PAAVAI ENGINEERING COLLEGE, NAMAKKAL – 637018
(AUTONOMOUS)
B.E. ELETRONICS AND COMMUNICATION ENGINEERING
REGULATIONS 2023
(CHOICE BASED CREDIT SYSTEM)
(Applicable to the students admitted from the academic year 2023-2024 onwards)
CURRICULUM
SEMESTER I

S. No	Category	Course Code	Course Title	L	T	P	C
1			Induction Programme				
Theory							
2	HS	GE23101	தமிழர் மரபு/Heritage of Tamils	1	0	0	1
3	BS	MA23101	Matrices and Calculus	3	1	0	4
4	BS	PH23101	Physics for Electronics Engineering	3	0	0	3
5	ES	CS23101	Problem Solving and Python Programming	3	0	0	3
6	ES	EC23101	Electron Devices	3	0	0	3
Theory with Laboratory							
6	HS	EN23101	Communication Skills for Engineers I	2	0	2	3
Practical							
7	BS	PH23104	Physics Laboratory for Electronics Engineering	0	0	2	1
8	ES	GE23102	Electrical and Electronics Engineering Practices Laboratory	0	0	2	1
9	ES	CS23103	Problem Solving and Python Programming Laboratory	0	0	4	2
			Total	**15**	**1**	**10**	**21**

SEMESTER II

S. No	Category	Course Code	Course Title	L	T	P	C
Theory							
1	HS	GE23201	தமிழரும் தொழில்நுட்பமும்/Tamils and Technology	1	0	0	1
2	BS	MA23201	Complex Variables and Differential Equations	3	1	0	4
3	BS	CH23201	Applied Chemistry	3	0	0	3
4	ES	ME23201	Engineering Graphics	2	0	2	3
5	ES	EC23201	Circuits and Networks	3	0	0	3
Theory with Laboratory							
6	HS	EN23201	Communication Skills for Engineers II	2	0	2	3
Practical							
7	BS	CH23204	Chemistry Laboratory	0	0	2	1
8	ES	GE23203	Civil and Mechanical Engineering Practices Laboratory	0	0	2	1
9	ES	EC23202	Circuit and Devices Laboratory	0	0	2	1
			Total	**14**	**1**	**10**	**20**

PAAVAI ENGINEERING COLLEGE
APPROVED
BOARD OF STUDIES
Electronics & Communication Engineering
29/4/25

SEMESTER – III

Course Code	Category	Course Title	L	T	P	C
Theory						
MA23302	BS	Linear Algebra and Numerical Methods	3	1	0	4
EC23301	PC	Analog Electronics	3	0	0	3
EC23302	PC	Digital Electronics	3	0	0	3
EC23303	PC	Signals and Systems	3	1	0	4
MC23302	MC	Human Values and Gender Equality	2	0	0	0
Theory with Practical						
IT23307	ES	Fundamentals of Data Structures in C	3	0	2	4
Practical						
EC23304	PC	Analog Electronics Laboratory	0	0	2	1
EC23305	PC	Digital Electronics Laboratory	0	0	4	2
GE23301	EE	Professional Development I	0	0	2	1
		TOTAL	**17**	**2**	**10**	**22**

SEMESTER – IV

Course Code	Category	Course Title	L	T	P	C
Theory						
MA23402	BS	Probability and Random Processes	3	1	0	4
EC23401	PC	Analog Integrated Circuits	3	0	0	3
EC23402	PC	Electromagnetic Fields and Waves	3	0	0	3
EC23403	PC	Digital Signal Processing	3	1	0	4
MC23401	MC	Environmental Sciences and Sustainability	2	0	0	0
Theory with Practical						
EC23404	PC	Microprocessor and Microcontrollers	3	0	2	4
Practical						
EC23405	PC	Analog Integrated Circuits Laboratory	0	0	4	2
EC23406	PC	Digital Signal Processing Laboratory	0	0	2	1
GE23401	EE	Professional Development II	0	0	2	1
		TOTAL	**18**	**2**	**10**	**22**

SEMESTER - V

Course Code	Category	Course Title	L	T	P	C
Theory						
BA23151	HS	Entrepreneurship Development	3	0	0	3
EC23501	PC	Analog and Digital Communication	3	0	0	3
EC23502	PC	RF Transmission Lines	3	0	0	3
EC23503	PC	Control Systems	3	1	0	4
EC23504	PC	Computer Communication Networks	3	0	0	3
EC2315*	PE 1	Professional Electives I	3	0	0	3
Practical						
EC23505	PC	Communication Systems Laboratory	0	0	2	1
EC23506	PC	Computer Networks Laboratory	0	0	4	2
EC23507	EE	Industrial Training	0	0	2	1
GE23501	EE	Professional Development III	0	0	2	1
		TOTAL	**18**	**1**	**10**	**24**

SEMESTER - VI

Course Code	Category	Course Title	L	T	P	C
Theory						
EC23601	PC	Antennas and Wave Propagation	3	0	0	3
EC23602	PC	VLSI Design	3	0	0	3
EC23603	PC	Machine Learning for Communication Engineers	3	0	0	3
EC23604	PC	Embedded and IoT Systems	3	0	0	3
EC2325*	PE 2	Professional Electives II	3	0	0	3
*******	OE1	Open Elective I	3	0	0	3
Practical						
EC23606	PC	VLSI Design Laboratory	0	0	4	2
EC23607	PC	Embedded and IoT Systems Laboratory	0	0	4	2
*******	EE	Design Thinking I	0	0	2	1
		TOTAL	**18**	**0**	**10**	**23**

SEMESTER - VII

Course Code	Category	Course Title	L	T	P	C
Theory						
EC23701	PC	Optical and Microwave Engineering	3	0	0	3
EC23702	PC	Wireless Communication	3	0	0	3
EC23703	PC	Cryptography and Network Security	3	0	0	3
EC2335*	PE3	Professional Electives III	3	0	0	3
EC2345*	PE4	Professional Electives IV	3	0	0	3
*******	OE2	Open Elective II	3	0	0	3
Practical						
EC23703	PC	Optical and Microwave Laboratory	0	0	4	2
EC23704	EE	Project Work - Phase I	0	0	6	3
		TOTAL	**18**	**0**	**10**	**23**

SEMESTER - VIII

Course Code	Category	Course Title	L	T	P	C
Theory						
EC2355*	PE5	Professional Electives V	3	0	0	3
EC2365*	PE6	Professional Electives VI	3	0	0	3
Practical						
EC23801	EE	Project Work - Phase II	0	0	12	6
		TOTAL	**6**	**0**	**12**	**12**

TOTAL CREDITS: 167

CURRICULUM STRUCTURE

S. NO.	CATEGORY	Credit Range		Total Credits	Number of Courses
		Min	Max		
1.	Basic Sciences(BS)	**25**	**28**	24	08
2.	Humanities and Social Sciences (HS)	**10**	**14**	11	05
3.	Engineering Sciences(ES)	**20**	**24**	21	09
4.	Professional Core Courses(PC)	**55**	**70**	73	27
5.	Professional Elective Courses(PE)	**15**	**18**	18	06
6.	Open Elective Courses (OE)	**6**	**12**	06	02
7.	Employability Enhancement Courses(EEC)	**11**	**13**	14	07
8.	Mandatory Courses	-	-	-	02
	Total			**167**	66

SUMMARY

S. NO.	CATEGORY	CREDITS AS PER SEMESTER								CREDITS TOTAL
		I	II	III	IV	V	VI	VII	VIII	
1	**HS**	4	4	-	-	3	-	-	-	11
2	**BS**	8	8	4	4	-	-	-	-	24
3	**ES**	9	8	4	-	-	-	-	-	21
4	**PC**	-	-	13	17	16	16	11	-	73
5	**PE**	-	-	-	-	3	3	6	6	18
6	**OE**	-	-	-	-	-	3	3	-	6
7	**EE**	-	-	1	1	2	1	3	6	14
8	**OCC**	-	-	-	-	-	-	-	-	-
9	**Non-Credit / Mandatory**	**	*	*	-	-	-	-	-	-
	Total	**21**	**20**	**22**	**22**	**24**	**23**	**23**	**12**	**167**

VERTICALS FOR PROFESSIONAL ELECTIVES

VERTICAL I - COMMUNICATION AND NETWORKS

Course Code	Course Title	L	T	P	C
EC23151	Wireless Networks	3	0	0	3
EC23152	Wireless Systems and Standards	3	0	0	3
EC23153	5G Communication Networks	3	0	0	3
EC23154	AdHoc and Wireless Sensor Networks	3	0	0	3
EC23155	Cognitive Radio Networks	3	0	0	3
EC23156	Fiber Optic Communication Networks	3	0	0	3
EC23157	Software Defined Networks	3	0	0	3

VERTICAL II - SIGNAL AND IMAGE PROCESSING

Course Code	Course Title	L	T	P	C
EC23251	Digital Image Processing	3	0	0	3
EC23252	Multimedia Compression Techniques	3	0	0	3
EC23253	Video Analytics	3	0	0	3
EC23254	Speech Processing	3	0	0	3
EC23255	Advanced Digital Signal Processing	3	0	0	3
EC23256	DSP Processors and its Applications	3	0	0	3
EC23257	RADAR Signal Processing	3	0	0	3

VERTICAL III - SEMICONDUCTOR CHIP DESIGN

Course Code	Course Title	L	T	P	C
EC23351	Analog IC Design	3	0	0	3
EC23352	Mixed Signal IC Design	3	0	0	3
EC23353	FPGA Based System Design	3	0	0	3
EC23354	System on Chip Design	3	0	0	3
EC23355	CAD for VLSI	3	0	0	3
EC23356	Testing of VLSI circuits	3	0	0	3
EC23357	Low Power VLSI	3	0	0	3

VERTICAL IV - RF AND SPACE TECHNOLOGIES

Course Code	Course Title	L	T	P	C
EC23451	Avionics	3	0	0	3
EC23452	Satellite Communication	3	0	0	3
EC23453	Nano Electronics	3	0	0	3
EC23454	Smart Antennas	3	0	0	3
EC23455	RF Transceivers	3	0	0	3
EC23456	RFID System Design and Testing	3	0	0	3
EC23457	EMI/EMC in System Design	3	0	0	3

VERTICAL V - SENSOR TECHNOLOGIES AND IOT

Course Code	Course Title	L	T	P	C
EC23551	Display Technologies	3	0	0	3
EC23552	Wearable Devices	3	0	0	3
EC23553	Sensors and Transducers	3	0	0	3
EC23554	Virtual Reality and Augmented Reality	3	0	0	3
EC23555	IoT Based System Design	3	0	0	3
EC23556	Industrial IoT and Industry 4.0	3	0	0	3
EC23557	Intelligent Blockchain Technologies in IoT	3	0	0	3

VERTICAL VI - HEALTH CARE ELECTRONICS

Course Code	Course Title	L	T	P	C
EC23651	Medical Electronics	3	0	0	3
EC23652	Internet of Medical Things	3	0	0	3
EC23653	Measurements and Instrumentation	3	0	0	3
EC23654	Artificial Intelligence in Healthcare	3	0	0	3
EC23655	Body Area Networks	3	0	0	3
EC23656	Human Assist Devices	3	0	0	3
EC23657	MEMS for Healthcare	3	0	0	3

Minor Degree in Computer Communication and Networks

Course Code	Course Title	L	T	P	C
EC23851	Fundamentals of Communication	3	0	0	3
EC23852	Basics of Computer Communication Networks	3	0	0	3
EC23853	Principles of Wireless Networks	3	0	0	3
EC23854	Wireless Systems and Standards	3	0	0	3
EC23855	4G / 5G Communication Networks	3	0	0	3
EC23856	AdHoc and Wireless Sensor Networks	3	0	0	3

SEMESTER - V

Course Code	Category	Course Title	L	T	P	C
Theory						
BA23151	HS	Entrepreneurship Development	3	0	0	3
EC23501	PC	Analog and Digital Communication	3	0	0	3
EC23502	PC	RF Transmission Lines	3	0	0	3
EC23503	PC	Control Systems	3	1	0	4
EC23504	PC	Computer Communication Networks	3	0	0	3
EC2315*	PE 1	Professional Electives I	3	0	0	3
Practical						
EC23505	PC	Communication Systems Laboratory	0	0	2	1
EC23506	PC	Computer Networks Laboratory	0	0	4	2
EC23507	EE	Industrial Training	0	0	2	1
GE23501	EE	Professional Development III	0	0	2	1
		TOTAL	**18**	**1**	**10**	**24**

SEMESTER - VI

Course Code	Category	Course Title	L	T	P	C
Theory						
EC23601	PC	Antennas and Wave Propagation	3	0	0	3
EC23602	PC	VLSI Design	3	0	0	3
EC23603	PC	Machine Learning for Communication Engineers	3	0	0	3
EC23604	PC	Embedded and IoT Systems	3	0	0	3
EC2325*	PE 2	Professional Electives II	3	0	0	3
*******	OE1	Open Elective I	3	0	0	3
Practical						
EC23606	PC	VLSI Design Laboratory	0	0	4	2
EC23607	PC	Embedded and IoT Systems Laboratory	0	0	4	2
*******	EE	Design Thinking I	0	0	2	1
		TOTAL	**18**	**0**	**10**	**23**

BA23151	ENTREPRENEURSHIP DEVELOPMENT	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1	empower to adopt the management principles
2	build entrepreneurial competencies and analyze support from government and agencies in entrepreneurship development.
3	appraise factors for launching a small business
4	adopt business opportunities and prepare feasibility reports.
5	develop entrepreneurial mindset, creativity, and understand startup ecosystems

UNIT I	BASICS OF MANAGEMENT AND ENTREPRENEURSHIP	9

Management: Meaning, Definition, Nature and Importance, Roles - Levels of Management - Functional areas of Management: Marketing, Finance, Production, HRM, IT, Research and Development. Introduction to Entrepreneurship and Intrapreneurship – similarities, differences, types of entrepreneurs - Functions of an entrepreneur

UNIT II	ENTREPRENEURIAL COMPETENCE AND ENVIRONMENT	9

Entrepreneurial Competence: Definitions, Roles, Styles, Characteristics, Competencies

Entrepreneurial Environment: Socio-cultural, Economic, Political factors; Institutional Support for small entrepreneurs. Central and State Government Industrial Policies and Regulations - Entrepreneurial Skillset: motivation, stress, ethical challenges

UNIT III	ENTREPRENEURIAL DEVELOPMENT AND STRUCTURES	9

Ownership Structures: Proprietorship, Partnership, Company, Cooperative, Franchise. Business Opportunity Identification, Feasibility Report, Financial & Technical Evaluation. Entrepreneurial Development Programs, Role of SSI, Failure Causes and Turnaround Strategies. Creativity techniques: Six Thinking Hats, Idea validation, Lean Canvas model.

UNIT IV	BUSINESS PLAN AND FUNDING STRATEGIES	9

Business Plan: Business opportunities-SWOT, Business plan process, Feasibility Study - AI in business plan preparation.

Financing ventures: sources of raising capital, seed funding, venture capital funding, funding opportunities for start-ups in India, - AI driven startup evaluation and scoring - Pitching, funding mix (debt vs equity), incubators, accelerators, crowd funding, angel investors.

UNIT V	WOMEN ENTREPRENEURSHIP AND SECTORAL OPPORTUNITIES	9

Women Entrepreneurship: Growth, Challenges, development. Strategic planning and growth for startups – Women Entrepreneurship Platform in India – Entrepreneurial schemes for women – SSI and MSME

Entrepreneurship in Formal Sector: AI in Rural, Agriculture, Tourism, Manufacturing, Healthcare, Transport and allied services. Digital economy tools: social media marketing, affiliated marketing, influential marketing, mobile marketing.

	TOTAL PERIODS	45

COURSE OUTCOMES		
At the end of this course, students will be able to		**BT Mapped (Highest Level)**
CO1	implement the necessary managerial skills to become an entrepreneur	Applying (K3)
CO2	develop self-employment having been exposed to entrepreneurial environment.	Synthesis (K5)
CO3	select a best business idea by using appropriate methods to assess its viability	Knowledge(K1)
CO4	formulate a business plan and deploy the resources for sustainable growth	Synthesis (K5)
CO5	analyze government support systems and startup ecosystem resources like incubators and funding options..	Analyzing (K4)

TEXT BOOKS

1. Entrepreneurship: Theory, Process, and Practice By Donald F. Kuratko 11th Edition, 2021, Cengage Learning
2. Entrepreneurship Development: New Venture Creation By S.S. Khanka 6th Edition, 2021, S. Chand Publishing

REFERENCE BOOKS

1. Entrepreneurship Development, by Sharma Sangeeta – Second Edition, 2020, PHI Learning
2. Entrepreneurship by Rajeev Roy – Second Edition, 2011, Oxford University Press
3. The Startup Owner's Manual: The Step-By-Step Guide for Building a Great Company, By Steve Blank and Bob Dorf, 2020 Edition
4. Entrepreneurship: Starting and Operating A Small Business, By Steve Mariotti and Caroline Glackin, 7th Edition, 2021, Pearson

CO-PO MAPPING :

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's) and Programme Specific Outcomes PSO's (1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes(POs)					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	1	-	1	-	-
CO2	-	-	-	-	1	2
CO3	-	-	-	1	-	1
CO4	-	-	2	-	2	-
CO5	1	-	1	-	2	-

EC23501	ANALOG AND DIGITAL COMMUNICATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the concepts of analog communication techniques
2.	learn the transition of analog to digital communication techniques
3.	comprehend the various types of digital communication methods
4.	know the basics of statistical theory of various communication
5.	be familiar with error control codes

UNIT I	ANALOG COMMUNICATION	9

Modulation - Types, Need for Modulation, Theory of Amplitude Modulation, Double side band Modulation, Single side band Modulation, Vestigial side band Modulation; Theory of Angle Modulation; Comparison of Analog Communication Systems - AM, FM, PM .

UNIT II	ANALOG TO DIGITAL TRANSITION SYSTEMS	9

Pulse Amplitude Modulation, Pulse Width Modulation, Pulse Position Modulation; Comparison of various Pulse Communication Systems - PAM, PWM, PPM; Pulse Code Modulation; Delta Modulation, Differential Pulse Code Modulation.

UNIT III	DIGITAL COMMUNICATION	9

Phase Shift Keying - ASK, FSK, BPSK, QPSK; Principles of M - ary Signaling; M - ary QAM; Inter Symbol Interference, Eye pattern, Pulse Shaping, Correlative-Level Coding, Adaptive Equalization.

UNIT IV	INFORMATION THOERY	9

Uncertainty, Information, Entropy and its Properties; Source Coding Theorem - Shannon Fano Coding, Huffman Coding; Discrete Memoryless Channels; Mutual information; Channel Capacity - Channel Coding Theorem; Information Capacity Theorem.

UNIT V	ERROR CONTROL CODING	9

Need for Coding; Linear block codes - Hamming codes, Syndrome Decoding; Cyclic Codes; Convolutional Codes - Viterbi Algorithm.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the fundamental concepts and types of analog modulation techniques such as AM, FM, and PM.	Understanding (K2)
CO2	compare various pulse modulation techniques	Analyzing (K4)
CO3	apply knowledge of digital modulation schemes like ASK, FSK, PSK, QAM.	Applying (K3)

CO4	assess the principles of information theory concepts	Applying (K3)
CO5	analyze error control coding schemes such as linear block codes, cyclic codes, and convolutional codes	Analyzing (K4)

TEXT BOOKS

1. Simon Haykin and Michael Moher, "Communication Systems", John Wiley and Sons, 5th Edition, 2016.
2. Samuel O. Agbo and Matthew O. Sadiku, "Principles of Modern Communication Systems", Cambridge University Press, Cambridge, United Kingdom, 2017.

REFERENCES

1. Wayne Tomasi, "Advanced Electronic Communication Systems", Pearson Education, 6th Edition, 2009.
2. John G. Proakis , Mosoud Salehi, "Digital Communication", 5th Edition, 2008.
3. H. Taub, D LSchilling and G Saha, "Principles of Communication", Pearson Education, 3rd Edition, 2009.
4. B.P. Lathi and Zhi Ding, Modern Digital and analog Communication Systems, 4th Edition, Oxford University Press, New York, 2009.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	1
CO2	3	2	-	-	-	-	-	-	-	-	-	-	3	1
CO3	3	3	2	-	-	-	-	-	-	-	-	-	3	1
CO4	3	3	-	2	-	-	-	-	-	-	-	-	3	2
CO5	3	3	2	2	-	-	-	-	-	-	-	-	3	2

EC23502	RF TRANSMISSION LINES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. get acquaintance with RF system
2. learn the various types of transmission lines and its characteristics
3. understand the concepts of high frequency line, power and impedance measurements
4. acquire knowledge about impedance matching using smith chart
5. know the basics and types of Waveguides

UNIT I **RF SYSTEM DESIGN CONCEPTS** **9**

Active RF components - Semiconductor basics in RF, bipolar junction transistors, RF field effect transistors, High Electron Mobility Transistors; Basic concepts of RF design - Mixers, Low noise amplifiers, voltage control oscillators, Power amplifiers; Transducer power gain and stability considerations.

UNIT II **TRANSMISSION LINE THEORY** **9**

General theory of Transmission lines - General solution, 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; Planar Transmission Lines.

UNIT III **HIGH FREQUENCY TRANSMISSION LINES** **9**

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 IV **IMPEDANCE MATCHING IN HIGH FREQUENCY LINES** **9**

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 V **WAVEGUIDES** **9**

General Wave behavior along uniform guiding structures - Transverse Electromagnetic Waves, Transverse Magnetic Waves, Transverse Electric Waves; TM and TE Waves between parallel plates; Field Equations in rectangular waveguides - TM and TE waves in rectangular waveguides, Bessel Functions; TM and TE waves in Circular waveguides.

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the fundamental components and active devices used in RF system design.	Understanding (K2)
CO2	analyze the theory and characteristics of transmission lines.	Analyzing (K4)
CO3	evaluate high-frequency transmission line parameters..	Analyzing (K4)
CO4	apply impedance matching techniques using Smith chart and stub matching for optimal RF design.	Applying (K3)
CO5	elucidate TE and TM wave propagation in various waveguide types.	Understanding (K2)

TEXT BOOKS

1. John D Ryder, Networks, Lines and Fields, 2nd Edition, Prentice Hall India, 2015.
2. Mathew M. Radmanesh, Radio Frequency &Microwave Electronicsl, Pearson Education Asia, 2nd Edition, 2002.

REFERENCES

1. Reinhold Ludwig and Powel Bretchko, RF Circuit Design – Theory and Applications, Pearson Education Asia, 2nd Edition, 2011.
2. D. K. Misra, Radio Frequency and Microwave Communication Circuits- Analysis and Design, John Wiley & Sons, 2nd Edition, 2004.
3. E.C.Jordan and K.G. Balmain, Electromagnetic Waves and Radiating Systems, Prentice Hall of India, 2006
4. G.S.N Raju, Electromagnetic Field Theory and Transmission Lines, Pearson Education, 1st Edition 2005.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	3	1
CO2	3	1	-	-	-	-	-	-	-	-	-	-	3	1
CO3	3	1	-	-	-	-	-	-	-	-	-	-	3	1
CO4	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO5	3	2	-	-	-	-	-	-	-	-	-	-	3	2

EC23503	CONTROL SYSTEMS	3	1	0	4

COURSE OBJECTIVES

To enable the students to

1.	learn about the system components and representation of control systems
2.	acquire knowledge about analyze the time response of the systems.
3.	be familiar about various methods of frequency response analysis.
4.	learn the various approach stability analysis of the systems.
5.	understand computational control system concepts

UNIT I	SYSTEMS COMPONENTS AND REPRESENTATION	12

Control System: Terminology and Basic Structure, Feed forward and Feedback control theory; Electrical and Mechanical Transfer Function Models; Block diagram Models; Block diagram reduction; Signal flow graphs models.

UNIT II	TIME RESPONSE ANALYSIS	12

Transient response - Steady state response - Time response analysis of first order and second order system - Effect of adding zeros and poles - Steady state error constant and system - Type number - Analytical design for PD, PI, PID control systems.

UNIT III	FREQUENCY RESPONSE ANALYSIS	12

Closed loop frequency response-Performance specification in frequency domain-Frequency response of standard second order system- Bode Plot - Polar Plot - Nyquist plots - Design of compensators using Bode plots-Cascade lead compensation-Cascade lag compensation-Cascade lag-lead compensation.

UNIT IV	STABILITY ANALYSIS	12

Concept of stability -Bounded Input Bounded Output stability - Routh stability criterion - Relative stability-Root locus concept-Guidelines for sketching root locus-Nyquist stability criterion; Concepts of Controllability and Observability-Stability of linear systems - Equivalence between transfer function and state variable representations.

UNIT V	COMPUTATIONAL CONTROL THEORY	12

Closed-Loop Control Systems Concepts: Computing methodologies - Computational control theory; AI Empowerment For Closed-Loop Control Systems- Artificial intelligence; Information systems - Process control systems; AI - based Process Modeling; Case Studies - Space shuttle and robotic arm, Automobile Spray Paint System, Mobile Camera for Playground.

TOTAL PERIODS	60

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	identify control system components and represent them using block diagrams and signal flow graphs.	Understanding (K2)
CO2	analyze time domain responses of systems.	Analyzing (K4)

CO3	analyze frequency domain characteristics using Bode plots, Polar plots, Nyquist plots.	Analyzing (K4)
CO4	evaluate system stability using Routh-Hurwitz, Root Locus, and Nyquist criteria.	Applying (K3)
CO5	apply computational control theory and AI-based approaches to solve real-world control problems.	Applying (K3)

TEXT BOOKS

1. M.Gopal, "Control System - Principles and Design", Tata McGraw Hill, 4th Edition, 2012.
2. Norman S. Nise, "Control Systems Engineering", 2019, 8th Edition, John Wiley & Sons, New Jersey, USA

REFERENCES

1. J.Nagrath and M.Gopal, "Control System Engineering", New Age International Publishers, 5th Edition, 2007.
2. K.Ogata, "Modern Control Engineering", PHI, 5th Edition, 2012
3. S.K.Bhattacharya, "Control System Engineering", Pearson, 3rd Edition, 2013.
4. Karl J. Astrom and Tore Hagglund, "The future of PID control, Control Engineering Practice", 2001.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	1	-	-	3	-
CO2	3	2	1	1	-	-	-	-	-	1	-	-	3	-
CO3	3	2	1	1	-	-	-	-	-	2	-	-	3	-
CO4	3	2	1	1	-	-	-	-	-	2	-	-	3	-
CO5	3	2	1	1	-	-	-	-	-	2	-	1	3	1

EC23504	COMPUTER COMMUNICATION NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the concepts of data communication
2.	be familiar with processes in Data Link Layer
3.	know about various routing protocols
4.	learn the congestion control and QoS mechanisms
5.	acquaint knowledge about various application layer protocols

UNIT I	NETWORK ARCHITECTURE	9

Data Communication - Components, Data Representation, Data flow; Networks - Network Criteria, Physical Structure; Topology; The OSI model; Layers in the OSI model, TCP/IP Protocol Suite ; Transmission media - Guided media - Twisted pair, Coaxial and fiber optic cables; Unguided media - Radio waves, Micro waves and infrared; Switching - Circuit switching, Packet Switching, Datagram Networks, Virtual Circuit Networks.

UNIT II	DATA LINK LAYER AND MAC	9

Data Link Control - Framing -Fixed Size, Variable Size; Flow and Error Control; Protocols- Noiseless channels- Simplest Protocol, Stop-and-Wait Protocol; Noisy Channels- Stop-and-Wait Automatic Repeat Request, Go-Back-N Automatic Repeat Request, Selective Repeat Automatic Repeat Request ; HDLC; PPP; Random Access - CSMA, CSMA/CD, CSMA/CA; Ethernet; Wireless LAN; Bluetooth.

UNIT III	NETWORK LAYER	9

Network Layer - Services, Performance; IPV4 addresses - Address Space, Classful Addressing, Classless Addressing, DHCP, Network Layer Protocols - IP, ICMPv4, IPv6; Unicast Routing- Routing algorithms - Distance Vector Routing, Link State Routing - Unicast Routing Protocols - RIP, OSPF; Multicast routing - DVMRP, PIM.

UNIT IV	TRANSPORT LAYER	9

Transport Layer - Services; Connectionless and Connection Oriented Protocols; Port Numbers; UDP - Well - known ports for UDP, User Datagram, Check Sum - UDP Operation ; TCP Services, Features ,Segment ,TCP Connection, Flow Control, Error Control, TCP Congestion control; QoS - Data-Flow characteristics, Flow control to Improve QoS.

UNIT V	APPLICATION LAYER	9

WWW and HTTP; FTP - Control connection, Data connection; E-Mail - Architecture, Message Transfer Agent - SMTP, Message Access Agent - POP, IMAP - Web-based mail, E-Mail Security; Domain Name System - Name Space, DNS in the internet, DDNS; Proxy servers.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain fundamental concepts of data communication and network architecture.	Understanding (K2)
CO2	analyze data link layer protocols including framing, flow, and error control mechanisms.	Analyzing (K4)
CO3	apply routing algorithms and protocols for network layer operations.	Applying (K3)
CO4	elucidate transport layer protocols, congestion control and QoS mechanisms.	Understanding (K2)
CO5	analyze application layer protocols such as HTTP, FTP, SMTP, DNS	Analyzing (K4)

TEXT BOOKS

1. Behrouz A. Forouzan - "Data Communications and Networking"- The McGraw-Hill Companies Inc. 4th edition, 2017.
2. William Stallings - "Data and Computer Communications" - 10th Edition, Pearson Education, 2015.

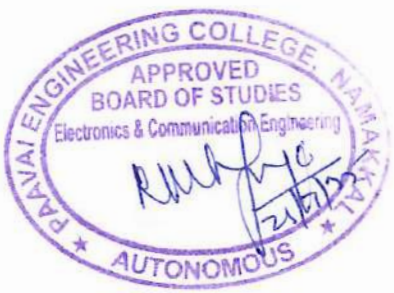
REFERENCES

1. Andrew S.Tannenbaum - "Computer Networks"- Prentice Hall, 2010.
2. James F. Kurose & Keith W. Ross - "Computer Networking - A Top-down Approach Featuring the Internet" Prentice Hall, 2013.
3. Larry L. Peterson & S. Peter Davie - "Computer Networks" - Harcourt, 2008.
4. Nader F. Mir, "Computer and Communication Networks", 2nd Edition, Prentice Hall, 2014.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	1	3	-
CO2	3	3	2	2	-	-	-	-	-	-	-	1	3	-
CO3	3	3	2	2	-	-	-	-	-	-	-	1	3	-
CO4	3	3	2	2	-	-	-	-	-	-	-	1	3	-
CO5	3	3	-	-	-	-	-	-	-	-	-	1	3	2



EC23505	COMMUNICATION SYSTEMS LABORATORY	0	0	2	1

COURSE OBJECTIVES

To enable the students to

1.	learn the concepts of Sampling and Time Division Multiplexing.
2.	be familiar with analog modulation schemes.
3.	know the concept of pulse modulation and digital modulation techniques.
4.	acquire knowledge about Huffman coding and Linear Block Codes.

LIST OF EXPERIMENTS

1	Write a program to verify Sampling Theorem.
2	Write a program to execute Time Division Multiplexing and De-multiplexing.
3	Design and Simulate Amplitude Modulation and Demodulation.
4	Design and Simulate Frequency Modulation and Demodulation.
5	Write a program to simulate Pulse Amplitude Modulation and Pulse Width Modulation.
6	Write a program to execute ASK, FSK and PSK schemes.
7	Simulation and performance evaluation of Quadrature Phase Shift Keying.
8	Performance evaluation of M-ary Quadrature Amplitude Modulation.
9	Design and verification of Huffman coding technique.
10	Design and simulation of Linear Block Codes.

TOTAL PERIODS 30

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	demonstrate sampling process and time division multiplexing.	Applying (K3)
CO2	implement analog modulation techniques.	Applying (K3)
CO3	illustrate pulse modulation and digital modulation schemes.	Applying (K3)
CO4	simulate Huffman coding and linear block codes.	Applying (K3)

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 - Strong , 2 - Medium , 1 - Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	3	-	-	-	-	1	-	1	3	2
CO2	3	3	3	-	3	-	-	-	-	1	-	1	3	2
CO3	3	3	3	-	3	-	-	-	-	1	-	1	3	2
CO4	3	3	3	-	3	-	-	-	-	1	-	1	3	2

EC23506	COMPUTER NETWORKS LABORATORY	0	0	4	2

COURSE OBJECTIVES	
To enable the students to	
1.	understand the network components and IP
2.	learn the configuration of LAN
3.	find the different ARQ protocols for error free transmission
4.	know the routing algorithms

LIST OF EXPERIMENTS	
1	Study of basic network devices, IP, switch and router in a LAN and verify ping and trace route output.
2	Implement the connection of PCs in Local Area Network for file and printer sharing.
3	Design and implement star and bus topology using packet tracer
4	Constitute a web server, DHCP server and a DNS server
5	Implementation of hamming code for error detection and correction.
6	Write a program to implement stop and wait protocol for reliable data transmission
7	Implementation of Go back N ARQ using sliding window protocol
8	Implementation of selective repeat ARQ protocol using sliding window.
9	Implement the data link layer framing method for bit stuffing
10	Implement the data link layer framing method for byte stuffing
11	Program to implement Distance vector routing algorithm by obtaining routing table at each node. (Take an example subnet graph with weights indicating delay between nodes).
12	Implement link state route algorithm to compute the shortest path through a graph
	TOTAL PERIODS 60

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the structure of networks and demonstrate configuration of LAN, including device roles and topology design.	Understanding (K2)
CO2	implement error detection and correction techniques.	Applying (K3)
CO3	apply and simulate framing techniques including bit stuffing and byte stuffing.	Applying (K3)
CO4	analyze and simulate routing algorithms such as distance vector and link state.	Applying (K3)

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 - Strong , 2 - Medium , 1 - Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	3	-	-	-	-	1	-	3	3	-
CO2	3	3	1	1	3	-	-	-	-	1	-	3	3	-
CO3	3	3	-	-	3	-	-	-	1	1	-	3	3	3
CO4	3	3	1	1	3	-	-	-	1	1	-	3	3	3

EC23507	INDUSTRIAL TRAINING	0	0	2	1

COURSE OBJECTIVES

To enable the students to

1	provide real-time industrial exposure to enhance their understanding of Electronics and Communication Engineering applications.
2	gain theoretical knowledge gained in classrooms to practical situations in industry / research environments.
3	develop professional ethics, workplace behavior, teamwork, and communication skills necessary for employment.
4	encourage to investigate industrial problems, suggest feasible solutions, and recommend improvements using engineering principles.

DESCRIPTION

Industrial Training provides work experience relevant to their field of specialization, before graduation, and it is an essential component for the development of practical and professional skills required for an engineering graduate and supports for prospective employment.

At the end of the industrial training, students should be able to improve their knowledge and skills relevant to their areas of specialization where they have been trained. The students should also be able to relate, apply, and adapt the relevant knowledge, concepts, and theories within an industrial organization, and also to practice the general workplace behavior and interpersonal skills.

The student (either in group or single) should undergo industrial training for a minimum period of two weeks during the summer vacation after the completion of fourth semester as specified in the curriculum in any research organization/university/industry of State/National and International level industry relevant to their branch of specialization, after getting proper approval from the Head of the Institution.

On the completion of the industrial training for the specified period, the student has to submit the industrial training report (at least 25-30 pages) containing the following details, along with the certificate obtained from the industry for the period of training undergone.

1. Introduction of the industry.
2. Industry layout and its various operations with its infrastructure facilities.
3. Formulation of practical problems, data required to formulate the problems and its analysis.
4. Suggestions and recommendations for the above problems

During the period of training, the student has to abide the rules and regulations enforced by the organization and to ensure FULL attendance during the period of industrial training and uphold the discipline and decorum of the institution.

On the completion of the industrial training, the End Semester Examinations shall be conducted by the Office of the Controller of Examinations at the end of the fifth semester. A three-member committee constituted by the Head of the Institution, consisting of (1) a senior faculty member at the Professor level, (2) senior faculty member at the Associate Professor and (3) faculty member from outside the department, will evaluate the industrial training undergone by the student. The evaluation shall be made based on the report submitted along with the presentation and a Viva voce Examination.

		TOTAL PERIODS :30
COURSE OUTCOMES At the end of the course, the students will be able to		**BT MAPPED** (Highest level)
CO1	demonstrate knowledge of industrial practices, infrastructure, and operations related to Electronics and Communication Engineering.	Understanding (K2)
CO2	exhibit professional skills including discipline, time management, teamwork, and interpersonal communication in industrial settings.	Understanding (K2)
CO3	apply the concepts, tools, and techniques of ECE to solve practical engineering problems encountered during training.	Applying (K3)
CO4	present a comprehensive industrial training report and defend it effectively through a viva voce examination.	Analyse (K4)

CO - PO MAPPING

Mapping of Course Outcomes with Programme Outcomes:

(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium , 1-Weak

COs	Programme Outcomes(POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	-	-	-	-	-	-	-	-	-	2	1	3
CO2	1	-	-	-	-	-	-	-	-	-	-	2	1	3
CO3	2	2	-	-	-	-	-	-	-	-	-	3	2	3
CO4	3	2	2	2	2	-	-	-	-	-	-	3	3	3

GE23501	PROFESSIONAL DEVELOPMENT III	0	0	2	1

COURSE OBJECTIVES

To enable students to

1.	enhance their Resume writing skills and improving corporate vocabularies to survive in the corporate world.
2.	evaluate their interview skills and improve their interview presentation.
3.	solve the quantitative aptitude problems and improve their mental ability.
4.	improve critical thinking and reasoning skills.

UNIT I	RESUME WRITING SKILLS	6

Updated Resume Building III – Self Introduction III – Dressing Etiquette – JAM V – Corporate Vocabulary.

UNIT II	INTERVIEW SKILLS	6

Interview skills – General guidelines - Work Ethics – Group Discussion III – JAM VI – Presentation Competence – Mock Interview.

UNIT III	QUANTITATIVE APTITUDE	9

Cube Root and Square Root - Time and Work - Ages - Permutation and Combination - Probability – Calendar.

UNIT IV	LOGICAL REASONING	9

Series Completion - Blood Relations - Coding and Decoding - Data Sufficiency - Statements and Assumptions.

TOTAL PERIODS: 30

COURSE OUTCOMES Upon completion of the course, the students will be able to		BT MAPPED (Highest Level)
CO1	excel in drafting Resumes and speaking.	Applying (K3)
CO2	demonstrate the participative skills in group discussions and Interviews.	Applying (K3)
CO3	solve problems based on quantitative aptitude.	Applying (K3)
CO4	enhance their logical and verbal reasoning.	Analyzing (K4)

TEXTBOOKS

1. Aggarwal, R. S. A Modern Approach to Verbal & Non-Verbal Reasoning. Revised ed., 2024–25, S. Chand & Company Ltd., 2024.
2. Aggarwal, R. S. Objective General English: Fully Revised Video Edition. S. Chand & Company Ltd., 2022.

REFERENCES

1. Abhijit Guha, "Quantitative Aptitude ", Tata-Mcgraw Hil1.2015.
2. Word Power Made Easy By Norman Lewis, Wr.Goyal Publications.2016.
3. Johnson, D.W. Reaching out — Interpersonal Effectiveness and self- actualisation. Boston: Allyn and Bacon.2019.
4. Infosys Campus Connect Program — students' guide for soft skills.2015.

CO/PO MAPPING:

Mapping of Course Outcome (CO's) with Programme Outcomes (PO's)
(1/2/3 indicates strength of correlation) 3-Strong, 2-Medium, 1-Weak

CO's	Programme Outcomes (PO's)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PS01	PS02
CO1	3	2	2	3	3	1	-	-	-	-	-	-	3	2
CO2	-	2	3	-	2	-	2	-	-	-	-	-	3	2
CO3	3	2	2	2	-	-	1	-	-	-	-	-	2	3
CO4	3	2	2	-	-	1	-	-	-	-	2	-	2	3

PAAVAI ENGINEERING COLLEGE, NAMAKKAL
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EC23151	WIRELESS NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. understand the concepts of Network planning
2. know the wireless network operations
3. be familiar with the fundamentals of Wireless WANs
4. have in depth knowledge about Wireless WLANs
5. acquire knowledge about wireless geolocation systems

UNIT I NETWORK PLANNING — **9**

Medium access alternatives - Fixed assignment for voice oriented networks, random access for data oriented networks; Network Planning - Wireless Network Topologies, Cellular Topology, Signal to Interference Ratio Calculation, Capacity Expansion Techniques.

UNIT II WIRELESS NETWORK OPERATIONS — **9**

Mobility Management - Location Management, Handoff Management, Mobile IP; Radio Resource Power Management - Power Control, Energy Efficient Designs; Security requirements for wireless networks.

UNIT III WIRELESS WANS — **9**

GSM - Services, Architecture; CDMA - IS-95 Forward Channel, Reverse Channel, Frame format; IMT2000; Mobile Data - classification; Cellular Digital Packet Data - Reference Architecture, Mobility Support, Protocol Layers; General Packet Radio Service.

UNIT IV WIRELESS WLANs — **9**

IEEE802.11 WLANs - Reference architecture, Layered Protocol architecture, Physical Layer, MAC layer, MAC Management Sublayer; Wireless ATM; HIPERLAN -1; HIPERLAN -2.

UNIT V WIRELESS GEOLOCATION SYSTEMS — **9**

Wireless Geolocation - Architecture; Technologies - Direction Based and Distance Based Techniques; Geolocation Standards E-911- architecture, services; Performance measures.

TOTAL PERIODS — **45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	explain wireless network planning, access methods, topology, and SIR analysis..	Understanding (K2)
CO2	analyze mobility, power/resource control, and security in wireless networks.	Analyzing (K4)
CO3	elucidate wireless WAN standards and their features.	Understanding (K2)
CO4	analyze different WLAN technologies.	Analyzing (K4)
CO5	understand geolocation techniques, E911 standards, and performance evaluation.	Understanding (K2)

TEXT BOOKS

1. Kaveh Pahlavan, "Principles of Wireless Networks" 2nd edition, Prentice Hall India, 2012.
2. Vijay Garg,"Wireless Communications and networking", 1st edition, Elsevier, 2009.

REFERENCES

1. P. Nicopolitidis , M. S. Obaidat , G. I. Papadimitriou , A. S. Pomportsis "Wireless Networks", Wiley, 2009.
2. Anurag Kumar, D.Manjunath, Joy kuri, "Wireless Networking", 1st edition, Elsevier 2011.
3. Simon Haykin, Michael Moher, David Koilpillai, "Modern Wireless Communications", 1st edition, Pearson Education 2013.
4. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband", 2nd edition, Academic Press, 2008.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 - Strong , 2 - Medium , 1 - Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	2	3	2
CO2	3	3	1	-	-	-	-	-	-	-	-	2	3	2
CO3	3	3	1	-	-	-	-	-	-	-	-	2	3	2
CO4	3	3	1	-	-	-	-	-	-	-	-	2	3	2
CO5	3	2	1	-	-	-	-	-	-	-	-	2	2	2

EC23152	WIRELESS SYSTEMS AND STANDARDS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	know the concepts of TDMA, GSM, CDMA in 2G and 3G UMTS in wireless cellular networks
2.	understand the wireless system operations and standards
3.	gain knowledge about various wireless application protocols
4.	be familiar with the different wireless network standards
5.	possess knowledge on Personal Area Network

UNIT I	SECOND AND THIRD GENERATION: ARCHITECTURE AND PROCESS FLOW	9

Second Generation TDMA - GSM Architecture, Air Interface, Channels, Voice-call setup, Handover, EDGE architecture; Second Generation CDMA - Forward and Reverse channel, Call Handoff; Third Generation systems - UMTS network architecture.

UNIT II	WIRELESS SYSTEM OPERATIONS AND STANDARDS	9

Cordless systems - Time Division Duplex, DECT Operation, ADPCM; Wireless Local Loop - Propagation considerations for WLL OFDM, IEEE 802.16; Long-Term Evolution-System Architecture, Transmission Techniques, Channels in the radio interface, Radio Resource Management.

UNIT III	WIRELESS APPLICATION PROTOCOLS	9

Wireless Application Protocol - Programming Model, Architectural Overview, Wireless Markup Language, WML Script, Wireless Application Environment, Wireless Session Protocol, Wireless Transaction Protocol, Wireless Datagram Protocol.

UNIT IV	WIRELESS LANS	9

Spread Spectrum LANs - Configuration, Transmission issues; Narrowband Microwave LANs - Licensed Narrow Band RF, Unlicensed narrowband RF; IEEE 802.11- Architecture and services; IEEE 802.11a/b/n standards; Infrared LANs - Strengths and Weakness, Transmission techniques.

UNIT V	WIRELESS PAN	9

IEEE 802.15.1 - Protocol stack, Link types, security, network connection establishment; IEEE 802.15 WPAN standards - network model; Zigbee- Device Architecture, Topologies, applications; IEEE 802.15.3a - Ultra-wide-Band Radio Communication.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	outline TDMA, GSM, and CDMA concepts in 2G wireless networks.	Understanding (K2)
CO2	describe the operation of various wireless communication standards.	Understanding (K2)
CO3	explain different wireless application protocols.	Understanding (K2)
CO4	analyze types of WLANs and summarize WLAN standards.	Analyzing (K4)

CO5	enumerate features and operations of Wireless PANs and their standards	Understanding (K2)

TEXT BOOKS

1. Clint Smith, P.E. and Daniel Collins, "3G Wireless Networks", Tata McGraw Hill, 2nd Edition, 2017.
2. Kaveh Pahlavan and Prashant Krishnamurthy, "Principles of Wireless networks - A unified Approach", Prentice Hall, 2013.

REFERENCE BOOKS

1. William Stallings, "Wireless Communications and Networks", Prentice Hall, 2nd Edition 2009.
2. Dharma Prakash Agarwal and Qing-An Zeng, "Introduction to Wireless and Mobile Systems", Thomson India, 3rd Edition, 2011.
3. Vijay. K. Garg, "Wireless Communication and Networking", Morgan Kauffmann Publishers, 2007.
4. Mischa Schwartz, "Mobile Wireless Communications", Cambridge University Press, 2005.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 - Strong , 2 - Medium , 1 - Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	1	-	-	-	-	-	-	-	-	-	2	-
CO5	3	2	1	-	-	-	-	-	-	-	-	-	2	-

EC23153	5G COMMUNICATION NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. explore the key concepts of 5G
2. understand Channel access methods in 5G
3. study about fundamentals of Radio Access Network for 5G
4. have in depth knowledge on 5G NR
5. learn about communication technologies for 5G

UNIT I **INTRODUCTION TO 5G** **9**

3G and 4G LTE overview - Introduction to 5G - Use Cases - Evolving LTE to 5G Capability- 5G NR and 5G core network - 5G Standardization - 3GPP and IMT2020 - Spectrum for 5G - 5G deployment - Options, Challenges and Applications.

UNIT II **5G CHANNEL ACCESS METHODS** **9**

OFDM and OFDMA - MIMO OFDM - Generalized Frequency Division Multiplexing - Non-Orthogonal Multiple Access - Universal Filtered OFDM - Filter bank multicarrier - Sparse Code Multiple Access - Comparison of multiple access methods.

UNIT III **RADIO ACCESS NETWORK FOR 5G** **9**

5G NR requirements - 5G Core Network Architecture – Radio - Access Network - Radio Protocol Architecture - User Plane Protocols - Radio Link Control - Medium-Access Control - Physical Layer functions - Control Plane Protocols - Network Slicing - RAN virtualization - Spectrum Management in 5G.

UNIT IV **CHANNEL MODELS FOR 5G NR** **9**

Channel Hierarchy in 5G NR - Logical Channels and Transport Channels in 5G NR - Physical Layer Data Channels in 5G NR - Downlink Physical Channel and Uplink Physical Channels - Propagation Channel models for 5G.

UNIT V **COMMUNICATION TECHNOLOGIES FOR 5G** **9**

Device-to-Device Communication - 5G for Massive Machine Type Communication and Massive IoT - V2X Communication - Full Duplex and Green Communication - mmWave Communications - Massive MIMO and Beamforming Techniques.

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	describe the concepts of 5G	Understanding (K2)
CO2	apply various channel access methods in 5G	Applying (K3)
CO3	elucidate the fundamentals of Radio Access Network for 5G	Understanding (K2)
CO4	interpret the concepts of 5G NR	Understanding (K2)
CO5	describe various communication technologies for 5G	Understanding (K2)

TEXT BOOKS

1. Saad Z. Asif, "5G Mobile Communications Concepts and Technologies, CRC Press, 1st Edition, 2019.
2. Erik Dahlman, Stefan Parkvall, Johan Skold "5G NR: The Next Generation Wireless Access Technology", Academic Press, 1st Edition, 2018.

REFERENCES

1. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons, 1st Edition, 2015.
2. Long Zhao, Hui Zhao, Kan Zheng, Wei Xiang, "Massive MIMO in 5G Networks: Selected Applications", Springer, 1st Edition, 2018.
3. Robert W. Heath Jr., Angel Lozano, "Foundations of MIMO Communication", Cambridge University Press, 1st Edition, 2019.
4. Mischa Schwartz, "Mobile Wireless Communications", Cambridge University Press, 2005.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 - Strong , 2 - Medium , 1 - Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	1	3	-
CO2	3	3	2	-	-	-	-	-	-	-	-	1	3	-
CO3	3	3	3	-	-	-	-	-	-	-	-	1	3	-
CO4	3	3	2	-	-	-	-	-	-	-	-	1	3	-
CO5	3	3	3	-	-	-	-	-	-	-	-	1	3	-

EC23154	ADHOC AND WIRELESS SENSOR NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. acquire knowledge about Ad Hoc MAC protocols.
2. be familiar with Ad Hoc routing protocols.
3. know the concepts of wireless sensor networks
4. have an in-depth knowledge about sensor localization and time synchronization.
5. understand the various network platforms

UNIT I **ADHOC NETWORKS - MAC PROTOCOLS** **9**

AdHoc Wireless Networks - Issues, Applications; MAC Protocols - Issues in designing, design goals; Classification of MAC protocols - Contention based protocols - MACAW, FAMA; Contention based with Reservation mechanisms - CATA, HRMA; FPRP; Contention based with Scheduling mechanisms - DWOP;

UNIT II **ADHOC ROUTING PROTOCOLS** **9**

Routing Protocol - Issues in Designing, Classifications of Routing Protocols, Table Driven Routing Protocols - Destination Sequenced Distance Vector Routing protocol; On-demand Routing - Dynamic Source Routing, AdHoc On-Demand Distance Vector routing protocol; Hybrid Routing protocol - Zone Routing Protocol.

UNIT III **WIRELESS SENSOR NETWORKS** **9**

Sensor Network - Issues and challenges; Sensor network architecture - Layered, Clustered; Data dissemination-Flooding, Gossiping; MAC protocol for sensor networks; Quality of Sensor Network - Coverage, exposure.

UNIT IV **SENSOR LOCALISATION AND TIME SYNCHRONIZATION** **9**

Localization - Indoor, Range - Based, Range - free, Event - driven; Time Synchronization - Synchronization problem, clocks, Time synchronization protocols.

UNIT V **SENSOR NETWORK PLATFORMS** **9**

Sensor node hardware - Berkeley motes, Programming Challenges; Node level software platforms - Tiny Operating System, CONTIKIOS.

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	describe various MAC protocols used in AdHoc networks.	Understanding (K2)
CO2	demonstrate various routing protocols for networking concepts.	Applying (K3)
CO3	apply foundational concepts of wireless sensor networks to real-time scenarios.	Applying (K3)
CO4	examine different synchronization and localization algorithms.	Analyzing (K4)
CO5	elucidate the architecture and features of various sensor network platforms.	Understanding (K2)

TEXT BOOKS

1. C. Siva Ram Murthy and B. S. Manoj - AdHoc Wireless Networks Architectures and Protocols, Prentice

Hall, 2006.

2. Carlos De Morais Cordeiro, Dharma Prakash Agrawal "AdHoc & Sensor Networks: Theory and Applications", World Scientific Publishing Company, 2nd edition, 2011.

REFERENCES

1. Feng Zhao and Leonidas Guibas, "Wireless Sensor Networks: an Information Processing Approach", Elsevier Publication, 2004.
2. Holger Karl and Andreas Willig, "Protocols and Architectures for Wireless Sensor Networks", Wiley, 2005.
3. Waltenegus Dargie, Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice", 1st Edition, John Wiley & Sons , 2011.
4. Kazem Sohraby, Daniel Minoli, & Taieb Znati , "Wireless Sensor Networks - Technology, Protocols, and Applications", John Wiley, 2007.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO4	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO5	3	3	-	-	-	-	-	-	-	-	-	-	3	1

EC23155	COGNITIVE RADIO NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. understand Software Defined Radio and Cognitive Radio technologies.
2. study the architecture and standards of cognitive radio.
3. learn spectrum sensing and dynamic spectrum access methods.
4. be familiar with communication network concepts.
5. explore advanced features and applications of cognitive radio.

UNIT I **INTRODUCTION TO SOFTWARE DEFINED RADIO AND COGNITIVE RADIO** **9**

Introduction, Software Defined Radio - Evolution of Software Defined Radio; Cognitive radio - goals, benefits, definitions, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations.

UNIT II **COGNITIVE RADIO ARCHITECTURE** **9**

Cognition cycle - orient, plan, decide and act phases; Inference Hierarchy; Building the CRA on SDR; Architectures - SWR and SDR Architecture; Principles; Radio Architecture; SCA - Function; Transforms Model of radio; Architecture Migration; Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

UNIT III **SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS** **9**

Primary user detection techniques - energy detection, feature detection, matched filtering, cooperative detection; Fundamental Tradeoffs in spectrum sensing - Spectrum sharing models of dynamic spectrum Access - unlicensed and licensed spectrum sharing; Fundamental limits of Cognitive Radio.

UNIT IV **COMMUNICATION NETWORKS** **9**

Architecture and building blocks; Protocol architecture; Switching technologies; Multiplexing ; Naming and addressing; Routing and forwarding ; TCP Congestion control; Multiple access schemes - polling , ALOHA, slotted ALOHA, CSMA - CSMA / CA.

UNIT V **ADVANCED TOPICS IN COGNITIVE RADIO** **9**

Overview of security issues in cognitive radios; Auction based spectrum markets in cognitive radio networks; Public safety and cognitive radio; Cognitive radio for Internet of Things; Features and applications; Enabling technologies and protocols.

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	elucidate the concepts about ATM and High Speed LAN	Understanding (K2)
CO2	explain the architecture and key standards of Cognitive Radio systems.	Understanding (K2)
CO3	describe the spectrum sensing and dynamic spectrum access methods.	Understanding (K2)

CO4	examine the key components and mechanisms of communication networks	Understanding (K2)
CO5	explore advanced concepts in cognitive radio.	Understanding (K2)

TEXT BOOKS

1. Alexander M.Wyglinski, Maziar Nekovee, Thomas Hou, "Cognitive Radio Communications and Networks", Academic Press, Elsevier, 2010.
2. Huseyin Arslan (E.d), "Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems", Springer, 2007.

REFERENCES

1. Bruce Fette, "Cognitive Radio Technology", 2nd Edition, Academic Press, 2009.
2. Kwang- Cheng Chen, Ramjee Prasad, "Cognitive Radio Networks", John Wiley and Sons, 2009.
3. Ezio Biglieri, Professor Andrea J.Goldmith, Dr Larry J. Greenstein, Narayan, B.Mandayam, H.Vincent Poor, "Principles of Cognitive Radio", Cambridge University Press, 2012
4. Markus Dillinger, Kambiz Madani Nancy Alonistioti, "Software Defined Radio", John Wiley, 2003.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 - Strong , 2 - Medium , 1 - Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	1	-	-	-	-	-	-	-	-	-	3	1
CO2	3	3	1	-	-	-	-	-	-	-	-	-	3	1
CO3	3	3	1	-	-	-	-	-	-	-	-	-	3	1
CO4	3	3	1	-	-	-	-	-	-	-	-	-	3	1
CO5	3	3	1	-	-	-	-	-	-	-	-	-	3	1

EC23156	FIBER OPTIC COMMUNICATION NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. understand the concepts of Optical Fibers.
2. be familiar with the signal degradation in optical fibers.
3. study about fundamentals of fiber optical sources.
4. have in-depth knowledge on fiber optic receiver and measurement.
5. learn about optical networks and system transmission.

UNIT I **INTRODUCTION TO OPTICAL FIBERS** **9**

Evolution of fiber optic system - Element of an Optical Fiber Transmission link - Total internal reflection- Acceptance angle - Numerical aperture - Skew rays in Ray Optics - Optical Fiber Modes and Configurations - Mode theory of Circular Wave guides - Overview of Modes - Key Modal concepts; Linearly Polarized Modes - Single Mode Fiber, Graded Index Fiber.

UNIT II **SIGNAL DEGRADATION IN OPTICAL FIBERS** **9**

Attenuation - Absorption losses, Scattering losses, Bending Losses, Core and Cladding losses; Signal Distortion in Optical Wave guides - Information Capacity determination - Group Delay; Material Dispersion - Wave guide Dispersion; Signal distortion in SM fibers - Polarization Mode dispersion, Intermodal dispersion; Pulse Broadening in Graded Index fibers - Mode Coupling; Design Optimization of Single Mode fibers - RI profile and cut-off wavelength.

UNIT III **FIBER OPTICAL SOURCES AND COUPLING** **9**

Direct and indirect band gap materials; LED structures - Light source materials - Quantum efficiency and LED power, Modulation of a LED; lasers Diodes - Modes and Threshold condition - Rate equations - External Quantum efficiency - Resonant frequencies, Temperature effects, Quantum laser; Fiber amplifiers - Power Launching and coupling, Lencing schemes, Fiber - to - Fiber joints, Fiber splicing - Signal to Noise ratio, Detector response time.

UNIT IV **FIBER OPTIC RECEIVER AND MEASUREMENTS** **9**

Fundamental receiver operation, Pre amplifiers, Error sources; Receiver Configuration - Probability of Error - Quantum limit; Fiber Attenuation measurements - Dispersion measurements - Fiber Refractive index profile measurements - Fiber cut- off Wave length Measurements - Fiber Numerical Aperture Measurements - Fiber diameter measurements.

UNIT V **OPTICAL NETWORKS AND SYSTEM TRANSMISSION** **9**

Basic Networks - SONET / SDH - Broadcast and select WDM Networks -Wavelength Routed Networks; Non-linear effects on Network performance - Link Power budget - Rise time budget; Noise Effects on System Performance; Operational Principles of WDM - Performance of WDM EDFA system ; Optical CDMA -Ultra High Capacity Networks.

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the concepts of Optical Fibers	Understanding (K2)
CO2	analyze the signal degradation in optical fibers	Analyzing (K4)
CO3	elucidate the fundamentals of fiber optical sources	Understanding (K2)
CO4	describe the concepts of fiber optic receiver and measurements	Understanding (K2)
CO5	explicate evolution of optical networks	Understanding (K2)

TEXT BOOKS

1. Gerd Keiser, "Optical Fiber Communication", 4th Edition, Mc Graw - Hill International, 2010.
2. John M. Senior , "Optical Fiber Communication", 2nd Edition, Pearson Education, 2007

REFERENCES

1. Ramaswami, Sivarajan and Sasaki, "Optical Networks", Morgan Kaufmann, 2009.
2. Senior, "Optical Communication, Principles and Practice", 3rd Edition, Prentice Hall of India, 2008.
3. J.Gower, "Optical Communication System", Prentice Hall of India, 2001.
4. Herbert Venghaus, Norbert Grote, "Fibre Optic Communication Key Devices", Springer Berlin Heidelberg, 2012.

CO-PO MAPPING :

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COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO4	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO5	3	3	-	-	-	-	-	-	-	-	-	-	3	1

EC23157	SOFTWARE DEFINED NETWORKS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	learn the need and data plane operations of SDN.
2.	understand the data and control plane operations.
3.	get knowledge about the applications plane operations.
4.	explore various techniques of network function virtualization.
5.	comprehend the concepts of NFV Functionality.

UNIT I	INTRODUCTION TO SOFTWARE DEFINED NETWORKS	9
Evolving Network Requirements; The SDN Approach - SDN Architecture; SDN Data Plane – Data plane functions; OpenFlow logical network device – Flow Table structure, Flow Table pipeline, Group table.		

UNIT II	SDN CONTROL PLANE	9
SDN Control Plane architecture - Control Plane Functions, Southbound Interface, Northbound Interface; SDN Controllers - Ryu, OpenDaylight, ONOS.		

UNIT III	SDN APPLICATION PLANE	9
SDN Application Plane Architecture - Network Services Abstraction Layer, Traffic Engineering; Measurement and Monitoring, Security, Data Centre Networking, Mobility and Wireless.		

UNIT IV	NETWORK FUNCTIONS VIRTUALIZATION	9
Network Function Virtualization concepts; Virtual Machines - NFV Concepts, NFV Benefits and Requirements; Network Reference Architecture; QoS – Integrated and Differentiated services.		

UNIT V	NFV FUNCTIONALITY	9
NFV Infrastructure - Virtualized Network Functions - NFV Management and Orchestration - NFV Use cases – Virtual LANs - OpenFlow VLAN Support; Virtual Private Networks – IPSec VPN, MPLS VPN.		

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	describe the motivation behind SDN	Applying (K3)
CO2	identify the functions of the Data Plane and Control Plane in a network.	Applying (K3)
CO3	design and develop network applications using SDN	Applying (K3)
CO4	orchestrate network services using NFV	Analyzing (K4)
CO5	explain various use cases of SDN and NFV	Understanding (K2)

TEXT BOOKS

1. William Stallings, "Foundations of Modern Networking: SDN, NFV, QoE, IoT and Cloud", Pearson Education, 1st Edition, 2015
2. Ken Gray, Thomas D. Nadeau, "Network Function Virtualization", Morgan Kauffman, 2016.

REFERENCES

1. Thomas D Nadeau, Ken Gray, "SDN: Software Defined Networks", O'Reilly Media, 2013
2. Fei Hu, "Network Innovation through OpenFlow and SDN: Principles and Design", 1st Edition, CRC Press, 2014.
3. Paul Goransson, Chuck Black Timothy Culver, "Software Defined Networks:A Comprehensive Approach", 2nd Edition, Morgan Kaufmann Press, 2016
4. Larry Peterson, Carmelo Cascone, Bruce Davie, "Software-Defined Networks A Systems Approach", Systems Approach LLC, 2021.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 - Strong , 2 - Medium , 1 - Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO4	3	3	-	-	-	-	-	-	-	-	-	-	3	1
CO5	3	3	-	-	-	-	-	-	-	-	-	-	3	1

EC23251	DIGITAL IMAGE PROCESSING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	be familiar with digital image fundamentals
2.	learn image enhancement techniques in Spatial and Frequency domain.
3.	study concepts of degradation function and restoration techniques
4.	understand the image segmentation and representation techniques
5.	gain knowledge about image compression and recognition methods

UNIT I **DIGITAL IMAGE FUNDAMENTALS** **9**

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** **9**

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** 9

Image Restoration - degradation model, Properties; Noise models - Mean Filters, Order Statistics, Adaptive filters, Band reject Filters, Band pass Filters; Notch Filters - Optimum Notch Filtering; Inverse Filtering - Wiener filtering.

UNIT IV **IMAGE SEGMENTATION** 9

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** 9

Need for data compression, Huffman Coding, Run Length Encoding, Arithmetic coding; JPEG standard; MPEG standards; Boundary representation - Boundary description, Fourier Descriptor; Regional Descriptors - Topological feature, Texture; Patterns and Pattern classes - Recognition based on matching.

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	interpret the basics and fundamentals of digital image processing.	Understanding (K2)
CO2	illustrate the techniques of smoothing and sharpening.	Applying (K3)
CO3	estimate the image restoration concepts and filtering techniques.	Understanding (K2)

CO4	categorize the concepts of image segmentation.	Analyzing (K3)
CO5	predict image compression and recognition methods.	Understanding (K2)

TEXT BOOKS

1. Rafael C. Gonzalez, Richard E. Woods, "Digital Image Processing", 3rd Edition, Pearson Education, 2018.
2. Anil K. Jain, "Fundamentals of Digital Image Processing", Pearson, 2002.

REFERENCES

1. Kenneth R. Castleman, "Digital Image Processing", Pearson, 2006.
2. Rafael C. Gonzalez, Richard E. Woods, Steven Eddins, "Digital Image Processing using MATLAB", Pearson Education Inc., 2011.
3. D.E. Dudgeon and RM. Mersereau, "Multidimensional Digital Signal Processing", Prentice Hall Professional Technical Reference, 1990.
4. S. Jayaraman, S. Esakkirajan, T. Veerakumar, "Digital Image Processing", Tata McGraw-Hill Education, 2009.

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COs	PO's												PSO's	
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CO2	3	3	1	-	-	-	-	-	-	-	-	-	3	1
CO3	3	3	1	-	-	-	-	-	-	-	-	-	3	1
CO4	3	3	1	-	-	-	-	-	-	-	-	-	3	1
CO5	3	3	1	-	-	-	-	-	-	-	-	-	3	1

EC23252	MULTIMEDIA COMPRESSION TECHNIQUES	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	learn the multimedia components and basics of compression.
2.	gain knowledge about text compression techniques.
3.	understand the concepts image compression techniques.
4.	know the concepts of audio and speech compression.
5.	be familiar with video compression standards.

UNIT I	BASICS OF MULTIMEDIA	9
Introduction to multimedia - Components of multimedia; Multimedia presentation - Graphics and image data representations; Data compression - Need for compression, Lossy and lossless compression techniques.		

UNIT II	TEXT COMPRESSION	9
Characteristics of text data; Run length encoding - Huffmann coding - Adaptive Huffmann coding - Arithmetic coding; Dictionary techniques - LZW algorithm, GIF, TIF, JBIG, JBIG2.		

UNIT III	IMAGE COMPRESSION	9
Fundamentals; Compression standards - JPEG standard - Orthogonal transforms - Vector quantization; Wavelet based methods - EZW, SPIHT coders, JPEG 2000 standards.		

UNIT IV	AUDIO COMPRESSION	9
Audio compression - Sound - Digital audio - Human auditory system - Wave audio format - μ - Law and A - Law companding - ADPCM audio compression - Speech compression - MPEG4- MPEG1/2 Advanced audio coding - Dolby AC-3.		

UNIT V	VIDEO COMPRESSION	9
Composite and components of video - Digital video - History of video compression - Video compression techniques and standards - MPEG, MPEG4, H.261 and H.264.		

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	discuss the basics of the data compression techniques	Understanding (K2)
CO2	elucidate various text compression algorithms.	Understanding (K2)
CO3	interpret compression techniques for image compression.	Applying (K3)
CO4	categorize various speech and audio compression techniques.	Analyzing (K4)
CO5	discriminate different video compression standards.	Analyzing (K4)

TEXT BOOKS

1. David Solomon, "Data Compression - The Complete Reference", 4th Edition, Springer Verilog, New York, 2010.
2. Mark S. Drew, Ze-Nian Li, "Fundamentals of Multimedia", Prentice Hall of India, 2009.

REFERENCES

1. Morgan Kauffman, Khalid Sayood, "Introduction to Data Compression", 2nd Edition, Harcourt India, 2000.
2. Yun Q.Shi, Huifang Sun, "Image and Video Compression for Multimedia Engineering - Fundamentals, Algorithms & Standards", CRC press, 2003.
3. Peter Symes, "Digital Video Compression", McGraw Hill Publications, 2004.
4. Vasudev Bhaskaran, Konstantinos Konstantinides, "Image and Video Compression Standards - Algorithms and Architectures", Kluwer Academic publishers, 2013.

CO-PO MAPPING :

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CO3	3	3	1	-	-	-	-	-	-	-	-	-	3	1
CO4	3	3	1	-	-	-	-	-	-	-	-	-	3	1
CO5	3	3	1	-	-	-	-	-	-	-	-	-	3	1

EC23253	VIDEO ANALYTICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. understand the basics of video compression for video analytics.
2. know the various background modelling methods.
3. infer the object classification methods for video analysis.
4. learn the video object tracking methods and surveillance networks.
5. illustrate the various video applications.

UNIT I	BASIC CONCEPTS OF IMAGE AND VIDEO PROCESSING	9

Basics of image processing - Introduction to digital image processing, Digital image processing systems - Digital image processing methods - Digital image segmentation - Applications - Television Signal Processing, Medical Image Processing.

UNIT II	VIDEO COMPRESSION, MOTION ANALYSIS AND BACKGROUND MODELING	9

Video compression - Types of video compression, latency, MPEG compression; Standards, motion segmentation, motion segmentation algorithms, optical flow methods, Applications; Background modeling techniques, non-statistical background modeling methods, statistical modeling methods - Shadow detection and removal.

UNIT III	OBJECT TRACKING AND RECOGNITION	9

Object classification - Shape based object classification, motion based object classification, Viola jones object detection framework, object classification using convolutional neural networks; Human activity recognition - Motion history image based human activity recognition, hidden Markov Models, HMM based activity recognition, dynamic time warping based activity recognition, abnormal activity recognition, challenges.

UNIT IV	VIDEO OBJECT TRACKING AND SURVEILLANCE SYSTEMS	9

Video object tracking - Steps in video object tracking system, Kalman filter, Region based tracking, Contour based tracking, Feature based tracking, Model based tracking, Mean shift based tracking, Applications of tracking algorithms; Camera network for surveillance - types of CCTV camera, smart cameras, smart images, multiple view geometry, Camera network, Camera calibration, camera placement, camera communication, multiple camera coordination and cooperation.

UNIT V	VIDEO APPLICATIONS AND CASE STUDY	9

Encoding human motion for automated activity recognition in surveillance applications - Object-based surveillance video synopsis using genetic algorithms - Technical evaluation, development, and Implementation of a remote monitoring system for a golf cart - Intelligent traffic monitoring system through auto and manual controlling using PC and android applications.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	describe the application based image processing.	Understanding (K2)
CO2	use compression and background modeling method.	Applying (K3)
CO3	classify object tracking and recognition	Analyzing (K4)
CO4	summarize the tracking and surveillance system.	Understanding (K2)
CO5	contruct video analytics concepts for various applications.	Applying (K3)

TEXT BOOKS

1. Maheshkumar H Kolekar, "Intelligent Video Surveillance Systems: An Algorithmic Approach", Kindle Edition, Chapman and Hall/CRC; 1st edition, 2018.
2. Nilanjan Dey, Amira Ashour and Suvojit Acharjee, "Applied Video Processing in Surveillance and Monitoring Systems", IGI global, 2017.

REFERENCES

1. Zhihao Chen , Ye Yang , Jingyu Xue , Liping Ye , Feng Guo , "The Next Generation of Video Surveillance and Video Analytics: The Unified Intelligent Video Analytics Suite", Create Space Independent Publishing Platform, 1st edition, 2014.
2. Caifeng Shan , Fatih Porikli, Tao Xiang, Shaogang Gong ,"Video Analytics for Business Intelligence", Springer, 2012.
3. Jean-Yves Dufour, "Intelligent video surveillance system", Network and Telecommunication Series, ISTE Ltd., John Wiley & Sons, 2013.
4. Nalini K Ratha, Rama Chellappa, Vishal M. Patel, "Deep Learning-Based Face Analytics ", Springer International Publishing, 2021.

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CO2	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-	2	-

EC23254	SPEECH PROCESSING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the speech production mechanism and various speech analysis techniques.
2.	know the speech compression techniques.
3.	recognize the speech recognition techniques.
4.	acquire knowledge about the speaker recognition.
5.	learn about text to speech synthesis techniques.

UNIT I **SPEECH SIGNAL CHARACTERISTICS & ANALYSIS** **9**

Speech production process - speech sounds and features - Phonetic Representation of Speech - representing speech in time and frequency domains - Short-Time Analysis of Speech - Short Time Energy and Zero - Crossing Rate - Short-Time Autocorrelation Function - Short-Time Fourier Transform (STFT) - Speech Spectrum - Cepstrum - Mel-Frequency Cepstrum Coefficients - Hearing and Auditory Perception - Perception of Loudness - Critical Bands - Pitch Perception.

UNIT II **SPEECH COMPRESSION** **9**

Sampling and Quantization of Speech (PCM) - Adaptive differential PCM - Delta Modulation - Vector Quantization- Linear predictive coding (LPC) - Code excited Linear predictive Coding (CELP).

UNIT III **SPEECH RECOGNITION** **9**

LPC for speech recognition - Hidden Markov Model (HMM) - training procedure for HMM - sub word unit model based on HMM - language models for large vocabulary speech recognition - Overall recognition system based on sub word units - Context dependent sub word units - Semantic post processor for speech recognition.

UNIT IV **SPEAKER RECOGNITION** **9**

Acoustic parameters for speaker verification - Feature space for speaker recognition - similarity measures - Text dependent speaker verification - Text independent speaker verification techniques.

UNIT V **TEXT TO SPEECH SYNTHESIS** **9**

Text to speech synthesis (TTS) - Concatenative and waveform synthesis methods, Sub word units for TTS, intelligibility and naturalness - Role of prosody.

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	summarize the speech production mechanism and speech analysis techniques.	Understanding (K2)
CO2	distinguish speech compression techniques.	Understanding (K2)
CO3	choose suitable speech recognition techniques.	Applying (K3)
CO4	elucidate speaker recognition systems.	Understanding (K2)
CO5	apprehend text to speech synthesis systems.	Understanding (K2)

TEXT BOOKS

1. Lawrence R. Rabiner, Ronald W. Schafer, "Theory and Applications of Digital Speech Processing", 1st Edition, Pearson Education, 2010.
2. Ben Gold and Nelson Morgan, "Speech and Audio signal processing- processing and perception of speech and music", John Wiley and sons, 2006.

REFERENCES

1. Lawrence Rabiner, Biiing and– Hwang Juang and B.Yegnanarayana, "Fundamentals of Speech Recognition", Pearson Education, 2009.
2. Claudio Becchetti and Lucio Prina Ricotti, "Speech Recognition", John Wiley and Sons, 1999.
3. Donglos O shanhnessy , "Speech Communication: Human and Machine", 2nd Edition, University press 2001.
4. Paul R. Hill, "Audio and Speech Processing with MATLAB", CRC Press, Taylor & Francis Group, 2019.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-	2	-

EC23255	ADVANCED DIGITAL SIGNAL PROCESSING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. learn the concepts of stationary and non-stationary random signals.
2. study the significance of power spectral density estimation.
3. get familiarize with linear estimation and prediction.
4. gain knowledge about adaptive filters.
5. know the wavelet concepts and applications.

UNIT I **DISCRETE-TIME RANDOM PROCESSES** **9**

Random variables - ensemble averages, Parameter Estimation: Bias and consistency; Random processes - ensemble averages, autocorrelation and auto-covariance matrices, ergodicity random process, white noise; Filtering random processes - Spectral factorization - Special types of random processes - AR, MA, ARMA.

UNIT II **SPECTRUM ESTIMATION** **9**

Non-parametric methods - Periodogram, Modified- Periodogram, performance analysis, Bartlett's method, Welch's method, Blackman - Tukey method, Performance comparison; Parametric methods - Spectrum estimation - AR, MA, ARMA; Frequency Estimation - Spectrum Estimation.

UNIT III **LINEAR ESTIMATION AND PREDICTION** 9

Wiener filtering - FIR Wiener filter - discrete Wiener Hopf equation, Applications, filtering, linear prediction, Noise cancellation; IIR Wiener filter - non-causal and causal filters; Discrete Kalman Filter.

UNIT IV **ADAPTIVE FILTERS** 9

Principles and properties of adaptive filters - FIR adaptive filters - Steepest descent algorithm, LMS algorithm, Convergence of LMS; Applications of adaptive filtering - noise cancellation, channel equalization; Adaptive Recursive Filters - Recursive Least Squares.

UNIT V **WAVELET THEORY AND APPLICATIONS** 9

Short-time Fourier Transform - Heisenberg uncertainty principle - Principles of multi-resolution analysis - subband coding - Continuous and discrete wavelet transform - Applications of wavelet transform - noise reduction, image compression.

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	articulate the concepts of special random processes.	Applying (K3)
CO2	appraise appropriate spectrum estimation techniques.	Analyzing (K4)
CO3	apply optimum filters appropriately for a given application.	Applying (K3)
CO4	relate appropriate adaptive algorithm for processing non-stationary signals.	Applying (K3)
CO5	interpret wavelet transforms for applications.	Understanding (K2)

TEXT BOOKS

1. Monson H. Hayes, "Statistical digital signal processing and modeling", John Wiley and Sons Inc. New York, Indian reprint 2008.
2. P. P. Vaidyanathan, "Multirate systems and filter banks", Prentice Hall Inc. 1993.

REFERENCES

1. John G. Proakis & Dimitris G.Manolakis, "Digital Signal Processing - Principles, Algorithms & Applications", 4th Edition, Pearson Education / Prentice Hall, 2007.
2. Sophoncles J. Orfanidis, "Optimum signal processing", McGraw Hill, 2000
3. D.E. Dudgeon and RM. Mersereau, "Multidimensional Digital Signal Processing", Prentice Hall Professional Technical Reference, 1990.
4. Li Tan, Jean Jiang, "Digital Signal Processing Fundamentals and Applications", Academic Press, 2013.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	1	-
CO3	3	3	1	-	-	-	-	-	-	-	-	-	1	-
CO4	3	3	1	-	-	-	-	-	-	-	-	-	1	-
CO5	3	3	1	-	-	-	-	-	-	-	-	-	1	-

EC23256	DSP PROCESSORS AND ITS APPLICATIONS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	study the architecture of programmable DSP processors.
2.	learn the architecture of TMS320C54xx DSP Processor.
3.	know the architecture of TMS320C6x DSP Processor.
4.	be familiar with various standard DSP algorithms in DSP Processors.
5.	gain knowledge about DSP Processor applications.

UNIT I	ARCHITECTURES FOR PROGRAMMABLE DSP PROCESSORS	9

Basic Architectural features, DSP Computational building blocks, Bus architecture and memory, Data addressing capabilities, Address generation Unit, Programmability and program execution, Speed issues, Features for external interfacing.

UNIT II	TMS320C5X PROGRAMMABLE DSP PROCESSOR	9

Architecture of TMS320C54xx DSP processors, Addressing modes - Assembly language Instructions - Memory space, interrupts, and pipeline operation of TMS320C54xx DSP Processor, On-Chip peripherals, Block Diagram of TMS320C54xx DSP starter kit.

UNIT III	TMS320C6X PROGRAMMABLE DSP PROCESSOR	9

Commercial TI DSP processors, Architecture of TMS320C6x DSP Processor, Linear and Circular addressing modes, TMS320C6x Instruction Set, Assembler directives, Linear Assembly, Interrupts, Multichannel buffered serial ports, Block diagram of TMS320C67xx DSP Starter Kit and Support Tools.

UNIT IV	IMPLEMENTATION OF DSP ALGORITHMS	9

DSP Development system, On-chip, and On-board peripherals of C54xx and C67xx DSP Development system, On-chip, and On-board peripherals of C54xx and C67xx DS development boards, Code Composer Studio (CCS) and support files, Implementation of Conventional FIR, IIR, and Adaptive filters in TMS320C54xx/TMS320C67xx, DSP processors for real-time DSP applications, Implementation of FFT algorithm for frequency analysis in real-time.

UNIT V	APPLICATIONS OF DSP PROCESSORS	9

Voice scrambling using filtering and modulation, Voice detection and reverse playback, Audio effects, Graphic Equalizer, Adaptive noise cancellation, DTMF signal detection, Speech thesis using LPC, Automatic speaker recognition.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	interpret the architectural features of DSP Processors.	Understanding (K2)
CO2	comprehend the organization of TMS320C54xx DSP processors.	Understanding (K2)
CO3	infer the components of TMS320C6x DSP Processors.	Understanding (K2)
CO4	demonstrate DSP Algorithms.	Applying (K3)
CO5	study the applications of DSP Processors.	Analyzing (K4)

TEXT BOOKS

1. Avtar Singh and S. Srinivasan, "Digital Signal Processing - Implementations using DSP Microprocessors with Examples from TMS320C54xx", Cengage Learning India Private Limited, 2012.
2. Rulph Chassaing and Donald Reay, "Digital Signal Processing and Applications with TMS320C6713 and TMS320C6416 DSK", 2nd Edition, Wiley India (P) Ltd, New Delhi, 2008.

REFERENCES

1. B.Venkataramani and M.Bhaskar, "Digital Signal Processors - Architecture, Programming and Applications", Tata McGraw Hill, 2003.
2. Lapsley et al , " DSP Processor Fundamentals, Architectures & Features", S. Chand & Co., 2000.
3. Woon-Seng Gan, Sen M. Kuo, "Embedded Signal Processing with the Micro Signal Architecture", Wiley-IEEE Press, 2007.
4. Jonatham Stein, "Digital Signal Processing", John Wiley, 2005.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO5	3	3	-	-	-	-	-	-	-	-	-	-	3	-

EC23257	RADAR SIGNAL PROCESSING	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	learn Radar Fundamentals like Radar Equation.
2.	understand the basic concepts of Radar systems.
3.	know the various types of Signal Processing in Radar.
4.	be familiar with Doppler signal processing.
5.	acquire knowledge about applications of Radar

UNIT I	RANGE EQUATION AND TYPES OF RADAR	9
Basic Radar, Radar equation, Radar parameters, Block diagram, Radar frequencies; Types of Radar: CW, Doppler, MTI, FMCW, Pulsed, Tracking Radar. DSP in Radar (MTD1), Radar measurements.		
UNIT II	**RADAR SYSTEM CONCEPTS**	**9**
Scattering and RCS, RCS models, propagation, antennas, receivers, Different type of Noise, Noise figure, False alarm & Missed detection, Radar cross section, Transmit/Receive and Anti Transmit/Receive Switches.		
UNIT III	**SIGNAL PROCESSING – I**	9
Radar Signal Processing Fundamentals - Detection and likelihood ratio, binary detection, matched filtering, Radar ambiguity functions, Pulse compression and Radar waveforms, Radar resolution; Detection of radar signals in Noise and clutter, detection of non-fluctuating target in noise, Matched filter response to delayed Doppler shifted signals.		
UNIT IV	**SIGNAL PROCESSING – II**	9
Doppler Processing - Linear FM Pulse Compression; Waveform diversity, Passive System: Digital compression, SAW pulse compression; Signal processing in Antenna arrays.		
UNIT V	**APPLICATIONS OF RADAR SIGNAL PROCESSING**	9
Pulse-Doppler radar, CFAR detection, synthetic aperture radar (SAR), inverse synthetic aperture radar (ISAR), moving target indication (MTI), displaced-phase-center-antenna technique (DPCA), adaptive radar, super resolution (MUSIC), space-time adaptive processing (STAP).		
	TOTAL PERIODS	**45**

COURSE OUTCOMES		BT MAPPED
At the end of this course, the students will be able to		(Highest Level)
CO1	demonstrate the basic principles of radar operation	Understanding (K2)
CO2	infer radar systems concepts.	Understanding (K2)

CO3	identify different signal processing tools in radar systems.	Understanding (K2)
CO4	interpret radar systems signal processing.	Understanding (K2)
CO5	analyze the applications of Radar.	Analyzing (K4)

TEXT BOOKS

1. M.I.Skolnik , "Introduction to Radar Systems", Tata McGraw Hill 2006.
2. Mark A. Richards, "Fundamentals of Radar Signal Processing", McGraw-Hill, 2005.

REFERENCES

1. Peyton Z. Peebles, Jr., "Radar Principles", Wiley India Pvt Ltd, 2007.
2. Nadav Levanon , "Radar Principles", Wiley – Technology and Engineering Publication, 1988.
3. Nathansan, "Radar design principles-Signal processing and environment", 2nd Edition, Prentice Hall India, 2007.
4. Roger J.Sullivan, "Radar foundations for Imaging and advanced concepts", Prentice Hall India, 2004.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and ProgramSpecific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO5	3	3	1	-	-	-	-	-	-	-	-	-	3	-

EC23351	ANALOG IC DESIGN	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	know the basics of MOS Circuits.
2.	understand the noise characteristics of amplifiers.
3.	learn the performance parameters of amplifiers.
4.	comprehend the compensation techniques.
5.	understand the detection and testing

UNIT I	SINGLE STAGE AMPLIFIERS	9

Basic MOS physics and equivalent circuits and models, CS, CG and Source Follower, differential amplifier with active load, Cascode and Folded Cascode configurations with active load; Differential and Cascade Amplifiers - specified SR, noise, gain, BW, ICMR and power dissipation, voltage swing, high gain amplifier structures.

UNIT II	HIGH FREQUENCY AND NOISE CHARACTERISTICS OF AMPLIFIERS	9

Miller effect, association of poles with nodes, frequency response of CS, CG and Source Follower, Cascode and Differential Amplifier stages, statistical characteristics of noise, noise in Single Stage amplifiers, noise in Differential Amplifiers.

UNIT III	FEEDBACK AND SINGLE STAGE OPERATIONAL AMPLIFIERS	9

Feedback - Properties and types of negative feedback circuits, effect of loading in feedback networks, Effects of feedback on noise; 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

Stability - Multipole Systems, Phase Margin, Frequency Compensation, Compensation of Two Stage Op Amps; Slewing In Two Stage Op Amps, Other Compensation Techniques.

UNIT V	DESIGN FOR TESTABILITY	9

Faults in Logic Circuits - Basic Concepts of Fault Detection- Design for Testability - Ad Hoc Techniques, Level-Sensitive Scan Design, Partial Scan, Built-in Self-Test.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	prepare amplifiers to meet user specifications.	Understanding (K2)
CO2	demonstrate frequency analysis and noise performance of amplifiers.	Analyzing (K4)
CO3	interpret feedback amplifiers and Op amps.	Understanding (K2)
CO4	analyse the stability in Op amp circuits.	Analyzing (K4)
CO5	illustrate Testing of logic circuits.	Applying (K3)

TEXT BOOKS

1. Behzad Razavi, "Design of Analog CMOS Integrated Circuits", Tata Mcgraw Hill, 2001.
2. Sung-Mo Kang, Yusuf Leblebici, "CMOS Digital Integrated Circuits", Tata Mcgraw Hill, 2008.

REFERENCES

1. Willey M.C. Sansen, "Analog Design Essentials", Springer, 2006
2. Jacob Baker "CMOS: Circuit Design, Layout, and Simulation", 3rd Edition, Wiley IEEE Press, 2010
3. Grebene, "Bipolar And Mos Analog Integrated Circuit Design", John Wiley & Sons Inc., 2003.
4. Gregorian, Temes, "Analog MOS Integrated Circuit for signal processing", John Wiley & Sons, 1986.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	2	-
CO5	3	3	2	-	-	-	-	-	-	-	-	-	2	-

EC23352	MIXED SIGNAL IC DESIGN	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. study the basics of Phase Locked Loop.
2. understand the design concepts of sampling circuits.
3. learn the D/A Converter architectures.
4. get familiar about A/D Converter architectures.
5. comprehend integrator based filters.

UNIT I	PHASE LOCKED LOOP	9

Characterization of a comparator; Basic CMOS comparator design; Analog multiplier design; Phase Locked Loop - simple PLL, charge-pump PLL, Non ideal effects in PLL, Delay locked loops, applications of PLL.

UNIT II	SAMPLING CIRCUITS	9

Basic sampling circuits for analog signal sampling, performance metrics of sampling circuits, different types of sampling switches; Sample-and-Hold Architectures; Open-loop & closed-loop architectures - open-loop architecture with miller capacitance; multiplexed-input architectures, recycling architecture, switched capacitor architecture, current-mode architecture.

UNIT III	D/A CONVERTER ARCHITECTURES	9

Input/output characteristics of an ideal D/A converter, performance metrics of D/A converter, D/A converter in terms of voltage, current, and charge division or multiplication, switching functions to generate an analog output corresponding to a digital input; Resistor-Ladder architectures, Current steering architectures.

UNIT IV	A/D CONVERTER ARCHITECTURES	9

Performance metrics - Flash Architecture - Two Steps Architecture - Interpolative and Folding Architecture - Pipelined architectures - Successive approximation architectures - Inter leaved architectures.

UNIT V	INTEGRATOR BASED FILTERS	9

Low Pass filters - Active RC integrators - MOSFET- C integrators - Transconductance - C integrator - Discrete time integrators - Filtering topologies - bilinear transfer function and biquadratic transfer function.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	describe the basics of Phase Locked Loop.	Understanding (K2)
CO2	demonstrate the design concepts of sampling circuits.	Understanding (K2)
CO3	illustrate the D/A Converter architectures.	Understanding (K2)
CO4	elucidate the A/D Converter architectures.	Understanding (K2)
CO5	summarize the integrator based filters.	Understanding (K2)

TEXT BOOKS

1. Razavi, "Design of analog CMOS integrated circuits", 2nd Edition, McGraw Hill, 2002.
2. Razavi, "Principles of data conversion system design", 1st Edition, Wiley IEEE Press, 1994.

REFERENCES

1. Jacob Baker, "CMOS Mixed-Signal circuit design", IEEE Press, 2009.
2. Gregorian, Temes, "Analog MOS Integrated Circuit for signal processing", John Wiley & Sons, 1986.
3. Baker, Li, Boyce, "CMOS: Circuit Design, layout and Simulation", Prentice Hall India, 2000.
4. Phillip E.Allen, Douglas R .Holberg, "CMOS Analog Circuit Design", 2nd Edition, Oxford University Press, 2002.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

Cos	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO2	3	3	1	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	1	-	-	-	-	-	-	-	-	-	2	-
CO4	3	3	1	-	-	-	-	-	-	-	-	-	2	-
CO5	3	3	1	-	-	-	-	-	-	-	-	-	2	-

EC23353	FPGA BASED SYSTEM DESIGN	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	know the fundamentals of programmable logic devices
2.	study the field programmable gate array
3.	acquire the SRAM Programmable FPGAS
4.	learn the necessity of Anti-Fuse Programmed FPGAS
5.	gain the knowledge of design applications of FPGA

UNIT I	BASICS OF PROGRAMMABLE LOGIC DEVICES	9

Introduction to Programmable Logic Arrays; Programmable Array Logic; Programmable Logic Devices/Generic Array Logic - Architecture of Xilinx Cool Runner XCR3064XL CPLD; CPLD Implementation of a Parallel Adder.

UNIT II	FIELD PROGRAMMABLE GATE ARRAYS	9

Organization of FPGAs; FPGA Programming Technologies; Programmable Logic Block Architectures; Programmable Interconnects; Programmable I/O blocks in FPGAs; Applications of FPGAs.

UNIT III	SRAM PROGRAMMABLE FPGAS	9

Programming Technology - Device Architecture, Xilinx XC3000, XC4000 Architectures, Software - Future - Design Applications - A Fast Video Controller, A Position Tracker For a Robot Manipulator, A Fast DMA Controller.

UNIT IV	ANTI-FUSE PROGRAMMED FPGAS	9

Programming Technology - Device Architecture, Actel - ACT2, ACT3 Architectures; Software - Future - Design Applications - Designing with ACT1 and ACT2 FPGAs; Designing with ACT FPGAs: A 1TL Perspective, Synthesis Design Flow, Designing Counters with ACT Devices, State Machine Design, Using FPGAs for Digital PLLs.

UNIT V	ERASABLE PROGRAMMABLE LOGIC DEVICES	9

Programming Technology - Device Architecture, Basic Concepts; Macrocell Architecture, Logic Array, Programmable Flip-Flops, MAX 7000; Design Applications - MAX 5000 Timing, Using Expanders to Build Registered Logic in MAX EPLDs, Fast Bus Controllers with the EPM5016, FIFO Controller Using an EPM7096, Controlling Complex CCD Imaging Systems with the EPS464 EPLD.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	examine the challenges in programmable logic devices	Understanding (K2)
CO2	elucidate the different concept field programmable gate array	Understanding (K2)
CO3	demonstrate the SRAM Programmable FPGAS	Applying (K3)
CO4	explain the necessity of Anti-Fuse Programmed FPGAS	Understanding (K2)
CO5	manipulate the design application concepts of FPGA	Applying (K3)

TEXT BOOKS

1. Stephen M. and Trim Berger, "Field Programmable Gate Array Technology", Springer, 1994.
2. Charles H. Roth Jr, Lizy Kurian John, and Byeong Kil Lee, "Digital Systems Design Using Verilog", Cengage Learning, 2016.

REFERENCES

1. John V. Oldfield and Richard C. Dorf, "Field Programmable Gate Arrays", Wiley India, 1995.
2. Pak K. Chan / Samiha Mourad, "Digital Design Using Field Programmable Gate Arrays", Pearson Low Price Edition, 2009.
3. Ian Grout, Newnes, "Digital Systems Design with FPGAs and CPLDs", Elsevier, 2008.
4. Ricardo Reis., "Design of System on a Chip: Devices and Components", 3rd Edition, Springer, 2004

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

Cos	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	-	2	-
CO2	3	2	1	1	-	-	-	-	-	-	-	-	2	-
CO3	3	2	1	1	-	-	-	-	-	-	-	-	2	-
CO4	3	2	1	1	-	-	-	-	-	-	-	-	2	-
CO5	3	2	1	1	-	-	-	-	-	-	-	-	2	-

EC23354	SYSTEM ON CHIP DESIGN	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. know the components of the system.
2. study the basic of time, area, power and reliability of chip.
3. learn the internal and external memory design.
4. understand the customization and configurability of the system.
5. gain knowledge about the design applications of SoC.

UNIT I	SYSTEM ARCHITECTURE	9

Components of the system - processors, memories, and interconnects; Hardware and software : programmability versus performance - Processor architectures - functional view, an architectural view; Memory and addressing - SoC memory examples, addressing architecture of memory, memory for SoC operating system; Approach for SoC design - requirements and specifications, design iteration; system architecture and complexity - product economics and implications for SoC - Dealing with design complexity.

UNIT II	CHIP BASICS: TIME, AREA, POWER, RELIABILITY AND PROCESSORS	9

Introduction - design trade-offs, requirements and specifications; Cycle time - defining a cycle, optimum pipeline, performance; Die area and cost - processor area, processor subunits; Ideal and practical scaling - Power - Area-time-power trade-offs in processor design - workstation processor, embedded processor; Reliability,- error detection and correction, dealing with manufacturing faults, memory and function scrubbing; Configurability; Processor selection for SoC - Basic concepts in processor architecture - Basic concepts in processor microarchitecture - Basic elements in instruction handling.

UNIT III	MEMORY DESIGN	9

Overview of SOC external memory - flash, SOC internal memory, placement, the size of memory; Scratchpads and cache memory - Basic notions - Cache organization - Cache data - Write polices; Strategies for Line Replacement at Miss Time - Multilevel Caches - Virtual-to-Real Translation, SOC (on-die) memory systems - Board-based (off-die) memory systems, Simple DRAM and the Memory Array - Models of Simple Processor - Memory Interaction.

UNIT IV	CUSTOMIZATION AND CONFIGURABILITY	9

Estimating Effectiveness of Customization - SOC Customization - Overview; Customizing instruction processors - Reconfigurable technologies - Reconfigurable Functional Units (FUs), Reconfigurable interconnects, software configurable processors; Mapping designs onto reconfigurable devices - Instance specific design, Customizable soft processor - Example - Reconfiguration.

UNIT V	DESIGN APPLICATION STUDIES	9

SOC Design Approach - AES - Algorithm and Requirements, AES: Design and Evaluation; Application of Image Compression - JPEG Compression , Example JPEG System for Digital Still Camera ; Application of

Video Compression - MPEG and H.26X Video Compression, requirements, H.264 Acceleration, Designs; Further Application - MP3 Audio Decoding, Software-Defined Radio with 802.16.

TOTAL PERIODS	**45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	describe the architectures and performance factors of system-on-chip.	Understanding (K2)
CO2	paraphrase the Chip basics in terms of time, area, power and reliability.	Understanding (K2)
CO3	interpret memory design for SoC.	Understanding (K2)
CO4	illustrate customization and configurability in SoC.	Understanding (K2)
CO5	Interpret SoC design approaches for real-world applications.	Understanding (K2)

TEXT BOOKS

1. Michael J. Flynn and Wayne Luk, "Computer System Design System-on-Chip", Wiley India Pvt. Ltd., 2011.
2. Steve Furber, "ARM System on Chip Architecture", 2nd Edition, Addison Wesley Professional, 2000.

REFERENCES

1. Ricardo Reis, "Design of System on a Chip: Devices and Components", 3rd Edition, Springer.,2004
2. Prakash Rashinkar, Peter Paterson and Leena Singh L, "System on Chip Verification - Methodologies and Techniques", Kluwer Academic Publishers, 2001
3. P. Marwedel, "Embedded System Design: Embedded Systems Foundations of Cyber - Physical Systems", 3rd Edition, Springer, 2018.
4. Ian Grout, Newnes, "Digital Systems Design with FPGAs and CPLDs", Elsevier, 2008.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

Cos	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	3	-	-	-	-	-	-	-	-	-	3	-
CO5	3	3	3	-	-	-	-	-	-	-	-	-	3	-

EC23355	CAD FOR VLSI	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. learn various VLSI design methodologies
2. understand data structures and algorithms required for VLSI design.
3. study the algorithms for partitioning and placement.
4. comprehend various algorithms for floor planning and routing.
5. be familiar with modeling, simulation and synthesis.

UNIT I VLSI DESIGN METHODOLOGIES 9

VLSI Design Methodologies - VLSI Design Cycle; New Trends in VLSI Design Cycle; Physical Design Cycle - New Trends in Physical Design Cycle, Design Styles; VLSI Design Automation Tools.

UNIT II ALGORITHMIC GRAPH THEORY AND COMPUTATIONAL COMPLEXITY 9

Data structure for the representation of graphs - Computational Complexity; Example of Graph Algorithms - Depth-first search, Breadth-first search, Dijkstra's Shortest-path Algorithms; Tractable and Intractable Problems - General Purpose Methods for Combinatorial Optimization.

UNIT III ALGORITHMS FOR PARTITIONING AND PLACEMENT 9

Layout Compaction - Design rules, Symbolic layout, Problem Formulation, Algorithms for Constraint Graph Compaction; Partitioning - Placement and Partitioning Algorithms.

UNIT IV ALGORITHMS FOR FLOOR PLANNING AND ROUTING 9

Floor planning - Problem Formulation, Floor planning Algorithms; Routing - Area Routing, Channel Routing, Global Routing, Detailed Routing.

UNIT V MODELING, SIMULATION AND SYNTHESIS 9

Simulation - Gate Level Modeling and Simulation - Logic Synthesis and Verification - Binary Decision Diagrams - High Level Synthesis.

TOTAL PERIODS 45

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	discuss VLSI design methodologies and automation tools.	Understanding (K2)
CO2	demonstrate graph theory and computational complexity concepts.	Understanding (K2)
CO3	analyze algorithms for partitioning and placement in VLSI layout design.	Analyzing (K4)
CO4	interpret floor planning and routing algorithms	Understanding (K2)
CO5	illustrate modeling, simulation, and synthesis of digital VLSI systems.	Understanding (K2)

TEXT BOOKS

1. Sabih H. Gerez, "Algorithms for VLSI Design Automation", 2nd Edition, Wiley-India, 2017.
2. Naveed a. Sherwani, "Algorithms for VLSI Physical Design Automation", 3rd Edition, Springer, 2017.

REFERENCES

1. Charles J. Alpert, Dinesh P. Mehta and Sachin S Sapatnekar, "Handbook of Algorithms for Physical Design Automation, CRC Press, 1st Edition, 2008.
2. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.
3. M.L.Bushnell ,V.D.Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers, 2002.
4. Martin Morf, Wolfgang Fichtner, "VLSI CAD Tools and Applications", Springer US, 2012.

CO-PO MAPPING :

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Cos	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	1	-	-	-	-	-	-	-	3	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	3	-

EC23356	TESTING OF VLSI CIRCUITS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. learn the basics of testing and fault modeling
2. understand the concepts of test generation for combinational and sequential circuits
3. be familiar with the design for testability
4. acquire knowledge about the self - test and test algorithms
5. understand the concepts of fault diagnosis

UNIT I	BASICS OF TESTING AND FAULT MODELING	9

Introduction to Testing - Faults in Digital Circuits, Modeling of faults; Logical Fault Models - Fault detection, Fault Location, Fault dominance; Logic simulation - Types of simulation, Delay models, Gate Level Event, driven simulation.

UNIT II	TEST GENERATION FOR COMBINATIONAL AND SEQUENTIAL CIRCUITS	9

Test generation for Combinational logic circuits - Testable Combinational logic circuit design - Test generation for Sequential circuits - Design of Testable sequential circuits.

UNIT III	DESIGN FOR TESTABILITY	9

Design for Testability - AdHoc design - Generic Scan based design - Classical scan based design - System level DFT approaches.

UNIT IV	SELF - TEST AND TEST ALGORITHMS	9

Built-in self-Test - Test pattern generation for BIST, Circular BIST, BIST Architectures; Testable Memory Design - Test Algorithms, Test generation for Embedded RAMs.

UNIT V	FAULT DIAGNOSIS	9

Logical Level Diagnosis - Diagnosis by Unit Under Test reduction - Fault Diagnosis for Combinational Circuits - Self checking design - System level Diagnosis.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the fundamentals of digital testing, types of faults, and fault models.	Understanding (K2)
CO2	generate test patterns for combinational and sequential circuits.	Applying (K3)
CO3	illustrate design-for-testability techniques.	Understanding (K2)
CO4	infer built-in self-test architectures and test algorithms.	Understanding (K2)
CO5	interpret fault diagnosis for combinational circuits.	Understanding (K2)

TEXT BOOKS

1. M.Abramovici, M.A.Breuer and A.D. Friedman, "Digital systems and Testable Design", Jaico Publishing House, 2002.
2. P.K. Lala, "Digital Circuit Testing and Testability", Academic Press, 2002.

REFERENCES

1. M.L.Bushnell ,V.D.Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwer Academic Publishers, 2002.
2. N.A. Sherwani, "Algorithms for VLSI Physical Design Automation", Kluwer Academic Publishers, 2002.
3. A.L.Crouch, "Design Test for Digital IC's and Embedded Core Systems", Prentice Hall International, 2002.
4. Angela Krstic, Kwang-Ting (Tim) Cheng, " Delay Fault Testing for VLSI Circuits", Springer US, 2012.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	1
CO2	3	2	2	-	-	-	-	-	-	-	-	-	3	1
CO3	3	2	2	-	-	-	-	-	-	-	-	-	3	1
CO4	3	2	2	-	-	-	-	-	-	-	-	-	3	1
CO5	3	2	2	-	-	-	-	-	-	-	-	-	3	1

EC23357	LOW POWER VLSI	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	acquire knowledge about low power technologies.
2.	be familiar with concepts of MOS inverters.
3.	know about various sources of power dissipation.
4.	have an in-depth knowledge supply voltage scaling techniques.
5.	understand the software approaches for low power VLSI.

UNIT I TECHNOLOGIES FOR LOW POWER **9**

Low power - Sources of power dissipation, dynamic and static Low power design methodologies; CMOS Fabrication; Latch problem - prevention; Emerging technologies for low power.

UNIT II MOS INVERTERS **9**

Inverter- Characteristics; MOS Inverter Configurations - Inverter ratio, Switching characteristics, delay parameters, Driving Large capacitive loads.

UNIT III SOURCES OF POWER DISSIPATION **9**

Short circuit power dissipation; Switching power dissipation - dynamic power, reduced voltage swing, switching activity; glitching power dissipation; Leakage power dissipation - Band - Band tunneling current, sub-threshold leakage current.

UNIT IV SUPPLY VOLTAGE SCALING **9**

Device feature size scaling; Architectural level approaches - Parallelism for low power, Multi-core for low power; Multi-level voltage scaling - Challenges in MVS; Adaptive voltage scaling.

UNIT V LOW POWER SOFTWARE APPROACHES **9**

Machine independent software optimization - Combining loop optimization with DVFS - Loop unrolling, Tiling, Permutation, Fusion; Power-Aware software prefetching

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	illustrate the various low power technologies	Understanding (K2)
CO2	interpret various concepts of MOS Inverters	Applying (K3)
CO3	explain about the power dissipation techniques	Understanding (K2)
CO4	examine the different scaling techniques for low power	Applying (K3)
CO5	summarize the optimization techniques used in low power VSLI	Understanding (K2)

TEXT BOOKS

1. Ajit Pal, "Low power VLSI Circuits and Systems", Springer, 2015.
2. Kaushik Roy, Sharat Prasad, "Low-Power CMOS VLSI Circuit Design", Wiley, 2000

REFERENCES

1. K.S. Yeo and K. Roy, "Low-Voltage Low-Power Subsystems", McGraw Hill, 2004.
2. Gary K. Yeap, "Practical Low Power Digital VLSI Design", Kluwer Academic Publishers, 2000.
3. Wayne Wolf, "Modern VLSI Design System on chip", Pearson education, 2012.
4. John P.Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley & Sons, 2016.

CO-PO MAPPING :

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COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	-	-	-	-	-	-	-	-	2	1
CO2	3	2	1	1	-	-	-	-	-	-	-	-	2	1
CO3	3	2	1	1	-	-	-	-	-	-	-	-	2	1
CO4	3	2	1	1	-	-	-	-	-	-	-	-	2	1
CO5	3	2	1	1	-	-	-	-	-	-	-	-	2	1

EC23451	AVIONICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. know the role of avionics system and its architecture.
2. understand the avionics display and communication system.
3. learn about the inertial sensors, attitude derivation and air data systems in avionics.
4. get acquire knowledge about maintenance of avionics system.
5. study the onboard navigation systems

UNIT I INTRODUCTION TO AVIONICS — **9**

Importance and role of Avionics - Systems which interface directly with pilot, Aircraft state sensor systems, External world sensor systems, Task automation systems; The avionics environment - Minimum weight, Environmental requirement, Reliability; Avionics System Integration - ARINC and MIL specification, Data bus systems - Electrical and optical data bus systems, Integrated modular avionics.

UNIT II DISPLAYS AND COMMUNICATION SYSTEMS — **9**

Introduction to displays; Head Up Displays, Helmet mounted displays, Head tracking systems; Data fusion in displays; Intelligent displays management; Introduction to voice and data communication systems - HF, VHF, UHF and Satellite communications, Flight data recorders.

UNIT III INERTIAL SENSORS, ATTITUDE DERIVATION AND AIR DATA SYSTEMS — **9**

Gyros and accelerometers - Angular momentum Gyroscopes, Optical Gyroscopes, Accelerometers; Air data Information and its use - measurement, Air Data quantities and its importance; Derivation of Air Data Laws and relationship - Units, Altitude-static pressure relationship, Variation of ground pressure, Speed of sound derivation, Mach Number, Calibrated Air Speed , True Air Speed, Pressure error; Air data sensors and Computing.

UNIT IV NAVIGATION SYSTEMS — **9**

Principles of DR Navigation systems; Inertial Navigation - Initial alignment and Gyro compassing, Strap-down IN System; Global Positioning Systems - System description, Basic principles, Integration of GPS and INS.

UNIT V SURVEILLANCE AND AUTO FLIGHT SYSTEMS — **9**

Traffic alert and collision avoidance systems; Enhanced ground proximity warning system - Weather radar; Autopilots - Basic principle, height control, heading control, ILS/MLS coupled autopilot control, Automatic Landing, Speed control and auto throttle Systems; Flight management systems - Flight planning, Navigation and Guidance, Flight path optimization and performance prediction, 4D Flight management.

TOTAL PERIODS — **45**

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	describe the architecture and role of avionics systems.	Understanding (K2)
CO2	infer the concepts of displays and communication systems.	Understanding (K2)
CO3	demonstrate the working of inertial sensors and air data systems.	Understanding (K2)
CO4	discuss the functioning of navigation systems.	Understanding (K2)
CO5	interpret surveillance systems and auto flight systems.	Understanding (K2)

TEXT BOOKS

1. Collinson R.P.G., "Introduction to Avionics", Chapman and Hall, 2012.
2. S. Nagabhushana, N. Prabhu , "Principles of Modern Avionics", 1st edition, I K International Publishing House, 2018.

REFERENCES

1. Spitzer, C.R., "Digital Avionics Systems", Prentice Hall, 1987.
2. Middleton D.H., "Avionics Systems, Longman Scientific and Technical", Longman Group UK Ltd, 1989.
3. Jim Curren, "Trend in Advanced Avionics", IOWA State University, 1992.
4. Cary R .Spitzer, "The Avionics Handbook", CRC Press, 2000.

CO-PO MAPPING :

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COs	PO's												PSO's	
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CO2	3	-	-	-	-	-	-	-	-	-	-	-	3	2
CO3	3	3	2	3	-	-	-	-	-	-	-	-	3	-
CO4	-	-	3	-	-	-	-	-	-	-	-	2	-	3
CO5	3	-	-	-	-	-	-	-	-	-	-	2	3	3

EC23452	SATELLITE COMMUNICATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. know the overview of Satellite system.
2. learn about the Orbit and various space segment.
3. comprehend the various types of earth segment and space link.
4. be familiar with the concept of TDMA and FDMA.
5. study about the network architecture and its application.

UNIT I	OVERVIEW OF SATELLITE SYSTEMS	9

Introduction – Frequency allocations for satellite services, Kepler's law, Definitions of terms for earth orbiting satellites, Orbital elements, Apogee and Perigee heights; Orbital perturbations - Effects of a non-spherical earth, Atmospheric drag, Inclined orbits, Calendars; The Orbital plane - Geocentric equatorial coordinate system, Earth station referred to the IJK frame, Topocentric horizon coordinate system, The sub-satellite point.

UNIT II	GEOSTATIONARY ORBIT AND SPACE SEGMENT	9

Antenna look angles - Limits of visibility, Earth eclipse of satellite, Sun transit outage; Launching orbits - Attitude control; Station keeping - telemetry, tracking and command sub system; Transponders - Wide band amplifier, Input demultiplexer, Power amplifier.

UNIT III	EARTH SEGMENT & SPACE LINK	9

Earth Segment - Introduction, Receive only home TV systems, Outdoor unit-Indoor unit for analog (FM); TV - MATV system, CATV system, Transmit receive earth stations; Space link - Equivalent isotropic radiated power, Transmission losses; Link power budget equation - Carrier to Noise ratio, Uplink C/N, Downlink C/N, Effects of rain.

UNIT IV	SATELLITE ACCESS TECHNIQUES	9

Single access - Pre-assigned FDMA, Demand assigned FDMA, SPADE system; TDMA - Reference burst, Preamble and Postamble, Carrier recovery, Network synchronization, Unique word detection, Traffic data, Frame efficiency and channel capacity, Pre assigned TDMA, Demand assigned TDMA; Code division multiple access; Space division multiple access.

UNIT V	SATELLITE SYSTEMS	9

INMARSAT - VSAT Systems, Network architectures, Access control, Multiple access selection; Overview of Radarsat and GEOSAT - Study of recently launched GEOSAT and its applications.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	describe the fundamental components of satellite systems.	Understanding (K2)
CO2	discuss the geostationary orbit and space segment.	Understanding (K2)
CO3	manipulate earth station systems and link budgets.	Applying (K3)
CO4	distinguish multiple access techniques.	Understanding (K2)
CO5	explain satellite network architecture and applications.	Understanding (K2)

TEXT BOOKS

1. Roddy Dennis, "Satellite Communications",4th Edition, Mc-Graw Hill, New York, 2017
2. Pratt Timothy, Bostian Charles and Allnutt Jeremy, "Satellite Communications",3rd Edition, Wiley India Private Limited, New Delhi, 2019.

REFERENCES

1. Varsha Agrawal and Anil K.Maini, "Satellite Communications", 1st Edition, Wiley India Pvt. Ltd., New Delhi,2010.
2. Wilbur L. Pritchand, Robert A Nelson and Henri G.Suyderhoud, "Satellite Communication Engineering", 2nd Edition, Pearson Publications, 2012.
3. M. Richharia, "Satellite Communications: Design Principles", 2nd Edition, BS Publications, 2003.
4. Tri T. Ha, "Digital Satellite Communications", 2nd edition, Mc Graw Hill education, 2017.

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CO3	2	-	2	2	-	-	-	-	-	-	-	2	3	2
CO4	2	3	3	2	-	-	-	-	-	-	-	-	3	2
CO5	2	-	-	-	-	-	-	-	-	-	-	-	3	3

EC23453	NANO ELECTRONICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	learn the basics of Nanotechnology.
2.	get introduced to Nanomaterials and its characterization.
3.	study the design the CMOL circuits.
4.	acquire knowledge on electronic transport in nanoscale systems.
5.	know the concepts of Spintronics.

UNIT I	INTRODUCTION TO NANOTECHNOLOGY	9

Introduction - Bottom-up and top-down approach, Zero-dimensional nanostructures; Nanoparticles through homogeneous nucleation and heterogeneous nucleation - One-dimensional nanostructures, Two-dimensional nanostructures, PVD, CVD, ALD.

UNIT II	SPECIAL NANOMATERIALS AND FABRICATION OF NANOSTRUCTURES	9

Carbon fullerenes and nanotubes - Micro and Meso-porous materials, Core shell structures - Organic Inorganic hybrids; Lithographic techniques - Structural characterization and chemical characterization.

UNIT III	HYBRID SEMICONDUCTOR MOLECULAR INTEGRATED ELECTRONICS	9

Introduction - Devices, Circuits; CMOL memories - CMOL FPGA circuits, CMOL DSP circuits; Nano mechanics - Surface effect, Defects, Phase transitions, Sensors, High density data storage; Optics and telecommunications - Nano manipulators, Catalysis.

UNIT IV	TRANSPORT IN NANOSTRUCTURES	9

Semiconductor device scaling, Quantum effect devices; Electronic transport in semiconductors; Transport in nanoscale systems - Diffusive transport in quantum confined systems; Transmission and transport in Nano scale systems - Single electron tunneling.

UNIT V	SPINTRONICS	9

Metallic magnetic multilayers - Interlayer exchange coupling, Giant Magneto Resistance, Magnetic tunnel junctions, Spin torque; Magnetic Hard Drives - Magnetic Random Access Memory; Semiconductor Spintronics - Ferromagnetic semiconductors, Spin coherence, Spin orbit coupling, Spin injection; Spin extraction and ferromagnetic proximity polarization - Lateral spin valve, Hanle effect, Spin hall effect.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the fundamental concepts of nanotechnology.	Understanding (K2)
CO2	infer the concepts of fabrication of nanostructures.	Understanding (K2)
CO3	categorize hybrid semiconductor molecular electronics circuits.	Analyzing (K4)
CO4	describe the transport phenomena in nanoscale systems.	Understanding (K2)
CO5	discuss the principles and applications of spintronics.	Understanding (K2)

TEXT BOOKS

1. Guozhong Cao, "Nanostructures and Nanomaterials: Synthesis, Properties and Applications", 2nd Edition, Imperial College press, 2011.
2. Anatoli Korkin and Federico Rosei, "Nanoelectronics and Photonics: From Atoms to Materials, Devices, and Architectures", Springer, 2008.

REFERENCES

1. Pradeep.T, "Nano The Essentials : Understanding nanoscience and nanotechnology", McGraw Hill Publishing Company Limited, 2017.
2. Simon Deleonibus, "Electronic Device Architectures for the Nano-CMOS Era: From ultimate CMOS scaling to Beyond CMOS devices", Pan Stanford Publishing, Singapore, 2009.
3. Teruya Shinjo , " Nanomagnetism and Spintronics" , 2nd Edition, Elsevier, 2013
4. Robert Puers, Livio Baldi, "Nano electronics: Materials, Devices and Applications", Wiley, 2017.

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COs	PO's												PSO's	
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CO3	3	-	2		-	-	-	-	-	-	-	-	3	-
CO4	-	3	-	2	-	-	-	-	-	-	-	-	3	-
CO5	-	2	2	-	-	-	-	-	-	-	-	-	3	3

EC23454	SMART ANTENNAS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	know various antennas parameters
2.	learn the basic knowledge of smart antennas and their radiation characteristics.
3.	acquire the knowledge of aperture antennas and their applications.
4.	understand the concepts of Microstrip antenna.
5.	get the knowledge of broad band antennas and their applications.

UNIT I	INTRODUCTION TO SMART ANTENNAS	9

Need for smart antennas; smart antennas configuration - Switched- Beam Antennas, Adaptive Antenna Approach; Architecture of smart antenna system - Receiver, Transmitter; Benefits and drawbacks; Mutual Coupling effects.

UNIT II	DOA ESTIMATION FUNDAMENTALS	9

The array response vector; Received signal model; The subspace-based Data Model, Signal Autocovariance matrices; Conventional DOA Estimation methods - Conventional Beamforming Methods, Capon's minimum variance method; Subspace approach to DOA Estimation - The MUSIC Algorithm, The ESPRIT Algorithm; Uniqueness of DOA Estimates.

UNIT III	BEAMFORMING FUNDAMENTALS	9

The Classic Beamforming; Statistically Optimum Beamforming weight vectors - Maximum SNR Beamformer, Multiple Side lobe canceller and maximum SINR Beamformer, Minimum Mean Square Error, Direct matrix inversion (DMI), linearly constrained minimum variance .

UNIT IV	ADAPTIVE ALGORITHMS	9

Adaptive algorithms for Beamforming - The least mean Square Algorithm, The recursive least-squares Algorithm, The constant-Modules Algorithm, The Affine-projection Algorithm, The quasi-newton Algorithm.

UNIT V	INTEGRATION AND SIMULATION OF SMART ANTENNAS	9

Overview, Antenna Design, Mutual Coupling, Adaptive signal processing Algorithms - DOA, Adaptive Beamforming, Beamforming and Diversity combining for Rayleigh - fading channel; Trellis-coded modulation for adaptive arrays; Smart antenna systems for mobile and AdHoc NETworks - The Protocol, Simulations.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	discuss key antenna parameters and smart antenna system.	Understanding (K2)
CO2	analyze Direction of Arrival estimation techniques.	Analyzing (K4)
CO3	apply beamforming fundamentals and algorithms.	Applying (K3)
CO4	interpret adaptive algorithms for dynamic beamforming.	Applying (K3)
CO5	describe the integration of smart antenna systems.	Understanding (K2)

TEXT BOOKS

1. A.Balanis, "Antenna Theory and Design", 3rd Edition, John Wiley & Sons, 2005.
2. B.Gross, " Smart Antennas for Wireless Communications", McGraw-Hill., 2005.

REFERENCES

1. D.Kraus and Ronald J Marhefka, "Antennas For all Applications", Tata McGraw-Hill, 2003.
2. E. Collin, "Antennas and Radio Wave Propagation", McGraw-Hill, 1985.
3. R. S. Elliot, "Antenna Theory and Design", Wiley-IEEE Press, 2003.
4. Garret Okamoto, "Smart Antenna Systems and Wireless LANs", Kluwer Academic Publishers, 2002.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	-	3	-	-	-	-	-	-	-	-	-	-	2
CO4	3	3	3	-	-	-	-	-	-	-	-	-	-	2
CO5	3	2	3	-	1	-	-	-	-	2	2	-	3	3

EC23455	RF TRANSCEIVERS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	understand the fundamentals of RF system design.
2.	acquaint various components of RF systems.
3.	know the receiver system design in RF systems.
4.	learn the principles transmitter system design.
5.	be familiar with applications of RF system.

UNIT I	FUNDAMENTALS OF SYSTEM DESIGN	9

Introduction to Wireless Systems; Elements of Digital Base - Band System - Sampling Process, Jitter Effect of Sampling and Quantizing Noise, Pulse-Shaping Techniques and Intersymbol Interference (ISI), Error Probability of Detection, Signal-to-Noise Ratio (SNR) and Carrier-to-Noise Ratio (CNR), RAKE Receiver.

UNIT II	RADIO ARCHITECTURES AND DESIGN CONSIDERATIONS	9

Super heterodyne Architecture - Configuration, Frequency Planning, Design Consideration; Direct-Conversion (Zero IF) Architecture - Configuration, Technical Challenges, Design Consideration; Low IF Architecture - Configuration, Approaches to Achieve High Image Rejection; Band-pass Sampling Radio Architecture - Basics of Band-pass Sampling, Design Consideration.

UNIT III	RECEIVER SYSTEM ANALYSIS AND DESIGN	9

Sensitivity and Noise Figure of Receiver - Sensitivity Calculation, Cascaded Noise Figure, Influence of Antenna VSWR to Receiver Noise Figure; Intermodulation Characteristics - Cascaded Input Intercept Point, Calculation of Receiver Intermodulation Characteristics; Single-Tone Desensitization - Cross-Modulation Products, Determination of the Allowed Single-Tone Interferer; Adjacent /Alternate Channel Selectivity and Blocking Characteristics; System Design and Performance Evaluation - Receiver System Design Basics, Receiver System Performance Evaluation.

UNIT IV	TRANSMITTER SYSTEM ANALYSIS AND DESIGN	9

Transmission Power and Spectrum; Modulation Accuracy; Adjacent and Alternate Channel Power; Noise-Emission Calculation; Considerations in System Design - Comparison of Architectures, Transmitter Chain Gain Distribution and Performance, AGC and Power Management.

UNIT V	APPLICATIONS OF SYSTEM DESIGN	9

Multimode and Multiband Super heterodyne Transceiver - Selection of a Frequency Plan, Receiver System Design, Transmitter System Design; Direct Conversion Transceiver - Receiver System Design, Transmitter System Design.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	discuss the fundamentals of RF system design.	Understanding (K2)
CO2	describe the radio architectures and their design considerations.	Understanding (K2)
CO3	illustrate receiver system parameters.	Analyzing (K4)
CO4	analyze transmitter system design in RF systems.	Analyzing (K4)
CO5	elucidate the applications of RF systems.	Understanding (K2)

TEXT BOOKS

1. Qizheng gu, "RF System Design of Transceivers for Wireless Communications", Springer, 2005.
2. Kevin McClaning, "Wireless Receiver Design for Digital Communications", 2nd Edition Scitech Publishing Inc., 2012.

REFERENCES

1. Ludwig R and Bretchko P, "RF Circuit Design Theory and Applications", Prentice Hall, 2000.
2. Razavi B, "Design of Analog CMOS Integrated Circuits", McGraw Hill, 2nd Edition, 2017.
3. Kyung-WhanYeom, "Microwave Circuit Design - A Practical Approach using ADS", Pearson Education, 2015.
4. Abbas Mohammadi and Fadhel M.Ghannouchi, "RF Transceiver Design for MIMO Wireless Communications", Springer, 2012.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	-	3	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	-
CO5	3	2	3	-	-	-	-	-	-	-	-	-	-	3

EC23456	RFID SYSTEM DESIGN AND TESTING	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	learn the fundamentals of RFID communications
2.	acquire knowledge about the standards and protocols used in RFID systems
3.	know the operating principles of RFID tag and reader
4.	study the security aspects of RFID systems
5.	recognize the industrial and scientific applications of RFID system

UNIT I	RFID COMMUNICATIONS	9

RFID Principles - Near-field based RFID, Properties of Magnetic field, Far-field based RFID, Properties of Backscatter RF Systems, Modulation techniques, Frequency based property, Comparison of RFID Systems; Automatic identification Systems - Barcode, OCR, Biometric Procedure, Smart Card, RFID system, Comparison; Differentiation features - Fundamental features, Transponders Construction formats, Frequency, range and Coupling, Information Processing, Selection Criteria.

UNIT II	RFID STANDARDS AND PROTOCOLS	9

RFID Industry standards: EPC global - ISO15693 Vicinity cards and RFID - ISO14443 Proximity cards and RFID - The NFC forum; Reading collocated RFID tags; Query Tree protocol - Query Slot protocol.

UNIT III	OPERATING PRINCIPLES	9

RFID Tag components - RFID tag types, the 1-Bit Transponder and Chipless Tags, RFID readers and middleware component; Communication fundamentals -Coupling, Data encoding, multi-path effect , Tag Reader and sensor communication.

UNIT IV	DATA INTEGRITY AND SECURITY	9

The checksum procedure - LRC, CRC; Multi-access procedures - SDMA, FDMA and TDMA; Attacks on RFID Systems - Protection by Cryptographic measures; Data Security - Mutual symmetrical authentication, Authentication with derived Keys, Encrypted data transfer.

UNIT V	RFID ENABLED SENSORS AND APPLICATIONS	9

RFID enabled Sensors: Antenna design challenges - IC design - Integration of sensors and RFID - Power consumption and Link budget. Applications - Contactless smart cards, Access control, Electronic passport, Industrial Automation, Medical applications, Challenges and opportunities.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	elucidate the fundamentals of RFID communication.	Understanding (K2)
CO2	describe RFID standards and protocols for system interoperability.	Understanding (K2)
CO3	explain the operating principles of RFID tags, readers, and middleware.	Understanding (K2)
CO4	analyze data integrity and security mechanisms in RFID.	Analyzing (K4)
CO5	interpret the applications of RFID-enabled sensors in various industries.	Understanding (K2)

TEXT BOOKS

1. Roy Want, "RFID Explained", Springer, 2022.
2. Amin Rida, Li Yang, Manos M. Tentzeris, "RFID Enabled Sensor Design and Applications", Artech House, 2010.

REFERENCES

1. Klaus Finkenzeller, "RFID Handbook", 3rd Edition, Wiley, 2010.
2. Syed Ahson, Mohammad Ilyas, "RFID Handbook", CRC Press, 2008.
3. Paris Kitsos, "Security in RFID and Sensor Networks", CRC Press, 2016.
4. V. Daniel Hunt, Albert Puglia, Mike Puglia, "RFID: A Guide to Radio Frequency Identification Hardcover", 1st Edition, Wiley, 2007.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	1
CO2	3	-	3	2	3	-	-	-	-	-	-	-	-	-
CO3	3	-	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	3	-	-	-	3	3	-
CO5	3	-	-	-	-	-	-	3	-	-	-	3	-	3

EC23457	EMI/EMC IN SYSTEM DESIGN	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	identify the various types and mechanisms of electromagnetic interference.
2.	find solution to EMI problems in PCB level / subsystem and system level design.
3.	realize the different types of shielding and grounding methods.
4.	understand the different types of EMI/EMC measurement techniques.
5.	be familiar with EMC Standards and Regulations.

UNIT I	EMI/EMC CONCEPTS	9

EMI/EMC Concepts Definition of EMI and EMC with examples, Classification of EMI/EMC - CE, RE, CS, RS, Units of Parameters, Sources of EMI, EMI coupling modes - CM and DM, ESD Phenomena and effects, Transient phenomena and suppression.

UNIT II	EMI COUPLING MECHANISMS	9

Classification of Coupling Mechanisms - Conductive coupling, Capacitive coupling, Inductive coupling and Radiated coupling; Conductive coupling - Common mode Conductive coupling, Differential-mode conduction; Near field cable to cable coupling; Field to cable coupling; Power mains and Power supply coupling.

UNIT III	EMI CONTROL METHODS AND FIXES	9

Working principle of Shielding and Murphy's Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketting and sealing, PCB Level shielding; Principle of Grounding - Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems; Filter types and operation - Surge protection devices, Transient protection; Isolation transformer.

UNIT IV	EMI MEASUREMENTS	

Basic principles of RE, CE, RS and CS measurements, EMI measuring instruments- Antennas, LISN, Feed through capacitor, current probe, EMC analyzer and detection technique open area site, shielded anechoic chamber, TEM cell.

UNIT V	EMC STANDARDS AND REGULATIONS	9

Need for Standards, Generic/General Standards for Residential and Industrial environment, Basic Standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, ACEC. Electro Magnetic Emission and susceptibility standards and specifications; Military standards -MIL STD 461D/462.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	classify various types and mechanisms of electromagnetic interference.	Understanding (K2)
CO2	illustrate EMI control and mitigation techniques.	Applying (K3)
CO3	use appropriate shielding, grounding and filtering methods for EMI/EMC compliance.	Analyzing (K4)
CO4	choose appropriate measuring techniques.	Applying (K3)
CO5	interpret EMC techniques based on standards and regulations.	Understanding (K2)

TEXT BOOKS

1. V Prasad Kodali, "Engineering Electromagnetic Compatibility", IEEE Press, New York, 2001.
2. Henry W. Ott, "Electromagnetic Compatibility Engineering", John Wiley & Sons, 2009.

REFERENCES

1. Clayton Paul, "Introduction to Electromagnetic Compatibility", Wiley Inter science, 2006.
2. W Scott Bennett, "Control and Measurement of Unintentional Electromagnetic Radiation", John Wiley & Sons Inc., 1997.
3. Daryl Gerke and William Kimmel, "EDN's Designer's Guide to Electromagnetic Compatibility", Elsevier Science & Technology Books, 2002.
4. C.R.Paul, "Introduction to Electromagnetic Compatibility", John Wiley and Sons, Inc, 2006.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	1	1
CO2	3	1	-	-	-	-	-	-	-	-	-	-	1	1
CO3	3	1	-	-	-	-	-	-	-	-	-	-	1	1
CO4	3	1	-	-	-	-	-	-	-	-	-	-	1	1
CO5	3	1	-	-	-	-	-	-	-	-	-	-	1	1

EC23551	DISPLAY TECHNOLOGIES	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	know the fundamentals of eye.
2.	acquire knowledge of various LCD technologies.
3.	understand the working of LED displays.
4.	determine the relation between the various 3-D technologies.
5.	gain knowledge the operation of micro displays.

UNIT I	FUNDAMENTAL OPTICS AND HUMAN VISION	9

Properties of Light, Geometric Optics, Optical Modulation - Magneto-optic Modulators, Acousto-optic modulators, Electro-optic modulators; Vision and Perception - Anatomy of Eye, Light Detection and Sensitivity, Visual Acuity, Flicker Sensitivity, Spatial Vision and Pattern Perception, Binocuolar Vision and Depth Perception.

UNIT II	LIQUID CRYSTAL DISPLAY	9

Display Glasses, Inorganic Semiconductor TFT Technology, Organic TFT Technology; Transparent Conductors, Liquid Crystal Displays - Properties of Liquid Crystals, LCD Device Technology; Twisted Numeric and Super twisted Numeric Displays.

UNIT III	ADVANCED LED DISPLAYS	9

Cathode Ray Tubes, Displays - Vacuum Florescent Displays, Filed Emission Displays; Plasma Display Panels, LED Display Panels; OLEDs, Active Matrix for OLED Displays.

UNIT IV	3-D TECHNOLOGY	9

3-D Displays; 3-D Cinema Technology, Auto stereoscopic 3-D Technology, Volumetric and 3-D Volumetric Display Technology, Holographic 3-D Technology; Mobile Displays - Trans reflective Displays for Mobile Devices, Energy Aspects of Mobile Display Technology.

UNIT V	MICRO DISPLAYS	9

DLP Projection Technology; Micro-display Applications - Projection Systems, Head Worn Displays; Electronic View Finders, Display Metrology.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of the course, the students will be able to		BT MAPPED (Highest Level)
CO1	describe fundamentals of optics and human vision.	Understanding (K2)
CO2	identify the types, construction and working of LCD display.	Understanding (K2)
CO3	Infer LED/OLED/plasma displays	Analyzing (K4)
CO4	compare 3-D display technologies	Analyzing (K4)
CO5	illustrate micro-display principles and applications	Applying (K3)

TEXT BOOKS

1. Janglin Chen, Wayne Cranton, Mark Fihn, "Handbook of Visual Display technology", Springer Publication, 2012.
2. Shoichi Matsumoto, "Electronic Display Devices", Wiley, 1990.

REFERENCES

1. Jacques I. Pankove, D.J. Channin, "Display Devices", Springer Berlin Heidelberg, 2014.
2. Joseph Castellano, "Handbook of Display Technology" 1st Edition, 2012.
3. R.R.Gulati, "Monochrome & Color Television", New Age International Publisher, 2003.
4. A.M.Dhake, "TV and Video Engineering", Tata McGraw-Hill Education, 1999.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO3	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO4	3	2	-	-	-	-	-	-	-	-	-	2	2	2
CO5	3	2	-	-	-	-	-	-	-	-	-	2	2	2

EC23552	WEARABLE DEVICES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. learn the fundamentals of sensors.
2. understand signal processing association in wearable systems.
3. get knowledge about various energy needs in wearable devices.
4. be familiar with wireless health systems.
5. know the applications of wearable devices.

UNIT I SENSORS — **9**

Need for wearable systems - Sensors for wearable systems, Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, Pneumography; Wearable ground reaction force sensor - GSR, Radiant thermal sensor, Wearable motion sensors, CMOS Based Biosensors; E-Textiles; Bio compatibility.

UNIT II SENSOR SIGNAL PROCESSING — **9**

Wearability issues - Physical shape and placement of sensor; Technical challenges - Sensor design, Signal acquisition, Constraint on sampling frequency for reduced energy consumption; Lightweight signal processing, Rejection of irrelevant information, Data mining.

UNIT III ENERGY HARVESTING FOR WEARABLE DEVICES — **9**

Solar cell; Vibration based; Thermal based; Human body as a heat source for power generation; Hybrid thermoelectric photovoltaic energy harvests; Thermopiles.

UNIT IV 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 V APPLICATIONS OF WEARABLE SYSTEMS — **9**

Medical Diagnostics; Medical Monitoring - Patients with chronic disease, Hospital patients, Elderly patients; Multi-parameter monitoring - Neural recording, Gait analysis, Sports Medicine, Smart Fabrics.

TOTAL PERIODS — **45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	explain the fundamentals aspects of sensors in wearable systems.	Understanding (K2)
CO2	analyze signal processing requirements and constraints.	Analyzing (K4)
CO3	categorize the energy requirement for a wearable system.	Analyzing (K4)
CO4	compare the security issues related to wearable systems.	Analyzing (K4)
CO5	demonstrate the wearable system applications.	Applying (K3)

TEXT BOOKS

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.
2. Sandeep K.S. Gupta, Tridib Mukherjee, Krishna Kumar Venkata Subramanian, "Body Area Networks: Safety, Security, and Sustainability", Cambridge University Press, 2013.

REFERENCES

1. Hang, Yuan-Ting, "Wearable Medical Sensors and Systems", Springer, 2013.
2. Mehmet R. Yuce, Jamil Y. Khan, "Wireless Body Area Networks: Technology, Implementation and Applications", Pan Stanford Publishing Pvt. Ltd., Singapore, 2012.
3. Guang-Zhong Yang , "Body Sensor Networks", Springer, 2006.
4. Andreas Lymberis, Danilo de Rossi, "Wearable eHealth Systems for Personalized Health Management - State of the Art and Future Challenges", IOS Press, The Netherlands, 2004.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO2	3	3	-	-	-	-	-	-	-	2	-	2	3	2
CO3	3	3	-	-	-	-	-	-	-	2	-	2	3	3
CO4	3	3	-	-	-	-	-	1	-	2	1	2	3	3
CO5	3	3	-	-	-	-	-	2	-	2	1	2	3	3

EC23553	SENSORS AND TRANSDUCERS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. understand the measurement process.
2. learn about various distance measurement sensors.
3. infer about the sensors used to measure various physical parameters.
4. know the concepts of optical, pressure and temperature sensor.
5. study the fundamentals of signal conditioning, data acquisition and communication systems.

UNIT I CLASSIFICATION OF SENSORS — 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 Output Signal Types.

UNIT II MOTION, PROXIMITY AND RANGING SENSORS — 9

Motion Sensors - Potentiometers, Resolver, Encoders, Optical, Magnetic, Inductive, Capacitive, LVDT, RVDT - Synchro - Microsyn, Accelerometer; GPS, Bluetooth, Range Sensors - RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR).

UNIT III FORCE, MAGNETIC AND HEADING SENSORS — 9

Strain Gage, Load Cell, Magnetic Sensors types, principle, requirement and advantages; Magneto resistive Hall Effect; Current sensor Heading Sensors - Compass, Gyroscope, Inclinometers.

UNIT IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS — 9

Photo conductive cell, photo voltaic, Photo resistive, LDR, Fiber optic sensors, Pressure, Diaphragm, Bellows, Piezoelectric - Tactile sensors, Temperature - IC, Thermistor, RTD, Thermocouple; Acoustic Sensors - flow and level measurement; Radiation Sensors; Smart Sensors; Film sensor; MEMS and Nano Sensors; LASER sensors.

UNIT V SIGNAL CONDITIONING AND DAQ SYSTEMS — 9

Amplification; filtering; sample and hold circuits; data acquisition-single channel and multi-channel data acquisition; data logging - applications, automobile, aerospace, home appliances, manufacturing, Environmental monitoring.

TOTAL PERIODS — 45

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	explain the measurement systems and sensor calibration techniques.	Understanding (K2)
CO2	analyze the principles of motion, proximity and ranging sensors.	Analyzing (K4)
CO3	compare the working principles of force, magnetic and heading sensors.	Analyzing (K4)
CO4	describe the operation of optical, pressure, temperature and smart sensors.	Understanding (K2)

CO5	illustrate the fundamentals of signal conditioning, data acquisition systems, and their applications.	Understanding (K2)

TEXT BOOKS

1. Ernest O Doebelin, "Measurement Systems - Applications and Design", Tata McGraw-Hill, 2009.
2. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12th Edition, Dhanpat Rai & Co, New Delhi, 2013.

REFERENCES

1. Patranabis D, "Sensors and Transducers", 2nd Edition, Prentice Hall India, 2015
2. John Turner and Martyn Hill, "Instrumentation for Engineers and Scientists", Oxford Science Publications, 1999.
3. Richard Zurawski,"Industrial Communication Technology Handbook", 2nd Edition, CRC Press, 2015.
4. Ian Sinclair, "Sensors and Transducers", 3rd Edition, Newnes, 2001.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
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CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	2
CO4	2	2	-	-	-	-	-	-	-	2	-	-	2	2
CO5	3	2	-	-	-	-	-	-	-	2	-	-	2	2

EC23554	VIRTUAL REALITY AND AUGMENTED REALITY	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. be familiar with the fundamental aspects of AR/VR technologies.
2. know the VR Modeling enabled applications.
3. learn about the VR programming.
4. gain knowledge about AR/VR application development.
5. Study the concepts of Augmented reality.

UNIT I INTRODUCTION **9**

Introduction to Virtual Reality and Augmented Reality - Definition - Introduction to Trajectories and Hybrid Space; Three I's of Virtual Reality - Virtual Reality vs 3D Computer Graphics - Benefits of Virtual Reality; Components of VR System - Introduction to AR-AR Technologies-Input Devices - 3D Position Trackers - Types of Trackers; Navigation and Manipulation Interfaces - Gesture Interfaces - Types of Gesture Input Devices - Output Devices - Graphics Display - Human Visual System - Personal Graphics Displays - Large Volume Displays - Sound Displays - Human Auditory System.

UNIT II VR MODELING **9**

Modeling - Geometric Modeling - Virtual Object Shape - Object Visual Appearance - Kinematics Modeling - Transformation Matrices - Object Position - Transformation Invariants - Object Hierarchies - Viewing the 3D World - Physical Modeling - Collision Detection - Surface Deformation - Force Computation - Force Smoothing and Mapping - Behavior Modeling - Model Management.

UNIT III VR PROGRAMMING **9**

VR Programming - Key Concepts, Toolkits and Scene Graphs-Definition, Functionality, Benefits, Examples, World ToolKit - Definition, Open Scene Graph, World kit by Unity Technologies, Java 3D; Comparison of World ToolKit and Java 3D-Definition.

UNIT IV APPLICATIONS **9**

Human Factors in VR - Methodology and Terminology - VR Health and Safety Issues - VR and Society-Medical Applications of VR - Education, Arts and Entertainment - Military VR Applications - Emerging Applications of VR - VR Applications in Manufacturing - Applications of VR in Robotics - Information Visualization - VR in Business - VR in Entertainment - VR in Education.

UNIT V AUGMENTED REALITY **9**

Introduction to Augmented Reality - Computer vision for AR – Interaction, Modeling and Annotation, Navigation, Wearable devices.

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the principles of virtual reality and augmented reality technologies.	Understanding (K2)
CO2	apply modeling techniques in virtual environments.	Applying (K3)
CO3	illustrate simple AR/VR applications using programming tools and scene graph toolkits.	Understanding (K2)
CO4	analyze the human factors, safety, and societal implications of VR applications.	Analyzing (K4)
CO5	describe computer vision techniques, interaction methods and wearable technologies involved in AR systems.	Understanding (K2)

TEXT BOOKS

1. Charles Palmer, John Williamson, "Virtual Reality Blueprints: Create compelling VR experiences for mobile", Packt Publisher, 2018.
2. Dieter Schmalstieg, Tobias Hollerer, "Augmented Reality: Principles & Practice", Addison Wesley, 2016.

REFERENCES

1. John Vince, "Introduction to Virtual Reality", Springer-Verlag, 2004.
2. William R. Sherman, Alan B. Craig: Understanding Virtual Reality - Interface, Application, Design", Morgan Kaufmann, 2003.
3. Bernhard Jung, Paul Grimm, Ralf Doerner, Wolfgang Broll , "Virtual and Augmented Reality (VR/AR) Foundations and Methods of Extended Realities (XR)", Springer International Publishing, 2022.
4. M. Claudia tom Dieck, Timothy Jung, Augmented Reality and Virtual Reality The Power of AR and VR for Business, 2019.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

Cos	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	1	1	2
CO2	3	2	2	-	-	-	-	-	-	-	-	1	2	2
CO3	3	2	2	-	-	-	-	-	-	-	-	1	2	2
CO4	3	2	2	-	-	-	-	-	-	-	-	1	2	2
CO5	3	2	2	-	-	-	-	-	-	-	-	1	2	2

EC23555	IOT BASED SYSTEM DESIGN	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	learn the basics of IoT.
2.	get knowledge about the various services provided by IoT.
3.	familiarize themselves with various communication techniques and networking.
4.	know the implementation of IoT with different tools.
5.	study the various applications in IoT.

UNIT I	INTRODUCTION TO INTERNET OF THINGS	9

Rise of the machines - Evolution of IoT - Web 3.0 view of IoT - Definition and characteristics of IoT- IoT Enabling Technologies - IoT Architecture - Fog, Edge and Cloud in IoT - Functional blocks of an IoT ecosystem - Sensors, Actuators, Smart Objects and Connecting Smart Objects - IoT levels and deployment templates - A panoramic view of IoT applications.

UNIT II	MIDDLEWARE AND PROTOCOLS OF IOT	9

Middleware technologies for IoT system (IoT Ecosystem Overview – Horizontal Architecture Approach for IoT Systems - SOA based IoT Middleware) Middleware architecture of RFID, WSN, SCADA, M2M - Interoperability challenges of IoT-Protocols for RFID, WSN, SCADA, M2M- Zigbee, KNX, BACNet, MODBUS - Challenges Introduced by 5G in IoT Middleware(Technological Requirements of 5G Systems - Perspectives and a Middleware Approach Toward 5G (COMPaaS Middleware) - Resource management in IoT.

UNIT III	COMMUNICATION AND NETWORKING	9

IoT Access Technologies: Physical and MAC layers, topology and Security of IEEE 802.15.4, 802.15.4g, 802.15.4e, 1901.2a, 802.11ah and LoRaWAN - Network Layer: IP versions, Constrained Nodes and Constrained Networks - Optimizing IP for IoT: From 6LoWPAN to 6Lo, Routing over Low Power and Lossy Networks - Application Transport Methods: Supervisory Control and Data Acquisition - Application Layer Protocols: CoAP and MQTT - Data aggregation & dissemination.

UNIT IV	IOT IMPLEMENTATION TOOLS	9

Introduction to Python, Introduction to different IoT tools, Developing applications through IoT tools, Developing sensor based application through embedded system platform, Implementing IoT concepts with python, Implementation of IoT with Raspberry Pi.

UNIT V	APPLICATIONS AND CASE STUDIES	9

Home automations; Smart cities; Environment; Energy; Retail; Logistics; Agriculture; Industry; Health and life style.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	articulate the main concepts, key technologies, strength and limitations of IoT.	Understanding (K2)
CO2	identify the architecture, infrastructure models of IoT.	Understanding (K2)
CO3	analyze the networking and how the sensors are communicated in IoT .	Analyzing (K4)
CO4	analyze and design different models for IoT implementation.	Analyzing (K4)
CO5	identify and design the new models for market strategic interaction.	Understanding (K2)

TEXT BOOKS

1. Honbo Zhou, "Internet of Things in the cloud:A middleware perspective", CRC press, 2012
2. Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-onApproach)", VPT, 1st Edition, 2014.

REFERENCES

1. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press, 2017.
2. Constandinos X. Mavromoustakis, George Mastorakis, Jordi MongayBatalla, "Internet of Things (IoT) in 5G Mobile Technologies" Springer International Publishing Switzerland, 2016.
3. Dieter Uckelmann, Mark Harrison, Florian Michahelles, "Architecting the Internet of Things" Springer-Verlag Berlin Heidelberg, 2011.
4. Kai Hwang, Min Chen, "Big-Data Analytics for Cloud, IoT and Cognitive Computing", Wiley, 2018

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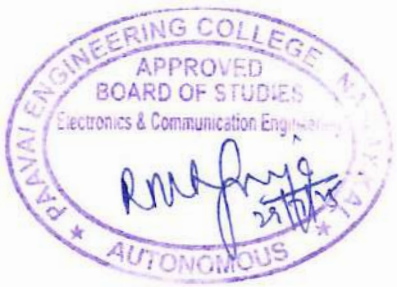
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	1
CO2	3	2	-	-	-	-	-	-	-	-	-	-	3	1
CO3	3	2	-	-	-	-	-	-	-	-	-	-	3	1
CO4	3	2	-	-	-	-	-	-	-	-	-	-	3	1
CO5	3	2	-	-	-	-	-	-	-	-	-	-	3	1



EC23556	INDUSTRIAL IOT AND INDUSTRY 4.0	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. learn IoT Nodes & Sensors.
2. get knowledge about IoT Gateways.
3. know the controlling hardware and sensors.
4. get acquire knowledge about IoT Cloud development platform.
5. study the challenges in IoT system Design - Hardware & Software.

UNIT I	UNDERSTANDING IOT CONCEPT AND DEVELOPMENT PLATFORM	9

IOT Definition, Importance of IoT, Applications of IOT, IoT architecture, Understanding working of Sensors, Actuators, Sensor calibration, Study of Different sensors and their characteristics

UNIT II	ANALYZING & DECODING OF COMMUNICATION PROTOCOL USED IN IOT DEVELOPMENT PLATFORM	9

UART Communication Protocol, I2C Protocol device interfacing and decoding of signal, SPI Protocol device interfacing and decoding of signal, WIFI and Router interfacing, Ethernet Configuration, Bluetooth study and analysis of data flow, Zigbee Interfacing and study of signal flow

UNIT III	IOT PHYSICAL DEVICES AND ENDPOINTS, CONTROLLING HARDWARE AND SENSORS	9

IoT Physical Devices and Endpoints- Introduction to Arduino and Raspberry Pi- Installation, Interfaces (serial, SPI, I2C), Programming - Python program with Raspberry PI with focus on interfacing external gadgets, controlling output, reading input from pins.

Controlling Hardware- Connecting LED, Buzzer, Switching High Power devices with transistors, Controlling AC Power devices with Relays, Controlling servo motor, speed control of DC Motor, unipolar and bipolar Stepper motors; Sensors- Light sensor, temperature sensor with thermistor, voltage sensor, ADC and DAC, Temperature and Humidity Sensor DHT11, Motion Detection Sensors, Wireless Bluetooth Sensors, Level Sensors, USB Sensors, Embedded Sensors, Distance Measurement with ultrasound sensor.

UNIT IV	CLOUD SERVICES USED IN IOT DEVELOPMENT PLATFORM	9

Configuration of the cloud platform, Sending data from the IOT nodes to the gateways using different communication options; Transferring data from gateway to the cloud; Exploring the web services like mail, Messaging (SMS) and Twitter etc.;Tracking of cloud data as per the requirement; Google Cloud service architect; AWS cloud Services architect; Microsoft Azure cloud services Architect; OEN source Cloud Services; Initial State Iot Dashboard & Cloud Services.

UNIT V	CHALLENGES IN IOT SYSTEM DESIGN – HARDWARE & SOFTWARE	9
Antenna design and placement, Chip-package system development, Power electronics, electromagnetic interference/compatibility (EMI/EMC), Electronics reliability; Battery simulation.		
	TOTAL PERIODS	**45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	understand the building blocks of IoT technology.	Understanding (K2)
CO2	use processors and peripherals to design IoT hardware.	Applying (K3)
CO3	explain the assess, select and customize technologies for IoT applications.	Understanding (K2)
CO4	describe IOT applications and real life problem solving.	Understanding (K2)
CO5	elucidate challenges in IOT system design.	Understanding (K2)

TEXT BOOKS

1. Arshdeep Bahga and Vijay Madisetti, "Internet of Things - A Hands-on Approach", Universities Press, 2015.
2. Matt Richardson & Shawn Wallace, "Getting Started with Raspberry Pi", O'Reilly (SPD), 2014.

REFERENCES

1. Simon Monk, O'Reilly, "Raspberry Pi Cookbook, Software and Hardware Problems and solutions", 2016.
2. N. Ida, Sensors, "Actuators and Their Interfaces", SciTech Publishers, 2014.
3. Peter Waher, "Learning Internet of Things", Packt Publishing, 2015.
4. Kai Hwang, Min Chen, "Big-Data Analytics for Cloud, IoT and Cognitive Computing", Wiley, 2018

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CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	2
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO4	3	3	-	-	-	-	-	-	-	-	-	-	3	3
CO5	3	3	-	-	-	-	-	-	-	-	-	-	3	3

EC23557	INTELLIGENT BLOCKCHAIN TECHNOLOGIES IN IOT	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	understand the fundamentals of IoT architecture and its challenges.
2.	learn blockchain principles and their integration into IoT.
3.	explore smart contracts and decentralized IoT applications.
4.	be familiar AI/ML-based intelligent decision-making in IoT blockchain systems.
5.	study real-world applications and security challenges in IoT-blockchain convergence..

UNIT I	INTRODUCTION TO IoT AND BLOCKCHAIN	9

Blockchain Basics: Blocks, transactions, hash functions - Need for Blockchain in IoT - Types of Blockchains: Public, Private, Consortium - Limitations of centralized IoT systems - Use-case-driven motivation.

UNIT II	BLOCKCHAIN MECHANISMS FOR IoT	9

Blockchain architecture in IoT - Consensus algorithms: PoW, PoS, PBFT, PoET- Data integrity, immutability, and transparency - Sensor data logging on blockchain - IoT data privacy and identity management with blockchain.

UNIT III	INTELLIGENCE IN BLOCKCHAIN-ENABLED IoT SYSTEMS	9

AI/ML in IoT data analytics -Intelligent contract-based automation - Edge computing with AI for latency reduction - Federated learning for privacy-preserving AI - Event prediction and anomaly detection using blockchain-stored data.

UNIT IV	ENERGY, COMMUNICATION & SECURITY CHALLENGES	9

Lightweight blockchain models for constrained IoT - Resource optimization and scalability - Wireless communication protocols (LoRaWAN, NB-IoT, BLE) - Blockchain security: Attacks, mitigation strategies - Security in smart contracts and oracles.

UNIT V	APPLICATIONS AND CASE STUDIES	9

Smart Cities, Smart Homes; Supply Chain Management (with traceability); Healthcare and wearable monitoring; Industrial IoT (IIoT); Agriculture and environment monitoring; Future trends - Web3, Interoperable blockchain systems.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain IOT architecture and blockchain fundamentals.	Understanding (K2)
CO2	analyze consensus mechanisms and blockchain integration in IOT.	Analyzing (K4)
CO3	apply AI/ML techniques for decision-making in blockchain-based IOT.	Applying (K3)
CO4	infer communication and security challenges in iot–blockchain systems.	Analyzing (K4)
CO5	elucidate real-world applications and future trends of blockchain in IOT	Understanding (K2)

TEXT BOOKS

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-On Approach", VPT, 2014.
2. Salman A. Baset et al., "Blockchain Applications in IoT", Springer, 2020.

REFERENCES

1. Joseph Bambara, Paul Allen, "Blockchain: A Practical Guide to Developing Business, Law, and Technology Solutions", McGraw Hill, 2018.
2. Mahmoud Elkhodr et al., "The Internet of Things: Secure Blockchain Technologies and Privacy Considerations", Wiley, 2022.
3. S. Nakamoto, "Bitcoin Whitepaper", 2008.
4. Imran Bashir, "Mastering Blockchain", 3rd Edition, Packt Publishing, 2021.

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COs	PO's												PSO's	
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CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO2	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO4	3	2	-	-	-	-	-	-	-	-	-	-	3	2
CO5	3	2	-	-	-	-	-	-	-	-	-	-	3	2

EC23651	MEDICAL ELECTRONICS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. know the basic methods of bio potential signal recording.
2. get knowledge on biochemical and non-electrical parameter measurement systems.
3. learn about various assistive medical devices and their functions.
4. study biotelemetry systems and their role.
5. gain insights into recent trends in healthcare.

UNIT I **ELECTRO-PHYSIOLOGY AND BIOPOTENTIAL RECORDING** **9**

Origin of bio-potentials, Bio-potential electrodes - Types; Bio amplifiers-Differential Amplifiers, Isolation Amplifiers; Electrocardiography, Electroencephalography, Electromyography, Phonocardiogram - Lead systems and recording methods.

UNIT II **BIO-CHEMICAL AND NON-ELECTRICAL PARAMETER MEASUREMENT** **9**

pH of Blood, PH, PO_2 and PCO_2 measurement, Colorimeter; Auto Analyzer, Blood flow meter; Cardiac output-Ficks Method, Indicator Dilution Method, Thermo Dilution Method, Measurement of Cardiac Output by Impedance Change; Respiratory measurement; Blood pressure, Temperature, Pulse rate, Blood cell counters.

UNIT III **CARDIAC ASSIST DEVICES** **9**

Cardiac pacemakers - Need, Components, Internal and External Pacemakers, Pacing modes; Ventilators - Classifications; DC defibrillators - Asynchronous and Synchronous Defibrillator.

UNIT IV **DIATHERMY AND BIOTELEMETRY** **9**

Diathermies - Shortwave, Ultrasonic, and Microwave type Diathermies, Applications; Surgical Diathermy; Telemetry Principles, Frequency Selection, Biotelemetry; Electrical Safety; AI-Assisted Biotelemetry Monitoring and Predictive Analytics.

UNIT V **RECENT TRENDS IN MEDICAL ELECTRONICS** **9**

Thermography - Principle; Endoscopy Unit; Radio Pill; Applications of Laser in Medicine, Cryogenic Application, Telemedicine; Refractometer; Audiometer; AI in Diagnostics Equipment.

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	describe the origin of bio-potentials and signal acquisition.	Understanding (K2)
CO2	demonstrate measurement techniques of physiological parameters.	Applying (K3)
CO3	interpret the working and design considerations of cardiac assist devices .	Understanding (K2)
CO4	elucidate biotelemetry systems.	Understanding (K2)
CO5	discuss about the recent trends in medical field.	Understanding (K2)

TEXT BOOKS

1. R.S. Khandpur, "Handbook of Biomedical Instrumentation", 3rd Edition, McGraw Hill, 2014.
2. John G. Webster, "Medical Instrumentation: Application and Design", 4th Edition, Wiley, 2009.

REFERENCES

1. Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, "Biomedical Instrumentation and Measurements", Pearson Education, 2nd Edition, 2011.
2. John G. Webster , "Bioinstrumentation", John Wiley & Sons (Asia), 2008
3. Olga Korostynska, Alex Mason, "Wearable and Wireless Systems for Healthcare IOT Applications", CRC Press, 2021.
4. Basma Abdulrazak, "Wireless Telemedicine Systems", Springer, 2015.

CO-PO MAPPING :

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COs	PO's												PSO's	
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CO2	3	3	-	-	-	-	-	-	-	-	-	1	3	-
CO3	3	2	-	-	-	-	-	-	-	-	-	2	3	2
CO4	2	2	-	-	-	-	-	-	-	-	-	3	2	3
CO5	2	3	-	-	-	-	-	-	-	-	-	3	2	3

EC23652	INTERNET OF MEDICAL THINGS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	learn the integration of IoT with medical and healthcare systems.
2.	be familiar with sensors, devices, and communication protocols.
3.	know the privacy, and security aspects of IoMT.
4.	study the concepts of medical data transmission.
5.	gain knowledge about simple IoMT applications.

UNIT I	INTRODUCTION TO IOMT	9
IoMT Devices, IoMT System Architecture, IoMT Attack Types, Challenges in IoMT Security Schemes.		

UNIT II	HEALTH CARE SCHEMA FOR REMOTE PATIENT MONITORING	9
Intelligent Transit Health care Schema: Vibration Sensing Methodology for Accident Detection, System Safeguards, GPS Integration, Hospital Communication about Accident Location, MCU Connection with the ITH - IoMT Subsystem.		

UNIT III	PROTECTING THE IOT BASED HEALTH RECORDS USING BLOCK CHAIN TECHNOLOGY	9
Introduction, Block Chain - Advantages and Challenges, Proposed Models: Personal Health Data Collection, Configuring Raspberry Pi Access Point (RAP), Virtual Private Server (VPS) based Hyperledger Fabric Framework.		

UNIT IV	MEDICAL DATA COMPRESSION FOR LOSELESS DATA TRANSMISSION	9
Introduction - Definition, Significance and Benefits; Characteristics of Data Acquisition and Storage; Entropy Coding, Coding Scheme for Loss-less Data Transmission.		

UNIT V	SMART HEALTHCARE SYSTEM APPLICATIONS	9
Internet of Medical Things Applications; Architectures and Challenges in Smart Healthcare Systems; Implementation of IoMT in hospitals and clinics, Remote patient monitoring systems, Smart wearable devices for health tracking.		

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	explain the system architecture of IoMT .	Understanding (K2)
CO2	compare IoMT-based remote healthcare systems.	Analyzing (K4)

CO3	apply blockchain frameworks for secure storage .	Applying (K3)
CO4	describe medical data compression techniques.	Understanding (K2)
CO5	demonstrate IoMT applications.	Understanding (K2)

TEXT BOOKS

1. D.Jude Hemanth, J.Anitha, George A.Tsihrintzis, "Internet of Medical Things", Springer, 2021.
2. RajkumarBuyya, Amir Vahid Dastjerdi, "Internet of Things: Principles and Paradigms", Morgan Kaufmann, 2016.

REFERENCES

1. Arsalan Shahid, "Internet of Medical Things (IoMT): Frameworks and Applications", CRC Press, 2022.
2. Nilanjan Dey, Amira S. Ashour, "Medical Internet of Things: Techniques, Practices and Applications", Springer, 2021.
3. Gigi Beltrame, Luca Benini, "Designing Embedded Systems for Medical Applications", Springer, 2022.
4. Bharat Rawal, "Cybersecurity and Privacy in Cyber Physical Systems", Springer, 2019.

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CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO3	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO4	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO5	3	2	-	-	-	-	-	-	-	-	-	-	1	1

EC23653	MEASUREMENTS AND INSTRUMENTATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	acquire knowledge about the basics of measurements.
2.	study the principle of Transducers.
3.	know the process of signal analyzers.
4.	learn the working of the digital measurement equipment.
5.	be familiar with data recording and display systems.

UNIT I	SCIENCE OF MEASUREMENT	9

Measurement System; Instrumentation; Characteristics of measurement systems - Static and Dynamic, Errors in Measurements, Calibration and Standards.

UNIT II	TRANSDUCERS	9

Classification of Transducers - Variable Resistive transducers, Strain gauges, Thermistor, RTD; Variable Inductive transducers - LVDT, RVDT; Variable Capacitive Transducers - Capacitor microphone, Photoelectric transducers, Piezoelectric transducers, Thermocouple-IC; Sensors - Fibre optic sensors, Smart/intelligent sensors.

UNIT III	SIGNAL ANALYZERS	9

DC and AC bridges - Wheatstone, Kelvin, Maxwell, Hay and Schering; Pre-amplifier; Isolation amplifier; Filters; Data acquisition systems; Spectrum Analyzers - Wave analyzers, Logic analyzers.

UNIT IV	DIGITAL INSTRUMENTS	9

Digital Voltmeters - Millimeters, Automation in Voltmeter, Accuracy and Resolution in DVM; Guarding techniques - Frequency counter, Data Loggers; Introduction to IEEE488/GPIB Buses.

UNIT V	DATA DISPLAY RECORDING AND SYSTEMS	9

Dual trace CRO - Digital storage and Analog storage oscilloscope; Analog and Digital Recorders and printers; Virtual Instrumentation - Block diagram and architecture, Applications in various fields;

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	discuss about the principles of various measurement techniques.	Understanding (K2)
CO2	describe the transducers and its impact.	Understanding (K2)
CO3	explain about the working of signal analyzers.	Applying (K3)
CO4	illustrate the digital measurement equipment.	Applying (K3)
CO5	emphasize the need for data acquisition, recording and display systems.	Understanding (K2)

TEXT BOOKS

1. Albert D.Helfrick and William D.Cooper, "Modern Electronic Instrumentation and Measurement Techniques", Prentice Hall of India, 2008.
2. Ernesto Doebelin and Dhanesh N Manik, "Measurement Systems", 5th Edition, McGraw-Hill, 2007.

REFERENCES

1. Robert B. Northrop, "Introduction to Instrumentation and Measurements", 3rd Edition, CRC Press, 2014.
2. Alan S. Morris, "Principles of measurement and instrumentation", Prentice Hall, 2007.
3. Alan S. Morris, Reza Langari, "Measurement and Instrumentation- Theory and Application", 3rd Edition, Elsevier, 2020.
4. Sawney A K and Puneet Sawney, "A Course in Mechanical Measurements and Instrumentation and Control", 12th Edition, Dhanpat Rai & Co, New Delhi, 2013.

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CO3	3	3	-	-	-	-	-	-	-	-	-	-	2	1
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	1
CO5	3	3	-	-	-	-	-	-	-	-	-	-	2	1

EC23654	ARTIFICIAL INTELLIGENCE IN HEALTHCARE	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. learn the basics of Artificial Intelligence in Healthcare.
2. understand the methods for disease diagnostics and treatment decisions.
3. know the techniques of Medical Imaging.
4. study the role of AI in assisted surgery.
5. understand the concepts of remote patient monitoring.

UNIT I	INTRODUCTION TO ARTIFICIAL INTELLIGENCE	9

Artificial Intelligence - The new age of healthcare, Precision medicine, Artificial intelligence and medical visualization, Intelligent personal health records; Robotics and artificial intelligence - powered devices, Ambient assisted living; Review of state of Artificial Intelligence in Healthcare, Ethical guidelines for Application of Artificial Intelligence in Healthcare.

UNIT II	DISEASE DIAGNOSTICS AND TREATMENT DECISIONS	9

Machine Learning and Deep learning for disease diagnosis and staging; Artificial intelligence to predict cancer treatment response and cancer recurrence and survival; Alzheimer disease detection; Monitoring of Dementia and Migraine; Neurodevelopmental disorders- ASD and ADHD Detection.

UNIT III	ARTIFICIAL INTELLIGENCE FOR MEDICAL IMAGING	9

Artificial Intelligence in Radiology - Data Augmentation, Transfer Learning; Clinical findings in Radiological Images using Deep learning- RadBot - CXR, Detection of osteoporosis using artificial intelligence, Artificial intelligence in Ultrasound imaging and visualization of Arteries.

UNIT IV	ARTIFICIAL INTELLIGENCE ASSISTED SURGERY	9

Artificial Intelligence in Preoperative diagnosis - Preoperative staging, Intraoperative, Autonomous surgery; Computer vision and Detection of post-operative complications.

UNIT V	REMOTE PATIENT MONITORING USING ARTIFICIAL INTELLIGENCE	9

Remote Patient Monitoring - Sensors, Smart phones, Apps and Devices; Natural language processing - Virtual reality, Augmented reality, Avathar; Chat bot and voice powered virtual assistants - Cardiac monitoring, Diabetes prediction and monitoring.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	discuss about the potential of Artificial Intelligence in Healthcare applications.	Understanding (K2)
CO2	describe the use of Artificial Intelligence in diagnoses.	Understanding (K2)
CO3	relate artificial intelligence for medical imaging applications.	Understanding (K2)
CO4	elucidate the concepts of artificial intelligence assisted surgery.	Understanding (K2)
CO5	demonstrate artificial intelligence algorithms for remote patient monitoring.	Analyzing (K4)

TEXT BOOKS

1. Adam Bohr, Kaveh Memarzadeh, "Artificial Intelligence in Healthcare", Elsevier, 2020.
2. Bernard Nordlinger, Cedric Villani, Daniela Rus, "Healthcare and Artificial Intelligence", Springer, 2020.

REFERENCES

1. Tianhua Chen, Jenny Carter, Mufti Mahmud, Arjab Singh Khuman, "Artificial Intelligence in Healthcare Recent Applications and Developments", Springer, 2022.
2. Kayvan Najarian, Delaram Kahrobaei, Enrique Dominguez, Reza Soroushmehr, "Artificial Intelligence in Healthcare and Medicine", CRC Press, 2022.
3. Chee Peng Lim, Ashlesh Vaidya, Kiran Jain, Virag U, Mahrokar, Lakhmi C Jain, "Handbook of Artificial Intelligence in Healthcare Vol 1- Advances and Applications", Springer, 2022.
4. Basma Abdulrazak, "Wireless Telemedicine Systems", Springer, 2015.

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Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	2	-	-	-	-	-	-	-	-	-	3	2
CO3	3	2	3	-	-	-	-	-	-	-	-	-	3	2
CO4	2	2	2	-	-	-	-	-	-	-	-	-	-	3
CO5	2	2	2	-	-	-	-	-	-	-	-	-	-	3

EC23655	BODY AREA NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. know the basics of BAN Architecture
2. acquire the knowledge about wireless communication technology.
3. learn about the network topology
4. Study various issues in BAN
5. identify the different applications of BAN

UNIT I **INTRODUCTION** **9**

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

UNIT II **HARDWARE FOR BAN** **9**

Wireless communication - RF communication in Body; Antenna design and testing, Matching Network, Propagation, Materials, Base Station, Power considerations, Wireless communication technologies for wearable systems, Body Area Network - Human Applications.

UNIT III **NETWORK TOPOLOGIES, PROTOCOLS AND STANDARDS** **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.

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**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	describe the fundamental architecture, and challenges of Body Area Networks.	Understanding (K2)
CO2	analyze wireless communication technologies and hardware components.	Analyzing (K4)
CO3	explain BAN topologies, protocols and standards.	Understanding (K2)
CO4	elucidate interference, security and regulatory issues in Body Area Networks	Understanding (K2)
CO5	discuss real-time medical and non-medical applications of BAN systems.	Understanding (K2)

TEXT BOOKS

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

REFERENCES

1. Zhang, Yuan-Ting, "Wearable Medical Sensors and Systems'', Springer, 2013
2. Guang-Zhong Yang(Ed.), "Body Sensor Networks'', Springer, 2006.
3. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer, 2011.
4. G. R. Kanagachidambaresan, R. Jayaparvathy, R. Maheswar, Sabu M. Thampi, "Body Area Networks Challenges and solutions", Springer International Publishing, 2018.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 - Strong , 2 - Medium , 1 - Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	-	-	-	-	-	1	1
CO2	3	2	3	-	-	-	-	-	-	-	-	-	1	-
CO3	3	2	3	-	-	-	-	-	-	-	-	-	1	-
CO4	3	3	2	-	-	-	-	-	-	-	-	-	1	-
CO5	3	2	3	-	-	-	-	-	-	-	-	-	1	1

EC23656	HUMAN ASSIST DEVICES	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. be familiar medical assist devices for disabled persons.
2. learn technology for visual Impairments.
3. gain knowledge about technology for Hearing Impairments.
4. know various assist devices for vital organs.
5. study about recent techniques used in clinical applications

UNIT I **ASSISTIVE TECHNOLOGY FOR PHYSICAL IMPAIRMENT** **9**

Basic assessment and evaluation for mobility - Alternative input devises to access computers, Eye gaze system, head tracking system, foot control system; Technology for daily living - wheel chairs types.

UNIT II **ASSISTIVE TECHNOLOGY FOR VISUAL IMPAIRMENT** **9**

Types of visual impairment; Color blindness; Corrective lenses - haptic as a substitute for vision; Mobility Canes - types, Guided Dog, Navigation - GPS; Cochlear implant substitute for vision.

UNIT III **ASSISTIVE TECHNOLOGY FOR HEARING IMPAIRMENT** **9**

Technology for non-aided users; Technology for aided users; Assistive listening system; Alerting devices; Augmentative and alternative methods for hearing impairment - Deafness, Hearing aid - Conventional hearing aid, Digital hearing aid.

UNIT IV **ASSIST DEVICES FOR VITAL ORGANS** **9**

Heart Lung Machine - Conditions; Oxygenators; Functioning and types of artificial heart; Cardiac assist devices - Intra-Aortic Balloon Pump (IABP), Prosthetic Cardiac Valves; Principle of hemodialysis - Dialystate, Wearable artificial kidney and its implantation; Operating principle of Ventilator - Types, Modes.

UNIT V **RECENT TRENDS** **9**

Transcutaneous Electrical Nerve Stimulator - TENS used to treat, TENS Techniques; Bio-Feedback - Procedure, Instrumentation; 3D-printed prosthetics and orthoses; Smart eyewear - Artificial iris; Regulation of software as a medical device; Diagnostic and point-of-care devices.

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	describe the assistive technologies designed for physical impairments.	Understanding (K2)
CO2	interpret technologies developed for visual impairments.	Analyzing (K4)
CO3	infer knowledge of hearing assistive devices and systems.	Applying (K3)
CO4	explain the working principles of assistive devices for vital organs.	Understanding (K2)
CO5	elucidate emerging technologies in clinical and assistive device.	Understanding (K2)

TEXT BOOKS

1. Yadin David, Wolf W. von Maltzahn, Michael R. Neuman, Joseph.D, Bronzino, "Clinical Engineering", 1st Edition, CRC Press, 2010.
2. Kenneth J. Turner, "Advances in Home Care Technologies: Results of the match Project", 1st Edition, Springer, 2011.

REFERENCES

1. Gerr. M. Craddock "Assistive Technology-Shaping the future", 1st Edition, IOS Press, 2003.
2. Marion. A. Hersh, Michael A. Johnson, "Assistive Technology for visually impaired and blind", 1st Edition, Springer Science & Business Media, 2010.
3. Donald R. Peterson, Joseph D. Bronzino," Medical Devices and Human Engineering", 3rd Edition Three volume set, CRC press, 2014.
4. Gray E Wnek, Gray L Browlin, "Encyclopedia of Biomaterials and Biomedical Engineering", Marcel Dekker Inc, New York, 2004.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 - Strong , 2 - Medium , 1 - Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	2
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	2
CO4	3	3	-	-	-	-	-	-	-	-	-	-	2	2
CO5	3	3	-	-	-	-	-	-	-	-	-	-	2	2

EC23657	MEMS FOR HEALTHCARE	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	gain knowledge about MEMS Fundamentals.
2.	study the concepts of Sensing and Detection methods.
3.	learn advanced topics like Microfluidics, Lab-on-Chips.
4.	know MEMS Applications in Healthcare.
5.	be familiar with clinical monitoring, implantable MEMS.

UNIT I	FUNDAMENTALS OF MEMS AND MICROFABRICATION	9

Introduction to MEMS: Definition, evolution, and significance in healthcare - Materials for MEMS: Silicon, Polymers, piezoelectric materials, and biocompatible substrates - Micro fabrication Techniques: Photolithography, doping, thin-film deposition, etching (wet and dry), and bonding methods - Micromachining Processes: Bulk and surface micromachining, LIGA process, and soft lithography.

UNIT II	SENSING AND DETECTION METHODS	9

Sensing and Detection, Senor Characteristics; Principles of Physical Sensing - Resistive, Capacitive, Inductive, Resonant Sensors; Biological and Chemical Detection Methods - Biological Sensors, Electrochemical Methods; Optical Detection methods - Fluorescence, Absorbance, Chemiluminescence.

UNIT III	MICROFLUIDICS AND LAB-ON-CHIP SYSTEMS	9

Microfluidic Principles: Laminar flow, Reynolds number and fluid dynamics at micro-scale; Components: Micro pumps, micro valves, mixers and channels; Lab-on-Chip (LOC) Devices: sample Pretreatment, Sample introduction, Separations.

UNIT IV	BIOMEDICAL MEMS APPLICATIONS	9

Cell Based Chips for Biotechnology - Cell Sorting, Cell Trapping; Wearable Health Monitors; Integration of MEMS in fitness trackers and health Monitoring devices.

UNIT V	CLINICAL MONITORING, MEMS IMPLANTS AND BIOELECTRIC INTERFACES	9

Clinical monitoring - Flow Cytometry, Microdialysis, Cather- Based Sensors, Endoscopy, Point of care; MEMS Implants and Bioelectric Interfaces - Implantable MEMS, Microelectrodes and Neural Probes, Implantable Sensors; Drug Delivery; Tissue Engineering.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	understand the fundamentals of MEMS relevant to healthcare applications.	Understanding (K2)
CO2	analyze various sensing and detection methods.	Analyzing (K4)
CO3	demonstrate knowledge of microfluidics and Lab-on-Chip technologies.	Applying (K3)

CO4	describe MEMS-based solutions for health monitoring systems.	Understanding (K2)
CO5	illustrate clinical monitoring systems and implantable MEMS.	Analyzing (K4)

TEXT BOOKS

1. Albert Folch, "Introduction to Biomems", 1st Edition, CRC Press, Florida, 2016.
2. Ellis Meng, "Biomedical Microsystems", CRC Press, 2011.

REFERENCES

1. Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture", Tata McGraw-Hill, 2017.
2. Wanjun Wang & Stephen A. Soper, "BioMEMS: Technologies and Applications", CRC Press, 2007.
3. Chang Liu, Foundations of MEMS, "Pearson Education", 2011.
4. Tatsuo Togawa, Toshiyo Tamura, P. Ake Oberg, "Biomedical Sensors and Instruments", CRC Press, UK, 2011.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 - Strong , 2 - Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	1	1
CO2	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	1	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	1	1

EC23851	FUNDAMENTALS OF COMMUNICATION	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	study the fundamentals of analog communication
2.	learn the concepts of digital communication
3.	gain knowledge about digital data theory
4.	know the basics of Optical communication
5.	acquire knowledge about satellite communication

UNIT I	ANALOG COMMUNICATION	9

Theory and Principles of amplitude modulation - AM envelope, Frequency spectrum and Bandwidth, Modulation index and percent modulation, AM power distribution; Angle modulation - FM and PM waveforms, Phase deviation and Modulation index, Frequency deviation and percent modulation.

UNIT II	DIGITAL COMMUNICATION	9

Pulse modulation - PAM, PWM, PPM; Pulse Code Modulation, Delta Modulation, Differential Pulse Code Modulation; Baseband transmission - Inter Symbol Interference, eye patterns.

UNIT III	INFORMATION THOERY	9

Uncertainty, Information, Entropy and its Properties; Source Coding Theorem - Shannon Fano Coding, Huffman Coding; Channel Capacity - Channel Coding Theorem; Information Capacity Theorem.

UNIT IV	OPTICAL COMMUNICATION	9

Optical Communication Systems - Advantages, Elements of Optical Fiber Transmission link; Types of Fiber - Single mode, Multimode; Losses in Optical fiber; Optical Fiber Sources and Detectors.

UNIT V	SATELLITE COMMUNICATION	9

Satellite Communication Systems - Kepler's Law, LEO and GEO Orbits, Footprint, Earth Station, Space Segment, Link model; Multiple access techniques in Satellite Communication - TDMA, FDMA, CDMA.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	elucidate the theories of analog communication.	Understanding (K2)
CO2	describe the concepts of digital communication.	Understanding (K2)
CO3	interpret the basics of information theory.	Understanding (K2)
CO4	infer the basics of Optical communication	Understanding (K2)
CO5	explain the principles of satellite communication	Understanding (K2)

TEXT BOOKS

1. Wayne Tomasi, "Advanced Electronic Communication Systems", 6th Edition, Pearson Education, 2007.
2. Simon Haykin, "Communication Systems", 4th Edition, John Wiley & Sons, 2001.

REFERENCES

1. H. Taub, D. L. Schilling, G. Saha, "Principles of Communication", 3rd Edition, 2007.
2. B.P.Lathi, "Modern Analog and Digital Communication systems", 3rd Edition, Oxford University Press, 2007.
3. Blake, "Electronic Communication Systems", Thomson Delmar Publications, 2002.
4. Martin S. Roden, "Analog and Digital Communication System", 3rd Edition, Prentice Hall India, 2002.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-	2	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-	2	-

EC23852	BASICS OF COMPUTER COMMUNICATION NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	study the fundamental concepts of Network Architecture and Physical Layer
2.	learn the concepts of Data Link Layer.
3.	be familiar with functions of Network Layer.
4.	be exposed to the required functionality of Transport Layer.
5.	get knowledge about Application Layer.

UNIT I	NETWORK ARCHITECTURE AND PHYSICAL LAYER	9

Data Communication - Components, Data Representation; Networks - Network Criteria, Physical Structure; Network Types - LAN, WAN; Topology; Network Models - TCP/IP Protocol Suite, The OSI model. Guided media - Twisted pair, Coaxial and fiber optic cables; Unguided media - Radio waves, Micro waves and infrared.

UNIT II	DATA LINK LAYER	9

Link Layer Addressing - Types, Address Resolution Protocol; DLC Services - Framing, Flow and Error Control; DLL Protocols; HDLC; PPP; Random Access - CSMA/CD, CSMA/CA; Controlled Access - Reservation, Polling, Token Passing.

UNIT III	NETWORK LAYER	9

Network layer services - IPV4 Address - Network layer protocols (IP, ICMP, Mobile IP); Routing algorithms - Distance Vector Routing, Link State Routing; IPv6 Addressing - Transition from IPv4 to IPv6.

UNIT IV	TRANSPORT LAYER	9

Transport Layer - Services; Connectionless and Connection Oriented Protocols; Port Numbers; UDP; TCP - Flow Control, Error Control, TCP Congestion control.

UNIT V	APPLICATION LAYER	9

WWW and HTTP; FTP - Control connection, Data connection; E-Mail - Architecture, Message Transfer Agent - SMTP, Message Access Agent - POP, IMAP - Web-based mail; Domain Name System - Name Space, DNS in the internet.

	TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	describe the fundamental concepts of Network Architecture and Physical Layer	Understanding (K2)
CO2	elucidate the concepts of Data Link Layer.	Understanding (K2)
CO3	discuss about the functions of Network Layer.	Understanding (K2)
CO4	interpret the functionality of Transport Layer.	Understanding (K2)
CO5	infer the knowledge about Application Layer.	Understanding (K2)

TEXT BOOKS

1. Behrouz A. Forouzan, "Data communication and Networking", 5th Edition, Tata McGraw Hill, 2017.
2. James F. Kurose, Keith W. Ross, "Computer Networking - A Top-Down Approach Featuring the Internet", 7th Edition, Pearson Education, 2016.

REFERENCES

1. Nader. F. Mir, "Computer and Communication Networks", 2nd Edition, Pearson Prentice Hall Publishers, 2014.
2. Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, "Computer Networks: An Open Source Approach", McGraw Hill Publisher, 2011.
3. Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", 5th Edition, Morgan Kaufmann Publishers, 2011.
4. Andrew S. Tanenbaum, Nick Feamster, David Wetherall, "Computer Networks", Pearson Education, 2021.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	2	-

EC23853	PRINCIPLES OF WIRELESS NETWORKS	3	0	0	3

COURSE OBJECTIVES	
To enable the students to	
1.	understand the concepts of Network planning
2.	know the wireless network operations
3.	be familiar with the fundamentals of Wireless WANs
4.	have in depth knowledge about Wireless WLANs
5.	acquire knowledge about wireless geolocation systems

UNIT I	NETWORK PLANNING	9

Medium access alternatives - Fixed assignment for voice oriented networks, Random access for data oriented networks; Network Planning - Wireless Network Topologies, Cellular Topology, Signal to Interference Ratio Calculation, Capacity Expansion Techniques.

UNIT II	WIRELESS NETWORK OPERATIONS	9

Mobility Management - Location Management, Handoff Management, Mobile IP; Radio Resource Power Management - Power Control, Energy Efficient Designs; Security requirements for wireless networks.

UNIT III	WIRELESS WANs	9

GSM - Services, Architecture; CDMA - IS-95 Forward Channel, Reverse Channel, Frame format; IMT2000; Mobile Data - classification; Cellular Digital Packet Data - Reference Architecture, Mobility Support, Protocol Layers; General Packet Radio Service.

UNIT IV	WIRELESS LANs	9

IEEE802.11 WLANs - Reference architecture, Layered Protocol architecture, Physical Layer, MAC layer, MAC Management Sublayer; Wireless ATM; HIPERLAN - 1; HIPERLAN - 2.

UNIT V	WIRELESS GEOLOCATION SYSTEMS	9

Wireless Geolocation - Architecture; Technologies - Direction Based and Distance Based Techniques; Geolocation Standards E-911 - Architecture, Services; Performance measures.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	discuss the concepts of Network planning in various applications.	Understanding (K2)
CO2	describe the wireless network operations.	Understanding (K2)
CO3	elucidate standards of Wireless WAN.	Understanding (K2)
CO4	compare various types of Wireless LAN.	Analyzing (K4)
CO5	explain about wireless geolocation systems	Understanding (K2)

TEXT BOOKS

1. Kaveh Pahlavan, "Principles of Wireless Networks" 2nd Edition, Prentice Hall India, 2012.
2. Vijay Garg, "Wireless Communications and Networking", 1st Edition, Elsevier, 2009.

REFERENCES

1. P.Nicopolitidis, M.S.Obaidat, G.I.Papadimitriou, A.S.Pomportsis, "Wireless Networks", Wiley, 2009.
2. Anurag Kumar, D.Manjunath, Joy kuri, "Wireless Networking", 1st Edition, Elsevier, 2011.
3. Simon Haykin, Michael Moher, David Koilpillai, "Modern Wireless Communications", 1st Edition, Pearson Education, 2013.
4. Erik Dahlman, Stefan Parkvall, Johan Skold and Per Beming, "3G Evolution HSPA and LTE for Mobile Broadband", 2nd Edition, Academic Press, 2008.

CO-PO MAPPING :

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COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	-	-	-	-	-	-	-	-	-	-	1	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-	1	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-	1	-
CO4	3	1	-	-	-	-	-	-	-	-	-	-	1	-
CO5	3	1	-	-	-	-	-	-	-	-	-	-	1	-

EC23854	WIRELESS SYSTEMS AND STANDARDS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1.	know the concepts of 2G and 3G in wireless networks.
2.	understand the wireless system operations and standards.
3.	gain knowledge about various wireless application protocols.
4.	be familiar with the standards of Wireless LANs.
5.	acquire knowledge about Personal Area Network.

UNIT I	SECOND AND THIRD GENERATION ARCHITECTURE	9

Second Generation TDMA - GSM Architecture, Air Interface, Channels, Voice-call setup, Handover, EDGE architecture; Second Generation CDMA - Forward and Reverse channel, Call Handoff; Third Generation systems - UMTS network architecture.

UNIT II	WIRELESS SYSTEM OPERATIONS AND STANDARDS	9

Cordless systems - Time Division Duplex, DECT Operation, ADPCM; Wireless Local Loop - Propagation considerations for WLL OFDM, IEEE 802.16; Long-Term Evolution-System Architecture, Transmission Techniques, Channels in the radio interface, Radio Resource Management.

UNIT III	WIRELESS APPLICATION PROTOCOLS	9

Wireless Application Protocol - Programming Model, Architectural Overview, Wireless Markup Language, WML Script, Wireless Application Environment, Wireless Session Protocol, Wireless Transaction Protocol, Wireless Datagram Protocol.

UNIT IV	WIRELESS LAN STANDARDS	9

Spread Spectrum LANs - Configuration, Transmission issues; IEEE 802.11- Architecture and services; IEEE 802.11a/b/n standards; Infrared LANs - Strengths and Weakness, Transmission techniques.

UNIT V	WIRELESS PAN	9

IEEE 802.15.1 - Protocol stack, Link types, security, network connection establishment; IEEE 802.15 WPAN standards - network model; Zigbee- Device Architecture, Topologies, applications; IEEE 802.15.3a- Ultra-wide-Band Radio Communication.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	discuss about the architecture of second and third generation networks.	Understanding (K2)
CO2	describe the working principles of various wireless standards.	Understanding (K2)
CO3	explain the various wireless application protocols.	Understanding (K2)
CO4	summarize the Wireless LAN concepts.	Understanding (K2)
CO5	enumerate the features Wireless Personal Area Networks.	Understanding (K2)

TEXT BOOKS

1. Clint Smith, P.E. and Daniel Collins, "3G Wireless Networks", 2nd Edition, Tata McGraw Hill, 2017.
2. Kaveh Pahlavan and Prashant Krishnamurthy, "Principles of Wireless networks - A unified Approach", Prentice Hall, 2013.

REFERENCE BOOKS

1. William Stallings, "Wireless Communications and Networks", 2nd Edition, Prentice Hall, 2009.
2. Dharma Prakash Agarwal and Qing-An Zeng, "Introduction to Wireless and Mobile Systems", 3rd Edition, Thomson India, 2011.
3. Vijay. K. Garg, "Wireless Communication and Networking", Morgan Kauffmann Publishers, 2007.
4. Mischa Schwartz, "Mobile Wireless Communications", Cambridge University Press, 2005.

CO PO MAPPING:

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COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
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CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	2	-

EC23855	4G / 5G COMMUNICATION NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. learn the evolution of wireless networks.
2. get acquainted with the fundamentals of 5G networks.
3. study the processes associated with 5G architecture.
4. gain knowledge on spectrum sharing and spectrum trading
5. be familiar with security features in 5G networks.

UNIT I **EVOLUTION OF WIRELESS NETWORKS** **9**

Networks evolution - 2G, 3G, 4G; Evolution of radio access networks - need for 5G, 4G versus 5G, Next Generation core, visualized Evolved Packet Core (vEPC).

UNIT II **5G CONCEPTS** **9**

Fundamentals of 5G technologies - overview of 5G core network architecture, 5G new radio and cloud technologies, Radio Access Technologies, EPC for 5G.

UNIT III **NETWORK ARCHITECTURE AND THE PROCESSES** **9**

5G architecture and core - network slicing, Multi-access Edge Computing , visualization of 5G components, end-to-end system architecture, service continuity, relation to EPC, and edge computing; 5G protocols - 5G NAS, NGAP, GTP-U, IPSec and GRE.

UNIT IV **DYNAMIC SPECTRUM MANAGEMENT AND MM-WAVES** **9**

Mobility management - Command and control, Spectrum sharing and spectrum trading; Cognitive radio based on 5G - millimeter waves.

UNIT V **SECURITY IN 5G NETWORKS** **9**

Security features in 5G networks - network domain security, user domain security, flow-based QoS framework, mitigating the threats in 5G.

TOTAL PERIODS **45**

COURSE OUTCOMES At the end of this course, the students will be able to		**BT MAPPED** (Highest Level)
CO1	summarize the evolution of wireless networks.	Understanding (K2)
CO2	describe the concepts of 5G networks	Understanding (K2)
CO3	comprehend the 5G architecture and protocols.	Understanding (K2)
CO4	infer the dynamic spectrum management.	Understanding (K2)
CO5	interpret the security aspects in 5G networks	Understanding (K2)

TEXT BOOKS

1. Stephen Rommer, "5G Core networks: Powering Digitalization", Academic Press, 2019.
2. Saro Velrajan, "An Introduction to 5G Wireless Networks: Technology, Concepts and Use Cases", 1st Edition, 2020.

REFERENCES

1. Jyrki T. J. Penttinen, "5G Simplified: ABCs of Advanced Mobile Communications", 1st Edition, Wiley, 2019.
2. Wan Lee Anthony, "5G system Design: An end to end Perspective", Springer Publications, 2019.
3. Saad Z. Asif, "5G Mobile Communications Concepts and Technologies", 1st Edition, CRC Press, 2019.
4. Erik Dahlman, Stefan Parkvall, Johan Skold, "5G NR: The Next Generation Wireless Access Technology", 1st Edition, Academic Press, 2018.

CO-PO MAPPING :

Mapping of Course Outcomes (CO's) with Programme Outcomes (PO's) and Program Specific Outcomes (PSO's) (1/2/3 indicates the strength of correlation) 3 – Strong , 2 – Medium , 1 – Weak

COs	PO's												PSO's	
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	2	-

EC23856	ADHOC AND WIRELESS SENSOR NETWORKS	3	0	0	3

COURSE OBJECTIVES

To enable the students to

1. learn AdHoc network fundamentals.
2. gain knowledge about AdHoc routing protocols.
3. get familiar with wireless sensor networking concepts.
4. understand the concepts of localization and synchronization.
5. have an exposure to sensor network platforms.

UNIT I	ADHOC NETWORKS – MAC PROTOCOLS	9

AdHoc Wireless Networks - Issues, Applications; MAC Protocols - Issues in designing , design goals; Classification of MAC protocols; Contention based protocols - MACAW, FAMA; Contention based with Reservation mechanisms - CATA, HRMA, FPRP; Contention based with Scheduling mechanisms – DWOP.

UNIT II	ADHOC ROUTING PROTOCOLS	9

Routing Protocol - Issues in Designing Classifications of Routing Protocols; Table Driven Routing Protocols - Destination Sequenced Distance Vector Routing protocol; On-demand Routing - Dynamic Source Routing, AdHoc On-Demand Distance Vector routing protocol; Hybrid Routing protocol - Zone Routing Protocol.

UNIT III	WIRELESS SENSOR NETWORKING CONCEPTS	9

Sensor network - Issues and challenges; Sensor network architecture - Layered, Clustered; Data dissemination- Flooding, Gossiping; MAC protocol for sensor networks; Quality of sensor network - Coverage, exposure.

UNIT IV	SENSOR LOCALISATION AND TIME SYNCHRONIZATION	9

Localization- Indoor, Range - Based, Range - free, Event - driven; Time Synchronization - Synchronization problem, clocks, Time synchronization protocols.

UNIT V	SENSOR NETWORK PLATFORMS	9

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms – Tiny OS, nesC, CONTIKIOS.

TOTAL PERIODS	45

COURSE OUTCOMES At the end of this course, the students will be able to		BT MAPPED (Highest Level)
CO1	discuss about AdHoc network fundamentals.	Understanding (K2)
CO2	interpret various AdHoc routing protocols.	Understanding (K2)
CO3	infer the concepts of Wireless Sensor Networks.	Understanding (K2)
CO4	summarize Sensor localization and synchronization.	Understanding (K2)
CO5	classify various sensor network platforms.	Understanding (K2)

TEXT BOOKS

1. C. Siva Ram Murthy and B. S. Manoj, "Ad Hoc Wireless Networks Architectures and Protocols", Prentice Hall, 2004.
2. Holger Karl, Andreas Willig, "Protocol and Architecture for Wireless Sensor Networks", John Wiley Publication, 2006.

REFERENCES

1. Feng Zhao, Leonidas Guibas, "Wireless Sensor Networks: an information processing approach", Elsevier publication, 2004.
2. Charles E. Perkins, "Ad Hoc Networking", Addison Wesley, 2000.
3. I.F. Akyildiz, W. Su, Sankarasubramaniam, E. Cayirci, "Wireless sensor networks: a survey", Computer Networks, Elsevier, 2002.
4. Isaac Woungang, "Guide to Wireless Sensor Networks", Springer London, 2009.

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CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO5	3	2	-	-	-	-	-	-	-	-	-	-	2	-