L	T	P	C
		3	0	0	3

Course Objective:

After completing this course, the students will be able,

- To design amplifier circuits that meet user-defined specifications in terms of gain, bandwidth, and linearity.
- To analyze the frequency response and noise performance of various amplifier configurations for optimized design.
- To design and evaluate feedback amplifiers and single-stage operational amplifiers, ensuring stability and desired performance.
- To design and analyze two-stage operational amplifiers to achieve high gain and wide bandwidth suitable for analog applications.
- To design and implement switched-capacitor circuits, addressing speed, precision, and charge injection considerations for integrated circuit design

Detailed Syllabus

UNIT I SINGLE STAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIERS 9

Introduction to Analog Design, Single Stage Amplifiers - Applications, General Considerations, Common Source Stage - Common-Source Stage with Resistive Load, CS Stage with Diode-Connected Load, CS Stage with Current-Source Load, CS Stage with Active Load, Differential Amplifiers - Single-Ended and Differential Operation, Basic Differential Pair, Common-Mode, Response, Differential Pair with MOS Loads, Gilbert Cell.

UNIT II HIGH FREQUENCY AND NOISE CHARACTERISTICS OF AMPLIFIERS 9

Miller Effect, Association of Poles with Nodes, frequency response of CS, CG, Source Follower, Cascode and Differential Pairs, Statistical Characteristics of Noise, Types of Noise, Noise in Single-Stage Amplifiers, Noise in Differential Pairs.

UNIT III FEEDBACK AND OPERATIONAL AMPLIFIERS	**9**
Properties and types of negative feedback circuits, effect of loading in feedback networks, operational amplifier performance parameters, single stage Op Amps, two-stage Op Amps, input range limitations, gain boosting, slew rate, power supply rejection, noise in Op Amps.	
UNIT IV STABILITY AND FREQUENCY COMPENSATION	**9**
Multipole Systems, Phase Margin, Basic Frequency Compensation, Compensation of Two-Stage Op Amps, Slewing in Two-Stage Op Amps, Other Compensation Techniques, Nyquist's Stability Criterion.	
UNIT V INTRODUCTION TO SWITCHED-CAPACITOR CIRCUITS	**9**
Sampling Switches - MOSFETS as Switches, Speed Considerations, Precision Considerations, Charge Injection Cancellation, Switched-Capacitor Amplifiers - Unity-Gain Sampler/Buffer, Noninverting Amplifier, Precision Multiply-by-Two Circuit, Switched-Capacitor Integrator, Switched-Capacitor Common-Mode Feedback.	
	Total Periods: 45

Learning Resources

1	Behzad Razavi, "Design of Analog CMOS Integrated Circuits", 2nd Edition, McGraw-Hill Education, 2017.
2	Willy M. C. Sansen, "Analog Design Essentials", Springer, 2006.
3	Phillip E. Allen and Douglas R. Holberg, "CMOS Analog Circuit Design", 3rd Edition, Oxford University Press, 2011.
4	R. Jacob Baker, "CMOS: Circuit Design, Layout, and Simulation", 4th Edition, Wiley - IEEE Press, 2019.
5	Analog IC Design: https://onlinecourses.nptel.ac.in/noc24_ee13/
6	Analog VLSI Design: https://onlinecourses.nptel.ac.in/noc24_ee111/

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Design amplifiers to meet user specifications	Apply
CO2	Analyze the frequency and noise performance of amplifiers	Analyze
CO3	Analyze the performance of feedback amplifiers and one stage op-amps	Analyze
CO4	Analyze the performance of two-stage op-amps	Analyze
CO5	Analyze the operation of switched-capacitor circuits	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	2	3	2			2	2		2	3	2
CO2	3	2	3	3	2			2	2		3	2	3
CO3	3	3	2	3	2			2	2		2	3	2
CO4	3	3	2	3	2			2	2		2	3	2
CO5	3	3	3	3	2			2	2		2	3	3
Avg.	**3**	**2.8**	**2.4**	**3**	**2**			**2**	**2**		**2.2**	**2.8**	**2.4**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECST02	MIXED SIGNAL IC DESIGN	L	T	P	C
		3	0	0	3

Course Objective:

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

- Describe the basic principles and building blocks of mixed-signal circuit design
- Explain the architecture, operation, and performance characteristics of Digital-to-Analog Converters (DACs).
- Explain the architecture, operation, and performance evaluation of Analog-to-Digital Converters (ADCs).
- Design and testing techniques for amplifiers, comparators, and data converter systems.
- Explore precision enhancement techniques.

Detailed Syllabus

UNIT I SAMPLE AND HOLD ARCHITECTURES	**9**
Sampling switches, Conventional open loop and closed loop sample and hold architecture, Open loop architecture with miller compensation, multiplexed input architectures, recycling architecture switched capacitor architecture.	
UNIT II DIGITAL TO ANALOG CONVERSION	**9**
Performance metrics, reference multiplication and division, switching and logic functions in DAC, Resistor ladder DAC architecture - Basic Structures, Speed Limitations, Differential RDACs, Effect of Gradients, Effect of Random Mismatches, Current steering DAC architecture -Basic Topologies, Basic Matching Considerations, Binary-Weighted and Thermometric IDACs, R-2R IDACs. Segmented IDACs. Nonlinearity Due to Output Impedance of Current Sources, Matrix Architecture, Dynamic Errors in IDACs.	
UNIT III ANALOG TO DIGITAL CONVERSION	**9**
Flash architecture - Sampling in Flash ADCs, Thermometer-to-Binary Conversion, Nonidealities, Bubble Correction, Fully-Differential Flash ADCs, Flash ADC Variants, Successive approximation architecture - General Concepts, Charge Redistribution SAR ADCs, SAR ADC Nonidealities - Sampling Nonidealities, Clock Generation, Pipelined Architecture-Basic Pipelining, Precision Multiply-by-2 Stages, Multiplying DACs, Basic Pipelined ADC, Multibit Pipelined Stages, Nonidealities in Pipelined ADCs - General Considerations, Time interleaved architecture - General Considerations, Effect of Mismatches, Charge Sharing and Interchannel Crosstalk, Interleaving Techniques.	
UNIT IV BUILDING BLOCKS OF DATA CONVERSION SYSTEMS	**9**
Amplifiers – Open loop amplifiers, Closed loop amplifiers, operational amplifiers, Gain boosting techniques, Common mode feedback, Comparators – Bipolar comparator, CMOS comparator and BICMOS comparator.	
UNIT V PRECISION TECHNIQUES AND TESTING	**9**
Comparator offset cancellation, Op Amp offset cancellation, Calibration techniques, range overlap and digital correction, Testing and characterization of Converters	
Total Periods: 45	

Learning Resources

1	Behzad Razavi, “Analysis and Design of Data Converters”, 1st Edition, Cambridge University Press & Assessment, 2025.

2	Marcel J. M. Pelgrom, "Analog-to-Digital Conversion", 4th Edition, Springer, 2022.
3	Rudy van de Plassche, "CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters", 2nd Edition, Springer, 2003.
4	Shanthi Pavan, Richard Schreier, and Gabor C. Temes, "Understand Delta-Sigma Data Converters", 2nd Edition, Wiley–IEEE Press, 2017.
5	Introduction to Data Conversion: https://nptel.ac.in/courses/117106034
6	Advanced Circuit Techniques: https://ocw.mit.edu/courses/6-331-advanced-circuit-techniques-spring-2002/

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Examine the fundamental principles and functional blocks of mixed-signal circuits.	Apply
CO2	Illustrate the architecture, operation, and performance parameters of Digital to Analog Converters.	Apply
CO3	Illustrate architecture, operation, and performance parameters of Analog-to-Digital Converters.	Apply
CO4	Design and testing methods of amplifiers, comparators, and data converters.	Apply
CO5	Apply offset cancellation and calibration methods to improve converter accuracy and performance.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	2	2		2	2		2	3	1
CO2	3	3	3	2	1	2		1	2		2	3	1
CO3	3	3	2	2	2	2		1	2		2	3	1
CO4	3	3	3	2	2	1		2	1		2	1	1
CO5	3	3	3	2	2	2		2	2		3	2	3
Avg.	**3.0**	**3.0**	**2.8**	**2.2**	**1.8**	**1.8**		**1.6**	**1.8**		**2.2**	**2.4**	**1.4**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECST03	**ASIC DESIGN**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

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

- Apply ASIC design flow, CMOS logic principles, transistor characteristics and standard cell concepts to develop basic ASIC logic cells and data path structures libraries.
- Examine different programmable ASIC technologies, architectures, and I/O cell configuration
- Describe FPGA architectures and embedded processor-based systems used in programmable ASICs.

- Interpret the methods of logic synthesis, floor planning, and routing in ASIC design flow.
- Analyze SoC design methodologies, communication architectures, and high-
- performance module integration.

Detailed Syllabus

UNIT I INTRODUCTION TO ASICS, CMOS LOGIC AND ASIC LIBRARY DESIGN	**9**
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 PROGRAMMABLE ASICS, PROGRAMMABLE ASIC LOGIC CELLS AND PROGRAMMABLE ASIC I/O CELLS	**9**
Anti Fuse - Static Ram - EPROM and EEPROM Technology - ACTEL ACT- Xilinx LCA –ALTERA FLEX - ALTERA MAX DC & AC Inputs and Outputs - Clock & Power Inputs - Xilinx I/O Blocks	
UNIT III PROGRAMMABLE ASIC ARCHITECTURE	**9**
Architecture and Configuration of ARTIX / Cyclone and KINTEX Ultra Scale / STRATIX FPGA – Micro-Blaze / NIOS Based Embedded Systems – Signal Probing Techniques	
UNIT IV LOGIC SYNTHESIS, PLACEMENT AND ROUTING	**9**
Logic Synthesis - Floor Planning Goals and Objectives, Measurement of Delay in Floor Planning, Floor Planning Tools, I/O and Power Planning, Clock Planning, Placement Algorithms. Routing: Global Routing, Detailed Routing, Special Routing.	
UNIT V SYSTEM-ON-CHIP DESIGN	**9**
SoC Design Flow, Platform-Based and IP Based SoC Designs, Basic Concepts of Bus-Based Communication Architectures, High Performance Filters using Delta-Sigma Modulators. Case Studies: Digital Camera, SDRAM, High Speed Data standards	
	Total Periods: 45

Learning Resources

1	M. J. S. Smith, “Application Specific Integrated Circuits”, Pearson, 2003.
2	Jan M. Rabaey, Anantha Chandrakasan and Borivoje Nikolić, “Digital Integrated Circuits: A Design Perspective”, 2nd Edition, Prentice Hall of India (PHI), 2003.
3	Steve Kilts, “Advanced FPGA Design”, Wiley Inter-Science, 2006.
4	Sabih H. Gerez, “Algorithms for VLSI Design Automation”, Wiley, 1999.
5	Digital System design with PLDs and FPGAs: https://nptel.ac.in/courses/117108040
6	Digital ASIC Design : https://www.classcentral.com/course/independent-digital-asic-design-859

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply Logical Effort Technique for predicting Delay, Delay Minimization and FPGA Architecture	Apply

CO2	Design Logic Cells and I/O Cells	Apply
CO3	Analyze the various resources of recent FPGAs	Analyze
CO4	Analyze Floor Planning, Placement and Routing Algorithms for area, delay and interconnect Optimization.	Analyze
CO5	Analyze High Performance Algorithms Available for ASICs	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3		2		2	2		2	3	1
CO2	3	3	3	2		1		2	2		2	3	1
CO3	3	3	2	2		2		2	2		2	3	1
CO4	3	3	3	2		1		2	2		2	1	1
CO5	3	3	3	2		2		2	2		3	2	3
Avg.	**3**	**3**	**2.8**	**2.2**		**1.6**		**2**	**2**		**2.2**	**2.4**	**1.4**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECST04	LOWPOWER IC DESIGN	L	T	P	C
		3	0	0	3

Course Objective:

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

- Determine the various sources of power in an Integrated Circuit (IC).
- Distinguish and compare different power reduction techniques based on technology-independent and technology-dependent methods.
- Apply suitable techniques to minimize power dissipation in IC design.
- Estimate the power dissipation in various MOS logic circuits
- Develop efficient algorithms for achieving low power dissipation in digital circuits

Detailed Syllabus

UNIT I POWER DISSIPATION IN CMOS 9

Hierarchy of Limits of Power – Sources of Power Consumption – Physics of Power Dissipation in CMOS FET Devices – Basic Principle of Low Power Design.

UNIT II POWER OPTIMIZATION 9

Logic Level Power Optimization – Circuit Level Low Power Design – Gate Level Low Power Design –Architecture Level Low Power Design – VLSI Subsystem Design of Adders, Multipliers, PLL, Low Power Design.

UNIT III DESIGN OF LOW POWER CMOS CIRCUITS 9

Computer Arithmetic Techniques for Low Power System – Reducing Power Consumption in Combinational Logic, Sequential Logic, Memories – Low Power Clock – Advanced Techniques – Special Techniques, Adiabatic Techniques – Physical Design, Floor Planning, Placement and Routing.

UNIT IV POWER ESTIMATION 9 Power Estimation Techniques, Circuit Level, Gate Level, Architecture Level, Behavioural Level, – Logic Power Estimation – Simulation Power Analysis –Probabilistic Power Analysis.
UNIT V SYNTHESIS AND SOFTWARE DESIGN FOR LOW POWER CMOS CIRCUITS 9 Synthesis for Low Power – Behavioural Level Transform –Algorithms for Low Power – Software Design for Low Power.
Total Periods: 45

Learning Resources

1	Kaushik Roy and Sharat C. Prasad, “Low-Power CMOS VLSI Circuit Design”, Wiley, 2015.
2	James B. Kuo and J. H. Lou, “Low-Voltage CMOS VLSI Circuits”, Wiley, 1999.
3	Jan M. Rabaey, “Low Power Design Essentials”, Springer, 2009.
4	James B. Kuo and Shih-Chia Lin, “Low-Voltage SOI CMOS VLSI Devices and Circuits”, Wiley, 2001.
5	Low Power VLSI Circuits & Systems : https://nptel.ac.in/courses/106105034

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Calculate the power dissipation of MOS circuits	Apply
CO2	Analyze various MOS logic circuits	Analyze
CO3	Apply low power techniques to minimize power consumption in VLSI circuits	Apply
CO4	Estimate the power dissipation of ICs	Analyze
CO5	Develop algorithms to reduce power dissipation by software tools	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	1			2	2		2	2	2
CO2	3	3	3	3	1			2	2		2	2	2
CO3	3	2	3	3	1			2	1		1	1	1
CO4	3	2	3	3	1			2	1		1	1	1
CO5	3	2	3	3	2			2	1		3	3	3
Avg.	**3**	**2.4**	**3**	**3**	**1.2**			**2**	**1.4**		**1.8**	**1.8**	**1.8**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECST05	RFIC DESIGN	L	T	P	C
		3	0	0	3

Course Objective:

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

- Describe the fundamental concepts and operating principles of RF receiver front-end circuits.
- Classify the design methodologies and performance constraints associated with Low Noise Amplifiers (LNAs), mixers, and frequency synthesizers.
- Develop the ability to analyze the functional characteristics and performance metrics of RF mixers.
- Design various oscillator architectures and evaluate their phase noise and stability.
- Analyze Phase-Locked Loops (PLLs) and frequency synthesizers for RF
- communication systems

Detailed Syllabus

UNIT I INTRODUCTION TO RFIC DESIGN	**9**
Introduction to RF and Wireless Technology, Basic concepts in RF design - Effects of Nonlinearity, Noise, Sensitivity and Dynamic Range, Passive Impedance Transformation, Scattering Parameters, Analysis of Nonlinear Dynamic System.	
UNIT II LOW-NOISE AMPLIFIERS	**9**
Problem of Input Matching, LNA Topologies - Common-Source Stage with Inductive Load, Common-Source Stage with Resistive Feedback, Common-Gate Stage, Cascode CS Stage with Inductive Degeneration, Variants of Common-Gate LNA, Noise-Cancelling LNAs, Gain Switching, Band Switching, Nonlinearity Calculations.	
UNIT III MIXERS	**9**
General Considerations, Passive Down conversion Mixers - Gain, LO Self-Mixing, Noise, Input Impedance, Current-Driven Passive Mixers, Active Down conversion Mixers - Conversion Gain, Noise in Active Mixers, Linearity, Improved Mixer Topologies - Active Mixers with Current-Source Helpers, Enhanced Trans conductance and Low Flicker Noise Up conversion Mixers.	
UNIT IV OSCILLATORS	**9**
Performance Parameters, Basic Principles, Cross-Coupled Oscillator, Three-Point Oscillators, Voltage-Controlled Oscillators, LC VCOs with Wide Tuning Range, Phase Noise, Design Procedure - Low-Noise VCOs, Mathematical Model of VCOs, Quadrature Oscillators.	
UNIT V PLL AND FREQUENCY SYNTHESIZERS	**9**
Phase Detector, Various types of PLLs and analysis, PFD/CP Nonidealities, Phase Noise in PLLs, Loop Bandwidth, Basic Integer-N Synthesizer, Settling Behavior, Spur Reduction Techniques, PLL-Based Modulation, Divider Design	
	Total Periods :45

Learning Resources

1	Behzad Razavi, “RF Microelectronics”, 2nd Edition, Pearson, 2011.
2	Bosco H. Leung, “VLSI for Wireless Communication”, 2nd Edition, Springer, 2011.
3	Thomas H. Lee, “The Design of CMOS Radio-Frequency Integrated Circuits”, 2nd Edition, Cambridge University Press, 2004.
4	Ian D. Robertson and Stanislaw Lucyszyn, “RFIC and MMIC Design and Technology”,

	2nd Edition, Institution of Engineering and Technology (IET), 2009.
5	RFIC Design: https://onlinecourses.nptel.ac.in/noc25_ee185/
6	High Speed Communication Circuits: https://ocw.mit.edu/courses/6-776-high-speed-communication-circuits-spring-2005/

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the principles of operation and functional aspects of RF receiver front-end architectures.	Understand
CO2	Apply design constraints and performance parameters for Low Noise Amplifiers (LNAs), mixers, and frequency synthesizers.	Apply
CO3	Analyze the behavior and performance of various mixer configurations used in RF systems.	Analyze
CO4	Design different types of oscillators and evaluate their noise performance characteristic	Apply
CO5	Design Phase-Locked Loops (PLLs) and frequency synthesizers to meet specific RF communication requirements.	Apply

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	2	2			2	2		2	3	2
CO2	3	3	3	2	2			2	2		2	3	2
CO3	3	2	3	2	2			2	2		2	3	2
CO4	3	3	3	2	2			2	2		2	2	2
CO5	3	3	3	3	3			2	2		2	3	3
Avg.	**3**	**2.6**	**2.8**	**2.2**	**2.2**			**2**	**2**		**2**	**2.8**	**2.2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECST06	**VLSI TESTING AND TESTABILITY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

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

- Simulate various types of faults in digital circuits at the gate level and their impact on circuit behavior.
- Differentiate equivalence and dominance relationships among faults in digital circuits.
- Develop techniques for verifying logic designs and diagnosing faults.
- Apply algorithms and strategies for automatic test pattern generation (ATPG).
- Design principles and architectures of built-in self-test mechanisms.

Detailed Syllabus

UNIT I INTRODUCTION TO TESTING	**9**
Importance of Testing - Testing during the VLSI Lifecycle - Challenges in the VLSI Testing: Test Generation - Fault Models - Levels of Abstraction in VLSI Testing - Historical Review of VLSI Test Technology.	
UNIT II DESIGN FOR TESTABILITY	**9**
Testability Analysis, Design for Testability Basics, Scan Cell Designs, Scan Architectures, Scan Design Rules, Special-Purpose Scan Designs, RTL Design for Testability.	
UNIT III LOGIC AND FAULT SIMULATION	**9**
Logic Simulation for Design Verification, Fault Simulation for Test and Diagnosis, Simulation Models - Gate-Level Network, Logic Symbols, Logic Element Evaluation, Timing Models, Logic Simulation - Compiled-Code Simulation, Event-Driven Simulation, Fault Simulation – Types.	
UNIT IV TEST GENERATION	**9**
Random Test Generation, Theoretical Background: Boolean Difference, Designing a Stuck-At ATPG for Combinational Circuits - A Basic ATPG Algorithm, D Algorithm, PODEM, Designing a Sequential ATPG, Designing a Simulation-Based ATPG, ATPG for Non-Stuck-At Faults, Other Test Generation Methods.	
UNIT V BUILT-IN SELF-TEST	**9**
BIST Design Rules, Test Pattern Generation - Exhaustive Testing, Pseudo-Random Testing, Pseudo-Exhaustive Testing, Output Response Analysis, Logic BIST Architectures - BIST Architectures for Circuits without and with Scan Chains, Fault Coverage Enhancement.	
	Total Periods: 45

Learning Resources

1	Laung-Terng Wang, Cheng-Wen Wu, and Xiaoqing Wen, “VLSI Test Principles and Architectures: Design for Testability”, Morgan Kaufmann, 2025.
2	Nurul A. Jha and S.D. Gupta, “Testing of Digital Systems”, Cambridge University Press, 2003.
3	Michael L. Bushnell and Vishwani D. Agrawal, “Essentials of Electronic Testing for Digital, Memory and Mixed Signal VLSI Circuits”, Kluwer Academic Publishers, 2000.
4	Parag K. Lala, “Digital Circuit Testing and Testability”, Academic Press, 1997.
5	Digital VLSI Testing : https://onlinecourses.nptel.ac.in/noc20_ee76/
6	VLSI Design Verification and Test: https://nptel.ac.in/courses/106103016

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Apply appropriate fault models for VLSI test generation and fault identification	Apply
CO2	Simulate faults and generate test patterns for combinational circuits.	Apply
CO3	Apply logic and fault simulation methods to validate and test digital circuits.	Apply
CO4	Develop and implement ATPG methods for detecting faults in Combinational and sequential circuits.	Analyze

CO5	Design BIST structures for digital systems to enhance fault coverage and reliability.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	2			2	1		2	2	2
CO2	3	3	3	3	2			2	1		2	2	2
CO3	3	3	3	3	2			2	2		2	2	2
CO4	3	2	3	2	3			3	2		2	3	2
CO5	3	3	3	3	3			3	3		2	3	2
Avg.	**3**	**2.8**	**3**	**2.8**	**2.4**			**2.4**	**1.8**		**2**	**2.4**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECST07	EMI/EMC CONCEPTS	L	T	P	C
		3	0	0	3

Course Objective:

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

- Discuss the fundamentals of Electro-Magnetic interface (EMI) and Electro-magnetic compatibility (EMC) including courses, coupling mechanism and energy transfer modes
- Analyze EMI generation and propagation mechanisms in electronic circuits and PCB layouts
- Apply EMC design principles in PCB design including grounding, decoupling, trace routing, zoning, and cable management
- Examine the international EMC regulatory requirements and mitigation techniques for compliance
- Classify knowledge of shielding principles, EMC standards, measurement techniques, and testing environment for electronic systems

Detailed Syllabus

Unit I Introduction to EMI **9**

Introduction to EMI - Definitions, Different Sources of EMI(Electro-magnetic Interference), Electrostatic discharge(ESD), Electro-magnetic pulse(EMP),Lightning, Mechanism of transferring Electromagnetic Energy: Radiated emission, radiated susceptibility, conducted emission, conducted susceptibility, Differential & common mode currents. EMI Coupling-Conductive coupling: Common-mode, Differential-mode - Inductive coupling -Capacitive coupling - Radiative coupling.

Unit II EMC Design of PCBs **9**

RF Sources in PCB - SMD / through hole components, Pins, Basic loops, Differential vs Common mode - Board layout: Ground plane and Power plane, ground bounce, Power distribution for two-layer boards, Power supply decoupling, Board zoning, Signal traces, Cross talk, Trace routing - Cables and connectors.

Unit III EMC Requirements for Electronic Systems **9**

World regulatory bodies- FCC, CISPR etc. Class-A devices, class-B devices, Regulations of the bodies on EMC issues. Different Mitigation Techniques for preventing EMI - Grounding: Fundamental grounding concepts, Floating ground, Single-point and Multi-point ground,

advantages & disadvantages of different grounding processes.	
Unit IV Shielding	**9**
Introduction - Shielding effectiveness - Far-field sources - Near-field sources - Low-frequency, magnetic field shielding - Effects of apertures.	
Unit V EMC Standards, Measurements and Testing	**9**
Need for standards - The international framework - Human exposure limits to EM fields -EMC measurement techniques - Measurement tools - Test environments.	
	Total Periods: 45

Learning Resources

1	Kodali V P, “Engineering Electromagnetic Compatibility”, Wiley India, Second Edition, 2010.
2	Clayton R. Paul, “Introduction to Electromagnetic Compatibility”, 2nd Edition, Wiley Interscience, 2006
3	Henry W.Ott., “Electromagnetic Compatibility Engineering”, Wiley, 2009.
4	Christos Christopoulos, “Principles and Techniques of Electromagnetic Compatibility”, Second Edition, CRC Press, Taylor & Francis Group,2024.
5	Electromagnetic Compatibility (EMC): https://nptel.ac.in/courses/108106138

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain different EMI sources such as Electrostatic Discharge (ESD), Electromagnetic Pulse (EMP), lightning, and distinguish between radiated and conducted emissions and susceptibility.	Understand
CO2	Analyze EMI coupling mechanisms including conductive, inductive, capacitive, and radiative coupling in practical systems.	Analyze
CO3	Design PCB layouts incorporating EMC principles such as grounding techniques, decoupling strategies, trace routing, and power distribution methods.	Analyze
CO4	Interpret international EMC regulations from bodies such as the Federal Communications Commission and International Special Committee on Radio Interference, and classify devices under Class A and Class B categories.	Analyze
CO5	Evaluate shielding effectiveness, EMC measurement techniques, and test environments to ensure compliance with international standards.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	2			2	1		2	2	2
CO2	3	3	3	3	2			2	1		2	2	2
CO3	3	3	3	3	2			2	2		2	2	2
CO4	3	3	3	3	3			2	2		2	3	2
CO5	3	3	3	3	3			2	3		2	3	2
Avg.	**3**	**3**	**3**	**3**	**2.4**			**2**	**1.8**		**2**	**2.4**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24ECST08	ELECTRONIC PACKAGING AND TESTING	L	T	P	C
		3	0	0	3

Course Objective:

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

- Explain the fundamentals of electronic systems packaging, packaging hierarchy, and the role of packaging in modern electronic systems.
- Explain the electrical issues in system packaging, including signal distribution, power distribution, transmission lines, and noise sources.
- Analyze the IC assembly technologies and chip packaging techniques such as wire bonding, flip chip, wafer level packaging, and system-in-package.
- Analyze PCB design, surface mount technology (SMT), and thermal management techniques used in electronic packaging.
- Develop Understand of reliability, failure mechanisms, and testing methods in electronic systems packaging.

Detailed Syllabus

Unit I OVERVIEW OF ELECTRONIC SYSTEMS PACKAGING **9**

Functions of an Electronic Package, Packaging Hierarchy, IC packaging: MEMS packaging, consumer electronics packaging, medical electronics packaging, Trends, Challenges, Driving Forces on Packaging Technology, Materials for Microelectronic packaging, Packaging Material Properties, Ceramics, Polymers, and Metals in Packaging, Material for high density interconnect substrates.

Unit II ELECTRICAL ISSUES IN PACKAGING **9**

Electrical Issues of Systems Packaging, Signal Distribution, Power Distribution, Electromagnetic Interference, Transmission Lines, Clock Distribution, Noise Sources, Digital and RF Issues. Design Process Electrical Design: Interconnect Capacitance, Resistance and Inductance fundamentals; Packaging roadmaps - Hybrid circuits - Resistive, Capacitive and Inductive parasitics.

Unit III CHIP PACKAGES **9**

IC Assembly - Purpose, Requirements, Technologies, Wire bonding, Tape Automated Bonding, Flip Chip, Wafer Level Packaging, reliability, wafer level burn – in and test. Single chip packaging: functions, types, materials processes, properties, characteristics, trends. Multi chip packaging: types, design, comparison, trends. System – in - package (SIP); Passives: discrete, integrated, and embedded**.**

Unit IV PCB, SURFACE MOUNT TECHNOLOGY AND THERMAL CONSIDERATIONS **9**

Printed Circuit Board: Anatomy, CAD tools for PCB design, Standard fabrication, Micro via Boards. Board Assembly: Surface Mount Technology, Through Hole Technology, Process Control and Design challenges. Thermal Management, Heat transfer fundamentals, Thermal conductivity and resistance, Conduction, convection and radiation – Cooling requirements.

Unit V TESTING **9**

Reliability, Basic concepts, Environmental interactions. Thermal mismatch and fatigue – failures – thermo mechanically induced –electrically induced – chemically induced. Electrical Testing: System level electrical testing, Interconnection tests, Active Circuit Testing, Design for Testability.

Total Periods: 45

Learning Resources



1	Rao R. Tummala, “Microelectronics Packaging Handbook”, McGraw Hill, 2008.
2	Glenn R. Blackwell, “The electronic packaging handbook”, CRC Press, 2000.
3	Walter C. Bosshart , “Printed Circuit Boards Design and Technology”, TataMcGraw Hill, 1988.
4	William D. Brown, “Advanced Electronic Packaging”, IEEE Press, 2nd Edition, 2006.
5	Electronic Packaging and Manufacturing : https://onlinecourses.nptel.ac.in/noc23_me38/preview

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the functions, hierarchy, materials, and trends in electronic systems packaging.	Understand
CO2	Analyze electrical issues such as signal integrity, EMI, and parasitic effects in electronic packaging.	Analyze
CO3	Evaluate IC packaging technologies and chip assembly techniques used in modern electronic systems.	Analyze
CO4	Analyze PCB fabrication, assemble and thermal management techniques based on performance and reliability requirements	Analyze
CO5	Assess reliability issues, failure mechanisms, and testing methods for electronic packaging systems.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3			2	2		2	2	2
CO2	3	3	3	3	3			2	2		2	2	2
CO3	3	3	3	3	3			2	2		2	2	2
CO4	3	3	3	3	3			2	2		2	3	2
CO5	3	3	3	3	3			3	3		3	3	3
Avg.	**3**	**3**	**3**	**3**	**3**			**2.2**	**2.2**		**2.2**	**2.4**	**2.2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

OPEN ELECTIVES

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24OEEC01	Smart Agricultural Systems	OEC	3	0	0	3	3	40	60
2	U24OEEC02	Electric and Hybrid Vehicles	OEC	3	0	0	3	3	40	60
3	U24OEEC03	Internet of Things Principles and Practices	OEC	1	0	4	3	3	50	50
4	U24OEEC04	Electronic Circuits for Smart Technologies	OEC	3	0	0	3	3	40	60
5	U24OEEC05	Mechatronics	OEC	3	0	0	3	3	40	60

U24OEEC01	SMART AGRICULTURAL SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

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

- Understand the applications of IT in remote sensing applications such as Drones etc.
- Get a clear Understand of how a greenhouse can be automated and its advantages
- Apply IT principles and concepts for management of field operations.
- Understand about weather models, their inputs and applications
- Understand of how IT can be used for e-governance in agriculture

Detailed Syllabus

Unit I PRECISION FARMING **9**

Precision agriculture and agricultural management – Ground based sensors, Remote sensing, GPS, GIS and mapping software, Yield mapping systems, Crop production modeling.

Unit II ENVIRONMENT CONTROL SYSTEMS **9**

Artificial light systems, management of crop growth in greenhouses, simulation of CO2 consumption in greenhouses, on-line measurement of plant growth in the greenhouse, models of plant production and expert systems in horticulture.

Unit III AGRICULTURAL SYSTEMS MANAGEMENT **9**

Agricultural systems - managerial overview, Reliability of agricultural systems, Simulation of crop growth and field operations, Optimizing the use of resources, Linear programming, Project scheduling, Artificial intelligence and decision support systems

Unit IV WEATHER PREDICTION MODELS **9**

Importance of climate variability and seasonal forecasting, Understand and predicting world's climate system, Global climatic models and their potential for seasonal climate forecasting, General systems approach to Apply seasonal climate forecasts.

Unit V E-GOVERNANCE IN AGRICULTURAL SYSTEMS **9**

Expert systems, decision support systems, Agricultural and biological databases, e-commerce, eBusiness systems & applications, Technology enhanced learning systems and solutions,

eLearning, Rural development and information society.
Total Hours:45

Learning Resources

1	National Research Council, “Precision Agriculture in the 21st Century”, National Academies Press, Canada, 1997.
2	H. Krug, Liebig, H.P., “International Symposium on Models for Plant Growth, Environmental Control and Farm Management in Protected Cultivation”, 1989
3	Peart, R.M., and Shoup, W. D., “Agricultural Systems Management”, Marcel Dekker, New York, 2004.
4	Hammer, G.L., Nicholls, N., and Mitchell, C., “Applications of Seasonal Climate”, Springer, Germany, 2000.
5	Irrigation and Drainage- Sprinkler Irrigation-Hydraulic design.- http://www.digimat.in/nptel/courses/video/126105010/L22.html
6	NPTEL: Micro Irrigation Engineering- https://onlinecourses.nptel.ac.in/noc25_ag20/preview

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Describe the applications of IT in remote sensing applications such as Drones etc.	Understand
CO2	Explain how a greenhouse can be automated and its advantages.	Understand
CO3	Apply IT principles and concepts for management of field operations.	Apply
CO4	Illustrate about weather models, their inputs and applications	Apply
CO5	Explain how IT can be used for e-governance in agriculture	Understand

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	2		2		2	3	2	2
CO2	3	3	3	3	3	2		2		2	3	2	2
CO3	3	3	3	3	3	2		2		2	3	2	2
CO4	3	3	3	3	3	2		2		2	3	2	2
CO5	3	3	3	3	3	2		2		2	3	2	2
Avg.	**3**	**3**	**3**	**3**	**3**	**2**		**2**		**2**	**3**	**2**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24OEEC02	**ELECTRIC AND HYBRID VEHICLES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

After completing this course, the students will be able ,

- To understand the need and design considerations of electric vehicles including performance parameters and resistances.
- To analyze different energy sources such as batteries, fuel cells, and ultra capacitors used in electric vehicles.

- To study the working principles, construction, and characteristics of various motors and drives used in EVs.
- To examine power converters, switching devices, and control techniques used in electric vehicle systems.
- To evaluate the configurations, operation modes, and control strategies of hybrid and electric vehicles.

Detailed Syllabus

UNIT I DESIGN CONSIDERATIONS FOR ELECTRIC VEHICLES	**9**
Need for Electric vehicle- Comparative study of diesel, petrol, hybrid and electric Vehicles. Advantages and Limitations of hybrid and electric Vehicles. - Design requirement for electric vehicles- Range, maximum velocity, acceleration, power requirement, mass of the vehicle. Various Resistance- Transmission efficiency- Electric vehicle chassis and Body Design, Electric Vehicle Recharging and Refuelling Systems.	
UNIT II ENERGY SOURCES	**9**
Battery Parameters- - Different types of batteries – Lead Acid- Nickel Metal Hydride - Lithium ion Sodium based- Metal Air. Battery Modelling - Equivalent circuits, Battery charging- Quick Charging devices. Fuel Cell- Fuel cell Characteristics- Fuel cell types-Half reactions of fuel cell. Ultra capacitors. Battery Management System	
UNIT III MOTORS AND DRIVES	**9**
Types of Motors- DC motors- AC motors, PMSM motors, BLDC motors, Switched reluctance motors working principle, construction and characteristics.	
UNIT IV POWER CONVERTERS AND CONTROLLERS	**9**
Solid state Switching elements and characteristics – BJT, MOSFET, IGBT, SCR and TRIAC -Power Converters – rectifiers, inverters and converters - Motor Drives - DC, AC motor, PMSM motors, BLDC motors, Switched reluctance motors – four quadrant operations –operating modes	
UNIT V HYBRID AND ELECTRIC VEHICLES	**9**
Main components and working principles of hybrid and electric vehicles, Different configurations of hybrid and electric vehicles. Power Split devices for Hybrid Vehicles - Operation modes - Control Strategies for Hybrid Vehicle - Economy of hybrid Vehicles - Case study on specification of electric and hybrid vehicles.	
	Total Hours:45

Learning Resources

1	Iqbal Husain, " Electric and Hybrid Vehicles-Design Fundamentals", CRC Press,2003
2	Mehrdad Ehsani, " Modern Electric, Hybrid Electric and Fuel Cell Vehicles", CRCPress,2005
3	James Larminie and John Lowry, "Electric Vehicle Technology Explained " John Wiley & Sons,2003
4	Lino Guzzella, " Vehicle Propulsion System" Springer Publications,2005
5	Ron Hodkinson, "Light Weight Electric/ Hybrid Vehicle Design", Butterworth Heinemann Publication, 2005.
6	NPTEL Course: Introduction to Hybrid and Electric Vehicles- https://nptel.ac.in/courses/108103009

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the design requirements and performance characteristics of electric vehicles.	Understand
CO2	Compare different energy storage systems and their suitability for EV applications.	Understand
CO3	Illustrate the operation of various motors and drives used in electric vehicles.	Understand
CO4	Analyze and select appropriate power converters and controllers for EV systems.	Analyze
CO5	Evaluate hybrid and electric vehicle configurations with suitable control strategies.	Evaluate

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24OEEC03	**INTERNET OF THINGS PRINCIPLES AND PRACTICES**	**L**	**T**	**P**	**C**
		1	**0**	**4**	**3**

Course Objective:

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

- Analyze the architecture, components, and characteristics of IoT systems and their applications.
- Examine the hardware and software features of Arduino and Raspberry Pi for IoT-based implementations.
- Evaluate the operation and interfacing of various sensors used in IoT environments.
- Analyze and implement sensor integration using Arduino and Raspberry Pi with appropriate communication protocols.
- Analyze real-time IoT case studies and assess the potential of IoT solutions in various application domains.

Detailed Syllabus

Unit I: INTRODUCTION TO IOT & ARDUINO **3**

Introduction to IoT – Fundamentals and characteristics of IoT - IoT architecture and components - Applications and challenges of IoT - Introduction to Arduino board and features - Arduino programming environment and basic syntax.

Unit II: RASPBERRY PI **3**

Introduction to Raspberry Pi board and models - Hardware architecture and GPIO pins - Installing and configuring Raspbian OS - Basics of Python programming for Raspberry Pi - Interfacing input/output devices with Raspberry Pi.

Unit III: SENSORS	**3**
Introduction and need for sensors in IoT - Classification of sensors – active and passive - Analog and digital sensors – working principles - Ultrasonic sensor: operation and interfacing -Temperature and humidity sensor: operation and interfacing.	
Unit IV: SENSOR INTEGRATION AND CLOUD PLATFORM	**3**
Sensor data acquisition using Arduino & Raspberry Pi - Data communication protocols – MQTT & HTTP - IoT cloud platforms Overview: ThingSpeak, Blynk, AWS IoT - Uploading sensor data to cloud - Real-time monitoring and data visualization.	
Unit V: CASE STUDIES	**3**
Smart home automation using IoT - Smart city applications and traffic monitoring - IoT-based environmental monitoring system - Smart agriculture and irrigation system - Industrial IoT applications - Future trends and challenges in IoT.	
	Total Hours:15

List of Experiments

Sl. No.	List of Experiments
1	Develop a program on the Arduino platform to control an LED.
2	Control an LED or relay using Python on Raspberry Pi.
3	Interfacing sensors with Arduino.
4	Interfacing sensors with Raspberry Pi.
5	Setup a cloud platform to log the data.
6	**Mini Projects: Design an IOT based system.** a. Smart Home Automation using IoT b. IoT-based Smart Agriculture System c. IoT-based Environmental Monitoring System d. IoT-based Smart Parking System e. IoT-based Industrial Application System f. IoT-based EV Charging & Fleet Monitoring System
	Total Periods: 75

Learning Resources

1	Arshdeep Bahga, Vijay Madisetti, “Internet of Things: A Hands-On Approach”, Universities Press / VPT Publication, 2nd Edition, 2021.
2	Bharat Bhushan, “Internet of Things: Technologies and Applications for a New Age of Intelligence”, Elsevier Publication,2nd Edition, 2024
3	Peter Waher, “ Mastering the Internet of Things: Design and Deploy Solutions Using IoT Platforms” ,Packt Publishing,2nd Edition, 2023
4	David Hanes et al., “IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things, Cisco Press, First Edition 2022.
5	NPTEL COURSE: Introduction to Internet of Things-https://nptel.ac.in/courses/106105166
6	NPTEL COURSE: Components and Applications of Internet of Things - https://onlinecourses.swayam2.ac.in/arp19_ap52/preview

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Analyze IoT system architecture by integrating hardware and software components for real-world applications.	Analyze
CO2	Create IoT devices with Raspberry Pi and Python Programming.	Create
CO3	Integrate multiple sensors with Arduino and Raspberry Pi using appropriate communication protocols to create functional IoT prototypes.	Evaluate
CO4	Develop cloud-enabled IoT systems for real-time data monitoring and visualization.	Create
CO5	Design IoT-based solutions for domains such as smart homes, agriculture, industries, and environment monitoring.	Create

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3			2	3	3		2	3	3
CO2	3	3	3	3			2	3	3		2	3	3
CO3	3	3	3	3			2	3	3		2	3	3
CO4	3	3	3	3	3		2	3	3		2	3	3
CO5	3	3	3	3	3		2	3	3		2	3	3
Avg.	**3**	**3**	**3**	**3**	**3**		**2**	**3**	**3**		**2**	**3**	**3**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24OEEC04	**ELECTRONIC CIRCUITS FOR SMART TECHNOLOGIES**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

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

- To give a comprehensive exposure to all types of devices and circuits constructed with discrete components. This helps to develop a strong basis for building linear and digital integrated circuits
- To analyze the frequency response of small signal amplifiers
- To design and analyze single stage and multistage amplifier circuits
- To study about feedback amplifiers and oscillators principles.
- To understand the analysis and design of multi vibrators

Detailed Syllabus

UNIT I SEMICONDUCTOR DEVICES **9**

PN junction diode, Zener diode, BJT, MOSFET, UJT –structure, operation and V-I characteristics, Rectifiers – Half Wave and Full Wave Rectifier, Zener as regulator

UNIT II AMPLIFIERS **9**

Load line, operating point, biasing methods for BJT and MOSFET, BJT small signal model –Analysis of CE, CB, CC amplifiers- Gain and frequency response –Analysis of CS and Source follower – Gain and frequency response- High frequency analysis.

UNIT III MULTISTAGE AMPLIFIERS AND DIFFERENTIAL AMPLIFIER **9**

Cascode amplifier, Differential amplifier – Common mode and Difference mode analysis – Tuned amplifiers – Gain and frequency response – Neutralization methods.
UNIT IV FEEDBACK AMPLIFIERS AND OSCILLATORS 9 Advantages of negative feedback – Analysis of Voltage / Current, Series , Shunt feedback Amplifiers – positive feedback–Condition for oscillations, phase shift – Wien bridge, Hartley, Colpitts and Crystal oscillators.
UNIT V POWER AMPLIFIERS AND DC/DC CONVERTERS 9 Power amplifiers- class A-Class B-Class AB-Class C-Temperature Effect- Class AB Power amplifier using MOSFET –DC/DC convertors – Buck, Boost, Buck-Boost analysis and design
Total Hours:45

Learning Resources

1	David A. Bell, "Electronic Devices and Circuits", Oxford Higher Education press, 5th Edition, 2010.
2	Robert L. Boylestad and Louis Nasheresky, “Electronic Devices and Circuit Theory”, 10th Edition, Pearson Education / PHI, 2008.
3	Adel .S. Sedra, Kenneth C. Smith, "Micro Electronic Circuits", Oxford University Press, 7 th Edition, 2014.
4	Donald.A. Neamen, "Electronic Circuit Analysis and Design", Tata McGraw Hill, 3 rd Edition, 2010.
5	Muhammad H.Rashid, "Power Electronics", Pearson Education / PHI, 2004.
6	Introduction to electronic devices and circuits https://www.youtube.com/watch?v=cmVMJ17XK8Y

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the structure and working operation of basic electronic devices	Apply
CO2	Design and analyze amplifiers.	Analyze
CO3	Analyze frequency response of BJT and MOSFET amplifiers	Analyze
CO4	Design and analyze feedback amplifiers and oscillator principles.	Analyze
CO5	Design and analyze power amplifiers and supply circuits	Analyze

Course Articulation Matrix

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

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

U24OEEC05	MECHATRONICS	L	T	P	C
		3	0	0	3

Course Objective:

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

- Selecting sensors to develop mechatronics systems.
- Explaining the architecture and timing diagram of microprocessor, and also interpret and develop programs.
- Analyze the appropriate interfacing circuits to connect I/O devices with microprocessor.
- Apply PLC as a controller in mechatronics system.
- Analyze the apt mechatronics system for an application.

Detailed Syllabus

UNIT I - INTRODUCTION AND SENSORS	**9**
Introduction to Mechatronics – Systems – Need for Mechatronics – Emerging areas of Mechatronics –Classification of Mechatronics. Sensors and Transducers: Static and Dynamic Characteristics of Sensor, Potentiometers – LVDT – Capacitance Sensors – Strain Gauges – Eddy Current Sensor – Hall Effect Sensor –Temperature Sensors – Light Sensors.	
UNIT II - 8085 MICROPROCESSOR	**9**
Introduction – Pin Configuration - Architecture of 8085 – Addressing Modes – Instruction set, Timing diagram of 8085.	
UNIT III - PROGRAMMABLE PERIPHERAL INTERFACE	**9**
Introduction – Architecture of 8255, Keyboard Interfacing, LED display – Interfacing, ADC and DAC Interface, Temperature Control – Stepper Motor Control – Traffic Control Interface.	
UNIT IV - PROGRAMMABLE LOGIC CONTROLLER	**9**
Introduction – Architecture – Input / Output Processing – Programming with Timers, Counters and Internal relays – Data Handling – Selection of PLC.	
UNIT V - ACTUATORS AND MECHATRONICS SYSTEM DESIGN	**9**
Types of Stepper and Servo motors – Construction – Working Principle – Characteristics, Stages of Mechatronics Design Process – Comparison of Traditional and Mechatronics Design Concepts with Examples – Case studies of Mechatronics Systems – Pick and Place Robot – Engine Management system – Automatic Car Park Barrier.	
	Total Hours:45

Learning Resources

1	Bolton W., “Mechatronics”, Pearson Education, 6th Edition, 2015
2	Ramesh S Gaonkar, “Microprocessor Architecture, Programming, and Applications with the 8085”, Penram International Publishing Private Limited, 6th Edition, 2013.
3	Nitaigour Premchand Mahalik, “Mechatronics Principles, Concepts and Applications”, McGraw Hill Education, 2015.
4	Devadas Shetty and Richard A. Kolk, “Mechatronics Systems Design”, Cengage Learning, 2010
5	NPTEL:Mechatronics- https://onlinecourses.nptel.ac.in/noc21_me27/preview
6	Digimat- Mechatronics Systems Example: http://www.digimat.in/nptel/courses/video/112107298/L02.html

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Select sensors to develop mechatronics systems.	Apply
CO2	Explain the architecture and timing diagram of microprocessor, and also interpret and develop programs.	Apply
CO3	Analyze appropriate interfacing circuits to connect I/O devices with microprocessor.	Analyze
CO4	Apply PLC as a controller in mechatronics system.	Apply
CO5	Analyze the apt mechatronics system for an application.	Analyze

Course Articulation Matrix

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3	3	3	3		3	3	2		2	3
CO2	3	3	3	2	3	3		2	3	2			2
CO3	3	3	3	3	2	2		3	2	2			
CO4	3	3	3	3	3	2		3	2	3			
CO5	3	3	3	2	3	3		2	3	3		2	1
Avg.	**3**	**3**	**3**	**2.6**	**2.8**	**2.6**		**2.6**	**2.6**	**2.4**		**2**	**2**

For CO-PO/PSO Mapping: 3 – Substantial (High), 2 – Moderate (Medium), 1 – Slight (Low)

MANDATORY COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MC11	Disaster Risk Reduction and Management	MC	3	0	0	3	0	100	-
2	U24MC21	Environmental Science	MC	3	0	0	3	0	100	-
3	U24MC31	History of Science and Technology in India	MC	3	0	0	3	0	100	-
4	U24MC41	Personal Finance	MC	3	0	0	3	0	100	-
5	U24MC51	Well-Being with Traditional Practices- Yoga, Ayurveda and Siddha	MC	3	0	0	3	0	100	-

U24MC11	DISASTER RISK REDUCTION AND MANAGEMENT	L	T	P	C
		3	0	0	0

Course Objective:

After completing this course, the students will be able ,

- To introduce the basic concepts of disasters, hazards, vulnerability, and disaster risks.
- To understand different types of disasters and their impacts on society and the environment.
- To study the principles and strategies of disaster risk reduction (DRR).
- To learn the disaster management framework, policies, and institutional mechanisms in India.
- To understand the use of modern tools, technology, and case studies in disaster management.

Detailed Syllabus

Unit I HAZRADS, VULNERABILITY AND DISASTER RISKS **9**

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Types of Disasters: Natural, Human induced, Climate change induced –Earthquake, Landslide, Flood, Drought, Fire etc –Technological disasters- Structural collapse, Industrial accidents, oil spills -Causes, Impacts including social, Economic, political, environmental, health, psychosocial, etc.- Disaster vulnerability profile of India and Tamil Nadu - Global trends in disasters: urban disasters, pandemics, Complex emergencies, Inter relations between Disasters and Sustainable development Goals.

UNIT II DISASTER RISK REDUCTION (DRR) **9**

Sendai Framework for Disaster Risk Reduction, Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community Based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions / Urban Local Bodies (PRIs/ULBs), States, Centre, and other stakeholders- Early Warning System – Advisories from Appropriate Agencies. - Relevance of indigenous Knowledge, appropriate technology and Local resources.

UNIT III DISASTER MANAGEMENT **9**

Components of Disaster Management – Preparedness of rescue and relief, mitigation, rehabilitation and reconstruction- Disaster Risk Management and post disaster management – Compensation and Insurance- Disaster Management Act (2005) and Policy - Other related policies, plans,

programmers and legislation - Institutional Processes and Framework at State and Central Level- (NDMA –SDMA- DDMA-NRDF- Civic Volunteers)
UNIT IV TOOLS AND TECHNOLOGY FOR DISASTER MANAGEMENT 9 Early warning systems -Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment. - Elements of Climate Resilient Development –Standard operation Procedure for disaster response – Financial planning for disaster Management.
UNIT V DISASTER MANAGEMENT: CASE STUDIES 9 Discussion on selected case studies to analyse the potential impacts and actions in the contest of disasters-Landslide Hazard Zonation: Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field work related to disaster management. - Field Work-Mock drill.
Total Periods: 45

Learning Resources

1	Taimpo (2016), Disaster Management and Preparedness, CRC Publications
2	Singh R (2017), Disaster Management Guidelines for earthquakes, Landslides, Avalanches and tsunami, Horizon Press Publications
3	Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN13:978-9380386423
4	Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the concepts of disasters, hazards, vulnerability, and disaster risks.	Understand
CO2	Describe different types of disasters and their impacts on society and the environment.	Understand
CO3	Explain the principles and strategies of disaster risk reduction.	Understand
CO4	Discuss disaster management policies, institutions, and frameworks in India.	Understand
CO5	Describe the disaster management tools, technologies, and case study knowledge to disaster situations.	Understand

U24MC21	ENVIRONMENTAL SCIENCE	L	T	P	C
		3	0	0	0

Course Objective:

After completing this course, the students will be able ,

- To introduce the basic concepts and importance of Environmental Science and natural resources.
- To understand ecosystem structure, energy flow, and the importance of biodiversity.
- To study different types of environmental pollution and their control measures.
- To understand major environmental issues and the concept of sustainable development.
- To understand environmental laws, policies, and the role of public participation in environmental
- protection.

Detailed Syllabus

UNIT I INTRODUCTION TO ENVIRONMENT AND NATURAL RESOURCES 8

Definition, scope, and importance of Environmental Science. Components of the environment: lithosphere, hydrosphere, atmosphere, and biosphere. Structure and functions of the environment. Natural resources: renewable and non-renewable resources. Resource distribution and utilization. Resource depletion and conservation strategies. Sustainable use of natural resources and the concept of equitable resource sharing. Importance of environmental awareness and responsibility.

UNIT II ECOSYSTEMS AND BIODIVERSITY 10

Concept, structure, and functions of ecosystems. Types of ecosystems: terrestrial and aquatic ecosystems. Food chains, food webs, and ecological pyramids. Energy flow in ecosystems. Biogeochemical cycles: water cycle, carbon cycle, and nitrogen cycle. Biodiversity: definition, types (genetic, species, and ecosystem diversity), values of biodiversity. Threats to biodiversity such as habitat destruction, overexploitation, pollution, and climate change. Biodiversity conservation methods: in-situ and ex-situ conservation strategies.

UNIT III ENVIRONMENTAL POLLUTION 10

Definition and types of environmental pollution: air pollution, water pollution, soil pollution, noise pollution, thermal pollution, and radioactive pollution. Sources, causes, effects, and control measures for different types of pollution. Solid waste management: types of waste, waste segregation, recycling, and disposal methods. Management of e-waste and plastic waste. Importance of pollution prevention and environmental protection practices.

UNIT IV ENVIRONMENTAL ISSUES AND SUSTAINABLE DEVELOPMENT 9

Major environmental issues: climate change, global warming, ozone layer depletion, acid rain, deforestation, land degradation, urbanization, and population growth. Impact of environmental issues on ecosystems and human health. Concept of sustainable development and sustainable lifestyles. Sustainable Development Goals (SDGs). Sustainable agriculture, renewable energy sources, and green buildings. Carbon footprint, life cycle assessment (LCA), environmental ethics, and green campus initiatives.

UNIT V ENVIRONMENTAL POLICIES, LEGISLATION AND FIELDWORK 8

Environmental policies and legislation in India: Environmental (Protection) Act, 1986; Air (Prevention and Control of Pollution) Act; Water (Prevention and Control of Pollution) Act; Forest Conservation Act; Biological Diversity Act. Role of National Green Tribunal (NGT). Environmental Impact Assessment (EIA). Role of government agencies, NGOs, and public participation in

environmental protection. Fieldwork/Project component: campus environmental audit, biodiversity survey, waste segregation activity, case study analysis, or visit to a pollution control facility.
Total Periods: 45

Learning Resources

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	R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 . Edition 2010.
4	Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.
5	Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005
6	https://moef.gov.in — Ministry of Environment, Forest and Climate Change, India
7	https://sdgs.un.org/goals — UN Sustainable Development Goals
8	https://niti.gov.in — NITI Aayog's SDG India Index

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the basic concepts of environment and natural resources.	Understand
CO2	Describe ecosystem structure, functions, and biodiversity conservation.	Understand
CO3	Identify different types of environmental pollution and their control methods.	Understand
CO4	Discuss major environmental issues and principles of sustainable development.	Understand
CO5	Explain environmental policies, legislation, and apply environmental practices through field activities.	Understand

U24MC31	**HISTORY OF SCIENCE AND TECHNOLOGY IN INDIA**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**0**

Course Objective:

After completing this course, the students will be able ,

- To introduce the basic concepts and perspectives of the history of science and technology.
- To understand the contributions of important scholars in the study of science and technology in India.
- To study the development of science and technology in ancient and medieval India.
- To understand the influence of colonial rule on science and technology in India.
- To understand the growth and impact of science and technology in post-independent India.

Detailed Syllabus

UNIT-I CONCEPTS AND PERSPECTIVES 9 Meaning of History Objectivity, Determinism, Relativism, Causation, Generalization in History; Moral judgment in history Extent of subjectivity, contrast with physical sciences, interpretation and speculation, causation verses evidence, concept of historical inevitability, Historical Positivism. Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.
UNIT-II HISTORIOGRAPHY OF SCIENCE AND TECHNOLOGY IN INDIA 9 Introduction to the works of D.D. Kosambi, Dharmpal, Debiprasad Chattopadhyay, Rehman, S. Irfan Habib, Deepak Kumar, Dhruv Raina, and others.
UNIT-III SCIENCE AND TECHNOLOGY IN ANCIENT INDIA 9 Technology in pre-historic period- Beginning of agriculture and its impact on technology- Science and Technology during Vedic and Later Vedic times - Science and technology from 1st century AD to C-1200.
UNIT-IV SCIENCE AND TECHNOLOGY IN MEDIEVAL INDIA 9 Legacy of technology in Medieval India, Interactions with Arabs- Development in medical knowledge, interaction between Unani and Ayurveda and alchemy- Astronomy and Mathematics: interaction with Arabic Sciences- Science and Technology on the eve of British conquest.
UNIT-V SCIENCE AND TECHNOLOGY IN COLONIAL INDIA 9 Science and the Empire- Indian response to Western Science- Growth of techno-scientific institutions.
UNIT-VI SCIENCE AND TECHNOLOGY IN A POST-INDEPENDENT INDIA Science, Technology and Development discourse- Shaping of the Science and Technology Policy-Developments in the field of Science and Technology- Science and technology in globalizing India-Social implications of new technologies like the Information Technology and Biotechnology.

Learning Resources

1	Deepak Kumar, Science and the Raj: A Study of British India, Oxford University Press, New Delhi, 1995.
2	S. Irfan Habib and Dhruv Raina, Social History of Science in Colonial India, Oxford University Press, New Delhi, 2007.
3	D. D. Kosambi, The Culture and Civilization of Ancient India in Historical Outline, Vikas Publishing House, New Delhi, 1997.
4	Dhruv Raina, Images and Contexts: The Historiography of Science and Modernity in India, Oxford University Press, 2003.



Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the basic concepts and sources of the history of science and technology.	Understand
CO2	Identify the contributions of major scholars in the historiography of science and technology in India.	Understand
CO3	Describe the development of science and technology in ancient and medieval India.	Understand
CO4	Discuss the impact of colonial rule on scientific development in India.	Understand
CO5	Explain the role of science and technology in post-independent India.	Understand

U24MC541	**PERSONAL FINANCE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**0**

Course Objective:

After completing this course, the students will be able ,

- To introduce students to the principles and importance of financial planning, goal setting, risk–return relationship, and informed financial decision-making.
- To develop the ability to apply time value of money concepts, compounding principles, and asset allocation strategies in Evaluate savings and investment alternatives.
- To familiarize students with various financial assets and investment avenues such as bank deposits, mutual funds, equity, bonds, gold, real estate, and small savings instruments.
- To create awareness about responsible borrowing, credit management, loan evaluation, and debt control strategies.
- To enable students to design a comprehensive personal financial plan incorporating insurance, retirement planning, tax planning, and periodic review mechanisms for longterm financial security.

Detailed Syllabus

Unit I Financial Planning **9**

Importance of Financial Planning – Steps involved in Financial Planning – SMART Goals –Achieving Goals – Risk & Returns – Savings & Investment – Loans & Investment.

Unit II Analyze Saving & Investment **9**

Time value of money – Power of Compounding – Rule of 72 and other rules like 69, 70, 144 –Personal Balance sheet and net worth – Inflation effect on Investment – Asset Allocation –Systematic Investment Planning.

Unit III Financial Asset **9**

Investment avenues , Small Savings – Post Office Savings Schemes – Company Fixed Deposits – Bank Deposits –Gold – Gold ETF – Mutual Funds – ELSS – Investing in Equity -Investment in Commodities – Government and Corporate Bonds – Collecting Antiques and artifacts – Real Estate – Chit Funds.

Unit IV Managing Loans	**9**
Personal Loan – Housing Loan – Reverse Mortgage – Education Loan – Gold Pledging – Basics & dangers of Credit Card Debts –CIBIL Score – Steps to avoid excess debt	
Unit V Protection Related Products	**9**
Insurance – Life Insurance – Importance of Term Life Insurance – Pension Schemes – Health Insurance - start early and peaceful retirement – Tracking and reviewing financial plan –Danger of Dipping your retirement savings, Basic of tax planning income tax.	
	Total Periods: 45

Learning Resources

1	Tyco Press (2014), "Personal Finance Simplified", Callisto Publishing, 20th Edition
2	Robert Kiyosaki, Rich Dad Poor Dad (2017), Plata Publishing , New Delhi
3	Madura, Jeff. (2013), 'Personal Finance', Pearson Education, 5th Edition
4	Jack Kapoor, Les Dlabay, Rober J. Huges, (2010), 'Personal Finance ', McGraw Hill

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the importance of financial planning, goal setting, risk-return relationship, and the role of savings and investment in personal finance.	Understand
CO2	Apply time value of money concepts, compounding principles, and asset allocation strategies to evaluate personal financial decisions.	Apply
CO3	Analyze various financial assets and investment avenues (bank deposits, mutual funds, equity, bonds, gold, real estate, etc.) to select suitable options based on risk profile and financial goals.	Analyze
CO4	Evaluate loan options, credit management practices, and debt risks to make responsible borrowing decisions and maintain financial stability.	Evaluate
CO5	Develop a comprehensive personal financial plan incorporating insurance, retirement planning, tax planning, and periodic review mechanisms.	Create

U24MC51	**WELL-BEING WITH TRADITIONAL PRACTICES-YOGA, AYURVEDA AND SIDDHA**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**0**

Course Objective:

After completing this course, the students will be able ,

- To enjoy life happily with fun filled new style activities that help to maintain health also
- To adapt a few lifestyle changes that will prevent many health disorders
- To be cool and handbill every emotion very smoothly in every walk of life
- To learn to eat cost effective but healthy foods that are rich in essential nutrients
- To develop immunity naturally that will improve resistance against many health disorders

Detailed Syllabus

UNIT I HEALTH AND ITS IMPORTANCE 2+4

Health: Definition - Importance of maintaining health - More importance on prevention than treatment Ten types of health one has to maintain - Physical health - Mental health - Social health -Financial health - Emotional health - Spiritual health - Intellectual health - Relationship health -Environmental health - Occupational/Professional heath.

Present health status - The life expectancy-present status - mortality rate - dreadful diseases -non- communicable diseases (NCDs) the leading cause of death - 60% - heart disease – cancer –diabetes chronic pulmonary diseases - risk factors – tobacco – alcohol - unhealthy diet - lack of physical activities.

Types of diseases and disorders - Lifestyle disorders – Obesity – Diabetes - cardiovascular diseases – Cancer – Strokes – COPD - Arthritis - Mental health issues.

Causes of the above diseases / disorders - Importance of prevention of illness - Takes care of health Improves quality of life - Reduces absenteeism - Increase satisfaction - Saves time

Simple lifestyle modifications to maintain health - Healthy Eating habits (Balanced diet according to age) Physical Activities (Stretching exercise, aerobics, resisting exercise) – Maintaining BMI- Importance and actions to be taken.

UNIT II DIET 4+6

Role of diet in maintaining health - energy one needs to keep active throughout the day - nutrients one needs for growth and repair - helps one to stay strong and healthy - helps to prevent diet-related illness, such as some cancers - keeps active and - helps one to maintain a healthy weight - helps to reduce risk of developing lifestyle disorders like diabetes – arthritis – hypertension – PCOD

–infertility – ADHD – sleeplessness -helps to reduce the risk of heart diseases - keeps the teeth and bones strong.

Balanced Diet and its 7 Components - Carbohydrates – Proteins – Fats – Vitamins – Minerals - Fibre and Water.

Food additives and their merits & demerits - Effects of food additives - Types of food additives -Food additives and processed foods - Food additives and their reactions

Definition of BMI and maintaining it with diet - Importance - Consequences of not maintaining BMI - different steps to maintain optimal BM

Common cooking mistakes - Different cooking methods, merits and demerits of each method

UNIT III ROLE OF AYURVEDA & SIDDHA SYSTEMS IN MAINTAINING HEALTH 4+4

AYUSH systems and their role in maintaining health - preventive aspect of AYUSH - AYUSH as a soft therapy.

Secrets of traditional healthy living - Traditional Diet and Nutrition - Regimen of Personal and Social Hygiene - Daily routine (Dinacharya) - Seasonal regimens (Ritucharya) - basic sanitation and healthy living environment - Sadvritta (good conduct) - for conducive social life.

Principles of Siddha & Ayurveda systems - Macrocosm and Microcosm theory - Pancheekarana Theory / (Five Element Theory) 96 fundamental Principles - Uyir Thathukkal (TriDosha Theory) -Udal Thathukkal

Prevention of illness with our traditional system of medicine - Primary Prevention - To decrease the number of new cases of a disorder or illness - Health promotion/education, and -Specific protective measures - Secondary Prevention - To lower the rate of established cases of a disorder or illness in the population (prevalence) - Tertiary Prevention - To decrease the

amount of disability associated with an existing disorder.
UNIT IV MENTAL WELLNESS 3+4 **Emotional health** - Definition and types - Three key elements: the subjective experience - the physiological response - the behavioral response - Importance of maintaining emotional health -Role of emotions in daily life -short term and long-term effects of emotional disturbances - Leading a healthy life with emotions - Practices for emotional health - Recognize how thoughts influence emotions - Cultivate positive thoughts - Practice self-compassion - Expressing a full range of emotions. **Stress management -** Stress definition - Stress in daily life - How stress affects one's life - Identifying the cause of stress - Symptoms of stress - Managing stress (habits, tools, training,professional help) - Complications of stress mismanagement. **Sleep -** Sleep and its importance for mental wellness - Sleep and digestion. **Immunity -** Types and importance - Ways to develop immunity
UNIT V YOGA 2+12 Definition and importance of yoga - Types of yoga - How to Choose the Right Kind for individuals according to their age - The Eight Limbs of Yoga - Simple yogasanas for cure and prevention of health disorders - What yoga can bring to our life
Total Periods: 45

Learning Resources

1	Nutrition and Dietetics - Ashley Martin, Published by White Word Publications, New York, NY 10001, USA
2	Yoga for Beginners_ 35 Simple Yoga Poses to Calm Your Mind and Strengthen Your Body, by Cory Martin, Copyright © 2015 by Althea Press, Berkeley, California
3	WHAT WE KNOW ABOUT EMOTIONAL INTELLIGENCE How It Affects Learning, Work, Relationships, and Our Mental Health, by Moshe Zeidner, Gerald Matthews, and Richard D. Roberts, A Bradford Book, The MIT Press, Cambridge, Massachusetts, London, England
4	The Mindful Self-Compassion Workbook, Kristin Neff, Ph.D Christopher Germer, Ph.D, Published by The Guilford Press A Division of Guilford Publications, Inc.370 Seventh Avenue, Suite 1200, New York, NY 10001
5	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4799645/
6	Simple lifestyle modifications to maintain health https://www.niddk.nih.gov/health-information/diet-nutrition/changing-habits-better-health#:~:text=Make%20your%20new%20healthy%20habit,t%20have%20time%20to%20cook.
7	Read more: https://www.legit.ng/1163909-classes-food-examples-functions.html
8	https://www.yaclass.in/p/science-state-board/class-9/nutrition-and-health-5926
9	Benefits of healthy eating https://www.cdc.gov/nutrition/resources-publications/benefitsof-healthy-eating.html
10	Food additives https://www.betterhealth.vic.gov.au/health/conditionsandtreatments/foodadditives
11	BMI https://www.hsph.harvard.edu/nutritionsource/healthy-weight/ https://www.who.int/europe/news-room/fact-sheets/item/a-healthy-lifestyle---recommendations

12	Yoga https://www.healthifyme.com/blog/types-of-ogal_oga/ https://yogamedicine.com/guide-types-yoga-styles/ Ayurveda: https://vikaspedia.in/health/ayush/ayurveda-1/concept-of-healthy-living-inayurveda
13	Siddha : http://www.tkdl.res.in/tkdl/langdefault/Siddha/Sid_Siddha_Concepts.asp
14	CAM : https://www.hindawi.com/journals/ecam/2013/376327/
15	Preventive herbs : https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3847409/

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the meaning of health, its types, and common lifestyle diseases.	Understand
CO2	Describe the importance of diet, balanced nutrition, and BMI for maintaining good health.	Understand
CO3	Explain the basic principles of Ayurveda and Siddha systems for disease prevention.	Understand
CO4	Discuss the importance of mental wellness, stress management, sleep, and immunity.	Understand
CO5	Describe the importance of yoga and practice simple yogasanas for a healthy life.	Understand

MINORS COURSES

VERTICAL – I BUSINESS DATA ANALYTICS

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MNBA01	Statistics for Management	PEC	3	0	0	3	3	40	60
2	U24MNBA02	Datamining for Business Intelligence	PEC	3	0	0	3	3	40	60
3	U24MNBA03	Human Resource Analytics	PEC	3	0	0	3	3	40	60
4	U24MNBA04	Marketing and Social Media Web Analytics	PEC	3	0	0	3	3	40	60
5	U24MNBA05	Operation and Supply Chain Analytics	PEC	3	0	0	3	3	40	60
6	U24MNBA06	Financial Analytics	PEC	3	0	0	3	3	40	60

U24MNBA01	STATISTICS FOR MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objective:

- To explain the role of statistics in managerial decision-making.
- To summarize the methods of data collection and presentation.
- To classify measures of central tendency and dispersion.
- To illustrate probability concepts and distributions.
- To interpret statistical inference techniques for business applications.

Detailed Syllabus

UNIT I: INTRODUCTION TO STATISTICS **9**

Meaning, Nature and Scope of Statistics – Importance in Business Decision Making – Types of Data – Data Collection Methods – Classification and Tabulation of Data – Diagrammatic and Graphical Presentation.

UNIT II: MEASURES OF CENTRAL TENDENCY **9**

Mean, Median and Mode – Properties and Uses – Weighted Mean – Measures of Central Tendency for Grouped and Ungrouped Data – Practical Applications in Business.

UNIT III: MEASURES OF DISPERSION AND SKEWNESS **9**

Range, Quartile Deviation, Mean Deviation and Standard Deviation – Coefficient of Variation – Skewness and Kurtosis – Interpretation and Applications.

UNIT IV: PROBABILITY AND DISTRIBUTIONS **9**

Concept of Probability – Laws of Probability – Conditional Probability – Theorem of Total Probability – Bayes' Theorem – Probability Distributions: Binomial, Poisson and Normal Distribution.

UNIT V: STATISTICAL INFERENCE **9**

Sampling Techniques – Sampling and Non-Sampling Errors – Estimation – Hypothesis Testing – t-test, Chi-square test and ANOVA – Applications in Business Decision Making.

Total: 45 Periods

Learning Resources

1	Statistics for Management – Richard I. Levin & David S. Rubin, Pearson, Latest Edition, 2021.
2	Business Statistics – S. P. Gupta, Sultan Chand & Sons, Latest Edition, 2020.
3	Statistics for Business and Economics – Paul Newbold, Pearson, Latest Edition, 2022.
4	Business Statistics Using Excel – David M. Levine, Pearson, Latest Edition, 2021.
5	Fundamentals of Statistics – S. C. Gupta & V. K. Kapoor, Sultan Chand & Sons, Latest Edition, 2020.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the role and importance of statistics in management.	Understand
CO2	Summarize methods of data collection and presentation.	Understand
CO3	Classify measures of central tendency and dispersion.	Understand
CO4	Illustrate probability concepts and statistical distributions.	Understand
CO5	Interpret basic statistical inference techniques for business decisions.	Understand

U24MNBA02	**DATAMINING FOR BUSINESS INTELLIGENCE**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

- To describe the concepts and significance of data mining in business intelligence.
- To outline the data preprocessing and data warehousing techniques.
- To explain classification and clustering methods used in data mining.
- To examine association rules and pattern discovery techniques.
- To discuss applications of data mining in business decision-making.

Detailed Syllabus

UNIT I: INTRODUCTION TO DATA MINING **9**

Data Mining – Meaning and Importance – Data Mining vs Data Analytics – Knowledge Discovery in Databases (KDD) Process – Business Intelligence Concepts – Applications of Data Mining in Business.

UNIT II: DATA PREPROCESSING AND WAREHOUSING **9**

Data Cleaning – Data Integration – Data Transformation – Data Reduction – Data Warehousing – Architecture of Data Warehouse – OLAP Operations – Data Marts.

UNIT III: CLASSIFICATION TECHNIQUES **9**

Classification – Decision Trees – Naïve Bayes Classification – K-Nearest Neighbor (KNN) – Model Evaluation Methods – Accuracy, Precision and Recall.

UNIT IV: CLUSTERING AND ASSOCIATION RULES **9**

Clustering – K-Means Clustering – Hierarchical Clustering – Association Rule Mining – Apriori Algorithm – Market Basket Analysis.

UNIT V: DATA MINING APPLICATIONS IN BUSINESS **9**

Customer Relationship Management (CRM) – Fraud Detection – Sales and Marketing Analysis – Risk Management – Web Mining – Ethical Issues in Data Mining.

	Total: 45 Periods

Learning Resources

1	Data Mining: Concepts and Techniques – Jiawei Han, Morgan Kaufmann, Latest Edition, 2022.
2	Introduction to Data Mining – Pang-Ning Tan, Pearson, Latest Edition, 2021.
3	Data Mining for Business Analytics – Galen Shmueli, Wiley, Latest Edition, 2020.
4	Business Intelligence Guidebook – Rick Sherman, Morgan Kaufmann, Latest Edition, 2015
5	Fundamentals of Data Mining in Genomics and Proteomics – Werner Dubitzky, Springer, Latest Edition, 2021.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Describe the concepts and importance of data mining in business intelligence.	Understand
CO2	Outline data preprocessing and data warehousing techniques.	Understand
CO3	Explain classification methods used in data mining.	Understand
CO4	Examine clustering and association rule techniques.	Understand
CO5	Discuss applications of data mining in business contexts	Understand

U24MNBA03	**HUMAN RESOURCE ANALYTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

- To recognize the role of analytics in human resource management.
- To explain HR metrics and data-driven decision-making in organizations.
- To illustrate techniques used in workforce analytics.
- To examine employee performance and retention analytics.
- To appraise the application of HR analytics in strategic management.

Detailed Syllabus

UNIT I: INTRODUCTION TO HR ANALYTICS	**9**
Meaning and Scope of HR Analytics – Evolution of HR Analytics – Role of Analytics in HRM – HR Analytics vs HR Metrics – Importance in Organizational Decision Making.	
UNIT II: HR DATA AND METRICS	**9**
Sources of HR Data – Types of HR Data – HR Metrics: Turnover Rate, Absenteeism, Cost per Hire – Data Collection and Management – HR Dashboards and Reporting.	
UNIT III: WORKFORCE ANALYTICS	**9**
Workforce Planning – Talent Analytics – Recruitment Analytics – Training and Development Analytics – Competency Mapping – Workforce Optimization.	
UNIT IV: PERFORMANCE AND RETENTION ANALYTICS	**9**
Employee Performance Analysis – Performance Appraisal Data – Predicting Employee Attrition – Retention Strategies – Employee Engagement Analytics.	
UNIT V: STRATEGIC HR ANALYTICS AND APPLICATIONS	**9**
HR Analytics in Strategic Decision Making – Predictive HR Analytics – HR Scorecards – Ethical Issues in HR Analytics – Future Trends in HR Analytics.	
Total: 45 Periods	

Learning Resources

1	HR Analytics: The What, Why and How – Tracey Smith, Kogan Page, Latest Edition, 2021.
2	Predictive HR Analytics – Kirsten Edwards, Kogan Page, Latest Edition, 2019.
3	Human Resource Analytics – Dipak Kumar Bhattacharyya, Sage Publications India, Latest Edition, 2017 (Reprint).
4	HR Analytics Handbook – Sharma and Sharma, McGraw Hill Education India, Latest Edition, 2020.
5	People Analytics for Dummies – Mike West, Wiley, Latest Edition, 2018 (Reprint).

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Recognize the importance of analytics in human resource management.	Understand
CO2	Explain HR data sources and key metrics used in organizations.	Understand
CO3	Illustrate workforce analytics techniques in HR functions.	Understand
CO4	Examine employee performance and retention analytics.	Understand
CO5	Appraise the role of HR analytics in strategic decision-making.	Understand

U24MNBA04	**MARKETING AND SOCIAL MEDIA WEB ANALYTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

- To identify the role of analytics in digital marketing and social media.
- To explain web analytics tools and techniques used in marketing.
- To differentiate key performance indicators and metrics in online marketing.
- To examine social media analytics and consumer engagement.
- To assess the application of web analytics in marketing strategies.

Detailed Syllabus

UNIT I: INTRODUCTION TO DIGITAL MARKETING ANALYTICS **9**

Digital Marketing – Concepts and Importance – Role of Analytics in Marketing – Web Analytics: Meaning and Scope – Types of Digital Data – Overview of Marketing Analytics.

UNIT II: WEB ANALYTICS TOOLS AND TECHNIQUES **9**

Web Analytics Tools – Google Analytics – Data Collection Techniques – Traffic Analysis – User Behaviour Analysis – Conversion Tracking – A/B Testing.

UNIT III: MARKETING METRICS AND KPIs **9**

Key Performance Indicators (KPIs) – Click Through Rate (CTR) – Cost per Click (CPC) – Conversion Rate – Customer Acquisition Cost – Return on Investment (ROI) – Campaign Performance Analysis.

UNIT IV: SOCIAL MEDIA ANALYTICS **9**

Social Media Platforms and Data – Engagement Metrics – Sentiment Analysis – Influencer Analytics – Social Media Monitoring Tools – Content Performance Evaluation.

UNIT V: APPLICATIONS AND STRATEGIES IN WEB ANALYTICS **9**
Marketing Strategy Development using Analytics – Customer Segmentation – Personalization Techniques – Predictive Marketing Analytics – Ethical Issues in Digital Analytics.
Total: 45 Periods

Learning Resources

1	Web Analytics 2.0 – Avinash Kaushik, Wiley, Latest Edition, 2020 (Reprint).
2	Digital Marketing Analytics – Chuck Hemann & Ken Burbary, Que Publishing, Latest Edition, 2018 (Reprint).
3	Marketing Analytics – Wayne L. Winston, Wiley, Latest Edition, 2020.
4	Social Media Analytics – Marshall Sponder, McGraw Hill Education, Latest Edition, 2019.
5	Digital Marketing – Dave Chaffey, Pearson, Latest Edition, 2022.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Identify the role of analytics in digital marketing and social media.	Understand
CO2	Explain web analytics tools and techniques used in marketing.	Understand
CO3	Differentiate key performance metrics and KPIs in online marketing.	Understand
CO4	Examine social media analytics and user engagement patterns.	Understand
CO5	Assess the application of web analytics in marketing strategies.	Understand

U24MNBA05	**OPERATION AND SUPPLY CHAIN ANALYTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

- To outline the role of analytics in operations and supply chain management.
- To explain demand forecasting and inventory analysis techniques.
- To describe analytical models used in logistics and distribution.
- To examine performance measurement in supply chains.
- To summarize the application of analytics in optimizing operations.

Detailed Syllabus

UNIT I: INTRODUCTION TO OPERATIONS AND SUPPLY CHAIN ANALYTICS **9**
Operations Management – Supply Chain Management: Concepts and Importance – Role of Analytics in Operations – Components of Supply Chain – Data-Driven Decision Making in Operations.
UNIT II: DEMAND FORECASTING AND INVENTORY ANALYTICS **9**
Demand Forecasting – Qualitative and Quantitative Methods – Time Series Basics – Inventory Management – EOQ Model – Safety Stock – Reorder Point – Inventory Control Techniques.
UNIT III: LOGISTICS AND DISTRIBUTION ANALYTICS **9**
Logistics Management – Transportation Models – Distribution Network Design – Warehouse Analytics – Routing and Scheduling – Cost Optimization in Logistics.

UNIT IV: SUPPLY CHAIN PERFORMANCE MEASUREMENT 9 Supply Chain Performance Metrics – Key Performance Indicators – Benchmarking – Service Level Measurement – Balanced Scorecard in Supply Chain – Risk Assessment in Supply Chain.
UNIT V: OPTIMIZATION AND APPLICATIONS IN OPERATIONS 9 Optimization Techniques in Operations – Linear Programming Basics – Capacity Planning – Lean Operations – Supply Chain Analytics Applications in Manufacturing and Services – Emerging Trends.
Total: 45 Periods

Learning Resources

1	Supply Chain Management: Strategy, Planning, and Operation – Sunil Chopra & Peter Meindl, Pearson, Latest Edition, 2022.
2	Operations Management – William J. Stevenson, McGraw Hill Education, Latest Edition, 2021.
3	Designing and Managing the Supply Chain – David Simchi-Levi, McGraw Hill Education, Latest Edition, 2020.
4	Supply Chain Analytics – Nada R. Sanders, Pearson, Latest Edition, 2020.
5	Operations Research – Hamdy A. Taha, Pearson, Latest Edition, 2019.

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Outline the role of analytics in operations and supply chain management.	Understand
CO2	Explain demand forecasting and inventory analysis techniques.	Understand
CO3	Describe logistics and distribution analytics models.	Understand
CO4	Examine supply chain performance measurement methods.	Understand
CO5	Summarize optimization approaches in operations and supply chain analytics.	Understand

U24MNBA06	**FINANCIAL ANALYTICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

- To explain the significance of analytics in financial decision-making.
- To interpret financial data using analytical tools and techniques.
- To describe models used in investment and risk analysis.
- To examine financial market behaviour using analytical approaches.
- To summarize applications of analytics in corporate finance and investments.

Detailed Syllabus

UNIT I: INTRODUCTION TO FINANCIAL ANALYTICS 9 Financial Analytics – Meaning and Scope – Role of Analytics in Finance – Types of Financial Data – Financial Statements Analysis – Ratio Analysis – Introduction to Financial Modelling.
UNIT II: CORPORATE FINANCE ANALYTICS 9 Cash Flow Analysis – Cost of Capital – Capital Budgeting Techniques – Payback Period – Net Present Value (NPV) – Internal Rate of Return (IRR) – Break-even Analysis.

UNIT III: FINANCIAL MARKET ANALYTICS	**9**
Risk and Return – Measurement of Risk – Time Series Basics in Finance – Stock and Bond Analysis – Market Indicators – Introduction to Volatility Concepts.	
UNIT IV: PORTFOLIO AND INVESTMENT ANALYTICS	**9**
Portfolio Analysis – Diversification – Capital Asset Pricing Model (CAPM) – Sharpe Ratio – Basics of Derivatives – Option Pricing Concepts – Investment Decision Analysis.	
UNIT V: RISK ANALYSIS AND APPLICATIONS	**9**
Financial Risk – Types of Risk – Credit Risk Concepts – Value at Risk (VaR) – Risk Management Techniques – Applications of Financial Analytics in Business.	
	Total: 45 Periods

Learning Resources

1	Financial Analytics *with R* – Mark J. Bennett & Dirk L. Hugen, Cambridge University Press, Latest Edition, 2020.
2	Python for Finance – *Yuxing Yan, Packt Publishing, Latest Edition, 2017 (Reprint).*
3	Quantitative Financial Analytics – *Edward E. Williams & John A. Dobelman, World Scientific, Latest Edition, 2017 (Reprint).*
4	Investment Analysis and Portfolio Management – *Prasanna Chandra, McGraw Hill Education India, Latest Edition, 2021.*
5	Financial Management – *I. M. Pandey, Vikas Publishing, Latest Edition, 2022.*

Course Outcomes

At the end of the course, the students will be able to		
CO	**Course Outcome Statement**	**Knowledge Level**
CO1	Explain the role and importance of financial analytics.	Understand
CO2	Interpret financial data using analytical techniques.	Understand
CO3	Describe models used in corporate finance and investment analysis.	Understand
CO4	Examine financial market behaviour and portfolio concepts.	Understand
CO5	Summarize risk analysis methods and financial applications.	Understand

VERTICAL – II PUBLIC ADMINISTRATION

SL. NO.	COURSE CODE	COURSE TITLE	CATE - GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS	ASSESSMENT	
				L	T	P			CIA	ESE
1	U24MNPA01	Principles of Public Administration	PEC	3	0	0	3	3	40	60
2	U24MNPA02	Constitution of India	PEC	3	0	0	3	3	40	60
3	U24MNPA03	Public Personnel Administration	PEC	3	0	0	3	3	40	60
4	U24MNPA04	Administrative Theories	PEC	3	0	0	3	3	40	60
5	U24MNPA05	Indian Administrative System	PEC	3	0	0	3	3	40	60
6	U24MNPA06	Public Policy Administration	PEC	3	0	0	3	3	40	60

U24MNPA01	PRINCIPLES OF PUBLIC ADMINISTRATION	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the meaning, nature, scope, and evolution of public administration.
- To learn the classical and modern administrative theories.
- To familiarize about the structure and principles of administrative organization.
- To understand the basic functions of personnel and financial administration.
- To describe about the development of administration and emerging trends in public administration.

Detailed Syllabus

UNIT I: INTRODUCTION TO PUBLIC ADMINISTRATION **9**

Meaning, Nature and Scope of Public Administration – Evolution of Public Administration – Public and Private Administration – New Public Administration (NPA) – New Public Management (NPM) – Governance: Concept and Dimensions.

UNIT II: ADMINISTRATIVE THOUGHT **9**

Classical Theories – Woodrow Wilson, Henri Fayol, Max Weber – Neo-Classical Theory: Human Relations Approach – Modern Theories: Systems Theory, Decision-Making Theory – Criticism of Classical Theories.

UNIT III: ADMINISTRATIVE STRUCTURE AND ORGANIZATION **9**

Principles of Organization – Hierarchy, Unity of Command, Span of Control – Line and Staff Agencies – Forms of Organization: Department, Corporation, Board and Commission – Public Enterprises – Accountability and Control.

UNIT IV: PERSONNEL AND FINANCIAL ADMINISTRATION **9**

Personnel Administration – Recruitment, Training, Promotion – Civil Service: Meaning and Types – Financial Administration – Budgeting, Accounting and Auditing – Performance Budgeting and Zero-Based Budgeting – Role of Finance Ministry.

UNIT V: DEVELOPMENT AND CONTEMPORARY PUBLIC ADMINISTRATION **9**
Development Administration – Concept and Features – Good Governance and E-Governance – Public Policy: Formulation and Implementation – Administrative Reforms in India – Role of NGOs and Civil Society.
Total: 45 Periods

Learning Resources

1	Public Administration – *M. Laxmikanth,* McGraw Hill Education India, Latest Edition, 2023.
2	New Horizons of Public Administration – Mohit Bhattacharya, Jawahar Publishers and Distributors, Latest Edition, 2022.
3	Public Administration: Concepts and Theories – Rumki Basu, Sterling Publishers, Latest Edition, 2021.
4	Administrative Thinkers – D. Ravindra Prasad, Sterling Publishers, Latest Edition, 2020.
5	Public Administration in Theory and Practice – M. P. Sharma & B. L. Sadana, Kitab Mahal, Latest Edition, 2022.

Course Outcomes

Upon completion of this course, the student should be able to:

CO	Course Outcome Statement	Knowledge Level
CO1	Explain the concept, scope, and significance of public administration.	Understand
CO2	Describe major administrative theories and contributions of thinkers	Understand
CO3	Explain organizational principles and administrative structures.	Understand
CO4	Describe personnel systems and financial management in public administration.	Understand
CO5	Explain development administration and recent administrative reforms.	Understand

U24MNPA02	**CONSTITUTION OF INDIA**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Objective:

- To understand the historical background and evolution of the Indian Constitution.
- To familiarize learners with the features and principles of the Constitution.
- To develop knowledge about fundamental rights, duties and directive principles.
- To understand the structure and functioning of Union and State governments.
- To analyse constitutional bodies and recent developments in Indian governance.

Detailed Syllabus

UNIT I: HISTORICAL BACKGROUND AND MAKING OF THE CONSTITUTION **9**
Historical background of the Indian Constitution – Regulating Act 1773, Charter Acts, Government of India Acts – Constituent Assembly: Composition and Functions – Drafting Committee – B. R. Ambedkar – Salient features of the Constitution.

UNIT II: FUNDAMENTAL RIGHTS AND DUTIES **9** Fundamental Rights – Right to Equality, Freedom, Against Exploitation, Freedom of Religion, Cultural and Educational Rights, Constitutional Remedies – Fundamental Duties – Directive Principles of State Policy – Relationship between Fundamental Rights and DPSP.
UNIT III: UNION GOVERNMENT **9** President – Powers and Functions – Vice President – Prime Minister and Council of Ministers – Parliament: Lok Sabha and Rajya Sabha – Legislative Procedures – Judicial Review.
UNIT IV: STATE GOVERNMENT AND JUDICIARY **9** Governor – Chief Minister and Council of Ministers – State Legislature – High Courts – Supreme Court of India – Judicial Activism and Independence of Judiciary.
UNIT V: CONSTITUTIONAL BODIES AND AMENDMENTS **9** Election Commission – Finance Commission – Union Public Service Commission – Comptroller and Auditor General (CAG) – Constitutional Amendments – Basic Structure Doctrine – Recent Constitutional Developments.
Total: 45 Periods

Learning Resources

1	Indian Polity – *M. Laxmikanth,* McGraw Hill Education India, Latest Edition, 2023.
2	Introduction to the Constitution of India – D. D. Basu, LexisNexis, Latest Edition, 2022.
3	Our Constitution – Subhash C. Kashyap, National Book Trust, Latest Edition, 2021.
4	Indian Government and Politics – B. L. Fadia, Sahitya Bhawan Publications, Latest Edition, 2022.
5	Constitutional Law of India – J. N. Pandey, Central Law Agency, Latest Edition, 2021.

Course Outcomes

Upon completion of this course, the student should be able to:

CO	Course Outcome Statement	Knowledge Level
CO1	Understand the historical background and features of the Indian Constitution.	Understand
CO2	Explain fundamental rights, duties and directive principles.	Understand
CO3	Describe the structure and functions of the Union Government.	Understand
CO4	Explain the organization of State Government and Judiciary.	Understand
CO5	Understand constitutional bodies and amendment procedures.	Understand

U24MNPA03	PUBLIC PERSONNEL ADMINISTRATION	L	T	P	C
		3	0	0	3

Course Objective:

- To interpret the role and significance of personnel administration in public organizations.
- To distinguish various systems and principles of public personnel management.
- To summarize recruitment, training and career development processes in civil services.
- To explain performance appraisal and promotion systems in government.
- To discuss discipline, ethics and accountability in public service.

Detailed Syllabus

UNIT I: INTRODUCTION TO PUBLIC PERSONNEL ADMINISTRATION 9 Meaning, Nature and Scope of Public Personnel Administration – Evolution of Personnel Systems – Role of Human Resources in Public Administration – Distinction between Public and Private Personnel Administration – Emerging Trends in HRM in Public Sector.
UNIT II: CIVIL SERVICE SYSTEMS 9 Civil Service: Meaning and Features – Types of Civil Services – Generalist vs Specialist – Neutrality and Anonymity – Recruitment Agencies – Union Public Service Commission – State Public Service Commission.
UNIT III: RECRUITMENT, TRAINING AND DEVELOPMENT 9 Principles of Recruitment – Methods of Recruitment – Training: Types and Importance – Training Institutions in India – Career Development – Capacity Building in Public Service.
UNIT IV: PERFORMANCE APPRAISAL AND PROMOTION 9 Performance Appraisal: Meaning and Methods – Confidential Reports – Promotion Policies – Seniority vs Merit – Pay Structure and Incentives – Employee Motivation in Public Sector.
UNIT V: DISCIPLINE, ETHICS AND ACCOUNTABILITY 9 Disciplinary Procedures – Conduct Rules – Administrative Ethics – Code of Conduct – Integrity in Public Service – Grievance Redressal Mechanisms – Role of Vigilance Institutions
Total: 45 Periods

Learning Resources

1	Personnel Administration in India – Avasthi and Maheshwari, Lakshmi Narain Agarwal, Latest Edition, 2021.
2	Public Personnel Administration – M. P. Sharma, Kitab Mahal, Latest Edition, 2022.
3	Human Resource Management in Public Sector – B. P. Singh, Excel Books, Latest Edition, 2020.
4	Public Administration in Theory and Practice – M. P. Sharma & B. L. Sadana, Kitab Mahal, Latest Edition, 2022.
5	Indian Administration – S. R. Maheshwari, Orient Blackswan, Latest Edition, 2021.

Course Outcomes

Upon completion of this course, the student should be able to:

CO	Course Outcome Statement	Knowledge Level
CO1	Interpret the role and importance of personnel administration in public organizations.	Understand
CO2	Distinguish various civil service systems and their features.	Understand

CO3	Summarize recruitment, training and development processes in public services.	Understand
CO4	Explain performance appraisal and promotion systems in administration.	Understand
CO5	Discuss discipline, ethics and accountability mechanisms in public service.	Understand

U24MNPA04	ADMINISTRATIVE THEORIES	L	T	P	C
		3	0	0	3

Course Objective:

- To outline the evolution of administrative thought.
- To clarify the principles of classical administrative theories.
- To examine human relations and behavioural approaches.
- To illustrate modern administrative theories and systems approach.
- To compare traditional and contemporary administrative perspectives.

Detailed Syllabus

UNIT I: EVOLUTION OF ADMINISTRATIVE THOUGHT **9**

Nature and Significance of Administrative Theory – Evolution of Administrative Thought – Politics-Administration Dichotomy – Contribution of Woodrow Wilson – Early Administrative Ideas.

UNIT II: CLASSICAL ADMINISTRATIVE THEORIES **9**

Scientific Management Theory – Contribution of F. W. Taylor – Administrative Theory of Henri Fayol – Bureaucratic Theory of Max Weber – Principles and Criticism.

UNIT III: NEO-CLASSICAL AND HUMAN RELATIONS APPROACH **9**

Human Relations Theory – Hawthorne Experiments – Contribution of Elton Mayo – Behavioural Approach – Motivation Theories – Limitations of Human Relations Approach.

UNIT IV: MODERN ADMINISTRATIVE THEORIES **9**

Systems Theory – Decision-Making Theory – Contribution of Herbert Simon – Ecological Approach – Comparative Public Administration – Critique of Modern Theories.

UNIT V: CONTEMPORARY ADMINISTRATIVE PERSPECTIVES **9**

New Public Administration – New Public Management – Governance Approach – Public Choice Theory – Emerging Trends in Administrative Thought.

Total: 45 Periods

Learning Resources

1	Administrative Thinkers – D. Ravindra Prasad, Sterling Publishers, Latest Edition, 2020.
2	New Horizons of Public Administration – Mohit Bhattacharya, Jawahar Publishers and Distributors, Latest Edition, 2022.
3	Public Administration: Concepts and Theories – Rumki Basu, Sterling Publishers, Latest Edition, 2021.
4	Administrative Behavior – Herbert A. Simon, Free Press, Latest Edition, 2013 (Reprint).

5	The Theory of Public Administration – Nigro and Nigro, Harper & Row, Latest Edition (Reprint), 2017.

Course Outcomes

Upon completion of this course, the student should be able to:

CO	Course Outcome Statement	Knowledge Level
CO1	Outline the evolution of administrative thought and early theories.	Understand
CO2	Clarify the principles of classical administrative theories.	Understand
CO3	Examine human relations and behavioural approaches in administration.	Understand
CO4	Illustrate modern administrative theories and their applications.	Understand
CO5	Compare traditional and contemporary administrative perspectives.	Understand

U24MNPA05	INDIAN ADMINISTRATIVE SYSTEM	L	T	P	C
		3	0	0	3

Course Objective:

- To describe the structure and characteristics of the Indian administrative system.
- To explain the organization of central and state administration.
- To identify the role of district and local administration in governance.
- To examine the functions of public institutions and regulatory bodies.
- To highlight administrative reforms and challenges in India.

Detailed Syllabus

UNIT I: EVOLUTION AND FEATURES OF INDIAN ADMINISTRATION **9**

Historical evolution of Indian Administration – Colonial legacy – Post-independence developments – Salient features of Indian Administrative System – Continuity and change in administration.

UNIT II: CENTRAL ADMINISTRATION **9**

President and Council of Ministers – Prime Minister and Cabinet Secretariat – Central Secretariat – Ministries and Departments – Role of Civil Services – Cabinet Secretariat.

UNIT III: STATE AND DISTRICT ADMINISTRATION **9**

State Administration – Governor and Chief Minister – State Secretariat – District Administration – Role of District Collector – Changing role in development administration.

UNIT IV: LOCAL ADMINISTRATION AND PUBLIC INSTITUTIONS **9**

Panchayati Raj Institutions – Urban Local Bodies – Functions and Responsibilities – Role of Public Sector Institutions – Regulatory Authorities and Statutory Bodies.

UNIT V: ADMINISTRATIVE REFORMS AND CHALLENGES **9**

Administrative Reforms in India – Administrative Reforms Commission – Good Governance Initiatives – E-Governance – Issues of Corruption, Transparency and Accountability – Contemporary Challenges in Indian Administration.

Total: 45 Periods

Learning Resources

1	Indian Administration – S. R. Maheshwari, Orient Blackswan, Latest Edition, 2021.
2	Indian Administration – Arora and Goyal, New Age International, Latest Edition, 2020.
3	Public Administration in India – Padma Ramachandran, National Book Trust, Latest Edition, 2021.
4	Indian Polity – M. Laxmikanth, McGraw Hill Education India, Latest Edition, 2023.
5	Governance in India – M. Laxmikanth, McGraw Hill Education India, Latest Edition, 2022.

Course Outcomes

Upon completion of this course, the student should be able to:

CO	Course Outcome Statement	Knowledge Level
CO1	Describe the evolution and features of the Indian administrative system.	Understand
CO2	Explain the structure and functioning of central administration.	Understand
CO3	Identify the organization of state and district administration.	Understand
CO4	Examine the role of local administration and public institutions.	Understand
CO5	Highlight administrative reforms and contemporary challenges in India.	Understand

U24MNPA06	PUBLIC POLICY ADMINISTRATION	L	T	P	C
		3	0	0	3

Course Objective:

- To define the concept and significance of public policy in governance.
- To classify different types and approaches of public policy.
- To explain the stages involved in public policy formulation and implementation.
- To interpret the role of institutions and stakeholders in policy processes.
- To review policy evaluation and contemporary policy challenges.

Detailed Syllabus

UNIT I: INTRODUCTION TO PUBLIC POLICY **9**

Meaning and Nature of Public Policy – Scope and Importance – Types of Public Policy – Public Policy vs Decision Making – Role of Government in Policy Making.

UNIT II: APPROACHES AND MODELS OF PUBLIC POLICY **9**

Institutional Approach – Group Theory – Elite Theory – Rational Model – Incremental Model – Systems Approach – Policy Analysis Frameworks.

UNIT III: POLICY FORMULATION AND IMPLEMENTATION **9**

Policy Formulation – Agenda Setting – Policy Design – Policy Implementation – Role of Bureaucracy and Political Executive – Factors influencing implementation.

UNIT IV: POLICY ACTORS AND INSTITUTIONS **9**

Role of Legislature, Executive and Judiciary – Role of Civil Society and NGOs – Role of International Organizations – NITI Aayog – Policy Networks and Stakeholders.

UNIT V: POLICY EVALUATION AND CONTEMPORARY ISSUES **9**

Policy Monitoring and Evaluation – Techniques of Policy Evaluation – Public Policy and Development – Issues in Policy Implementation – Emerging Policy Challenges in India.

Total: 45 Periods

Learning Resources

1	Public Policy: Concepts, Theory and Practice – B. Guy Peters, Routledge, 2021.
2	Public Policy – Thomas R. Dye, Pearson, Latest Edition, 2020.
3	Understanding Public Policy – Thomas R. Dye, Pearson, Latest Edition, 2021.
4	Public Policy and Administration in India – Rajesh K. Shukla, Sage Publications India, Latest Edition, 2022.
5	Public Policy in India – Kuldeep Mathur, Oxford University Press India, Latest Edition, 2020.

Course Outcomes

Upon completion of this course, the student should be able to:

CO	Course Outcome Statement	Knowledge Level
CO1	Define the concept and significance of public policy.	**Understand**
CO2	Classify various approaches and models of public policy.	**Understand**
CO3	Explain the stages of policy formulation and implementation.	**Understand**
CO4	Interpret the role of institutions and stakeholders in policy processes.	**Understand**
CO5	Review policy evaluation methods and contemporary policy issues.	**Understand**