COIMBATORE INSTITUTE OF TECHNOLOGY, COIMBATORE – 641 014
(An Autonomous Institution affiliated to ANNA UNIVERSITY, CHENNAI)
DEPARTMENT OF ELECTRONICS AND COMMUNICATION
REGULATIONS 2023 CHOICE BASED CREDIT SYSTEM

B. E. ELECTRONICS AND COMMUNICATION

VISION

To impart knowledge in the field of Electronics and Communication Engineering so as to nurture excellence in students, mould their capability to meet current and impending challenges and ignite aspirations to become innovators and entrepreneurs, thereby benefit the nation and world.

MISSION

- To impart high quality education and training to the students in the field of Electronics and Communication Engineering.
- To promote creation and dissemination of knowledge.
- To equip the students with right aptitude and attitude for continuous learning.
- To provide a framework for collaborative research with industries leading to innovation.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

PEO 1: The graduates will exhibit knowledge in Mathematics, Engineering fundamentals, Electronics and Communication Engineering and related fields for professional achievement in industry and organizations.

PEO 2: The graduates will be able to identify, analyze and apply engineering concepts for design of Electronics and Communication Systems and demonstrate multidisciplinary expertise to meet contemporary requirements.

PEO 3: The graduates will be able to function with leadership qualities, team spirit, managerial skills, attitude and ethics needed for successful career and entrepreneurship.

PROGRAM OUTCOMES (POs)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO1: Design and develop models for signal processing and communication systems
PSO2: Design, develop and test electronic and embedded systems for real time applications

MAPPING OF PROGRAMME EDUCATIONAL OUTCOMES WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC COUTCOMES

PEOs	PROGRAMME OUTCOMES												PSOs	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
1	3	1	1	2	2	1	1					1	1	1
2	2	2	2	2	2	1	2				2	1	2	2
3				1		2	1	1	2		2	1		

COIMBATORE INSTITUTE OF TECHNOLOGY, COIMBATORE – 641 014
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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
REGULATIONS 2023 - CHOICE BASED CREDIT SYSTEM

B. E. ELECTRONICS AND COMMUNICATION ENGINEERING

CURRICULA AND SYLLABI

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23FYH111	Technical English	HSC	2	2	0	4	4
2	23FYM114	Calculus and Differential Equations	BSC	3	1	0	4	4
3	23FYP114	Physics for Communication Engineering	BSC	3	0	0	3	3
4	23FYC114	Engineering Chemistry	BSC	3	0	0	3	3
5	23EC111	Electrical Engineering and Instrumentation	ESC	3	0	0	3	3
PRACTICALS								
6	23FPC122	Basic Sciences Laboratory	BSC	0	0	4	4	2
7	23EC121	Electrical Engineering and Instrumentation Laboratory	ESC	0	0	2	2	1
8	23EC122	Problem Solving Skills and Practices	ESC	0	0	2	2	1
MANDATORY COURSES								
9	23FYH121	Heritage of Tamils / தமிழர் மரபு	HSC	15 Hours			1	1
10	23MC101	Induction Programme	MC	2 Weeks			2 Weeks	-
11	23MC102	Soft Skills	EEC	15 Hours			1	-
		TOTAL		**14**	**3**	**8**	**27**	**22**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23FYM214	Complex Variables, Laplace Transforms and Fourier Series	BSC	3	1	0	4	4
2	23FYP212	Semiconductor Physics	BSC	3	0	0	3	4
3	23EC211	Problem Solving Using C Programming	ESC	3	0	0	3	3
4	23EC212	Electron Devices	ESC	3	0	0	3	3
5	23EC213	Network Theory	ESC	3	1	0	4	4
PRACTICALS								
6	23FYH221	English Communication Competency Laboratory	HSC	0	0	4	4	2
7	23EC221	C Programming Laboratory	ESC	0	0	2	2	1
8	23EC222	Devices and Circuits Laboratory	ESC	0	0	2	2	1
MANDATORY COURSES								
9	23FYH222	Tamils and Technology / தமிழரும் தொழில்நுட்பமும்	HSC	15 Hours			1	1
10	23FYC221	Environmental Science and Engineering	HSC	15 Hours			1	1
11	23CC	Co-Curricular Activities*	MC	15 Hours			1	1
		23CC221-NSS						
		23CC222-YRC						
		23CC223-RSP						
		23CC224-SPORTS						
TOTAL				**15**	**2**	**18**	**28**	**24**

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	23M314	Linear Algebra and Probability	BSC	3	1	0	4	4
2	23EC311	Signals and Systems	PCC	3	1	0	4	4
3	23EC312	Analog Electronics	PCC	3	0	0	3	3
4	23EC313	Digital Electronics	PCC	3	0	0	3	3
5	23EC314	Electromagnetic Fields and Transmission Lines	PCC	3	1	0	4	4
PRACTICALS								
6	23EC321	Analog Electronics Laboratory	PCC	0	0	3	3	1.5
7	23EC322	Digital Electronics Laboratory	PCC	0	0	3	3	1.5
8	23EC323	Python Programming Laboratory	ESC	0	0	2	2	1
MANDATORY COURSES								
9	23MC301	Induction Programme	MC	1 Week				
10	23MC321	Human Values and Professional Ethics	MC	15 Hours			1	1
11	23MC322	Design Thinking	EEC	15 Hours			1	1
TOTAL				**15**	**3**	**8**	**28**	**24**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Antennas and Wave Propagation	PCC	3	0	0	3	3
2		Principles of Communication	PCC	3	1	0	4	4
3		Linear Integrated Circuits	PCC	3	0	0	3	3
4		Microcontroller based Systems	PCC	3	1	0	4	4
5		Data structures and Algorithms	PCC	3	1	0	4	4
PRACTICALS								
6		Linear Integrated Circuits Laboratory	PCC	0	0	3	3	1.5
7		Microcontrollers Laboratory	PCC	0	0	3	3	1.5
8		Data structures and Algorithms Laboratory	PCC	0	0	2	2	1
MANDATORY COURSES								
9		Community Services and Engineering	EEC	15 Hours			-	-
10		Value Added Course I	MC	15 Hours			-	-
11								
TOTAL				**15**	**3**	**8**	**26**	**22**

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Control Systems	PCC	3	1	0	4	4
2		Digital Signal Processing	PCC	3	1	0	4	4
3		Embedded Systems and IoT	PCC	3	0	0	3	3
4		Elective –I	PEC/ OEC	3	0	0	3	3
5		Elective –II	PEC	3	0	0	3	3
PRACTICALS								
6		Signal Processing Laboratory	PCC	0	0	2	2	1
7		Embedded Systems and IoT Laboratory	PCC	0	0	2	2	1
8		DBMS Laboratory	PCC	0	0	2	2	1
		In-Plant Training*	EEC	2 Weeks			-	1
MANDATORY COURSES								
9		Seminar and Technical Writing	EEC	15 Hours			1	1
10		Value Added Course II	EEC	15 Hours			-	-
TOTAL				**15**	**1**	**6**	**22**	**22**

* IN-PLANT TRAINING to be completed in fourth semester

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		VLSI Design	PCC	3	0	0	3	3
2		Digital Communication	PCC	3	1	0	4	4
3		Data Communication Networks	PCC	3	0	0	3	3
4		Elective -III	PEC/ OEC	3	0	0	3	3
5		Elective – IV	PEC	3	0	0	3	3
PRACTICALS								
6		VLSI Design Laboratory	PCC	0	0	2	2	1
7		Analog and Digital Communication Laboratory	PCC	0	0	2	2	1
8		Java Programming Laboratory	PCC	0	0	2	2	1
9		Mini Project	EEC	0	0	4	4	2
MANDATORY COURSES								
10		Hackathon	EEC	15 Hours				1
TOTAL				**15**	**1**	**10**	**26**	**22**

SEMESTER VII

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Digital Image Processing	PCC	3	1	0	4	4
2		Wireless Communication and Networks	PCC	3	0	0	3	3
3		Microwave Engineering and Optical Communication	PCC	4	0	0	4	4
4		Elective -V	PEC	3	0	0	3	3
5		Elective -VI	PEC	3	0	0	3	3
PRACTICALS								
6		Wireless Communication and Networking Laboratory	PCC	0	0	2	2	1
7		Microwave Engineering and Optical Communication Laboratory	PCC	0	0	2	2	1
8		Electronic Systems Design Laboratory	PCC	0	0	2	2	1
TOTAL				**16**	**1**	**6**	**23**	**20**

SEMESTER VIII

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
		ELECTIVE –VII	PEC	3	0	0	3	3
		ELECTIVE -VIII	PEC	3	0	0	3	3
PRACTICALS								
		Project Work and Viva-Voce	EEC	0	0	12	6	6
TOTAL				**6**	**0**	**12**	**12**	**12**

LIST OF PROFESSIONAL ELECTIVE COURSES:

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
ELECTRONICS AND VLSI								
1.		CAD for VLSI Circuits	PEC	3	0	0	3	3
2.		ASIC Design	PEC	3	0	0	3	3
3.		High Speed Digital Design	PEC	3	0	0	3	3
4.		Reconfigurable Computing	PEC	3	0	0	3	3
5.		VLSI Technology	PEC	3	0	0	3	3
6.		Bio-Medical CMOS ICs	PEC	3	0	0	3	3
7.		Validation and Testing Technology	PEC	3	0	0	3	3
8.		Quantum Circuit Design	PEC	3	0	0	3	3
9.		Signal Integrity for High Speed Devices	PEC	3	0	0	3	3
10.		System on Chip	PEC	3	0	0	3	3
11.		Semiconductor Device Modeling	PEC	3	0	0	3	3
12.		Semiconductor Memory Design	PEC	3	0	0	3	3
13.		Design Fundamentals of Electric and Hybrid Vehicles	PEC	3	0	0	3	3
14.		Power Electronics	PEC	3	0	0	3	3
15.		Electronic Packaging	PEC	3	0	0	3	3
EMBEDDED SYSTEMS &IoT								
16.		Automotive Electronics	PEC	3	0	0	3	3
17.		Real Time Operating Systems	PEC	3	0	0	3	3
18.		Programming for IoT Boards	PEC	3	0	0	3	3
19.		IoT System Design and Applications	PEC	3	0	0	3	3
20.		Real Time Applications using Python	PEC	3	0	0	3	3
21.		Drone Technologies	PEC	3	0	0	3	3
22.		Robotics	PEC	3	0	0	3	3
23.		Foundation Skills for Integrated Product Development	PEC	3	0	0	3	3
COMMUNICATION AND SIGNAL PROCESSING								
24.		Multimedia Compression and Communication	PEC	3	0	0	3	3
25.		Digital Switching and Transmission	PEC	3	0	0	3	3
26.		Error Control Coding	PEC	3	0	0	3	3
27.		Cognitive Radio Communication Systems	PEC	3	0	0	3	3
28.		Satellite Communication	PEC	3	0	0	3	3

29.		Under Water Communication	PEC	3	0	0	3	3
30.		Optical Communication Networks	PEC	3	0	0	3	3
31.		Wireless Adhoc and Sensor Networks	PEC	3	0	0	3	3
32.		Wireless Networks and Standards	PEC	3	0	0	3	3
33.		Next Generation Networks	PEC	3	0	0	3	3
34.		Network Routing and Infrastructure Management	PEC	3	0	0	3	3
35.		Cryptography and Network Security	PEC	3	0	0	3	3
36.		Radar and Navigational Aids	PEC	3	0	0	3	3
37.		Compressive Sensing and Sparse Signal Processing	PEC	3	0	0	3	3
38.		Pattern Recognition	PEC	3	0	0	3	3
39.		Machine Learning for Signal Processing	PEC	3	0	0	3	3
40.		Adaptive Signal Processing	PEC	3	0	0	3	3
MICROWAVE AND RF DESIGN								
41.		Modern Antennas	PEC	3	0	0	3	3
42.		Electromagnetic Interference and Compatibility	PEC	3	0	0	3	3
43.		RF Microelectronics	PEC	3	0	0	3	3
44.		Radiation Systems	PEC	3	0	0	3	3
45.		Electromagnetic Radiation Hazards and Safety	PEC	3	0	0	3	3
46.		Advanced Antenna Technology	PEC	3	0	0	3	3
SOFT COMPUTING								
47.		Machine Learning Algorithms	PEC	3	0	0	3	3
48.		Deep Learning	PEC	3	0	0	3	3
49.		Artificial Intelligence	PEC	3	0	0	3	3
50.		Cyber Security	PEC	3	0	0	3	3
51.		Operating Systems	PEC	3	0	0	3	3
52.		Relational Database Management Systems	PEC	3	0	0	3	3
53.		Java Programming	PEC	3	0	0	3	3
54.		Intel Collaborated Course: Introduction to Machine Learning	PEC	3	0	0	3	3

LIST OF OPEN ELECTIVE COURSES OFFERED FOR THE STUDENTS OF OTHER UG PROGRAMMES:

Sl. No	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	C	UG PROGRAMME
CO1:		Signal Processing and Its Applications	OEC	3	0	0	3	3	**All Branches**
CO2:		Smart Sensors and IoT	OEC	3	0	0	3	3	
CO3:		Consumer Electronics	OEC	3	0	0	3	3	
CO4:		Information Theory and Coding Techniques	OEC	3	0	0	3	3	
CO5:		Automotive Embedded Systems	OEC	3	0	0	3	3	
CO6:		5G Technologies and Applications	OEC	3	0	0	3	3	
CO7:		Vehicular Communication	OEC	3	0	0	3	3	

SUMMARY

Category; BSC – Basic sciences, HSC– Humanities and Social Sciences, ESC–Engineering sciences, PCC –Professional Core, PEC- Professional Elective, OEC-Open Elective Course, EEC –Employability Enhancement Course, MC – Mandatory Course

B.E. ELECTRONICS AND COMMUNICATION ENGINEERING										
Sl. No.	**Subject Area**	**Credits per Semester**								**Credits Total**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
1	HSC	5	4							9
2	BSC	12	7	4						23
3	ESC	5	12	1						18
4	PCC			17	22	14	13			66
5	PEC/OEC					6	6	6	6	24
6	EEC			1		2	3	14	6	26
7	MC		1	1						2
									TOTAL CREDITS	168

VERTICALS-MAJOR

CODE	COURSE	L	T	P	Credit	Category
SIGNAL PROCESSING						
	SPEECH SIGNAL PROCESSING	3	0	0	3	VERTICAL-MAJOR
	DSP ARCHITECTURE AND PROGRAMMING	2	0	2	3	VERTICAL-MAJOR
	BIOMEDICAL SIGNAL PROCESSING	3	0	0	3	VERTICAL-MAJOR
	SIGNAL PROCESSING FOR COMMUNICATION	3	0	0	3	VERTICAL-MAJOR
	MULTIRATE SIGNAL PROCESSING	3	0	0	3	VERTICAL-MAJOR
	STATISTICAL SIGNAL PROCESSING	3	0	0	3	VERTICAL-MAJOR
	DIGITAL IMAGE AND VIDEO PROCESSING	2	0	2	3	VERTICAL-MAJOR
	AI-ML ALGORITHMS FOR IMAGE PROCESSING APPLICATIONS	3	0	0	3	VERTICAL-MAJOR
SENSOR TECHNOLOGIES AND IoT						
	IoT PROCESSORS	3	0	0	3	VERTICAL-MAJOR
	COMMUNICATION AND NETWORKING TECHNOLOGIES FOR IOT	2	0	2	3	VERTICAL-MAJOR
	WEARABLE TECHNOLOGY AND APPLICATIONS	3	0	0	3	VERTICAL-MAJOR
	INDUSTRIAL IoT AND INDUSTRY 4.0	3	0	0	3	VERTICAL-MAJOR
	SMART SENSORS AND APPLICATIONS FOR IOT	3	0	0	3	VERTICAL-MAJOR
	IoT EDGE COMPUTING	3	0	0	3	VERTICAL-MAJOR
	MOBILE APP DEVELOPMENT FOR IoT	3	0	0	3	VERTICAL-MAJOR
	NANO SENSORS AND APPLICATIONS	3	0	0	3	VERTICAL-MAJOR
HIGH SPEED COMMUNICATIONS						
	OPTICAL COMMUNICATION SYSTEMS	3	0	0	3	VERTICAL-MAJOR
	SOFTWARE DEFINED RADIO ARCHITECTURE AND APPLICATIONS	3	0	0	3	VERTICAL-MAJOR
	HIGH SPEED COMMUNICATION CIRCUITS	3	0	0	3	VERTICAL-MAJOR
	5G COMMUNICATION NETWORKS	2	0	2	3	VERTICAL-MAJOR
	WIRELESS BROADBAND NETWORKS	3	0	0	3	VERTICAL-MAJOR
	MASSIVE MIMO NETWORKS	3	0	0	3	VERTICAL-MAJOR
	MILLIMETER WAVE COMMUNICATION SYSTEMS	3	0	0	3	VERTICAL-MAJOR
	ADVANCED WIRELESS COMMUNICATION TECHNIQUES	3	0	0	3	VERTICAL-MAJOR
SEMICONDUCTOR CHIP DESIGN AND TESTING						
	WIDE BAND GAP DEVICES	3	0	0	3	VERTICAL-MAJOR
	SYSTEM DESIGN USING FPGA	3	0	0	3	VERTICAL-MAJOR
	LOW POWER IC DESIGN	2	0	2	3	VERTICAL-MAJOR
	VLSI TESTING AND DESIGN FOR TESTABILITY	3	0	0	3	VERTICAL-MAJOR

	ANALOG IC DESIGN	3	0	0	3	VERTICAL-MAJOR
	MIXED SIGNAL IC DESIGN	3	0	0	3	VERTICAL-MAJOR
	VERILOG HDL	3	0	0	3	VERTICAL-MAJOR
	VLSI SIGNAL PROCESSING	3	0	0	3	VERTICAL-MAJOR

VERTICALS-MINOR

CODE	COURSE	L	T	P	Credit	Category
INTERNET OF EVERYTHING: SMART SENSING TECHNOLOGIES						
	COMMUNICATION AND NETWORKING TECHNOLOGIES FOR IOT	2	0	2	3	VERTICAL-MINOR
	MOBILE APP DEVELOPMENT FOR IOT	3	0	0	3	VERTICAL-MINOR
	PYTHON PROGRAMMING FOR IOT APPLICATIONS	2	0	2	3	VERTICAL-MINOR
	NANO SENSORS AND APPLICATIONS	3	0	0	3	VERTICAL-MINOR
	SMART SENSORS AND APPLICATIONS FOR IOT	3	0	0	3	VERTICAL-MINOR
	IoT EDGE COMPUTING	3	0	0	3	VERTICAL-MINOR

SEMESTER I

23FYH111	TECHNICAL ENGLISH	L	T	P	C
		2	2	0	4

MODULE I FOCUS ON LANGUAGE: GRAMMAR & VOCABULARY 6

Embedded Sentence – Numerical Adjectives - Subject Verb Agreement – If Conditionals – Active Passive Voice – Reported Speech - Idiomatic Expressions - Business and Job Related Vocabulary - Relative Clause – Pronouns – Adjectives - Degrees of Comparison - Technical Vocabulary – Avoidance of Jargon - Collocations - Formal and Informal Vocabulary – Verbal Analogy - Tenses - Prepositions – Articles – Homophones and Homonyms - One Word Substitutes – Linking Words

MODULE II TECHNICAL COMMUNICATION 6

Importance of Technical Communication - Objective & Characteristics of Technical Communication – General and Technical Communication – Process of Communication - Levels of Communication – Flow of Communication – Visual Aids in Technical Communication - Barriers to Communication: Noise – Classification of Barriers – Non-verbal Communication: Kinesics – Proxemics – Chronemics

MODULE III READING& LISTENING 6

Reading Comprehension Techniques: Understanding Technical Articles – Skimming and Scanning – Summarizing - Intensive & Extensive Reading - Note Making – SQ3R Reading Technique - Meaning and Art of Listening-Importance of Listening & Empathy in Communication – Reasons for Poor Listening – Traits of a good listener – Listening to Technical Talks – Listening to TED/INK Talks.

MODULE IV WRITING 6

Paragraph Writing – Interpreting Charts and Graphs – Instructions – Checklists – Recommendations – Describing a Process – Extended Definitions – Essay Writing – Report Writing – Minutes of the Meetings - Email Writing - Essay Writing - Job Application Letters.

MODULE V SPEAKING 6

Introducing Oneself- Asking for and Giving Directions – Seeking Clarification – Speaking about a Process – Introduction to Technical Presentation – Mechanics of Presentation – Achieving Confidence, Clarity & Fluency – Vocal Cues - Barriers to Speaking – Types of Speaking – Persuasive Speaking – Public Speaking. .

COURSE OUTCOMES

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

CO1: categorize the barriers to communication and formulate solutions using appropriate vocabulary.

CO2: apply the rules of the grammar and construct grammatically correct sentences.

CO3: comprehend the nuances of Technical Communication

CO4: make inferences and interpret texts using reading and listening strategies

CO5: perceive the mechanics of business writing and presentation skills

CO6: develop LSRW skills to excel in workplace communication

TOTAL : 45 PERIODS

TEXT BOOKS:

1. “English for Engineers and Technologists” Volume I by Orient Blackswan, 2022

2. “English for Science & Technology - I” by Cambridge University Press, 2023

REFERENCES:

1. “Interchange” by Jack C.Richards, 5th Edition, Cambridge University Press, 2017.

2. “English for Academic Correspondence and Socializing” by Adrian Wallwork, Springer, 2011.

3. “The Study Skills Handbook” by Stella Cortrell, Red Globe Press, 2019

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1									2	3		1		
2									2	3		1		
3									2	3		1		
4									2	3		1		
5									2	3		1		
6									2	3		1		
Avg.									2	3		1		

1-low, 2-medium, 3-high

23FYM114	CALCULUS AND DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

MODULE I DIFFERENTIAL CALCULUS **9+3**

Partial derivatives – Total derivatives – Jacobians –Taylor's series for functions of two variables – Maxima and minima for functions of two variables – Lagrange's method of un-determined multipliers**.**

MODULE II MULTIPLE INTEGRALS **9+3**

Double integrals - Change of order of integration – Double integrals in polar coordinates - Area enclosed by plane curves - Triple integrals – Volume of solids in Cartesian coordinates.

MODULE III VECTOR CALCULUS **9+3**

Reading Comprehension Techniques: Understanding Technical Articles – Skimming and Scanning – Summarizing - Intensive & Extensive Reading - Note Making – SQ3R Reading Technique - Meaning and Art of Listening-Importance of Listening & Empathy in Communication – Reasons for Poor Listening – Traits of a good listener – Listening to Technical Talks – Listening to TED/INK Talks.

MODULE IV ORDINARY DIFFERENTIAL EQUATIONS **9+3**

Paragraph Writing – Interpreting Charts and Graphs – Instructions – Checklists – Recommendations – Describing a Process – Extended Definitions – Essay Writing – Report Writing – Minutes of the Meetings - Email Writing - Essay Writing - Job Application Letters.

MODULE V PARTIAL DIFFERENTIAL EQUATIONS **9+3**

Formation of partial differential equation – Solutions of first order non-linear partial differential equations (standard types only) – Lagrange's linear equation - Second and higher order linear homogeneous partial differential equations with constant coefficients.

COURSE OUTCOMES

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

CO1: determine the maxima, minima of functions of two or three variables and evaluate multiple integrals.

CO2: compute partial derivatives of multivariable functions and determine maxima, minima of functions of two or three variables subject to the constraints.

CO3: calculate double & triple integrals to find the area of regions and volume of solids.

CO4: apply principles of gradient, divergence and curl of a vector point function.

CO5: interpret differential equations in modeling and solving physical problems, solve the linear and first order non- linear partial differential equations,

CO6: solve the second and higher order ordinary and partial differential equations, evaluate the line, surface, volume integrals using Green's, Stoke's and Gauss divergence theorems.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Higher Engineering Mathematics" by Grewal B.S, "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2017.
2. "Thomas Calculus" by Weir, M.D and Joel Hass, 12th Edition , Pearson India, 2016.

REFERENCES:

1. “Advanced Engineering Mathematics” by Jain R.K. and Iyengar S.R.K., 5th Edition, Narosa Publications, New Delhi, 2016.
2. "Engineering Mathematics" by Srimantha Pal and Bhunia, S.C, Oxford University Press, 2015.
3. “Higher Engineering Mathematics” by B.V.Ramana, Kindle Edition, Tata McGraw-Hill Publishing, New Delhi, 2017.
4. “Engineering Mathematics” by P. Sivaramakrishna Das , C. Vijayakumari, 1st Edition, Pearson Education, Delhi, , 2017.
5. “Advanced Engineering Mathematics" by Erwin Kreyszig, 10th Edition, John Wiley and Sons, New Delhi, 2018.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	1									1		1
2	3	3	1									1		1
3	3	3	1									1		1
4	3	3	1									1		1
5	3	3	1									1		1
6	3	3	1									1		1
AVg.	3	3	1									1		1

1-low, 2-medium, 3-high

23FYP114	PHYSICS FOR COMMUNICATION ENGINEERING	L	T	P	C
		3	0	0	3

MODULE I ULTRASONICS **9**

Production of ultrasonic waves – piezoelectric effect – piezoelectric generator – Properties of ultrasonic waves – Detection of ultrasonic waves – Cavitation – Velocity measurement- acoustic grating – Industrial applications – soldering and cleaning – SONAR – Non Destructive Testing – pulse echo system through transmission and reflection modes – A, B and C scan displays, Medical application – Sonogram.

MODULE II LASER **9**

Characteristics of laser – Absorption - Spontaneous emission - Stimulated emission - Einstein's theory of stimulated emission – Conditions for Laser action – Population inversion – Sources of excitation – Active medium – Resonant cavity – Nd-YAG laser – CO2 laser - Semiconductor laser – Applications of laser – Laser printer – Holography (construction & reconstruction).

MODULE III FIBER OPTICS **9**

Snell's law and total internal reflection - Optical fiber - Advantages of optical fiber as wave guide – Structure of optical fiber – propagation of light in optical fiber - Numerical aperture and acceptance angle - Types of optical fiber - Plastic and glass fiber – Single and multimode fiber – Step index and graded index fiber – Applications - Fiber optic communication system, Fiber endoscope.

MODULE IV QUANTUM PHYSICS **9**

Limitations of classical Physics – Introduction to Quantum theory – Wave particle duality - Properties of matter waves – De-Broglie wavelength in terms of voltage, energy, and temperature – Physical significance of a wave function - Schrödinger's Time independent and Time dependent wave equations – Eigen values and eigen function – Particle in a one dimensional potential well – Scanning Electron Microscope

MODULE V DIELECTRICS **9**

Permittivity – Polarizability – Electrical susceptibility – dielectric constant – electronic, ionic, orientational and space charge polarization – Langevin Debye equation – frequency and temperature dependence of polarization – dielectric loss – dielectric breakdown – applications of dielectric materials in capacitors and transformers.

COURSE OUTCOMES

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

CO1: explain the fundamental principles and the practical applications of ultrasonic waves and LASER.

CO2: explain the properties of ultrasonic waves and its applications.

CO3: explain the working of various types of lasers and interpret their applications

CO4: recognize different types of optical fibers and identify their applications in various fields.

CO5: relate particle-wave duality, utilize quantum principles to solve Schrödinger's equations and explain the concepts of dielectrics and its applications.

CO6: identify different types of optical fibers, explain basic quantum physics concepts and explain the significance of dielectrics in electronic devices.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. "Engineering Physics" by Rajendran, V., Tata McGraw Hill Publishing, 2012.
2. "Engineering Physics" by Palanisamy, P. K, Scitech Publications (India), 4th Edition, 2014.

REFERENCES:

1. "Lasers: Fundamentals and Applications" by Thyagarajan. K, & Ghatak. A, Springer Science & Business Media, 2010.
2. "Optical Fiber Communications" by Keiser. G, McGraw-Hill Publishing, 4th Edition, 2000.
3. "A Textbook of Engineering Physics" by Avadhanulu, M. N., Kshirsagar, P. G., & Arun Murthy, T. V. S. 11th Edition ,S. Chand Publishing, 2018.
4. "Introduction to Solid State Physics" by Kittel. C, 8th Edition ,John Wiley & Sons, 2005.
5. "Dielectrics Materials and Applications" by Nair K. M. and Suraishkumar G. K. (Volume 2), Springer, 2019.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2												
2	3	2												
3	3	2	1											
4	3	2	1											
5	3	2												
6	3	2	1											
AVg.	3	2	1											

1-low, 2-medium, 3-high

23FYC114	ENGINEERING CHEMISTRY	L	T	P	C
		3	0	0	3

MODULE I ENERGY SYSTEMS 9

Introduction to batteries – construction - working of Lithium ion - sodium ion batteries - Air batteries: Zinc air battery - Lithium air batteries - Solar photo voltaic cell: Introduction - Construction and Working - advantages and Disadvantages - Quantum Dot sensitized solar cells (QDSSC'S) Principle - properties and applications - Generation of Energy(Green Hydrogen) by Electrolysis of water and its Advantages.

MODULE II ENGINEERING MATERIALS 9

Semiconductors – Insulators - Superconductors- Conducting polymers - LEDs - Liquid Crystals - Photovoltaic cell - Materials used for fabric sensors - Organo Electronics - Molecular Switches - Chemical Sensors - Transducers.

MODULE III DISPLAY 9

Display: Liquid Crystals(LCs) – Introduction – Classification - Properties and Application in Liquid crystal Displays (LCDs) - Properties and applications of organic light emitting Diodes (OLEDs) - Quantum Light emitting Diodes(QLEDs) - Light emitting electrochemical cells.

MODULE IV SENSORS 9

Sensors: Introduction – Working - Principle and application of Conductometric Sensors - Electrochemical sensors - Thermometric Sensors (Flame Photometry) - Optical sensors (Colorimetry) - Sensors for measurement of Dissolved Oxygen (DO) - Electrochemical sensors for the pharmaceuticals - Electrochemical gas sensors for SOX and NOX - Disposable sensors in the detection of biomolecules and pesticides.

MODULE V GREEN CHEMISTRY 9

Principles of Green chemistry - Green Methods in Electronic production - Green materials for Electronic production - Green Materials for Electronics and Advanced Technologies - Aluminium Borosilicate - Glass Iron Alloys - Graphene biomaterials - Electronic-Waste: Plastics in Electronic Waste - Impact of Electronic Waste on environmental public health.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- **CO1:** Apply the concepts of physical chemistry and Engineering materials.
- **CO2:** Apply the concept for developing batteries.
- **CO3:** Develop the material for different electronic devices
- **CO4:** Identify and apply the material for LED technologies.
- **CO5:** Develop different types of Sensors and apply Green Chemistry concepts for fabricating Electronic devices.
- **CO6:** Develop LCD, LED based sensors through green chemistry.

TEXT BOOKS:

1. "A Text book of Engineering Chemistry" by S.S.Dara, S.Chand & Company, New Delhi, 2013.
2. "Engineering Chemistry" by Jain P.C. and Monika Jain., Dhanpat Rai Publishing, New Delhi, 17thEdition, 2006.

REFERENCES:

1. "A Text Book of Engineering Chemistry" by ShashiChawla, 6th Edition ,Danpath Rai & Co., , Reprint, 2017.
2. "Text Book of Engineering Chemistry" by AshutoshKar, ED-Tech Publications, 2018.
3. "Fuel cells, Principles and Applications"by Viswanathan,B. and AuliceScibioh M, Universities press, 2006.
4. "Textbook of Engineering Chemistry" C. Parameswara Murthy, C.V. Agarwal, Andra Naidu, BS Publications, 2019.
5. "Engineering Chemistry" by O.G Palanna, McGraw-Hill Publishing (India), 2017.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	2			1	2	2				1	2	2	3
2	3	2	2	1	1	1	2	2				1	2	2	3
3	3	2	2				2	2				1	2	2	3
4	3	2	2				2	2				1	2	2	3
5	3	2	2	1			2	2				1	2	2	3
6	3	2	2	1	1	1	2	2				1	2	2	3
AVg.	3	3	3	1	1	1	2	2				1	2	2	3

1-low, 2-medium, 3-high

23EC111	ELECTRICAL ENGINEERING AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

MODULE I DC MACHINES **10**

Mesh and Nodal analysis for DC circuits – Construction of DC Machines – Motor and Generator mode: Working - EMF and Torque equation - Methods of Excitation.

MODULE II TRANSFORMERS **9**

Single phase Transformer- Principle - Ideal and Practical Transformer - Constructional details – Equivalent circuit - Voltage Regulation - Auto Transformer.

MODULE III ELECTRICAL INSTALLATION **8**

Systems of Wiring- Accessories of Electrical Installation - Domestic Wiring Installation - Fluorescent Tubes - Earthing of Installation - Testing of Electrical Installation**.**

MODULE IV MEASUREMENTS AND INSTRUMENTATION **9**

Methods of Measurements – Classification of Instruments - Functional elements of an Instrument - Moving Coil and Moving Iron meters –Static and Dynamic Characteristics of Measurement - Errors in Measurement – Bridges – Wheatstone bridge - Maxwell Bridge – Schering Bridge.

MODULE V ELECTRONIC INSTRUMENTS AND TRANSDUCERS **9**

Multimeter – Function Generator - Oscilloscope – Transducers - Classification of Transducers - Strain Gauge - Resistance Thermometers – Thermocouples - LVDT - Piezo electric Transducer - Virtual Instrumentation with LABVIEW - Front Panel - Block diagram – Measurement of Temperature.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

- CO1: Apply mesh & nodal analysis for DC circuits and explain the construction & working of DC Machines and Transformers
- CO2: Interpret the construction and working principle of DC Machines
- CO3: Differentiate the ideal and practical transformer and calculate the voltage regulation of single phase transformer
- CO4: Interpret the system of wiring and testing of domestic electrical Installation.
- CO5: Classify the bridge circuits to determine the unknown impedances and identify the suitable transducers for the measurement of parameters.
- CO6: Summarize the concepts of wiring installation, measurements and electronic instruments.

TEXT BOOKS

1. "Basic Electrical Engineering" BY Mittle V.N., Arvind Mittal., 2nd Edition, Tata McGraw Hill, New Delhi, , 2006.
2. "Modern Electronic Instrumentation and Measurement Techniques" BY Albert D Helfrick, Cooper. W.D, Prentice Hall of India, New Delhi, 2006.

REFERENCES

1. "Principles of Electrical Engineering" by V.K.Mehta, Rohit Mehta,, 2ndEdition,S. Chand & Co., New Delhi, 2011.
2. "Fundamentals of Electrical Engineering and Electronics" by Thereja. B.L , S. Chand & Co., New Delhi, 2022.
3. "Basic Electrical and Electronics Engineering" by Kothari DP and I.J Nagrath, 2nd Edition,McGraw Hill Education, 2020.
4. "A Course in Electrical & Electronic Measurements & Instrumentation" by A.K. Sawhney, Puneet Sawhney, Dhanpat Rai & Co, New Delhi, 2015.
5. "Electronic Measurements and Instrumentation" by R.S. Sedha, 1stEdition, S. Chand & Co., New Delhi, 2013.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2												1	3
2	3													1	3
3	3	1												1	3
4	3					2								1	3
5	3													1	3
6	3					1								1	3
AVg.	3	1.5				1.5								1	3

1-low, 2-medium, 3-high

23FPC122	BASIC SCIENCES LABORATORY	L	T	P	C
		0	0	4	2

PHYSICS LABORATORY

LIST OF EXPERIMENTS

- Determination of Band gap of a Semiconductor.
- Study of I-V characteristics of a solar cell and determination of its efficiency.
- Determination of the capacitance value of an unknown capacitor by charging and discharging.
- Determination of wavelength of a laser light using optical grating.
- Determination of the dielectric constant of a material through capacitance measurement.
- Determination of figure of merit of a galvanometer.
- Determination of specific resistance of a wire.
- Calibration of voltmeter and ammeter using potentiometer.

CHEMISTRY LABORATORY

LIST OF EXPERIMENTS

- Determination of strength of given HCl using NaOH by pH measurement.
- Determination of Alkalinity of water.
- Determination of equivalent conductance of a strong electrolyte.
- Estimation of Dissolved Oxygen in water sample.
- Determination of sodium in water sample by flame photometry
- Estimation of iron in water sample by spectrophotometry
- Determination of corrosion rate of steel in acid media by weight loss method.
- Estimation of ferrous ion by potentiometric titration.

COURSE OUTCOMES

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

CO1: apply various experimental principles, instruments/setup, and procedure and summarize the experimental results.

CO2: develop critical thinking and analytical reasoning ability by interpreting experimental data.

CO3: develop communication skills, teamwork skills and ability to collaborate by working in groups.

CO4: Identify dissolved oxygen, alkalinity and metal ions in water sample.

CO5: Implement different types of elemental analysis through titrations like volumetric, potentiometric and conduct-metric.

CO6: Utilize analytical tools such as spectro-photometer, flame photometer and potentiometer for engineering applications.

TOTAL : 60 PERIODS

REFERENCES:

1. Physics Laboratory Manual Department of Physics, CIT

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	1	3										
2	3	2	1	3										
3									3					
AVg.	3	2	1	3					3					

1-low, 2-medium, 3-high

23EC121	ELECTRICAL ENGINEERING AND INSTRUMENTATION LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

- Verification of series and parallel circuits
- Verification of KVL using Mesh Analysis
- Verification of KCL using Nodal Analysis
- Measurement of resistance using wheat stone bridge
- Measurement of Inductance using Maxwells bridge
- Speed control of dc motor
- V-I characteristics of an incandescent lamp
- Domestic wiring Installation
- Measurement of Temperature/Displacement/Force
- Measurement of frequency using Lissajous Method
- Measurement of signal parameters using CRO

COURSE OUTCOMES:

At the end of the course, students will be able to demonstrate an ability to,

CO1: Apply KVL and KCL to analyse the electric circuits
CO2: Calculate the unknown impedance using bridge circuits
CO3: Apply electrical principles for wiring installation
CO4: Interpret knowledge on sensors, transducers, and CRO
CO5: Develop communication skills and capability to work in team

TOTAL : 30 PERIODS

REFERENCES:

1. Electrical Engineering and Instrumentation Laboratory Manual, Department of ECE, CIT.
2. "Schaum's Outline of Electric Circuits" by Joseph Edminister, MahmoodNahvi, , 7th Edition ,McGraw-Hill Publishing, 2017.
3. "A Course in Electrical & Electronic Measurements & Instrumentation" by A.K. Sawhney, Puneet Sawhney Dhanpat Rai & Co, New Delhi, 2015.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	3	1		1									1	2
2	3	1	1		1	1								1	3
3									1	2					
AVg.	2.5	2	1		1	1			1	2				1	2.5

1-low, 2-medium, 3-high

23EC122	PROBLEM SOLVING SKILLS AND PRACTICES	L	T	P	C
		0	0	2	1

PROBLEM SOLVING:

1. Introduction to problem solving and algorithmic thinking
2. Thinking with numbers
3. Logical Reasoning - Data Arrangements & Relations
4. Solving problems based on Coding & decoding, Series, Analogy, Odd man out , Visual reasoning and finding the shortest path
5. Problems based on Number system, Percentages, Simple & Compound Interest
6. Problems based on Ages, Logical Connectives, Syllogisms, Data Interpretation & Data Sufficiency
7. Order statistics and Introduction to Pseudo coding / algorithm and flowchart development
8. Branching & Repetition problems and finding optimal solutions
9. Solving problems on Clocks Calendars, Direction Sense & Cubes
10. App Development

Total: 30 PERIODS

COURSE OUTCOMES

At the end of the course, students will be able to demonstrate an ability to

CO1: Develop algorithmic solutions to simple computational problems.
CO2: Solve quantitative aptitude and logical reasoning problems.
CO3: Develop flowchart and algorithm for solving scientific or technical problems.
CO4: Solve Branching & Repetition problems and find optimal solutions.
CO5: Develop communication skills and capability to work in team.

REFERENCES:

1. "Quantitative Aptitude for Competitive Examination" by R.S. Aggarwal, S. Chand & Co., New Delhi, 2017.
2. “Quantitative Aptitude for Competitive Examinations” by Dinesh Khattar, Pearson Publishing, 2020.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2		1	1				2	2			1	1	3
2	3	2		1	1				2	2			1	1	3
3									3	2			1	1	
AVg.	2	2		1	1				2.33	2			1	1	2

1-low, 2-medium, 3-high

23FYM214	COMPLEX VARIABLES, LAPLACE TRANSFORMS AND FOURIER SERIES	L	T	P	C
		3	1	0	4

MODULE I ANALYTIC FUNCTIONS 9

Analytic functions – Necessary and sufficient conditions – Cauchy-Riemann equations - Properties of analytic functions – Harmonic conjugates – Construction of an analytic function - Conformal mapping by elementary functions ($w = z+a$, cz, $1/z$, z^2) - Bilinear transformation.

MODULE II COMPLEX INTEGRATION 9

Cauchy's integral theorem – Cauchy's integral formula – Laurent's series – Classification of Singularities – Cauchy's Residue theorem – Applications - Contour integration using circular and semicircular contours.

MODULE III LAPLACE TRANSFORMS 9

Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems - Transforms of derivatives and integrals – Initial and final value theorems - Transforms of periodic functions – Inverse transforms – Convolution theorem.

MODULE IV FOURIER SERIES 9

Response of LTI Systems to Complex Exponentials – Fourier Series Representation of Continuous time Periodic Signals – Magnitude and Phase Spectra of a Periodic Signal – Continuous time Fourier Series Analysis Equation – Convergence of Continuous time Fourier Series – Gibbs Phenomenon – Properties of Continuous Time Fourier Series.

MODULE V APPLICATIONS OF LAPLACE TRANSFORMSAND FOURIER SERIES 9

Application to solution of linear second order ordinary differential equations with constant coefficients using Laplace transforms.

Application of Fourier Series – Response of a Continuous Time Linear Time Invariant system to a periodic signal, Harmonic analysis.

TOTAL: (45+15) PERIODS

COURSE OUTCOMES:

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

CO1. Determine the conjugate harmonic function and apply the concept of singularities in evaluation of contour integrals.
CO2. Make use of the concepts of analytic functions, conformal mapping and bilinear transformation.
CO3. Apply ideologies of complex integration and its properties.
CO4. Apply Laplace transform, inverse Laplace transform for standard functions and periodic functions.
CO5. Calculate both real and complex forms of Fourier series, utilize Fourier series to analyze continuous time signals.
CO6. Apply Laplace transform technique for various related theorems, solve second and higher order ordinary differential equations, test the convergence of continuous time Fourier series and apply the continuous time Fourier series to find the response of CT LTI system

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 44th Edition, 2017.
2. Krishnaveni.V and Rajeswari. A, "Signals and Systems", Wiley India, 1st Edition, Reprint, 2019.

REFERENCES:

1. "Advanced Engineering Mathematics" by Erwin Kreyszig, 10th Edition, John Wiley & Sons, New Delhi, 2018.
2. "Engineering Mathematics" by Srimanta Pal and Suboth. C. Bhunia, Oxford University Press, New Delhi, 2015.
3. "Advanced Engineering Mathematics" by Bali N., Goyal M. and Watkins C., Firewal Media, 8th Edition, Lakshmi Publications, New Delhi, 2015.
4. "Advanced Engineering Mathematics" by Jain R.K. and Iyengar S.R.K., 5th Edition, Narosa Publications, New Delhi , 2016.
5. "Engineering Mathematics" by Sastry, S.S, Vol. I & II, 4th Edition ,PHI Learning, New Delhi, 2014.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	1									1	2	
2	3	3	1									1	2	
3	3	3	1									1	2	
4	3	3	1									1	2	
5	3	3	1									1	2	
6	3	3	1									1	2	
AVg.	3	3	1									1	2	

1-low, 2-medium, 3-high

23FYP212	SEMICONDUCTOR PHYSICS	L	T	P	C
		2	0	0	3

MODULE I CRYSTALLOGRAPHY 9

Crystal structure – crystal lattice –basis – unit cell and lattice parameters – crystal systems and Bravais lattices – Miller indices – d-spacing in cubic lattice – Atomic radius, coordination number and packing factor for simple cubic, body centred cubic, face centred cubic and hexagonal close packed structures - Crystal imperfections – point and line defects - Burger vector.

MODULE II ELECTRONIC MATERIALS 9

Classical free electron theory – Expression for electrical conductivity and Thermal conductivity – Widemann-Franz law – Lorentz number – Merits and drawbacks of classical free electron theory – Quantum theory – Fermi distribution function – Effect of temperature on Fermi Function – Density of energy states – carrier concentration.

MODULE III BAND THEORY 9

Electron in periodic potential: Bloch theorem – Energy bands in solids – classification of solids on the basis of band theory –tight binding approximation – effective mass of electron – concept of hole – E-k diagram – directand indirect band gap semiconductors–elementaland compound semiconductors.

MODULE IV INTRINSIC AND EXTRINSIC SEMICONDUCTORS 9

Intrinsic semiconductor:energy band diagram – carrier concentration –electrical conductivity – band gap determination – Extrinsic semiconductor: n-type doping – p-type doping – compensation doping– carrierconcentration derivation in n-type and p-type semiconductor (no derivation) – temperature dependence of conductivity –Hall effect – determination of Hall coefficient – applications.

MODULE V SEMICONDUCTOR PARAMETER MEASUREMENTS 9

Four-point probe and van der Pauw measurements for carrier density, resistivity, and mobility; Hot-point probe measurement, capacitance-voltage measurements, parameter extraction from diode I-V characteristics, DLTS, band gap by UV-Vis spectroscopy, absorption/transmission.

COURSE OUTCOMES:

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

CO1. understand the atomic arrangement in crystals and also about the basic concepts of classical and quantum free electron theories.
CO2. identify crystals based on their atomic arrangement and also gain knowledge about the imperfections present in crystals.
CO3. recall the limits of classical physics and use quantum physics and apply these ideas to explain the behaviour of free electron in semiconductors.
CO4. apply band theory to classify materials and also utilize doping techniques for modifying semiconductor properties.
CO5. examine charge transport properties of semiconducting materials and their characterization techniques.
CO6. identify suitable semiconductor materials for device applications.

TOTAL: 45 PERIODS

TEXTBOOKS:

1. "Solid State Electronic Devices by Ben G. Streetman and Sanjay Kumar Banerjee ", 6th Edition, 2005, Pearson.

2. "Principles of Electronic Materials and Devices", by S. O. Kasap, 4th Edition, 2020, McGraw-Hill Education

REFERENCES:

1. "Introduction to Solid State Physics", Charles Kittel, 8th Edition, Wiley 2004.
2. "Semiconductor Physics and Devices, Basic Principles", Donald A. Neamen, 4th Edition, McGraw-Hill Education2011
3. "Solid State Physics" ¸by Neil W. Ashcroft and N. David Mermin, 1st Edition, Brooks Cole1976
4. "Nanoelectronics and Nanosystems", Goser, K., Glosekotter, P., & Dienstudent, J., Springer International Edition2005
5. "Semiconductor Device Fundamentals", Robert F. Pierret, 2nd Edition ,Addison-Wesley,,1996.

CO-PO & PSO MAPPING

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2													
2	3	2													
3	3	2													
4	3		1												
5	3		1												
6	3	2	1												
AVg.	3	2	1												

1-low, 2-medium, 3-high

23EC211	PROBLEM SOLVING USING C PROGRAMMING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO C PROGRAMMING 11

Fundamentals of programming –Programming Languages - Program Execution - Structured Programming – Algorithm - Flowchart - C data types - Operators- Hierarchy of operators – Associativity of operators – Expressions. Single dimensional arrays – console I/O functions - formatted I/O.

MODULE II CONTROL STATEMENTS 9

If statements, if-else statement, nested if statements – Ternary operators – while loop, do-while loop, for loop-break statement - continue statement - switch case statement – Goto statement.

MODULE III ARRAYS AND POINTERS 8

Arrays: Defining an array - Processing an array – Multidimensional arrays – Strings.
Pointers: Definition - Pointer Arithmetic – types of pointer - const pointer, pointer to a constant, void pointer, null pointer.

MODULE IV FUNCTION 8

Function declaration and prototypes – parameter passing Recursion - Function pointers - Passing pointers to functions – Passing arrays to functions - passing function to other functions, Storage classes.

MODULE V STRUCTURES AND FILES 9

Definition of structure – Array of structures – Pointer to structures - Self-referential structures – Union - Bit fields - typedef – enum data types - File handling: opening, closing, reading & writing a data file.

TOTAL: 45 PERIODS

COURSE OUTCOMES

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

CO1. Construct flowchart and develop C program solution to solve simple problems using conditional and looping statements
CO2. Illustrate data types, operators, and I/O function for writing C programs
CO3. Develop C programs using conditional and looping statements and interpret results
CO4. Develop C programs using arrays, pointers and standard string library functions and interpret results
CO5. Develop C Programs using function, structures, union & files and interpret results
CO6. Identify given problems and develop solutions using functions, structures and files

TEXT BOOKS:

1. Byron S.Gottfried and Jitender Kumar Chhabra, “Programming with C”, Tata McGraw Hill Publishing, New Delhi, 4th Edition, 2018.
2. E. Balaguruswamy, “Programming in ANSI C”, Tata McGraw-Hill Publishing Company, New Delhi, 8th Edition, 2019.

REFERENCES:

1. PradipDey and ManasGhosh, “Programming in C”, Oxford University Press, New Delhi, 2nd Edition, 2018.
2. Deitel and Deitel, “C How to Program”, Pearson Education, New Delhi, 9th Edition, 2021.
3. YashwantKanetkar, “Let us C”, BPB Publications, 17th Edition, 2020.

4. Brian W.Kernigham and Dennis M.Ritchie, “C programming Language (ANSI C)”, Prentice Hall of India, New Delhi, 2010.
5. Yashwant Kanetkar, “Understanding Pointers in C & C++”, BPB Publications, 5th Edition, 2019.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3											2	
2	3	3											2	
3	3	3											2	
4	3	3											2	
5	3	3											2	
6	3	3											2	
Avg.	3	3											2	

1 - low, 2 - medium, 3 - high

23EC212	ELECTRON DEVICES	L	T	P	C
		3	0	0	3

MODULE I PN JUNCTION DIODE 10

PN junction diode - Current equations – Forward and reverse bias characteristics - Resistance Level – Diode Equivalent circuit - Transition capacitance – Diffusion capacitance – Reverse Recovery time - Avalanche and Zener breakdown – Zener diode – Application: Clipper and Clamper Circuits – Voltage Multiplier – Half Wave and Full Wave rectifier – Zener Voltage Regulator.

MODULE II BIPOLAR JUNCTION TRANSISTOR 8

Transistor Construction – Transistor Operation - Transistor Configuration - Input and Output characteristics of CE, CB and CC - Early effect - BJT Transistor Modeling: r_e transistor model – h-parameter – Ebers' Moll Model.

MODULE III FIELD EFFECT TRANSISTORS 9

JFET - Types – construction - Drain and Transfer characteristics - Current equations – Pinch-off voltage and its significance - MOSFET-Enhancement MOSFET – Depletion MOSFET – Characteristics of MOSFET – Channel Length Modulation – FET switching - Comparison of JFET and BJT.

MODULE IV SPECIAL SEMICONDUCTOR DEVICES* 9

Schottky Barrier diode – Varactor diode – Tunnel diode – LASER diode – LDR – Photo diode – Photo Transistor – IR Emitter – MESFET – FINFET.

MODULE V POWER DEVICES AND DISPLAY DEVICES* 9

Power diode – UJT – SCR – DIAC – TRIAC – VMOS – LED – LCD – Opto Coupler – Solar cell – CCD.

*Qualitative Treatment only

COURSE OUTCOMES

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

CO1: Infer the characteristics of diode and BJT configuration
CO2: Interpret the operation and characteristics of semiconductor diode and its applications.
CO3: Model the Bipolar Junction Transistor and possess a comprehensive knowledge of its working details and its characteristics.
CO4: Interpret knowledge on construction, working details and switching characteristics of Field Effect Transistor (FET)
CO5: Summarize the concepts of special semiconductor devices and display devices.
CO6: Categorize the types of Field Effect Transistor and summarize the concepts of special semiconductor and display devices

TOTAL: 45 PERIODS

TEXT BOOKS:

1. "Electronic Devices and Circuit Theory" by Robert L. Boylstead and Louis Nashelsky, 11th Edition, Prentice-Hall of India, New Delhi,, 2017.
2. "Electronic Devices and Circuits" by David A. Bell, , 5th Edition, Oxford Higher education, 2010.

REFERENCES:

1. "Semiconductor Physics and Devices" by Donald A Neaman, , 4th Edition, Tata McGraw Hill, 2017.
2. " Micro Electronic circuits" by Adel .S. Sedra, 7th Edition ,Kenneth C. Smith Oxford University Press, 2014.
3. "Electronic Devices and Circuits: An Introduction" by Allen Mottershed, PHI Learning, 2015.

4. “Electronic Devices” by Thomas L.Floyd, 9th Edition , Pearson Education Asia, 2017.
5. “Electron Devices and Circuits” by Salivahanan, 2nd Edition, Tata McGraw-Hill, New Delhi, 2017.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2												1
2	3	1												1
3	3	1												1
4	3	1												1
5	3	1												1
6	3	1												1
Avg.	3	1.16												1

1 - low, 2 - medium, 3 - high

23EC213	NETWORK THEORY	L	T	P	C
		3	1	0	4

MODULE I NETWORK TOPOLOGY AND THEOREMS 9

Network Topology: Graphs of a network - Tree and co-tree - Twigs and Links **-** Incidence Matrix and its properties - Reduced Incidence matrix - Link Currents.

Network theorems: Superposition theorem - Thevenin's theorem - Norton's theorem - maximum power transfer theorem – duals and duality (for AC and DC circuits with independent sources).

MODULE II RESONANCE CIRCUITS 9

Series resonance - impedance and phase angle of a series resonant circuit - Voltages and currents in a series resonant circuit - Bandwidth of an RLC circuit - Quality factor and its effect on bandwidth- magnification in resonance - Parallel resonance - Resonant frequency for a tank circuit – Variation of impedance with frequency - Q-factor of parallel resonance – magnification.

MODULE III COUPLED CIRCUITS 9

Conductively coupled circuit and mutual impedance - Mutual inductance - Dot convention - Coefficient of coupling - Analysis of multi winding coupled circuit - Series and parallel connection of coupled circuits -Tuned circuits - Single Tuned circuits.

MODULE IV TRANSIENTS 9

Steady state and transient response - Classical methods of analysis for determining the DC and Sinusoidal Response of series RL, RC and RLC Circuits.

MODULE V ELEMENTS OF REALIZABILITY AND SYNTHESIS OF ONE-PORT NETWORKS 9

Hurwitz polynomials - Positive real functions - Frequency response of reactive one port - Synthesis of reactive one port - Synthesis of RL network and RC network by Foster and Cauer method.

COURSE OUTCOMES:

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

CO1. Calculate the circuit parameters using network theorems and resonant circuits.
CO2. Determine the network characteristics and use fundamental network theorems to find the voltage and current in DC and AC circuits.
CO3. Model the resonant circuit and calculate its resonant frequencies.
CO4. Use dot convention method to design the magnetically coupled circuits.
CO5. Predict the steady-state and transient response of series RL, RC, and RLC circuits, as well as synthesize one-port networks.
CO6. Compare coupled circuits, response of series RL, RC, and RLC circuits, and construct one-port networks.

TOTAL: (45+15) PERIODS

TEXT BOOKS:

1. "Circuits and Networks-Analysis and Synthesis" by Sudhakar A. and Shyam Mohan S.P, 5th Edition, Tata McGraw Hill, New Delhi, 2017.
2. "Circuit Theory" by Chakrabarti A., 7th Edition, Dhanpat Rai & Co., New Delhi, , 2018.

REFERENCES:

1. "Network Analysis" by Van Valkenburg and T.S. Rathore, 3rd Edition, Prentice Hall 2019.
2. "Networks Analysis with applications" by William D.Stanley, 4th Edition ,Pearson Education, 2009.
3. "Electric Circuits" by Mahmood Nahvi, Joseph A. Edminister, 7th Edition, Schaum's outline series, Tata McGraw Hill, New Delhi, 2017.
4. "Electric Circuits and Networks" by Suresh Kumar. K.S, 1st Edition ,Pearson Education, Delhi, 2008.
5. "Engineering Circuit Analysis" by William Hart Hayt, Jack E. Kemmerly, 8th Edition, Tata McGraw Hill, New Delhi, 11th Reprint, 2016.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3												1
2	3	3												1
3	2		1											1
4	2		1											1
5	2	2												1
6	2	2	1											1
Avg.	2.3	2.5	1											1

1 - low, 2 - medium, 3 - high

23FYH221	ENGLISH COMMUNICATION COMPETENCY LABORATORY	L	T	P	C
		0	0	4	2

MODULE I VERBAL APTITUDE

Alphabet test – Alphabet Order, Alphabet Series - Letter Word Problem, Word Formation and Scramble - Series Completion – Para Jumbles- Synonyms and Antonyms - Sentence Completion - Logical Sequence of Words - Word Power Exercises - Common Errors in English - Sentence Correction.

MODULE II SPEAKING AND WRITING

Self-Introduction- Greeting - Thanking – Apologizing - Congratulating - Complaining - Giving Instructions - Advising and Sympathizing – Requesting and warning people - Introduction to Phonetics – Consonants and Vowels - Extempore - Just a Minute - Book Reviews - Describing an object -- Story Building – Creative Writing – Describing a Picture – Dialogue Writing – Paraphrasing.

MODULE III READING AND LISTENING

Reading Comprehension- Skimming and Scanning - Reading Prose – Bacon's Essays (Speaking Activity based on the essays) - Listening to Short Conversations – Listening to Monologues – Listening and Gap Filling.

MODULE IV CAREER DEVELOPMENT SKILLS

Technical Presentation - Applications of MS Power Point - Group Discussion – Interview Skills - Telephoning Skills

List of Experiments based on the above syllabus:

- Speech Sounds
- Vocabulary
- Reading Comprehension
- Listening Practice - I
- Dialogue Writing
- Conversational Exercise - I
- Focus on Language
- Creative Writing
- Conversational Exercise –II
- Listening Practice - II
- Greeting & Thanking
- Complaining, Apologizing & Congratulating
- Asking & Giving Directions
- Alphabet Series & Letter Series Word Formation
- Para Jumbles
- Synonyms and Antonyms
- Sentence Completion & Correction
- Presentation Skills
- Group Discussion
- Interview Skills

COURSE OUTCOMES:

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

CO1: Solve timed objective questions on logical reasoning and verbal ability.
CO2: Use appropriate functional expression and converse effectively.
CO3: Assimilate meaning and comprehend text.
CO4: Perceive the nuances of Presentation, Interview and Group Discussion skills.
CO5: Generate language structures accurately and speak fluently.

TOTAL: 60 PERIODS

REFERENCES

"Touchstone – Level 2" by Michael Mccarthy et al. , 2nd Edition, Cambridge University Press 2014.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1									2	3		1		
2									2	3		1		
3									2	3		1		
Avg.									2	3		1		

1 - low, 2 - medium, 3 - high

23EC221	C PROGRAMMING LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

Develop C Programs using

- I/O Statements
- Operators and Expressions
- Decision-making Constructs (if, if-else if ladder, switch and goto)
- Looping Constructs (for, while, do-while, nested loops)
- Multi-dimensional Arrays
- Built-in functions for String Manipulation
- Pointers
- Function, its types and function-call
- Structures
- File Access

The above experiments are executed using TURBO C/DEV C/ONLINE COMPILER

COURSE OUTCOMES:

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

CO1. Develop C programs using conditional & looping statements and develop flowcharts for the given problem.

CO2. Develop C programs using arrays & standard string library functions and develop flowcharts for the given problem.

CO3. Develop C Programs using pointers & functions and develop flowcharts for the given problem.

CO4. Develop C Programs using structures & files and develop flowcharts for the given problem.

CO5. Develop communication skills and capability to work in teams

TOTAL: 30 PERIODS

REFERENCES:

1. "Programming with C" by Byron S.Gottfried and Jitender Kumar Chhabra,, , 4th Edition ,Tata McGraw Hill Publishing, New Delhi, 2018.
2. "C programming Language(ANSI C)" by Brian W.Kernigham and Dennis M.Ritchie, , 2nd Edition Pearson India, 2015.
3. "Programming in C" by PradipDey and ManasGhosh, 2nd Edition, Oxford University Press, New Delhi, 2011.
4. "C How to Program" by Deitel and Deitel, , 7th Edition, Pearson Education, New Delhi2013.
5. "Programming in ANSI C" by E. Balaguruswamy, 8th Edition Tata McGraw-Hill, New Delhi, 2019.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	2	1	2	2			2	2			2	2
2	3	3	2	1	2	2			2	2			2	2
3									3	2				
Avg.	3	3	2	1	2	2			2.33	2			2	2

1 - low, 2 - medium, 3 - high

23EC222	DEVICES AND CIRCUITS LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

- Verification of Super Position Theorem
- Verification of Thevenin & Norton theorem
- Verification of maximum power transfer theorem
- Characteristics of PN Junction Diode
- Zener diode Characteristics & application
  - Characteristics of Zener diode using Multisim
- Wave Shaping Circuits
- Rectifier Circuits
  - Full wave rectifier using Multisim
- Common Emitter input-output Characteristics
- Characteristics of FET
- Characteristics of SCR
- Characteristics of LDR

COURSE OUTCOMES:

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

CO1: Use network theorems for analysing electronic circuits and validate the results

CO2: Examine the characteristics of semiconductor diodes and calculate its parameters under forward and reverse bias conditions

CO3: Construct wave shaping circuits and calculate the ripple factor in rectifier circuits.

CO4: Examine the characteristics of BJT, FET, SCR & LDR

CO5: Develop communication skills and capability to work in team.

TOTAL: 30 PERIODS

REFERENCES:

1. Laboratory Manual prepared by ECE Department, CIT.
2. "Fundamentals of Electronic Devices and Circuits Lab Manual" by David A Bell, , 5th Edition ,Oxford University Press, Canada, 2009.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2												1
2	3	2												1
3									1	2				1
Avg.	2	2							1	2				1

1 - low, 2 - medium, 3 - high

23FYC221	ENVIRONMENTAL SCIENCE & ENGINEERING	L	T	P	C
		1	0	0	1

MODULE I NATURAL RESOURCES **3**

Forest resources: Use and over - exploitation and deforestation.
Water resources: Use and over - utilization of surface and ground water. Dams - benefits and problems.
Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources.

MODULE II ENVIRONMENTAL POLLUTION **3**

Sources, causes, effects and management of air pollution and water pollution, soil pollution and radioactive pollution - Solid waste Management.

MODULE III ECOSYSTEM AND BIODIVERSITY **3**

Concept of an ecosystem - structure and functions - food chain and food webs.
Biodiversity - types, Importance and values of biodiversity, India as a mega diversity nation, hot spots of biodiversity, Threats to biodiversity, conservation of biodiversity.

MODULE IV GREEN CHEMISTRY 3

Significance of green chemistry - basic components of green chemistry. Industrial application of green chemistry - green fuels - e-green propellants and bio catalysts.

MODULE V GLOBAL ENVIRONMENTAL ISSUES AND MANAGEMENT **3**

Water conservation, Rain water harvesting, Climate change, Ozone depletion, Acid rain, Greenhouse effect and global warming. Disaster management - Earthquakes, Floods, Landsides and cyclones.

COURSE OUTCOMES:

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

CO1: Use natural resources effectively and interpret cause of environmental pollution.

CO2: Utilize forest, water and mineral resources effectively

CO3: Interpret cause of environmental pollution and control.

CO4: Identify the importance of biodiversity and take measures to conserve biodiversity

CO5: Predict threat to biodiversity and apply the components of green chemistry in industries.

CO6: Develop remedy for global environmental issues and conserve biodiversity.

TOTAL: 15 PERIODS

TEXT BOOKS:

1. "Text book of Environmental chemistry and Pollution Control" by S.S.Dara, S.Chand & Co. Ltd., New Delhi, 2011.
2. "Environmental Studies" by R.Rajagopalan, Oxford University Press, New Delhi, 2015.

REFERENCES:

1. "A Basic Course in Environmental Studies" by Surinder Deswal & Dr. Anupama Deswal, Dhanpat Rai & Co., New Delhi, 2013.
2. "Environmental Studies" by Benny Joseph, Tata McGraw-Hill Publishing, New Delhi, 2018.
3. "Environmental Science and Engineering" by Anubha Kaushik & C.P. Kaushik, 2nd Edition, New Age International Publishers, 2006.
4. "Introduction to Environmental Science and Technology" by Dr.S.Amalraj, Laxmi Publications, New Delhi, 2005.
5. "A Text book of Environmental Science", Vidhya Thakur, Scientific Publishers, India, 2019.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	2				1	3	2				1		
2	2	2	2			1	3	2				1		
3	2	2	2			1	3	2				1		
4	2	2	2			1	3	2			1	1		
5	2	2	2	1		1	3	2	1		1	1		
6														
Avg.	2	2	2	1		1	3	2	1		1	1		

1 - low, 2 - medium, 3 - high

SEMESTER III

23M314	LINEAR ALGEBRA AND PROBABILITY	L	T	P	C
		3	1	0	4

MODULE I MATRICES 9+3

Eigenvalues and Eigenvectors— Properties of Eigenvalues and Eigenvectors (without proof) – Cayley-Hamilton theorem (without proof)-Applications to find the inverse and higher powers of a matrix – Diagonalization of matrices using orthogonal transformation –Transformation of Quadratic form to canonical form.

MODULE II VECTOR SPACES AND LINEAR TRANSFORMATION 9+3

Vector spaces and Subspaces-Null spaces, column spaces, span - Linear Transformations- Matrix representation of Linear Transformations- Linearly Independent sets; Bases-Coordinate systems-The dimension of a vector space-Rank and Nullity-Change of Basis.

MODULE III INNER PRODUCT SPACES 9+3

Inner product, Length and orthogonality - Orthogonal sets- Orthogonal Projections –The Gram-Schmidt process-Least-Squares problems, Singular value decomposition.

MODULE IV PROBABILITY AND DISTRIBUTIONS 9+3

Probability Axioms – Conditional Probability: Law of Total Probability, Bayes' Theorem.

Discrete Random Variables: Probability Mass Function – Bernoulli, Binomial and Poisson Random Variables – Cumulative Distribution Function – Expectations.

MODULE V TWO-DIMENSIONAL RANDOM VARIABLES 9+3

Continuous Random Variables: Probability Density Function – Uniform, Exponential and Gaussian Random Variables, Expectations.

Pairs of Random Variables: Joint Cumulative Distribution Function – Joint Probability Mass Function – Marginal Probability Mass Function – Joint Probability Density Function – Marginal Probability Density Function – Expected Values – Covariance – Correlation – Independent Random Variables.

COURSE OUTCOMES:

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

CO1: apply the concept of Cayley Hamilton theorem to find the inverse of the matrix, relate matrices and linear transformations that evolves as a generalization of real time problems.

CO2: make use of various computational techniques and algebraic skills in the study of eigenvalues, eigenvectors, diagonalization and quadratic forms.

CO3: examine how to impose a coordinate system on a vector space and compare the null space and column space of a matrix.

CO4: determine the orthonormal basis of inner product spaces, find the least square approximations and perform matrix decomposition.

CO5: apply the basic probability axioms and concepts in engineering field, evaluate mean, variance for discrete and continuous probability distributions.

CO6: make use of Gram-Schmidt orthogonalization process, probability functions of discrete, continuous random variables and correlation in engineering applications.

TOTAL: 45+15 PERIODS

TEXT BOOKS:

1. "Linear Algebra and its Applications" by David C.Lay, 6^{th} Edition, Pearson Education, 2021.
2. "Probability and Statistics for Engineering and Sciences" by Jay L Devore, Cengage Learning, 2015.

REFERENCES:

1. "Linear Algebra" by Stephen H. Friedberg, Arnold J.Insel, Lawrence E. Spence, 5th Edition, Pearson, 2022.
2. "Linear Algebra – A Geometric Approach" by Kumaresan, S., Reprint, Prentice – Hall of India, New Delhi, 2010.
3. "Higher Engineering Mathematics" by Grewal B.S., 44^{th} Edition, Khanna Publishers, New Delhi, 2021.
4. "Probability and Stochastic Processes" Roy D. Yates and David J Goodman, A friendly Introduction for Electrical and Computer Engineers, John Wiley & Sons, New Delhi, 2012.
5. "Miller and Freund's Probability and Statistics for Engineers" by R.A.,Miller and Freund J., 8^{th} Edition, Pearson Education, Asia, 2015.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	1									1	1	
2	3	3	1									1	1	
3	3	3	1									1	1	
4	3	3	1									1	1	
5	3	3	1									1	1	
6	3	3	1									1	1	
Avg.	3	3	1									1	1	

1 - low, 2 - medium, 3 - high

23EC311	SIGNALS AND SYSTEMS	L	T	P	C
		3	1	0	4

MODULE I INTRODUCTION TO SIGNALS AND SYSTEMS 12+3

Basic continuous time signals and discrete time signals - Representation of signals in terms of impulses - Continuous time systems - Discrete time systems - Properties of systems - Linear Time Invariant systems - Convolution Integral – Convolution Sum.

MODULE II FOURIER ANALYSIS OF CONTINUOUS TIME SIGNALS AND SYSTEMS 9+3

Continuous Time Fourier Series - Continuous Time Fourier Transform - Properties of Fourier Transform - Response of Continuous time systems to complex exponentials - Continuous time system representation by differential equations - Frequency response of systems characterized by differential equations.

MODULE ILL SAMPLING 7+3

Representation of continuous time signals by its samples – Impulse train sampling- Zero-Order hold sampling- Reconstruction from samples using interpolation - Effect of under sampling - Aliasing error.

MODULE IV FOURIER ANALYSIS OF DISCRETE TIME SIGNALS AND SYSTEMS 9+3

Discrete Time Fourier Series - Fourier Transform of Discrete time aperiodic signals - Properties of Discrete Time Fourier Transform - Response of discrete time systems to complex exponentials - Discrete time system representation by difference equation - Frequency response of systems characterized by difference equations.

MODULE V z TRANSFORM ANALYSIS OF DISCRETE TIME SIGNALS AND SYSTEMS 8+3

z-Transform and Inverse z-Transform using partial fractions - Properties of z transform - Analysis and characterization of Discrete time LTI system using z-Transform- State space representation of Discrete- time LTI systems.

COURSE OUTCOMES:

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

CO1: represent basic continuous time and discrete time signals and systems and explain signal properties such as periodicity, even or odd, energy or power and system properties such as causality, linearity and time-invariance.

CO2: find the response of an LTI System for a given continuous time or discrete time input signal.

CO3: determine the frequency response of periodic and aperiodic continuous time signals.

CO4: convert a continuous time signal into discrete time signal and reconstruct the continuous time signal.

CO5: determine the frequency response of periodic and aperiodic discrete time signals.

CO6: analyze and characterize LTI system using z-Transform.

TOTAL: 45+15 PERIODS

TEXT BOOKS:

1. "Signals and Systems" by Alan V. Oppenheim, Alan S. Willsky, 2nd Edition, Pearson Education, 2015.
2. "Signals and Systems" by Krishnaveni.V and Rajeswari. A, 1st Edition, Wiley India Pvt. Ltd, Reprint 2019.

REFERENCES:

1. "Signals and Systems, by Haykin. S and Barry Van Veen, 2nd Edition , John Wiley and Sons, 2021.
2. "Signals and Systems" by Hsu.H.P and Rakesh Ranjan, 3rd Edition, Tata Mc Graw Hill, 2008.
3. "Signals and Systems" by Sanjit Kumar Mitra 1st Edition, Oxford University Press, 2015
4. "Linear Systems and Signals" by Lathi. B. P, 3rd Edition , Oxford University Press, 2018.
5. "Signals and Systems - Continuous and Discrete" by Ronald E. Ziemer, William H. Transter and Ronald. D. Fanmin, 4th Edition, Pearson Higher Education, 1998.
6. https://ocw.mit.edu/courses/res-6-007-signals-and-systems-spring-2011.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	1							1	1			2	2
2	3	2	1		3				1	1		1	3	2
3	3	2	1						1	1		1	3	1
4	2	1							1	1		1	2	1
5	3	2	1						1	1		1	3	
6	3	3	2	1					1	1		1	3	
Avg.	2.67	1.83	1.25	1	3				1	1		1	2.67	1.5

1 - low, 2 - medium, 3 - high

23EC312	ANALOG ELECTRONICS	L	T	P	C
		3	0	0	3

MODULE I TRANSISTOR BIASING CIRCUITS 10

DC load line - Operating point – BJT biasing circuits: Fixed bias configuration, Emitter bias configuration, Voltage divider bias configuration- Emitter follower configuration – Common base configuration – Bias stabilization – Stability factors

FET & MOSFET biasing circuits: Fixed bias configuration - self bias configuration - voltage divider biasing – common gate configuration - Depletion Type MOSFETs - Enhancement Type MOSFETs

MODULE II BJT AMPLIFIERS 9

AC load line – approximate hybrid equivalent circuit - Common emitter amplifier: Fixed bias configuration, voltage divider configuration, un-bypassed emitter bias configuration - Emitter follower -Common Base amplifier - Multistage amplifiers: capacitor coupled two stage amplifier - direct coupled two stage circuits - Two stage circuit with emitter follower output-Cascode amplifiers

MODULE III FET AMPLFIERS 9

AC load line – FET AC equivalent circuit – Common source amplifier - Common gate amplifier –

Source follower – MOSFET AC equivalent circuit – D - MOSFET voltage divider configuration - E-MOSFET Drain feedback configuration - E-MOSFET voltage-divider configuration

MODULE IV FREQUENCY ANALYSIS OF BJT AND FET AMPLIFIERS 8

Low frequency analysis - low frequency response of BJT amplifier, low frequency response of FET amplifier - Miller effect capacitance - high frequency response of BJT amplifier: high frequency hybrid π model, short circuit current gain, beta cut-off frequency, alpha cut-off frequency, unity gain bandwidth - high frequency response of FET amplifier - multistage frequency effect

MODULE V POWER AMPLIFIERS AND FEEDBACK AMPLIFIERS 9

Series-Fed Class A Amplifier - Transformer coupled class A Amplifier, class B and class AB power amplifier- Amplifier distortion - Power transistor heat sinking - Class C amplifiers.

Feedback concepts - Feedback connection types – Practical feedback circuits – Current series and Current shunt feedback using BJTs - Voltage series and Voltage shunt feedback using FETs.

COURSE OUTCOMES:

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

CO1: apply circuit analysis techniques to compute the operating point, stability factors for BJT biasing circuits and to compute gain & impedance for single stage BJT amplifiers using approximate hybrid model.

CO2: apply circuit analysis techniques to compute the operating point for FET and MOSFET amplifiers.

CO3: apply small signal analysis to compute voltage gain for multistage BJT amplifiers

CO4: make use of the small signal model of FET to compute voltage gain and impedance for FET amplifiers

CO5: infer the frequency response characteristics of BJT amplifiers, FET amplifiers and feedback amplifiers

CO6: interpret the operating principle and characteristics of FET amplifiers, different classes of power amplifiers and feedback amplifiers

TOTAL: 45 PERIODS

TEXT BOOKS:

1. "Electron Devices and Circuits: Theory and Practice" by Robert L. Boylestead and Louis Nasheresky, 11th Edition, Prentice Hall of India 2017.
2. "Electronic Devices and Circuits" by David A. Bell, 5th Edition, Prentice Hall of India ,2010.

REFERENCES:

1. "Integrated Electronics" by Millman and Halkias.C, 2nd Edition, Tata McGraw Hill ,2010.
2. "Electronic Devices: Conventional Current version" by Thomas.L.Floyd, 9th Edition, Pearson, 2015.
3. "Micro Electronic Circuits" by Adel .S. Sedra, Kenneth C. Smith, 7th Edition, Oxford University Press, 2014.
4. "A Textbook of Electronic Devices and Circuits" by Dr.R.S.Sedha, 1st Edition , S.Chand and Company Ltd., 2015
5. "Electronic Circuit Analysis" by B. Visvesvara Rao, K.Raja Rajeswari, P. Chalam Raju Pantulu and K.Bhaskara Rama, 1st Edition, Pearson, 2011.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	1											1
2	3	2	1											1
3	3	2	1											1
4	3	2	1											1
5	3	1	1											1
6	3	1	1											1
Avg.	3	1.66	1											1

1 - low, 2 - medium, 3 - high

23EC313	DIGITAL ELECTRONICS	L	T	P	C
		3	0	0	3

MODULE I NUMBER SYSTEMS AND BOOLEAN ALGEBRA 9

Binary Number Systems - Binary codes - Boolean Algebra and Functions - Canonical and standard forms - Digital Logic gates - Karnaugh Map-Product of Sums Simplification - Sum of Products Simplification - Don't care conditions - NAND and NOR implementation - Quine-McCluskey method.

MODULE II COMBINATIONAL LOGIC CIRCUITS 9

Design procedure - Binary Adder - Subtractor - BCD adder - Magnitude Comparator -Decoders - Encoders - Multiplexers – Demultiplexers - Design of Combinational Logic Circuits using decoders, multiplexers and demultiplexers - Implementation of combinational circuits using ROM - PLDs:Programmable Array Logic- Programmable Logic Array.

MODULE III SYNCHRONOUS SEQUENTIAL LOGIC CIRCUITS 9

Sequential Circuits – Latches - Flip-Flops - Types - Analysis of clocked sequential circuits - state equations - State table- State diagrams - State reduction - State Assignment - Mealy/Moore models - Design procedure of synchronous sequential circuits

MODULE IV ASYNCHRONOUS SEQUENTIAL LOGIC CIRCUITS 9

Shift registers - Universal Shift registers - Binary counter - BCD Ripple counter - Modulo-N counters - Ring Counter - Johnson's Counter – Block diagram of asynchronous sequential logic circuits - Analysis procedure –Design of fundamental mode asynchronous sequential circuits- Design of pulse mode asynchronous sequential circuits- Races – Hazards.

MODULE V VERILOG 9

Introduction to Verilog HDL - Structural modelling – Dataflow modelling – behavioral modelling of combinational and sequential logic circuits.

COURSE OUTCOMES:

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

CO1: apply Boolean algebra and Karnaugh maps to design combinational circuits.

CO2: simplify Boolean expressions using Boolean algebra, Karnaugh Map and Quine Mc-Cluskey methods.

CO3: make use of decoders, multiplexers, demultiplexers and memories to implement combinational circuits.

CO4: Construct synchronous sequential logic circuits using flip-flops.

CO5: develop asynchronous sequential circuits using latches and Verilog HDL

CO6: develop hazard-free sequential circuits using flip-flops and Verilog HDL.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. "Digital Design: with an Introduction to the Verilog HDL " by M. Morris Mano,6th Edition, Pearson Education, 2020.
2. "Digital Fundamentals" by Thomas L. Floyd, David Buchla, 11th Edition, Pearson Education, 2018

REFERENCES:

1. “Fundamentals of Digital Logic with Verilog Design” by S.Brown and Z.Vranesic, 12th Edition, Tata McGraw Hill, 2019.
2. "Digital Systems - Principles and Applications" by Tocci R J and Widmer N S, 12th Edition, Prentice Hall of India, New Delhi, 2017.
3. “Digital Systems Design using Verilog" by Charles Roth, Lizy Kurian John , 1st Edition, Cengage India private limited, 2016
4. Digital Design Principles and Practices" by John.F.Wakerly, 4th Edition, Pearson Education, 2008.
5. "Digital Design and Verilog HDL Fundamentals" by Joseph Cavanagh, 2nd Edition ,CRC Press, 2017.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2											1	1
2	3	2	2										1	1
3	3	2	2										1	1
4	3	2	2										1	1
5	3	2	1										1	1
6	3	2	1										1	1
Avg.	3	2	1.6										1	1

1 - low, 2 - medium, 3 - high

23EC314	ELECTROMAGNETIC FIELDS AND TRANSMISSION LINES	L	T	P	C
		3	1	0	4

MODULE I ELECTROSTATIC FIELDS 10+3

Introduction to electrostatic fields - Electric Field - Coulomb's Law - Electric flux density and dielectric constant - Gauss's law- Maxwell's equation - Application of Gauss's law - Conductors in static electric field, Dielectrics in static electric field - Electric potential - Relationship between E and V- Energy density – Boundary conditions in electrostatic fields - Capacitance of parallel plate- Capacitance of Coaxial cable - Laplace and Poisson's equations- Current density and Ohm's law

MODULE II MAGNETOSTATIC FIELDS 8+3

Ampere's circuital law - Applications - Magnetic flux density and Maxwell's equations - Magnetic Vector potential- Magnetic Boundary conditions - Inductors and Inductances - Energy stored in magnetic field

MODULE III ELECTROMAGNETIC WAVES 9+3

Maxwell's equation of time varying field- Equation of continuity - Inconsistency of Ampere's law - wave equation for conducting medium – Sinusoidal time variation- Polarization -Reflection by a perfect conductor -Normal incidence - Reflection by a Dielectric- Normal incidence – Brewster angle - Poynting Vector and Theorem

MODULE IV TRANSMISSION LINE THEORY 9+3

General Transmission Line equations – general solution-the infinite line- Input Impedance in a line – Propagation constant-Attenuation and Phase constants-Wavelength-Waveform distortion-Velocity of Propagation– Distortion less Transmission Line Loading methods-Line not terminated in Z0-Reflection coefficient– Standing Waves Ratio-Power delivered-Input and transfer impedance — Open and short circuited lines — reflection factor- reflection loss-Insertion loss-return loss.

MODULE V HIGH FREQUENCY TRANSMISSION LINES 9+3

Transmission line equations at radio Frequencies-Line of Zero Dissipation-Voltage and Current of dissipation-less Line-Standing Wave Ratio- Input impedance of the dissipation-less Line-Open & Short Circuited lines-Quarter Wave transformer - Smith Chart –Solutions of problems using smith chart- Single Stub Matching using Smith Chart.

COURSE OUTCOMES:

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

CO1: apply Maxwell’s equations of electrostatic field and magnetostatic field to determine the field strength at various charge distributions.

CO2: apply the principles of electrostatic to compute the electric field strength, flux, potential and energy density.

CO3: apply the principles of magnetostatic to compute the magnetic field strength, flux and potential and energy density.

CO4: examine the behavior of time-varying electromagnetic field in different media and find the average power transmission.

CO5: infer the fundamental characteristics of transmission line theory and impedance matching.

CO6: solve problems in transmission line and wave propagation by using Maxwell‘s equations.

TOTAL: (45+15) PERIODS

TEXT BOOKS:

1. "Elements of Electromagnetics" by Mathew.N.O.Sadiku, 7th Edition, Oxford University press, 2021.
2. "Networks, Lines and Fields" by John.D.Ryder, 3rd Edition, Prentice Hall of India, 2007.

REFERENCES:

1. "Field and Wave Electromagnetics" by David K.Cheng, 2nd Edition, Pearson Education, 2013.
2. “Engineering Electromagnetics" by William H.Hayt, 8th Edition, Tata McGraw-Hill, 2012.
3. “Fundamentals of Engineering Electromagnetics” by Rajeev Bansal, Taylor & Francis, 2018.
4. "Circuits and Networks: Analysis and Synthesis", Sudhakar.A, Shyammohan S.P, 4th Edition, Tata McGraw Hill, 2015.
5. “Electromagnetic Waves and Radiating Systems" by Edward.C.Jordan & Keith.G.Balmain, 2nd Edition, Prentice Hall of India, 1995.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2											1	
2	3	2											1	
3	3	2											1	
4	3	2											1	
5	3	2											1	
6	3	2	1										1	
Avg.	3	2	1										1	

1 - low, 2 - medium, 3 - high

23EC321	ANALOG ELECTRONICS LABORATORY	L	T	P	C
		0	0	3	1.5

LIST OF EXPERIMENTS

- Design and testing of BJT biasing circuits
- Design and testing of FET biasing circuits
- Frequency response of CE, CB and CC amplifier
- Testing of Frequency response of Common Source amplifier
- Testing of Frequency response of Source follower
- Design and testing of Two stage RC coupled amplifier
- Design and testing of Direct coupled amplifier
- Testing of Frequency response of Cascode amplifier
- Testing of Frequency response of Feedback amplifiers
- Design and testing of Power amplifiers

COURSE OUTCOMES:

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

CO1: design and test biasing circuits for BJT and FET amplifiers and test the frequency response characteristics of single stage BJT and FET amplifiers

CO2: design and test multistage transistor amplifiers, feedback amplifiers and power amplifiers

CO3: develop communication skills and capability to work in teams

TOTAL: 45 PERIODS

REFERENCES:

1. Laboratory manual prepared by ECE Department, CIT.
2. "Fundamentals of Electronic Devices and Circuits Lab Manual" by David A Bell, 5th Edition, Oxford University Press, Canada, 2009

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2	3	2	1								1
2	3	2	2	3	2	1								1
3									1	2				
Avg.	3	2	2	3	2	1			1	2				1

1 - low, 2 - medium, 3 – high

23EC322	DIGITAL ELECTRONICS LABORATORY	L	T	P	C
		0	0	3	1.5

LIST OF EXPERIMENTS

- Design and verify the De-Morgans theorem
- Design and simulation of Adders and Subtractors
- Design and simulation of Four-bit binary adder/subtractor and BCD adder
- Design and test the BCD to Excess 3 converters and Excess 3 code to BCD converters
- Design and test the Binary to Gray code and Gray code to binary converters
- Design and test the Magnitude Comparator and parity generator and checker
- Design and simulation of Multiplexers and De-multiplexers
- Design and simulation of Encoders and Decoders
- Design and simulation of Ripple counter and Modulus counter
- Design and simulation of Synchronous Up/Down counter

All the experiments are simulated using Verilog HDL

COURSE OUTCOMES:

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

CO1: design, simulate and test combinational logic circuits using Digital ICs and Verilog HDL
CO2: design, simulate and test sequential logic circuits using Digital ICs and Verilog HDL
CO3: Develop communication skills and capability to work in team

TOTAL: 45 PERIODS

REFERENCES:

1. Digital Circuits Laboratory Manual prepared by ECE Department, CIT.
2. "Digital Design: with an Introduction to the Verilog HDL " by M. Morris Mano, 6th Edition, Pearson Education, 2020.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2	3	2	1							1	1
2	3	2	2	3	2	1							1	1
3									1	2				
Avg.	3	2	2	3	2	1	-	-	1	2			1	1

1 - low, 2 - medium, 3 - high

23EC323	PYTHON PROGRAMMING LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

Developing programs using Python Language to the following topics

- Programs using simple statements, data types and expressions
- Input/output and conditional statements in scripts
- Different operator and conversion functions.
- Conditionals and Iterative loops.
- Implementing Real-time applications using Lists and Tuples.
- Implementing Real-time applications using Sets and Dictionaries.
- Functions: Parameter Passing and returning datatypes and recursive
- Handling Strings.
- Implementing Sorting and Searching Techniques
- Programs using written modules and Python Standard Libraries
- Implementing Real-time applications using File handling.
- Implementing Real-time/technical applications using Exceptions
- Integrating Python Libraries specific to AI/ML

COURSE OUTCOMES

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

CO1: develop Python programs using Conditional statements, Operators, built-in data structures, conditionals and loops for solving real world problems.

CO2: develop Python programs to implement string manipulation, sorting and searching techniques using functions, and solve real world problem using file handling and exceptions.

CO3: develop communication skills and capability to work in team.

TOTAL: 30 PERIODS

REFERENCES:

1. "Programming in Python 3: A Complete Introduction to the Python Language" by Mark Summerfield, 2nd Edition, Addison- Wesley Professional, 2009.
2. "Python Programming: Using Problem Solving Approach" by Reema Thareja, 1st Edition, Oxford university Press, 2017.
3. "Head First Python: A Brain-Friendly Guide" by Paul Barry, 2nd Edition, O'Reilly Media., 2016.
4. "Learning Scientific Programming with Python" by Christian Hill, 2nd Edition, Cambridge University press, 2020.
5. "Python Cookbook: Recipes for Mastering Python 3" by David Beazley, Brian K. Jones, 3rd Edition, O'Reilly Media Inc.,2013.
6. "Computer Fundamentals and Programming in C" by Anita Goel and Ajay Mittal, 1st Edition, Pearson Education, 2013.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2	1	2	1			2	2			2	2
2	3	2	2	1	2	1			2	2			2	2
3									3	2			1	1
Avg.	3	2	2	1	2	1			2.33	2			1.67	1.67

1 - low, 2 - medium, 3 - high

SEMESTER IV

COURSE CODE	ANTENNAS AND WAVE PROPAGATION	L	T	P	C
		3	0	0	3

MODULE I FUNDAMENTALS OF ANTENNA 9

Types of antennas – Radiation mechanism – Current distribution on a thin wire antenna – Antenna parameters – Friis Transmission formula – Duality of Antennas – Radiation fields of oscillating dipole – Monopole and Half wave Dipole: Power radiated and Radiation Resistance.

MODULE II ANTENNA ARRAYS 9

Need for antenna arrays – Array of two point sources – Broad side array, End fire array, Pattern multiplication, N-element linear array, Binomial arrays – Dolph- Chebychev arrays – Log periodic dipole array – Folded dipole – Yagi Uda antenna.

MODULE III SPECIAL ANTENNAS 9

Loop antenna: emf equation of loop antenna – Application in Radio direction finding – Horn antenna – Reflector antennas and their feed systems – Micro strip antennas: Basic Characteristics – Feeding methods – Rectangular patch: Transmission line model – Circular patch.

MODULE IV MODERN PRINTED ANTENNAS 9

Phased array -Smart antennas: switched beam and adaptive arrays – RFID Antennas – Radio navigation satellite system antennas – Printed antennas for medical applications – IoT antennas.

MODULE V ANTENNA MEASUREMENTS & WAVE PROPAGATION 9

Antenna Test Ranges: Elevated Ranges – Ground reflection ranges – Anechoic chambers & absorbing materials – Compact Antenna Test Ranges (CATRS) – Measurement of Gain – Radiation Pattern – Beam Width.

Wave propagation: Modes of propagation – Structure of atmosphere – Ground wave propagation – Sky wave propagation –Virtual height – Maximum usable frequency – Critical angle – Skip distance – Space wave propagation.

COURSE OUTCOMES:

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

CO1: Interpret the concept of the radiation mechanism and explain the relationship between antenna parameters and the foundational principles of antenna arrays
CO2: Utilize antenna parameters, gain, directivity, efficiency, bandwidth, and polarization, to analyze and characterize the radiation properties of monopole and dipole antennas.
CO3: Identify and analyze the various antenna array configurations, broadside array, end-fire array, pattern multiplication, N-element linear array, and binomial arrays
CO4: Design a single-element microstrip patch antenna and characterize small loop antennas
CO5: Explain the fundamental and radiation characteristics of modern printed antennas in medical and IoT applications.
CO6: Evaluate the performance of microstrip patch antennas, printed antennas and explain the characteristics of wave propagation and its dependence on frequency and terrain.

TOTAL:45 PERIODS

TEXT BOOKS:

1. "Antenna Theory: Analysis and Design" by Balanis.C.A, 4th Edition, John Wiley & Sons Inc., 2016.
2. "Practical Microstrip and Printed Antenna Design" by Anil Pandey, 1st Edition, Artech House 2019.

REFERENCES:

1. "Antennas & Wave Propagation" by K.D.Prasad, 3rd Edition , Satya Prakashan, New Delhi, 2003.
2. "Antennas and Wave Propagation" 4th Edition by John D.Kraus, Ronald J.Marhefka, Ahmad S Khan, Tata Mc Graw Hill, 2010.
3. Debatosh Guha, Yahia M. M. Antar, "Microstrip and Printed Antennas New Trends, Techniques and Applications", 1st Edition, Wiley, 2011.
4. "Antenna theory and design" by Warren L. Stutzman, Gary A. Thiele, 3rd Edition, John Wiley and Sons Ltd., 2013.
5. "Antennas and Wave Propagation" by A.R.Harish, M.Sachidananda, 1st Edition , Oxford University Press, 2007.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1											2	
2	3	1	1										2	
3	3	1	1										2	
4	3	1	1										2	
5	3												2	
6	3	1	1										2	
Avg.	3	1	1										2	

1 - low, 2 - medium, 3 - high

COURSE CODE	PRINCIPLES OF COMMUNICATION	L	T	P	C
		3	1	0	4

MODULE I RANDOM PROCESSES 9+3

Random Process - Stationary Processes - Mean, Auto Correlation & Cross Correlation – Wide Sense Stationary Processes - Transmission of a Random Process through a Linear Time-Invariant Filter - Power Spectral Density - Gaussian Process - Central Limit theorem – White Noise - Narrowband Noise and its representation in terms of In-phase and Quadrature components.

MODULE II AMPLITUDE MODULATION 9+3

Elements of Communication System - Communication Channels - Need for Modulation - Frequency Translation – Types of Amplitude Modulation and their Spectrum – DSB-SC Modulators: Product Modulator, Balanced Modulator - SSB-SC Modulators: Filter Method, Phase Shift Method - AM Transmitters.

MODULE III ANGLE MODULATION 9+3

Phase Modulation - Frequency Modulation - Narrow Band FM - Wide Band FM - Frequency Spectrum of FM – Transmission Bandwidth of FM Signals - Direct FM generation: Reactance Modulator - Narrowband FM generation- Indirect FM generation - Pre-Emphasis and De-Emphasis – Armstrong FM Transmitter.

MODULE IV ANALOG RECEIVERS 9+3

Envelope detector, Coherent Detection of DSB-SC, SSB-SC - Costas Receiver - AM Receivers: Super heterodyne- Noise in DSB-SC, SSB-SC, AM.

Foster Seeley Discriminator, Ratio Detector, PLL Demodulator- FM Receivers-Noise in FM Receivers.

MODULE V PULSE MODULATION 9+3

Sampling Process - Pulse Amplitude Modulation - Pulse Width Modulation - Pulse Position Modulation - Quantization Process – Uniform and Non-Uniform Quantization - Pulse Code Modulation - Delta Modulation- Differential Pulse Code Modulation - Adaptive Differential Pulse Code Modulation- SNR of PCM and DM systems.

COURSE OUTCOMES:

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

CO1 Infer the purpose of random process for effective understanding of communication systems
CO2 Outline the working principle of various modulators, demodulators used in AM and FM transmitters & receivers
CO3 Solve problems in random process, amplitude modulation and angle modulation schemes
CO4 Explain the generation and detection of various pulse analog and pulse digital modulation techniques
CO5 Infer the performance of DSB-SC, SSB-SC, AM, FM, PCM and DM systems under AWGN
CO6 Interpret the functioning of various analog modulators and demodulators used in communication systems

TOTAL: 45+15 PERIODS

TEXT BOOKS:

1. "Communication Systems" by Simon Haykin, 4th Edition, John Wiley & Sons, 2004.
2. "Principles of communication" by Herbert Taub and Donald L. Schilling, 3rd Edition, McGraw Hill International student Edition, 2008.

REFERENCES:

1. "Electronic Communication Systems: Fundamentals Through Advanced" by Wayne Tomasi, 5th Edition, Pearson Education,2009.
2. "Fundamentals of Communication Systems" by John G. Proakis and Masoud Salehi, 2nd Edition, Pearson Education, 2015.
3. "Electronic Communication Systems" by Kennedy G, 4th Edition, Tata McGraw Hill, 1999.
4. "Communication Systems" by Lathi. B. P, 4th Edition, BS Publications, 2004.
5. "Schaum's Outlines of Analog and Digital Communication" by Hwei P. Hsu, 3rd Edition, McGraw Hill, 2003.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2											2	
2	3	2											2	
3	3	2											2	
4	3	3											2	
5	3	2											2	
6	3	3	2		2				3	3			2	
Avg.	3	2.3	2		2				3	3			2	

1 - low, 2 - medium, 3 - high

COURSE CODE	LINEAR INTEGRATED CIRCUITS	L	T	P	C
		3	0	0	3

MODULE I OPERATIONAL AMPLIFIERS 9

Differential amplifier - differential amplifier with constant current source - current mirror - Widlar current source-current repeaters - Wilson current source-Building blocks of operational amplifier-I/O stages, gain stage and level translator stage of op-amp - Characteristics of Ideal Operational Amplifier - Op-amp parameters & characteristics- frequency response – stability - frequency compensation.

MODULE II OP-AMP APPLICATIONS 9

Linear applications: voltage follower - inverting, non-inverting amplifiers - summing, scaling, averaging amplifiers-instrumentation amplifiers – AC amplifiers - V to I & I to V converters - difference amplifier - integrator - differentiator. Nonlinear applications: Precision half wave & full wave rectifiers - peak detector-sample & hold circuit-log & anti-log amplifiers. Open loop applications: Comparator - zero crossing detector- Schmitt trigger - voltage limiters-window detectors.

MODULE III ACTIVE FILTERS AND OSCILLATORS 9

Active filters - Sallen-Key filter structure- Butterworth filters: Low pass filter- High pass filter- Band pass filter- Band reject filter - All pass filters - Switched capacitor filters- Oscillators: RC phase shift oscillator- Wien bridge oscillator- LC Oscillators: Hartley oscillator - Colpitts oscillator - Clapp oscillator- Crystal oscillator.

MODULE IV MULTIVIBRATORS AND DATA CONVERTERS 9

Astable Multivibrator & Monostable Multivibrator using Op.Amp -Triangular wave generator-Saw tooth wave generator - IC 555 timer: Functional block diagram and description - Astable & Monostable multivibrators using IC555 - Digital to Analog converters: Binary Weighted Network - R-2R Ladder Network- inverted R-2R ladder network - Analog to Digital converters: Successive Approximation - Counter Type - Dual slope - Flash type converters.

MODULE V SPECIAL FUNCTION ICS 9

Phased Locked Loop: operating principles - Basic building blocks - Applications: Frequency multiplier/divider - Frequency translator - Frequency synthesizer - FM demodulator - FSK demodulator -– IC Voltage regulators: Fixed voltage regulator-Adjustable voltage regulator - Dual tracking regulator – General Purpose Regulator - Self-oscillating type switching regulator - Function Generator IC.

COURSE OUTCOMES:

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

- **CO1:** apply circuit analysis techniques to compute CMRR of a differential amplifier, current transfer ratio of constant current sources and the transfer function of operational amplifier application circuits
- **CO2:** infer the characteristics of operational amplifiers.
- **CO3:** Make use of the inverting and, non-inverting configurations of operational amplifiers to build op-amp based application circuits
- **CO4:** interpret the operating principle and characteristics of active filters and oscillators
- **CO5:** interpret the operating principle of multivibrators, data converters, voltage regulators, function generator, PLL and PLL applications
- **CO6:** Choose appropriate component values for active filters, oscillators, multivibrators and voltage regulators based on the design specifications

TOTAL: 45 PERIODS

TEXT BOOKS:

1. "Op-amps and Linear Integrated Circuits" by Gayakwad Ramakant A, 4th Edition, Pearson Education, 2015.
2. "Linear Integrated Circuits" by Roy Choudhury and Shail Jain, 5th Edition, New Age International Private Limited, New Delhi, 2018.

REFERENCES:

1. "Design with operational amplifiers and analog integrated circuits" by Sergio Franco, 3rd Edition, Tata McGraw-Hill, 2007.
2. "Integrated Circuits" by K.R.Botkar, 2nd Edition, Khanna Publishers, 2003.
3. "Linear Integrated Circuits, Analysis, Design and Applications" by B.Somanathan Nair, 1st Edition, Wiley India Publishers, 2009.
4. "OP AMPs for Everyone" by Ron Mancini, 2nd Edition, Newnes, An Imprint of Elsevier, 2003.
5. “Operational Amplifiers and Linear Integrated Circuits” by Robert F. Coughlin, Frederick F. Driscoll, 6th Edition, Prentice Hall, 2001.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2											2
2	3	2	2											2
3	3	2	2											2
4	3	2	2											2
5	3	2	2											2
6	3	2	2											2
Avg.	3	2	2											2

1 - low, 2 - medium, 3 - high

COURSE CODE	MICROCONTROLLER BASED SYSTEMS	L	T	P	C
		3	1	0	4

MODULE I CPU ARCHITECTURE AND INSTRUCTION SET PRINCIPLES 9

CPU and memory organization - Instruction set design - Instruction Cycle - Single bus processor - Hardwired Control - Micro programmed Control - CISC and RISC architectures.

MODULE II MICROCONTROLLER ARCHITECTURE AND INSTRUCTION SET 9

Architecture of 8051 microcontroller - Program and Data Memory Organization - Special Function Registers - I/O Pins, Ports and Circuits - Instruction Set - Addressing Modes - Assembly language Programming - Time Delay Routines

MODULE III ON-CHIP PERIPHERALS AND PROGRAMMING IN ASSEMBLY AND EMBEDDED C 9

Parallel I/O Ports programming – I/O Port Pins and their Functions, Bit /Byte Manipulation - Timer / Counter Programming : Timer Registers, Timer Modes, Overflow Flags - Serial port : UART- Setting Baud Rate - Serial Communication Registers - Serial Transmission - Serial Reception- Interrupt Programming : Interrupt Enable & priority Registers - Hardware and Software Interrupts

MODULE IV PERIPHERAL DEVICES AND PROGRAMMING 9

Programmable Peripheral Interface (8255) – Keyboard / Display Controller (8279) - Programmable Interrupt Controller (8259) - Case Studies: Home Automation System, Traffic Light Control System, Interfacing Matrix Keyboard – Display Interfacing: Seven Segment and LCD display

MODULE V INTERFACING MEMORY AND PERIPHERAL WITH 8051 9

External Memory Interface: Memory Address Decoding, 8031/8051 Interfacing with External ROM, 8051 Data Memory Space, –MAX232 chip for Serial Communication - ADC, DAC and Temperature Sensor Interfacing - DC Motor and Stepper Motor Interfacing.

COURSE OUTCOMES:

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

CO1: Explain the concepts of CPU and 8051 microcontroller architecture & Instruction set

CO2: Infer the concepts of computer architecture, Instruction set and control design using hardwired & micro programmed control unit

CO3: Interpret the architecture & instruction Set of 8051 microcontroller to develop assembly language programs

CO4: Develop assembly language and embedded C programs to implement the functions of on-chip peripherals in 8051 microcontroller

CO5: Interpret the functional blocks of different peripheral ICs to develop 8051 based practical Applications

CO6: Integrate memory modules, I/O devices ADC, DAC, Sensors and Motors With 8051 microcontroller to build real time applications

TOTAL: 45+15 PERIODS

TEXT BOOKS:

1. "The 8051 Microcontroller and Embedded Systems Using Assembly and C " by Muhammed Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinley, 2nd Edition, Pearson Education 2013.
2. "The 8051 Microcontroller. Architecture, Programming and Applications" Kenneth J. Ayala, 3rd Edition, West publishing company 2014

REFERENCES:

1. "Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086, 8051, 8096" by Krishna Kant, 2nd Edition, Prentice Hall of India, 2014.
2. "Microprocessors and Microcontrollers Architecture Programming and Interfacing using 8085, 8086 & 8051by Soumitra Kumar Mandal ,1st Edition,Tata McGraw Hill Publishing Co Ltd, 2012.
3. "Programming and Customizing the 8051 Microcontroller" by Myke Predko, 1st Edition,Tata McGrawHill Publishing Co Ltd , 2012.
4. "The 8051 Microcontroller Based Embedded Systems " by Manish K Patel, Ist Edition, Tata McGrawHill Publishing Co Ltd, 2014.
5. "Computer architecture and Organisation: Design principles and Applications" by Govindarajalu.B, 2nd Edition, Tata McGraw Hill Education, 2010.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3								1	1				2
2	3		1						1	1				2
3	3		2		2				1	1				2
4	3		2		2				1	1				2
5	2		2						1	1		2		2
6	2		2						1	1		2		2
Avg.	2.6		1.8		2				1	1		2		2

1 - low, 2 - medium, 3 - high

COURSE CODE	DATA STRUCTURES AND ALGORITHMS	L	T	P	C
		3	1	0	4

MODULE I ALGORTIHM AND ITS ANALYSIS 9

Data vs Information - Number System conversions- Dense and Sparse Matrix-Algorithm definition - Basic steps in development of an algorithm - Algorithm notations and its complexity - Space and Time complexity- Order notations

MODULE II ARRAYS, STACKS AND QUEUES 9

Arrays: Representations- Operations - Sparse Matrices- Applications of arrays. Stacks: Definition-Operations and its implementation- Queues: Representation and its implementation-Priority queue- Circular Queue - Dequeue - Application of stacks: Recursion - Evaluation of expressions - Difference between stacks and queues

MODULE III LINKED LISTS AND TREES 9

Lists: Operations - Singly linked lists, doubly linked lists- Applications- Linked Stacks-Linked queues-Application of Linked lists: Polynomial manipulation

Trees: Terminologies – Binary trees- Sequential and linked representation - operations –Traversals.Binary search tree--Expression trees -Infix, Postfix and Prefix expressions – Heaps-Max heap-Min heap**.**

MODULE IV GRAPHS 9

Graphs: Definition-Representations- Graph search methods (BFS and DFS methods)-Connected components-spanning trees-Shortest path: Warshall algorithm, Dijkstra's Algorithm -Transitive closure –topological sort

MODULE V SORTING AND SEARCHING TECHNIQUES 9

Sorting algorithms: Selection sort- Bubble sort-Heap sort - Merge sort-Quick sort-shell sort Searching: Linear search, Binary search - Hashing Techniques -Time and Space complexity of sorting and searching algorithms

COURSE OUTCOMES:

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

CO1: Using the principles of linear data structures, analyze an algorithm's notations and complexity in order to address real-time problems

CO2: Develop programs and algorithms for various kinds of problems and estimate their time and space complexity.

CO3: Identify the ideas that make use of arrays, stacks, and queues to solve problems in real time.

CO4: Use the concepts and features of dynamic and non-linear data structures, like trees, graphs, and linked lists, to solve real-time challenges.

CO5: Develop programs and algorithms with non-linear data structures, searching, and sorting methods.

CO6: Determine the best linear and non-linear data structures, as well as searching and sorting methods, to address various kinds of computation problems.

TOTAL:60 PERIODS

TEXT BOOKS:

1. "Fundamentals of Data Structures in C" by Ellis Horowitz, Sartaj Sahni, Galgotia Publications, 2008.

2. "An Introduction to Data Structures with Applications" by Jean-Paul Tremblay and Paul G. Sorenson, 2nd Edition, McGraw Hill,2008

REFERENCES:

1. "Data Structures" by Seymour Lipschutz, Schaum's Outline, McGraw Hill, 2017.
2. "Data Structures using C" by Seymour Lipschutz,, 1st Edition,McGraw Hill, 2013.
3. "Classic Data Structures", Debasis Samanta,2nd Edition, Eastern Economy Edition,PHI,2009
4. "Introduction to Algorithms" by Thomes H Cormen, Charles E Leiserson, Ronald L Rivest and Clifford Stein, 3rd Edition, The MIT Press, 2009.
5. "Data Structures and Algorithm Analysis in C" by Mark Allen Weiss, 2nd Edition, Pearson Education, 2007

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	-	1	1	-	-	-	-	-	-	-	-	2
2	3	2	-	1	1	-	-	-	-	-	-	-	-	2
3	3	2	-	1	1	-	-	-	-	-	-	-	-	2
4	3	2	-	1	1	-	-	-	-	-	-	-	-	2
5	3	2	-	1	1	-	-	-	-	-	-	-	-	2
6	3	2	-	1	1	-	-	-	-	-	-	-	-	2
Avg.	3	2	-	1	1	-	-	-	-	-	-	-	-	2

1 - low, 2 - medium, 3 - high

COURSE CODE	LINEAR INTEGRATED CIRCUITS LABORATORY	L	T	P	C
		0	0	3	1.5

LIST OF EXPERIMENTS

- Testing of Operational Amplifier Characteristics
- Design and Testing of Operational Amplifier Application circuits
- Design and testing of comparator & Schmitt Trigger
- Design and testing of active Filters
- Design and testing of Oscillators
- Design and testing of Multivibrators using operational amplifier and Timer
- Design and testing of Data Converters
- Testing of PLL Characteristics
- Design and testing of PLL based application circuits
- Design and testing of IC Voltage Regulators

COURSE OUTCOMES:

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

CO1: Test the characteristics of operational amplifier and special purpose integrated circuits

CO2: Design and test active filters, oscillators, multivibrators, comparators, Schmitt Trigger, data converters, voltage regulators and PLL based circuits

CO3: Develop communication skills and capability to work in teams

TOTAL: 45 PERIODS

REFERENCES:

1. Linear Integrated Circuits Laboratory Manual of ECE Department, CIT.
2. "Lab Manual to Accompany Op-Amps and Linear Integrated Circuits " by Gayakwad Ramakant A, 4th Edition, Prentice Hall, 1999.
3. "Laboratory Manual for Operational Amplifiers and Linear ICs" by David A.Bell, 2nd Edition, Oxford University Press, 2006.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	3	3	3								2	2
2	3	3	3	3	3								2	2
3									1	2				
Avg.	3	3	3	3	3				1	2			2	2

1 - low, 2 - medium, 3 - high

COURSE CODE	MICROCONTROLLERS LABORATORY	L	T	P	C
		0	0	3	1.5

Developing 8051 Assembly Language Programs using KEIL uVISION5 IDE

- Arithmetic and Logical operations (Single and Multibyte data)
- Data manipulating operations
- Bit Manipulation and Delay Routines
- Searching & Sorting
- Code Conversion Methods

Developing 8051 Assembly Language/ Embedded C Programs using Hardware Kits

- Input/Output Port Programming
  - ✔ Interfacing Input devices : LED & 7-segment Display
  - ✔ Interfacing Output devices :Switches and 4x4 Matrix keyboard
- Timer/Counter Programming : Generate Square wave form using Timer registers
- Serial Port Programming: Transmitting and Receiving a message using UART protocol
- Interrupt Programming: Handling Hardware and Software Interrupts using Edge & Level Triggering Methods

Interfacing Experiments

- Interfacing ADC
- Interfacing DAC

Case Study Experiments

- Design a data acquisition system using sensors such as LDR, thermistor & LM35 Sensor.
- Design an Object detection system to detect an object and calculate the distance of the object using Ultrasonic sensor and IR sensor

COURSE OUTCOMES

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

CO1: Develop an 8051 microcontroller Assembly Language Programs using KEIL uVISION IDE for Arithmetic logical and array operations & bit manipulation

CO2: Integrate I/O devices, ADC, DAC boards, sensors and controller boards with 8051 Microcontroller to develop practical applications

CO3: Develop communication skills and capability to work in teams

TOTAL: 45 PERIODS

REFERENCES:

1. Microcontrollers Laboratory manual prepared by ECE department, CIT.
2. "Microprocessor and Microcontroller Architecture, Programming and System Design using 8085, 8086, 8051, 8096" by Krishna Kant, Ist Edition, Prentice Hall of India, 2011.
3. "The 8051 Microcontroller and Embedded Systems Using Assembly and C " by Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinley, 2nd Edition, Pearson Education 2013.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	3	3	3	-	-	-	1	2	-	-	-	2
2	3	-	3	3	3	-	-	-	1	2	-	-	-	2
3	-	-	-	-	-	-	-	-	3	2	-	-	-	2
Avg.	3	-	3	3	3	-	-	-	166	2	-	-	-	2

1 - low, 2 - medium, 3 - high

COURSE CODE	DATA STRUCTURES AND ALGORITHMS LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

- Representation of Sparse and Dense Matrix and its operations
- Implementation of stack and queue Abstract Data Types (ADTs)
- Application of stack and queue Abstract Data Types (ADTs)
- Implementation of Linked List- Singly linked and Doubly linked lists
- Implementation of Binary search trees
- Graph representation and traversal algorithms
- Implementation of Sorting and Searching algorithms

COURSE OUTCOMES:

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

CO1: Develop programs using linear data structures for various applications

CO2: Develop programs using non-linear data structures for various applications

CO3: Develop communication skills and capability to work in team and achieve goals

TOTAL: 30 PERIODS

REFERENCES:

1. Data structures and algorithms Laboratory Manual prepared by ECE Department, CIT.
2. "An Introduction to Data Structures with Applications" by Jean-Paul Tremblay and Paul G. Sorenson, 2nd Edition, McGraw Hill, 2017.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	-	1	-	-	-	-	-	-	-	-	1	1
2	3	3	-	1	-	-	-	-	-	-	-	-	1	1
3	3	3	-	1	-	-	-	-	-	-	-	-	1	1
Avg.	3	3	-	1	-	-	-	-	-	-	-	-	1	1

1 - low, 2 - medium, 3 - high

SEMESTER V

COURSE CODE	CONTROL SYSTEMS	L	T	P	C
		3	1	0	4

MODULE I CONTROL SYSTEMS COMPONENTS AND THEIR REPRESENTATION 10+3

Linear control systems - Open loop and closed loop systems - Examples of control system - Transfer function- Mechanical systems: Translational & Rotational systems - Electrical systems - Analogous system- Block diagram reduction method - Signal flow graph-Mason's gain formula

MODULE II TIME DOMAIN RESPONSE 9+3

Standard test signals - Type and order of systems – First order system - Step response analysis of second order feedback control systems - Time domain specifications - Steady state errors - Error constants - Introduction to P, PI and PID Controllers

MODULE III FREQUENCY DOMAIN RESPONSE 9+3

Introduction to frequency response - Frequency domain specifications - Bode plot- Polar plot - All pass and minimum phase systems - Introduction to compensators

MODULE IV STABILITY RESPONSE 9+3

Concepts of stability – S plane for stability - Necessary conditions for stability - Routh Hurwitz criterion - Root locus - Construction of root loci - Nyquist stability Criterion

MODULE V STATE VARIABLE ANALYSIS 8+3

Concepts of State, State variable and state mode l- State space representation using physical, phase and canonical variables (Electrical Systems) - State transition matrix - Solution of state equations - Concepts of Controllability & Observability (Kalman's test only)

COURSE OUTCOMES:

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

CO1: Determine the transfer function of different physical systems and explore the knowledge on transient response analysis.

CO2: Apply block diagram reduction and signal flow graph methods for mechanical and electrical systems to find the transfer function.

CO3: Evaluate the time domain specification parameters and steady state errors for first and second order systems.

CO4: Use the bode and polar plots to deduce the frequency response characteristics of open and closed loop systems.

CO5: Identify the stability of the system and state variables to obtain the state space representation.

CO6: Inspect the frequency response, stability and the solution of state equation for the specified system.

TOTAL: 45+15 PERIODS

TEXT BOOKS:

1. "Control Systems Engineering" by Nagrath,I.J. and Gopal.M, 7th edition, New age International Publishers,2022.
2. "Modern Control Engineering" by Katsuhiko Ogata, 5th edition, Prentice Hall of India Private Limited, 2010.

REFERENCES:

1. "Control Systems Engineering" by Norman S.Nise, 6th edition, John Wiley, 2018.
2. "Modern Control Systems" by Richard C. Dorf and Robert H. Bishop, 11thedition, Pearson Prentice Hall, 2011.
3. "Automatic control systems" by Farid Golnaraghi and Benjamin C. Kuo,10th edition, McGraw-Hill Education,2017.
4. "Control Systems" by Nagoor Kani.A", 1st edition, RBA Publications,2014.
5. "Introduction to Control Systems" by Arun K. Ghosh, 2nd edition, PHI Learning Private Limited, 2013.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2												2
2	3	2												2
3	3	1												2
4	3	3												2
5	3	2												2
6	3	2												2
Avg.	3	2												2

1 - low, 2 - medium, 3 - high

COURSE CODE	DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	1	0	4

MODULE I DISCRETE FOURIER TRANSFORM 12+3

Review of sampling, Discrete Time Fourier Transform (DTFT) & z Transform, Discrete Fourier Transform – Operations on Finite-Length Sequences – DFT Symmetry Relations - Discrete Fourier Transform Theorems – Fourier Domain Filtering – Linear Convolution using the DFT - Radix-2 FFT Algorithms - Decimation-in-Time FFT algorithm, Decimation-in-Frequency FFT algorithm.

MODULE II IIR DIGITAL FILTER DESIGN 10+3

Design of Discrete time IIR Butterworth and Chebyshev type I Low pass & High pass filters - Design of IIR Filter by Impulse Invariance and Bilinear Transformation - Structure of IIR Systems - Direct, Cascade and Parallel form structures.

MODULE III FIR DIGITAL FILTER DESIGN 9+3

Symmetric and Antisymmetric FIR Filters - Design of Linear Phase low pass and high pass FIR Filters using Rectangular, Hamming & Hann Windows and Frequency Sampling Method - Design of FIR Differentiators - Structure of FIR Systems- linear phase structures.

MODULE IV FINITE WORD LENGTH EFFECTS IN DIGITAL FILTERS 6+3

Quantization Process and Errors - Quantization of Fixed point and Floating point numbers - A/D Conversion Noise Analysis - Dynamic range Scaling - Limit Cycles in IIR Digital Filter

MODULE V APPLICATIONS OF DIGITAL SIGNAL PROCESSING 8+3

Signal enhancement and filtering, Noise reduction and two band digital crossover, Digital audio equalizer, Adaptive Noise cancellation, Echo cancellation.

COURSE OUTCOMES:

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

CO1: Compute DFT and IDFT of a given discrete time sequence using Radix-2 Fast Fourier Transform algorithms.

CO2: Design digital IIR Butterworth and Chebyshev type I low pass and high pass filters for the given specifications.

CO3: Design Linear phase low pass and high pass FIR digital filters using windowing & frequency sampling methods

CO4: Model IIR and FIR systems using direct, cascade and parallel form structures.

CO5: Examine the effects of quantization error in digital filters.

CO6: Design signal processing systems for various applications.

TOTAL: 45 +15 PERIODS

TEXT BOOKS:

1. "Digital Signal Processing Principles, Algorithms and Applications" by John G Proakis and Dimitris G Manolakis, 5th Edition, Pearson Education, 2022.
2. "Digital Signal Processing - A computer based approach" by . Sanjit. K. Mitra, 4th Edition, Tata McGraw Hill, 2013.

REFERENCES:

1. "Discrete-Time Signal Processing" by V. Oppenheim, R. W. Shafer and J.R.Buck, 4th Edition, Pearson Education, 2011.
2. "Digital Signal Processing: A Practical Approach" by Ifeachor E.C. & Jervis B.W, 2nd Edition, Pearson Education, 2002.
3. "Fundamentals of Digital Signal Processing" by Lonnie C.Ludeman, Wiley, 2009.
4. "Schaum's Outlines of - Digital Signal Processing" by Monson H Hayes, 2nd Edition, Tata McGraw Hill, 2012.
5. "Digital Signal Processing Fundamentals and Applications" by Li Tan, 2nd Edition, Academic Press, 2013.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	1						1	1			3	
2	3	2	1						1	1			3	
3	3	2	1						1	1			3	
4	3	2	1						1	1			3	
5	3	2	1						1	1			3	
6	3	3	2	1					1	1			3	
Avg.	3	2.2	1.2	1					1	1			3	

1 - low, 2 - medium, 3 - high

COURSE CODE	EMBEDDED SYSTEMS AND IoT	L	T	P	C
		3	0	0	3

MODULE I ARCHITECTURE OF ARM CORTEX M4 MICROCONTROLLER 9

Overview of Embedded System **-** Features and Architecture Considerations - Embedded Systems vs General computing system- Classification and Characteristics of Embedded Systems -Typical architecture and Core of embedded system - Sensors & Actuators - Communication Interfaces - ARM Embedded System - CISC and RISC Processors - ARM Cortex M4 Architecture - Programmer's model, Memory, Interrupts and exceptions - Operating Modes - Program status registers - Memory Protection Unit (MPU)- Floating Point Unit (FPU)

MODULE II ARM CORTEX-M4 PROGRAMMING 9

ARM Instruction Set - ARM Instruction Types: Moving data within the processor - Arithmetic operations - Logic operations - Shift and rotate instructions - Data conversion operations (extend and reverse ordering) - Bit-field processing instructions- Compare and test- Program flow control - Memory endianness -Memory bit band operations - NVIC Registers for interrupt control.

MODULE III DEVICES AND BUSES FOR DEVICES NETWORK 9

I/O Devices: Types and Examples of I/O devices, Synchronous, ISO-synchronous and Asynchronous Communications - Internal Serial-Communication Devices: SPI, SCI, SI, UART, Parallel Port Devices - Wired & Wireless Protocols:I2C, USB, CAN and Ethernet - LoRa, Bluetooth and WiFi.

MODULE IV REAL TIME OPERATING SYSTEM 9

Foreground / Background systems - Critical section of code - Resource - Shared Resource - Tasks, Process and Threads, States - Types of Real-time tasks - Task Periodicity - Multiprocessing and Multitasking - RTOS Task scheduling models: Co-operative Round Robin Scheduling, Cyclic Scheduling with Time Slicing, Preemptive SJF, RM and EDF - Priority Inheritance Protocol - Inter Process Communication : Semaphores , Message Queues , Mailboxes and Dead lock situations.

MODULE V IoT AND ITS APPLICATIONS 9

IoT Definition - Characteristics - IoT Functional Blocks –IoT Architecture -Physical design of IoT - Logical design of IoT - Communication models - Enabling Technologies .

Case study on IoT Domain specific applications*:* Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture, Smart Traffic Control and Smart water management.

COURSE OUTCOMES:

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

CO1: Explain the architecture & instruction set of ARM processor to develop Cortex M4 based assembly language programs

CO2: Infer the characteristics of embedded systems, architecture and various operating modes of ARM Cortex M4 processor

CO3: Develop an assembly language programs to implement the functions of On-chip peripherals of ARM based Embedded Systems

CO4: Explain the functional blocks of serial & parallel communication devices and wired & wireless protocols

CO5: Apply the concepts of real time operating system and the architecture features of IoT to develop an IoT based applications

CO6: Make use various protocols and RTOS kernel to build an IoT based system for the given domain specific applications

TOTAL: 45 PERIODS

TEXT BOOKS:

1. "The Definitive Guide to ARM Cortex-M3 and Cortex-M4 processors" by Joseph Yiu, 3rd Edition, Elsevier - Newness publication, 2014.
2. "Embedded systems Architecture, Programming and Design" by Raj Kamal, 3rd edition, reprint, McGraw Hill Education, India, 2017.

REFERENCES:

1. "ARM System Developer's Guide: Designing and Optimizing System Software" by Andrew N.Sloss, Dominic Symes and Chris Wright, 1st Edition, Morgan Kaufmann Publishers, 2004.
2. "Embedded Systems Design" by Steve Heath, 3rd edition, EDN Series, 2013.
3. "Embedded Systems Building Blocks" by Jean J.Labrosse, 2nd Edition, CMP Books, 2010.
4. "Internet of Things – A hands-on approach" by Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015.
5. "Practical Microcontroller Engineering with ARM- Technology" by Ying Bai, IEEE Press & Wiley publishers, 2016.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3		2											2
2	3		2											2
3	3		2		2							1		2
4	3				1									2
5	3				2							1		2
6	3				2							1		2
Avg.	3		2		1.75							1		2

1 - low, 2 - medium, 3 - high

COURSE CODE	SIGNAL PROCESSING LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

The following experiments are implemented using open source software and Fixed / Floating point DSP Processors.

- Verification of Linear Convolution, Circular Convolution and Correlation
- Computation of Discrete Fourier Transform(DFT) and Inverse Discrete Fourier
- Transform(IDFT)
- Computation of DFT using Radix 2 DIT and DIF FFT Algorithms
- Design of IIR Low pass and High Pass filters
- Design of FIR Low pass and High pass filters using Windowing technique and analyze the quantization effects
- Determination of Voice/Unvoiced/Silence regions of Speech
- Design of Adaptive channel Equalizer for Noise cancellation
- Design of Acoustic Echo Canceller

COURSE OUTCOMES:

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

CO1: Interpret the spectrum of discrete time signals and frequency response of Linear Time Invariant systems.

CO2: Design FIR and IIR filter for the given specifications, analyze its quantization effects and simulate the frequency response.

CO3: Develop communication skills and capability to work in team.

TOTAL: 30 PERIODS

REFERENCES:

1. Signal Processing Lab Manual, Department of ECE, CIT.
2. "Real-Time Digital Signal Processing: Fundamentals, Implementations and Applications" by Sen M. Kuo, Bob H. Lee, and Wenshun Tian, 3rd Edition Wiley, 2013.
3. "Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416DSK" by Rulph Chassaing, Donald S. Reay,, 2nd Edition, Wiley, 2011.
4. "Digital Signal Processing and Applications with the OMAP - L138 Experimenter" by Donald Reay Wiley, 2012.
5. “Digital Signal Processing-A Practical Guide for Engineers and Scientists” by Steven K Smith, 1st Edition, Newnes, 2003.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	1		3				2	2			3	
2	3	2	1		3				2	2			3	
3									3	2			2	
Avg.	3	2	1		3				2.3	2			2.7	

1 - low, 2 - medium, 3 - high

COURSE CODE	EMBEDDED SYSTEMS AND IoT LABORATORY	L	T	P	C
		0	0	2	1

Developing ARM CORTEX M4 based Assembly Language programs (KEIL MDK-ARM) using STM32F446 Nucleo-64 development board

- Study of ARM cortex M4 architecture & simple ALP Programs
- Shift and Rotate operations
- Array Handling
- Arithmetic Evaluation

Developing Embedded 'C' (KEIL MDK-ARM) programs using STM32F446 Nucleo-64 development board

- GPIO Programming
  - ✔ Interfacing Input devices : LED & 7-segment Display.
  - ✔ Interfacing Output devices : External Switches and Potentiometer.
- Timer/Counter Programming : Generate delay using System tick timer & delay driver.
- Serial Port Programming: Implement USART transmitter and Receiver.
- Interrupt Programming: Handling Hardware and Software Interrupts using Edge & Level Triggering Methods.

Case Study:

- IOT BASED WEATHER MONITORING SYSTEM
  - ✔ Develop an IoT based weather monitoring system to monitor room temperature and humidity data and upload the data to Cloud IoT Analytics Platform using Raspberry Pi 3.
- Data acquisition and control using MQTT protocol.
  - ✔ Develop a Python code to publish and subscribe the messages using Raspberry Pi 3 and MQTT based cloud server with the user interface as Mobile APP / MQTT Lens.

COURSE OUTCOMES:

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

CO1: Develop an ARM CORTEX M4 based Assembly Language Programs for arithmetic, logical & array operations using KEIL MDK-ARM

CO2: Develop embedded C programs to implement the functions of On-chip peripherals of ARM CORTEX M4 processor using STM32F446 Nucleo-64 development board

CO3: Develop communication skills and capability to work in teams

TOTAL: 30 PERIODS

REFERENCES:

1. Embedded Systems Laboratory manual prepared by ECE department, CIT.
2. "ARM System-on-Chip Architecture" by Steve Furber, 2nd Edition, Pearson Edition, 2012.
3. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases" by Pethuru Raj and Anupama C. Raman, CRC Press, 2017.
4. STM32F446 Processor manual https://www.st.com/resource/en/datasheet/stm32f446mc.pdf
5. Tinkercad online circuit simulator
6. https://wokwi.com/
7. https://www.circuito.io/component/esp8266-01-wifi-module/

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	3	3	3	-	-	-	1	2	-	-	-	2
2	3	-	3	3	3	-	-	-	1	2	-	-	-	2
3	-	-	-	-	-	-	-	-	3	2	-	-	-	2
Avg.	3	-	3	3	3	-	-	-	1.66	2	-	-	-	2

1 - low, 2 - medium, 3 - high

COURSE CODE	DBMS LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

- Create a database table, add constraints (primary key, unique, check, Not null), insert rows, update and delete rows using SQL DDL and DML commands.
- Create a set of tables, add foreign key constraints and incorporate referential integrity.
- Query the database tables using different 'where' clause conditions and also implement aggregate functions.
- Query the database tables and explore sub queries and simple join operations.
- Query the database tables and explore natural, equi and outer joins.
- Write user defined functions and stored procedures in SQL.
- Execute complex transactions and realize DCL and TCL commands.
- Write SQL Triggers for insert, delete, and update operations in a database table.
- Create View and index for database tables with a large number of records.
- Create an XML database and validate it using XML schema.
- Create Document, column and graph based data using NOSQL database tools.
- Develop a simple GUI based database application and incorporate all the above-mentioned features.

COURSE OUTCOMES:

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

CO1. Create databases with different types of key constraints and construct simple and complex SQL queries using DML and DCL commands.

CO2. Use advanced features such as stored procedures and triggers and incorporate in GUI based application development.

CO3. Develop communication skills and capability to work in team.

TOTAL: 30 PERIODS

REFERENCES:

1. "Database System Concepts" by Abraham Silberschatz, Henry F. Korth, S. Sudharshan, 7th Edition, McGraw Hill, 2020.
2. "Fundamentals of Database Systems" by Ramez Elmasri, Shamkant B. Navathe, 7th Edition, Pearson Education, 2017.
3. "An Introduction to Database Systems" by C.J.Date, A.Kannan, S.Swamynathan, 8th Edition, Pearson Education, 2006.
4. "Database Management System A Practical Approach" by Rajiv Chopra, 4th Edition, S.Chand & company Pvt Ltd., 2014.
5. "Database Systems With Case Studies" by Bernard, Margaret, Bachu, Eshwar, PHI Learning Pvt Ltd., 2015.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	1		2				2	2			1	1
2	3	2	1		2				2	2			1	1
3									3	2			1	1
Avg.	3	2	1		2				2.33	2			1	1

1 - low, 2 - medium, 3 - high

SEMESTER VI

COURSE CODE	VLSI DESIGN	L	T	P	C
		3	0	0	3

MODULE I MOS TRANSISTORS AND FABRICATION 9

CMOS Logic - VLSI Design flow – Ideal I-V Characteristics of MOS Transistors - Non-Ideal I-V Effects - DC Transfer characteristics - n-well CMOS Processing Technology - Stick Diagram and layout design rules - Layout of CMOS Circuits –Fan-in-Fan-out- Delay Estimation.

MODULE II COMBINATIONAL CIRCUITS DESIGN 9

Circuit Families: Logical Effort and Transistor Sizing - Static CMOS – Ratioed Circuits – Cascode Voltage Switch Logic – Dynamic Circuits - Pass transistor Logic - Transmission gate logic – Differential Circuits.

MODULE III SEQUENTIAL CIRCUITS DESIGN 9

Sequencing static circuits - Conventional CMOS Latches and flip-flops - Pulsed latches - Resettable latches and flip-flops - enabled latches and flip flops - Incorporating Logic into latches - TSPC Latches and flip-flops - Sequencing dynamic circuits.

MODULE IV VLSI SUBSYSTEMS AND MEMORY DESIGN 9

Single bit Addition - Ripple Carry Adder - Carry look-ahead adder – Carry skip adder - Subtractor - One/Zero detectors – Comparators - Unsigned array and 2's complement array multipliers - Booth encoding – 6T SRAM and DRAM cell design – Power Dissipation in Memories.

MODULE V FPGA ARCHITECTURE AND VLSI TESTING 9

CPLD Architectures – Xilinx FPGA Architectures: Organization – Programming Technologies – PLB Architectures - Programmable Interconnects – Programmable I/O Blocks.

Manufacturing Test Principles: Fault Models, Observability and Controllability, Fault Coverage and ATPG - Design for Testability: BIST and IDDQ Testing.

COURSE OUTCOMES:

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

CO1: Examine CMOS transistor characteristics and its logic styles.
CO2: Outline the I-V and DC characteristics of MOS transistors and show the layout of CMOS Circuits
CO3: Compare the static and dynamic CMOS combinational circuits using different logic styles
CO4: Inspect the static CMOS sequential circuits using different logic styles and summarize various VLSI sub systems
CO5: Explain memory cell design, FPGA architectures and VLSI Testing methods
CO6: Test the sequential circuits to design FPGA based VLSI circuit and memory units.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "CMOS VLSI Design - A Circuits and Systems Perspective" by Neil H.E.Weste, David Harris, , 4th Edition, Pearson Education, 2015.
2. "Digital System design using VHDL" by Charles H.Roth and Lizy Kurian John, 3rd Edition ,John Wiley& Sons, 2018

REFERENCES:

1. "VLSI Design" by V.S.V. Prabhakar K. Lal Kishore, 1st Edition, John Wiley and Sons, 2010.
2. "VLSI Design" by Debaprasad Das, 2nd Edition, Oxford University Press, 2015.
3. "CMOS Digital Integrated Circuits Analysis & Design" by Sung-Mo Kang, Yusuf Leblebici, Chul Woo Kim", 4th Edition , McGraw-Hill Education,, 2015.
4. "Digital Integrated Circuits: A Design Perspective" by Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, 2nd Edition, Prentice Hall of India, 2003.
5. "Introduction to VLSI Circuits and Systems" by John P.Uyemura, John Wiley & Sons, 2009.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1	-	1	-	-	-	-	-	-	-	-	-	-
2	3	1	-	1	-	-	-	-	-	-	-	-	-	-
3	3	-	2	1	-	-	-	-	-	-	-	-	-	2
4	3	-	2	1	-	-	-	-	-	-	-	-	-	2
5	3	-	2	1	-	-	-	-	-	-	-	-	-	2
6	3	-	2	-	-	-	-	-	-	-	-	-	-	-
Avg.	3	1	2	1	-	-	-	-	-	-	-	-	-	2

1 - low, 2 - medium, 3 - high

COURSE CODE	DIGITAL COMMUNICATION	L	T	P	C
		3	1	0	4

MODULE I INFORMATION THEORY & SOURCE CODING 11+3

Uncertainty -Information and Entropy - Basic Properties of entropy - Information rate - Conditional entropy - Joint Entropy - Mutual Information - Channel capacity of a Gaussian channel - Channel models - BSC and BEC channels - Shannon's channel coding theorem - Shannon-Fano coding, Huffman Coding, Arithmetic Coding, Lempel-Ziv Algorithm, Run length coding..

MODULE II MEMORYLESS FINITE SCHEMES FOR CHANNEL CODING 11+3

Linear Block codes - Cyclic codes - Convolutional codes – Trellis structure and Decoding of convolution codes – Encoding Parallel Concatenated codes - LDPC codes - LDPC code construction - Encoding LDPC codes - Serial Concatenated codes - design of LDPC decoders.

MODULE III BASEBAND TRANSMISSION AND RECEPTION 7+3

Baseband Binary PAM systems –Baseband Pulse shaping: Intersymbol Interference , Nyquist Criteria for distortion less Baseband Binary Transmission- Pulse shaping by Digital Methods -Duobinary Baseband PAM System - Eye Diagrams

MODULE IV DIGITAL MODULATION AND TRANSMISSION 8 **+3**

Geometric Representation of signals - Generation and signal space representation of Binary Frequency Shift Keying - Binary Phase Shift Keying - DPSK, DEPSK, QPSK, M-ary PSK - Quadrature Amplitude modulation

MODULE V OPTIMAL RECEPTION OF DIGITAL SIGNAL 8+3

Optimum filter Realization using Matched filter and Correlator - Optimum receiver for Digital Modulation Scheme: BFSK, BPSK, DPSK, QPSK- Probability of Error: BFSK, BPSK, DPSK, QPSK, M-ary PSK, QAM-OQPSK- Comparison of Modulation Systems

COURSE OUTCOMS:

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

CO1: Determine the minimum number of bits per symbol required to represent the source and the maximum rate at which reliable communication can take place over the channel.

CO2: Detect and correct the errors introduced in the channel using error control coding schemes.

CO3: Construct the baseband pulse for ISI free transmission over finite bandwidth channels.

CO4: Compare the different digital modulation schemes for binary data transmission.

CO5: Analyze the BER performance of digital modulation schemes.

CO6: Evaluate the performance of optimum receivers and analyze the performance of bit error rate of a digital modulation system

TOTAL: 45+15 PERIODS

TEXT BOOKS:

1. "Fundamentals of Information Theory and Coding Design" by Roberto Togneri, Christopher J.S DeSilva, CRC press, 2003.
2. "Principles of Communication Systems" by Herbert Taub, Donald L Schilling and Gautam Saha, 4th Edition, Tata McGraw Hill, 2013.

REFERENCES:

1. "Digital Communications" by Simon Haykins, 1st Edition, Wiley India edition, 2010.
2. "Digital and Analog Communication systems" by K.Sam Shanmugam, John Wiley and sons, 2008.
3. "Digital Communications" by John G. Proakis and Masoud Salehi, 5th Edition,McGraw-Hill Education, 2008.
4. “Information Theory, Coding and Cryptography” by Ranjan Bose, McGraw-Hill,2005.
5. "Error Correction Coding: Mathematical Methods and algorithms" by Todd K.Moon, John Wiley & Sons, 2005.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	-	-	1	-	-	-	1	1	-	-	2	-
2	3	2	-	-	2	-	-	-	1	1	-	-	2	-
3	3	1	-	-	-	-	-	-	1	1	-	-	2	1
4	3	2	-	-	2	-	-	-	1	1	-	-	2	2
5	3	2	-	-	2	-	-	-	1	1	-	-	2	2
6	3	2	-	-	2	-	-	-	1	1	-	-	2	2
Avg.	3	1.8	-	-	1.8	-	-	-	1	1	-	-	2	1.75

1 - low, 2 - medium, 3 - high

COURSE CODE	DATA COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

MODULE I NETWORK ARCHITECTURE AND DATA LINK LAYER 9

Introduction: Components, Data representation, Data flow, Topology, Physical structures, Protocols and Standards- Network models: OSI model, TCP/IP protocol suite, Addressing - Packet Switching - Logical Link Control functions - Framing - Stop and wait protocol for noisy and noiseless channels - Go-Back-N protocol for noisy channel - Selective repeat protocol for noisy channel.

MODULE II MEDIUM ACCESS SUB-LAYER 9

Medium Access layer: Random access - Controlled access - Wired LAN - IEEE 802.3: Standard Ethernet, IEEE 802.4: Token ring - IEEE 802.5: Token bus – Inter Connecting devices: Repeaters, Hubs, Switches, Gateways, Router, Brouter and NIC - Virtual LANs.

MODULE III NETWORK LAYER 9

Logical addressing – Address allocation - IPv4 and IPv6 address formats - IPv4 and IPv6 datagram formats – Transition from IPv4 to IPv6 - Address Resolution Protocol (ARP) - Reverse Address Resolution Protocol (RARP) - Internet Control Message Protocol (ICMP) - Internet Group Management Protocol (IGMP) - Forwarding and Routing techniques - Distance Vector Routing - Link State Routing.

MODULE IV TRANSPORT LAYER 9

Process-to-Process delivery - User Datagram Protocol (UDP) - Transmission Control Protocol (TCP) : Segments, Connection Establishment, Data Transfer, Termination , Flow Control, Error Control, Congestion Control - Stream Control Transmission Protocol (SCTP) – QoS - Queuing : FIFO, Priority and Weighted Fair Queuing - Traffic shaping: Leaky bucket and Token Bucket.

MODULE V APPLICATION LAYER AND SOFTWARE DEFINED NETWORKS 9

Terminal Network (TELNET) - Simple Mail Transfer Protocol (SMTP) - File Transfer Protocol (FTP) – Hypertext Transfer Protocol (HTTP) – Simple Network Management Protocol (SNMP).

Software Defined Network (SDN): Traditional versus SDN, benefits, challenges, SDN reference model, SDN Infrastructure Architectures.

COURSE OUTCOMES:

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

CO1: Infer the functionality of layered architectures
CO2: Interpret the various mechanisms for flow control, and error control in noisy channel.
CO3: Categorize suitable medium access control mechanisms for channel access at data link layer.
CO4: Use subnet masks for network capacity planning and provisioning. Identify suitable network layer protocols to fulfill networking requirements.
CO5: Interpret the essential features of transport and application layer protocols
CO6: Summarize the need for SDN and Cloud networks.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. "Data Communications and Networking" by Forouzan, Behrouz A, Global Edition 5e. United Kingdom: McGraw-Hill Education, 2012.
2. "Data and Computer Communication" by Stallings.W, 10th Edition, Pearson Education, 2017.

REFERENCES:

1. " Computer Networks: A Systems Approach"by Larry L. Peterson and Bruce S. Davie, 5th Edition, Elsevier Science, 2012.
2. "Computer Networking-A top down approach" by J.F.Kurkose and K.W.Rose, 8th Edition, Pearson Education, 2021.
3. "Computer Networks" by Andrew Tanenbaum, Nick Feamster and David Wetherall, Pearson Education, 2022.
4. "A Survey on Software-Defined Networking" by W. Xia, Y. Wen, C. H. Foh, D. Niyato and H. Xie, in IEEE Communications Surveys & Tutorials, vol. 17, no. 1, pp. 27-51, Firstquarter 2015, doi: 10.1109/COMST.2014.2330903.
5. "Computer Networks and the Internet: A Hands-On Approach" by Howser, Gerry, Germany, Springer International Publishing, 2019.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												3	
2	3	2											3	
3	3	2											3	
4	3	2	2									1	3	
5	3												3	
6	3												3	
Avg.	3	2	2									1	3	

1 - low, 2 - medium, 3 - high

COURSE CODE	VLSI DESIGN LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

SIMULATION BASED EXPERIMENTS USING MICROWIND:

- Design and Simulation of CMOS inverter
- Design and Simulation of Logic circuits using pass transistors, transmission gates and static CMOS logic styles
- Design and Simulation of dynamic CMOS circuits
- Design and Simulation of simple combinational circuits (encoder, multiplexer, code converters)

HARDWARE BASED EXPERIMENTS USING FPGA:

- Design and Simulation of ALU subsystem-Adders, Multipliers
- Design and Simulation of sequential circuits (counters, shift registers)
- Design and Simulation of Memory cell
- Power analysis of combinational and sequential circuits
- Testing of Stuck at faults of combinational digital Circuits

COURSE OUTCOMES:

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

CO1: Build and test the CMOS combinational circuits and ALU subsystems

CO2: Use flip-flops and latches to design and simulate sequential circuits , memory cells and test for stuck at faults in combinational circuits

CO3: Develop communication skills and capability to work in team and achieve goals

TOTAL: 30 PERIODS

REFERENCES:

1. VLSI Design Laboratory Manual prepared by ECE Department, CIT.
2. "CMOS VLSI Design - A Circuits and Systems Perspective" by Neil H.E.Weste, David Harris, 4th Edition, Pearson Education, 2015.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	3	3	3	-	-	-	-	-	-	-	-	2
2	3	-	3	3	3	-	-	-	-	-	-	-	-	2
3	-	-	-	-	-	-	-	-	1	2	-	-	-	-
Avg.	3	-	3	3	3	-	-	-	1	2	-	-	-	2

1 - low, 2 - medium, 3 - high

COURSE CODE	ANALOG AND DIGITAL COMMUNICATION LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

- Generation and demodulation of Amplitude Modulated signal
- Generation and demodulation of Frequency Modulated signal
- Verification of sampling theorem for low pass signals and testing of pulse analog modulation circuits
- Testing of Pulse Digital Modulation circuits
- Generation and detection of BFSK, BPSK, QPSK and QAM modulation scheme
- Implementation of Linear Block Coders, Cyclic Coders, Convolutional Coders and LDPC codes
- Testing the performance of Digital Communication system under AWGN using Software Defined Radio

COURSE OUTCOMES:

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

CO1: Construct and test analog , pulse analog , pulse digital modulation and demodulation circuits
CO2: Simulate and test Linear Block Coders, Cyclic Coders, Convolutional Coders and LDPC codes
CO3: Develop communication skills and capability to work in team

TOTAL: 30 PERIODS

REFERENCES:

1. Analog and Digital Communication Laboratory Manual, Department of ECE, CIT.
2. "Digital Communication Physical Layer Exploration Lab Using the NI USRP" by Robert W. Heath J., National Technology & Science Press, 2012.
3. "Digital Communications: Fundamentals and Applications" by Bernard Sklar, 2nd Edition, Pearson Education, 2009.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	2	2	2								3	
2	3	3	2	2	2								3	
3									2	2				
Avg.	3	3	2	2	2				2	2			3	

1 - low, 2 - medium, 3 - high

COURSE CODE	JAVA PROGRAMMING LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

- Develop a Java package with simple Stack and Queue classes. Use JavaDoc comments for documentation.
- Design a class for Complex numbers in Java. In addition to methods for basic operations on complex numbers, provide a method to return the number of active objects created.
- Design a Date class similar to the one provided in the java.util package.
- Develop with suitable hierarchy, classes for Point, Shape, Rectangle, Square, Circle, Ellipse, Triangle, Polygon, etc. Design a simple test application to demonstrate dynamic polymorphism.
- Design a Java interface for ADT Stack. Develop two different classes that implement this interface, one using array and the other using linked-list. Provide necessary exception handling in both the implementations.
- Write a Java program to read a file that contains DNA sequences of arbitrary length one per line (note that each DNA sequence is just a String) and sort the sequences in descending order with respect to the number of 'TATA' subsequences present. Finally write the sequences in sorted order into another file.
- Develop a simple paint-like program that can draw basic graphical primitives in different dimensions and colors. Use appropriate menu and buttons.
- Develop a scientific calculator using even-driven programming paradigm of Java.
- Develop a template for linked-list class along with its methods in Java.
- Design a thread-safe implementation of Queue class. Write a multi-threaded producer-consumer application that uses this Queue class.
- Write a multi-threaded Java program to print all numbers below 100,000 that are both prime and fibonacci number (some examples are 2, 3, 5, 13, etc.). Design a thread that generates prime numbers below 100,000 and writes them into a pipe.
- Design another thread that generates fibonacci numbers and writes them to another pipe. The main thread should read both the pipes to identify numbers common to both.
- Develop a multi-threaded GUI application of your choice.

COURSE OUTCOMES:

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

CO1: Develop advanced proficiency in Java programming for implementing diverse set of applications, encompassing fundamental data structures to intricate multi-threaded and graphical user interface (GUI) programs.

CO2: Develop strong object-oriented design skills and problem-solving abilities, including the creation of classes, interfaces, and hierarchies, as well as implementing solutions for real-world scenarios such as file handling, string manipulation, and complex mathematical computations.

CO3: Develop communication skills and capability to work in team.

TOTAL: 30 PERIODS

REFERENCES:

1. "Java: The complete reference" by Herbert Schildt, 9th Edition, TataMc-Graw Hill, 2017.
2. "Programming with Java" by E. Balagurusamy, 3rd Edition, TataMc-Graw Hill, 2014.
3. "Internet and WWW How to Program" by Paul Deitel, Harvey Deitel, Abbey Deitel, 5 th Edition, Tata McGraw Hill, 2011.
4. "Advanced Java 2 Platform: How to Program" by Harvey M. Deitel, Paul J. Deitel, Sean Santry, Prentice Hall, 2002.
5. "Core Java: Fundamentals" by Cay S. Horstmann, Volume 1", 11th Edition, Prentice Hall, 2020.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2	1	2				2	2			1	1
2	3	2	2	1	2				2	2			1	1
3									3	2			1	1
Avg.	3	2	2	1	2				2.33	2			1	1

1 - low, 2 - medium, 3 - high

SEMESTER VII

COURSE CODE	DIGITAL IMAGE PROCESSING	L	T	P	C
		3	1	0	4

'MODULE I DIGITAL IMAGE FUNDAMENTALS & TRANSFORMS 9+3

Fundamentals of Image processing - Image sampling and Quantization - Basic relationship between pixels. Image Transforms: Discrete Fourier Transform, Discrete Cosine Transform, Walsh Transform, Hadamard Transform, Haar Transform, Karhunen Loeve Transform and Discrete Wavelet Transform .

MODULE II IMAGE ENHANCEMENT 9+3

Gray Level transformations – Histogram Processing - Smoothing Spatial filters - Sharpening Spatial filters – Smoothing Frequency domain filters- Sharpening Frequency domain filters - Homomorphic Filtering - Color image fundamentals: RGB, HSI Models, CMY and CMY.

MODULE III IMAGE RESTORATION 9+3

Model of image degradation - Noise Models – Mean filters - Order statistics filters - Adaptive filters: Local noise reduction filter and Median filter - Linear position invariant degradations - Inverse filtering -Wiener filtering - Constrained least square filtering - Morphological operators - Dilation, Erosion, Opening and Closing- Hit or Miss Transformation.

MODULE IV IMAGE COMPRESSION 9+3

Coding redundancy - Spatial and temporal redundancy - Irrelevant information - Measuring image information - Fidelity criteria - Image compression models - Image formats - Huffman coding- Arithmetic coding - LZW coding – Run length coding - Bit plane coding - Predictive coding - Block transform coding - JPEG Compression- Wavelet Coding.

MODULE V IMAGE SEGMENTATION AND DESCRIPTION 9+3

Point detection - line detection - Edge detection - Edge linking and boundary detection: Local processing, Global processing: Hough Transform - Thresholding: Global thresholding, Adaptive thresholding and Optimal thresholding - Region based segmentation – Image Representation: Chain codes, Skeletons - Boundary descriptors: Simple descriptors, Shape numbers - Regional Descriptors: Simple descriptors, Topological descriptors,Texture.

COURSE OUTCOMES:

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

CO1: Apply image transforms, enhancement techniques, restoration filters, and morphological operators' techniques to enhance the visual perception of an image.

CO2: Interpret the need for image transforms in digital image processing techniques with their properties.

CO3: Evaluate the techniques for image enhancement in the spatial and frequency domain for improving the visual perception of an image.

CO4: Apply restoration filters and morphological operators to improve the image quality of an image.

CO5: Apply image compression techniques to reduce the size and image segmentation techniques to separate an image into different regions.

CO6: Make use of image restoration techniques to remove noise and artifacts from the image, compression methods to reduce the size of the image, and segmentation methods to extract regions of interest from the image.

TOTAL: 45+15 PERIODS

TEXT BOOKS:

1. "Digital Image Processing" by Rafael C.Gonzalez & Richard E.Woods, 4th Edition, Pearson Education, 2018.
2. “Digital Image Processing” by Jayaraman S. Esakirajan & Veerakumar.T ,Tata McGraw Hill, reprint 2010.

REFERENCES:

1. "Fundamentals of Digital Image Processing" by Anil.K.Jain, Pearson, 2015.
2. "Image Processing - Theory, Algorithm and Architecture" by Sid Ahmed M.A., McGraw Hill, 2009.
3. "Digital Image Processing" by William K.Pratt, 4th Edition, John Wiley, 2007.
4. "Image processing, Analysis and Machine Vision" by Milan Sonka, Vaclav Hlavac & Roger Boyle, 4th Edition, Thomson Asia Prt. Ltd, 2015.
5. “Image Processing and analysis: A Primer” by Georgy Gimel Jarb, Patrice Delmas, World Scientyic Publishing Europe Ltd., 2020.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2										2	
2	3	2	2										2	
3	3	2	2										2	
4	3	2	2										2	
5	3	2	2										2	
6	3	2	2										2	
Avg.	3	2	2										2	

1 - low, 2 - medium, 3 - high

COURSE CODE	WIRELESS COMMUNICATION AND NETWORKS	L	T	P	C
		3	0	0	3

MODULE I MOBILE RADIO PROPAGATION 9

Radio Wave Propagation - Free Space Propagation Model - Ground Reflection Model, Diffraction, Scattering - Practical link budget design - Small scale fading - Time dispersion parameters - Coherence bandwidth - Doppler spread & Coherence time, Fading due to Multipath time delay spread - Fading due to Doppler spread.

MODULE II CELLULAR ARCHITECTURE 9

Frequency Reuse - Channel Assignment Strategies - Handoff Strategies - Interference and System Capacity - Trunking and Grade of Service - Capacity in Cellular Systems.
Multiple Access Techniques: FDMA, TDMA, CDMA, OFDMA.

MODULE III MULTIPATH MITIGATION TECHNIQUES 9

Equalization – Adaptive equalization: Linear and Non-Linear equalization, - Diversity – Micro and Macro diversity - Diversity combining techniques - Rake receiver- MIMO: Alamouti Scheme

MODULE IV MODULATION TECHNIQUES AND NEW WAVEFORMS 9

Minimum Shift Keying - Gaussian Minimum Shift Keying - Multicarrier modulation: Orthogonal Frequency Division Multiplexing (OFDM) -PAPR reduction –Windowed OFDM - Filtered OFDM – Generalized Frequency Division Multiplexing (GFDM) – Filter Bank Multicarrier Modulation (FBMC) - Universal Filtered Multi Carrier (UFMC).

MODULE V WIRELESS NETWORKS 9

4G LTE – LTE+ – 5G Network – Near Field Communication (NFC) systems – Wireless LAN technology – Hyper LAN – Ad hoc networks – Bluetooth – Ultra Wideband (UWB) - mmWave – Introduction to 6G.

COURSE OUTCOMES:

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

- **CO1:** Interpret the concepts of radio propagation and fading channel models in wireless communication
- **CO2:** Interpret the functionalities of various cellular concepts and multiple access techniques used in cellular communication
- **CO3:** Solve problems in path loss due to large and small scale fading effects, channel assignment and traffic intensity in cellular system.
- **CO4:** Infer the impact of Inter Symbol Interference and fading channel effects in wireless communication systems
- **CO5:** Explain the need for multicarrier modulation techniques & new waveforms used in 5G system
- **CO6:** Summarize the concepts of cellular architecture and its alliance

TOTAL: 45 PERIODS

TEXT BOOKS:

1. "Wireless communications" by Rappaport.T.S, 2nd Edition, Pearson Education, 2010
2. "Wireless Communications" by Andreas.F. Molisch, 2nd Edition, Wiley, 2011.

REFERENCES:

1. “Evolution of air interface towards 5G Radio Access Technology and Performance Analysis”, by Suvra Sekhar Das and Ramjee Prasad ,River Publishers,2018
2. "Fundamentals of Wireless Communication", by David Tse, Pramod Viswanath, 1st Edition, Cambridge University Press, 2006.
3. “Wireless Communications” by Goldsmith A., Cambridge University Press, 2005.
4. “Principles of Modern Wireless Communication Systems Theory and Practice” by Aditya K Jagannatham ,1st Edition, McGraw Hill Education (India) Private Limited, 2017
5. "Wireless Communications and networks" by William Stallings, 2nd Edition, Pearson, 2009.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2			2				1				3	
2	3	2			2				1				3	
3	3	3											3	
4	3				1				1				3	
5	3												3	
6	3								3	3			3	
Avg.	3	2.3			1.6				1.5	3			3	

1 - low, 2 - medium, 3 - high

COURSE CODE	MICROWAVE ENGINEERING AND OPTICAL COMMUNICATION	L	T	P	C
		4	0	0	4

MODULE I MICROWAVE DEVICE CHARACTERIZATION 11

Frequency Spectrum - Scattering Matrix - Properties - Testing of reciprocal and lossless networks - Transmission (ABCD) Matrix - Two port, Three port and Four port Network Characterization - T Junction Power Divider - Resistive Power Divider - – 90^O Quadrature Hybrid Coupler - 180^O Hybrid Junction

MODULE II MICROWAVE GENERATION 12

High frequency limitations of conventional tubes - Principle of velocity modulation –Two cavity Klystron and Reflex klystron – transit time -density modulation - Traveling wave tube amplifier- Magnetron oscillators - Gunn diode.

MODULE III SEMICONDUCTOR DEVICES & MICROWAVE MEASUREMENTS 12

IMPATT Diode- TRAPATT diode - PIN diode - Spectrum analyzer - Network analyzer - Insertion Loss, Attenuation and VSWR measurements – Power measurement- Impedance measurement by Slotted line method - Dielectric constant measurement by waveguide method.

MODULE IV OPTICAL FIBER COMMUNICATION 13

Elements of an Optical Fiber Transmission link - Optical transmission basics - Light propagation in optical fiber- Optical Fiber Modes and Configurations - Optical Sources: LEDs, Laser Diodes - Detectors: PIN diode, APD- Signal Degradation in Optical Fibers: Attenuation, absorption, scattering losses and bending loss

MODULE V OPTICAL SYSTEM COMPONENTS & MEASUREMENTS 12

Optical Components: Couplers, Isolators, Circulators, Multiplexers & Filters - Optical Amplifiers - Switches - Wavelength Converters - Fiber attenuation measurements -Fiber refractive index profile measurements- Fiber cut off wavelength Measurements – Fiber numerical aperture measurements

COURSE OUTCOMES:

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

CO1: Infer the characteristics and construction of microwave generation devices.
CO2: Apply properties of scattering parameters to compute the scattering matrix of the three port network, four port network and hybrid couplers.
CO3: Interpret the generation of microwave signal and its construction.
CO4: Interpret the operating principle of microwave semiconductor devices, measuring losses, scattering and spectral parameters.
CO5: Infer the concepts of optical fiber communication systems and its signal degradation factors.
CO6: Interpret the various microwave and optical fiber measurements & components.

TOTAL : 60 PERIODS

TEXT BOOKS:

1. "Microwave Engineering" by David M. Pozar, 4th edition, Wiley India (P) Ltd, New Delhi, 2021
2. "Fiber Optic Communications", by Gerd Keiser Springer, 2021

REFERENCES:

1. "Microwave Devices and Circuits" by Samuel Y. Liao, 4th Edition, Prentice Hall of International Ltd, 2009.
2. "RF Circuit Design: Theory and Applications" by Reinhold Ludwig and Gene Bogdanov, 2nd Edition, Pearson Education Inc., 2009.
3. "Microwave Engineering" by Annapurna Das and Sisir K Das, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2017
4. "Optical Networks: A Practical Perspective" by Rajiv Ramaswami and Kumar N. Sivarajan, Galen Sasaki, 3rd Edition, Morgan Kaufmann Ltd, 2009, 2009.
5. "Optical Fiber Communications Principles and Practice" by John M. Senior, 3rd edition, PHI, New Delhi, 2009.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1											1	
2	3	2											1	
3	3	1											1	
4	3												1	
5	3	1											2	
6	3												2	
Avg.	3	1.25											1.33	

1 - low, 2 - medium, 3 - high

COURSE CODE	WIRELESS COMMUNICATION AND NETWORKING LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

The following experiments are implemented using software and hardware

- Large Scale & Small-Scale Fading Channel Modeling
- Equalization Techniques
- Diversity Techniques
- Spread Spectrum systems
- OFDM Transmitter & Receiver
- Wireless communication systems design using Software Defined Radio (SDR)
- Simulation of wireless networks and their performance analysis

COURSE OUTCOMES:
At the end of the course, students will be able to

CO1: Implement the fading channel models, diversity & equalization techniques and multi carrier modulation techniques
CO2: Simulate and test the performance of wireless communication systems and networks
CO3: Develop communication skills and capability to work in team

TOTAL: 30 PERIODS

REFERENCES:

1. "Digital Communication Physical Layer Exploration Lab Using the NI USRP" by Robert W. Heath J., National Technology & Science Press, 2012.
2. "Wireless communications" by Rappaport,T.S, 2nd Edition, Pearson Education, 2010.
3. Wireless Communication and Networking Laboratory Manual, Department of ECE, CIT.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	2	2	2								3	
2	3	3	2	2	2								3	
3									3	3				
Avg.	3	3	2	2	2				3	3			3	

1 - low, 2 - medium, 3 - high

COURSE CODE	MICROWAVE ENGINEERING AND OPTICAL COMMUNICATION LABORATORY	L	T	P	C
		0	0	2	1

LIST OF EXPERIMENTS

- Measurement of scattering parameters in branch line directional coupler and rat race hybrid ring coupler using Microwave Integrated Circuit Trainer Kit
- Measurement of return loss, bandwidth, gain using S-Band microstrip antenna trainer kit
- Measurement and characterization of passive devices: Isolator, Circulator, Magic Tee and Directional coupler
- Measurement of directivity, radiation pattern of the antenna
- Measurement of mode characteristics of Reflex Klystron
- Measurement of VSWR, Frequency, Guide-Wavelength and Unknown Impedance
- Measurement of dielectric constant of a dielectric material.
- Design, simulation and analysis of Microstrip-lines and antenna using Antenna
- simulation software
- Analysis of Electric, magnetic fields and radiation pattern of an antenna
- Measurement of fiber Losses
- Measurement of numerical aperture in optic fiber.
- Study of A Law companding
- Measurement of frequency characteristics of transmission line using FDR method
- Test and characterize the optical telecommunication network using OTDR.
- Characterization of detectors and sources for optical fiber systems

COURSE OUTCOMES:

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

CO1: Test and simulate the characteristics of the microwave passive device and microwave oscillator.

CO2: Test and simulate the optical characteristics of fiber-optic devices

CO3: Develop communication skills and capability to work in teams

TOTAL:30 PERIODS

REFERENCES:

1. Microwave Lab Manual by Department of ECE, CIT
2. "Microwave Engineering" by David M. Pozar, 4th edition, Wiley India (P) Ltd, 2021
3. "Microwave Engineering" by Annapurna Das and Sisir K Das, Tata McGraw Hill Publishing Company Ltd, 2017
4. "Optical Fiber Communications Principles and Practice", by John M. Senior, 3rd edition, PHI, New Delhi, 2009
5. " Practical Microstrip and Printed Antenna Design" by Anil Pandey, 1st Edition, Artech House, 2019.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	2	2									2	
2	3	3		2									2	
3									3	3				
Avg.	3	3	2	2						3	3		2	

1 - low, 2 - medium, 3 – high

COURSE CODE	ELECTRONIC SYSTEMS DESIGN LABORATORY	L	T	P	C
		0	0	2	1

This laboratory is intended for developing models / prototypes in the following domains:
Electronics and VLSI, Embedded Systems &IoT, Communication and Signal Processing, Microwave and RF Design, Soft Computing

- DC power supply design
- Design of Instrumentation amplifier with bridge type transducer
- Design of AC/DC voltage regulator
- Design of process control timer
- Design of communication systems.
- PCB layout design using CAD/Eagle
- Design of reconfigurable architectures
- Design of high speed CMOS VLSI circuits
- Design and fabrication of RF circuits
- Design and fabrication of Antennae
- Design of microcontroller based systems
- Design of IoT based systems
- Design of DSP based system design
- Development of Machine Learning models
- Applications of image processing

COURSE OUTCOMES:
At the end of the course, students will be able to

CO1: Design and develop models for signal processing and communication systems
CO2: Design, develop and test electronic and embedded systems for real time applications
CO3: Develop communication skills and capability to work in team.

TOTAL: 30 PERIODS

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	3	3	3	2	1	1					3	
2	3	3	3	3	3	2	1	1						3
3								3	3	3	3	3		
Avg.	3	3	3	3	3	2	1	1.6	3	3	3	3	3	3

1 - low, 2 - medium, 3 - high

ELECTIVE COURSES

COURSE CODE	CAD FOR VLSI CIRCUITS	L	T	P	C
		3	0	0	3

MODULE I ALGORITHM & SYNTHESIS **9**

VLSI Design cycle - Role of CAD tools in the VLSI Design process -data structures and algorithms: Complexity of algorithms, General purpose methods for combinatorial optimization, logic synthesis – two level synthesis, Binary decision diagrams, and ROBDD principles.

MODULE II PHYSICAL DESIGN AUTOMATION **9**

Partitioning - KL, FM algorithms, Placement – Simulation based algorithms- Simulated Annealing, Force Directed Algorithm, partitioning based algorithms- Breuer's Algorithm, Terminal propagation Algorithm, Cluster Growth Algorithm, Floor planning – slicing floor plan, Constraint Based Floor Planning, Integer Program Based Floor Planning – Pin Assignment

MODULE III ROUTING **9**

Grid routing – Maze Routing Algorithms, Global routing - Shortest Path Based Algorithms, Steiner tree based Algorithms, detailed routing – Left Edge algorithm, Dog-Leg Algorithm ,Greedy Channel Routing, Switch Box Routing algorithms- over the cell routing, Clock Routing

MODULE IV LAYOUT SYNTHESIS AND OPTIMIZATION **9**

Layout generation and Optimization of standard cell layout, gate matrix layout and PLA, Layout Compaction-one dimensional and two dimensional compaction.

MODULE V HIGH LEVEL SYNTHESIS **9**

Hardware Models- Internal Representation-Allocation assignment and scheduling-Simple scheduling algorithm- Assignment Problem.

COURSE OUTCOMES

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

CO1: explain the significance of each stage in the VLSI design process

CO2: interpret the degree of algorithm complexity in VLSI design.

CO3: develop innovative solutions using these algorithms for partitioning challenges.

CO4: develop new routing strategies or modifications to existing algorithms to address specific design requirements.

CO5: explain the principles behind routing algorithms in grid and global routing and generate compact layout for a specific design requirement

CO6: explain the effectiveness of allocation, assignment, and scheduling strategies in achieving design goals.

TOTAL : 45 PERIODS

TEXT BOOKS:

3. "Algorithms for VLSI Physical Design Automation" by N.A. Sherwani, 2nd Edition, Kluwer Academic Publishers, 2012.
4. "Algorithms for VLSI Design Automation" by S.H. Gerez, 2nd Edition, John Wiley and Sons, 2006.

REFERENCES:

4. "Evolutionary Algorithms for VLSI CAD" by R. Drechsler, Springer-Verlag New York Inc, 2010.
5. "Algorithms and Techniques for VLSI Layout Synthesis" by D.D. Hill, Shugard, Fishburn, J., and Kuetzer, K., Springer US, 2012.
6. "VLSI Physical Design: From Graph Partitioning to Timing Closure" by Andrew B. Kahng, Jens Lienig, Igor L. Markov, and Jin Hu, 1st Edition, Springer Science & Business Media, 2011.

7. "Synthesis and Optimization of Digital Circuits" by G.D. Micheli, Tata McGraw Hill, 2016.
8. "Algorithms and Data Structures in VLSI Design" by Christoph Meinel and Thorsten Theobald, Springer, 2012.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	2	-	-	-	-	-	-	-	-	-	-	-	2
4	3	2	-	-	-	-	-	-	-	-	-	-	-	2
5	3	2	-	-	-	-	-	-	-	-	-	-	-	2
6	3	2	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	2	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	ASIC DESIGN	L	T	P	C
		3	0	0	3

MODULE I ASIC LIBRARY DESIGN **9**

Types of ASICs - Design flow - CMOS transistors CMOS Design rules - Combinational Logic Cell – Sequential logic cell - Data path logic cell - Transistors as Resistors - Transistor Parasitic Capacitance- Logical effort –Library cell design - Library architecture.

MODULE II PROGRAMMABLE ASICS, LOGIC CELLS AND I/O CELLS **9**

Anti-fuse - static RAM - EPROM and EEPROM technology - PREP benchmarks - Actel ACT - Xilinx LCA –Altera FLEX - Altera MAX DC & AC inputs and outputs - Clock & Power inputs - Xilinx I/O blocks

MODULE III PROGRAMMABLE ASIC INTERCONNECT AND DESIGN SOFTWARE **9**

Actel ACT -Xilinx LCA - Xilinx EPLD - Altera MAX 5000 and 7000 - Altera MAX 9000 - Altera FLEX – Design systems - Logic Synthesis - Half gate ASIC -Schematic entry, Low level design language - PLA tools -EDIF- CFI design representation.

MODULE IV FPGA ARCHITECTURES, SIMULATION AND TESTING **9**

FPGA Architectures. SRAM-Based FPGAs. Permanently Programmed FPGAs. Chip I/O, Types of simulation –boundary scan test-Fault simulation-Automatic Test Pattern Generation, Introduction to JTAG

MODULE V PHYSICAL DESIGN OF ASIC **9**

System partition - FPGA partitioning - partitioning methods - floor planning - placement - physical design flow – global routing - detailed routing - special routing - circuit extraction - DRC.

COURSE OUTCOMES

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

- **CO1:** infer the basics of ASIC design flow, associated library design and architectures, requirements of logic cells and I/O cells that are used to build different ASIC designs.
- **CO2:** explain the Application specific integrated circuit design flow and its architectural structures that can be used to build user specific applications
- **CO3:** interpret different vendor specific logic and input/output standard cells available for building their own design
- **CO4:** make use of suitable structures for establishing interconnects between various basic blocks of different ASIC designs.
- **CO5:** utilize the FPGA architectures to model design circuits and test the functionalities considering the physical design issues for improving the performance of the ASIC.
- **CO6:** interpret the interconnects between logical and I/O blocks in different ASIC and FPGA design by considering the physical design issues in ASIC design flow so that the overall efficiency of the designs are improved.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Application-Specific Integrated Circuits" by M.J.S. Smith, Pearson Education, 2013.
2. "VLSI Circuits and Systems in Silicon" by Andrew Brown, McGraw Hill, 2011.

REFERENCES:

1. "Field Programmable Gate Arrays" by S.D. Brown, R.J. Francis, J. Rox, and Z.G. Uranesic, Kluwer Academic Publishers, 2012.
2. "Analog VLSI Signal and Information Processing" by Mohammed Ismail and Terri Fiez, McGraw Hill,

2000.
3. "FPGA-Based System Design" by Wayne Wolf, Prentice Hall, 2004.
4. "Design of Analog-Digital VLSI Circuits for Telecommunication and Signal Processing" by Jose E. France and Yannis Tsividis, Prentice Hall, 1994.
5. "A Practical Guide for VLSI Designers: FPGA/ASIC Design and Implementation Flows Illustrated with Examples" by Vikram Arkalgud Chandrasetty, CreateSpace, 2011.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	HIGH SPEED DIGITAL DESIGN	L	T	P	C
		3	0	0	3

MODULE I MODELLING OF HIGH SPEED WIRES AND TRANSMISSION LINES 9

Frequency- time and distance- Knee Frequency and its significance- Propagation Delay- Capacitance and Inductance Effects- High speed properties of logical gates- Speed and power. Geometry and Electrical properties of wires-Electrical model of wires. Lattice Diagram Analysis of Transmission Lines, Simple and Special Transmission Lines.

MODULE II POWER DISTRIBUTION AND NOISE SOURCES IN DIGITAL SYSTEM 9

Power supply network- Local power regulation- IR drops- Area bonding- On chip bypass capacitors-Bypass Capacitor Design- Symbiotic bypass capacitors-Power supply isolation-Power supply Noise, Cross talk, Inter-symbol Interference

MODULE III SIGNALLING CONVENTIONS AND TERMINATOR CIRCUITS 9

Signaling modes for transmission lines-Signaling over lumped transmission media-Signaling over RC interconnects-driving lossy LC lines- simultaneous bi-directional Signaling. Transmitter and receiver circuits

MODULE IV CLOCK DISTRIBUTION AND SYNCHRONIZATION 9

Timing fundamentals-Timing properties of clocked storage elements-signals and events- Open loop Timing-level sensitive clocking- Pipeline Timing- Closed loop Timing- Clock Distribution-Synchronization failure and Metastability- PLL and DLL based clock aligners

MODULE V HIGH-SPEED CHANNEL MODELING 9

Creating a Physical Transmission-Line Model-Tabular Approach- Generating a Tabular Dielectric Model-Generating a Tabular Conductor Model-Non-Ideal Return Paths-Path of Least Impedance-Transmission Line Routed Over a Gap in the Reference Plane-Vias-Via Resonance-Plane Radiation Losses-Parallel-Plate Waveguide.

COURSE OUTCOMES

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

CO1: explain the significant parameters to be considered in modelling high speed devices.

CO2: infer the fundamental concept of modelling of high speed wires and transmission lines

CO3: interpret the methods of power distribution and sources of noise in digital systems.

CO4: explain the signalling conventions and understand the importance of terminator circuits.

CO5: infer the clock distribution schemes, clock skew and high speed channel modelling to model the design issues to be considered for synchronization.

CO6: interpret the need for terminator circuits, high speed channel modelling and summarize the challenges in designing high speed circuits

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Digital System Engineering" by Dally & Paulton, Cambridge University Press, 1998.
2. "High Speed Digital Design: A Handbook of Black Magic" by Johnson & Graham, Prentice Hall, 1993

REFERENCES:

1. "Design of Analog-Digital VLSI Circuits for Telecommunication and Signal Processing" by Jose E. France and Yannis Tsividis, Prentice Hall, 1994.

2. "High Speed Digital Circuits" by Masakazu Shoji, Addison Wesley Publishing, 1996.
3. "Digital Integrated Circuits: A Design Perspective" by Jan M. Rabaey et al., 2nd Edition, PHI Publications, 2003.
4. "High Speed Digital Design: A Handbook of Black Magic" by Howard Johnson and Martin Graham, 3rd Edition, Prentice Hall Modern Semiconductor Design Series, 2006.
5. "High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices" by Stephen H. Hall, Garrett W. Hall, and James A. McCall, Wiley, 2007.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	RECONFIGURABLE COMPUTING	L	T	P	C
		3	0	0	3

MODULE I DEVICE ARCHITECTURE 9

General Purpose Computing Vs Reconfigurable Computing – Simple Programmable Logic Devices – Complex Programmable Logic Devices – FPGAs – Device Architecture - Case Studies**.**

MODULE II RECONFIGURABLE COMPUTING ARCHITECTURES AND SYSTEMS 9

Reconfigurable Processing Fabric Architectures – RPF Integration into Traditional Computing Systems – Reconfigurable Computing Systems – Case Studies – Reconfiguration Management.

MODULE III PROGRAMMING RECONFIGURABLE SYSTEMS 9

Compute Models - Programming FPGA Applications in HDL – Compiling C for Spatial Computing – Operating System Support for Reconfigurable Computing

MODULE IV MAPPING DESIGNS TO RECONFIGURABLE PLATFORMS 9

The Design Flow - Technology Mapping – FPGA Placement and Routing – Configuration Bitstream Generation – Case Studies with Appropriate Tools

MODULE V APPLICATION DEVELOPMENT WITH FPGAS 9

Case Studies of FPGA Applications – System on a Programmable Chip (SoPC) Designs

COURSE OUTCOMES

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

CO1: explain the new paradigm for computing that offers flexibility, scalability, and performance.
CO2: outline the concepts behind CPLDs and FPGAs
CO3: identify the suitable reconfigurable architectures for high-performance applications.
CO4: develop a HDL program for use with FPGAs.
CO5: examine suitable mapping methods for SoPC designs
CO6: develop a HDL code for SoPC-based FPGA applications using appropriate tools.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Reconfigurable Computing: Accelerating Computation with Field-Programmable Gate Arrays" by Maya B. Gokhale and Paul S. Graham, Springer, 2011.
2. "Reconfigurable Computing – The Theory and Practice of FPGA-Based Computing" by Scott Hauck and Andre Dehon (Eds.), Elsevier Science, 2010.

REFERENCES:

1. "Introduction to Reconfigurable Computing – Architectures, Algorithms and Applications" by Christophe Bobda, Springer, 2010.
2. "Dynamic Reconfiguration: Architectures and Algorithms" by R. Vaidyanathan and Trahan Jerry, Springer US, 2003.
3. "Design Recipes for FPGAs using Verilog and VHDL" by Peter Wilson, Elsevier Science, 2015.
4. "Field Programmable Gate Arrays" by Stephen D. Brown, Robert J. Francis, Jonathan Rose, Zvonko G. Vranesic, Kluwer Academic Publishers, 2012.
5. "Practical FPGA Programming in C" by D. Pellerin and S. Thibault, Prentice-Hall, 2005.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	VLSI TECHNOLOGY	L	T	P	C
		3	0	0	3

MODULE I MATERIAL PROPERTIES & CRYSTAL GROWTH 9

Crystal structure- axes & planes, Crystal defects-Point defects & dislocations Crystal growth- Bridgman, Czochralski techniques & Zone process, Doping in the melt.

MODULE II DIFFUSION & ION IMPLANTATION 9

Nature of diffusion-interstitial, Substitutional, interstitial substitutional movements, Diffusion constant, Dissociate process, Diffusion equation- D is constant & function, Diffusion systems, problems in Si Diffusion, Evaluation Techniques Ion Implantation: Penetration range, Implantation Damage, Annealing, Implantation Systems.

MODULE III OXIDATION & EPITAXY OXIDATION 9

Thermal Oxidation-Intrinsic, Extrinsic silicon Glass, Oxide formation, Kinetics of Oxide growth, Oxidation systems, Faults, Anodic Oxidation. EPITAXY: Vapour Phase Epitaxy (VPE)- transport, reaction and growth, Chemistry of growth, Insitu etching, Selective epitaxy, imperfections, Liquid Phase Epitaxy, LPE system, Evaluation of epitaxial layers

MODULE IV ETCHING & LITHOGRAPHY 9

LITHOGRAPHY: Pattern generation & Masking, Printing & Engraving-Optical, E-Beam, ion Beam, X-Ray, Photo resists, Defects. ETCHING: Wet chemical etching- anisotropic etchants, Etching for non-crystalline films- Plasma etching, Plasma-assisted etching, cleaning

MODULE V DEVICE & CIRCUIT FABRICATION 9

Isolation- Mesa, Oxide, PN-junction isolations, Self Alignment, Local Oxidation, Planarization, Metallization and Packaging. Circuits — N, P and CMOS Transistors, Memory devices, BJT Circuits — Buried Layer, PNP and NPN Transistors, Diodes, Resistors, Capacitors

COURSE OUTCOMES

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

CO1: explain the diffusion process and the fundamentals and characteristics of semiconductor materials.
CO2: outline the dynamics of crystal formation and the material characteristics.
CO3: explain the ion implantation and diffusion in the VLSI fabrication method.
CO4: examine the semiconductor materials' oxide growth and epitaxy oxidation kinetics.
CO5: examine the kinetics of oxide growth and epitaxy oxidation in semiconductor materials
CO6: summarize the different fabrication techniques used in VLSI technology.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "VLSI Fabrication Principles – Silicon and Gallium Arsenide" by Sorab K Gandhi, Wiley India Publications, New York, 2009.
2. "VLSI Technology" by Sze S M, 2nd Edition, McGraw-Hill Education (India) Pvt Limited, New York, 2003

REFERENCES:

1. "Physics of Semiconductor Devices" by Massimo Rudan, Springer International Publishing, 2018.
2. "Semiconductor Physics and Devices" by Donald Neamen, McGraw-Hill Education, 2012.
3. "Physics of Semiconductor Devices" by Sze S M and Kwok K Ng, 3rd Edition, Wiley India, 2008.

4. "VLSI Technology, Fundamentals and Applications" by Yasuo Tarui, Springer-Verlag, 2013.
5. "Silicon VLSI Technology" by James D. Plummer, Michael D. Deal, and Peter D. Griffin, Prentice Hall, 2009.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	BIO-MEDICAL CMOS ICS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO BIO-MEDICAL CMOS ICS 9

Introduction to Bioelectricity - Electrical Properties of the Human body - Equivalent Circuit Model of Tissues and Organs - Biomedical Devices - Current Research Trends in Biomedical Electrical Instruments.

MODULE II BIOMEDICAL ELECTRODES 9

Electrical properties of Electrode–Skin interface - Electrode Design- Modern Disposable Electrodes - Solid Conductive Adhesive Electrodes- wearable electrodes for personalized health - Implant Electrodes– Microelectrodes- Electrode Standards.

MODULE III READOUT CIRCUITS 9

Bio-potential Acquisition- Power Efficient Instrumentation Amplifier Topologies- Current Mode Instrumentation Amplifiers - Examples of ICs for Bio-potential Acquisition.

MODULE IV LOW POWER CMOS ICs 9

Low power ADCs for Bio-Medical Applications: ADC specifications – challenges -Charge sharing successive approximation ADCs–Comparator based Asynchronous binary search ADCs- Low Power Bio-Medical Digital Signal Processor: Basic operating principle and architectures.

MODULE V BIO-MEDICAL WIRELESS COMMUNICATION 9

Short distance Wireless Communications: Telemetry Methods, Modulation Methods, Compression, Error Correction, Carrier frequency selection - Telemetry applications: physiological monitoring, Implant monitoring and stimulation - Biomedical Transmitters.

COURSE OUTCOMES

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

CO1: infer the characteristics of biological systems and biomedical electrodes

CO2: interpret the electrical properties of tissues and organs using equivalent circuit models

CO3: compare the features of different types of biomedical electrodes

CO4: examine Instrumentation Amplifier Topologies used for Bio-potential Signal Extraction

CO5: compare low power ADC architectures, telemetry methods and modulation techniques used for biomedical applications

CO6: interpret the operating principle of bio amplifiers, low power ADCs used for biomedical applications, biomedical transmitters and biotelemetry applications in physiological monitoring & implant monitoring

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Integrated Circuits and Systems- Bio Medical CMOS ICs" by Hoi-Jun Yoo and Chris van Hoof, Springer, 2010.

REFERENCES:

1. "Biomedical Signal Processing: Principles and Techniques" by D C Reddy, Tata McGraw-Hill Publishing Co. Ltd, 2005.
2. "Biomedical Signal Analysis: A Case Based Approach" by R M Rangayyan, IEEE Press, John Wiley and Sons. Inc., 2002.
3. "Handbook of Modern Sensors: Physics, Designs, and Applications" by Jacob Fraden, Springer, 2010.

4. "The Measurement, Instrumentation and Sensors Handbook vol. 1" by J. G. Webster, CRC Press, 1st Edition, 1998.
5. "VLSI Circuits for Biomedical Applications" by Krzysztof Iniewski, Artech House, 2008.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1	1	-	-	-	-	-	-	-	-	-	-	1
2	3	1	1	-	-	-	-	-	-	-	-	-	-	1
3	3	2	1	-	-	-	-	-	-	-	-	-	-	1
4	3	2	1	-	-	-	-	-	-	-	-	-	-	1
5	3	2	1	-	-	-	-	-	-	-	-	-	-	1
6	3	1	1	-	-	-	-	-	-	-	-	-	-	1
Avg.	3	2	1	-	-	-	-	-	-	-	-	-	-	1

1-low, 2-medium, 3-high

COURSE CODE	VALIDATION AND TESTING TECHNOLOGY	L	T	P	C
		3	0	0	3

MODULE I CMOS TECHNOLOGY **9**

Introduction to IC Technology – MOS, PMOS, NMOS, CMOS &BiCMOS Technologies-VLSI Fabrication-Oxidation-Lithography-Diffusion-Ion Implantation-Metallization-Integrated Resistors and Capacitors

MODULE II VLSI TESTING METHODOLOGIES **9**

Design Flow of VLSI Systems-Design and manufacturing defect models - Simulation based design verification-Fault Simulation: Parallel, Deductive, Concurrent - Functional Testing Methodologies: Exhaustive testing - Pseudo-exhaustive testing.

MODULE III STRUCTURE BASED TESTING **9**

Fault model based testing- Stuck-at faults- Bridging faults- Stuck-open faults- Delay faults - Fault Grading -Automatic Test Pattern Generation Algorithms: D-Algorithms- PODEM- FAN

MODULE IV SILICON VALIDATION AND TESTING **9**

Need for Testing-Testing at Various Levels- Objectives of Testing - VLSI Test process and Test Equipment - Types of Testing: Functionality Tests-Silicon Debug- Manufacturing Tests-Defectduring manufacturing - Fault Modelling-Observability and Controllability- Fault Coverage- Fault Sampling – ATE- Test economics.

MODULE V SYSTEM VERILOG – DATA TYPES & PROCEDURAL STATEMENTS **9**

Introduction to System Verilog – Literal values-data Types – Arrays – Array methods – Creating new types with typedef – user defined structures – Enumerated types – attributes - operators – expressions - Procedural statements and control flow - Processes in System Verilog – Task and functions – Routine arguments – Returning from a routine Module-Connecting Test bench and Design -Program, Interface, Stimulus timing, Module interactions, Connecting together, Development of self-checking test environment – Generator, Transactor, Driver, Monitor, Checker, Scoreboard

COURSE OUTCOMES

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

CO1: infer the fundamental concept of CMOS fabrication processes, testing methodologies and fault simulation for VLSI circuits and compare their strengths and limitations.

CO2: explain different fabrication techniques and challenges faced in manufacturing an IC.

CO3: interpret the concept of VLSI testing methodologies and fault simulation.

CO4: infer the need for testing and fault detection prior to IC manufacturing.

CO5: explain the basics of Testing and understand the concepts of Fault Modeling in order to test the functionality of the designed models.

CO6: interpret the need of fault simulation and develop System Verilog codes for modeling and testing digital systems.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Essentials of VLSI Circuits and Systems" by Kamran Eshraghian, Douglas A. Pucknell, and Sholeh Eshraghian, PHI, EEE,2005.
2. "System Verilog for Verification: A Guide to Learning the Test Bench Language Features" by Chris Spear, Third Edition, Springer publications, 2012.

REFERENCES:

1. "CMOS VLSI Design" by Neil H. E. Weste, David Harris, Ayan Banerjee, Pearson Education, 1999.
2. "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits" by M.L. Bushnell, V.D. Agrawal, Kluwer Academic Publishers, 2004.
3. "Testing of Digital Systems" by N.K. Jha, S.G. Gupta, Cambridge University Press, 2003.
4. "Basics of CMOS Cell Design" by Etienne Sicard, Sonia Delmas Bendhia, TMH, EEE, 2005.
5. "Principles of Testing Electronic Systems" by Samiha Mourad, Yervant Zorian, Wiley, 2000.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	QUANTUM CIRCUIT DESIGN	L	T	P	C
		3	0	0	3

MODULE I MATHEMATICS IN QUANTUM COMPUTATION 9

Quantum Computation vs Classical Computation - Mathematics and Quantum Mechanics Preliminaries - Linear Algebra - Unitary Matrices - Tensor Product - Pauli Matrices - Notions of Quantum Information - Quantum state - Dirac Notation - Superpostition - Entanglement - Bell State - Probabilities and Measurements

MODULE II QUANTUM GATES AND CIRCUITS 9

Qubits - Quantum Gates - Single Qubit Gates - Multiple Qubit Gates - Quantum Gates Acting on One Qubit - Bloch sphere Representation - Circuit Models - Design of Quantum Circuits

MODULE III QUANTUM ALGORITHM AND IMPLEMENTATION 9

Deutsch's Algorithm - Deutsch-Jozsa Algorithm - Bernstein-Vazirani Algorithm - Quantum Fourier Transform - Shor's Factoring Algorithm - Grover's Search Algorithm - Quantum error correction - Fault-tolerant Computation - Computational Complexity

MODULE IV QUANTUM CRYPTOGRAPHY 9

No Cloning Theorem - Private Key Cryptography - Quantum Key Distribution - BB84 protocol - B92 protocol - EPR protocol - Secured Quantum Key Distribution - Post Quantum Cryptography.

MODULE V QCA BASED DIGITAL CIRCUITS 9

QCA terminologies- Logic Primitives in QCA- Clocking in QCA - Role and Types -Design of Logic Gates and Multiplexer in QCA - Design of a One-Bit Full-Adder - Flip-Flop in QCA - Design ofRipple Carry Adder (RCA) and Prefix Adders in QCA- Design of 16-Bit Hybrid Adder in QCA- Layout Level Implementation of adders and Comparisons. Introduction to 19 Multipliers -Design of a Multiplier in QCA - The Baugh - Wooley Multiplier for 2's Complement Numbers- Design of BaughWooley Multiplier in QCA

COURSE OUTCOMES

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

CO1: interpret the basic concepts of Quantum computation for quantum gates and circuits
CO2: examine the various quantum computational mathematical models for quantum design
CO3: construct various quantum circuits using Quantum gates and circuit models
CO4: develop various quantum algorithms for quantum circuits design
CO5: identify the protocols in Quantum key distribution and post Quantum cryptography and QCA.
CO6: design quantum dot cellular automato based digital circuits

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Quantum Computation and Quantum Information" by Michael A. Nielsen and Isaac L. Chuang, Cambridge University Press, 2010.
2. "An Introduction to Quantum Computing" by Phillip Kaye, Raymond Laflamme, and Michele Mosca, Oxford University Press, 2007.

REFERENCES:

1. "Quantum Computing: A Gentle Introduction" by Eleanor Rieffel and Wolfgang Polak, The MIT Press,

2014.
2. "Quantum Circuit Simulation" by George F. Viamontes, Igor L. Markov, and John P. Hayes, Springer, 2009.
3. "Quantum Computing for Everyone" by Chris Bernhardt, The MIT Press, 2020.
4. "Design of Arithmetic Circuits in Quantum Dot Cellular Automata Nanotechnology" by K. Sridharan, Vikramkumar Pudi, Studies in Computational Intelligence, Springer International Publishing, 2015.
5. "Quantum-Dot Cellular Automata Based Digital Logic Circuits: A Design Perspective" by Anand Mohan, Ashutosh Kumar Singh, and Trailokya Nath Sasamal, Springer Nature, 2019.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	SIGNAL INTEGRITY FOR HIGH SPEED DEVICES	L	T	P	C
		3	0	0	3

MODULE I SIGNAL PROPAGATION IN TRANSMISSION LINES 9

Importance of Signal Integrity- Wave Propagation- Wave equation- Transmission-Line Structures- Wave Propagation on Loss-Free Transmission Lines- Transmission-Line Properties- Parameters for the Loss-Free-Transmission-Line Reflections.

MODULE II CROSS-TALK IN TRANSMISSION LINES 9

Mutual Inductance and Capacitance- Coupled Wave Equations- Coupled Line Analysis- Modal Analysis- Crosstalk Minimization- Near and far-end cross-talk, minimizing cross-talk- Differential signalling- cross-talk in differential pairs, S-parameters for signal integrity- Matrix elements- Return and Insertion loss.

MODULE III NON-IDEAL EFFECTS 9

Signals Propagating in Unbounded Conductive Media- Classic Conductor Model for Transmission Line Losses- Conductor DC Losses- Dielectric DC Losses- Skin effect- Frequency-Dependent Dielectric Losses-Variation in dielectric constant- Intersymbol Interference- Effects of 90˚ Bends- Effects of Topology

MODULE IV SYSTEM DESIGN AND I/O CIRCUIT MODELS 9

I/O Design Considerations- Push–Pull Transmitters- CMOS receivers- ESD Protection Circuits- On-Chip Termination- Open-Drain Transmitters- Differential Current-Mode Transmitters- Low-Swing and Differential Receivers- IBIS Models- Eye Diagram- Bit Error Rate

MODULE V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS 9

Timing margin- Clock slew- Low impedance drivers- Source Terminations of Multiple-clock Lines- Delay Adjustments- Clock Signal Duty cycle- Cancelling parasitic capacitance- Clock Jitter.

COURSE OUTCOMES

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

CO1: explain the significance of multi-conductor system cross talk in transmission lines for digital timing.

CO2: outline how waves propagate through transmission lines without loss.

CO3: provide an overview of cross-talk in transmission lines and characteristic impedance matching strategies.

CO4: show differential signalling and non-ideal transmission line effects both theoretically and practically.

CO5: find the fundamental specifications for clock skew principles, circuit modeling, and I/O system design.

CO6: examine non-ideal effects, I/O circuit models, clock distribution, and oscillators to ensure high-speed device signal integrity.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Advanced Signal Integrity for High-Speed Digital Designs, " by Stephen H. Hall, Howard L. Heck,, A John Wiley & Sons, Inc., Publication,, 2009.
2. "Modern Semiconductor Design Series, " by Eric Bogatin, Signal and Power Integrity – Simplified, Prentice Hall, Pearson Education, Inc, 2009.

REFERENCES:

1. "Signal Integrity - From High-Speed to Radiofrequency Applications" by Fabien Ndagijimana, Wiley-ISTE, 2014.
2. "Signal Integrity Issues and Printed Circuit Board Design" by Douglas Brooks, Prentice Hall Professional, 2003.
3. "High-Speed Digital System Design—A Handbook of Interconnect Theory and Design Practices" by Stephen H. Hall, Garrett W. Hall, James A. McCall, Wiley-Interscience Publication, 2000.
4. "High Speed Digital Design" by Hanqiao Zhang, Steven Krooswyk, Jeffrey Ou, Elsevier Science, 2015.
5. "Power Integrity for I/O Interfaces with Signal Integrity/ Power Integrity Co-Design" by Vishram S. Pandit, Woong Hwan Ryu, Myoung Joon Choi, Prentice Hall, 2011.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	SYSTEM ON CHIP	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO SYSTEM APPROACH 9

System Architecture, Components of the system, Hardware and Software, Processor Architectures, Memory and Addressing. System level interconnection, An approach for SOC Design, System Architecture and Complexity

MODULE II PROCESSORS 9

Introduction to Processor- Processor Selection for SOC, Basic concepts in Processor Architecture, Basic concepts in Processor Micro Architecture, Basic elements in Instruction handling. Buffers: minimizing Pipeline Delays, Branches, More Robust Processors, Vector Processors and Vector Instructions extensions, VLIW Processors, Superscalar Processors

MODULE III MEMORY DESIGN FOR SOC 9

Overview of SOC external memory, Internal Memory, Size, Scratchpads and Cache memory, Cache Organization, Cache data, Write Policies, Strategies for line replacement at miss time, Types of Cache, Split – I, and D – Caches, Multilevel Caches, Virtual to real translation, SOC Memory System, Models of Simple Processor – memory interaction

MODULE IV INTERCONNECT CUSTOMIZATION AND CONFIGURATION 9

Interconnect Architectures, Bus: Basic Architectures, SOC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SOC Customization: An overview, Customizing Instruction Processor, Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance Specific design, Customizable Soft Processor, Reconfiguration – overhead analysis and trade-off analysis on reconfigurable Parallelism

MODULE V APPLICATION STUDIES / CASE STUDIES 9

SOC Design approach, AES algorithms, Design and evaluation, Image compression – JPEG compression

COURSE OUTCOMES

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

CO1: interpret various concepts of processor architecture for system-on-chip (SOC)

CO2: explain the basic concepts of System-on-Chip (SoC) design approach

CO3: outline the basic elements of processor and knowledge on basic elements in the system

CO4: summarize an overview on System-On-Chip (SOC) internal and external memory design.

CO5: explain the architecture with the knowledge of system interconnect and configuring designs for various applications

CO6: apply memory design and system interconnects for customizing the circuits onto a single chip.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Computer System Design System-on-Chip" by Michael J. Flynn and Wayne Luk, Wiley India Pvt. Ltd, 2011.
2. "ARM System on Chip Architecture" by Steve Furber, 2nd Edition, Pearson, 2015.

REFERENCES:

1. "Design of System on a Chip: Devices and Components" by Ricardo Reis, 1st Edition, Springer, 2004.
2. "Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology)" by Jason Andrews, Newnes, BK and CDROM.
3. "System on Chip Verification – Methodologies and Techniques" by Prakash Rashinkar, Peter Paterson, and Leena Singh L, Kluwer Academic Publishers, 2001.
4. "System-On-A-Chip: Design and Test" by Rochit Rajsuman, Artech House Signal Processing Library, 2000.
5. "System-on-Chip: Next Generation Electronics (Materials, Circuits and Devices)" by Bashir M. Al-Hashimi, 2006.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	SEMICONDUCTOR DEVICE MODELLNG	L	T	P	C
		3	0	0	3

MODULE I MOS CAPACITORS **9**

Surface Potential: Accumulation, Depletion, and Inversion, Electrostatic Potential and Charge Distribution in Silicon, Capacitances in an MOS Structure, Polysilicon-Gate Work Function and Depletion Effects, MOS under Nonequilibrium and Gated Diodes, Charge in Silicon Dioxide and at the Silicon–Oxide Interface, Effect of Interface Traps and Oxide Charge on Device Characteristics, High-Field Effects, Impact Ionization and Avalanche Breakdown, Band-to-Band Tunneling, Tunneling into and through Silicon Dioxide, Injection of Hot Carriers from Silicon into Silicon Dioxide, High-Field Effects in Gated Diodes, Dielectric Breakdown

MODULE II MOSFET DEVICES **9**

Long-Channel MOSFETs, Drain-Current Model, MOSFET I–V Characteristics, Subthreshold Characteristics, Substrate Bias and Temperature Dependence of Threshold Voltage, MOSFET Channel Mobility, MOSFET Capacitances and Inversion-Layer Capacitance Effect, Short-Channel MOSFETs, Short-Channel Effect, Velocity Saturation and High-Field Transport Channel Length Modulation, Source–Drain Series Resistance, MOSFET Degradation and Breakdown at High Fields -Applications

MODULE III CMOS DEVICE DESIGN **9**

CMOS Scaling, Constant-Field Scaling, Generalized Scaling, Nonscaling Effects, Threshold Voltage, Threshold-Voltage Requirement, Channel Profile Design, Nonuniform Doping, Quantum Effect on Threshold Voltage, Discrete Dopant Effects on Threshold Voltage, MOSFET Channel Length, Various Definitions of Channel Length, Extraction of the Effective Channel Length, Physical Meaning of Effective Channel Length, Extraction of Channel Length by C–V Measurements.

MODULE IV BIPOLAR DEVICES **9**

n–p–n Transistors, Basic Operation of a Bipolar Transistor, Modifying the Simple Diode Theory for Describing Bipolar Transistors, Ideal Current–Voltage Characteristics, Collector Current, Base Current, Current Gains, Ideal IC–VCE Characteristics, Characteristics of a Typical n–p–n Transistor, Effect of Emitter and Base Series Resistances, Effect of Base–Collector Voltage on Collector Current, Collector Current Falloff at High Currents, Nonideal Base Current at Low Currents, Bipolar Device Models for Circuit and Time-Dependent Analyses Basic dc Model, Basic ac Model, Small-Signal Equivalent-Circuit Model, Emitter Diffusion Capacitance, Charge-Control Analysis, Breakdown Voltages, Common-Base Current Gain in the Presence of Base–Collector Junction Avalanche, Saturation Currents in a Transistor-applications

MODULE V MATHEMATICAL TECHNIQUES FOR DEVICE SIMULATIONS **9**

Poisson equation, continuity equation, drift-diffusion equation, Schrodinger equation, hydrodynamic equations, trap rate, finite difference solutions to these equations in 1D and 2D space, grid generation

COURSE OUTCOMES

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

- **CO1:** describe the characteristics of MOSFETs and MOS capacitors.
- **CO2:** analyze MOS devices' second-order effects.
- **CO3:** examine the different MOSFET device characteristics.
- **CO4:** describe the different CMOS design parameters and how they affect the device's performance.
- **CO5:** interpret the BJT transistors' device-level characteristics and select a suitable mathematical method for simulation.
- **CO6:** construct circuits based on MOSFET, CMOS, and bipolar devices for various types of applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Fundamentals of Modern VLSI Devices" by Yuan Taur and Tak H. Ning, Cambridge University Press, 2016.
2. "Compact MOSFET Models for VLSI Design" by A.B. Bhattacharyya, John Wiley & Sons Ltd, 2009.

REFERENCES:

1. "Transport Equations for Semiconductors" by Ansgar Jungel, Springer, 2009.
2. "Device Modeling for Analog and RF CMOS Circuit Design" by Trond Ytterdal, Yuhua Cheng, and Tor A. Fjeldly, John Wiley & Sons Ltd, 2004.
3. "Fundamentals of Microelectronics" by Behzad Razavi, 2nd Edition, Wiley Student Edition, 2014.
4. "Physics of Semiconductor Devices" by J. P. Collinge and C. A. Collinge, Springer, 2002.
5. "Physics of Semiconductor Devices" by S. M. Sze and Kwok K. NG, Springer, 2006.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	SEMICONDUCTOR MEMORY DESIGN	L	T	P	C
		3	0	0	3

MODULE I RANDOM ACCESS MEMORY TECHNOLOGIES 9

Static Random Access Memories (SRAMs): SRAM Cell Structures-MOS SRAM Architecture-MOS SRAM Cell and Peripheral Circuit Operation-Bipolar SRAM Technologies-Silicon on Insulator (SOI) Technology-Advanced SRAM Architectures and Technologies-Application Specific SRAMs. Dynamic Random Access Memories (DRAMs): DRAM Technology Development-CMOS DRAMs- DRAMs Cell Theory and Advanced Cell Structures-BiCMOS, DRAMs-Soft Error Failures in DRAMs-Advanced DRAM Designs and Architecture-Application, Specific DRAMs

MODULE II NON VOLATILE MEMORIES 9

Masked Read-Only Memories (ROMs)-High Density ROMs-Programmable Read-Only Memories (PROMs)-BipolarPROMs-CMOS PROMs-Erasable (UV) - Programmable Road-Only Memories (EPROMs)-Floating-Gate EPROM Cell-One-Time Programmable (OTP) EPROMs-Electrically Erasable PROMs (EEPROMs)-EEPROM Technology and Architecture-Non- volatile SRAM-Flash Memories (EPROMs or EEPROM)-Advanced Flash Memory Architecture.

MODULE III MEMORY FAULT MODELING AND TESTING 9

RAM Fault Modeling, Electrical Testing, Pseudo Random Testing-Megabit DRAM Testing Non-volatile Memory Modelling and Testing-IDDQ Fault Modelling and Testing Application Specific Memory Testing. General Design for Testability Techniques – Ad Hoc Design Techniques, Structured Design Techniques – RAM Built-In Self – Test (BIST).

MODULE IV RELIABILITY AND RADIATION EFFECTS 9

General Reliability Issues-RAM Failure Modes and Mechanism-Non-volatile Memory Reliability - Reliability Modelling and Failure Rate Prediction-Design for Reliability -Reliability Test Structures-Reliability screening and Qualification. Radiation Effects-Single Event Phenomenon (SEP)- Radiation Hardening Techniques- Radiation Hardening Process and Design Issues-Radiation Hardened Memory Characteristics-Radiation Hardness Assurance and Testing - Radiation Dosimetry-Water Level Radiation Testing and Test Structures

MODULE V PACKAGING TECHNOLOGIES 9

Random Access Memories (MRAMs)-Experimental Memory Devices. Memory Hybrids and MCMs (2D)-Memory Stacks and MCMs (3D)-Memory MCM Testing and Reliability Issues-Memory Cards High Density Memory Packaging Future Directions

COURSE OUTCOMES

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

- **CO1:** interpret the operating principle of SRAM, DRAM and read only memories
- **CO2:** compare the characteristics and features of Random Access Memory architectures
- **CO3:** classify non-volatile memories based on the operating principle
- **CO4:** infer the characteristics of fault models for fault detection in memories
- **CO5:** interpret reliability modelling and reliability issues in packaging technologies
- **CO6:** interpret the concepts of test methods, radiation hardening process and different packaging techniques used in semiconductor memories

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Semiconductor Memories Technology, Testing and Reliability" by Ashok K. Sharma, Prentice Hall of India Private Limited, New Delhi, 2004.

REFERENCES:

1. "Advanced Semiconductor Memories – Architecture, Design and Applications" by Ashok K. Sharma, Wiley, 2002.
2. "CMOS Memory Circuits" by Tegze P. Haraszti, Kluwer Academic Publishers, 2001.
3. "Semiconductor Memory Design & Application" by Luecke Mize Care, McGraw Hill, 1973.
4. "Semiconductor Memories: A Handbook of Design, Manufacture and Application" by Betty Prince, Wiley, 1991.
5. "Emerging Memories: Technologies and Trends" by Betty Prince, Kluwer Academic Publishers, 2002.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1	1	-	-	-	-	-	-	-	-	-	-	1
2	3	1	1	-	-	-	-	-	-	-	-	-	-	1
3	3	1	1	-	-	-	-	-	-	-	-	-	-	1
4	3	1	1	-	-	-	-	-	-	-	-	-	-	1
5	3	1	1	-	-	-	-	-	-	-	-	-	-	1
6	3	1	1	-	-	-	-	-	-	-	-	-	-	1
Avg.	3	1	1	-	-	-	-	-	-	-	-	-	-	1

1-low, 2-medium, 3-high

COURSE CODE	DESIGN FUNDAMENTALS OF ELECTRIC AND HYBRID VEHICLES	L	T	P	C
		3	0	0	3

MODULE I ALTERNATIVE VEHICLE AND VEHICLE MECHANICS 9

Electric and Hybrid Electric Vehicle components - Vehicle Mass and Performance-Well to wheel analysis - EV/ICE Comparison: Efficiency and Pollution comparison - Electric Vehicle Market - Road way fundamentals -Vehicle kinetics - Dynamics of vehicle motion -Propulsion Power -Velocity and acceleration

MODULE II ALTERNATIVE VEHICLE ARCHITECTURE 9

Electric Vehicles - Hybrid series and parallel architecture - Plug in Hybrid Electric Vehicle - Power train component sizing: EV Power train component sizing, HEV Power train component sizing and example - Mass analysis and packaging

MODULE III ENERGY STORAGE 9

Batteries in Electric Vehicle - Battery basics - Battery parameters - Electro chemical fundamentals - Battery Modeling: Circuit Model, Empirical Model -Traction Batteries - Battery pack management - Fuel Cell based energy storage, Super Capacitor and Flywheel based energy storage

MODULE IV POWER ELECTRONICS CONVERTERS AND ELECTRIC MACHINES 9

Power Electronic Switches - DC / DC converter: Non isolated and isolated converters - Cell balancing converters - Fundamentals of Electric Machines - Simple DC Machine - Three phase AC Machines - Types of AC Machines: Induction Machine, Permanent Magnet Synchronous Machine (PMSM) - Switched Reluctance Machine

MODULE V HYBRID VEHICLE CONTROL STRATEGY 9

Vehicle supervisory Controller - Mode selection strategy: Mechanical Power split hybrid model - Series and parallel Hybrid 2 X 2 modes - Series, parallel, Series and parallel control Strategies - Energy storage system Control-Regeneration control

COURSE OUTCOMES

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

- **CO1:** interpret the electric and hybrid vehicle components, vehicle dynamics and different vehicle architecture.
- **CO2:** differentiate the electric and hybrid vehicle and also describe the vehicle mechanics.
- **CO3:** categorize the vehicle architecture and find the power train component for EV &HEV
- **CO4:** interpret the concepts of battery, fuel cell, super capacitor and fly wheel energy storage device used in EV.
- **CO5:** list the types of power electronics converters and electrical machines for EV and use the control methods for series and parallel hybrid vehicle.
- **CO6:** summarize the concepts of battery, types of DC/DC converter, electrical machines and also control methods for hybrid vehicle.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Electric & Hybrid Vehicles - Design Fundamentals" by Iqbal Hussain, 2nd Edition, CRC Press, 2011.
2. "Vehicular Electric Power Systems" by Ali Emadi, Mehrdad Ehsani, Marcel Dekker, Inc., New York, 2004.

REFERENCES:

1. "Electric Vehicle Battery Systems" by Sandeep Dhameja, Newnes, an imprint of Elsevier, 2002.
2. Miller J.M., "Propulsion Systems for Hybrid Vehicles", Institution of Electrical Engineers (IEE), London, UK, 2004.
3. James Larminie, "Electric Vehicle Technology Explained", 2nd Edition, John Wiley & Sons, 2012.
4. John G. Hayes, G. Abas Goodarzi, "Electric Power Train: Energy Systems, Power Electronics Drives for Hybrid, Electric and Fuel Cell Vehicles", 1st Edition, John Wiley, 2018.
5. Indian vehicle emission standards: https://www.dieselnet.com/standards/in/2wheel.php

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3		-	-	-	-	-	-	-	-	-	-	-	1
2	3		-	-	-	-	-	-	-	-	-	-	-	1
3	3		-	-	-	-	-	-	-	-	-	-	-	1
4	3	1	-	-	-	-	-	-	-	-	-	-	-	1
5	3	1	-	-	-	-	-	-	-	-	-	-	-	1
6	3	1	-	-	-	-	-	-	-	-	-	-	-	1
Avg.	3	1	-	-	-	-	-	-	-	-	-	-	-	1

1-low, 2-medium, 3-high

COURSE CODE	POWER ELECTRONICS	L	T	P	C
		3	0	0	3

MODULE I POWER SEMICONDUCTOR DEVICES 9

Power Diodes - Power Transistors–SCR – TRIAC - GTO- Power MOSFET - IGBT - IGCT -Static and Dynamic Characteristics

MODULE II POWER SUPPLIES 9

Switching Power Supplies - Control of switch mode DC Power supplies - Power Supply Protection - Driver and Snubber circuits - Buck, Boost, Buck-Boost converters

MODULE III PHASE CONTROLLED RECTIFIERS 9

Single Phase Half Controlled Rectifier with R and RL load – Single Phase Full Controlled Rectifier with RL load - Effect of free-wheeling diode - Continuous and Discontinuous Mode of operation – Three phase full converters – Dual converters - Light Dimmer - Excitation system - Solar PV systems.

MODULE IV CONVERTERS 9

DC to DC converters - Step-down and step-up choppers -Types of choppers-A, B, C, D and E–SMPS-Battery operated vehicles - AC to AC converters -Single phase and Three phase AC voltage controllers–Integral cycle Control – Sequence control -Single phase cyclo converters – Matrix converters

MODULE V INVERTERS 9

Single phase voltage source inverters – Voltage control - Single PWM - Multiple PWM - Sinusoidal PWM – Space Vector Modulation in Three phase inverters – Harmonic reduction - Single phase current source inverters -Induction heating – UPS

COURSE OUTCOMES

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

- **CO1:** identify the power semiconductor devices based on their static and dynamic characteristics and to design switching power supplies
- **CO2:** interpret the operation, characteristics and performance parameters of power semiconductor devices
- **CO3:** classify the Power electronic devices for conversion, control and conditioning of the electrical power and to design switching power supplies
- **CO4:** analyze the performance of phase controlled rectifiers for different power factor loads
- **CO5:** illustrate the characteristics and classification of choppers and inverters
- **CO6:** apply PWM techniques and control methods to design rectifiers, converters and inverters

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Power Electronics Devices, Circuits, and Applications" by Muhammad Harunur Rashid, Fourth Edition, Pearson, 2018.
2. "Power Electronics" by P. S. Bimbhra, Fifth Edition, Khanna Publishers, 2012.

REFERENCES:

1. "Elements of Power Electronics" by Philip T. Krein, Oxford University Press, 2016.
2. "Power Electronics: Converters, Applications, and Design" by Ned Mohan, Tore M. Undeland, William P. Robbins, Third Edition, John Wiley & Sons, 2003.
3. "Power Electronics" by Vedam Subramanyam, Second Edition, New Age International, 2006.

4. "Power Electronics" by M. D. Singh and K. B. Khanchandani, Second Edition, Tata McGraw Hills, 2008.
5. "Power Electronics" by P. C. Sen, 30th Reprint, Tata McGraw-Hill, 2008.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	ELECTRONIC PACKAGING	L	T	P	C
		3	0	0	3

MODULE I OVERVIEW OF ELECTRONIC SYSTEMS PACKAGING 9

Definition of a system and history of semiconductors, Products and levels of packaging, Packaging aspects of handheld products, Definition of PWB, Basics of Semiconductor and Process flowchart, Wafer fabrication, inspection and testing, Wafer packaging; Packaging evolution; Chip connection choices, Wire bonding, TAB and flip chip

MODULE II SEMICONDUCTOR PACKAGES 9

Single chip packages or modules (SCM), Commonly used packages and advanced packages; Materials in packages; Thermal mismatch in packages; Multichip modules (MCM)-types; System-in-package (SIP); Packaging roadmaps; Hybrid circuits; Electrical Design considerations in systems packaging, Resistive, Capacitive and Inductive Parasitics, Layout guidelines and the Reflection problem, Interconnection

MODULE III CAD FOR PRINTED WIRING BOARDS 9

Benefits from CAD; Introduction to DFM, DFR & DFT, Components of a CAD package and its highlights, Beginning a circuit design with schematic work and component, layout, DFM check, list and design rules; Design for Reliability, Printed Wiring Board Technologies: Board-level packaging aspects, Review of CAD output files for PCB fabrication; Photo plotting and mask generation, Process flow-chart; Vias; PWB substrates; Surface preparation, Photoresist and application methods; UV exposure and developing; Printing technologies for PWBs, PWB etching; PWB etching; Resist stripping; Screen printing technology, through-hole manufacture process steps; Panel and pattern plating methods, Solder mask for PWBs; Multilayer PWBs; Introduction to, microvias, Microvia technology and Sequential buildup technology process flow for high-density, interconnects

MODULE IV SURFACE MOUNT TECHNOLOGY AND THERMAL CONSIDERATIONS 9

SMD benefits; Design issues; Introduction to soldering, Reflow and Wave Soldering methods to attach SMDs, Solders; Wetting of solders; Flux and its properties; Defects in wave soldering, Vapour phase soldering, BGA soldering and De soldering/Repair; SMT failures, SMT failure library and Tin Whisker, Tin-lead and lead-free solders; Phase diagrams; Thermal profiles for reflow soldering; Lead freev Alloys, Lead-free solder considerations; Green electronics; RoHS compliance and e-waste recycling, Issues, Thermal Design considerations in systems packaging

MODULE V EMBEDDED PASSIVES TECHNOLOGY 9

Introduction to embedded passives; Need for embedded passives; Design Library; Embedded resistor processes, Embedded capacitors; Processes for embedding capacitors; Case study examples

COURSE OUTCOMES

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

- **CO1:** interpret the fundamentals of electronic systems packaging
- **CO2:** compare the characteristics and features of commonly used and advanced packages
- **CO3:** explain the semiconductor packages types
- **CO4:** infer the CAD for printed wiring boards
- **CO5:** interpret surface mount technology and its thermal considerations
- **CO6:** interpret the concepts of embedded passive technologies

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Fundamentals of Microsystems Packaging" by Rao R. Tummala, McGraw Hill, NY, 2001.
2. "Nanopackaging Nanotechnologies and Electronics Pack" by James E. Morris, Springer, 2010.

REFERENCES:

1. "Advanced Electronic Packaging" by Richard K. Ulrich, William D. Brown, Wiley, 2006.
2. "Advanced Electronic Packaging with Emphasis on Multichip Modules" by William D. Brown, Wiley, 1999.
3. "Electronic Packaging Design, Materials, Process, and Reliability" by John H. Lau, McGraw-Hill, 1998.
4. "Electronic Packaging Materials and Their Properties" by Michael Pecht, Rakish Agarwal, F. Patrick McCluskey, CRC Press, 2017.
5. "Electronic Packaging Science and Technology" by King-Ning Tu, Chih Chen, Hung-Ming Chen, John Wiley, 2021.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	AUTOMOTIVE ELECTRONICS	L	T	P	C
		3	0	0	3

MODULE I AUTOMOTIVE VEHICLE SYSTEMS 9

Basics of the gasoline (SI) engine - Method of operation, Fuel supply - Fuel delivery with manifold injection, Fuel delivery with gasoline direct injection - Inductive ignition system – Design, Function and method of operation - Spark plugs - Function, usage, electrode materials – Control modes: Automatic Transmission Control – Differential and Traction Control, Hybrid Electric Vehicle Powertrain Control

MODULE II ELECTRONICS IN AUTOMOTIVE SYSTEMS 9

Basics of Electronic Engine Control - Exhaust Emissions - Fuel Economy - Federal Government Test Procedures - Concept of an Electronic Engine Control System - Exhaust Catalytic Converters - Electronic Fuel Control System - Open-Loop Control, closed-Loop Control - Analysis of Intake Manifold Pressure - Idle Speed Control - Electronic Ignition System - Antilock Braking System Electronic Suspension System - Electronic Steering Control – Electronics safety related systems: Airbag safety device, Blind Spot Detection.

MODULE III AUTOMOTIVE SENSORS AND ACTUATORS 9

Automotive engine control sensors: Air Flow Rate Sensor, Engine Crankshaft Angular position Sensor, Throttle Angle Sensor, Temperature Sensors, Coolant Sensor, Sensors for Feedback Control, Knock Sensors, LIDAR - Automotive Engine Control Actuators: Fuel Injection, Exhaust Gas Recirculation (EGR), VVT valve

MODULE IV AUTOMOTIVE INSTRUMENTATION AND DIAGNOSTICS 9

Modern Automotive Instrumentation - Display Devices – LED, LCD, Transmissive LCD, VFD, Flat Panel Display. Measurements: Fuel Quantity, Coolant Temperature, Oil Pressure, Vehicle Speed - Trip Information Computer – Telematics - Diagnostics: Onboard Diagnostics Model - Diagnostic Fault Codes - Onboard Diagnosis (OBD II).

MODULE V VEHICLE COMMUNICATION PROTOCOLS 9

Vehicle Communication Protocols: CAN, Local Interconnect Network (LIN), FLEXRAY IVN,MOST IVN

COURSE OUTCOMES

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

- **CO1:** describe the performance of automobiles using mechanical and electronic automotive system components.
- **CO2:** interpret the principles of mechanical engine control systems in automobiles.
- **CO3:** interpret the principles of electronics engine control and safety systems in modern automobiles.
- **CO4:** make use of various sensors and actuators to control the automotive engine.
- **CO5:** interpret the diagnostic procedures to collect information about the vehicle's performance using automotive instruments and communication protocols.
- **CO6:** describe the performance of engine control elements, instruments, and vehicle communication protocols in automobiles.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Understanding Automotive Electronics, An Engineering Perspective" by William B. Ribbens, 8th Edition, Elsevier Publications, 2017.
2. "Gasoline Engine Management, Systems and Components" by Konrad Reif, Springer Fachmedien Wiesbaden, 2015.

REFERENCES:

1. "BOSCH Automotive Handbook" by Bosch, 11th edition, Wiley Publication, 2022.
2. "Automobile Electrical and Electronics Systems" by Denton T., 5th edition, SAE (Society for Automobile Engineers) International, 2018.
3. "Automotive Technology: A Systems Approach" by Jack Erjavec, 7th edition, Delmar Cengage Learning, 2018.
4. "Today's Technician: Automotive Electricity and Electronics (Classroom manual)" by Barry Hollembeak, 7th edition, Delmar Cengage Learning, 2017.
5. "Automotive Electronics Design Fundamentals" by Najamuz Zaman, 1st edition, Springer, 2015.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	REAL TIME OPERATING SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO REAL TIME OPERATING SYSTEMS 9

Introduction-Producing quality software-modeling the software-the importance of time and timing-handling multiple jobs-handling complex multiple jobs-using interrupts as the execution engine-simple quasi –concurrency-basic features of real time operating systems

MODULE II SCHEDULING CONCEPTS AND IMPLEMENTATIONS 9

Introduction-simple cyclic, timed cyclic and cooperative scheduling- task priorities-priority pre-emptive scheduling-using queues-implementing queues-the processor descriptor-tick-priority and system responsiveness-By passing the scheduler-code sharing and reentrancy

MODULE III MULTI PROCESSOR SYSTEMS 9

Processor structures-multi core processors-multi computer structures-software issues-structuring software as a set of functions-structuring software as a set of data processing operations-software control and execution issues-scheduling and execution of AMP, SMP, BMP system

MODULE IV DISTRIBUTED SYSTEMS 9

Software structuring in distributed systems-communication and timing aspects of distributed systems-mapping software into hardware in distributed systems

MODULE V PERFORMANCE AND BENCHMARKING OF RTOS 9

Introduction-measuring computer performance-computation performance benchmarking-OS performance-Time overhead in processor system-OS performance and representative bench mark-basic requirements-test categories-test stressing methods

COURSE OUTCOMES

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

- **CO1:** apply the concepts of Real time operating systems and suitable scheduling algorithms for real time applications
- **CO2:** interpret the basic concepts of Real time operating systems.
- **CO3:** explain the different types of scheduling algorithms used in RTOS.
- **CO4:** interpret the concepts of multiprocessor and distributed systems
- **CO5:** explain software into hardware mapping and benchmarking performance methods of RTOS
- **CO6:** infer the performance and software & execution issues in embedded operating Systems.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Real-time Operating Systems" by Jim Cooling, 1st edition, Lindentree Associates, 2018.
2. "MicroC/OS-II: The Real-Time Kernel" by Jean J. Labrosse, 1st edition, Newnes, 2002.

REFERENCES:

1. "Embedded and Real-time Operating Systems" by Wang K.C., 1st edition, Springer International Publishing, 2017.
2. "Real-time Concepts for Embedded Systems" by Qing Li, 3rd edition, Taylor and Francis Limited, 2017.
3. "Simple Real-time Operating System: A Kernel Inside View for a Beginner" by Chowdary Venkateswara

Penumuchu, Trafford Publishing, 2007.
4. "Real-Time Systems: Theory and Practice" by Rajib Mall, 1st edition, Pearson Education India, 2009.
5. "Real-Time System Design and Analysis" by Philips A. Laplante, 3rd Edition, John Wiley & Sons, 2004

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	PROGRAMMING FOR IoT BOARDS	L	T	P	C
		3	0	0	3

MODULE I PROGRAMMING ESP 8266 MODULE 9

ESP8266 WiFi Module: Overview- Setting Up the Hardware- Interfacing with Arduino- Creating an IoT Temperature and Humidity Sensor System- Overview of DHT-22 Sensor-Interfacing the Hardware: Arduino-ESP8266 WiFi Module and DHT-22 Sensor- ThingSpeak cloud platform for data analytics - Connecting Arduino Set-up to Blynk via WiFi.

MODULE II PYTHON PROGRAMMING 9

Basics of the Python programming language-Programming on the Raspberry Pi- Python Programming Environment: Python Expressions- Strings- Functions and Function arguments- Lists- List Methods- Control Flow- Communication with devices through the pins of the Raspberry Pi- RPi. GPIO library- Python Functions- setting up the General purpose IO Pins- Protocol Pins- GPIO Access- Generating Pulse Width Modulated signals

MODULE III IoT PHYSICAL AND CLOUD SERVERS 9

Introduction to Cloud Storage models and communication APIs: Web Server – Web server for IoT-Cloud for IoT- Python web application framework-Designing a RESTful web API-Connecting to APIs -IoT Design using Raspberry Pi - Communicating data using on-board module-Home automation using Pi-Node-RED-MQTT Protocol-Using Node-RED Visual Editor on Rpi.

MODULE IV IoT USING SINGLE BOARD COMPUTERS 9

ASUS Tinker board:Programming with the GPIO Pins-Android on Tinker board-Tinker board-Connecting to Wi-Fi-Camera- Audio and video-APKInstaller - Tinker board project: Using an e-Paper Display for Weather Data

MODULE V APPLICATION OF IoT BOARDS 9

Raspberry Pi Robot car-Building a car- Controlling the car-Connecting sensory inputs from the Robo car to web- Case study: Wireless sensor network applications- Commercial building automation using IoT, underwater acoustic sensor systems, cognitive sensing and spectrum management, and security and privacy management, Remote power generation monitoring and control

COURSE OUTCOMES

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

- **CO1:** make use of ESP 8266 module for developing real time control based applications.
- **CO2:** apply python language to program IoT based boards for communication based applications.
- **CO3:** infer the need for programming and utilize it to provide solutions for real time problems.
- **CO4:** interpret the cloud storage models and communication APIs and protocols available for the IoT environment.
- **CO5:** utilize single board computers for developing web based IoT applications.
- **CO6:** develop applications on various IoT boards using embedded C and Python languages.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Internet of Things Programming Projects: Build modern IoT solutions with the Raspberry Pi 3 and Python" by Colin Dow, Packt Publishing, 2018.

2. "Practical Tinker Board: Getting Started and Building Projects with the ASUS Single-Board Computer" by Liz Clark, Apress, 2019.

REFERENCES:

1. "Programming the Raspberry Pi: Getting started with Python" by Simon Monk, McGraw Hill publications, 2013.
2. "Internet of Things Using Single Board Computers: Principles of IoT and Python Programming" by G. Kanagachidambaresan, 2022.
3. "IoT Product Development with Programming: Easy programming" by Mahesh Sambhaji Jadhav, Tejas Sarang Patil, Hightech Easy publishing, 2020.
4. "Raspbian OS Programming with the Raspberry Pi: IoT Projects" by Agus Kurniawan, Apress, 2018.
5. "The Internet of Things Using NODEMCU" by Dr. Umesh Dutta, Nilansh Khurana, Devdutt, 2021.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	2	-	-	-	-	-	-	-	-	-	-	2
2	3	-	2	-	-	-	-	-	-	-	-	-	-	2
3	3	-	2	-	-	-	-	-	-	-	-	-	-	2
4	3	-	1	-	-	-	-	-	-	-	-	-	-	2
5	3	-	1	-	-	-	-	-	-	-	-	-	-	2
6	3	-	1	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	1.5	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	IOT SYSTEMS DESIGN AND APPLICATIONS	L	T	P	C
		3	0	0	3

MODULE I FUNDAMENTALS OF IoT **9**

Evolution of Internet of Things – Enabling Technologies –M2M Communication -IoT World Forum (IoTWF)– Standarized architecture-Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT – Functional Blocks of an IoT Ecosystem -Sensors, Actuators and Smart Objects and connecting Smart objects

MODULE II IoT PROTOCOLS **9**

IoT Access Technologies: Physical and MAC layers - topology and Security of IEEE 802.15.4- 802.11ah and Lora WAN-Network Layer: IP versions-Constrained Nodes and Constrained Networks - 6LoWPAN-Application Transport Methods: SCADA - Application Layer Protocols: CoAP and MQTT

MODULE III INTRODUCTION TO PYTHON & EMBEDDED SYSTEMS **9**

Basic Python Syntax - Data Types - Numbers and Math functions -Variables & Names –Strings - Conditional statements - For and while Loop - List, Tuple and Dictionary -Python Functions –Modules - Exceptions, File Handling Embedded Systems - Open source hardware (Raspberry pi) - LED and Switch Interfacing- Digital Sensor Interfacing applications - Actuator Interfacing - Application Development using Digital sensors

MODULE IV IOoT DESIGN USING RASPBERRY PI **9**

Introduction to SPI -Analog Sensor Interfacing applications -Data collection and visualization for real-time systems - Open source IoT cloud and end device -Real time data monitoring application development - Bluetooth Communication using RFCOMM & L2CAP - Sensor Data transmission - Sensor Data transmission through Bluetooth to Cloud -UDP Communication of Devices using WiFi without using Internet - Device Control & application design using UDP - Transmit and Receive Text using UART Communication between two devices - Device Control & Application Design using UART Communication -MQTT based application development-Device Control using Mobile & Web application

MODULE V INDUSTRIAL APPLICATIONS **9**

Manufacturing– Oil and gas-Utilities-smart and connected cities-Transportation-Mining-public Safety-Case study

COURSE OUTCOMES

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

CO1: interpret the fundamental concepts and communication protocols used for developing IoT application
CO2: explain the fundamental concepts of IoT .
CO3: use suitable communication protocols for developing IoT applications
CO4: develop python programs for Application Development using Raspberry Pi.
CO5: interpret the concepts cloud based data communication using different application software.
CO6: develop Raspberry pi-based python programs for Industrial based IOT application using Digital sensors and actuators

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things" by David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton, Jerome Henry, 1st edition, CISCO Press, 2017.
2. "Internet of Things (A Hands-on Approach)" by Vijay Madisetti and Arshdeep Bahga, 1st edition, VPT, 2014.

REFERENCES:

1. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases" by Pethuru Raj and Anupama C. Raman, 1st edition, CRC Press, 2017.
2. "Internet of Things (IoT) in 5G Mobile Technologies" by Constandinos X. Mavromoustakis, George Mastorakis, Jordi Mongay Batalla, Springer International Publishing Switzerland, 2016.
3. "Architecting the Internet of Things" by Dieter Ackermann, Mark Harrison, Florian Michahelles, 1st edition, Springer-Verlag Berlin Heidelberg, 2011.
4. "Internet of Things in the Cloud: A Middleware Perspective" by Honbo Zhou, 1st edition, CRC Press, 2012.
5. "Internet of Things: Architecture and Design Principles" by Raj Kamal, 1st edition, McGraw-Hill, 2017.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	2	-	-	-	-	-	-	-	-	-	-	2
2	3	-	2	-	-	-	-	-	-	-	-	-	-	2
3	3	-	2	-	-	-	-	-	-	-	-	-	-	2
4	3	-	1	-	-	-	-	-	-	-	-	-	-	2
5	3	-	1	-	-	-	-	-	-	-	-	-	-	2
6	3	-	1	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	1.5	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	REAL TIME APPLICATIONS USING PYTHON	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO PYTHON 9

Basic Syntax Variable and Data Types Operator: int, float, boolean, string, and list -Variables, expressions, statements, tuple assignment, precedence of operators, comments -Modules and functions, function definition and use, flow of execution, parameters and arguments - Illustrative programs: Exchange the values of two variables - Circulate the values of n variables - Distance between two points.

MODULE II CONTROL FLOW & FUNCTIONS 9

Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else) - Iteration: state, while, for, break, continue, pass - Fruitful functions: return values, parameters, local and global scope, function composition, recursion - Strings: string slices, immutability, string functions and methods, string module - Lists as array s- Lists, Tuples, Dictionaries- Illustrative programs: Square root – GCD – Exponentiation - Sum an array of numbers - Linear search - Binary search

MODULE III LISTS, TUPLES, DICTIONARIES & FILE HANDLING 9

Lists - List Operations – Mutation – Aliasing - Cloning – Tuple assignment - Tuple as return value - Dictionaries: Operations and methods - Advanced list processing - List comprehension – Variables - Illustrative programs: Selection sort - Insertion sort - Mergesort, Histogram.

Files and exception Handling : text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: Word count - Copy file.

MODULE IV CLASSES AND INHERITANCE 9

Object Oriented Programming - Class Instances - Class and object- Attributes -Inheritance –Overloading - Overriding - Data hiding- An Extended Example: Building a Class - Visualizing the Hierarchy - Adding another Class - Using Inherited Methods – Grade book – Generators

MODULE V PROGRAMMING THE RASPBERRY PI 3 USING PYTHON 9

Programming General Purpose Input / Output (GPIO) port pins -Interfacing seven segment LED and LCD Display , servomotor - Real time Monitoring & Data logging System using I2C protocol - Email notifier using Gmail SMTP server -Data Acquisition and control for Industrial/ Home Automation using MQTT Protocol. Case studies: The Weather Station, The Home Security System

COURSE OUTCOMES

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

- **CO1:** interpret the programming concepts of Python to develop simple computational programs.
- **CO2:** develop Python programs using conditionals & loops and functions.
- **CO3:** infer the datatypes of python language and utilize it for developing solutions for real time applications.
- **CO4:** make use of Python lists, tuples & dictionaries for data manipulation and file handling
- **CO5:** apply the concepts of classes and inheritance of Object Oriented Programming to develop python based applications.
- **CO6:** develop Raspberry pi based applications using Input/output devices, sensors and actuators.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Think Python: How to Think Like a Computer Scientist" by Allen B. Downey, 2nd Edition, Shroff/O'Reilly Publishers, 2016.
2. "Learn Raspberry Pi Programming with Python" by Wolfram Donat, ebook, Apress Publishers, May 2014.

REFERENCES:

1. "Introduction to Computer Science using Python: A Computational Problem-Solving Focus" by Charles Dierbach, Wiley India Edition, 2013.
2. "Python Programming with Raspberry Pi" by Sai Yamanoor & Srihari Yamanoor, 1st Edition, Packt Publishing, 2017.
3. "Introduction to Computation and Programming Using Python" by John V Guttag, 1st Edition, MIT Press, 2013.
4. "An Introduction to Python" by Guido van Rossum and Fred L. Drake Jr, 1st Edition, Network Theory Ltd., 2011.
5. "Programming the Raspberry Pi: Getting Started with Python" by Simon Monk, 1st Edition, McGraw-Hill, 2013.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2	-	-	-	-	-	-	-	-	-	-	3
2	3	2	2	-	-	-	-	-	-	-	-	-	-	3
3	3	2	2	-	-	-	-	-	-	-	-	-	-	3
4	3	2	2	-	-	-	-	-	-	-	-	-	-	3
5	3	2	2	-	-	-	-	-	-	-	-	-	-	3
6	3	2	2	-	-	-	-	-	-	-	-	-	-	3
Avg.	3	2	2	-	-	-	-	-	-	-	-	-	-	3

1-low, 2-medium, 3-high

COURSE CODE	DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO DRONE TECHNOLOGY 9

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion - Drone technology impact on the businesses - Drone business through entrepreneurship - Opportunities/applications for entrepreneurship and employability

MODULE II DRONE DESIGN, FABRICATION AND PROGRAMMING 9

Classifications of the UAV - Overview of the main drone parts - Technical characteristics of the parts - Function of the component parts - Assembling a drone- The energy sources - Level of autonomy- Drones configurations - The methods of programming drone - Download program - Install program on computer - Running Programs - Multi rotor stabilization - Flight modes - Wi-Fi connection

MODULE III DRONE FLYING AND OPERATION 9

Concept of operation for drone -Flight modes - Operate a small drone in a controlled environment Drone controls Flight operations - management tool - Sensors-On board storage capacity - Removable storage devices - Linked mobile devices and applications

MODULE IV DRONE COMMERCIAL APPLICATIONS 9

Choosing a drone based on the application - Drones in the insurance sector - Drones in delivering mail, parcels and other cargo - Drones in agriculture - Drones in inspection of transmission lines and power distribution - Drones in filming and panoramic picturing

MODULE V FUTURE DRONES AND SAFETY 9

The safety risks - Guidelines to fly safely - Specific aviation regulation and standardization - Drone license - Miniaturization of drones - Increasing autonomy of drones - The use of drones in swarms

COURSE OUTCOMES

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

CO1: identify the basic methodology for designing an efficient drone.
CO2: examine the basic concepts of drone technologies.
CO3: categorize the fundamentals of the design, fabrication, and programming of drones.
CO4: interpret the knowledge of flying and operation of the drone flight modes.
CO5: interpret drone flying and operations for commercial applications
CO6: build drone for the commercial applications following operations, aviation regulation and standardization

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation" by Daniel Tal and John Altschuld, John Wiley & Sons, Inc., 2021.
2. "Make: Getting Started with Drones" by Terry Kilby and Belinda Kilby, Maker Media, Inc., 2016.

REFERENCES:

1. "Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs" by John Baichtal, Que Publishing, 2016.
2. "Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillance" by

Zavrsnik, Springer, 2018.
3. "Unmanned Aircraft Systems: UAVS Design, Development and Deployment" by Austin, Wiley, 2010.
4. "Smart Autonomous Aircraft: Flight Control and Planning for UAV" by Sebbane, CRC Press, 2015.
5. "Building a Quadcopter with Arduino" by Vasilis Tzivaras, Packt Publishing, 2016.

WEB REFERENCES:

1. https://www.dronezon.com/learn-about-drones-quadcopters/
2. http://ardupilot.org/copter/docs/advanced-multicopter-design.html

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	ROBOTICS	L	T	P	C
		3	0	0	3

MODULE I ROBOT KINEMATICS **10**

Introduction - Robotics and programmable automation - Historical background - Laws of Robotics - Robot definitions - Robotics system and Robot anatomy - Specifications of Robots - Safety measures in Robotics..

MODULE II ROBOTIC DRIVERS AND CONTROLS **9**

Robot drives, actuators and control - Functions of drive systems - General types of fluids - Pump classification - Pneumatic systems - Electrical drives - DC motors - Stepper motors - Drive mechanism

MODULE III SENSORS AND MACHINE VISION **9**

Need for sensing systems- Principles and Applications of the following types of sensors- Position and displacement sensors – Potentiometers, Encoders, Linear Variable Differential Transformer, Force and Torque sensors- Wrist sensor, Joint sensor, Tactile array sensor, Slip sensors- Proximity sensors- Range finders- Imaging sensors- Inductive Proximity switch- Acoustic sensors- Opto-electronic sensors- Lighting Techniques, Robot Vision- Sensing and Digitizing, Image Processing and analysis- Preprocessing, Segmentation, Description, Recognition, Interpretation and Applications of robot vision system

MODULE IV ROBOTIC LANGUAGE AND PROGRAMMING **8**

Robot language and programming. Robot language - Classification of Robot languages - Computer control and robot software - VAL system and language. Applications of Robots: Capabilities of Robots - Robotics applications - Obstacle avoidance

MODULE V ARTIFICIAL INTELLIGENCE IN ROBOTICS **9**

The history of Artificial Intelligence- Artificial and Natural Intelligence- Artificial Intelligence and Automated manufacturing- The application domains of Artificial Algorithms- Risks and Benefits of AI- Agents and Environments- Knowledge representation

COURSE OUTCOMES

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

CO1: interpret on the specifications of robot anatomy, drivers and controls
CO2: explore the concepts of robotics, safety measures and homogeneous transformation.
CO3: formulate the concepts of mechanical drives and controls in robotics.
CO4: utilize the concepts of sensors to understand the applications of robot vision system.
CO5: develop robotics programming, classifications and its applications.
CO6: use the concepts of sensors and robot programming languages to explore AI based applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Robotics Technology and Flexible Automation" by Satya Ranjan Deb, 2nd Edition, Tata McGraw Hill, 2012.
2. "Artificial Intelligence: A Modern Approach" by Stuart Russell and Peter Norvig, Pearson Education, 2014.

REFERENCES:

1. "Introduction to AI Robotics" by Robin R. Murphy, 2nd edition, The MIT Press, Cambridge, Massachusetts, London, England, 2019.
2. "Advances in Robot Kinematics 2016" by Jadran Lenarcic, Jean-Pierre Merlet, Springer International Publishing AG, 2018.
3. "Robotics" by Peter McKinnon, CreateSpace Independent Publishing Platform, 2016.
4. "Intelligent Planning for Mobile Robotics: Algorithmic Approaches" by Ritu Tiwari, Anupam Shukla, Rahul Kala, Information Science Reference, United States of America, 2013.
5. "Artificial Intelligence: Foundations of Computational Agents" by David L. Poole and Alan K. Mackworth, Cambridge University Press, 2011.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	3	-	-	-	-	-	-	-	-	-	-	-	2
6	3	2	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	2.5	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	FOUNDATION SKILLS FOR INTEGRATED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

MODULE I FUNDAMENTALS OF PRODUCT DEVELOPMENT 9

GLOBAL TRENDS ANALYSIS AND PRODUCT DECISION : Types of various trends affecting product decision - Social Trends (Demographic, Behavioral, Psychographic), Technical Trends (Technology, Applications, Tools, Methods), Economical Trends(Market, Economy, GDP, Income Levels, Spending Pattern, target cost, TCO), Environmental Trends(Environmental Regulations and Compliance), Political/Policy Trends(Regulations, Political Scenario, IP Trends and Company Policies) - PESTLE Analysis

MODULE II INTRODUCTION TO PRODUCT DEVELOPMENT METHODOLOGIESAND MANAGEMENT 10

Overview of Products and Services (Consumer product, Industrial product, Specialty products etc.,) Types of Product Development (NPD/ Re-Engineering (Enhancements, Cost Improvements)/ Reverse Engineering/ Design Porting & Homologation) Overview of Product Development methodologies (Over the Wall/ Waterfall/ V-Model/ Stage-Gate Process/ Spiral/Systems Engineering/ Agile) - Product Life Cycle (S-Curve, Reverse Bathtub Curve) - Product Development Planning and Management (Budgeting, Risk, Resources and Design Collaboration, Scheduling, Change Management, Product Cost Management

MODULE III REQUIREMENTS AND SYSTEM DESIGN REQUIREMENT ENGINEERING 9

Types of Requirements (Functional, Performance, Physical, Regulatory, Economical, Behavioral, Technical, Stakeholder, Environmental, Industry specific, Internal-Company Specific) - Requirement Engineering (Gathering (VOC), Analysis (QFD), Design Specification) - Traceability Matrix and Analysis - Requirement Management. System Design & Modeling: Introduction to System Modeling - System Optimization - System Specification - Sub-System Design- Interface Design

MODULE IV DESIGN AND TESTING 9

Conceptualization: Industrial Design and User Interface Design - Introduction to Concept generation Techniques – Concept Screening & Evaluation, Concept Design , S/W Architecture, Hardware Schematics and simulation. Detailed Design: Component Design and Verification - High Level Design/Low Level Design of S/W Programs, S/W Testing -Hardware Schematic, Component design, Layout and Hardware Testing. Prototyping: Types of Prototypes (Mockups, Engineering Assessment Prototype, Alpha, Beta, Gama) - Introduction to Rapid Prototyping and Rapid Manufacturing. System Integration, Testing, Certification and Documentation: Manufacturing/Purchase and Assembly of Systems – Integration of Mechanical, Embedded and S/W systems - Introduction to Product verification processes and stages - Industry specific (DFMEA, FEA, CFD)Introduction to Product validation processes and stages - Industry specific (Sub-system Testing/ Integration Testing/ Functional Testing/ Performance Testing / Compliance Testing) - Product Testing standards and Certification - Industry specific - Product Documentation (Compliance Documentation, Catalogue, Brochures, user manual, maintenance.e Manual, Spares Parts List, Warranty, Disposal Guide, IETMS, Web Tools)

MODULE V SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT

Sustenance: Maintenance and Repair - Enhancements. Product EoL: Obsolescence Management - Configuration Management - EoL Disposal

MODULE VI BUSINESS DYNAMICS - ENGINEERING SERVICES INDUSTRY 8

The Industry: Engineering Services Industry - overview - Product development in Industry versus Academia.The IPD Essentials: Introduction to vertical specific product development processes - Product development Trade-offs - Intellectual Property Rights and Confidentiality - Security and configuration management

COURSE OUTCOMES

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

CO1: identify the interface design and engineering requirements for the new product development.
CO2: analyze the global trends and development methodologies for the products and services
CO3: interpret the requirements for system design and product development.
CO4: interpret the industrial design, integration challenges and testing.
CO5: relate sustenance engineering and end-of-life support for the product development
CO6: develop various teams to validate design requirements and sustain up to the EoL (End of Life) support activities for the engineering service industry

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Foundation Skills in Integrated Product Development (FSIPD) - Student Handbook", 1st Edition, Published by IT –ItesS Sector Skills Council, NASSCOM, 2013.
2. "Product Design and Development" by Karl T. Ulrich and Steven D. Eppinger, 5th Edition, McGraw-Hill, 2012.
3. "Product Design Techniques in Reverse Engineering and New Product Development" by Kevin N. Otto, PEARSON, New Delhi, 2011.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	1	-	-	-	-	-	-	-	-	-	-	2
3	3	-	1	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	1	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	1	-	-	-	-	-	-	-	-	1	-	2

1-low, 2-medium, 3-high

COURSE CODE	MULTIMEDIA COMPRESSION AND COMMUNICATION	L	T	P	C
		3	0	0	3

MODULE I MULTIMEDIA COMPONENTS 9

Multimedia components and their characteristics – Multimedia software, editing and authoring tools-File formats: GIF, PNG, JPEG, TIFF, Windows BMP, PS and PDF, Applications of Multimedia

MODULE II TEXT AND IMAGE COMPRESSION 9

Compression principles-Source encoders and destination encoders-Lossless and lossy compression-Entropy encoding -Source encoding- Text compression -Static Huffman coding, Dynamic Huffman coding - Arithmetic coding - Lempel Ziv-Welsh Compression–Lossy Image Compression standard: JPEG

MODULE III AUDIO AND VIDEO COMPRESSION 9

Audio compression: ADPCM, Vocoders –Channel vocoder, Linear Predictive Coding, Code Excited LPC-Perceptual coding.

Video compression: H.261, H.263, MPEG 1, 2, 7

MODULE IV MULTIMEDIA COMMUNICATION AND NETWORKING 9

Protocol Layers of Computer Communication Networks - Network Layer: IP – Transport Layer: TCP and UDP - Protocols for multimedia transmission and interaction: HTTP, RTP, RTCP, RTSP-Internet telephony: H.323, SIP-QoS and QoE for multimedia communication- Integrated and differentiated services

MODULE V CLOUD COMPUTING AND AUGMENTED REALITY FOR MULTIMEDIA 9

Cloud computing Overview: Representative Storage Service Amazon S3, Representative Computation Service: Amazon EC2 - Multimedia content sharing over cloud: Case study Netflix.

Start-of-the-art technology, systems and applications in Augmented Reality-Workflow of Augmented reality: Sensory data collection, Localization and alignment, world generation and emission – Enabling Hardware and infrastructure – Limitations and Challenges

COURSE OUTCOMES

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

- **CO1:** summarize the various multimedia components, text and image compression techniques.
- **CO2:** infer the necessity of different multimedia components, editing tools and its file formats.
- **CO3:** use suitable compression techniques to determine the code word for text and image.
- **CO4:** describe the various audio and video compression standards.
- **CO5:** infer the various communication protocols, to improve QoS and QoE in a real time interactive multimedia applications using cloud computing.
- **CO6:** explain the various compression standards, communication protocols, Cloud and Augmented reality techniques to enhance multimedia services

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Fundamentals of Multimedia" by Ze-Nian Li, Mark S. Drew, Jiangchuan Liu, 3rd edition, Springer International Publishing, 2022.
2. "Multimedia Communication – Applications, Networks, Protocols and Standards" by Fred Halsall, Pearson Education, 2013.

REFERENCES:

1. "Computer Networking: A Top-Down Approach" by Kurose and W. Ross, 7th Edition, Pearson Education, 2017.
2. "Multimedia: Making It Work" by Tay Vaughan, 9th Edition, Tata McGraw Hill, 2014.
3. "Multimedia Communication Systems: Techniques, Standards and Networks" by K.R. Rao, Z. S. Bojkovic, and D. A. Milovanovic, Pearson Education, 2007.
4. "Multimedia Computing, Communications and Applications" by R. Steimnetz and K. Nahrstedt, 1st Edition, Pearson Education, 1995.
5. "Principles of Multimedia" by Ranjan Parekh, 2nd Edition, Tata McGraw Hill, 2012.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1	-	-	-	-	-	-	-	-	-	-	2	-
2	3	1	-	1	-	-	-	-	-	-	-	-	2	-
3	3	1	-	1	-	-	-	-	-	-	-	-	2	-
4	3	-	-	-	-	-	-	-	-	-	-	-	2	-
5	3	-	-	-	-	-	-	-	-	-	-	-	2	-
6	3	-	-	-	-	-	-	-	2	2	-	-	2	-
Avg.	3	1	-	1	-	-	-	-	2	2	-	-	2	-

1-low, 2-medium, 3-high

COURSE CODE	DIGITAL SWITCHING AND TRANSMISSION	L	T	P	C
		3	0	0	3

MODULE I EVOLUTION AND BUILDING BLOCKS OF SWITCHING SYSTEMS 9

Message switching and Circuit switching - Functions of switching systems - Distribution systems -Digital Switching Systems-Switching system hierarchy - Evolution of switching systems - Stored program control switching system - Basic Call processing- Call signaling - SS7 signalling.

MODULE II DIGITAL SWITCHING TECHNOLOGIES 9

Space Division switching - Folded switches - Digital Time Division switching - Combinational two dimensional switching: Space-Time and Time-Space switching - Three dimensional: Space-Time-Space and Time Space Time switching - Digital Cross Connect Systems - DCS hierarchy

MODULE III TELECOMMUNICATION TRAFFIC 9

Congestion - traffic parameters - Busy Hours Call Attempt - Traffic Intensity - Call processing capacity- Call Completion Ratio - Call Blocking Probability - Grade of Service - Holding time distributions - Arrival time Distributions – Loss Systems in tandem - Erlang B-Formula - Delay Systems - Service Times – Erlang C Formula

MODULE IV NETWORK SYNCHRONISATION 9

Timing Recovery - Clock instability - Jitter - Slips - Asynchronous Multiplexing - Plesiochronous Network Synchronization – Pulse stuffing -Mutual synchronization - Master Slave synchronization -Hierarchical synchronization

MODULE V TRANSMISSION SYSTEMS 9

Network Structure - services - regulations - standards - Digital Transmission -PDH and SDH - SDH Features - Network evolution - Cross connect - Add-Drop Mux - SDH Frame structure

COURSE OUTCOMES

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

- **CO1:** summarize the fundamental building blocks of digital switching and their operating principles
- **CO2:** infer the evolution of switching systems
- **CO3:** explain the features and operation of time and space division switching mechanisms
- **CO4:** examine the traffic parameters related to call connect and grade-of service
- **CO5:** interpret the different network synchronization procedures for digital transmission
- **CO6:** examine the traffic and synchronization issues in a digital transmission system

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Telecommunications Switching, Traffic and Networks" by John Edward Flood, Pearson Education India, First Indian Reprint, 2001.
2. "Telecommunication Switching Systems and Networks" by Thiagarajan Viswanathan and Manav Bhatnagar, 2nd Edition, PHI Learning, 2015.

REFERENCES:

1. "Digital Telephony" by John C. Bellamy, 3rd Edition, John Wiley and Sons, 2006.
2. "Signaling in Telecommunication Networks" by Bosse J. G. van and Fabrizio U. Devetak, 2nd Edition, John

Wiley & Sons, 2007.
3. "Fundamentals of Digital Switching" by John C. McDonald, 2nd Edition, Springer US, 2013.
4. "Digital Transmission Systems" by David R. Smith, 3rd Edition, Springer US, 2013.
5. "Telecommunication Switching and Networks" by Gnanasivam P., Newage, India, 2005.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
5	3	-	-	-	-	-	-	-	-	-	-	-	2	-
6	3	2	2	-	-	-	-	-	-	-	-	-	2	-
Avg.	3	2	2	-	-	-	-	-	-	-	-	-	2	-

1-low, 2-medium, 3-high

COURSE CODE	ERROR CONTROL CODING	L	T	P	C
		3	0	0	3

MODULE I BASICS OF ALGEBRA & DIGITAL TRANSMISSION 9

Algebra: Groups - Fields - Binary field arithmetic- Construction of Galois Field GF (2^m) – Properties of a Galois Field GF (2^m) - Computations using Galois field GF (2^m) arithmetic - Vector spaces - Matrices.

Coding for reliable digital transmission and storage - Types of Codes - Modulation and Demodulation - Maximum Likelihood Decoding - Types of Errors - Error control strategies

MODULE II RANDOM AND BURST ERROR CODES 9

Linear Block codes –Syndrome and Error Detection – Error-detecting and Error-correcting capabilities of a Block code – Description of cyclic codes – Generator and Parity-check matrices of cyclic codes – Encoding of cyclic codes – Syndrome computation and Error detection –Convolutional codes – Trellis Diagram- Viterbi Algorithm

MODULE III HADAMARD, GOLAY and REED-MULLER CODES 9

Hadamard Matrices and Hadamard Codes-Sylvester Construction-Quadratic Residues- Binary Hadamard Matrices and Hadamard codes - Quadratic Residue Codes- Golay Codes – Construction of Reed-muller codes

MODULE IV BCH and RS CODES 9

Generator Polynomial approach to BCH Codes- Weight distribution of BCH Codes- Properties of Reed-Solomon Codes – Modified Reed-Solomon Codes – Galois field Fourier transform approach to BCH and Reed-Solomon Codes

MODULE V TURBO CODES and LDPC CODES 9

Turbo codes – Introduction – Distance properties – Performance analysis of turbo codes – Design of Turbo codes- Iterative Decoding of Turbo codes.

LDPC Codes – Introduction – Tanner Graphs for Linear Block Codes – Geometric Construction of LDPC Codes

COURSE OUTCOMES

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

CO1: apply mathematical tools from group and filed and evaluate error control codes
CO2: apply the principles of error control strategies in coding for reliable digital transmission
CO3: interpret the encoding and decoding of linear block codes, cyclic codes, and convolutional codes.
CO4: infer the construction of Hadamard, Golay and Reed-Muller Codes.
CO5: construct advanced coding techniques like Hadamard, Golay, BCH, RS codes
CO6: evaluate various error-correcting codes suitable for digital communication system

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Error Control Coding: Fundamentals and Applications" by Shu Lin and Daniel J. Costello Jr., Prentice Hall, 2004.
2. "Error Control Systems for Digital Communication and Storage" by S. B. Wicker, Prentice Hall International, 1995.

REFERENCES:

1. "Theory and Practice of Error Control Codes" by Blahut R. E, Addison Wesley, 1983.
2. "Introduction to Coding Theory" by Van Lint, J. H, 3rd Edition, Springer Berlin Heidelberg, 2012.
3. "Channel Codes - Classical and Modern" by W.E. Ryan and S. Lin, Cambridge University Press, 2009.
4. "Information Theory and Network Coding" by R.W. Yeung, Springer, 2008.
5. NPTEL course on Error Correcting Codes.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
5	3	2	-	-	-	-	-	-	-	-	-	-	2	-
6	3	2	-	-	-	-	-	-	-	-	-	-	2	-
Avg.	3	2	-	-	-	-	-	-	-	-	-	-	2	-

1-low, 2-medium, 3-high

COURSE CODE	COGNITIVE RADIO COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO SOFTWARE-DEFINED RADIO AND COGNITIVE RADIO 9

Evolution of Software Defined Radio and Cognitive radio – goals – benefits – definitions – architectures - enabling technologies - radio frequency spectrum and regulations

MODULE II COGNITIVE RADIO ARCHITECTURE 9

Cognition cycle – orient – plan - decide and act phases – organization of CR - SDR as a platform for Cognitive Radio – Hardware and Software Architectures - Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

MODULE III SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS 9

Introduction – Primary user detection techniques – energy detection - feature detection - matched filtering - cooperative detection and other approaches - Fundamental Tradeoffs in spectrum sensing - Spectrum Sharing Models of Dynamic Spectrum Access - Unlicensed and Licensed Spectrum Sharing - Fundamental Limits of Cognitive Radio

MODULE IV MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO 9

MAC for cognitive radios: Polling – ALOHA - slotted ALOHA – CSMA - CSMA / CA - Network layer design: routing in cognitive radios - flow control and error control techniques

MODULE V APPLICATIONS OF COGNITIVE RADIO 9

Security issues in cognitive radios - public safety and cognitive radio - cognitive radio for Internet of Things

COURSE OUTCOMES

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

- **CO1:** summarize the importance of cognitive radio and software defined radio in identifying frequency bands
- **CO2:** interpret cognition cycle to analyze the functions involved in cognitive radio communication system
- **CO3:** defend the role of SDR and CR in next generation communication systems based on IEEE 802.22 standard
- **CO4:** infer the performance of different spectrum sensing techniques used in cognitive Radio
- **CO5:** explain the responsibilities of Medium Access Control layer and Network layer in Cognitive Radio
- **CO6:** evaluate the performance of cognitive radio using dynamic spectrum access technique and explore the role of CR in public safety and IoT applications

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Cognitive Radio Communications and Networks – Principles and Practice" by Alexander M. Wyglinski, Maziar Nekovee, and Thomas Hou, Academic Press, Elsevier, 2010.
2. "Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems" by Huseyin Arslan, Springer, 2014.

REFERENCES:

1. "Cognitive Radio Technology" by Bruce A. Fette, 2nd Edition, Elsevier Science, 2009.

2. "Cognitive Radio Networks" by Kwang Cheng Chen and Ramjee Prasad, John Wiley and Sons, 2009.
3. "Principles of Cognitive Radio" by Ezio Biglieri, Andrea J. Goldsmith, Dr. Larry J. Greenstein, Narayan B. Mandayam, and H. Vincent Poor, Cambridge University Press, 2013.
4. "Cognitive Radio Networks – From Theory to Practice" by Ahmed Khattab, Dmitri Perkins, and Magdy Bayoumi, Springer Series: Analog Circuits and Signal Processing, 2014.
5. "Introduction to Cognitive Radio Networks and Applications" by Geetam Singh Tomar, Ashish Bagwari, and Jyotshana Kanti, CRC Press, Taylor & Francis Group, 2016.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
5	3	2	-	-	-	-	-	-	-	-	-	-	2	-
6	3	2	-	-	-	-	-	-	2	2	-	-	2	-
Avg.	3	2	-	-	-	-	-	-	2	2	-	-	2	-

1-low, 2-medium, 3-high

COURSE CODE	SATELLITE COMMUNICATION	L	T	P	C
		3	0	0	3

MODULE I SATELLITE ORBITS AND TRAJECTORIES 9

Kepler's Laws, orbital parameters, orbit perturbations, geo stationary and non Geo-stationary orbits – Look Angle Determination- Limits of visibility – Earth eclipse satellite –Sun transit outage-Launching orbits- Satellite Launch Vehicle

MODULE II SPACE SEGMENT 9

Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Station keeping, Thermal control and Propulsion, communication subsystems, Telemetry, Tracking and command-Transponders Antenna Subsystem

MODULE III LINK DESIGN 9

Basic transmission theory - System Noise temperature and G/T ratio – Noise figure and noise temperature- G/T ration for Earth Station Link budgets- Uplink and Downlink budget calculations , Design for a specified C/N ratio with GEO and LEO examples - Atmospheric and Rain effects on link performance

MODULE IV MULTIPLE ACCESS AND CODING TECHNIQUES 9

Modulation and Multiplexing: Voice, Data, Video, Analog – digital transmission system, Digital video Broadcast, Multiple access : Frequency division Multiple access (FDMA) – Time division Multiple access (TDMA) - Onboard Processing systems – Demand access Multiple access (DAMA) and Permanently assigned Multiple access (PAMA) –Code division Multiple access (CDMA)- compression – encryption- Coding Schemes

MODULE V APPLICATIONS 9

Remote sensing - Navigation - Scientific and military application - VSAT: Network architecture, Access Control protocols and techniques, VSAT Earth stations - Satellite Mobile Telephony - Global star - DBS/DTH Television - GPS - Weather satellites - Maritime satellites

COURSE OUTCOMES

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

CO1: identify the different orbital parameters and the subsystems involved in designing space segment.

CO2: summarize the types of satellite orbits and determine the orbital parameters.

CO3: classify the different subsystems used in satellite communication to build a space segment.

CO4: determine the link design for the signal-to-noise ratio.

CO5: explain the different multiplexing techniques used in satellite systems for various applications.

CO6: apply the link design for signal-to-noise ratio and multiplexing techniques for various satellite applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Satellite Communications" by Dennis Roddy, 4th Edition, McGraw Hill, 2017.
2. "Satellite Communications" by Pratt T, Bostian C, and Allnutt J, 3rd Edition, John Wiley and Sons, 2021

REFERENCES:

1. "Satellite Communication System Engineering" by Pritchard W. L., Suyderhoud H. G., and Nelson R. A., 2nd Edition, Prentice Hall, 2013.
2. "Satellite Technology: Principles and Applications" by Anil K. Mani and Varsha Agrawal, 2nd Edition, Wiley India Pvt. Ltd., 2015.
3. "Digital Satellite Communications" by Tri T. Ha, 2nd Edition, McGraw Hill, 2017.
4. "Satellite Communication" by Manojit Mithra, Prentice Hall, 2005.
5. "Satellite Systems for Personal Applications" by Madhavendra Richharia and Leslie David Westbrook, John Wiley, 2010.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1	-	-	-	-	-	-	-	-	-	-	2	-
2	3		-	-	-	-	-	-	-	-	-	-	2	-
3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
5	3		-	-	-	-	-	-	-	-	-	-	2	-
6	3	2	-	-	-	2	-	-	-	-	-	1	2	-
Avg.	3	1.75	-	-	-	2	-	-	-	-	-	1	2	-

1-low, 2-medium, 3-high

COURSE CODE	UNDER WATER COMMUNICATION	L	T	P	C
		3	0	0	3

MODULE I UNDERWATER FIBRE OPTIC COMMUNICATION 9

Elements of Fibre Optics communication: Working Principle, Single Mode, Multi-Mode, Effect on Fibre bending, Standard FO Connectors, Cable Requirement for Underwater Application, Cable Characteristics, design for Electro-Optical(E-O) Underwater Cable, Handling system for E-O cables, Optical slip ring and its application.

MODULE II UNDERWATER OPTICAL COMMUNICATION 9

Classification of Underwater Wireless Optical Communication Links, Underwater Optical Communication (UWOC) System: Modulation, Coding, Light Source Technology, Common Lasers in UWOC, Signal Detectors and its merits and demerits, Alignment and Compensation, UWC Network, Absorption and Scattering Losses, UWOC Channel Modelling, UWOC Link Turbulence, Noise in the UWOC Channel.

MODULE III UNDERWATER MI COMMUNICATION & SENSOR NETWORKS 9

Fundamental Principles of Magnetic Induction, Basic Element of Magnetism, Magnetic Induction, Lenz's Law, Mutual and Self Induction, Inductive and Capacitive Reactance of the coil, MI Communication System: MI Coil, Matching Network, Communication Block MI Wireless Sensor Networks: UW sensor network application and its architecture, Localization, Medium Access protocols, Routing Protocols, Cross-layer Protocols, Recent trend on MI communication

MODULE IV UNDERWATER ACOUSTIC COMMUNICATION 9

Ocean Acoustic environment; Measuring sound levels and relevant units; Sound propagation in the ocean – sound velocity profiles in the deep water and shallow water Speed of underwater sound, Underwater Sound Transmission Loss, Acoustic Field Model: Ray Theory Model, Structure and Performance of UWAC System, Performance Indicators of UWAC System, Characteristics of the UWA Channel

MODULE V UNDERWATER ACOUSTIC NETWORK TECHNOLOGY 9

Underwater Acoustic Modem and its construction, Bandwidth and its limitations, Characteristics of UWA Network, Topology of UWA Network, Network Protocol Architecture of UWA Network, UWAC Challenges and Research Trends, Comparison study on RF, Optical and Acoustic Communication in Underwater. Underwater telephone, Acoustic Positioning System, Underwater beacon.

COURSE OUTCOMES

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

CO1: compute the performance of underwater wired and wireless optical communication system.
CO2: interpret the working principles of underwater fiber optic communication.
CO3: describe the various types of underwater wireless optical communication, channel modelling and its losses.
CO4: demonstrate the operating principles of underwater MI Communication System.
CO5: classify the need for underwater MI and acoustic communication & its challenges.
CO6: categorize the factors that affect the performance of underwater MI and acoustic Network.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Underwater Communications and Networks" by Yi Lou and Niax Ahmed, First Edition, Springer, 2021.
2. "Underwater Acoustic Systems" by William S. Burdic, Prentice Hall Inc., 2002.

REFERENCES:

1. "The Ocean Engineering Handbook" by Ferial El-Hawary, First Edition, CRC Press, 2001.
2. "Fundamentals of Ocean Acoustics" by L. M. Brekhovskikh and Yu. P. Lysanov, Third Edition, Springer, 2003.
3. "Principles of Underwater Sound" by Robert J. Urick, Third Edition, Peninsula Publishing, 2013.
4. "Deep Sea Mining Handbook" by Rahul Sharma, First Edition, Springer, 2017.
5. "Acoustical Oceanography: Principles and Applications" by Clarence S. Clay and Herman Medwin, United Kingdom: Wiley, 1977.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	3	-	-	2	-	-	-	1	1	-	-	2	1
2	3	1	-	-	-	-	-	-	1	1	-	-	2	1
3	3	2	-	-	2	-	-	-	1	1	-	-	2	2
4	3	3	-	-	2	-	-	-	1	1	-	-	2	1
5	3	2	-	-	-	-	-	-	1	1	-	-	2	-
6	3	3	-	-	2	-	-	-	1	1	-	-	2	-
Avg.	2.83	2.33	-	-	2	-	-	-	1	1	-	-	2	1.25

1-low, 2-medium, 3-high

COURSE CODE	OPTICAL COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

MODULE I OPTICAL SYSTEM COMPONENTS 9

Optical transmission basics - Network evolution - Light propagation in optical fibers - Loss & bandwidth, System limitations, Non- Linear effects - Solitons - Optical Components: Couplers, Isolators, Circulators, Multiplexers & Filters - Optical Amplifiers - Switches - Wavelength Converters

MODULE II OPTICAL NETWORK ARCHITECTURES 9

Introduction to Optical Networks - SONET/SDH –Optical Transport Network – Layered Architecture; Broadcast and Select Networks – Topologies for Broadcast Networks, Media- Access Control Protocols, Wavelength Routing Architecture.

MODULE III WAVELENGTH ROUTING NETWORKS 9

WDM Network Elements-Optical Line Terminals, Optical Line Amplifiers, Optical Add/Drop Multiplexers, Optical Cross connects-WDM Network Design - Cost Trade –offs-LTD and RWA problems – Dimensioning Wavelength –Routing Networks-Statistical Dimensioning Models- Maximum Load Dimensioning Models

MODULE IV PACKET SWITCHING AND ACCESS NETWORKS 9

Photonic Packet Switching - OTDM - Multiplexing and Demultiplexing - Synchronization - Burst switching – Test beds -Access Networks - Network Architecture overview –Enhanced HFC –Fiber to the Curb

MODULE V NETWORK DESIGN AND MANAGEMENT SYSTEM 9

Transmission System Engineering - System model - Power penalty - Transmitter - Receiver - Crosstalk - Dispersion - Wavelength stabilization - Overall design considerations - Control and management: Network management functions, Configuration management, Performance management, Fault management, Optical safety

COURSE OUTCOMES

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

CO1: classify the working of an Optical component and network architecture.

CO2: evaluate the performance of optical networks with nonlinear effect

CO3: categorize the architecture and traffic flow of different client layer Optical networks.

CO4: interpret the traffic models suitable for wavelength routing networks and determine the cost trade-off for designing a ring network

CO5: identify the need for synchronization in Photonic packet switching network and interpret the effect of cross-talk for limited distance in optical networks

CO6: compare the differences in the design of data plane, control plane, routing, switching, resource allocation methods, network management and protection methods in optical network.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Optical Networks: A Practical Perspective" by Rajiv Ramaswami, Kumar N. Sivarajan, and Galen H. Sasaki, Elsevier/Morgan Kaufmann, 3rd Edition, 2010.
2. "WDM Optical Networks: Concept, Design and Algorithms" by C. Siva Ram Moorthy and Mohan Gurusamy, Prentice Hall of India, 2002.

REFERENCES:

1. "Optical WDM Networks" by Biswanath Mukherjee, Springer Science, 2006.
2. "Multiwavelength Optical Networks: Architecture, Design and Control" by Thomas E. Stern, Georgios Ellinas, and Krishna Bala, 2nd Edition, Cambridge University Press, 2009.
3. "Fiber-Optic Communication Systems" by Govind P. Agrawal, 4th Edition, John Wiley and Sons, 2012.
4. "Fiber Optic Networks" by P. E. Green, Prentice Hall, 1993.
5. "Optical Networks" by Rajiv Ramaswami, 2nd Edition, Elsevier, 2004.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	1	-	-	-	-	-	-	-	-	-	2	1
2	3	2	1	-	-	-	-	-	-	-	-	-	2	1
3	3	2	-	-	-	-	-	-	-	-	-	-	2	1
4	3	2	1	-	-	-	-	-	-	-	-	-	2	1
5	3	2	-	-	-	-	-	-	-	-	-	-	2	-
6	3	3	2	-	-	-	-	-	-	-	-	-	2	-
Avg.	3	2.33	1.25	-	-	-	-	-	-	-	-	-	2	1

1-low, 2-medium, 3-high

COURSE CODE	WIRELESS ADHOC AND SENSOR NETWORKS	L	T	P	C
		3	0	0	3

MODULE I FUNDAMENTALS OF AD HOC & SENSOR NETWORKS 9

Fundamentals of Wireless Communication Technology – The Electromagnetic Spectrum – Radio propagation Mechanisms – Cellular and Ad Hoc Networks (MANETs) – issues in Ad hoc networks - Wireless sensor networks (WSNs): Challenges and Constraints - Single node architecture – Hardware components, Energy consumption of sensor nodes - Applications of Ad Hoc and Sensor Networks.

MODULE II MAC PROTOCOLS FOR AD HOC WIRELESS NETWORKS 9

Issues in designing a MAC Protocol- Classification of MAC Protocols- Contention based protocols: A Media Access Protocol for Wireless LAN (MACAW), Busy Tone Multiple Access protocols - Contention based protocols with Reservation Mechanisms: Distributed Packet reservation Multiple Access Protocol (D-PRMA), Five Phase Reservation Protocol (FPRP) - Contention based protocols with Scheduling Mechanisms: Distributed Priority Scheduling and Medium Access in Ad Hoc Networks, Distributed Wireless Ordering protocol (DWOP).

MODULE III ROUTING PROTOCOLS AND TRANSPORT LAYER IN AD HOC WIRELESS NETWORKS 9

Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks – Classifications of Routing Protocols – Table–Driven Routing Protocols – Destination Sequenced Distance Vector (DSDV) – Wireless Routing Protocol (WRP) – Cluster Switch Gateway Routing (CSGR) – Source–Initiated On–Demand Approaches – Ad hoc On–Demand Distance Vector Routing (AODV) – Dynamic Source Routing (DSR) –Temporally Ordered Routing Algorithm (TORA) —Location–Aided Routing (LAR) – Zone Routing Protocol (ZRP).

MODULE IV MAC AND ROUTING FOR WIRELESS SENSOR NETWORKS 9

MAC Protocols for Wireless Sensor Networks: IEEE 802.15.4, Zigbee, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC - The Mediation Device Protocol - Wakeup Radio Concepts - Address and Name Management - Routing Protocols: Energy-Efficient Routing, Geographic Routing

MODULE V LOCALIZATION TRACKING AND INFRASTRUCTURE ESTABLISHMENT 9

A Tracking Scenario – Problem formulation - Distributed representation and inference of states– Tracking multiple objects – Sensor models – Topology control – Clustering – Time synchronization – Localization and Localization Services

COURSE OUTCOMES

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

- **CO1:** summarize the challenges & issues in the wireless Ad Hoc and sensor network and its subsystems and interpret network architecture and its components
- **CO2:** interpret the essential principles of the MAC & Routing protocols for Wireless Ad Hoc Networks
- **CO3:** categorize the use of MAC & Routing protocols for Wireless Ad Hoc Networks constrained to real time scenario and QoS metric.
- **CO4:** summarize the features of MAC & Routing protocols for WSN
- **CO5:** infer the principles of localization tracking and infrastructure establishment in WSN
- **CO6:** use the sensor motes to evaluate the performance of WSN in terms of QoS metric

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Ad Hoc Wireless Networks – Architectures and Protocols" by C. Siva Ram Murthy and B. S. Manoj, Pearson Education, 2012.
2. "Wireless Sensor Networks: Technology, Protocols and Applications" by Kazem Sohraby, Daniel Minoli, and Taieb Znati, Wiley Interscience, A John Wiley & Sons, Inc., Publication, 2007.

REFERENCES:

1. "Ad Hoc and Sensor Network: Theory and Applications" by Carlos de Morais Cordeiro and Dharma Prakash Agarwal, 2nd Edition, World Scientific Publishing Co, 2011.
2. "Protocols and Architectures for Wireless Sensor Networks" by Holger Karl and Andreas Willig, John Wiley, 2005.
3. "Wireless Sensor Networks: An Information Processing Approach" by Feng Zhao and Leonidas Guibas, Elsevier, 2004.
4. "Ad Hoc Mobile Wireless Networks" by C. K. Toh, Pearson Education, 2009.
5. "Wireless Sensor Networks" by Ian F. Akyildiz and Mehmet Can Vuran, John Wiley, 2010.
6. "Wireless Sensor Networks and Applications" by Yingshu Li, My T. Thai, and Weili Wu, Springer, 2008.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	1	-	-	-	-	-	-	-	-	2	-
2	3	-	-	1	-	-	-	-	-	-	-	-	2	-
3	3	-	-	1	-	-	-	-	-	-	-	-	2	-
4	3	-	-	1	-	-	-	-	-	-	-	-	2	-
5	3	-	-	1	-	-	-	-	3	3	-	-	2	-
6	3	-	2	-	3	-	-	-	3	3	-	-	2	-
Avg.	3	-	2	1	3	-	-	-	2	2	-	-	2	-

1-low, 2-medium, 3-high

COURSE CODE	WIRELESS NETWORKS AND STANDARDS	L	T	P	C
		3	0	0	3

MODULE I THIRD AND FOURTH GENERATION: ARCHITECTURE AND PROCESS FLOW 9

Overview of CDMA2000, UMTS Services, UMTS Air Interface, 3GPP Release1999 Core Network Architecture, Distributed Network Architecture, IP Multimedia Network Architecture, Long-Term Evolution: System Architecture, Transmission Techniques, Channels in the radio interface, Radio Resource Management

MODULE II WIRELESS SYSTEM OPERATIONS AND STANDARDS 9

Cordless systems: Time Division Duplex, DECT Operation, ADPCM- Wireless Local Loop: Propagation considerations for WLL-OFDM –WiMAX and IEEE 802.16, Evolution of LTE Technology to Beyond 4G, 5G road map, 10 pillars of 5G, 5G Architecture, 5G -Objectives and usage scenarios, New Radio Air interface.

MODULE III MOBILE IP AND WIRELESS APPLICATION PROTOCOLS 9

Mobile IP: Operation of Mobile IP, Discovery using Agent Solicitation, Move Detection, Co-located addresses – Registration: Securing the Registration Procedure –Tunneling: IP-within-IP Encapsulation, Minimal Encapsulation – Wireless Application Protocol: Architectural Overview, Wireless Markup Language, WML Script, Wireless Application Environment, Wireless Session Protocol, Wireless Transaction Protocol, Wireless Transport Layer Security, Wireless Datagram Protocol .

MODULE IV WIRELESS LANS 9

Introduction - Spread Spectrum LANs: Configuration, Transmission issues – Narrowband Microwave LANs : Licensed Narrow Band RF, Unlicensed narrowband RF – IEEE 802.11: Architecture and services , Wi-Fi alliance, Medium Access Control ,Reliable Data Delivery, IEEE 802.11a/b Physical Layer – Introduction to 802.11n – Infrared LANs : Strengths and Weakness, Transmission techniques

MODULE V WPAN 9

Introduction – Radio Specification – Baseband and Specification – Link Manager Specification – Logical Link Control and Adaptation Protocol – IEEE 802.15: IEEE 802.15.3/a, IEEE 802.15.4 – UWB – Optical Wireless Wavelength Division Multiplexing (OWWDM).

COURSE OUTCOMES

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

CO1: describe the performance of various cellular networks in a wireless system.
CO2: infer the Services, air interfaces, and architectures of third and fourth-generation systems.
CO3: interpret the working principles and operation of WiMAX, 4G, and 5G network systems.
CO4: outline the functions of Mobile IP and wireless application protocols.
CO5: describe the wireless LAN types and Wireless PAN Standards.
CO6: infer the features of mobile IP, Wireless LAN, PAN and their standards.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Wireless Communications and Networks" by William Stallings, 2nd Edition, Prentice Hall, 2009.
2. "3G Wireless Networks" by Clint Smith, P.E. and Daniel Collins, 2nd Edition, Tata McGraw Hill, 2007.

REFERENCES:

1. "Fundamentals of 5G Mobile Networks" by Jonathan Rodriguez, 1st Edition, Wiley, 2015.
2. "LTE Small Cell Optimization: 3GPP Evolution to Release 13" by Harri Holma, Antti Toskala, and Jussi Reunanen, 1st Edition, Wiley, 2016.
3. "5G Mobile Communication: Concepts and Challenges" by Saad Z. Asif, CRC Press, 2019.
4. "Wireless Communication and Networking" by Vijay K. Garg, Morgan Kaufmann Publishers, 2007.
5. "Introduction to Wireless and Mobile Systems" by Dharma Prakash Agarwal and Qing-An Zeng, 3rd Edition, Thomson India, 2011.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1	-	-	-	-	-	-	-	-	-	-	2	-
2	3	1	-	-	-	-	-	-	-	-	-	-	2	-
3	3	1	-	-	-	-	-	-	-	-	-	-	2	-
4	3	1	-	-	-	-	-	-	-	-	-	-	2	-
5	3	1	-	-	-	-	-	-	-	-	-	-	2	-
6	3	1	-	-	-	2	-	-	-	-	-	-	2	-
Avg.	3	1	-	-	-	2	-	-	-	-	-	-	2	-

1-low, 2-medium, 3-high

COURSE CODE	NEXT GENERATION NETWORKS	L	T	P	C
		3	0	0	3

MODULE I NEXT GENERATION NETWORKS 9

Bottlenecks of conventional telecommunication networks – Evolution towards NGN - Technology requirements- NGN functional architecture - NGN entities - Fixed, Mobile, Cable and Internet evolution towards NGN- Applications - Advantages and disadvantages.

MODULE II NGN MANAGEMENT AND STANDARDIZATION 9

NGN requirements on Management - Customer, Third Party, Configuration, Accounting, Performance, Device and Information Management. Service and control management - End-to-End QoS and security - ITU and GSI-NGN releases, ETSI-NGN concept and releases.

MODULE III SOFTWARE DEFINED NETWORKS 9

Evolution of Programmable Networks to SDN - SDN Paradigm and Applications - SDN for Wireless Challenges - Leveraging SDN for 5G Networks - Mobility management and Ubiquitous Connectivity - SDN for Mobile Application Services.

MODULE IV SOFTWARE DEFINED MOBILE NETWORKS 9

SDMN Architectures and Network Implementation - Restructuring Mobile Networks to SDN - LTE Network: Options for Location of the SDMN Controller - Mobile Backhaul Scaling - Mobile cloud - SDN and LTE Integration Benefits for End Users.

MODULE V NEXT-GENERATION SMART-GRID 9

Evolution from classical grid to next-generation smart grid - smart grid architecture – NFV based approach in next generation smart grid – 5G support services to the next generation smart grid - smart grid enabled by 5G network slicing- Artificial intelligence and machine learning for next generation smart grid.

COURSE OUTCOMES

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

CO1: summarize the concepts of NGN architecture and its entities
CO2: explain the NGN management and standardization principles
CO3: outline the concepts of SDN to mobile application services
CO4: infer the necessity of NGN and SDN for mobile communication
CO5: use the concepts of SDN to SDMN for LTE integration benefits to end user
CO6: explain the concepts of next generation smart grid to support 5G use cases

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Software Defined Mobile Networks beyond LTE Network Architecture" by Madhusanga Liyanage, Andrei Gurtov, and Mika Ylianttila, Wiley, 2015.
2. "Integrating Artificial Intelligence, Internet of Things, and 5G for Next-Generation Smartgrid: A Survey of Trends, Challenges, and Prospect" by E. Esenogho, K. Djouani, and A. M. Kurien, IEEE Access, 10, pp. 4794-4831, 2022.

REFERENCES:

1. "Advanced Wireless Networks: Technology and Business Models" by Savo G. Glisic, 3rd Edition, Wiley, 2016.

2. "Next Generation Networks: Perspectives and Potentials" by Jingming Li Salina and Pascal Salina, Wiley, 2008.
3. "3G, 4G and Beyond: Bringing Networks, Devices and Web Together" by Martin Sauter, 2nd Edition, Wiley, 2013.
4. "Next Generation Network Services" by Neill Wilkinson, John Wiley Publications, 2002.
5. "Next Generation Networks" by Monique J. Morrow, CISCO Press, 2007.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
3	3	-	-	1	-	-	-	-	-	-	-	-	2	-
4	3	-	-	1	-	-	-	-	-	-	-	-	2	-
5	3	-	-	1	-	-	-	-	-	-	-	-	2	-
6	3	-	-	1	-	-	-	-	2	2	-	-	2	-
Avg.	3	-	-	1	-	-	-	-	2	2	-	-	2	-

1-low, 2-medium, 3-high

COURSE CODE	NETWORK ROUTING AND INFRASTRUCTURE MANAGEMENT	L	T	P	C
		3	0	0	3

MODULE I NETWORK FUNDAMENTALS 9

OSI and TCP/IP models-Network Infrastructure based Components: Firewalls, Access Points - Wireless controllers-Cloud resources on network architecture-Network topologies-Troubleshooting methodologies to resolve network problems.

MODULE II LAN SWITCHING TECHNOLOGIES 9

Switching concepts-MAC learning and aging-Frame switching-Frame flooding-MAC address table-Troubleshoot interface and cable issues-Configure, verify, and troubleshoot VLANs multiple switches.

MODULE III IPV4 AND IPV6 ROUTING TECHNOLOGIES 9

IPv4 addressing-Configure, verify, and troubleshoot IPv4 addressing and sub netting.IPv6 addressing-Configure, verify, and troubleshoot IPv6 addressing-routing concepts - components of a routing table-static routing and dynamic routing.

MODULE IV WAN TECHNOLOGIES 9

WAN topology options-WAN access connectivity options-Metro Ethernet-Broadband PPPoE-Internet VPN-QoS concepts-Congestion management

MODULE V INFRASTRUCTURE MANAGEMENT AND SECURITY 9

Components and need for network management – challenges - WAN Links Performance Management - Router Monitoring - Switch Monitoring - Networking Tools - WAN Fault Management – network security services.

COURSE OUTCOMES

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

CO1: explain the fundamentals of layered architecture and networking concepts
CO2: infer different network components and troubleshooting methodologies
CO3: summarize the concepts of network switching technologies
CO4: examine the given IPv4 and IPv6 address for effective network configuration and planning
CO5: infer the connectivity options with different WAN technologies for infrastructure management
CO6: interpret the network related issues in routing, congestion and security.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "CCNA Routing and Switching 200-125 Official Cert Guide Library" by Wendell Odom, Cisco Press Publications, 2016.
2. "Introduction to Networking: How the Internet Works" by Charles R. Severance, CreateSpace Independent Publishing Platform, 2015.

REFERENCES:

1. "CCNA Routing and Switching Practice Tests: Exam 100-105, Exam 200-105, and Exam 200-125" by Jon Buhagiar, United Kingdom, Wiley, 2017.
2. "Introduction to Networking with Network" by Timothy Pintello, United Kingdom, Wiley, 2012.
3. "Understanding the Network: A Practical Guide to Internetworking" by Michael J. Martin, New Riders Publishing, 2000.
4. "Network Routing: Algorithms, Protocols, and Architectures" by Karthik Ramasamy and Deep Medhi,

Netherlands, Elsevier Science, 2017.
5. "Integrated Network Management VIII", United States, Springer, 2014.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	2	-
2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
4	3	-	-	-	-	-	-	-	-	-	-	-	2	-
5	3	2	-	-	-	-	-	-	-	-	-	-	2	-
6	3	2	2	-	-	-	-	-	-	-	-	-	2	-
Avg.	3	2	2	-	-	-	-	-	-	-	-	-	2	-

1-low, 2-medium, 3-high

COURSE CODE	CRYPTOGRAPHY AND NETWORK SECURITY	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION AND NUMBER THEORETIC 9

Significance of network and data security in todays communication scenario – Overall Classification - Model of network security – Security attacks, services and mechanisms –Modular Arithmetic – matrices – Linear congruence - Substitution ciphers – Transposition ciphers .

MODULE II MODERN SYMMETRIC KEY CIPHERS 9

Algebraic structures – GF(2^n) fields- Modern block ciphers – Modern stream ciphers – DES – AES – uses of modern block ciphers and stream cipher

MODULE III ASYMMETRIC KEY ENCIPHERMENT 9

Mathematics of cryptography – Primality Testing – Factorization – Chinese Remainder Theorem – Quadratic – Exponentiation & Logarithm – RSA, Rabin – Elliptic curve Cryptography

MODULE IV INTEGRITY AUTHENTICATION AND KEY MANAGEMENT 9

Message integrity – message authentication – SHA-512 -Digital signature Standard– Kerberos – symmetric key management – public key distribution – steganography, Diffie Hellman key exchange.

MODULE V NETWORK SECURITY 9

Security at the Application Layer: E-mail – PGP – S/MIME – Security at the transport layer: SSL and TLS – Security at the network layer: IPsec, System Security: Intruders – viruses – Firewalls.

COURSE OUTCOMES

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

CO1: examine the security attacks and symmetric key ciphers used in communication Networks

CO2: explain the issues, scope and significance of various security mechanisms and services applicable to communication networks.

CO3: interpret modern symmetric key ciphers to various cryptographic applications

CO4: outline the various cryptographic techniques used in asymmetric key encipherment

CO5: apply various authentication, key management schemes to enhance security and inspect the system security

CO6: examine the applications of cryptography in application, transport and network layers

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Cryptography and Network Security: Principles and Practice" by William Stallings, Pearson Education, 7th Edition, 2016.
2. "Cryptography & Network Security" by Behrouz A. Forouzan, Tata McGraw-Hill Education, 5th Edition, 2011.

REFERENCES:

1. "Cryptography: Theory and Practice" by Douglas R. Stinson, CRC Press Series on Discrete Mathematics and Its Applications, 1995.
2. "Network Security: Private Communication in a Public World" by Charlie Kaufman, Radia Perlman, and Mike Speciner, Pearson Education, 2nd Edition, 2003.
3. "Cryptography and Network Security" by Atul Kahate, McGraw-Hill Education, 3rd Edition, 2013.
4. "Network Security: Current Status and Future Directions" by Christos Douligeris and Dimitrios N.

Serpanos, John Wiley, 2007.
5. "Wireless Security" by R. K. Nichols, Tata McGraw Hill Education, 2006.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
5	3	2	-	-	-	-	-	-	-	-	-	-	2	-
6	3	2	-	-	-	-	-	-	-	-	-	-	2	-
Avg.	3	2	-	-	-	-	-	-	-	-	-	-	2	-

1-low, 2-medium, 3-high

COURSE CODE	RADAR AND NAVIGATIONAL AIDS	L	T	P	C
		3	0	0	3

MODULE I RANGE EQUATION **9**

Basic Radar - Radar Range equation - Radar parameters - Block diagram - Radar frequencies - Derivation of simple range equation - Effect of various factors: radar cross section transmitted Power - Pulse repetition frequency - System losses - S/N ratio and propagation losses.

MODULE II MTI, PULSE DOPPLER and CW RADAR SYSTEMS **9**

Doppler effect - Pulsed radar - CW radar - MTI and Pulsed Doppler radar - Block diagrams and principles of working - Delay line cancellers and filters - Staggered PRFs - Doppler filter banks -Digital MTI processing - Range gates and filters used in MTI - Comparison of radar systems

MODULE III TRACKING RADARS **9**

Basic principles of tracking in angle - sequential lobe switching - conical scanning - Monopulse tracking methods: Amplitude comparison and Phase comparison - Limitations to tracking accuracy - methods to reduce errors and inaccuracy -Low angle tracking - Tracking in range - Tracking in Doppler - Comparison of tracking radars

MODULE IV RADIO NAVIGATION AND LANDING AIDS **9**

General principles - Radio compass Non Directional Beacon (NDB) – Automatic Direction Finding (ADF), VHF Omnidirectional Radio (VOR), Distance Measuring Equipment (DME) - Hyperbolic Navigation DECCA, OMEGA, LORAN - Mechanics of Landing: Instrument Landing System - Microwave Landing System

MODULE V RADAR TRANSMITTER AND RECEIVER **9**

Linear beam power tubes- Solid state RF power sources- solid state devices used in RADAR Magnetron crossed field amplifiers- other aspects of radar transmitter- RADAR Receiver- Receiver noise figure- super heterodyne receiver- dynamic range- RADAR Displays.

COURSE OUTCOMES

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

CO1: apply the radar range equation and Doppler principles to understand the motion of targets in radar scenarios
CO2: outline the radar parameters and effects of various factors on radar.
CO3: explain the block diagrams for different radar systems, including pulsed radar, CW radar, MTI, and pulsed Doppler radar.
CO4: summarize the principles and operation of sequential lobbing, conical scanning, and mono-pulse tracking radars.
CO5: identify the key concepts in the underlying navigation and communication systems.
CO6: classify various tracking radars, mechanics of landing, and radar displays.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Introduction to Radar Systems" by Merrill I. Skolnik, 3rd Edition, Tata McGraw Hill, 2017.
2. "Avionics Navigation Systems" by Myron Kayton and W. R. Fried, John Wiley & Sons, 1997.

REFERENCES:

1. "Elements of Electronic Navigation" by Nagaraja, 2nd Edition, Tata McGraw Hill, 1996.
2. "Radar Design Principles: Signal Processing and Environment" by Nathanson, 2nd Edition, SciTech

Publishing, 1999.
3. "GPS: Theory and Practice" by Hofmann-Wellenhof, H. Lichtenegger, and J. Collins, 5th Edition, Springer Verlag, 2012.
4. "Global Navigation Satellite Systems: Insights into GPS, GLONASS, Galileo, Compass, and Others" by B. Bhatta, BS Publications, 2010.
5. Website: www.gsa.europa.eu

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
2	3	-	-	-	-	-	-	-	-	-	-	-	2	-
3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
4	3	-	-	-	-	-	-	-	-	-	-	-	2	-
5	3	2	-	-	-	-	-	-	-	-	-	-	2	-
6	3	2	-	-	-	-	-	-	-	-	-	-	2	-
Avg.	3	2	-	-	-	-	-	-	-	-	-	-	2	-

1-low, 2-medium, 3-high

COURSE CODE	COMPRESSIVE SENSING AND SPARSE SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

MODULE I REVIEW OF SIGNAL SPACES **9**

Normed linear spaces, Finite and infinite dimensional signal spaces, Hamel basis, Schauder basis and Riesz basis, Orthogonality and bi-orthogonality, Frames, Linear transformations and change of basis, Sampling as an isomorphism, Separable signal spaces, Quotient spaces and, Decomposition of signals, Underdetermined system of equations - methods of solution, sparse solution

MODULE II COMPRESSED SENSING **9**

Classical sampling theorem for band-limited signals, Bandpass sampling theorem, Sample-rate reduction and multi-channel sampling, Sampling of random signals, Sampling of duration-limited signals and motivation for compressed sampling., Compressed Sensing.

MODULE III SPARSITY AND SIGNAL RECOVERY **9**

Sparse representation of signals - Sparsity and compressibility, Construction of measurement basis - Sensing matrix, Null-space conditions and the spark, The Restricted Isometry Property (RIP), RIP and null-space property

MODULE IV SPARSE RECOVERY METHODS **9**

Convex optimization algorithms – Basis Pursuit and LASSO, Greedy algorithms- Orthogonal Matching Pursuit (OMP), Thresholding based sparse recovery methods, MAP estimation-based sparse recovery methods.

MODULE V APPLICATIONS OF COMPRESSIVE SENSING **9**

Signal compression, Signal Denoising, Sparse linear regression, Video surveillance, Image Fusion; Single-Pixel Imaging

COURSE OUTCOMES

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

CO1: apply the mathematical concepts of signal spaces for sparse signal recovery.
CO2: examine the concept of compressed sensing as an alternative to traditional sampling.
CO3: apply compressed sensing techniques and effectively recover sparse signals using mathematical principles.
CO4: examine the principles of sparse recovery methods.
CO5: explain the applications of compressed sensing in signal, image and video processing.
CO6: apply sparse recovery methods and utilize compressed sensing principles in signal, image, and video processing applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Compressed Sensing: Theory and Applications" by Yonina Eldar and Gitta Kutyniok, 1st Edition reprint, Cambridge University Press, 2012.
2. "Sparse and Redundant Representations – From Theory to Applications in Signal & Image Processing" by Michael Elad, Springer, 2010.

REFERENCES:

1. "A Mathematical Introduction to Compressive Sensing" by Simon Foucart and Holger Rauhut, Birkhäuser, 2013.

2. "An Introduction to Compressive Sensing" by Richard G. Baraniuk, Mark A. Davenport, Marco F. Duarte, Chinmay Hegde, Connexions (Publishing) Rice University, Houston, Texas, 2012.
3. "A Wavelet Tour of Signal Processing: The Sparse Way" by S. G. Mallat, Academic Press/Elsevier, 2009.
4. "Compressed Sensing & Sparse Filtering" by Avishy Y. Carmi, Lyudmila Mihaylova, Simon J. Godsill, Springer Berlin Heidelberg, 2016.
5. "Sparse Representations and Compressive Sensing for Imaging and Vision" by Vishal M. Patel, Rama Chellappa, Springer, 2013.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1	-	-	-	-	-	-	-	-	-	-	3	-
2	3	-	-	-	-	-	-	-	-	-	-	-	3	-
3	3	1	-	-	-	-	-	-	-	-	-	-	3	-
4	3	-	-	-	-	-	-	-	-	-	-	-	3	-
5	3	-	-	-	-	-	-	-	-	-	-	-	3	-
6	3	1	-	-	-	-	-	-	-	-	-	-	3	-
Avg.	3	1	-	-	-	-	-	-	-	-	-	-	3	-

1-low, 2-medium, 3-high

COURSE CODE	PATTERN RECOGNITION	L	T	P	C
		3	0	0	3

MODULE I PATTERN CLASSIFIER **9**

Overview of pattern recognition-Discriminant functions-Supervised learning-Parametric estimation, Maximum likelihood estimation, Bayesian parameter estimation-perceptron algorithm-LMSE algorithm-problems with Bayes approach-Pattern classification by distance functions-Minimum distance pattern classifier.

MODULE II UNSUPERVISED CLASSIFICATION **9**

Clustering for unsupervised learning and classification -Clustering – C means algorithm-Hierarchical clustering procedures-Graph theoretic approach to pattern clustering- Validity of clustering solutions

MODULE III STRUCTURAL PATTERN RECOGNITION **9**

Elements off or mal grammars-String generation as pattern Syntactic description-Parsing-Stochastic grammars structural representation

MODULE IV FEATURE EXTRACTION AND SELECTION **9**

Entropy minimization-Karhunen-Loeve transformation-Feature selection through Functions approximation-Binary feature selection.

MODULE V APPLICATIONS OF PATTERN RECOGNITION **9**

Speech recognition, Image recognition, Fingerprint identification, Medical diagnosis, Industrial automation.

COURSE OUTCOMES

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

CO1: interpret supervised learning algorithms and to apply them for solving problems.
CO2: apply unsupervised techniques for clustering data without prior knowledge.
CO3: apply pattern recognition techniques for both supervised and unsupervised learning to classify patterns and analyze data.
CO4: use structural pattern recognition techniques and feature extraction methods, to analyze and represent patterns and apply pattern recognition in real-world applications.
CO5: design pattern recognition and feature extraction methods to extract interesting patterns from structured data like graph and syntactic description.
CO6: apply pattern recognition techniques to diverse applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Pattern Classification and Scene Analysis" by R. O. Duda and P. E. Hart, 2nd Edition, Wiley, 2001.
2. "Pattern Recognition: Statistical, Structural and Neural Approaches" by Robert J. Schalkoff, John Wiley & Sons Inc., New York, 2007.

REFERENCES:

1. "Pattern Recognition and Machine Learning" by Christopher M. Bishop, Springer, 2011.
2. "Pattern Recognition Principles" by Tou and Gonzales, Wesley Publication Company, London, 1974.
3. "Pattern Recognition Engineering" by Morton Nadier and Eric P. Smith, John Wiley & Sons, New York, 1993.
4. "The Elements of Statistical Learning" by Trevor Hastie, Robert Tibshirani, and Jerome Friedman, Springer

Series, 2017.
5. "Pattern Recognition: Techniques and Applications" by Rajjan Shinghal, Technology & Engineering, 2006.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	-	-	-	-	-	-	-	-	-	-	3	-
2	3	3	2	-	2	-	-	-	-	-	-	-	3	-
3	3	3	2	-	2	-	-	-	-	-	-	-	3	-
4	3	3	2	-	2	-	-	-	-	-	-	-	3	-
5	3	3	2	-	2	-	-	-	-	-	-	-	3	-
6	3	3	2	-	2	-	-	-	-	-	-	-	3	-
Avg.	3	2.83	2	-	2	-	-	-	-	-	-	-	3	-

1-low, 2-medium, 3-high

COURSE CODE	MACHINE LEARNING FOR SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

MODULE I REVIEW OF SIGNAL PROCESSING CONCEPTS 9

Introduction - Notion of a signal- Basic digital representation of text, speech, image and video-- Complex Exponential functions- Shannon Information Theory, Convolution, Correlation and Covariance Functions- Wavelets- Fourier Transform - DCT and Wavelets, Gaussian Processes.

MODULE II OPTIMIZATION TECHNIQUES 9

Gradient ascent/descent- Basics of convex optimization- Constrained optimization, Convex sets, Hyperplanes/ Half-spaces, Lagrange multipliers, projected gradients- Bio-Inspired Algorithms

MODULE III DATA-DRIVEN REPRESENTATIONS 9

Dictionary based representations - Eigen representations – Karhunen Loeve Theorem - Principal Component Analysis- Properties- Independent Component Analysis(ICA)- ICA for representations and Denoising - Non-negative matrix factorization.

MODULE IV STATISTICAL MACHINE LEARNING 9

Feature and kernel functions, Mixture modelling, Classification- SVM, Regression, Clustering, Dimensionality reduction

MODULE V MACHINE LEARNING APPLICATIONS FOR SIGNAL PROCESSING 9

Machine Learning for Audio Classification - Time Series Analysis, LSTMs and CNNs. Machine Learning for Image Processing - Transfer Learning, Attention models, Attribute-based learning

COURSE OUTCOMES

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

CO1: interpret mathematical methods for implementing signal processing and machine learning techniques.
CO2: use optimization techniques for various machine learning models.
CO3: develop methods of data representations for signal processing in machine learning environment.
CO4: apply basic machine learning models and prediction techniques on signals.
CO5: apply machine learning techniques to analyze and solve complex machine learning problems.
CO6: apply machine learning models and techniques for signal processing applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Machine Learning for Signal Processing: Data Science, Algorithms, and Computational Statistics" by Max A. Little, Oxford Publisher, 2019.
2. "Machine Learning for Audio, Image and Video Analysis: Theory and Applications" by Francesco Camastra and Alessandro Vinciarelli, 2nd Edition, 2015.

REFERENCES:

1. "Machine Learning in Signal Processing: Applications, Challenges, and the Road Ahead" by Sudeep Tanwar, Anand Nayyar, and Rudra Rameshwar, 1st Edition, CRC Press, 2022.
2. "Signal Processing for Communications" by Paolo Prandoni and Martin Vetterli, 1st Edition, CRC Press, 2008.
3. "Convex Optimization" by Stephen Boyd and Lieven Vandenberghe, 1st Edition, Cambridge University Press, 2004.
4. "Pattern Recognition and Machine Learning" by C. M. Bishop, 2nd Edition, Springer, 2011.

5. "Signal Processing and Machine Learning with Applications" by Michael M. Richter, Sheuli Paul, Veton Këpuska, and Marius Silaghi, 1st Edition, Springer International Publishing, 2022.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1	-	-		-	-	-	-	-	-	-	3	-
2	3	2	-	-	2	-	-	-	-	-	-	-	3	-
3	3	2	-	-	2	-	-	-	-	-	-	-	3	-
4	3	2	-	-	2	-	-	-	-	-	-	-	3	-
5	3	2	-	-	2	-	-	-	-	-	-	-	3	-
6	3	2	2	-	2	-	-	-	-	-	-	-	3	-
Avg.	3	1.83	2	-	2	-	-	-	-	-	-	-	3	-

1-low, 2-medium, 3-high

COURSE CODE	ADAPTIVE SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

MODULE I ADAPTIVE SYSTEMS **9**

Definition and characteristics, General properties, Open and Closed Loop Adaptations, Applications. Adaptive Linear Combiner: Performance function, Gradient and Mean Square Error, Examples.

MODULE II THEORY OF ADAPTATION WITH STATIONARY SIGNALS **9**

Properties of the Quadratic Performance Surface, Significance of Eigen values, Eigen vectors, correlation matrix. Searching the Performance Surface: A simple gradient search algorithm, Stability and Rate of convergence, the learning curve.

MODULE III GRADIENT ESTIMATION AND ITS EFFECTS ON ADAPTATION **9**

Gradient component estimation by derivative measurement, performance penalty, Variances of the gradient estimate, effects on the weight – vector solution, Excess mean square error and time constants, misadjustments, total misadjustments and other practical considerations

MODULE IV ADAPTIVE ALGORITHM AND STRUCTURE **9**

LMS Algorithm, Derivation, Convergence of the weight vector, learning curve, noise vector in weight vector solution, misadjustment, Performance analysis

MODULE V APPLICATIONS OF ADAPTIVE SIGNAL PROCESSING **9**

Adaptive modeling of a multi-path communication channel, model in geophysical exploration, FIR digital filter synthesis

COURSE OUTCOMES

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

CO1: interpret the characteristics and properties of adaptive systems.
CO2: examine adaptation theory in the context of stationary signals.
CO3: interpret adaptive systems and the estimation of gradients and its effects on adaptation.
CO4: examine the performance of adaptive algorithms through various metrics such as mean squared error, signal-to-noise ratio, and misadjustment.
CO5: apply adaptive signal processing techniques in real-world applications.
CO6: apply adaptive algorithms and utilize adaptive signal processing techniques in real-world applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Adaptive Signal Processing" by Bernard Widrow and Samuel D. Stearns, Pearson Education India, 2016.
2. "Adaptive Filter Theory" by Simon Haykin, Pearson Education, 2014.

REFERENCES:

1. "Adaptive Signal Processing: Applications to Real-World Problems" by J. Benesty and Y. Huang, Springer, 2013.
2. "Adaptive Signal Processing: Next Generation Solutions" by T. Adali and S. Haykin, John Wiley & Sons Inc., 2010.
3. "Fundamentals of Adaptive Filtering" by Sayed Ali H., John Wiley & Sons, 2003.
4. "Theory and Design of Adaptive Filters" by John R. Treichler, C. Richard Johnson, and Michael G. Larimore, Prentice-Hall of India, 2002.

5. "Adaptive Signal Processing" by D. G. Manolakis, V. K. Ingle, and S. M. Kogon, McGraw-Hill, 2000.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1	-	-	-	-	-	-	-	-	-	-	3	-
2	3	1	-	-	-	-	-	-	-	-	-	-	3	-
3	3	1	-	-	-	-	-	-	-	-	-	-	3	-
4	3	2	1	-	-	-	-	-	-	-	-	-	3	-
5	3	2	1	-	-	-	-	-	-	-	-	-	3	-
6	3	2	1	-	-	-	-	-	-	-	-	-	3	-
Avg.	3	1.5	1	-	-	-	-	-	-	-	-	-	3	-

1-low, 2-medium, 3-high

COURSE CODE	MODERN ANTENNAS	L	T	P	C
		3	0	0	3

MODULE I MOBILE HANDESET ANTENNAS **9**

Review of antenna basic parameters – Frequency bands for commercial applications – Cellular handset antenna design issues – Helical wire antennas and variants – Evolution of the PIFA – Ceramic chip and resonator antennas – SAR measurement and minimization – Provision for GPS and Bluetooth.

MODULE II FRACTAL ANTENNAS **9**

Fractal antenna geometries – Iterated function systems – Fractal antenna elements – Radiation characteristics - Fractal antenna arrays – Antenna arrays based on aperiodic tilings – Hybrid Fractal antenna – Fractal MIMO structures

MODULE III MILLIMETER WAVE ANTENNAS **9**

Millimeter wave and Terahertz applications – Waveguide antennas – Printed planar antennas – On-chip antennas – Sub millimeter wave antennas – Vivaldi antenna & long slot array for ultra-wideband characteristics – Dielectric resonating antennas –Substrate integrated waveguide antennas –Reflector antennas

MODULE IV BROADBAND PLANAR ANTENNA **9**

Suspended plate antennas – Techniques for broad impedance bandwidth – Techniques for enhanced radiation performance – Planar monopole antennas – Applications in high speed wireless communications

MODULE V ANTENNAS FOR MEDICAL APPLICATIONS **9**

Environment-Antennas for medical imaging-Heating-Bio-Telemetry-Pulsed Electromagnetic Fields-sensing-Future directions

COURSE OUTCOMES

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

CO1: interpret the concept of PIFA, Helical and fractal antenna
CO2: make use of antenna parameters to compute the SAR measurement in mobile handset antenna
CO3: make use of Fractal structure to design antenna element and array structure
CO4: apply principle of microstrip antenna to design terahetz frequency antennas
CO5: categorize antennas for millimeter wave and broad impedance bandwidth based on their operating frequency
CO6: infer the antenna characteristics suitable for wireless and medical applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Antenna Engineering Handbook" by John L. Volakis, 5th Edition, Tata McGraw Hill, 2018.
2. "Modern Antenna Handbook" by Constantine A. Balanis, John Wiley and Sons, 2011.

REFERENCES:

1. "Modern Antennas" by Drabowitch S. and Papiernik A., 2nd Edition, Springer, 2005.
2. "Antennas for Portable Devices" by Zhi Ning Chen, John Wiley & Sons, 2007.
3. "Smart Antennas" by Lal Chand Godara, CRC Press, 2018.
4. "Antennas for All Applications" by John D. Kraus, Ronald J. Marhefka, and Ahmad S. Khan, 3rd Edition, John Wiley & Sons, New York, 2002.

5. "Antenna Theory and Design" by Warren L. Stutzman and Gary A. Thiele, 3rd Edition, John Wiley & Sons, 2013.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
3	3	-	-	-	-	-	-	-	-	-	-	-	1	-
4	3	-	-	-	-	-	-	-	-	-	-	-	1	-
5	3	-	-	-	-	-	-	-	-	-	-	-	1	-
6	3	-	-	-	-	-	-	-	-	-	-	-	1	-
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	1	-

1-low, 2-medium, 3-high

COURSE CODE	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	C
		3	0	0	3

MODULE I EMI ENVIRONMENT **9**

EMI/ EMC concepts and definitions - Electromagnetic environment- Natural and Nuclear sources of EMI: Celestial Electromagnetic Noise, Lightning Discharge, Electrostatic Discharge, Electromagnetic Pulse- EMI from apparatus and circuits: Noise from Relays and Switches

MODULE II EMI COUPLING PRINCIPLES AND STANDARDS **9**

Conducted, radiated and transient coupling- Common ground impedance coupling – Common mode and ground loop coupling - Differential mode coupling – Near field cable to cable coupling - Field to cable coupling – Power mains and Power supply coupling-Cross talk in transmission lines.

MODULE III EMI CONTROL TECHNIQUES **9**

Shielding- Filtering- Grounding- Electrical Bonding- Isolation Transformer - EMI Suppression Cables- EMC connectors- Transient suppressors and Surge Suppression Devices

MODULE IV EMC DESIGN OF PCBS **9**

Component selection and mounting; Choice of capacitors, inductors, transformers and resistors, Power Distribution Decoupling – Zoning - Motherboard Designs and Propagation Delay Performance Models

MODULE V EMI MEASUREMENTS AND STANDARDS **9**

Open area test site Measurements-Measurement Precautions-Anechoic Chamber- TEM cell- Reverberating Chamber, GTEM cell- Comparison of test facilities- Civilian standards: CISPR, FCC, EN- Military standards: MIL 461/462.

COURSE OUTCOMES

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

CO1: interpret the concepts of EMI/EMC and various coupling principles
CO2: infer the electromagnetic interference in natural, cable and transmission lines
CO3: interpret the common mode and differential mode coupling for EMI
CO4: apply various control techniques to suppress EMI effects
CO5: make use of PCBs and chamber to control EMI effects
CO6: summarize the EMI control and measurement techniques

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Engineering EMC: Principles, Measurements and Technology" by V. P. Kodali, 2nd Edition, Wiley-Blackwell, 2016.
2. "Introduction to Electromagnetic Compatibility" by Clayton R. Paul, John Wiley & Sons, 2014

REFERENCES:

1. "Principles and Techniques of Electromagnetic Compatibility" by Christos Christopoulos, 2nd Edition, CRC Press, 2018.
2. "Foundations of Electromagnetic Compatibility with Practical Applications" by Bogdan Adamczyk, Wiley, 2017.
3. "Electromagnetic Compatibility: Methods, Analysis, Circuits and Measurements" by David A. Weston, 3rd Edition, CRC Press, 2016.

4. "Noise Reduction Techniques in Electronics Systems" by Henry W. Ott, John Wiley and Sons, New York, 1998.
5. "Principles of Electromagnetic Compatibility" by Bernhard Keiser, 3rd Edition, Artech House, 1994.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
3	3	-	-	-	-	-	-	-	-	-	-	-	1	-
4	3	-	-	-	-	-	-	-	-	-	-	-	1	-
5	3	-	-	-	-	-	-	-	-	-	-	-	1	-
6	3	-	-	-	-	-	-	-	-	-	-	-	1	-
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	1	-

1-low, 2-medium, 3-high

COURSE CODE	RF MICROELECTRONICS	L	T	P	C
		3	0	0	3

MODULE I TRANSCEIVER ARCHITECTURES 9

Heterodyne and Homodyne architectures – Direct conversion Transceiver-Low IF receiver - Discrete and CMOS realization of passive components for RF - Distortion - IP3 – Blockers and Blocker Filtering - Friis Formula for cascaded blocks

MODULE II CMOS LNAS AND MIXERS 9

Noise Figure and impedance matching issues –Common Source Amplifier – Common Gate Amplifier and differential LNAs - Passive mixers - Active mixers - Gilbert cells - linearity and Noise Figure of mixers

MODULE III OSCILLATORS 9

LC Resonator- Analysis of Oscillator as Feedback System-Negative Resistance generated by amplifier – Basic differential oscillator topologies – Modified Common-Collector Colpitts' Oscillator with Buffering-Phase Noise

MODULE IV FREQUENCY SYNTHESIS 9

PLL Components-Continuous Time Analysis for PLL Synthesizers-Discrete Time Analysis for PLL Synthesizers-Transient Behavior of PLLs-Fractional-N PLL Frequency Synthesizers

MODULE V POWER AMPLIFIERS 9

Class A, B , C , D , E ,F and AB power amplifiers – Summary of Amplifier classes for RF Integrated Circuits -Matching to achieve desired power- Effects and Implication of Non- Linearity

COURSE OUTCOMES

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

CO1: interpret the characteristics of RF transmitter and receiver
CO2: apply the principle of LNA to improve the noise figure at RF receive section
CO3: interpret the frequency determining components and feedback mechanisms in oscillators
CO4: infer the characteristics of power amplifiers, PLL and frequency synthesizers
CO5: infer the significance of filters, oscillators, mixer, feedback systems
CO6: infer the significance of power amplifiers, phase locked loop and frequency synthesizers in RF transceiver architecture

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Radio Frequency Integrated Circuit Design" by John Rogers and Calvin Plett, 2nd Edition, Artech House, 2010.
2. "RF Microelectronics" by Behzad Razavi, 2nd Edition, Pearson Education, 2014.

REFERENCES:

1. "The Design of CMOS Radio Frequency Integrated Circuits" by Thomas H. Lee, 2nd Edition, Cambridge University Press, 2004.
2. "RF and Microwave Microelectronics Packaging" by Ken Kuang, Franklin Kim, and Sean S. Cahill, Springer, 2009.
3. "Future Trends in Microelectronics: Up the Nano Creek" by Serge Luryi, Jimmy Xu, and Alex Zaslavsky, 3rd Edition, John Wiley & Sons, 2007.
4. "RF Power Amplifiers" by Marian K. Kazimierczuk, 2nd Edition, Wiley, 2014.

5. "Design Methodology for RF CMOS Phase Locked Loops" by Carlos Quemada, Guillermo Bistue, and Inigo Adin, Artech House, 2008.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1	-	-	-	-	-	-	-	-	-	-	1	-
2	3	1	-	-	-	-	-	-	-	-	-	-	1	-
3	3	1	-	-	-	-	-	-	-	-	-	-	1	-
4	3	1	-	-	-	-	-	-	-	-	-	-	1	-
5	3	1	-	-	-	-	-	-	-	-	-	-	1	-
6	3	1	-	-	-	-	-	-	-	-	-	-	1	-
Avg.	3	1	-	-	-	-	-	-	-	-	-	-	1	-

1-low, 2-medium, 3-high

COURSE CODE	RADIATION SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I CONCEPTS OF RADIATION **9**

Retarded vector potential- and Maxwell's equation approach - Duality theorem - The Lorentz guage condition - Fields radiated by an alternating current element and half wave dipole - Total power radiated and radiation resistance of alternating current element and half wave dipole - Power radiated in the far field - Linear, elliptical and circular polarization- Development of the Poincare sphere

MODULE II ANTENNA ARRAY **9**

N element linear array - uniform amplitude and spacing - Phased arrays - Directivity of Broadside and End fire arrays - Three dimensional characteristics - Pattern multiplication - Binomial arrays and Dolph-T chebycheff arrays - Circular array - Planar array - array factor, beam width, directivity

MODULE III ANTENNA SYNTHESIS **9**

Synthesis problem - line source based beam synthesis methods, Fourier transform and Woodward - Lawson sampling methods - Linear array shaped beam synthesis method- Low side lobe, narrow main beam synthesis methods - discretization of continuous sources. Schelkunoff polynomial method.

MODULE IV SPECIAL ANTENNAS **9**

Aperture antennas - Huygens Principle. Rectangular apertures - Circular apertures and their design considerations - Babinets principle, Fourier transform in aperture antenna theory. Micro strip antennas: feeding methods - Rectangular patch - transmission line model - circular patch - Micro strip array and feed networks.

MODULE V SMART ANTENNAS **9**

Beam steering - degree of freedom - optimal antenna - adaptive antennas - smart antennas - key benefits of smart antennas technology - wide band smart antennas - Narrow band processing: signal model, conventional beam former, null steering beam former, optimal beam former, optimization using reference signal and beam space processing

COURSE OUTCOMES

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

CO1: relate the concept of the radiation mechanism with antenna parameters
CO2: apply Heuristic approach and Maxwell's equations to determine the basic concepts of radiation
CO3: apply Maxwell's equations to find the radiation strength in array antennas
CO4: describe different antenna synthesis methods
CO5: apply the principles of the radiation mechanism to determine the radiation parameters for special and smart antennas
CO6: interpret the working principle of synthesize antenna, special and smart antennas

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Antenna Theory: Analysis and Design" by Constantine A. Balanis, 4th Edition, John Wiley and Sons, 2016.
2. "Smart Antennas" by Lal Chand Godara, CRC Press, 2018.

REFERENCES:

1. "Antennas for All Applications" by John D. Kraus, Ronald J. Marhefka, and Ahmad S. Khan, 3rd Edition, John Wiley and Sons, 2002.
2. "Electromagnetic Waves and Radiating Systems" by Edward C. Jordan and Keith G. Balmain, 2nd Edition, Prentice Hall of India, 2015.
3. "Antenna Theory and Design" by Warren L. Stutzman and Gary A. Thiele, 3rd Edition, John Wiley and Sons, 2013.
4. "Smart Antennas: Adaptive Arrays, Algorithms, & Wireless Position Location" by Theodore S. Rappaport, IEEE Press, 1998.
5. "Radiowave Propagation and Smart Antennas for Wireless Communications" by Ramakrishna Janaswamy, Kluwer Academic Publishers, 2002.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1	-	-	-	-	-	-	-	-	-	-	1	-
2	3	1	-	-	-	-	-	-	-	-	-	-	1	-
3	3	1	-	-	-	-	-	-	-	-	-	-	1	-
4	3	1	-	-	-	-	-	-	-	-	-	-	1	-
5	3	1	-	-	-	-	-	-	-	-	-	-	1	-
6	3	1	-	-	-	-	-	-	-	-	-	-	1	-
Avg.	3	1	-	-	-	-	-	-	-	-	-	-	1	-

1-low, 2-medium, 3-high

COURSE CODE	ELECTROMAGNETIC RADIATION HAZARDS AND SAFETY	L	T	P	C
		3	0	0	3

MODULE I SOURCES OF ELECTROMAGNETIC RADIATION 9

Sources of Extremely Low frequency Fields: DC Sources and AC Sources – Electric Utility System - Extremely Low frequency Fields in the Environment -Elements of Radio Frequency Radiation System – Radio and Television Transmitters – Radar Systems – Satellite Earth Stations – Microwave Communications – Mobile Radio Equipment – Cellular Communication – Nano communication Sources

MODULE II BIOLOGICAL EFFECTS 9

Interaction Mechanisms - Extremely Low frequency Fields and Cancer – Cellular Studies – Animal Studies – Human Studies – Epidemiological studies of Cancer and Nano cancer – Thermal Effects – Athermal and Nonthermal Effects – Genetic Effects – Cell Proliferation – Cell Transformation.

MODULE III INCIDENT AND INTERNAL FIELD DOSIMETRY 9

Radio Frequency Radiation Modeling – Measurement Techniques - Time Averaging – Spatial Averaging – Mitigation in Public and Occupational Environments – Specific Absorption Rate – Types – parameters – Estimation of Specific Absorption rate – Theoretical Dosimetry – Experimental Dosimetry – Phantom Models – Dosimetric Studies of Cellular Phones

MODULE IV SAFETY AND REGULATION 9

Safety Standards - Extremely Low frequency Standards in Europe – Regulations in United States – ANSI/IEEE C95.1 – National Council on Radiation Protection and Measurement – National Institute for Occupational Safety and Health – Regulations in Asia Pacific – International Regulatory Activities: International Radiation Protection Association – International Commission on Non-Ionizing Radiation Protection

MODULE V RADIO FREQUENCY SITE SURVEYS 9

Survey on Mobile Systems – Survey of Broadcast Stations – Survey of Traffic Radar Devices – Survey of Radio Frequency Heating Equipment – Microwave Ovens – Survey of Radio Frequency Interference on Medical Devices.

COURSE OUTCOMES

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

CO1: outline the sources of radio frequency radiation and its effects in human
CO2: classify various sources of electromagnetic radiation
CO3: infer the biological interaction of electromagnetic radiation on human cells
CO4: interpret the dosimetry effects of electromagnetic radiation using specific absorption rate
CO5: summarize how radiation effects is standardized in national & international
CO6: infer the internal field dosimetry, safety standards and radio frequency survey on RF and medical devices

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Electromagnetic Fields and Radiation: Human Bioeffects and Safety" by Riadh W.Y. Habash, 1st Edition, CRC Press, 2018
2. "Introduction to Electromagnetic Fields and Waves" by Dale Corson, Paul Lorrain, Literary Licensing, LLC, 2013.

REFERENCES:

1. "Human Exposure to Electromagnetic Fields: From Extremely Low Frequency (ELF) to Radiofrequency" by Patrick Staebler, John Wiley & Sons, 2017.
2. "Non-ionizing Radiation Protection: Summary of Research and Policy Options" by Andrew W. Wood, Ken Karipidis, John Wiley & Sons, 2017.
3. "Practical Radiation Protection in Healthcare" by Colin J. Martin, David G. Sutton, Oxford University Press, 2015.
4. "Epidemiology of Electromagnetic Fields" by Martin Roosli, 1st Edition, CRC Press, 2014.
5. "Biological Effects of Electromagnetic Fields: Mechanisms, Modeling, Biological Effects, Therapeutic Effects, International Standards, Exposure Criteria" by Peter Stavroulakis, Springer Science & Business Media, 2014.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
3	3	-	-	-	-	-	-	-	-	-	-	-	1	-
4	3	-	-	-	-	-	-	-	-	-	-	-	1	-
5	3	-	-	-	-	-	-	-	-	-	-	-	1	-
6	3	-	-	-	-	-	-	-	-	-	-	-	1	-
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	1	-

1-low, 2-medium, 3-high

COURSE CODE	ADVANCED ANTENNA TECHNOLOGY	L	T	P	C
		3	0	0	3

MODULE I LENS ANTENNA **9**

Artificial dielectric lens antenna - Luneburg & Einstein lenses - electrically & physically small antenna - ground plane antenna - sleeve antenna - turnstile antenna - submerged antenna, surface wave & leaky wave antenna - weather-vane antenna

MODULE II SMART ANTENNAS **9**

Antenna arrays - Antenna classification - Diversity techniques - Introduction - Need for smart antennas - Overview - Smart antenna configurations - Space Division Multiple Access - Architecture of a smart antenna system - Mutual coupling effects

MODULE III MOBILE SATELLITE ANTENNAS **9**

Introduction - system requirements for vehicle antennas - omnidirectional antennas for mobile satellite communication - directional antennas for mobile satellite communication - antenna systems for GPS - Multiband antennas for future GPS/ITS services - Satellite constellation systems and antenna requirements

MODULE IV MOBILE HANDESET ANTENNAS **9**

Review of antenna basic parameters - Frequency bands for commercial applications - Cellular handset antenna design issues -Helical wire antennas and variants - Evolution of the PIFA - Ceramic chip and resonator antennas - SAR measurement and minimization - Provision for GPS and Bluetooth

MODULE V SPECIAL ANTENNAS **9**

Principle of frequency independent antennas –Spiral antenna, Helical antenna, Log periodic-Reconfigurable antenna, Active antenna, Dielectric antennas - flagpote antenna - chimney antenna - ILS antenna - sugar-scoop antenna - asteroid detection antenna - embedded antenna - plasma antenna

COURSE OUTCOMES

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

CO1: infer the radiation characteristics of various lens and smart antennas
CO2: interpret design constraints of lens antennas for different application
CO3: interpret the significance of smart antenna, its configuration and architecture
CO4: infer the basic concept of mobile satellite antennas in satellite communication
CO5: identify the suitable mobile antenna for satellite & commercial communication, GPS, bluetooth and SAR minimization
CO6: apply the principles of the radiation mechanism to determine the radiation parameters for mobile and special antennas

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Advanced Antenna Technology" by Clarricoats PJB, 2nd Edition, Microwave Exhibitions and Publishers, 2018.
2. "Introduction to Smart Antennas" by Constantine A. Balanis, Panayiotis I. Ioannides, 1st Edition, Morgan & Claypool Publishers, 2007.

REFERENCES:

1. "Antennas for Portable Devices" by Zhi Ning Chen, 1st Edition, John Wiley & Sons, 2007.
2. "Mobile Antenna Systems Handbook" by Kyohei Fujimoto, 3rd Edition, Artech House, 2008.
3. "Antennas for All Applications" by John D. Kraus, Ronald J. Marhefka, Ahmad S. Khan, 3rd Edition, John Wiley and Sons, 2002.
4. "Smart Antennas for Wireless Communications" by Frank Gross, 1st Edition, McGraw-Hill, 2005.
5. "Broadband Microstrip Antennas" by Girish Kumar, K. P. Ray, Artech House Inc., 2003.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	1	-
2	3	-	-	-	-	-	-	-	-	-	-	-	1	-
3	3	-	-	-	-	-	-	-	-	-	-	-	1	-
4	3	-	-	-	-	-	-	-	-	-	-	-	1	-
5	3	-	-	-	-	-	-	-	-	-	-	-	1	-
6	3	-	-	-	-	-	-	-	-	-	-	-	1	-
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	1	-

1-low, 2-medium, 3-high

COURSE CODE	MACHINE LEARNING ALGORITHMS	L	T	P	C
		3	0	0	3

MODULE I LEARNING MODELS **9**

Machine Learning – Unsupervised Learning- Reinforcement Learning - Supervised Learning- Applications of Machine learning- Modelling and Evaluation: Training a model- Model Representation and Interpretation- Evaluating & Improving Performance of a Model.

MODULE II BAYESIAN DECISION THEORY AND UNSUPERVISED LEARNING **9**

Bayes' Theorem - Losses and Risks - Discriminant Functions - Association Rules- Unsupervised Learning- Clustering: k-means Clustering Algorithm- Centroid-based clustering- Gaussian distribution- DBSCAN- Hierarchical clustering- Fuzzy clustering

MODULE III SUPERVISED LEARNING: CLASSIFICATION & REGRESSION **9**

Classification Algorithms: k- Nearest Neighbour- Decision tree- Random Forest model- Support Vector Machine- Regression Algorithms: Linear regression- Multiple linear regression- Improving Accuracy in Linear Regression Model- Logistic Regression- Maximum Likelihood Estimation

MODULE IV FEATURE TRANSFORMATION AND SUBSET SELECTION **9**

Feature Construction- Feature Extraction- Principal Component Analysis- Singular Value Decomposition- Linear Discriminant Analysis- Feature Subset selection– Feature Selection: Relevance and Redundancy- Selection Process- Feature Selection Approaches

MODULE V ML APPLICATION **9**

Machine Learning Algorithms and their Applications in Image Recognition- Speech Recognition- Self-Driving cars- Image Segmentation- Natural Language Processing

COURSE OUTCOMES

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

CO1: interpret machine learning models with a focus on training, representation, and performance evaluation.
CO2: apply clustering methods to learn the parameters from data and predict uncertain probabilities.
CO3: model machine learning algorithms with associated mathematical foundations in solving real-world problems.
CO4: summarize supervised learning algorithms for classification and regression models.
CO5: explain various methods for feature selection in real-time applications.
CO6: apply appropriate machine learning algorithms for both classification and regression applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Introduction to Machine Learning" by Ethem Alpaydin, 4th Edition, The MIT Press, April 2020.
2. "Machine Learning" by Tom M. Mitchell, 1st Edition, McGraw-Hill Private Limited, 2017.

REFERENCES:

1. "Machine Learning" by Saikat Dutt, Subramanian Chandramouli, Amit Kumar Das, Pearson India Education Services Pvt. Ltd, 2021.
2. "Mathematics for Machine Learning" by Marc Peter Deisenroth, Aldo Faisal, Cheng Soon Ong, Cambridge University Press, April 2020.
3. "Foundations of Machine Learning" by Mehryar Mohri, Afshin Rostamizadeh, Ameet Talwalkar, 2nd

Edition, MIT Press, 2019.
4. "Machine Learning Algorithms" by Giuseppe Bonaccorso, Packt Publishing, July 2017.
5. "Machine Learning: An Algorithmic Perspective" by Stephen Marsland, 2nd Edition, Chapman Hall/CRC, 2015.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	-	-	-	-	-	-	-	-	-	-	-	2
2	3	2	-	-	-	-	-	-	-	-	-	-	-	2
3	3	2	-	-	-	-	-	-	-	-	-	-	-	2
4	3	2	-	-	-	-	-	-	-	-	-	-	-	2
5	3	2	1	-	-	-	-	-	-	-	-	-	-	2
6	3	2	2	1	-	-	-	-	-	-	-	-	-	2
Avg.	3	2	1.5	1	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	DEEP LEARNING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION **9**

Motivation for deep learning - Machine learning Basics: Learning algorithms - Overfitting - Underfitting - Hyper parameters Estimators - Validation - Maximum Likelihood estimation - Bayesian Statistics - Challenges in Machine Learning

MODULE II DEEP LEARNING NETWORKS **9**

Gradient based learning - Hidden Units - Architectural design - Back - propagation for MLP - Regularization - Parameter Regularization - Data Augmentation - Dropout - Optimization algorithms - Adaptive learning rates

MODULE III CONVOLUTIONAL NEURAL NETWORKS **9**

Architecture - Pooling - Convolution and its variants - CNN for Image Recognition

MODULE IV SEQUENCE MODELING **9**

Recurrent Neural Networks (RNN) - Bi-directional RNN, Encoder Decoder Architecture - Recursive Nets - LSTM-Gated RNN - RNN for Sentiment Analysis

MODULE V DEEP LEARNING MODELS **9**

Auto encoders - Deep Boltzmann Machine - Deep Belief Networks - Architecture - Greedy Learning - Speech Processing and Recognition using DBN

COURSE OUTCOMES

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

CO1: explain the basics of machine learning, including hyper parameters and statistical methods, and gain proficiency in deep learning network design and optimization techniques
CO2: summarize the basic concepts and challenges in machine learning and deep learning algorithms
CO3: interpret on various parameters and optimization algorithms in deep learning networks
CO4: explore the architecture and applications of different neural networks
CO5: apply sequence modeling techniques and deep learning models, focusing on sentiment analysis and speech recognition applications
CO6: develop skills to design and implement convolutional neural networks for image recognition and deep learning models for speech processing applications

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Deep Learning" by Ian Goodfellow, Yoshua Bengio, Aaron Courville, 1st Edition, MIT Press, USA, 2016.
2. "Deep Learning: A Practitioner's Approach" by Adam Gibson, Josh Patterson, 1st Edition, O'Reilly, USA, 2016.

REFERENCES:

1. "Deep Learning: Practical Neural Networks with Java" by Yusuke Sugomori, 1st Edition, Packt Publisher, New York, 2016.
2. "Artificial Intelligence for Humans: Deep Learning and Neural Networks" by Jeff Heaton, 1st Edition, Lightning Source Inc, Tennessee, 2015.
3. "Neural Networks and Learning Machines" by Simon Haykin, 3rd Edition, Pearson Prentice Hall, 2009.

4. "Deep Learning with Python" by Francois Chollet, 1st Edition, Manning Publications, 2012.
5. "Deep Learning" by John D. Kelleher, 1st Edition, The MIT Press, 2019.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	2	-	-	-	-	-	-	-	-	-	-	2
2	3	-	2	-	-	-	-	-	-	-	-	-	-	2
3	3	-	2	-	-	-	-	-	-	-	-	-	-	2
4	3	-	2	-	-	-	-	-	-	-	-	-	-	2
5	3	-	2	-	-	-	-	-	-	-	-	-	-	2
6	3	-	2	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	2	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3

MODULE I INTELLIGENT AGENTS **9**

Artificial Intelligence - The state of art - Intelligent Agents - Rationality - Nature of Environments – Structure of Agents – Example Introduction to AI – Agents and Environments – concept of rationality – nature of environments – structure of agents. Problem solving agents – search algorithms – uninformed search strategies.

MODULE II PROBLEM SOLVING AGENTS **9**

Heuristic search strategies – heuristic functions. Local search and optimization problems – local search in continuous space – search with non-deterministic actions – search in partially observable environments – online search agents and unknown environments pruning

MODULE III GAME PLAYING AND CONSTRAINT SATISFACTION PROBLEMS **9**

Game theory – optimal decisions in games – alpha-beta search – monte-carlo tree search – stochastic games – partially observable games. Constraint satisfaction problems – constraint propagation – backtracking search for CSP – local search for CSP – structure of CSP

MODULE IV LOGICAL REASONING **9**

Knowledge-based agents – propositional logic – propositional theorem proving – propositional model checking – agents based on propositional logic. First-order logic – syntax and semantics – knowledge representation and engineering – inferences in first-order logic – forward chaining – backward chaining – resolution

MODULE V PROBABILISTIC REASONING **9**

Acting under uncertainty – Bayesian inference – naïve Bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks

COURSE OUTCOMES

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

CO1: interpret the basics of artificial intelligence with examples
CO2: develop search algorithms to find the solution for optimal decisions
CO3: apply game playing and constraint satisfaction problems techniques
CO4: explain the knowledge representation and reasoning in AI
CO5: apply mathematical concepts to build AI networks
CO6: develop algorithms for AI planning

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Artificial Intelligence – A Modern Approach" by Stuart J. Russell and Peter Norvig, 3rd Edition, Prentice Hall of India, Pearson Education, New Delhi, 2021.
2. "Artificial Intelligence" by Elaine Rich, Kevin Knight, and Shivashankar B. Nair, 3rd Edition, Tata McGraw Hill Publishing Company, New Delhi, 2019.

REFERENCES:

1. "Artificial Intelligence: Structures and Strategies for Complex Problem Solving" by George F. Luger, 6th Edition, Pearson Education, New Delhi, 2021.
2. "Artificial Intelligence: Concepts and Applications" by Lavika Goel, Wiley, 2021.

3. "Practical Explainable AI Using Python: Artificial Intelligence Model Explanations Using Python-based Libraries, Extensions, and Frameworks" by Pradeepta Mishra, Apress, 2021.
4. "A First Course in Artificial Intelligence" by Deepak Khemani, McGraw Hill Education, New Delhi, 2017.
5. "Artificial Intelligence For Dummies" by John Paul Mueller, Wiley, 2018.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	2	-	-	-	-	-	-	-	-	-	-	2
2	3	-	2	-	-	-	-	-	-	-	-	-	-	2
3	3	-	2	-	-	-	-	-	-	-	-	-	-	2
4	3	-	2	-	-	-	-	-	-	-	-	-	-	2
5	3	-	2	-	-	-	-	-	-	-	-	-	-	2
6	3	-	2	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	2	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	CYBER SECURITY	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO NUMBER THEORY 9

Finite Fields and Number Theory: Modular arithmetic, Euclidian Algorithm, Primality Testing: Fermats and Eulers theorem, Chinese Reminder theorem, Discrete Logarithms

Finite Fields and Number Theory: Modular arithmetic - Euclidian Algorithm - Primality Testing: Fermats and Eulers theorem - Chinese Reminder theorem - Discrete Logarithms

MODULE II CRYPTOGRAPHIC TECHNIQUES 9

Symmetric key cryptographic techniques: Introduction to Stream cipher - Block cipher: DES, AES,IDEA - Asymmetric key cryptographic techniques: principles, RSA, ElGamal, Elliptic Curve cryptography - Key distribution and Key exchange protocols

MODULE III INTEGRITY AND AUTHENTICATION 9

Hash functions - Secure Hash Algorithm (SHA) - Message Authentication - Message Authentication Code (MAC) - Digital Signature Algorithm: RSA ElGamal

MODULE IV CYBERCRIMES AND CYBER OFFENSES 9

Classification of cybercrimes - planning of attacks - Social engineering: Human based - Computer based – Cyberstalking - Cybercafe and Cybercrime

MODULE V CYBER THREATS, ATTACKS AND PREVENTION 9

Phishing - Password cracking - Keyloggers and Spywares - DoS and DDoS attacks - SQL Injection Identity Theft (ID) : Types of identity theft, Techniques of ID theft

COURSE OUTCOMES

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

CO1: relate the concepts of number theory and cryptographic techniques
CO2: interpret the basic principle of number theory
CO3: interpret the various cryptographic techniques used for authentication
CO4: categorize the various algorithms used for integrity and authentication of a system
CO5: classify various cybercrimes and offenses related to social engineering
CO6: interpret data related to the damage caused by various attacks, cybercrimes, threats, social engineering cyber offences and prevention

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Cryptography and Network Security" by William Stallings, 7th Edition, Pearson Education, 2016.
2. "Cyber Security, Understanding Cybercrimes, Computer Forensics and Legal Perspectives" by Nina Godbole, Sunit Belapure, Wiley Publications, Reprint 2016.

REFERENCES:

1. "Cybersecurity for Dummies" by Brian Underdahl, Wiley, 2011.
2. "Cryptography and Network Security" by Behrouz A. Forouzan, Debdeep Mukhopadhyay, 2nd Edition, McGraw Hill Education, 2011.
3. "Cryptography and Network Security" by Atul Kahate, 3rd Edition, McGraw-Hill Education, 2013.
4. "Network Security: Current Status and Future Directions" by Christos Douligeris, Dimitrios N. Serpanos, John Wiley, 2007.

5. "Information Security-Principles and Practices" by Mark Merkow, 2nd Edition, Pearson Education, 2014.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	OPERATING SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I OPERATING SYSTEM OVERVIEW 9

Objectives and functions of OS - Evolution of OS - Operating system components - Interrupts - System call - Virtual Machines - Symmetric Multiprocessing - Microkernel

MODULE II PROCESS DESCRIPTION AND CONTROL 9

Process - Process states - Process description - Process control -Processes and Threads - Uniprocessor Scheduling: Types of Processor Scheduling - Scheduling Algorithms

MODULE III MUTUAL EXCLUSION AND SYNCHRONIZATION 9

Principles of concurrency - Mutual exclusion: Hardware approaches – Semaphores - Monitors – Message Passing- Readers/Writers problem. Deadlock and Starvation: Principles of deadlock - Deadlock Prevention - Deadlock Detection - Deadlock Avoidance

MODULE IV MEMORY MANAGEMENT 9

Memory management requirements - Memory partitioning - Paging - Segmentation. Virtual Memory: Hardware and control structures - Operating Systems software: Fetch policy, Placement Policy, Replacement policy algorithms, cleaning policy

MODULE V I/O MANAGEMENT AND FILE MANAGEMENT 9

I/O devices - Organization of I/O function - OS design issues - I/O buffering - Disk scheduling. File management: Overview - File organization and access - File directories - File sharing - Record blocking- Secondary storage management

COURSE OUTCOMES

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

CO1: interpret the concepts of operating systems and apply scheduling algorithms for process management.
CO2: infer the basic functionalities and components of operating systems, various types of operating system and system software.
CO3: apply suitable scheduling algorithms for resource sharing and synchronization
CO4: apply principles of mutual exclusion and synchronization techniques for process execution.
CO5: interpret the concepts of i/o and file management techniques
CO6: infer the performance of an operating system using memory, file and i/o management techniques

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Operating Systems Internals and Design Principles" by William Stallings, Pearson Education, Ninth Edition, 2019.
2. "Operating System Concepts" by Silberchatz, Galvin, Gagne, John Wiley, Tenth Edition, 2018.

REFERENCES:

1. "Operating Systems" by Harvey M. Deitel, Paul J. Deitel, David R. Choffnes, Pearson Education, Third Edition, 2007.
2. "Operating System" by Gary Nutt, Addison Wesley, USA, 2009.
3. "Modern Operating Systems" by Andrew S. Tanenbaum and Herbert Bos, Prentice Hall of India, Fourth Edition, 2015.

4. "Operating System: A Concept Based Approach" by Dhananjay M. Dhamdhere, McGraw Hill Publication, Third Edition, 2017.
5. "Understanding Operating Systems" by Ann McIver McHoes, Ida M. Flynn, Cengage Learning India Pvt Ltd, USA, 2017.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	RELATIONAL DATABASE MANAGEMENT SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I BASIC CONCEPTS **11**

Introduction to databases - Characteristics of database approach - Advantages of using DBMS-Database concept and architecture - Data Abstraction - Data Models - Instances and Schema - Data Independence - Schema Architecture- Conceptual modeling: Entities, attributes, relationships -associations- roles and structural constraints - Weak and Strong entity types Design of Entity Relationship data models (ERD) - Enhanced ER model: - Specialization and Generalization-constraints-Aggregation-Applications

MODULE II RELATIONAL MODEL **11**

Introduction to Relational Data Model Basic concepts Enforcing data Integrity constraints - Relational Algebra: Unary Relational Operations, Set theory Operations Binary relational operations-additional operations- Queries using relational algebra. FILE ORGANIZATION: Storage device characteristics - Operations on file - Serial files - Sequential files - Index sequential files - Direct files - Indexing.

MODULE III SQL PROGRAMMING **11**

Introduction to Structured Query Language (SQL) - datatypes- Data definition Language-, Constructing database, Manipulations on database - Basic data retrieval operations - Advanced Queries in SQL - Functions in SQL - Aggregation - Categorization - Updates in SQL - Views in SQL.

MODULE IV DATA BASE DESIGN THEORY **6**

Data base design process - Relational Database Design - Relation Schema - Anomalies in a database - Functional dependencies - Axioms - Normal forms based on primary keys - Second Normal form. Third Normal form, Boyce - Codd Normal form - Examples - Conversion of ERD into tables

MODULE V DATABASE SECURITY AND INTEGRITY CONTROL **6**

Security and Integrity threats - Defense mechanisms - Transaction and concurrency control mechanisms

COURSE OUTCOMES

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

- **CO1:** explain the database fundamentals, including data models, ERD design, and relational models, and gain knowledge in data integrity, relational algebra, and various file organization methods
- **CO2:** interpret the basic concepts, characteristics, advantages and architectures of database management systems
- **CO3:** infer the relational data model, relational algebra and file organisation techniques for effective data management and querying
- **CO4:** develop SQL programming for effective database manipulation
- **CO5:** develop skills in relational database design, normalization, and security and integrity control
- **CO6:** build proficiency in SQL programming, database design theory including normalization, and learn to manage database security, integrity and concurrency

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Database System Concepts" by Silberschatz A, Korth H, Sudarshan S, 6th Edition, Tata McGraw Hill, 2013.
2. "Fundamentals of Database Systems" by Elmasri R, Navathe S B, 7th Edition, Pearson Education, 2016.

REFERENCES:

1. "An Introduction to Database Systems" by Date C J, Kannan A, Swamynathan S, 8th Edition, Pearson Education, 2006.
2. "Database Management System" by Raghu Ramakrishnan, Johannes Gehrke, 3rd Edition, Tata McGraw Hill, 2007.
3. "Oracle 12c: The Complete Reference" by Bob Bryla, Kevin Loney, Oracle Press, 2014.
4. "Computer Fundamentals and RDBMS" by Smita Vaze, Subhalaxmi Joshi, epub, Himalaya Publication House, 2010.
5. "Database Management Systems" by Gerald V. Post, 2nd Edition, McGraw-Hill Irwin, 2002.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	2	-	-	-	-	-	-	-	-	-	-	2
2	3	-	2	-	-	-	-	-	-	-	-	-	-	2
3	3	-	2	-	-	-	-	-	-	-	-	-	-	2
4	3	-	2	-	-	-	-	-	-	-	-	-	-	2
5	3	-	2	-	-	-	-	-	-	-	-	-	-	2
6	3	-	2	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	2	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	JAVA PROGRAMMING	L	T	P	C
		3	0	0	3

MODULE I OBJECT-ORIENTED PROGRAMMING AND JAVA 9

Object Oriented Paradigm, Object Oriented Programming concepts, Java History – Java features – Java Environment – JDK – API, Java program structure – Java Tokens- Java Virtual Machine (JVM) – Command Line Arguments.

MODULE II JAVA PROGRAMMING ELEMENTS 9

Constants – Variables – Data types - Scope of variables – Type casting – Types of operators – Expressions – Evaluation of Expressions, Decision making and branching statements- Decision making and Looping– break – labeled loop – continue Statement. Arrays: One Dimensional Array – Creating an array – Array processing – Multidimensional Array – Vectors – ArrayList.

MODULE III CLASS AND OBJECTS 9

Defining a class – Methods – Creating objects – Accessing class members – Constructors – Method overloading – Static members –Nesting of Methods – this keyword – Command line input. Inheritance: Defining inheritance –types of inheritance– Overriding methods – Final variables and methods – Final classes – Final methods - Abstract methods and classes – Visibility Control- Interfaces: Defining interface – Extending interface - Implementing Interface - Accessing interface variables. Strings: String Array – String Methods – String Buffer Class

MODULE IV JAVA PACKAGES 9

Java API Packages – System Packages – Naming Conventions –Creating & Accessing a Package – Adding Class to a Package – Hiding Classes. Exception Handling: Limitations of Error handling – Advantages of Exception Handling - Types of Errors – Basics of Exception Handling – try blocks – throwing an exception – catching an exception – finally statement. Multithreading: Creating Threads – Life of a Thread – Defining & Running Thread – Thread Methods – Thread Priority – Synchronization – Implementing Runnable interface – Thread Scheduling

MODULE V I/O STREAMS 9

File – Streams – Advantages - The stream classes – Byte streams –Character streams. Applets: Applet Life cycle – Creating & Executing an Applet –Applet tags in HTML – Parameter tag – Aligning the display - Graphics Class: Drawing and filling lines – Rectangles – Polygon – Circles – Arcs – Line Graphs – Drawing Bar charts AWT Components and Even Handlers: Abstract window tool kit – Event Handlers – Event Listeners – AWT Controls and Event Handling: Labels – Text Component – Action Event – Buttons – Check Boxes – Item Event – Choice– Scrollbars – Layout

COURSE OUTCOMES

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

- **CO1:** interpret the principles of Object-Oriented Programming and use fundamental programming elements for Java programming.
- **CO2:** interpret Object-Oriented Programming principles and exhibit proficiency in utilizing the Java Environment, JDK, API, and Command Line Arguments.
- **CO3:** develop Java programs using fundamental programming elements like constants, variables, data types, operators, expressions, and decision-making structures.
- **CO4:** develop proficiency in class and object creation, method implementation, inheritance, interfaces, and manipulation of strings within Java programming.
- **CO5:** apply Java API Packages to computing and effectively manage classes within packages.

CO6: develop Java programs using classes and objects, Java API Packages, and I/O Streams.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Java: The Complete Reference" by Herbert Schildt, 9th Edition, Tata McGraw Hill, 2017.
2. "Programming with Java" by E. Balagurusamy, 3rd Edition, Tata McGraw Hill, 2014.

REFERENCES:

1. "Core Java: Volume I – Fundamentals" by Cay S. Horstmann and Gary Cornell, 8th Edition, Sun Microsystems Press, 2008.
2. "The JAVA Programming Language" by K. Arnold and J. Gosling, 3rd Edition, Pearson Education, 2000.
3. "Understanding Object-oriented Programming with Java" by Timothy Budd, Pearson Education, 2000.
4. "An Introduction to Object-oriented Programming with Java" by C. Thomas Wu, 4th Edition, Tata McGraw-Hill Publishing Company Ltd., 2006.
5. "Internet and WWW How to Program" by Paul Deitel, Harvey Deitel, Abbey Deitel, 5th Edition, Tata McGraw Hill, 2011.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	2	-	-	-	-	-	-	-	-	-	-	2
2	3	-	2	-	-	-	-	-	-	-	-	-	-	2
3	3	-	2	-	-	-	-	-	-	-	-	-	-	2
4	3	-	2	-	-	-	-	-	-	-	-	-	-	2
5	3	-	2	-	-	-	-	-	-	-	-	-	-	2
6	3	-	2	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	2	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	INTEL COLLABORATED COURSE: INTRODUCTION TO MACHINE LEARNING	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO MACHINE LEARNING AND TOOLS

Classify the type of problem to be solved - Demonstrate supervised learning algorithms - Choose an algorithm- tune parameters- and validate a model - Explain key concepts like under- and over-fitting- regularization- and cross-validation. - Apply Intel Extension for Scikit-learn* patching to leverage underlying compute capabilities of hardware

MODULE II SUPERVISED LEARNING AND ALGORITHMS

Explain supervised learning as applied to regression and classification problems - Apply K-Nearest Neighbor (KNN) algorithm for classification - Apply patching to leverage underlying compute capabilities of hardware

MODULE III TRAIN TEST SPLITS VALIDATION LINEAR REGRESSION

Explain the difference between over-fitting and under-fitting - Describe Bias-variance tradeoffs - Find the optimal training and test data set splits - Apply cross-validation - Apply a linear regression model for supervised learning - Apply Intel® Extension for Scikit-learn* to leverage underlying compute capabilities of hardware

MODULE IV REGULARIZATION AND GRADIENT DESCENT

Explain cost functions- regularization- feature selection- and hyper-parameters - Summarize complex statistical optimization algorithms like gradient descent and its application to linear regression - Apply patching to leverage underlying compute capabilities of hardware

MODULE V LOGISTIC REGRESSION AND CLASSIFICATION ERROR METRICS

Describe Logistic regression and how it differs from linear regression - Identify metrics for classification errors and scenarios in which they can be used - Apply patching to leverage underlying compute capabilities of hardware

MODULE VI SVM AND KERNELS

Apply support vector machines (SVMs) for classification problems - Recognize SVM similarity to logistic regression - Compute the cost function of SVMs - Apply regularization in SVMs and some tips to obtain non-linear classifications with SVMs - Apply patching to leverage underlying compute capabilities of hardware

MODULE VII DECISION TREES

Recognize Decision trees and apply them for classification problems - Recognize how to identify the best split and the factors for splitting - Explain strengths and weaknesses of decision trees - Explain how regression trees help with classifying continuous values - Describe motivation for choosing Random Forest Classifier over Decision Trees - Apply patching to Random Forest Classifier

MODULE VIII BAGGING

Describe bootstrapping and aggregating (aka “bagging”) to reduce variance - Reduce the correlation seen in bagging using Random Forest algorithm - Apply patching to leverage underlying compute capabilities of hardware

MODULE IX BOOSTING AND STACKING

Explain how the boosting algorithm helps reduce variance and bias. - Apply patching to leverage underlying compute capabilities of hardware

MODULE X INTRODUCTION TO UNSUPERVISED LEARNING AND CLUSTERING METHODS

Describe unsupervised learning algorithms their application - Apply clustering - Apply dimensionality reduction - Apply patching to leverage underlying compute capabilities of hardware

MODULE XI DIMENSIONALITY REDUCTION AND ADVANCED TOPICS

Explain and Apply Principal Component Analysis (PCA) - Explain Multidimensional Scaling (MDS) - Apply patching to leverage underlying compute capabilities of hardware

COURSE OUTCOMES

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

CO1: classify various types of machine learning problems and gain knowledge in applying appropriate supervised learning algorithms and tuning models

CO2: apply supervised learning techniques to both regression and classification problems, including the use of K-Nearest Neighbor (KNN) algorithms

CO3: apply linear regression, manage bias-variance tradeoffs, and use cross-validation to optimize regression models for accuracy and efficiency

CO4: utilize advanced classification methods such as SVMs and Decision Trees, understanding their applications and effectiveness in real-world situations

CO5: use ensemble learning techniques, like bagging and boosting, to enhance model performance and reduce prediction errors.

CO6: explore and implement unsupervised learning algorithms, applying clustering and dimensionality reduction methods to analyze and interpret complex datasets.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Machine Learning with oneAPI" by Shriram K. Vasudevan, Nitin Vamsi Dantu, Sini Raj Pulari, T.S. Murugesh, 1st Edition, CRC Press, 2023, ISBN 9781003393122.

REFERENCES:

1. Console.cloud.intel.com (Training and resources, Machine Learning with oneAPI)
2. Git code repos - https://github.com/IntelSoftware/Machine-Learning-using-oneAPI
3. Home page - https://www.intel.com/content/www/us/en/developer/tools/oneapi/training/machine-learning-using-oneapi.html

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	2	-	-	-	-	-	-	-	-	-	-	2
2	3	-	2	-	-	-	-	-	-	-	-	-	-	2
3	3	-	2	-	-	-	-	-	-	-	-	-	-	2
4	3	-	1	-	-	-	-	-	-	-	-	-	-	2
5	3	-	1	-	-	-	-	-	-	-	-	-	-	2
6	3	-	1	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	1.5	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

OPEN ELECTIVE COURSES

COURSE CODE	SIGNAL PROCESSING AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

MODULE I SPECTRAL ANALYSIS **9**

DFT-Properties of DFT- Linear convolution using DFT - FFT and structures-Decimation in time-Decimation in Frequency – Periodogram Averaging – Parametric spectrum analysis – Wavelet Analysis.

MODULE II IIR AND FIR DIGITAL FILTER DESIGN **9**

Design of IIR filters - Structure of IIR Systems - Direct, Cascade and Parallel form structures - Design of Linear Phase FIR Filters using Windows and Frequency Sampling Method - Structure of FIR Systems-linear phase structures- Noise reduction and Two-band digital crossover

MODULE III SIGNAL PROCESSING IN COMMUNICATION RECEIVER **9**

Temporal Equalization-Space Time Equalization-Frequency Domain Equalization-Symbol Timing Recovery- Channel Quality Estimation- Automatic Frequency Control-Overall Receiver Block.

MODULE IV ERROR CORRECTING CODES & CHANNEL CODING **9**

Error Correcting codes-Error Correction-Linear Blocks Codes-Cyclic Codes- Bose, Chaudhari and Hocquenghem Codes-Convolution Codes-Viterbi Decoding-Interleaving Codes-Concatenated Codes-Turbo Codes.

MODULE V SPEECH CODING **9**

Speech Coding-Adaptive Predictive Coding-Sub Band Coding,-Vocoders-Liner Predictive Coding- Image Coding-Joint Photo Graphic Expert Group (JPEG)-Moving Pictures Expert Group (MPEG), the layer-3 of MPEG-1 Algorithms(MP3),Lempel- ZIV Algorithms - Recognition techniques: Speech Recognition and Image recognition.

COURSE OUTCOMES

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

CO1: apply Discrete Fourier Transform (DFT) to analyze the signal in frequency domain.

CO2: design IIR and FIR digital filters and apply for various signal processing applications.

CO3: examine different equalization techniques and assess their respective performances.

CO4: calculate channel capacity using Shannon's channel capacity theorem and develop channel error control codes.

CO5: interpret speech processing methods in time and frequency domain and design codec methods for speech compression techniques.

CO6: interpret signals in frequency domain using DFT and design IIR and FIR digital filters for a wide range of signal processing applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Digital Signal Processing Principles, Algorithms and Applications" by John G. Proakis and Dimitris G. Manolaki, 5th EditionPearson Education, 2022.
2. "Digital Signal Processing and Applications" by Day Stranneby and William Walker,2nd Edition, Elsevier Publications, 2013.

REFERENCES:

1. "Discrete-Time Signal Processing" by V. Oppenheim, R. W. Shafer, and J.R. Buck,3rd Edition,

Pearson Education, 2011.
2. "Digital Signal Processing: Fundamentals and Applications" by Lizhe Tan and Jean Jiang,2nd Edition, Elsevier, 2013.
3. "Digital Communications Systems" by Simon Haykin, 1st Edition, Wiley, 2013.
4. "Digital Processing of Speech signals" by L.R. Rabiner and R.W. Schaffer,1st Edition, Prentice Hall, 1978.
5. "Signal Processing and Its Applications" by Nirmal K. Bose and Calyampudi Radhakrishna Rao, 1st Edition, Elsevier Science, 1993

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	1						1	1			3	
2	3	2	1						1	1			3	
3	3	2	1						1	1			3	
4	3	2	1						1	1			3	
5	3	2	1						1	1			3	
6	3	2	1						1	1			3	
Avg.	3	2	1						1	1			3	

1-low, 2-medium, 3-high

COURSE CODE	SMART SENSORS AND IoT	L	T	P	C
		3	0	0	3

MODULE I SENSORS BASICS 9

Sensor Classification, Performance and Types, Error Analysis characteristics- Semiconductor Packaging- Hybrid Packaging- Packaging for Monolithic Sensors- Reliability Implications-Testing Smart Sensors- HVAC Sensor Chip- Amplification and Signal Conditioning- Integrated Signal Conditioning- Digital conversion- MCU Control-MCUs for Sensor Interface- Techniques and System Considerations- Sensor Integration.

MODULE II ELECTRONIC SENSORS 9

Resistance strain gauge - piezoelectric pressure gauge - characteristics- load cells-torque sensor- Piezo-resistive sensor- optoelectronic pressure sensors- vacuum sensors- LVDT- - liquid level detectors-flow sensors - ultrasonic sensor- - Electronic and Optical properties of semiconductor as sensors – LED - Semiconductor lasers- Fiber optic sensors- Thermal detectors - photoconductive detectors- Photo diodes- Avalanche photodiodes - Intensity sensor

MODULE III TEMPERATURE, GAS AND AIR QUALITY SENSORS 9

Bimetallic strip- Bourdon temperature gauge- thermocouples- Resistance thermometers- thermistors- bolometer- Pyroelectric detector-Engine combustion process- Catalytic exhaust after treatment, Emission limits- Exhaust sensors and Engine control - Exhaust sensors for OBD- Hydro-Carbon Sensors- NOx-Sensors-Oxygen Sensors- Measurement of oxides of sulphur,oxides of nitrogen unburnt hydrocarbons,carbonmonoxide, dust mist and fog- smoke sensors

MODULE IV SMART SENSORS 9

IoT Definition – Characteristics - IoT Functional Blocks –IoT Architecture –Physical design of IoT – Logical design of IoT- Sensing & Actuation -Basics of Networking - Communication Protocols- Machine-to-Machine - Communication models & APIs.

Domain specific applications of IoT: Smart and Connected Cities: Layered architecture, Smart Lighting, Smart Parking Architecture, Smart Traffic Control and Smart water management

COURSE OUTCOMES

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

CO1: Infer the classification ,types, packaging and testing of smart sensors
CO2: Understand the construction and working principles of Electronic sensors
CO3: Utilize the Electronic sensors for developing IoT based applications.
CO4: Interpret the key concepts of temperature ,gas and airquality sensors used to measure the parameters.
CO5: Interpret the characteristics, functional blocks and architecture of IoT
CO6: Develop application programs to provide solutions for real world problems.

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TOTAL : 45 PERIODS

TEXT BOOKS:

1. " Handbook of modern sensors: physics, designs, and applications " by Jacob Fraden, 5TH Edition, Springer, 2016.
2. " Understanding Smart Sensors " by Randy Frank, 2nd Edition, Artech House, Boston, 2011.

REFERENCES:

1. "Internet of Things – A hands-on approach" by Arshdeep Bahga, Vijay Madisetti, Universities Press, 2015.
2. "Sensor Technology Hand Book" by Jon. S. Wilson, 1st edition, Elsevier, Netherland,2011.
3. "Measurement, Instrumentation and sensor Handbook" by John G Webster, 2nd edition, CRC Press, Florida,2017.
4. "Principles of Measurement systems" by John P. Bentley, 3rd Edition, Pearson Education Asia Pvt. Ltd, 2009.
5. " Sensors and Transducers" by D. Patranabis, 2nd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2006.
6. "Measurement Systems, Application and Design" by Ernest O Doebelin, Dhanesh N Manik, 6th Edition ,McGraw Hill, 2007

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													2
2	3													2
3	3													2
4	3													2
5	2	2												2
6	2	2				2						1		2
Avg.	2.7	2				2						1		2

1-low, 2-medium, 3-high

COURSE CODE	CONSUMER ELECTRONICS	L	T	P	C
		3	0	0	3

MODULE I AUDIO SYSTEMS **9**

Microphones Carbon, moving coil, wireless microphone; Loudspeakers – Direct radiating Electrostatic and horn loudspeaker; multi-speaker system; Sound Recording - Magnetic Recording, Digital Recording, Optical Recording (CD system and DVD).

MODULE II MONOCHROME TV **9**

Elements of TV communication system, scanning process, scanning methods and Aspect Ratio, Need of synchronizing and blanking pulses, Composite Video Signal, Camera Tube: Vidicon.

MODULE III COLOUR TELEVISION **9**

Primary, secondary colours, Concept of Mixing, Colour Triangle, Camera tube, PAL TV Receiver, Concept of Compatibility with Monochrome Receiver, NTSC, PAL, SECAM.

MODULE IV LCD AND LED TELEVISION **9**

Basic principle and working of LCD & LED TV, Cable Television: Working of Cable TV, DTH

MODULE V DOMESTIC & CONSUMER APPLIANCES **9**

Operation of Microwave Oven, Automatic Washing Machine, Photostat Machine, Digital Camera, Vacuum cleaner, Food Processors, Scanner.

COURSE OUTCOMES

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

- **CO1:** describe the audio systems and signal transmission on a monochrome TV.
- **CO2:** describe the types of microphones and loudspeakers.
- **CO3:** describe the composite video signal used in TV signal transmission.
- **CO4:** interpret the scanning process and working principles of colour TV.
- **CO5:** interpret the principles and operation of TV units and home appliances.
- **CO6:** infer the technical considerations using a broad systems perspective in consumer appliances.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Consumer Electronics" by Bali S.P, Pearson Education, 2017.
2. "Audio Video Systems: Principle Practices & Troubleshooting" by Bali R. and Bali S.P., Khanna Book Publishing Co. (P) Ltd., 2010.

REFERENCES:

1. "Modern Television Practices" by Gulati R.R., New Age International Publication (P) Ltd., 2011.
2. "Audio Video Systems" by Gupta R.G., 2nd Edition, Tata McGraw Hill, 2010.
3. "Standard Handbook of Audio Engineering" by Whitaker Jerry and Benson Blair, 3rd Edition, McGraw-Hill Professional, 2010.
4. "The Digital Consumer Technology Handbook" by Amit Dhir, Elsevier Science, 2004.
5. "A Beginner's Guide to Consumer Electronics Repair, Handbook and Tutorial" by Douglas Kinney, iUniverse, 2006.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													2
2	3													2
3	3													2
4	3													2
5	3					2								2
6	3					2								2
Avg.	3					2								2

1-low, 2-medium, 3-high

COURSE CODE	INFORMATION THEORY AND CODING TECHNIQUES	L	T	P	C
		3	0	0	3

MODULE I INFORMATION THEORY AND SCHEMES FOR SOURCE CODING 9

Uncertainty Information and Entropy - Basic Properties of entropy - Information rate - Conditional entropy - Joint Entropy - Mutual Information - Channel capacity of a Gaussian channel

SOURCE CODING : Prefix codes - Necessary conditions for source coding - Kraft Mcmillan Inequality- Huffman Coding- Shannon Fano Coding Efficiency calculations.

MODULE II MEMORYLESS FINITE SCHEMES FOR CHANNEL CODING 9

Discrete Memoryless Channel - Channel models - BSC and BEC channels - Cascaded channels - Channel capacity of discrete and analog channels - Channel capacity of a Gaussian channel-Bandwidth-S/N trade-off-Channel coding theorem - Information capacity theorem - Code rate and redundancy-Parity check codes - Rate Distortion Theory.

MODULE III LINEAR BLOCK CODES AND CYCLIC CODES 9

Rationale for coding - Types of codes - Matrix description of linear block codes - Syndrome decoding - Minimum distance considerations -Repetition codes - Dual codes- Cyclic codes :Generator polynomial - Parity check polynomial - Encoder of cyclic codes - Calculation of syndrome - Cyclic codes for error correction.

MODULE IV CONVOLUTIONAL CODES 9

Convolutional codes : Tree codes- Trellis codes- Viterbi decoding of convolutional codes - Catastrophic Error Propagation in Convolutional Codes -Performance Bounds for Convolutional Codes - Coding Gain - Convolutional Code Trade off - Soft Decision Viterbi Decoding -Feedback Decoding - Sequential Decoding

MODULE V CODING TECHNIQUES IN DATA COMPRESSION 9

Static and Dynamic Huffman coding - Arithmetic coding – Run length encoding- Lempel-Ziv coding – Image compression techniques –JPEG standard for Lossy and Lossless compression- Video compression standards.

COURSE OUTCOMES

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

CO1: Apply fundamental concepts of information theory to analyze and estimate channel's capacity

CO2: Interpret the information content in a discrete memoryless source through parameters such as entropy and mutual information.

CO3: Estimate a channel's capacity based on Shannon's channel capacity theorem

CO4: Interpret the encoding and decoding of linear block codes and cyclic codes

CO5: Apply error control coding methods for random error and burst error detection and correction techniques

CO6: Evaluate different coding techniques for various applications in digital communication

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Fundamentals of Information Theory and Coding Design" by Roberto Togneri, Christopher J.S. DeSilva, CRC Press, 2003.

2. "Information Theory, Coding and Cryptography" by Ranjan Bose, 3rd Edition, Tata McGraw Hill, 2016

REFERENCES:

1. "Applied Coding and Information Theory for Engineers" by Richard B. Wells, 1st Edition Indian Reprint, Pearson Education, 2009.
2. "Introduction to Data Compression" by Khalid Sayood, Fourth Edition, Elsevier, 2012.
3. "Digital Communications: Fundamentals and Applications" by Bernard Sklar, 2nd Edition, Pearson Education, 2009.
4. "Elements of Information Theory" by Thomas M. Cover and Joy A. Thomas, 2nd Edition, John Wiley & Sons, 2006.
5. "An Introduction to Information Theory" by Reza F. M., McGraw Hill, 2000.
6. "Error Correction Coding - Mathematical Methods and Algorithms" by Todd K. Moon, 1st Edition, John Wiley & Sons, 2021.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2											2	
2	3	2											2	
3	3	2											2	
4	3	2											2	
5	3	2											2	
6	3	2											2	
Avg.	3	2											2	

1-low, 2-medium, 3-high

COURSE CODE	AUTOMOTIVE EMBEDDED SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I AUTOMOTIVE SYSTEMS **9**

Overview of Automotive industry - Tools and Processes - Introduction to modern automotive systems - Spark and Compression Ignition Engines - Automotive Transmissions - Vehicle braking fundamentals - Steering Control - Overview of Hybrid Vehicles - Analog and Digital Systems - Basic measurements systems.

MODULE II SENSORS AND ACTUATORS **9**

Sensors: Characteristics, response and modeling - Actuators - Microcontroller and Digital Signal Processors used for automotive applications.

MODULE III EMBEDDED COMMUNICATION **9**

Embedded Automotive Protocols: CAN, LIN, FLEXRAY, MOST. .

MODULE IV SAFETY SYSTEMS **9**

Active Safety Systems: ABS, TCS, ESP, brake assist - Passive Safety Systems: Airbag systems, Advance Driver Assistance system (ADAS) - Computer vision techniques - Connected cars technology - Trends towards Autonomous vehicles. Basic wiring system and Multiplex wiring system

MODULE V DIAGNOSTICS **9**

Self-Diagnostic system - various On board and off board diagnostics in Automobiles - Diagnostics tools - Diagnostics Protocols: KWP20000 and UDS.

COURSE OUTCOMES

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

CO1: develop a basic measurement system & interfacing using sensors, actuators using modern processors for automotive applications.

CO2: infer the engine controls, tools, and measurements for modern automotive systems.

CO3: interpret the automotive applications, and understand the various sensors, actuators, microcontrollers, and digital signal processors.

CO4: identify the embedded communication protocols for automotive systems.

CO5: interpret the safety and diagnostic system in automotive systems.

CO6: identify the various communication protocols, safety and diagnostic system for embedded automotive applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Automotive Electronics Handbook" by Ronald K. Jurgen, 2nd Edition, McGraw-Hill, 1999.
2. "Understanding Automotive Electronics" by William B. Ribbens, Ph.D, 7th Edition, Elsevier Publications, 2012.

REFERENCES:

1. "Advance Automotive Diagnosis" by Tom Denton, 2nd Edition, Elsevier, 2006.
2. "BOSCH Automotive Handbook" by Robert Bosch GmbH, 8th Edition, Bentley Publishers, 2011.

3. "Automobile Electrical and Electronics Systems" by Tom Denton, 3rd Edition, SAE (Society for Automobile Engineers) International, 2004.
4. "Automotive Technology: A Systems Approach" by Jack Erjavec, 5th Edition, Delmar Cengage Learning, 2009.
5. "Automotive Embedded Systems Handbook (Industrial Information Technology)" by Nicolas Navet, Francoise Simonot-Lion, Richard Zurawski, 1st Edition, CRC Press, 2008.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	-	-	-	-	-	-	-	-	2
6	3	-	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	5G TECHNOLOGIES AND APPLICATIONS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO 5G **9**

ITU Standardization Process - Motivation for 5G - 5G targets – Technology components - Spectrum – capabilities - The role of 3GPP in standardization - use cases – 5GPPP (Public-Private Partnership)

MODULE II 5G RADIO ACCESS NETWORK **9**

Radio access – 3GPP Releases – 5G New Radio (NR) – Requirements – 3GPP phases for IMT-2020 - NR air interface – 5G RAN architecture.

MODULE III 5G SERVICES **9**

Enhanced Mobile Broadband (eMBB) systems - Massive Machine Type Communication (MMTC) system - Ultra Reliable and Low Latency Communication (URLLC) systems – Design approaches.

MODULE IV SPECTRUM USAGE AND MANAGEMENT **9**

Spectrum authorization – usage options for 5G – Bandwidth demand – Frequency bands for 5G – Spectrum usage aspects at high frequencies – Spectrum management.

MODULE V EMERGING TECHNOLOGIES IN 5G **9**

Massive MIMO – Network Function Virtualization – Software Defined Networking - Cognitive radio – Millimetre Wave - Heterogeneous network – Internet of Things.

COURSE OUTCOMES

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

CO1: explain the standardization process and use cases of 5G technologies

CO2: infer the development 5G network based on 3GPP standards and explore about RAN architecture

CO3: determine the role of standardization process and spectrum management in 5G and assess the requirements of new radio

CO4: perceive various applications and services offered by 5G technologies

CO5: infer the role of 5G in emerging next generation wireless technologies

CO6: develop applications using 5G technology and evolving wireless technologies

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "5G Mobile Communications Concepts and Technologies" by Saad Asif, CRC Press, 2019.
2. "5G Outlook Innovations and Applications" by Ramjee Prasad, River Publishers, 2022.

REFERENCES:

1. "Rolling out 5G: Use Cases, Applications and Technology Solutions" by Biljana Badic, Christian Drewes, Ingolf Karls, Markus Mueck, Apress, 2016.
2. "5G Technology: 3GPP New Radio" by Antti Toskala, Harri Holma, Takehiro Nakamura, Wiley & Sons Ltd., 2020.
3. "Design and Optimization for 5G Wireless Communications" by Haesik Kim, 1st Edition, Wiley, 2020.
4. "5G for the Connected World" by Devaki Chandramouli, Juho Pirskanen, Rainer Liebhart, 1st Edition, Wiley, 2019.

5. "5G Networks: Fundamental Requirements, Enabling Technologies, and Operations Management" by Anwer Al-Dulaimi, IEEE Press, Wiley, 2018.
6. "5G System Design: Architectural and Functional Considerations and Long Term Research" by Mauro Boldi, Olav Queseth, Patrick Marsch, Ömer Bulakci, 1st Edition, Wiley, 2018."An Introduction to Information Theory" by Reza F. M., McGraw Hill, 2000.
7. "Error Correction Coding - Mathematical Methods and Algorithms" by Todd K. Moon, 1st Edition, John Wiley & Sons, 2021.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2											2	
2	3	2											2	
3	3	2											2	
4	3	2											2	
5	3	2											2	
6	3	2											2	
Avg.	3	2											2	

1-low, 2-medium, 3-high

COURSE CODE	VEHICULAR COMMUNICATION	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO VEHICULAR RADIO NETWORKS 9

Basic principles and challenges-Mobile Wireless Communications and Networks-Need for Vehicular Communications-VANET activities- Network Architecture for Vehicular Communications.

MODULE II PHYSICAL LAYER AND MAC LAYER ROUTING PROTOCOLS 9

Signal Propagation-Doppler spread and its impact on OFDM Systems-Proposed MAC approaches and standards, Intelligent Transportation Systems: IEEE 802.11p-ITS-IVC- Opportunistic packet forwarding.

MODULE III VANET ROUTING 9

Flooding and the 'Broadcast Storm Problem'-Traditional MANET routing-Topology based / table-driven routing protocols- Proactive (DSDV) vs. Reactive / On-demand (DSR, AODV, DYMO) routing protocols-Geographic routing protocols.

MODULE IV VEHICULAR MOBILITY MANAGEMENT 9

Connected Vehicles& Connected Autonomous Vehicles- Dedicated Short Range Communication-flow and traffic models-Standards and Regulations- DSRC Protocol Stack, Cellular V2X

MODULE V EMERGING VANET APPLICATIONS 9

Vehicle to Infrastructure Safety Applications-communication paradigms-message coding and composition-data aggregation- Security and Privacy.

COURSE OUTCOMES

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

CO1: interpret the basic principles, technologies, and system architecture of vehicular ad-hoc networks (VANET)

CO2: examine the physical Layer and MAC Layer routing protocols for vehicular communication

CO3: propose the routing mechanism through efficient VANET network architecture

CO4: Interpret the challenges and issues in establishing cellular V2X connection and mobility management.

CO5: outline vehicular communication platforms for various emerging applications

CO6: interpret the VANET applications through proper mobility, privacy and security management

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "VANET: Vehicular Applications and Inter-Networking Technologies" by H. Hartenstein and K. P. Laberteaux, John Wiley & Sons Ltd., 1st Edition, 2010.
2. "Vehicle Safety Communications: Protocols, Security, and Privacy" by Luca Delgrossi, Tao Zhang, John Wiley & Sons Ltd., 1st Edition, 2012.

REFERENCES:

1. P. H.-J. Chong, I. W.-H. Ho, Vehicular Networks: Applications, Performance Analysis and Challenges, Nova Science Publishers, 2019.
2. C. Sommer, F. Dressler, Vehicular Networking, Cambridge University Press, 2015.
3. Popescu-Zeletin R, Radusch I and Rigani M.A, "Vehicular-2-X Communication",Springer,2010.
4. M. Watfa, Advances in Vehicular Ad-Hoc Networks: Development and Challenges, Information

Science Reference, 2010.
5. H. Moustafa, Y. Zhang, Vehicular Networks: Techniques, Standards, and Applications, CRC Press, 2009.
6. Xiang W, “Wireless Access in Vehicular Environments Technology”, Springer, 2015

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2											1	
2	3	2											1	
3	3	2											1	
4	3	2											1	
5	3	2											1	
6	3	2											1	
Avg.	3	2											1	

1-low, 2-medium, 3-high

VERTICALS-MAJOR

COURSE CODE	SPEECH SIGNALPROCESSING	L	T	P	C
		3	0	0	3

MODULE I MECHANICS OF SPEECH 9

Speech production: Mechanism of speech production, Acoustic phonetics - Digital models for speech signals - Representations of speech waveform: Sampling speech signals, basics of quantization, delta modulation, and Differential PCM.

MODULE II TIME DOMAIN METHODS FOR SPEECH PROCESSING 9

Time domain parameters of Speech signal – Methods for extracting the parameters Energy, Average Magnitude, Zero crossing Rate – Silence Discrimination using ZCR and energy – Short Time Auto Correlation Function – Pitch period estimation using Auto Correlation Function.

MODULE III FREQUENCY DOMAIN ANALYSIS OF SPEECH SIGNALS 9

Short Time Fourier analysis: Fourier transform and linear filtering interpretations, Sampling rates - Spectrographic displays - Pitch and formant extraction - Analysis by Synthesis - Analysis synthesis systems: Phase vocoder, Channel Vocoder - Homomorphic speech analysis: Cepstral analysis of Speech, Formant and Pitch Estimation, Homomorphic Vocoders.

MODULE IV LINEAR PREDICTIVE ANALYSIS OF SPEECH 9

Linear predictive analysis – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin's Recursive algorithm – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP.

MODULE V APPLICATION OF SPEECH PROCESSING 9

Speech Recognition, Speech synthesis, Speech Understanding, Speaker Verification, Speech Enhancement.

COURSE OUTCOMES

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

- **CO1.** interpret the mechanics of speech and perform time domain analysis for different applications in speech processing.
- **CO2.** interpret the complexities of speech production mechanisms, acoustic phonetics, and digital models for speech signals.
- **CO3.** apply time domain parameters of speech signals for tasks such as silence discrimination and pitch period estimation.
- **CO4.** examine the speech signals in frequency domain.
- **CO5.** apply linear predictive analysis for speech processing applications.
- **CO6.** apply Speech Processing techniques in various applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Digital Processing of Speech Signals" by L. R. Rabiner and R. W. Schaffer, Prentice Hall, 2009.
2. "Speech and Audio Signal Processing" by Ben Gold and Nelson Morgan, John Wiley & Sons Inc., 2007.

REFERENCES:

1. "Discrete-time Speech Signal Processing: Principles and Practice" by Thomas F. Quatieri, Pearson Education, 2008.
2. "Fundamentals of Speech Recognition" by L. R. Rabiner and B. H. Juang, Pearson Education, 2003.
3. "Signal Processing of Speech" by Owens, F.J., McGraw-Hill, 1993.
4. "Speech Recognition" by Claudi Becchetti and Lucio Prina Ricotti, John Wiley and Sons, 1999.
5. "Discrete-Time Processing of Speech Signals" by John R. Deller, John H. L. Hansen, John G. Proakis, Wiley-IEEE Press, 2000.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	1							1	1			3	
2	3	2							1	1			3	
3	3	2							1	1			3	
4	3	2							1	1			3	
5	3	2							1	1			3	
6	3	2							1	1			3	
Avg.	2.83	1.83							1	1			3	

1-low, 2-medium, 3-high

COURSE CODE	DSP ARCHITECTURE AND PROGRAMMING	L	T	P	C
		2	0	2	3

MODULE I PROGRAMMABLE DSPs **6**

Architectural Features of Programmable DSPs, Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access in PDSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals.

MODULE II TMS320C6748 PROCESSOR **6**

Architecture - Instruction Set - DSP Development System: Introduction– DSP Starter Kit Support Tools- Code Composer Studio.

MODULE III ADSP –BF606 BLACKFIN PROCESSOR **6**

Architecture, Overview of Hardware Processing Units and Register files, Address Arithmetic Unit, Control Unit, Bus Architecture and Memory, Basic Peripherals.

MODULE IV INTERFACING MEMORY AND I/O PERIPHERALS TO PROGRAMMABLE DSP DEVICES 6

Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct memory access (DMA)

MODULE V APPLICATIONS OF DSP PROCESSORS **6**

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

PRACTICAL EXERCISES:

1. Spectrum analysis using DFT
2. Design of FIR filters
3. Design of IIR filters
4. Analysis of Finite word length effect in fixed point DSP systems
5. Adaptive noise cancellation

COURSE OUTCOMES

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

CO1: interpret the architecture, memory and peripherals of programmable DSPs and develop practical skills in using the TMS320C6748 processor and associated development tools.

CO2: interpret the architectural features of programmable Digital Signal Processors.

CO3: develop application programs for signal processing using TMS320C6X processor

CO4: interpret the micro signal architecture and various hardware processing units of Blackfin processors.

CO5: develop skills to interface memory and I/O peripherals with programmable DSP devices.

CO6: apply DSP processors in diverse real-world applications, demonstrating expertise in voice processing, audio effects, signal detection, speech synthesis, and speaker recognition.

TOTAL : (30+30) PERIODS

TEXT BOOKS:

1. "Digital Signal Processing and Applications with the C6713 and C6416 DSK" by Rulph Chassaing and Donald Reay, 2nd Edition, John Wiley & Sons, Inc., 2012.
2. "Digital Signal Processors – Architecture, Programming and Applications" by B. Venkataramani and M. Bhaskar, 2nd Edition, Tata McGraw Hill Publishing Company Limited, 2011.

REFERENCES:

1. Lapsley et al., "DSP Processor Fundamentals, Architectures & Features", S. Chand & Co, 2010.
2. Ifeachor E. C., Jervis B. W, "Digital Signal Processing: A practical approach", 2nd Edition, Pearson Education, PHI/ 2002.
3. Peter Pirsch , "Architectures for Digital Signal Processing", John Weily, 2009.
4. Sen M. Kuo, Woon Seng S.Gan, "Digital Signal Processors Architectures, Implementation and Application", Pearson Education, 2009.
5. Yu Hen Hu, "Programmable Digital Signal Processors: Architecture: Programming, and Applications", Taylor & Francis, 2002.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	1							1	1			3	
2	2	1							1	1			3	
3	3	3	2	1	3				2	2			3	
4	2	1							1	1			3	
5	3	3	2	1	3				2	2			3	
6	3	3	2	1	3				2	2			3	
Avg.	2.5	2	2	1	3				1.5	1.5			3	

1-low, 2-medium, 3-high

COURSE CODE	BIOMEDICAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

MODULE I CHARACTERISTICS OF BIOMEDICAL SIGNALS 9

Action Potential, Characteristics of Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electroneurogram (ENG), Event-Related Potentials (ERPS), Electrogastrogram (EGG), Objectives of Biomedical Signal Analysis

MODULE II FILTERING FOR REMOVAL OF ARTIFACTS 9

Random and Structured Noise, Physiological Interference, Stationary and Nonstationary Processes, Time and Frequency Domain Filters, Adaptive filters for removal of interference, Removal of Artifacts in ECG.

MODULE III ECG AND EEG SIGNAL PROCESSING 9

EEG Signal Characteristics, EEG Analysis, Linear Prediction Theory, Autoregressive Method, Sleep EEG, Application of Adaptive Filter for Noise Cancellation in ECG and EEG Signals; Detection of P, Q, R, S and T Waves in ECG, EEG Rhythms, Waves and Transients, Detection of Events and Waves, Correlation Analysis , Cross-spectral techniques.

MODULE IV ANALYSIS OF NONSTATIONARY SIGNALS 9

Heart Sounds and Murmurs, Characterization of Nonstationary Signals and Dynamic Systems, Short-Time Fourier Transform, Considerations in Short-Time Analysis, Adaptive Segmentation.

MODULE V BIOSIGNAL CLASSIFICATION AND RECOGNITION 9

Statistical signal classification, linear discriminate functions, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats.

COURSE OUTCOMES

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

CO1: interpret the characteristics of diverse biomedical signals and acquire skills in effective artifact removal using various filtering techniques.
CO2: interpret the characteristics of different types of biomedical signals.
CO3: apply filtering to remove physiological interferences and artifacts from biosignals.
CO4: interpret the characteristics of ECG and EEG Signals and detect ECG waves and EEG events using correlation analysis and cross-spectral techniques.
CO5: apply Short Time Fourier Transform to non-stationary signals.
CO6: apply different methods for biosignal classification and recognition.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Biomedical Signal Analysis" by R.M. Rangayyan, Vol. 33, John Wiley & Sons, 2015.
2. "Biomedical Signal Processing: Principles and Techniques" by D.C. Reddy, McGraw-Hill, 2005.

REFERENCES:

1. "Bio-Medical Signal Processing Vol I and Vol II" by Arnon Cohen, CRC Press Inc., Boca Raton, Florida, 1999.
2. "Bioelectrical Signal Processing in Cardiac and Neurological Applications" by L. Sörnmo and P. Laguna, Vol. 8, Academic Press, 2005.
3. "Biomedical Digital Signal Processing" by Willis J. Tompkins, 1st Edition, Prentice Hall India Private

Limited, 2006.
4. "Digital Signal Processing: Principles, Algorithms, Applications" by John G. Proakis and Dimitris G. Manolakis, 4th Edition, PHI, 2006.
5. "Biosignal and Biomedical Image Processing" by Semmlow, Marcel Dekker, 2005.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2	1											3	
2	2	1											3	
3	3	2	1										3	
4	2	1											3	
5	3	2	1										3	
6	3	2	1										3	
Avg.	2.5	1.5	1										3	

1-low, 2-medium, 3-high

COURSE CODE	SIGNAL PROCESSING FOR COMMUNICATION	L	T	P	C
		3	0	0	3

MODULE I FFT IN COMMUNICATION 9

Overview of Radix 2 FFT Algorithms, FFT based modulation and demodulation techniques, Channel equalization and signal detection using FFT, Spectral analysis in digital communication systems, OFDM and FFT.

MODULE II FILTERING IN COMMUNICATION 9

Equalization filters for channel compensation, Polyphase decomposition and filter banks, Applications of filter banks in communication systems, Filter requirements for modulation and demodulation, Raised cosine and Nyquist filters, Filter design for pulse shaping and matched filtering, Applications of adaptive filters in echo cancellation and equalization.

MODULE III MULTIRATE SIGNAL PROCESSING FOR COMMUNICATION 9

Overview of multirate signal processing, Filter design techniques for interpolation and decimation, Multirate channelization using filter banks, Time-division multiple access and code-division multiple access, Multirate channel estimation and equalization in OFDM.

MODULE IV COMPRESSIVE SENSING IN COMMUNICATION 9

Compressive sensing-based channel sensing and spectrum sensing, channel estimation, Cooperative sensing and compressive sensing fusion, Compressed sensing in MIMO systems

MODULE V SIGNAL PROCESSING IN MULTIMEDIA COMMUNICATION SYSTEMS 9

Overview of audio, image, and video processing, Audio coding standards, image and video compression standards, speech recognition and synthesis in multimedia systems.

COURSE OUTCOMES

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

- **CO1:** apply FFT and filtering techniques in communication applications.
- **CO2:** apply FFT in channel equalization & signal detection, and understand the applications of FFT in communication systems.
- **CO3:** interpret the principles and applications of filtering in communication systems.
- **CO4:** explain the theory and applications of multirate signal processing techniques in communication systems.
- **CO5:** summarize the application of compressive sensing in channel sensing and spectrum sensing and explore the integration of compressive sensing in Multiple-Input Multiple-Output systems.
- **CO6:** explain the various signal processing techniques used in audio, image, and video communication.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Digital Signal Processing in Communications Systems" by Marvin Frerking, Springer, 2013.
2. "Digital Signal Processing for Communication Systems" by Tadeusz Wysocki, Hashem Razavi, Bahram Honary, Springer, 2013.

REFERENCES:

1. "Fast Fourier Transform: Algorithms and Applications" by K.R. Rao, D.N. Kim, J.J. Hwang, Springer, 2010.
2. "Digital Signal Processing for Communication Systems" by Tadeusz Wysocki, Hashem Razavi, Bahram Honary, Springer, 1997.
3. "Multirate Signal Processing for Communication Systems" by Fredric J. Harris, CRC Press, 2022.
4. "Compressed Sensing: Theory and Applications" by Yonina C. Eldar, Gitta Kutyniok, Cambridge University Press, 2012.
5. "Multimedia Communications: Applications, Networks, Protocols and Standards" by Fred Halsall, Addison-Wesley, 2001.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	1										3	
2	3	3	1										3	
3	3	2											3	
4	3	2											3	
5	3	2											3	
6	3	2											3	
Avg.	3	2.33	1										3	

1-low, 2-medium, 3-high

COURSE CODE	MULTIRATE SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

MODULE I FUNDAMENTALS OF MULTIRATE SYSTEMS 9

Multirate operations, Interconnection of building blocks, Polyphase representation, Multistage implementations, Application of multirate systems, Special filters and filter banks.

MODULE II MAXIMALLY DECIMATED FILTER BANKS 9

Errors created in the QMF bank, simple alias free QMF system, Power symmetric QMF banks, M-channel filter banks, Polyphase representation, Perfect reconstruction systems, alias free filter banks, Tree structured filter banks, Transmultiplexers.

MODULE III PARAUNITARY PERFECT RECONSTRUCTION FILTER BANKS 9

Lossless transfer matrices, Filter banks properties induced by paraunitariness, Two channel FIR paraunitary QMF banks, Two channel paraunitary QMF lattice, M - channel FIR paraunitary filter banks, Tranform coding and LOT.

MODULE IV LINEAR PHASE AND COSINE MODULATED FILTER BANKS 9

Lattice structures for linear phase FIR PR QMF banks, formal synthesis of linear phase FIR PR QMF Lattice, Pseudo QMF banks, Design of pseudo QMF bank, Efficient polyphase structures, Cosine modulated perfect reconstruction systems.

MODULE V WAVELET FILTER BANKS 9

Short Time Fourier Transform, Wavelet transform, Discrete Time orthonormal Wavelets, Continuous time orthonormal Wavelet basis.

COURSE OUTCOMES

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

CO1: interpret the principles of multirate systems and maximally decimated filter banks for efficient signal processing.

CO2: examine the spectral characteristics of sample rate converted discrete time signals by using interpolation and decimation

CO3: develop efficient polyphase implementations of sampling rate converters and design perfect reconstruction filter bank system

CO4: explain the properties of paraunitary perfect reconstruction filter banks

CO5: model linear phase and cosine modulated filter banks using efficient structures.

CO6: interpret wavelet transform and its relation to multirate filter banks.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Multirate Systems and Filter Banks" by P.P. Vaidyanathan, PTR Prentice Hall, Englewood Cliffs, New Jersey, 2008.
2. "Multirate Systems: Design and Applications" by Gordana Jovanovic Dolecek, Idea Group Pub, 2012..

REFERENCES:

1. " "Digital Signal Processing: Principles, Algorithms, Applications" by John G. Proakis and Dimitris G. Manolakis, 4th Edition, PHI, 2006.
2. "Multirate Digital Signal Processing" by N.J. Fliege, John Wiley & Sons, 1999.

3. "Wavelet Transforms: Introduction to Theory and Applications" by Raghuveer Rao, Ajit Bopardikar, Pearson Education Asia, 1998.
4. "Introduction to Wavelets and Wavelet Transform" by C. Sidney Burrus, R.A. Gopinath, Haitao Guo, Prentice Hall, 1998.
5. "Multirate Digital Signal Processing" by Ronald E. Crochiere, Lawrence R. Rabiner, Prentice-Hall, 1983.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1											3	
2	3	1											3	
3	3	1											3	
4	3	1											3	
5	3	1											3	
6	3	1											3	
Avg.	3	1											3	

1-low, 2-medium, 3-high

COURSE CODE	STATISTICAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

MODULE I DISCRETE RANDOM SIGNAL PROCESSING 9

Discrete Random Processes – Ensemble averages, Gaussian processes, Stationary processes, Autocovariance and Autocorrelation matrices, Ergodicity, Parseval's Theorem – Wiener–Khintchine Theorem – Power Spectrum, Filtering random processes, Spectral Factorization.

MODULE II SPECTRUM ESTIMATION 9

Bias and Consistency of estimators, Non-Parametric Methods –Periodogram, Modified Periodogram, Bartlett and Welch methods, Blackman–Tukey method – Parametric Methods – AR, MA, and ARMA model based spectrum estimation

MODULE III SIGNAL MODELING AND OPTIMUM FILTERS 9

Least square method – Pade approximation – Prony's method – Levinson Recursion – FIR Wiener filter – IIR Wiener Filter – Discrete Kalman filter.

MODULE IV ADAPTIVE FILTERS 9

FIR Adaptive filters - Steepest Descent Adaptive filter – LMS Adaptive algorithm – Convergence – Normalized LMS – Applications – Noise cancellation - channel equalization – echo canceller – Adaptive Recursive Filters – Recursive Least Squares – Exponentially weighted RLS sliding window RLS

MODULE V IMPLEMENTATION OF STATISTICAL SIGNAL PROCESSING ALGORITHMS 9

Spectrum estimation using parametric and non-parametric methods, Design of Wiener filter, Noise cancellation, Echo cancellation and channel equalization using adaptive filters.

COURSE OUTCOMES

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

CO1: interpret the principles of discrete random signal processing, including Gaussian processes, spectral analysis, and diverse estimation techniques.
CO2: interpret the characteristics of discrete random processes
CO3: apply parametric and non-parametric methods to estimate the frequency spectrum of random signals
CO4: design FIR and IIR Wiener filter and compute the minimum mean square estimate of a given random process
CO5: apply adaptive filter algorithms for signal processing applications
CO6: implement statistical signal processing algorithms for various applications.

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TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Digital and Statistical Signal Processing" by Anastasia Veloni, Nikolaos Miridakis, Erysso Boukouvala, CRC Press, 2018.
2. "Statistical Digital Signal Processing and Modeling" by Monson H. Hayes, John Wiley and Sons, Singapore, 2009.

REFERENCES:

1. " Algorithms for Statistical Signal Processing" by John G. Proakis et al., Pearson Education, 2003.
2. "Adaptive Signal Processing – Next Generation Solutions" by T. Adali and Simon Haykin, 1st Edition, Wiley India Pvt. Ltd., 2010.
3. "Adaptive Signal Processing" by Bernard Widrow, Samuel D. Strearns, Pearson Education, 2005.
4. "Optimum Signal Processing: An Introduction" by Sophocles J. Orfanidis, 2nd Edition, McGraw-Hill, New York, 1988.
5. "Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing" by Dimitris G. Manolakis, Vinay K. Ingle, and Stephen M. Kogon, McGraw Hill International Edition, 2005.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1											3	
2	3	1											3	
3	3	2											3	
4	3	2	2										3	
5	3	2	2										3	
6	3	2	2										3	
Avg.	3	1.67	2										3	

1-low, 2-medium, 3-high

COURSE CODE	DIGITAL IMAGE AND VIDEO PROCESSING	L	T	P	C
		2	0	2	3

MODULE I DIGITAL IMAGE PROCESSING **6**

Imaging sensor-Digital image- Color images -RGB color space-converting RGB to Gray scale-HSI,HSV,YUV and YC_bC_r color representation- Point Processing: Histogram Equalization and Adaptive Histogram Equalization-Color thresholding-Thresholding in Video.

MODULE II DIGITAL IMAGE AND VIDEO ENHANCEMENT AND RESTORATION **6**

Basic linear and non linear filtering with applications to image enhancement- Morphological filtering for image analysis and enhancement and feature detection- Video enhancement and restoration.

MODULE III DIGITAL IMAGE AND VIDEO SEGMENTATION AND CLASSIFICATIONS **6**

Statistical methods for image segmentation- Multiband techniques, Texture Classification and segmentation- Video segmentation- 2D and 3D Motion tracking in Digital Video- Adaptive and neural Methods for Image Segmentation.

MODULE IV BLOB ANALYSIS AND VIDEO CODING **6**

BLOB Extraction- Recursive Grass-Fire Algorithm- Sequential Grass-Fire Algorithm- BLOB features-BLOB classification-Basic concepts and Techniques of Video Coding and the H.261 standard- Interframe Subband / Wavelet scalable Video Coding

MODULE V IMAGE AND VIDEO ANALYSIS **6**

Synthetic Aperture Radar - Finger print Classification and Matching-Face recognition from still images and videos- Exploiting Visual Information in Automatic Speech Processing-Coin sorting using a robot

PRACTICAL EXPERIMENTS:

1. Analysis of images with different color models.
2. Histogram equalization of color image
3. Filtering of color image corrupted by noise
4. Region based segmentation.
5. Object analysis to detect edges, circles, lines and trace boundaries
6. Feature Detection and Extraction
7. Image quality analysis: Peak signal-to-noise ratio, structural similarity index (SSIM)
8. Image and video Ground Truth Labeling
9. Tracking and Motion Estimation

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COURSE OUTCOMES

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

CO1: apply the enhancement and restoration filters to enhance the quality of the image and video.
CO2: interpret the Concepts of digital image and video processing.
CO3: interpret the Concepts of enhancement and restoration used in image and video.
CO4: interpret the Concepts of Image and Video segmentation and Classifications.
CO5: make use of BLOB analysis and image processing techniques in real world applications.
CO6: apply segmentation to classify the image and video, BLOB analysis to analyse the shape features, and image processing techniques in real-world applications.

TOTAL : 30+30 PERIODS

TEXT BOOKS:

1. "Introduction to Video and Image Processing: Building Real Systems and Applications" by Thomas B. Moeslund, Springer Science & Business Media, 2012.
2. "Handbook of Image and Video Processing" by Al Bovik, 2nd Edition, Elsevier Science, 2005.

REFERENCES:

1. "The Essential Guide to Video Processing" by Alan C. Bovik, Elsevier Science, Netherlands, 2009.
2. "Image and Video Processing in the Compressed Domain" by Jayanta Mukhopadhyay, CRC Press, 2011.
3. "Real-Time Image and Video Processing" by M. Gamadia, N. Kehtarnavaz, Morgan & Claypool Publishers, 2006.
4. "Multimedia Image and Video Processing" by Ling Guan, Yifeng He, Sun-Yuan Kung, CRC Press, United States, 2017.
5. "Practical Image and Video Processing Using MATLAB" by Oge Marques, Wiley, Ukraine, 2011.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2										2	
2	3	2	2										2	
3	3	2	2										2	
4	3	2	2										2	
5	3	2	2										2	
6	3	2	2										2	
Avg.	3	2	2										2	

1-low, 2-medium, 3-high

COURSE CODE	AI-ML ALGORITHMS FOR IMAGE PROCESSING APPLICATIONS	L	T	P	C
		3	0	0	3

MODULE I IMAGE PROCESSING **9**

Fundamentals of Image Processing- Pixel Brightness Transformation- Geometric transformations- Local pre-processing- Image smoothing- Edge detectors- Scale in image processing- Canny edge detection- Parametric edge models- Local pre-processing in the frequency domain- Line detection by local pre-processing operators- Detection of corners- Image Restoration.

MODULE II IMAGE SEGMENTATION ALGORITHMS **9**

Thresholding- Edge-based segmentation- Region-based segmentation- Template Matching- Mean shift Segmentation- Region Identification- Contour-based shape representation- Region-based shape representation- Hidden Markov models.

MODULE III OBJECT DETECTION **9**

Classification principles- Nearest neighbours- Support vector machines- Cluster analysis- Histogram of Oriented Gradients- Scale Invariant Feature Transform- RANSAC Algorithm- Speeded up Robust Features- Image Understanding Control Strategies- Random forests.

MODULE IV PATTERN RECOGNITION ALGORITHMS **9**

Fundamentals in Pattern Recognition- Linear Regression- Decision Function- Statistical Decision Theory- Gaussian Classifier- Parameter Estimation- Clustering for Knowledge Representation- Dimension Reduction- Template Matching- ANN for Pattern Recognition- Convolutional Neural Networks.

MODULE V AI/ ML APPLICATION **9**

Machine Learning Algorithms and their Applications in Medical Image Segmentation- Motion Estimation and Object Tracking- Facial Expression Recognition- Gesture Recognition- Image Fusion.

COURSE OUTCOMES

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

- **CO1:** explain the fundamental concepts of image processing and segmentation algorithms.
- **CO2:** interpret the principles of pre-processing and edge detection techniques.
- **CO3:** apply image segmentation algorithms and techniques to enhance visual perception.
- **CO4:** explain the characteristics used to represent, detect, and define the boundaries of objects.
- **CO5:** predict patterns in various applications that impact the performance of the model.
- **CO6:** apply pattern recognition techniques and object detection algorithms for solving real-world classification and recognition problems.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Image Processing, Analysis and Machine Vision" by Milan Sonka, Vaclav Hlavac, and Roger Boyle, 4th Edition, CL Engineering, 2015.
2. "Computer Vision: Algorithms and Applications" by Richard Szeliski, 2nd Edition, Springer-Texts in Computer Science, 2022.

REFERENCES:

1. "Computer Vision and Image Processing: Fundamentals and Applications" by Manas Kamal Bhuyan, CRC Press, Taylor & Francis Group, USA, 2020.
2. "Computer Vision: A Modern Approach" by Forsyth & Ponce, 2nd Edition, Pearson Education, 2015.
3. "Pattern Recognition and Machine Learning" by Christopher M. Bishop, Springer, 2006.
4. "Multiple View Geometry in Computer Vision" by Richard Hartley and Andrew Zisserman, 2nd Edition, Cambridge University Press, 2004.
5. "Machine Learning in Computer Vision" by N. Sebe, Ira Cohen, Ashutosh Garg, Thomas S. Huang, Springer, 2005.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2												2
2	3	2												2
3	3	2												2
4	3	2												2
5	3	2	1											2
6	3	2	2	1										2
Avg.	3	2	1.5	1										2

1-low, 2-medium, 3-high

COURSE CODE	IoT PROCESSORS	L	T	P	C
		3	0	0	3

MODULE I SYSTEM-ON-CHIP **9**

Introduction to SoC Architecture, An approach for SOC Design, System Architecture and Complexity. Processor Selection for SOC, Basic concepts in Processor Architecture, Overview of SOC external memory, Internal Memory, Scratchpads and Cache memory, SOC Memory System, Models of Simple Processor – memory interaction, SOC Standard Buses.

MODULE II SINGLE BOARD COMPUTER SYSTEM **9**

Raspberry Pi's architecture and set up - Setting up Raspberry Pi- Basic hardware needed-The microSD card- Installing screen and Vim- Running tests on the OS and configuration changes- Programming on Raspbian operating system.

MODULE III PROGRAMMING WITH RASPBERRY PI **9**

GPIO pins - Programming Raspberry Pi with Python: Controlling LED- Switch- Sending an email on switch press- Audio shield interfacing with the Raspberry Pi - Interacting with audio through GPIO- Sonic Pi - Building a Web Server: Building a python web server- Database support for webserver.

MODULE IV I/O PROGRAMMING **9**

GPIO Pin connections – Digital Inputs and Outputs- Analog Inputs and Outputs- - Integrating Genuino/Arduino Microcontroller with RPi- Serial communication over USB- Communication between the Arduino and Raspberry Pi via GPIO- Communication over I2C- Communication over the web.

MODULE V ESP32 AND ESP8266 WITH MICROPYTHON **9**

Micropython basics - uPyCraft IDE - Flashing Micropython firmware to ESP32/ESP8266- Establishing communication with the board- Use cases using ESP32/ESP8266: Web controlled IoT based Robotic Arm- Advanced Weather Station with BME280 and Live Weather data- Real Time Data Transfer between Two ESP32 using Web-Socket Client on Arduino IDE- Data Logging to Google Sheets with Google Scripts.

COURSE OUTCOMES

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

- **CO1:** summarize the architecture, features and concepts of System-on-Chip and Raspberry Pi.
- **CO2:** interpret the concepts of System-on-Chip.
- **CO3:** interpret the architecture and features of Raspberry Pi.
- **CO4:** explore the on-chip peripherals of Raspberry Pi and develop python programs to implement their functions.
- **CO5:** develop Python programs to implement functions on Raspberry Pi and also establish serial communication by integrating add-on boards with Raspberry Pi.
- **CO6:** interpret on the hardware and software techniques used in Raspberry Pi and also realise the programming concepts of Micro python for ESP32 and ESP8266 boards.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "System On Chip: Computer System Design" by Michael J. Flynn and Wayne Luk, Wiley India, 2011.
2. "Raspberry Pi Computer Architecture Essentials" by Andrew K. Dennis, 2nd Edition, PACKT Publishing, 2016.

REFERENCES:

1. "Programming the Raspberry Pi: Getting Started with Python" by Simon Monk, 3rd Edition, McGraw Hill, 2021.
2. Rui Santos, Sara Santos, "MicroPython Programming with ESP32 and ESP8266", Random Nerd Tutorials, Version 1.2.
3. Arshdeep Bahga and Vijay Madisetti, "Internet of Things: A Hands-on Approach", Universities Press, 2014.
4. "ARM System-on-Chip Architecture" by Steve Furber, 2nd Edition, Pearson, 2015.
5. Web Reference: https://iotdesignpro.com/esp32-projects

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	3	-	-	-	-	-	-	-	-	-	-	-	2
5	3	3	-	-	-	-	-	-	-	-	-	-	-	2
6	3	2	-	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	2.66	-	-	-	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	COMMUNICATION AND NETWORKING TECHNOLOGIES FOR IoT	L	T	P	C
		2	0	2	3

MODULE I INTERNET OF THINGS **6**

Definition and Characteristics of IoT - Physical Design of IoT - Logical design of IoT - IoT enabled Technologies: Wireless Sensor Networks, Cloud Computing, Big data analytics, Communication protocols and Embedded Systems - IoT Levels & Deployment Templates.

MODULE II ARCHITECTURE AND PROTOCOLS OF IoT **6**

Architecture for IoT using Mobile devices- Mobile Technologies for supporting IoT ecosystem- IoT and M2M: Software defined networking, Network function virtualization-IoT System Management with NETCONF-YANG, SNMP, NETOPEER- Layered architecture for IoT- Protocol architecture of IoT- Infrastructure Protocols.

MODULE III COMMUNICATION TECHNOLOGIES **6**

Enablling Technologies : 6LoWPAN, Zigbee,Wi-Fi, BT, BLE, SIG, NFC, LORA- IoT protocols and softwares: MQTT – UDP -MQTT brokers –Publish and subscribe modes – HTTP – COAP -XMPP and gateway protocols.

MODULE IV PHYSICAL DEVICES & LOGICAL DESIGN **6**

Basic building blocks of a loT Device- Python packages of interest for loT- Python web application framework-Programming Inputs and outputs, Serial, SPI and I2C – Sensors and its Interfacing using Raspberry Pi. **OPEN SOURCE HARDWARE:** Raspberry Pi physical devices- Raspberry Pi Interfaces- Pi Programming APIs/Packages- Web services.

MODULE V IoT APPLICATION AND USE CASES **6**

Street light monitoring using light radiation sensors- health monitoring: Bio signal Sensors for Cardiovascular System Monitoring - Fire detection using temperature sensors - Inventory Management and Quality Control- Green House control— Smart Home, Automobile theft control- Air Quality Monitoring systems using web server and cloud support.

PRACTICAL EXPERIMENTS

Embedded 'C' programs using NODE MCU ESP 8266 boards

1. IoT Controlled LED using Google Firebase Console
2. IoT based weather monitoring system to track temperature and humidity data over the internet using ESP 8266 and ThingSpeak.
3. Track a Vehicle on Google Maps using Arduino, ESP8266 & GPS
4. IoT Based Air Pollution Monitoring System to monitor the Air Quality over a webserver using internet
5. Develop an Android application using called MIT App Inventor 2 to control the colour of an RGB LED with a smart phone via Bluetooth module.

Python Programming using Raspberry Pi boards

1. Getting started with Raspberry Pi – OS Installation, library dependencies, Internet Connectivity.
2. Interfacing XBee Module with Raspberry Pi
3. Data acquisition and control using the MQTT based cloud server with the user interface as Mobile APP and web browser
4. Real Time Face Recognition with Raspberry Pi and OpenCV

COURSE OUTCOMES

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

CO1. interpret the fundamental concepts and terminology related to the architecture and protocols used in IoT-based systems
CO2. explain the physical and logical design principles of IoT systems.
CO3. infer the benefits of a layered architecture approach for organizing complex IoT systems
CO4. explain the principles underlying communication protocols and technologies in IoT.
CO5. develop python based application program for serial communication and Sensor interfacing using raspberry.
CO6. develop innovative IoT-based applications tailored to specific use cases and requirements, integrating sensor data, communication protocols, data analytics, and user interfaces.

TOTAL : 30+30 PERIODS

TEXT BOOKS:

1. "Internet of Things - A Hands-on Approach" by Arshdeep Bahga and Vijay Madisetti, 1st Edition, Universities Press, 2015.
2. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases" by Pethuru Raj, Anupama C. Raman, 1st Edition, CRC Press (Taylor & Francis Group), 2017.

REFERENCES:

1. "Enabling Things to Talk – Designing IoT Solutions with the IoT Architecture Reference Model" by Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, 1st Edition, Springer Open, 2016.
2. "The Internet of Things: From RFID to the Next-Generation Pervasive Network" by Lu Yan, Yan Zhang, Laurence T. Yang, Huansheng Ning, 1st Edition, Auerbach Publications, March 2008.
3. "Introduction to IoT" by Sudip Misra, Anandarup Mukherjee, Arijit Roy, 1st Edition, Cambridge University Press, 2021.
4. "Getting Started with Raspberry Pi" by Matt Richardson & Shawn Wallace, 1st Edition, O'Reilly Media Press, 2012.
5. "Internet of Things in the Cloud: A Middleware Perspective" by Honbo Zhou, 1st Edition, CRC Press, 2012.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2											2
2	3	2	2											2
3	3	2	2											2
4	3	2	2											2
5	3	2	2	2	2				1	2				2
6	3	2	2	2	2				1	2				2
Avg.	3	2	2	2	2				1	2				2

1-low, 2-medium, 3-high

COURSE CODE	WEARABLE TECHNOLOGY AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

MODULE I INTRODUCTION TO WEARABLE SYSTEMS 9

Wearable Systems: Introduction- Need for Wearable Systems- Drawbacks of Conventional Systems for Wearable Monitoring- Applications of Wearable Systems- Types of Wearable Systems- Components of wearable Systems.

MODULE II SENSORS FOR WEARABLE SYSTEMS 9

Inertia movement sensors- Respiration activity sensor- Impedance plethysmography- Galvanic skin response- Pulse Oximetry- Radiant Thermal Sensor- Gas sensor- Cardiopulmonary Activity Systems.

MODULE III ENERGY HARVESTING FOR WEARABLE DEVICES 9

Energy Harvesting in Wearable Systems- Principles- Characteristics of Wearable TEGs-Wearable Thermoelectric power supply- TEGs in Wearable Devices- Photovoltaic Wearable Energy Harvesters- TEGs in Clothing- Wearables Thermopiles.

MODULE IV WEARABLE DEVICES IN AESTHETICS 9

Role of Wearables, Attributes of Wearables, The Meta Wearables – Textiles and clothing- Social Aspects: Interpretation of Aesthetics, Adoption of Innovation and aesthetic change- On-Body Interaction: social acceptance of gesture.

MODULE V ROLE OF IoT IN WEARABLE DEVICES 9

Wearable IoT use cases: Smart watches- Android wear- Smart glasses- Fitness trackers- Health care devices- Cameras- Smart clothing.

COURSE OUTCOMES

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

CO1: explore the components, applications, types and principles of sensors used in wearable applications.
CO2: interpret on the need, types, components and applications of wearable systems.
CO3: explore the principles of sensors used in wearable applications.
CO4: explore the energy harvesting concepts for self-powered wearable devices.
CO5: interpret on the energy harvesting concepts and features of wearable in textile, clothing and aesthetics.
CO6: apply the concepts of wearable technologies to implement IoT based applications in self-powered devices and textile sector.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Wearable Monitoring Systems" by Annalisa Bonfiglio and Danilo De Rossi, Springer, 2011.
2. "Wearable Sensors: Fundamentals, Implementation and Applications" by Edward Sazonov, Michael R. Neuman, Elsevier, 2014.

REFERENCES:

1. "The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing

the World" by Michael Miller, 1st Edition, Pearson Education Inc., 2015.
2. "Fundamentals of Wearable Computers and Augmented Reality" edited by Woodrow Barfield, 1st Edition, CRC Press, 2015.
3. "Wearable Computing: From Modeling to Implementation of Wearable Systems Based on Body Sensor Networks" by Giancarlo Fortino, Raffaele Gravina, Stefano Galzarano, 1st Edition, John Wiley & Sons, 2018.
4. "Sensor Technology Handbook" by Jon S. Wilson, Elsevier Inc., 2005.
5. "Wearable Electronics Sensors: For Safe and Healthy Living" by Subhas C. Mukhopadhyay, Springer International Publishing, 2015.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													2
2	3													2
3	3													2
4	3													2
5	3													2
6	3	3												2
Avg.	3	3												2

1-low, 2-medium, 3-high

COURSE CODE	INDUSTRIAL IOT AND INDUSTRY 4.0	L	T	P	C
		3	0	0	3

MODULE I INDUSTRY 4.0 **9**

Sensing & actuation - Communication-Industry 4.0: Globalization and Emerging Issues - The Fourth Revolution - LEAN Production Systems - Smart and Connected Business Perspective - Smart Factories.

MODULE II INDUSTRIAL IIOT: SENSING & ACTUTAION **9**

Industrial Processes - Industrial Sensing & Actuation - Industrial Internet Systems - Industrial IoT: Business Model and Reference Architecture-Industrial IoT - Layers: IIoT Sensing - IIoT Processing - IIoT Communication.

MODULE III INDUSTRIAL DATA TRANSMISSION **9**

Fieldbus-Profibus - HART - Interbus - Bitbus - Modbus - Digital Storm - CAN - DeviceNet - Wireless HART - LoRa and LoRaWAN - NB-IoT - IEEE802.11AH..

MODULE IV MACHINE LEARNING AND DATA SCIENCE IN INDUSTRIES **9**

Machine learning - Categorization of ML - Applications of ML in industries - Data science in industries - Deep learning - Application of Deep learning in industries.

MODULE V INDUSTRIAL IoT APPLICATIONS AND CASE STUDIES **9**

Healthcare Applications in Industries - Inventory Management and Quality Control - Plant Safety and Security

Case studies: Manufacturing industry - Automotive industry - Mining industry.

COURSE OUTCOMES

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

- **CO1:** examine the basic idea in Industry 4.0 and Industrial IoT
- **CO2:** interpret the Industry 4.0 globalization and revolution
- **CO3:** list common types of sensor and actuators used in IIoT
- **CO4:** categorize the various industrial data transmission.
- **CO5:** identify the analytics used in machine learning and data science applications for the IIoT.
- **CO6:** build IIoT based applications for inventory management, quality control, safety & security using standard transmission and Machine Learning Techniques.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Industry 4.0: The Industrial Internet of Things" by Alasdair Gilchrist, Apress, 2016.
2. "Sensors, Actuators and Their Interfaces" by N. Ida, SciTech Publishers, 2014.

REFERENCES:

1. "Hands-on Industrial Internet of Things: Create a Powerful Industrial IoT Infrastructure using Industry

4.0" by Giacomo Veneri and Antonio Capasso, 1st Edition, Packt Publishing Ltd, 2018.
2. "Getting Started with Raspberry Pi" by Matt Richardson & Shawn Wallace, O'Reilly (SPD), 2014.
3. "Internet of Things - A Hands-on Approach" by Arshdeep Bahga and Vijay Madisetti, Universities Press, 2015.
4. "Learning Internet of Things" by Peter Waher, Packt Publishing Ltd, 2015.
5. "Internet of Things for Architects: Architecting IoT Solutions by Implementing Sensors, Communication Infrastructure, Edge Computing, Analytics, and Security" by Perry Lea, 1st Edition, Packt Publishing Ltd, 2018.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													2
2	3													2
3	3													2
4	3													2
5	3													2
6	3													2
Avg.	3													2

1-low, 2-medium, 3-high

COURSE CODE	SMART SENSORS AND APPLICATIONS FOR IoT	L	T	P	C
		3	0	0	3

MODULE I STRAIN AND PRESSURE SENSORS **9**

Static and dynamic characteristics of an instrumentation system– Principles and classification of transducers – Electrical transducers– basic requirements of transducers- Resistance strain gauge – piezoelectric pressure gauge – characteristics – Electronic circuits for strain gauge – load cells – Interferometry – Pressure gauges: Aneroid capacitance pressure gauge– Ionization gauge.

MODULE II DISPLACEMENT, FORCES AND TORQUE MEASUREMENT **9**

Resistive potentiometer: Linear, circular L.V.D.T. – variable inductance and capacitive sensors: The Parallel Plate Capacitive Sensor, Stretched Diaphragm Variable Capacitance Transducer – Piezo electrical transducers– Accelerometer systems–Proximity sensors– synchros and resolvers–Torque and Position Sensors.

MODULE III LIGHT RADIATION SENSORS **9**

Color temperature – light flux – photosensors – photomultiplier – photoresistor and photoconductors – photodiodes – phototransistors – photovoltaic devices – fiber optic applications – light transducers – solid-state transducers – liquid crystal displays.

MODULE IV SMART SENSORS **9**

Primary Sensors – humidity sensors – thermocouples – Resistance thermometers – fluid velocity sensors – Excitation – Amplification– Filters – Converters – Compensation – Information Coding Process – Data Communication – Standards for Smart Sensor Interface – The Automation.

MODULE V INTERNET OF THINGS APPLICATIONS **9**

Tyre and water monitoring using pressure sensors–Elevator using displacement sensors – Intruder alarms, Automatic ticket gates using proximity sensors – Humidity Measurement, Monitoring Room Temperature, Fire detection using temperature sensors–Street light monitoring using light radiation sensors – Smart Home, Automobile theft control, Air Quality Monitoring using smart sensors.

COURSE OUTCOMES

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

- **CO1:** Summarize the working principles of strain, pressure sensors, displacement, forces and torque.
- **CO2:** Explain the static, dynamic characteristics of instrumentation systems.
- **CO3:** Describe the principles of operation of synchros and resolvers.
- **CO4:** Identify the working of different types of light radiation sensors.
- **CO5:** Using the humidity sensors, develop systems for monitoring room temperature, humidity, and fire detection.
- **CO6:** Make use of light radiation sensors to monitor street lights, smart sensors to monitor air quality, automobile theft control, and smart homes.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Sensors and Transducers" by Patranabis D, 2nd Edition, Prentice Hall of India, 2005.
2. "Sensors and Transducers" by Ian R. Sinclair, 3rd Edition, Newnes Publishers, 2001.

REFERENCES:

1. "Measurement Systems, Application and Design" by Ernest O. Doebelin, Dhanesh N. Manik, 6th Edition, McGraw Hill, 2007.
2. "Experimental Methods for Engineers" by Jack P. Holman, 7th Edition, McGraw Hill, USA, 2012.
3. "Transducers, Sensors and Detectors" by Robert G. Seippel, Reston Publishing Company, USA, 1983.
4. "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications" by Rahul Dubey, 1st Edition, Cengage India Publication, 2019.
5. "Make Sensors" by Terokarvinen, Kemo, Karvinen, Villey Valtokari, 1st Edition, Maker Media, 2014.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	2	2	-	-	-	-	-	-	-	-	-	-	-	2
6	2	2	-	-	-	2	-	-	-	-	-	1	-	2
Avg.	2.7	2	-	-	-	2	-	-	-	-	-	1	-	2

1-low, 2-medium, 3-high

COURSE CODE	IoT EDGE COMPUTING	L	T	P	C
		3	0	0	3

MODULE I NEW COMPUTING PARADIGMS **9**

Relevant Technologies-Fog and Edge Computing - Completing the Cloud-Hierarchy of Fog and Edge Computing-Business Models-Opportunities and Challenges **-** Integrating IoT, Fog and Cloud Infrastructures**.**

MODULE II NETWORK SLICES IN 5G, FOG, EDGE, AND CLOUDS **9**

Network Slicing-Network Slicing in Software-Defined Clouds-Network Slicing Management in Edge and Fog- Internet of Vehicles: Architecture, Protocol and Security Seven layered model architecture for Internet of Vehicles- IoV: Network Models.

MODULE III MIDDLEWARE FOR FOG AND EDGE COMPUTING: DESIGN ISSUES **9**

Need for Fog and Edge Computing Middleware-Design Goals-State-of-the-Art Middleware Infrastructures-System Model-Proposed Architecture-Case Study Example.

MODULE IV TECHNOLOGIES IN FOG COMPUTING **9**

Fog Data Management-Motivating Example: Smart Building-Predictive Analysis with Fog Torch Machine Learning in Fog Computing - Data Analytics in the Fog - Data Analytics in the Fog Architecture-Configurations.

MODULE V APPLICATIONS **9**

Exploiting Fog Computing in Health Monitoring-Smart Surveillance Video Stream Processing at the Edge for Real-Time Human Objects Tracking - Fog Computing Model for Evolving Smart Transportation Applications..

COURSE OUTCOMES

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

CO1: explain the principles of Fog and Edge Computing, Network Slicing in 5G, and their integration with Cloud computing and IoT

CO2: interpret the concepts of Fog and Edge Computing & their integration with IoT and Cloud infrastructures

CO3: infer the concepts of Network Slicing Management in Edge and Fog Computing and architecture, protocols, and security in the Internet of Vehicles (IoV)

CO4: apply the key concepts in designing various middleware for Fog and Edge Computing

CO5: examine the technologies of Fog Computing and apply these technologies in fields such as health monitoring, smart surveillance, and intelligent transportation systems

CO6: utilize the appropriate middleware design in Fog/Edge Computing to develop real-time applications

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Internet of Things: A Hands-on Approach" by Arshdeep Bahga and Vijay Madisetti, 1st edition, Universities Press, 2014.

2. "Fog and Edge Computing: Principles and Paradigms" by Buyya, Rajkumar and Satish Narayana Srirama, 1st edition, John Wiley & Sons, 2019.

REFERENCES:

1. "Internet of Things – From Research and Innovation to Market Deployment" by Ovidiu Vermesan, Peter Friess, 1st edition, River Publishers, 2014.
2. "Hands-on Artificial Intelligence for IoT" by Amita Kapoor, 1st edition, Packt Publishing, 2019.
3. "The Internet of Things Enabling Technologies, Platforms, and Use Cases" by Pethuru Raj, Anupama C. Raman, 1st edition, CRC Press (Taylor & Francis Group), 2017.
4. "Internet of Things Challenges and Opportunities" by Subhas Chandra Mukhopadhyay, 1st edition, Springer, 2015.
5. "Getting Started with Raspberry Pi" by Matt Richardson & Shawn Wallace, 1st edition, O'Reilly Media Press, 2012.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													2
2	3													2
3	3				2							1		2
4	3				1									2
5	3	2			2							1		2
6	3	2			2							1		2
Avg.	3	2			1.75							1		2

1-low, 2-medium, 3-high

COURSE CODE	MOBILE APP DEVELOPMENT FOR IOT	L	T	P	C
		3	0	0	3

MODULE I IOT ECOSYSTEM **9**

IoT ecosystem - Application development platforms for IoT - IoT Data sources - Overview of Mobile App and Mobile Interface: Mobile System - Mobile Interface and Applications - Mobile Cloud.

MODULE II SENSORS FOR MOBILE & HAND HELD DEVICES **9**

Temperature sensors - Proximity sensor - IR sensors, Image sensors - Motion detection sensors - Accelerometer sensors - Gyroscope sensors - Optical sensors.

MODULE III SENSOR DATA PROCESSING **9**

Sensor Data - Gathering and Data - Dissemination Mechanisms; Sensor Database system architecture; Sensor data - fusion mechanisms; Data - fusion Architectures and models.

MODULE IV PROGRAMMING AND FRAMEWORKS FOR IOT **9**

IoT Programming Approaches: Node - Centric Programming - Database approach – Model - Driven Development - IoT Programming Frameworks: MIT app inventor - Android Things - ThingSpeak - IoTivity – Node - RED - DeviceHive - Contiki and Cooja - Zetta.

MODULE V APPLICATIONS AND CASE STUDIES **9**

Applications and Case Studies: Home automations - Smart cities - Environment - Energy - Healthcare - Logistics -Agriculture - Industry - Health and life style.

COURSE OUTCOMES

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

CO1: examine the need for sensors, application development platforms and interface
CO2: interpret the application development platforms and mobile interface for IoT
CO3: identify suitable sensor circuits interfacing using microcontrollers.
CO4: categorize the sensor data for processing various models in IoT
CO5: interpret the IoT programming and framework for various applications
CO6: build mobile applications for different applications using sensor data and IoT frameworks.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Parallel Computing Architectures and APIs: IoT Big Data Stream Processing" by Vivek Kale, 1st edition, CRC Press, 2019.
2. "Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security" by Perry Lea, 1st edition, Packt Publishing Ltd, 2018.

REFERENCES:

1. "Mobile Computing" by Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal, 2nd Edition, Tata McGraw Hill Pub, 2010.
2. "Mobile Applications Development With Android Technologies and Algorithms" by Meikang Qiu,

Wenyun Dai, and Keke Gai, Chapman and Hall/CRC Publication, 2016.
3. "JavaScript and Jquery: Interactive Front-End Web Development" by Jon Duckett, Gilles Ruppert, and Jack Moore, CreateSpace Independent Publishing Platform, 2017.
4. "Professional Mobile Application Development" by Jeff McWherter and Scott Gowell, John Wiley & Sons, 2012.
5. "IoT, AI, and Blockchain for .NET: Building a Next-Generation Application from the Ground Up" by Nishith Pathak, Anurag Bhandari, Apress, 2018.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	1	-	-	-	-	-	-	-	-	2
6	3	-	1	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	1	-	1	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	NANO SENSORS AND APPLICATIONS	L	T	P	C
		3	0	0	3

MODULE I NANO SENSORS **9**

Nano science and Nanotechnology - Definition of sensor parameters and characteristics - Evolution of Semiconductor-based Micro sensors- Definition and Classification of Nano sensors, Examples of Nano sensors.

MODULE II MATERIALS FOR NANO SENSORS **9**

Classification of Nanoparticles – Core/Shell-structured Nanoparticles- Optical Properties of Bulk Metals and Metallic Nanoparticles - Quantum Dots- Carbon Nanotubes –Nanoporous Materials.

MODULE III NANO BIOSENSORS **9**

Nanoparticle-based Electrochemical Biosensors - CNT-based Electrochemical Biosensors - Functionalization of CNTs for Biosensor Fabrication - Nanotube and Nanowire-based FET Nano biosensors - Cantilever- based Nano biosensors.

MODULE IV NANOTECHNOLOGY ENABLED DEVICES **9**

Scanning Tunnelling Microscope, Atomic Force Microscope, Mechanical Nanosensors, Thermal Nanosensors, Optical Nanosensors, Magnetic Nanosensors – Gas Sensors-based on Nanomaterials – Metallic Nanoparticle-based Gas Sensors- MQ-2, 3,4,6,7,135 Gas Sensors

MODULE V APPLICATIONS OF NANO SENSORS **9**

Soil moisture Nanosensors - Nanosensors for pesticide detection in soil- Nanosensors for intelligent food packaging – Electrochemical Nanosensors for blood glucose analysis - Nanomaterials for Groundwater Remediation- Injectable Nanoparticles for Efficient Drug Delivery.

COURSE OUTCOMES

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

CO1: interpret the technology and materials used for nano sensors
CO2: illustrate the characteristics, evolution and classification of nanosensors
CO3: classify the nanoparticles and infer the properties of nanomaterials
CO4: interpret the functionalization of biosensors based on nanostructured materials
CO5: infer the working of nanotechnology enabled devices and applications of nano sensors
CO6: make use of nano biosensors and devices for real time applications

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Nanosensors: Physical, Chemical and Biological" by Vinod Kumar Khanna, Taylor & Francis, 2016.
2. "Nanostructured Materials: Processing, Properties and Applications" by Carl C. Koch, Jaico Publication House, 2006.

REFERENCES:

1. "Nanosensors for Smart Agriculture" by Adil Denizli, Ashok Kumar Nadda, Ghulam Yasin, Susai

Rajendran, Tuan Anh Nguyen, Elsevier Science, 2021.
2. "Nanosensors for Chemical and Biological Applications" by Kevin C. Honeychurch, Elsevier Science, 2014.
3. "Environmental Nanotechnology: Applications and Impacts of Nanomaterials" by Mark R. Wiesner, Jean-Yves Bottero, McGraw Hill Professional, 2007.
4. "Nanoparticle Technology for Drug Delivery" by Ram B. Gupta, Uday B. Kompella, Taylor & Francis, 2006.
5. "Nanomaterials for Biosensors" by Challa S. S. R. Kumar, Wiley-VCH Verlag GmbH & Co. KGaA, 2007.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	2	-	-	-	-	-	-	-	2
6	3	-	-	-	-	3	-	-	-	-	-	1	-	2
Avg.	3	-	-	-	-	2.5	-	-	-	-	-	1	-	2

1-low, 2-medium, 3-high

COURSE CODE	OPTICAL COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I FIBER OPTIC GUIDES **9**

Light wave generation systems, system components, optical fibers: SI, GI fibers, modes, Dispersion in fibers, limitations due to dispersion, Fiber loss, Non linear optics –Brilluion, Raman effects, Four wave mixing, Dispersion shifted and Dispersion flattened fibers.

MODULE II OPTICAL TRANSMITTERS AND RECEIVERS **9**

Basic concepts, LED's structure spectral distribution, semiconductor lasers, gain coefficients, Transmitter design, Receiver PIN and APD diodes design, noise sensitivity and degradation, Receiver amplifier design, laser amplifiers, Raman – and Brillouin – fiber amplifiers, Erbium doped – fiber amplifiers.

MODULE III LIGHT WAVE SYSTEM **9**

Coherent, homodyne and heterodyne keying formats, BER in synchronous – and asynchronous – receivers, sensitivity degradation, system performance, Multichannel systems: WDM systems and networks, multiple access networks, WDM components, TDM, Subcarrier and Code division multiplexing.

MODULE IV DISPERSION COMPENSATION SCHEMES **9**

Limitations, Post- and Pre- compensation techniques, Equalizing filters, fiber based gratings, Soliton communication system, fiber Soliton, Soliton based communication system design, High capacity and WDM soliton system.

MODULE V HIGH SPEED DATA TRANSMISSION TECHNIQUES **9**

SDM Techniques, modes of optical fiber, SDM Components, MMF and MCF based SDM systems, Optical signal processing: Nonlinear Optical Loop Mirrors, Parametric Amplifiers, Optical Flip–Flops, XPM-Based Wavelength Converters.

COURSE OUTCOMES

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

- **CO1:** classify Fiber optics communication system with its advantages & disadvantages
- **CO2:** demonstrate the working principles of various fiber and the effect of nonlinearity issues in optical fiber transmission system
- **CO3:** categorize the types of sources and receivers with respect to its working function
- **CO4:** interpret the function of a lightwave system and its role in multiplexing techniques
- **CO5:** examine the effect of dispersion on signal quality in high-speed data transmission..
- **CO6:** describe the principles of WDM and its application in increasing data transmission capacity in lightwave systems.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Fiber-Optic Communication Systems" by Govind P. Agrawal, 5th Edition, John Wiley and Sons, 2021.

2. "Lightwave Technology: Components and Devices" by Govind P. Agrawal, John Wiley and Sons, New Jersey, 2004.

REFERENCES:

1. "Optical Networks: A Practical Perspective" by Rajiv Ramaswami, Kumar N. Sivarajan, and Galen H. Sasaki, Third Edition, Harcourt Asia Pvt. Ltd., 2010.
2. "Applications of Nonlinear Fiber Optics" by Govind P. Agrawal, Academic Press, Elsevier, Burlington, 2007.
3. "Multiwavelength Optical Networks - Architecture, Design and Control" by Thomas E. Stern, Georgios Ellinas, and Krishna Bala, 2nd Edition, Cambridge University Press, 2009.
4. "Fiber Optic Networks" by Green P.E., Prentice Hall, 1993.
5. "Optical Communication, Systems and Components" by Franz & Jain, Narosa Publications, New Delhi, 2000.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2			2				1	1			2	1
2	3	1			2				1	1			2	1
3	3	1			2				1	1			2	1
4	3	1			2				1	1			2	1
5	3	1			2				1	1			2	1
6	3	2			2				1	1			2	1
Avg.	3	1.33			2				1	1			2	1

1-low, 2-medium, 3-high

COURSE CODE	SOFTWARE DEFINED RADIO ARCHITECTURE AND APPLICATIONS	L	T	P	C
		3	0	0	3

MODULE I SOFTWARE DEFINED RADIO **9**

Software Defined Radio: Benefits of Multi-standard Terminals - Operational Requirements - New Base-Station and Network - Smart Antenna Systems – Projects and Sources of Information on Software Defined Radio.

MODULE II SDR ARCHITECTURE **9**

Software Defined Radio Architectures - Ideal Software Defined Radio Architecture - Required Hardware Specifications - Digital Aspects of a Software Defined Radio - Current Technology Limitations - Impact of Superconducting Technologies on Future SDR Systems.

MODULE III SIGNAL PROCESSING DEVICES AND ARCHITECTURES **9**

General Purpose Processors(GPP) - Digital Signal Processors(DSP) - Field Programmable Gate Arrays(FPGA) - Specialized Processing Units - Application-Specific Integrated Circuits – GPP Based SDR – FPGA Based SDR - Host Interface - Architecture for FPGA Based SDR- Hybrid and Multi-FPGA Architectures, Hardware Acceleration- Multi-Channel SDR.

MODULE IV COGNITIVE RADIO: TECHNIQUES AND SIGNAL PROCESSING **9**

Communication policy and Spectrum Management - SDR architecture for cognitive radio Cognitive radio cycle - Cognitive radio architecture - Spectrum sensing: Energy detection – Cyclo-stationary and Wavelet based sensing - Performance analysis based on probability of detection versus SNR - Cooperative sensing: different fusion rules, wideband spectrum sensing- performance analysis based on probability of detection versus SNR.

MODULE V COGNITIVE RADIO: HARDWARE AND APPLICATIONS **9**

Spectrum allocation models - Spectrum handoff - Cognitive radio performance analysis - Hardware platforms for Cognitive radio – Universal Software radio Peripheral (USRP) – Wireless Open Access Research Platform (WARP) - Applications of Cognitive radio.

COURSE OUTCOMES

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

- **CO1:** identify the benefits, requirements and processors used in Software Defined Radio.
- **CO2:** explain Software Defined Radio architecture and Cognitive architecture with specifications and limitations.
- **CO3:** interpret various signal processing devices and architectures used in SDR architecture.
- **CO4:** infer the performance of various spectrum sensing methods based on probability of detection.
- **CO5:** identify suitable cognitive radio test bed for spectrum sensing applications
- **CO6:** evaluate the performance of various cognitive radio test beds for real time signals

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "RF and Baseband Techniques for Software Defined Radio" by Peter B. Kenington, Artech House, 2005.
2. "Implementing Software Defined Radio" by Eugene Grayver, Springer New York, 2014.

REFERENCES:

1. "Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems" by Hüseyin Arslan, Springer Netherlands, 2014.
2. "Cognitive Radio Technology" by Bruce A. Fette, Elsevier Science, 2009.
3. "Cognitive Radio Communications and Networks: Principles and Practice" by Alexander M. Wyglinski, Maziar Nekovee, and Thomas Hou, Elsevier Science, 2009.
4. "Software Radio Architecture: Object-Oriented Approaches to Wireless Systems Engineering" by Joseph Mitola, Wiley, 2004.
5. "Software Radio: A Modern Approach to Radio Engineering" by Jeffrey Hugh Reed, Prentice Hall, 2002.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2											2	
2	3	2											2	
3	3	2											2	
4	3	2											2	
5	3	2											2	
6	3	2							2	2			2	
Avg.	3	2							2	2			2	

1-low, 2-medium, 3-high

COURSE CODE	HIGH SPEED COMMUNICATION CIRCUITS	L	T	P	C
		3	0	0	3

MODULE I CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES 8

CMOS: MOSFET Physics - Noise: Thermal, shot, flicker, popcorn noise - Transceiver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR - Phase noise - Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low-IF Architectures - Transmitter: Direct-up conversion, Two-step up conversion schemes.

MODULE II HIGH FREQUENCY AMPLIFIER 10

Review of S-parameters and Smith chart - High frequency amplifier design - Unconditional Stability - Design for Maximum Gain and Specified Gain -Low Noise Amplifiers: Power match and Noise match, single-ended and differential LNAs.

MODULE III FILTERS, OSCILLATORS AND MIXERS 12

Basic resonator and filter configuration, special filter realizations, filter implementation - Impedance Normalization- Basic oscillator model, high-frequency oscillator configuration, Colpitt's oscillator design – basic characteristics of mixers, single and double-balanced mixers - Image Reject Mixer.

MODULE IV FEEDBACK SYSTEMS AND POWER AMPLIFIERS 8

Feedback Systems: Stability of feedback systems, Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations, Compensation - Power Amplifiers: General model - Class A, AB, B, C, D, E and F amplifiers .

MODULE V PLL AND FREQUENCY SYNTHESIZERS 7

PLL: Linearized Model, Noise properties, Phase detectors, Loop filters and Charge pumps Frequency Synthesizers: Integer-N frequency synthesizers - Direct Digital Frequency Synthesizers.

COURSE OUTCOMES

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

- **CO1:** outline the nonlinear effects in RF transceiver circuits and stability condition in high frequency amplifier.
- **CO2:** interpret the characteristics of RF transmitter and receiver
- **CO3:** make use of the stability condition to compute maximum gain and specified gain for RF amplifiers
- **CO4:** infer the performance of RF passive microwave filters, mixer and oscillators for high-speed communication network
- **CO5:** infer the characteristics of power amplifiers, PLL and frequency synthesizers
- **CO6:** infer the significance of filters, oscillators, mixer, feedback systems, power amplifiers, phase locked loop and frequency synthesizers in high speed communication networks.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Design of CMOS RF Integrated Circuits" by Lee T., 2nd Edition, Cambridge University Press, 2019.
2. "RF Microelectronics" by Razavi B., 2nd Edition, Pearson Education, 2014.

REFERENCES:

1. "Microwave Devices and Circuits" by Samuel Y. Liao, 4th Edition, Prentice Hall of International Ltd, 2009.
2. "RF Circuit Design: Theory and Applications" by Reinhold Ludwig and Gene Bogdanov, 2nd Edition, Pearson Education Inc., 2009.
3. "Microwave Engineering" by David M. Pozar, 4th Edition, Wiley India (P) Ltd, New Delhi, 2021.
4. "Design of Analog CMOS Integrated Circuits" by Razavi B., 2nd Edition, McGraw Hill, 2017.
5. "Radio Frequency Circuit Design" by Alan Davis, 2nd Edition, John Wiley and Sons, 2011.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1											1	
2	3	1											1	
3	3	2	2										1	
4	3	2											1	
5	3	1											1	
6	3	1											1	
Avg.	3	1.33	2										1	

1-low, 2-medium, 3-high

COURSE CODE	5G COMMUNICATION NETWORKS	L	T	P	C
		2	0	2	3

MODULE I 4G NETWORK & ITS ARCHITECTURE **6**

4G features and challenges - Applications of 4G – 4G Technologies - Multicarrier Modulation: OFDM principle- Modulation, Cyclic Prefix – Windowing – PAPR - OFDM in LTE - Timing and Frequency Synchronization - OFDMA and SC-FDMA in LTE - IMS Architecture.

MODULE II 5G NETWORK ARCHITECTURE **6**

Fundamentals of 5G technologies - Goals and Challenges - 5G NR - 5G Architecture: NFV and SDN, RAN – High-level Requirements and Functional Architecture – Physical Architecture - 5G Use Cases.

MODULE III 5G RADIO-ACCESS TECHNOLOGIES **6**

Orthogonal Multiple access systems - (OMA) - Spread spectrum multiple-access systems - Multi-carrier with filtering: a new waveform: Filter-Bank Based Multi-carrier (FBMC) - Universal filtered OFDM - Nonorthogonal multiple access (NOMA) –Superposition Coding - Successive Interference Cancellation - Sparse Code Multiple Access (SCMA) - Interleave division multiple access (IDMA).

MODULE IV MASSIVE MIMO FOR 5G **6**

MIMO in LTE - Single user MIMO - Multi-user MIMO, Capacity of massive MIMO - Hybrid Beam forming for Interference Clustering and User Grouping - Channel models - BER Analysis.

MODULE V SECURITY IN 5G NETWORKS **6**

Security features in 5G networks - Network domain security - User domain security - Flow based QoS framework - Mitigating the threats in 5G.

PRACTICAL EXPERIMENTS:

- 5G-Compliant Waveform Generation and Testing
- OFDM modeling and Performance Analysis
- Performance Analysis of NOMA System
- Performance Analysis of FBMC
- Performance Analysis of Massive MIMO
- Modeling of 5G Synchronization Signal Blocks and Bursts
- Channel Modeling in 5G networks
- 5G New Radio Polar Coding

COURSE OUTCOMES

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

CO1: interpret the performance of multicarrier modulation scheme
CO2: explain the architecture of 5G Network and its use cases
CO3: interpret the performance of new waveforms of 5G system
CO4: interpret the concepts of massive MIMO in 5G networks and evaluate its BER performance metrics

CO5: explain the threats and security features in 5G networks
CO6: develop a code to estimate the performance of 5G waveform

TOTAL : 60 (30+30) PERIODS

TEXT BOOKS:

1. "5G Mobile and Wireless Communications Technology" by Afif Osseiran, Jose F. Monserrat, and Patrick Marsch, Cambridge University Press, 2016.
2. "Evolution of Air Interface for 5G: Radio Access Technology and Performance Analysis" by Suvra Sekhar Das and Ramjee Prasad, River Publishers, 2018.

REFERENCES:

1. "Fundamentals of LTE" by Arunabha Ghosh, Jan Zhang, Jefferey Andrews, and Riaz Mohammed, Pearson Education, 2010.
2. "5G Mobile Communications" by Xiang W., Zheng K., and Shen X.S., Springer, 2016.
3. "5G Wireless: A Comprehensive Introduction" by William Stallings, 1st Edition, 2021.
4. "Fundamentals of Massive MIMO" by Thomas L. Marzetta, Erik G. Larsson, Hong Yang, and Hien Quoc Ngo, Cambridge University Press, 2018.
5. "Opportunities in 5G Networks: A Research and Development Perspective" by Fei Hu, CRC Press, Taylor & Francis Group, 2016.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1		2	2								3	
2	3												3	
3	3												3	
4	3	1		2	2								3	
5	3								2	2			3	
6	3				2				2	2			3	
Avg.	3	1		2	2				2	2			3	

1-low, 2-medium, 3-high

COURSE CODE	WIRELESS BROADBAND NETWORKS	L	T	P	C
		3	0	0	3

MODULE I 4G NETWORKS AND ITS PROTOCOLS 9

Overall network architecture, EPC architecture, E- UTRAN architecture - mobility management, radio resource management, Quality of service, Mobile IP- Client based and Network based IP mobility Network architecture evolution and small cells. E-UTRAN and NAS protocols.

MODULE II MEDIUM ACCESS CONTROL FUNCTIONS IN 4G 9

Logical and transport channel mapping, downlink/uplink data transfer, MAC control element, PDU packet formats, scheduling services, random access procedure.

MODULE III PHYSICAL LAYER FUNCTIONS 9

Down link physical layer - Characteristics of wireless channels, frame structure, resource structure, allocation, mapping, synchronization.

Uplink physical layer - Principles of SC-FDMA, Uplink frame structure, Physical resource structure and channel mapping, Uplink reference signals and channel estimation.

MODULE IV NETWORK SLICING FOR 5G AND BEYOND 9

Heterogeneous Networks, Device-to-Device Communication, Network Slicing: Concept and Definitions, Network Slicing Principles, Network Slicing Enablers, Resource Management for Network Slicing - Motivation and Introduction, RAN Resources, Use Case: Virtual Reality (VR).

MODULE V BROADBAND COMMUNICATIONS FOR UBIQUITOUS CONNECTIVITY 9

Dynamic UAV Communication Networks Based on Deep Reinforcement Learning, Utility-Based Dynamic Resource Allocation in IEEE 802.11ax Networks: A Genetic Algorithm Approach.

COURSE OUTCOMES

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

- **CO1:** outline the evolution of basic architectures and MAC layer functions in 4G wireless networks.
- **CO2:** describe the architecture and evolution of the 4G network and its protocols.
- **CO3:** infer the functions of the MAC layer, uplink / downlink data transfer, packet formats, scheduling services and random access procedures.
- **CO4:** outline the performance of the downlink / uplink physical layers, including characteristics, frame and resource structure, allocation, mapping, and synchronisation of physical layer functions.
- **CO5:** describe heterogeneous networks, device-to-device communication, principles, enablers & resource management for network slicing, RAN & virtual reality and ubiquitous computing in broadband connection.
- **CO6:** interpret the interconnecting network functionalities by layer level functions, and ubiquitous connections in broadband communication

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "LTE-Advanced – A Practical Systems Approach to Understanding the 3GPP LTE Releases 10 and

11 Radio Access Technologies" by Sassan Ahmadi, Elsevier, 2014.

2. "Network Slicing for 5G and Beyond Networks" by Ahsan Kazmi S. M., Latif U. Khan, Nguyen H. Tran, Springer, 2019.

REFERENCES:

1. "Broadband Communications, Computing, and Control for Ubiquitous Intelligence" by Lin Cai, Brian L. Mark, Jianping Pan, Springer, 2022.
2. "Resource Allocation in Next-Generation Broadband Wireless Access Networks" by Chetna Singhal, Swades De, IGI Global, 2017.
3. "Emerging Innovations in Wireless Networks and Broadband Technologies" by Naveen Chilamkurti, IGI Global, 2016.
4. "Fundamentals of 5G Mobile Networks" by Jonathan Rodriguez, John Wiley, 2015.
5. "LTE and Evolution to 4G Wireless: Design and Measurement Challenges" by Moray Rumney, Agilent Technologies, 2008.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2	3												2	
3	3												2	
4	3												2	
5	3												2	
6	3												2	
Avg.	3												2	

1-low, 2-medium, 3-high

COURSE CODE	MASSIVE MIMO NETWORKS	L	T	P	C
		3	0	0	3

MODULE I MIMO SYSTEMS **9**

The crowded spectrum, need for high data rate, MIMO systems – Array Gain, Diversity Gain, Data Pipes, Spatial MUX, MIMO System Model. MIMO System Capacity – channel known at the TX, Channel unknown to the TX – capacity of deterministic channels, Random channels and frequency selective channels.

MODULE II MIMO DIVERSITY AND SPATIAL MULTIPLEXING **9**

Sources and types of diversity, Analysis under Rayleigh fading, Diversity and channel knowledge. Alamouti space time code. MIMO spatial multiplexing: Space time receivers, ML, ZF, MMSE and Sphere decoding, BLAST receivers and Diversity multiplexing trade – off.

MODULE III MASSIVE MIMO SYSTEM **9**

MIMO for LTE, Capacity of massive MIMO, Pilot Design for massive MIMO, Resource allocation and transceivers design, Base band and RF implementation, Channel Models.

MODULE IV MILLIMETER WAVES **9**

Millimeter wave characteristics- Channel performance at 60 GHz – Gigabit wireless communication – Development of millimeter wave standards-coexistence with wireless backhaul – review of modulation for millimeter wave – OOK, PSK, FSK and QAM.

MODULE V TRANSCEIVERS FOR MILLIMETER WAVES **9**

Millimeter wave link budget – Transceiver architecture – Transceiver without mixer- Receiver without local oscillator – Millimeter wave calibration – Millimeter wave antennas – parameters – beam steering antenna- Millimeter wave design consideration.

COURSE OUTCOMES

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

- **CO1:** infer MIMO systems and its diversity & multiplexing
- **CO2:** classify the various techniques required for improving the capacity of the wireless channel in MIMO systems.
- **CO3:** interpret diversity and spatial multiplexing for MIMO systems.
- **CO4:** infer the concepts of transceiver structure for Massive MIMO and resource allocation issues
- **CO5:** identify the issues and challenges of millimetre wave communication and explain modulation schemes for millimetre waves.
- **CO6:** outline the characteristics of Massive MIMO and millimetre wave communication.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Fundamentals of Wireless Communication" by David Tse and Pramod Viswanath, 1st Edition, Cambridge University Press, 2009.
2. "Millimeter Wave Communication Systems" by Kao-Cheng Huang, Zhaocheng Wang, Wiley, 2011.

REFERENCES:

1. "Handbook of RF, Microwave, and Millimeter-Wave Components" by Sergey M. Smolskiy, Leonid A. Belov, and Victor N. Kochemasov, Artech House Microwave Library, 2012.
2. "Space-Time Coding: Theory and Practice" by Hamid Jafarkhani, Cambridge University Press, 2005.
3. "Coding for MIMO Communication Systems" by Tolga M. Duman, Ali Ghrayeb, John Wiley & Sons, Ltd, 2007.
4. "Foundations of Massive MIMO" by T.L. Marzetta, E.G. Larsson, Hong Yang, H.Q. Ngo, Cambridge University Press, 2017.
5. "Introduction to Space Time Wireless Communication Systems" by A. Paulraj, Rohit Nabar, Dhananjay Gore, Cambridge University Press, 2003.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3												2	
2	3												2	
3	3												2	
4	3												2	
5	3												2	
6	3												2	
Avg.	3												2	

1-low, 2-medium, 3-high

COURSE CODE	MILLIMETER WAVE COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

MODULE I MM WAVE CHANNEL MODEL **9**

Millimeter wave characteristics– Millimeter wave wireless – Implementation challenges– Radio wave propagation for mm wave: large scale propagation channel effects – Small scale channel effects – Outdoor and Indoor channel models – Emerging applications of millimeter wave communications.

MODULE II MM WAVE DEVICES AND CIRCUITS **9**

Millimeter wave generation and amplification: Peniotrons – Ubitrons – Gyrotrons and Free electron laser – HEMT– Models for mm wave Transistors – Transistor configurations – Analog mm wave components: Amplifiers – Mixers – VCO – PLL. Metrics for analog mm wave devices – Consumption factor theory – Trends and architectures for mm wave wireless –ADC's and DAC's.

MODULE III MM WAVE COMMUNICATION SYSTEMS **9**

Modulations for millimeter wave communications: OOK, PSK, FSK, QAM, OFDM – Millimeter wave link budget – Transceiver architecture– Transceiver without mixer– Receiver without Oscillator– Millimeter wave calibration– production and manufacture – Millimeter wave design considerations.

MODULE IV MM WAVE MIMO SYSTEMS **9**

Massive MIMO Communications – Spatial diversity of Antenna Arrays – Multiple Antennas – Multiple Transceivers– Noise coupling in MIMO system – Potential benefits for mm wave systems – Spatial – Temporal and Frequency diversity – Dynamic spatial – frequency and modulation allocation.

MODULE V ANTENNAS FOR MM WAVE SYSTEMS **9**

Antenna beam width –Polarization – Advanced beam steering and beam forming – mm wave design consideration – On–chip and In package mm wave antennas – Techniques to improve gain of on–chip antennas – Implementation for mm wave in adaptive antenna arrays – Device to Device communications over 5G systems – Design techniques of 5G mobile.

COURSE OUTCOMES

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

- **CO1:** infer the characteristics channel and propagation effects influencing millimeter wave communication systems
- **CO2:** classify the characteristic of millimeter wave channel modelling
- **CO3:** interpret the various components of Millimeter wave Communications system.
- **CO4:** compute the trade-offs between modulation and coding schemes in millimeter-wave communication
- **CO5:** examine the diversity and beamforming techniques in millimeter wave systems.
- **CO6:** describe the overall performance of millimeter-wave communication systems based on antenna systems, modulation and coding techniques, and diversity schemes.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Millimeter Wave Communication Systems" by Kao-Cheng Huang, Zhaocheng Wang, Wiley, 2011.

2. "Millimeter-Wave Wireless Communication Systems: Theory and Applications" by Chia-Chin Chong, Kiyoshi Hamaguchi, Peter F. M. Smulders, Su-Khiong, Hindawi Publishing Corporation, 2006.

REFERENCES:

1. "Millimeter Wave Wireless Communications" by Theodore S. Rappaport, Robert W. Heath Jr., Robert C. Daniels, James N. Murdock, Pearson Education, 2015.
2. "5G Mobile Communications" by Xiang W., Zheng K., Shen X.S., Springer, 2016.
3. "Introduction to RF Propagation" by John S. Seybold, John Wiley and Sons, 2005.
4. "Millimeter-Wave (mmWave) Communications" by Manuel García Sanchez, MDPI, 2020.
5. "mmWave Massive MIMO – A Paradigm for 5G" by Shahid Mumtaz, Jonathan Rodriguez, Linglong Dai, Elsevier Science, 2016.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3								1	1			3	
2	3								1	1			3	2
3	3								1	1			3	2
4	3								1	1			3	2
5	3								1	1			3	1
6	3								1	1			3	2
Avg.	3								1	1			3	1.8

1-low, 2-medium, 3-high

COURSE CODE	ADVANCED WIRELESS COMMUNICATION TECHNIQUES	L	T	P	C
		3	0	0	3

MODULE I COOPERATIVE COMMUNICATIONS AND GREEN CONCEPTS 9

Network architectures and research issues in cooperative cellular wireless networks - Cooperative communications in OFDM and MIMO cellular relay networks: issues and approaches - Green modulation and coding schemes.

MODULE II COOPERATIVE TECHNIQUES 9

Cooperative techniques for energy efficiency - Cooperative base station techniques for cellular wireless networks - Antenna architectures for cooperation - Cooperative communications in 3GPP LTE-Advanced.

MODULE III RELAY-BASED COOPERATIVE CELLULAR NETWORKS 9

Collaborative relaying in downlink cellular systems - Radio resource optimization - Adaptive resource allocation - Cross-layer scheduling design for cooperative wireless two-way relay networks - Network coding in relay-based networks.

MODULE IV GREEN RADIO NETWORKS 9

Base Station Power-Management Techniques - Energy-saving techniques in cellular wireless base stations - Power-management for base stations in smart grid environment - Cooperative multi cell processing techniques for energy-efficient cellular wireless communications.

MODULE V ACCESS TECHNIQUES FOR GREEN RADIO NETWORKS 9

Cross-layer design of adaptive packet scheduling for green radio networks - Energy-efficient relaying for cooperative cellular wireless networks - Energy performance in TDD-CDMA multihop cellular networks - Resource allocation for green communication in relay-based cellular networks.

COURSE OUTCOMES

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

- **CO1:** explain the concepts of cooperative cellular wireless networks and infer the cooperative techniques utilized for energy efficiency
- **CO2:** summarize the modulation and coding schemes used in green radio networks
- **CO3:** explain the concepts of cooperative communication in 3GPP LTE-Advanced
- **CO4:** explain the techniques applied in Relay-based cooperative cellular networks
- **CO5:** use of power management and power saving techniques for green radio networks
- **CO6:** explain the concepts of access techniques and resource allocation for green radio networks

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Cooperative Cellular Wireless Networks" by Ekram Hossain, Dong In Kim, Vijay K. Bhargava, Cambridge University Press, 2011.
2. "Green Radio Communication Networks" by Ekram Hossain, Vijay K. Bhargava, Gerhard P. Fettweis, Cambridge University Press, 2012.

REFERENCES:

1. "Green Communications and Networking" by F. Richard Yu, Yu Zhang, and Victor C. M. Leung, CRC Press, 2012.
2. "Towards Green ICT" by Ramjee Prasad, Shingo Ohmori, Dina Simunic, River Publishers, 2010.
3. "Green Communications: Theoretical Fundamentals, Algorithms and Applications" by Jinsong Wu, Sundeep Rangan, and Honggang Zhang, CRC Press, 2012.
4. "Green Communications: Principles, Concepts and Practice" by Konstantinos Samdanis, Peter Rost, Andreas Maeder, John Wiley & Sons Ltd, 2015.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3			1									2	
2	3			1									2	
3	3												2	
4	3												2	
5	3												2	
6	3								3	3			2	
Avg.	3			1					3	3			2	

1-low, 2-medium, 3-high

COURSE CODE	WIDE BANDGAP DEVICES	L	T	P	C
		3	0	0	3

MODULE I WBG DEVICES AND THEIR APPLICATION IN REAL WORLD 9

Review of semiconductor basics-Operation and characteristics of the SiC Schottky Barrier Diode-SiC DMOSFET and GaN HEMT-Review of Wide bandgap semiconductor technology -Advantages and disadvantages.

MODULE II SWITCHING CHARACTERIZATION OF WBG 9

Turn-on and Turn-off characteristics of the device-Hard switching loss analysis-Double pulse test set-up.

MODULE III DRIVERS FOR WIDE BAND GAP DEVICES 9

Gate driver- Impact of gate resistance- Gate drivers for wide bandgap power devices - Transient immunity integrated gate drivers.

MODULE IV HIGH FREQUENCY DESIGN COMPLEXITY AND PCB DESIGNING 9

Effects of parasitic inductance- Effects of parasitic capacitance- EMI filter design for high frequency power converters High frequency PCB design- Conventional power loop design- High frequency power loop optimization- Separation of power from signal PCB.

MODULE V APPLICATIONS OF WIDE BANDGAP DEVICES 9

Consumer electronics applications- Wireless power transfer applications- Electric vehicle Applications- Renewable energy sources applications.

COURSE OUTCOMES

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

- **CO1:** explain the need for wide bandgap devices and utilize it for various test cases.
- **CO2:** interpret the design principles of power devices and summarize the real world application of Wide band gap devices
- **CO3:** infer the switching characteristics of the Wideband gap devices and analyse the losses occurred in choosing WBG devices
- **CO4:** make use of the suitable drivers for different applications of wide band gap devices
- **CO5:** interpret the challenges in using WBG for high frequency applications and PCB designing.
- **CO6:** utilize wideband gap devices for suitable real time applications.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "GaN Transistors for Efficient Power Conversion" by A. Lidow, J. Strydom, M. D. Rooij, D. Reusch, Wiley, 2014, ISBN-13: 978-1118844762.
2. "Gallium Nitride-enabled High Frequency and High Efficiency Power Conversion" by G. Meneghesso, M. Meneghini, E. Zanoni, Springer International Publishing, 2018, ISBN: 978-3-319-77993-5.

REFERENCES:

1. "Characterization of Wide Bandgap Power Semiconductor Devices" by F. Wang, Z. Zhang, and E. A.

Jones, IET, ISBN-13: 978-1785614910, 2018.
2. "Gallium Nitride and Silicon Carbide Power Devices" by B. J. Baliga, World Scientific Publishing Company, 3 Feb. 2017.
3. "Digital Control of High Frequency Switched-Mode Power Converters" by L. Corradini, D. Maksimovic, P. Mattavelli, R. Zane, Wiley, ISBN-13: 978-1118935101, 9th June 2015.
4. "GaN Transistors for Efficient Power Conversion" by Alex Lidow, Michael De Rooij, Johan Strydom, David Reusch, and John Glaser, Third Edition, Wiley, 2020.
5. "Gallium Nitride and Silicon Carbide Power Devices" by Jayant Baliga B., World Scientific, 2017.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													2
2	3													2
3	3													2
4	3													2
5	3													2
6	3													2
Avg.	3													2

1-low, 2-medium, 3-high

COURSE CODE	SYSTEM DESIGN USING FPGA	L	T	P	C
		3	0	0	3

MODULE I COMPLEX PROGRAMMABLE LOGIC DEVICES AND FPGAs 9

Programmable Logic to ASICs - PROMS, PLAs, PALs, MGA ASICs, CPLDs and FPGAs - CPLDs - CPLD Architectures - Function Blocks - I/O Blocks - Clock Drivers – Interconnects - CPLD Technology and Programmable Elements - Embedded devices.

FPGAs - FPGA Architectures - Configurable Logic Blocks - Configurable I/O Blocks – Programmable interconnects - Clock Circuitry - SRAM vs Antifuse Programming - Emulating and prototyping ASICs. Comparison of CPLDs and FPGAs.

MODULE II FPGA BASED SYSTEMS AND FABRICS 9

Introduction - Basic Concepts- Digital Design and FPGAs - Role of FPGAs - FPGA Types - FPGA Based System Design- Registers and RAM.

Introduction to FPGA Fabrics - FPGA Architectures - SRAM Based FPGAs - Permanently Programmed FPGAs-Chip I/O - Circuit Design of FPGA Fabrics - Architecture of FPGA Fabrics.

MODULE III COMBINATIONAL AND SEQUENTIAL LOGIC NETWORKS DESIGN 9

Logic Design Process – Modeling with HDLs - Combinational Network Delay-Power and Energy Optimization - Arithmetic Logic - Logic implementation for FPGAs - Physical Design for FPGAs - Sequential Machine Design Process - Sequential Design styles - Rules for Clocking – Performance analysis - Power Optimization.

MODULE IV FPGA ARCHITECTURE DESIGN AND LARGE SCALE SYSTEMS 9

Behavioral Design - Data path controller Architectures - Scheduling and Allocation – Power – Pipelining - Design Methodologies - Design Example - Digital Signal Processor.

Introduction to Large scale systems - Busses - Platform FPGAs - Multi FPGA systems, Novel Architectures.

MODULE V PLACEMENT & ROUTING AND APPLICATIONS 9

Programmable interconnect - Partitioning and Placement, Routing resources, Modelling concepts in Verilog HDL ,System Design Examples using Xillinx FPGAs – Traffic light Controller, Real Time Clock - Interfacing using FPGA: VGA, Keyboard, LCD.

COURSE OUTCOMES

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

- **CO1:** model Complex Programmable Logic devices and FPGAs based digital systems
- **CO2:** interpret the various features of CPLDs and FPGAs
- **CO3:** explain the FPGA based systems and their fabrication process
- **CO4:** model combinational and sequential circuits logic networks
- **CO5:** outline the FPGA architecture, large scale systems and Placement-Routing methods

CO6: develop real time examples using FPGAs.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "FPGA Based System Design" by Wayne Wolf, Prentice Hall Modern Semiconductor Design Series, 2005.
2. "Designing with FPGAs and CPLDs" by Bob Zeidman, Elsevier, CMP Books, 2002.

REFERENCES:

1. "Verilog HDL" by Samir Palnitkar, 2nd Edition, Pearson Education, 2003.
2. "FPGA-Based System Design" by Wayne Wolf, Pearson Education, International Edition, 2004.
3. "Digital Systems Design with FPGAs and CPLDs" by Ion Grout, Elsevier, 2008.
4. "Advanced Digital Design with the Verilog HDL" by Michael D. Ciletti, 2nd Edition, Prentice Hall, 2011.
5. "Digital VLSI System Design: A Design Manual for Implementation of Projects on FPGAs and ASICs Using Verilog" by S. Ramachandran, Springer Publication, 2007.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													2
2	3													2
3	3													2
4	3													2
5	3													2
6	3													2
Avg.	3													2

1-low, 2-medium, 3-high

COURSE CODE	LOW POWER IC DESIGN	L	T	P	C
		2	0	2	3

MODULE I POWER DISSIPATION IN CMOS **6**

Hierarchy of limits of power – Sources of power consumption – Physics of power dissipation in CMOS FET devices – Basic principle of low power design.

MODULE II POWER OPTIMIZATION **6**

Logical level power optimization – Circuit level low power design – Circuit techniques for reducing power consumption in Adders and Multipliers.

MODULE III DESIGN OF LOW POWER CMOS CIRCUITS **6**

Computer Arithmetic techniques for low power systems – Reducing power consumption in memories – Low power clock– Interconnect and layout design – Advanced techniques – Special techniques.

MODULE IV POWER ESTIMATION **6**

Power estimation techniques – Logic level power estimation – Simulation power analysis – Probabilistic power analysis.

MODULE V SYNTHESIS AND SOFTWARE DESIGN FOR LOW POWER **6**

Synthesis for low power –Behavioral level transforms – Software design for low power.

PRACTICAL EXERCISES

1. Modeling and Sources of Power Consumption
2. Power estimation at different design levels (mainly circuit, transistor, and gate)
3. Power optimization for combinational circuits
4. Power optimization for sequential circuits
5. Power optimization for Register Trasnfer and algorithmic levels

COURSE OUTCOMES

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

CO1: explain the principles of low power circuit design and its sources
CO2: recall the fundamentals of power optimization techniques
CO3: describe the sources of power and physics of power dissipation
CO4: explain the low power methods for memories
CO5: build memory circuits and low-voltage, low-power arithmetic circuits
CO6: describe the software design for low power vlsi circuits

TOTAL : 60(30+30) PERIODS

TEXT BOOKS:

1. "Low Power CMOS VLSI Circuit Design" by K. Roy and S.C. Prasad, Wiley & Sons, 2014.
2. "Practical Low Power Digital VLSI Design" by Gary K. Yeap, Springer US, 2012.

REFERENCES:

1. "Low-Power VLSI Circuits and Systems" by Ajit Pal, Springer, Technology & Engineering, 2014.
2. "Low Power VLSI Design Fundamentals" by Angsuman Sarkar, Swapnadip De, Manash Chanda, Chandan Kumar Sarkar, De Gruyter, 2016.
3. "Low Power Digital VLSI Design" by Abdellatif Bellaouar, Mohamed I. Elmasry, Kluwer, 2008.
4. "Designing CMOS Circuits for Low Power" by Dimitrios Soudris, Christian Piguet, Costas Goutis, Springer US, 2010.
5. "Low Voltage SOI CMOS VLSI Devices and Circuits" by James B. Kuo, Shih-Chia Lin, John Wiley and Sons, Inc., 2004.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3				1									2
2	3				1									2
3	3				1									2
4	3				1									2
5	3				1									2
6	3				1									2
Avg.	3				1									2

1-low, 2-medium, 3-high

COURSE CODE	VLSI TESTING AND DESIGN FOR TESTABILITY	L	T	P	C
		3	0	0	3

MODULE I TEST REQUIREMENTS AND METRICS **9**

Validation platforms- SOC design methodology-IP components-Integration-Clocking- I/Os and Interfaces-Device modes- Logic memories-analog, I/Os, power management-Test requirements-Test handoffs-ATPG, DFT, BIST,COF, TTR-Test cost metrics and test economics- Logic fault models- SAF, TDF, PDF, Iddq, StBDG, Dy-BDG- SDD-Basics of test generation and fault simulation- Combinational circuits,Sequential.

MODULE II SCAN DESIGN AND BIST **9**

Scan Design- Scan design requirements-Types of scan and control mechanisms- Test pattern construction for scan-Managing scan in IPs and SOCs-Scan design optimisations- Partitioning, Clocking requirements for scan and delay fault testing-Speed of operation-BIST – Framework-Controller configurations-FSMs-LFSRs- STUMPS architecture- Scan compression and bounds-Test per cycle-Test per scan- Self-testing and self-checking circuits-online test.

MODULE III MEMORY TEST AND TEST INTERFACES **9**

Memory Test -Memory fault models-Functional architecture as applicable to test-Test of memories- Test of logic around memories-BIST controller configuration- Test of logic around memories- DFT and architecture enhancements- Algorithmic optimisations- Test Interfaces-Test control requirements- Test interfaces -SOC test,Board test, System test, Boundary scan.

MODULE IV DESIGN CONSIDERATIONS AND POWER MANAGEMENT DURING TEST **9**

Design Considerations- Design considerations-Physical design congestion-Partitioning- Clocks-Test modes-Pins- Test scheduling- Embedded test- Architecture improvements-Test in the presence of security; Power management during test- Methods for low power test, ATPG methods,DFT methods, Scan methods-Low power compression-Test of power management- Implications of power excursions, Optimisations.

MODULE V ANALOG TEST **9**

Test requirements- DFT methods.BIST methods- Test versus measurement- Defect tests versus performance tests- Tests for specific modules - PLL, I/Os, ADC, DAC, SerDes- RF test requirements.

COURSE OUTCOMES

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

CO1: explain different test procedures to find various faults that can occur during the design of an IC.

CO2: interpret the logic and fault simulation requirements and testability measures for device under test.

CO3: infer the requirements for testing and methods that aids Design for Testability and understand the test pattern generations and self-testing.

CO4: make use of test models for testing memory and interfaces.
CO5: explain testing with power management techniques and efficient memory fault models.
CO6: interpret the need for various testing procedures for manufacturing an Integrated circuit.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits" by Vishwani Agrawal and Michael Bushnell, Springer, 2002.

2. "Digital Systems Testing and Testable Design" by Miron Abramovici, Melvin A. Breuer, and Arthur D. Friedman, John Wiley & Sons Inc, 1994.

REFERENCES:

1. "VLSI Test Principles and Architectures: Design for Testability" by Laung-Terng Wang, Cheng-Wen Wu, Xiaoqing Wen, Elsevier Science, 2006.
2. "Fault Tolerant and Fault Testable Hardware Design" by Parag K. Lala, B S Publications, 2002.
3. "Advanced VLSI Design and Testability Issues" by Suman Lata Tripathi, Sobhit Saxena, Sushanta Kumar Mohapatra, CRC Press, 2020.
4. "Testing and Diagnosis of VLSI and ULSI" by F. Lombardi, M.G. Sami, Springer Netherlands, 2012.
5. "System-on-Chip Test Architectures Nanometer Design for Testability" by Laung-Terng Wang, Charles E. Stroud, Nur A. Touba, Elsevier Science, 2010.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													2
2	3													2
3	3													2
4	3													2
5	3													2
6	3													2
Avg.	3													2

1-low, 2-medium, 3-high

COURSE CODE	ANALOG IC DESIGN	L	T	P	C
		3	0	0	3

MODULE 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 - design of Differential and Cascode Amplifiers to meet specified SR, noise, gain, BW, ICMR and power dissipation, voltage swing, high gain amplifier structures.

MODULE 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.

MODULE III FEEDBACK AMPLIFIER AND OPERATIONAL AMPLIFIERS 9

Properties and types of negative feedback circuits - effect of loading in feedback networks - operational amplifier performance parameters - single stage Op Amps - two-stage Op Amps - input range limitations - gain boosting - slew rate - power supply rejection - noise in Op Amps.

MODULE IV STABILITY, FREQUENCY COMPENSATION 9

Multipole Systems - Phase Margin - Frequency Compensation - Compensation Of Two Stage Op Amps - Slewing In Two Stage Op Amps - Other Compensation Techniques.

MODULE V VOLTAGE AND CURRENT REFERENCES 9

Current sinks and sources, Current mirrors, Wilson current source, Widlar current source, Cascode current source, Design of high swing Cascode sink, current amplifiers, Supply independent biasing, temperature independent references, PTAT and CTAT current generation, Constant-Gm Biasing.

COURSE OUTCOMES

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

- **CO1:** make use of the small signal model of MOSFET to derive the small-signal equivalent circuit of single stage MOSFET amplifiers, differential amplifiers and cascode amplifiers
- **CO2:** apply small signal analysis to compute the transfer function of single stage amplifiers
- **CO3:** infer the frequency response and noise characteristics of MOSFET amplifiers
- **CO4:** compare the characteristics of feedback amplifier and operational amplifier topologies
- **CO5:** interpret frequency stability & compensation techniques in operational amplifiers and the characteristics of voltage and current references
- **CO6:** interpret the concepts of feedback amplifiers, operational amplifiers, voltage references and current references

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Design of Analog CMOS Integrated Circuits" by Behzad Razavi, Tata McGraw Hill, 2001.

2. "Analysis and Design of Analog Integrated Circuits" by Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, 5th Edition, John Wiley & Sons, 2009.

REFERENCES:

1. "Analog Design Essentials" by Willy M.C. Sansen, Springer, 2006.
2. "Bipolar and MOS Analog Integrated Circuit Design" by Grebene, John Wiley & Sons, 2003.
3. "CMOS Analog Circuit Design" by Phillip E. Allen, Douglas R. Holberg, 2nd Edition, Oxford University Press, 2002.
4. "CMOS: Circuit Design, Layout, and Simulation" by Jacob Baker, 3rd Edition, Wiley IEEE Press, 2010.
5. "Voltage References From Diode to Precision Higher Order Band Gap Circuits" by Gabriel A. Rincon-Mora, John Wiley & Sons, 2002.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2											1
2	3	2	2											1
3	3	2	2											1
4	3	2	2											1
5	3	2	2											1
6	3	2	2											1
Avg.	3	2	2											1

1-low, 2-medium, 3-high

COURSE CODE	MIXED SIGNAL IC DESIGN	L	T	P	C
		3	0	0	3

MODULE I SUBMICRON CMOS CIRCUIT DESIGN 9

CMOS Process flow – Capacitors and resistors –Digital circuit design: MOSFET switch – Delay elements – adder- Analog circuit design: Biasing – Op amp Design – Mixed-Signal Layout Issues: Floor Planning- Power Supply and Grounding Issues- Fully Differential Design- Guard Rings- Shielding -Interconnect.

MODULE II CONTINUOUS TIME FILTERS 9

First order filters-Second order filters- G_m-C filters- Transconductors Using Fixed Resistors- CMOS Transconductors Using Triode Transistors- CMOS Transconductors Using Active Transistors- Bipolar Transconductors - Bicmos Transconductors - Active RC and MOSFET-C Filters- Tuning Circuitry- Complex Filters.

MODULE III NONLINEARITY AND SWITCHED CAPACITOR CIRCUITS 9

Basic building blocks - Basic operation and analysis - Noise in Switched Capacitor Circuits - First-Order Filters - Biquad Filters- Charge Injection- Switched Capacitor Gain Circuits- Correlated Double-Sampling Techniques- Switched capacitor amplifiers - Switched capacitor integrator - Nonlinearity – Mismatch.

MODULE IV DIGITAL TO ANALOG AND ANALOG TO DIGITAL CONVERTERS 9

Introduction and characterization of DAC - Parallel DAC - Extending the resolution of parallel DAC - Serial DAC - Introduction and characterization of ADC - Serial ADC - Medium ADC - High speed ADC.

MODULE V OSCILLATORS AND PLLs 9

Oscillatory system – Ring oscillators – LC oscillators – Voltage Controlled Oscillators (VCO) – Mathematical model of VCO - Simple PLL - Charge - pump PLLs - Non ideal effects in PLLs: PFD/CP non idealities - jitter in PLLs - Delay locked loops - PLL applications.

COURSE OUTCOMES

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

CO1: infer the characteristics of mixed signal circuits and continuous time filters
CO2: interpret the concepts of mixed signal circuit design
CO3: interpret the concepts of continuous time filters
CO4: infer the characteristics of switched capacitor circuits
CO5: infer the characteristics of data converters, oscillators and PLLs
CO6: interpret the concepts of switched capacitor circuits, data converters, oscillators and PLLs.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "CMOS Circuit Design, Layout, and Simulation" by R.J. Baker, H.W. Li, D.E. Boyce, Wiley-IEEE Press, 3rd Edition, 2010.
2. "Design of Analog CMOS Integrated Circuits" by Behzad Razavi, Tata McGraw Hill, 2001.

REFERENCES:

1. "CMOS Mixed-Signal Circuit Design" by R.J. Baker, Wiley Publications, 2002.
2. "CMOS Analog Circuit Design" by Phillip E. Allen and Douglas R. Holberg, Oxford University Press, 2002.
3. "Analog Integrated Circuit Design" by Tony Chan Carusone, David A. Johns, and Ken Martin, 2nd Edition, John Wiley and Sons, 2011.
4. "Electronic Filter Design Handbook" by Williams and Taylor, McGraw-Hill, 3rd Edition, 1995.
5. "Continuous-Time Active Filter Design" by Deliyannis, Sun, and Fidler, CRC Press, 1998.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2											1
2	3	2	2											1
3	3	2	2											1
4	3	2	2											1
5	3	2	2											1
6	3	2	2											1
Avg.	3	2	2											1

1-low, 2-medium, 3-high

COURSE CODE	VERILOG HDL	L	T	P	C
		3	0	0	3

MODULE I OVERVIEW OF DIGITAL DESIGN WITH VERILOG HDL 9

Evolution of Computer Aided Digital Design and Emergence of HDLs - Typical Design flow - Importance of HDLs - Popularity of Verilog HDL - Hierarchical Modeling Concepts: Design Methodologies - 4 bit Ripple Carry Counter - Modules - Instances - Components of a Simulation.

MODULE II GATE LEVEL MODELING 9

Basic Concepts: Lexical Conventions - Data types - System Tasks and Compiler - Modules - Ports - Gate Types: AND Gate, OR Gate, Buffer, Not Gate - Multiplexer - 4 bit Full Adder - Gate Delays: Rise, Fall, Turn off Delays, Minimum, Typical, Maximum Delays - Delay Examples.

MODULE III DATA FLOW MODELING 9

Continuous Assignments: Implicit Continuous Assignment - Delays: Regular Assignment Delay, Implicit Continuous Assignment Delay, Net Declaration Delay - Expressions, Operators and Operands - Operator Types-Operator Precedence- 4 to1 Multiplexer-4 bit Full Adder - Ripple Counter.

MODULE IV BEHAVIOURAL MODELING 9

Structured Procedures - Procedural Assignments - Timing Controls - Conditional Statements - Multiway Branching - Loops - Sequential and Parallel Blocks - 4 to 1 Multiplexer - 4 bit Counters - Traffic Signal Controller.

MODULE V TASKS, FUNCTIONS AND SWITCH LEVEL MODELING 9

Tasks - Functions - Differences between Tasks and Functions - Switch Level Modeling: Switch Level Modeling Elements - MOS Switches - CMOS Switches - Bidirectional Switches - Power and Ground - Resistive Switches - Delay Specification on Switches - CMOS NOR gate - 2 to 1 Multiplexer - Simple CMOS Flip Flop.

COURSE OUTCOMES

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

- **CO1:** identify the correct level of abstraction for a given digital design
- **CO2:** understand the Verilog HDL language constructs and programming principles
- **CO3:** develop Verilog code for various types of gate level modeling combinational circuits.
- **CO4:** develop Verilog code in data flow level modeling for combinational and sequential circuits.
- **CO5:** utilize Verilog HDL's behavioral and switch level modeling for constructing the digital circuits.
- **CO6:** construct the digital circuits with various Verilog HDL modeling techniques.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Verilog HDL - A Guide to Digital Design and Synthesis" by Samir Palnitkar, 2nd Edition, Pearson Education, 2003.
2. "Fundamentals of Digital Logic with Verilog Design" by Stephen Brown and Zvonko G. Vranesic, 3rd

Edition, McGraw Hill Higher Education, 2014.

REFERENCES:

1. "Design Through Verilog HDL" by Padmanabhan T.R, Bala Tripura Sundari B., John Wiley & Sons, 2008.
2. "The Verilog Hardware Description Language" by Donald E. Thomas, Philip R. Moorby, 5th Edition, Springer US, 2013.
3. "Advanced Digital Design with the Verilog HDL" by Michael D. Ciletti, 2nd Edition, Pearson (Prentice Hall), 2011.
4. "Verilog HDL Synthesis, A Practical Primer" by Bhasker J., 3rd Edition, Star Galaxy Publishing, 2018.
5. "Verilog Digital System Designs" by Zainalabedin Navabi, 2nd Edition, McGraw Hill, 2005.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2											2
2	3	2	2											2
3	3	2	2											2
4	3	2	2											2
5	3	2	2											2
6	3	2	2											2
Avg.	3	2	2											2

1-low, 2-medium, 3-high

COURSE CODE	VLSI SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

MODULE I LOW POWER FIR FILTERS **9**

Introduction to DSP systems – Typical DSP algorithms, Data flow and Dependence graphs - critical path, Loop bound, iteration bound, longest path matrix algorithm, Pipelining and Parallel processing of FIR filters, Pipelining and Parallel processing for low power.

MODULE II RETIMING AND ALGORITHMIC STRENGTH REDUCTION **9**

Retiming – definitions and properties, Unfolding – an algorithm for unfolding, properties of unfolding, sample period reduction and parallel processing application, Algorithmic strength reduction in filters and transforms – 2-parallel FIR filter, 2-parallel fast FIR filter, DCT architecture, rank-order filters, Odd-Even merge-sort architecture, parallel rank-order filters.

MODULE III LOW POWER IIR **9**

Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm, Pipelined and parallel recursive filters – Look-Ahead pipelining in first-order IIR filters, Look-Ahead pipelining with powerof-2 decomposition, Clustered look-ahead pipelining, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.

MODULE IV BIT-LEVEL ARITHMETIC ARCHITECTURES **9**

Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, Design of Lyon's bit-serial multipliers using Horner's rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner's rule for precision improvement, Distributed Arithmetic fundamentals and FIR filters.

MODULE V SYNCHRONOUS, WAVE AND ASYNCHRONOUS PIPELINING **9**

Numerical strength reduction – sub expression elimination, multiple constant multiplication, iterative Matching, synchronous pipelining and clocking styles, clock skew in edge-triggered single phase clocking, two-phase clocking, wave pipelining. Asynchronous pipelining bundled data versus dual rail protocol.

COURSE OUTCOMES

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

CO1: explain the principles of low-power parallel computing, algorithmic strength reduction of DSP filters.
CO2: explain the concepts of loop bound, iteration bound, pipelining and parallel processing of FIR filters
CO3: interpret the retiming and algorithmic strength reduction methods for FIR filters
CO4: develop a various low power algorithms for IIR filters
CO5: develop an optimized DSP architectures using bit-level arithmetic and pipelining methods
CO6: build a low power IIR filters and optimal VLSI architectures for DSP applications

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "VLSI Digital Signal Processing Systems Design and Implementation" by Keshab K. Parhi, Wiley India Pvt. Limited, 2007.
2. "Digital Signal Processing with Field Programmable Gate Arrays" by Uwe Meyer Baese, Second Edition, Springer, 2013.

REFERENCES:

1. "Digital Signal Processing – Principles, Algorithms, and Applications" by John G. Proakis and Dimitris G. Manolakis, 4th Edition, Pearson Education, 2014.
2. "Analog VLSI Integration of Massive Parallel Signal Processing Systems" by Peter Kinget and Michiel Steyaert, Springer US, 2013.
3. "VLSI Signal Processing Technology" by Magdy A. Bayoumi and E. Swartzlander, Springer, 2012.
4. "VLSI Design Methodologies for Digital Signal Processing Architectures" by Magdy A. Bayoumi, Springer US, 2012.
5. "Architectures for Digital Signal Processing" by Peter Pirsch, Wiley India (P) Ltd., 2009

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2												1
2	3	2												1
3	3	2												1
4	3	2												1
5	3	2												1
6	3	2												1
Avg.	3	2												1

1-low, 2-medium, 3-high

VERTICALS-MINOR

COURSE CODE	COMMUNICATION AND NETWORKING TECHNOLOGIES FOR IoT	L	T	P	C
		2	0	2	3

MODULE I INTERNET OF THINGS **6**

Definition and Characteristics of IoT - Physical Design of IoT - Logical design of IoT - IoT enabled Technologies: Wireless Sensor Networks, Cloud Computing, Big data analytics, Communication protocols and Embedded Systems - IoT Levels & Deployment Templates.

MODULE II ARCHITECTURE AND PROTOCOLS OF IoT **6**

Architecture for IoT using Mobile devices- Mobile Technologies for supporting IoT ecosystem- IoT and M2M: Software defined networking, Network function virtualization-IoT System Management with NETCONF-YANG, SNMP, NETOPEER- Layered architecture for IoT- Protocol architecture of IoT- Infrastructure Protocols.

MODULE III COMMUNICATION TECHNOLOGIES **6**

Enablling Technologies : 6LoWPAN, Zigbee,Wi-Fi, BT, BLE, SIG, NFC, LORA- IoT protocols and softwares: MQTT – UDP -MQTT brokers –Publish and subscribe modes – HTTP – COAP -XMPP and gateway protocols.

MODULE IV PHYSICAL DEVICES & LOGICAL DESIGN **6**

Basic building blocks of a IoT Device- Python packages of interest for IoT- Python web application framework-Programming Inputs and outputs, Serial, SPI and I2C – Sensors and its Interfacing using Raspberry Pi. **OPEN SOURCE HARDWARE:** Raspberry Pi physical devices- Raspberry Pi Interfaces- Pi Programming APIs/Packages- Web services

MODULE V IoT APPLICATION AND USE CASES **6**

Street light monitoring using light radiation sensors- health monitoring: Bio signal Sensors for Cardiovascular System Monitoring - Fire detection using temperature sensors - Inventory Management and Quality Control- Green House control— Smart Home, Automobile theft control- Air Quality Monitoring systems using web server and cloud support.

PRACTICAL EXPERIMENTS

Embedded 'C' programs using NODE MCU ESP 8266 boards

1. IoT Controlled LED using Google Firebase Console
2. IoT based weather monitoring system to track temperature and humidity data over the internet using ESP 8266 and ThingSpeak.
3. Track a Vehicle on Google Maps using Arduino, ESP8266 & GPS
4. IoT Based Air Pollution Monitoring System to monitor the Air Quality over a webserver using internet
5. Develop an Android application using called MIT App Inventor 2 to control the colour of an RGB LED with a smart phone via Bluetooth module.

Python Programming using Raspberry Pi boards

1. Getting started with Raspberry Pi – OS Installation, library dependencies, Internet Connectivity.
2. Interfacing XBee Module with Raspberry Pi
3. Data acquisition and control using the MQTT based cloud server with the user interface as Mobile APP and web browser
4. Real Time Face Recognition with Raspberry Pi and OpenCV

COURSE OUTCOMES

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

CO1: interpret the fundamental concepts and terminology related to the architecture and protocols used in IoT-based systems

CO2: explain the physical and logical design principles of IoT systems.

CO3: infer the benefits of a layered architecture approach for organizing complex IoT systems

CO4: explain the principles underlying communication protocols and technologies in IoT.

CO5: develop python based application program for serial communication and Sensor interfacing using raspberry.

CO6: develop innovative IoT-based applications tailored to specific use cases and requirements, integrating sensor data, communication protocols, data analytics, and user interfaces.

TOTAL : 60(30+30) PERIODS

TEXT BOOKS:

1. "Internet of Things - A Hands-on Approach" by Arshdeep Bahga and Vijay Madisetti, 1st Edition, Universities Press, 2015.
2. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases" by Pethuru Raj, Anupama C. Raman, 1st Edition, CRC Press (Taylor & Francis Group), 2017.

REFERENCES:

1. "Enabling Things to Talk – Designing IoT Solutions with the IoT Architecture Reference Model" by Alessandro Bassi, Martin Bauer, Martin Fiedler, Thorsten Kramp, Rob van Kranenburg, Sebastian Lange, Stefan Meissner, 1st Edition, Springer Open, 2016.
2. "The Internet of Things: From RFID to the Next-Generation Pervasive Network" by Lu Yan, Yan Zhang, Laurence T. Yang, Huansheng Ning, 1st Edition, Auerbach Publications, March 2008.
3. "Introduction to IoT" by Sudip Misra, Anandarup Mukherjee, Arijit Roy, 1st Edition, Cambridge University Press, 2021.
4. "Getting Started with Raspberry Pi" by Matt Richardson & Shawn Wallace, 1st Edition, O'Reilly Media Press, 2012.
5. "Internet of Things in the Cloud: A Middleware Perspective" by Honbo Zhou, 1st Edition, CRC Press, 2012.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2											2
2	3	2	2											2
3	3	2	2											2
4	3	2	2											2
5	3	2	2	2	2				1	2				2
6	3	2	2	2	2				1	2				2
Avg.	3	2	2	2	2				1	2				2

1-low, 2-medium, 3-high

COURSE CODE	MOBILE APP DEVELOPMENT FOR IOT	L	T	P	C
		3	0	0	3

MODULE I IoT ECOSYSTEM **9**

IoT ecosystem - Application development platforms for IoT - IoT Data sources - Overview of Mobile App and Mobile Interface: Mobile System - Mobile Interface and Applications - Mobile Cloud.

MODULE II SENSORS FOR MOBILE & HAND HELD DEVICES **9**

Temperature sensors - Proximity sensor - IR sensors, Image sensors - Motion detection sensors - Accelerometer sensors - Gyroscope sensors - Optical sensors.

MODULE III SENSOR DATA PROCESSING **9**

Sensor Data - Gathering and Data - Dissemination Mechanisms; Sensor Database system architecture; Sensor data - fusion mechanisms; Data - fusion Architectures and models.

MODULE IV PROGRAMMING AND FRAMEWORKS FOR IoT **9**

IoT Programming Approaches: Node - Centric Programming - Database approach – Model - Driven Development - IoT Programming Frameworks: MIT app inventor - Android Things - ThingSpeak - IoTivity – Node - RED - DeviceHive - Contiki and Cooja - Zetta.

MODULE V APPLICATIONS AND CASE STUDIES **9**

Applications and Case Studies: Home automations - Smart cities - Environment - Energy - Healthcare - Logistics -Agriculture - Industry - Health and life style.

COURSE OUTCOMES

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

CO1: examine the need for sensors, application development platforms and interface
CO2: interpret the application development platforms and mobile interface for IoT
CO3: identify suitable sensor circuits interfacing using microcontrollers.
CO4: categorize the sensor data for processing various models in IoT
CO5: interpret the IoT programming and framework for various applications
CO6: build mobile applications for different applications using sensor data and IoT frameworks.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Parallel Computing Architectures and APIs: IoT Big Data Stream Processing" by Vivek Kale, 1st Edition, CRC Press, 2019.
2. "Internet of Things for Architects: Architecting IoT Solutions by Implementing Sensors, Communication Infrastructure, Edge Computing, Analytics, and Security" by Perry Lea, 1st Edition, Packt Publishing Ltd, 2018.

REFERENCES:

1. "Mobile Computing" by Asoke K. Talukder, Hasan Ahmed, Roopa R. Yavagal, 2nd Edition, Tata McGraw Hill Pub, 2010.

2. "Mobile Applications Development with Android Technologies and Algorithms" by Meikang Qiu, Wenyun Dai, and Keke Gai, Chapman and Hall/CRC Publication, 2016.
3. "JavaScript and jQuery: Interactive Front-End Web Development" by Jon Duckett, Gilles Ruppert, and Jack Moore, CreateSpace Independent Publishing Platform, 2017.
4. "Professional Mobile Application Development" by Jeff McWherter and Scott Gowell, John Wiley & Sons, 2012.
5. "IoT, AI, and Blockchain for .NET: Building a Next-Generation Application from the Ground Up" by Nishith Pathak, Anurag Bhandari, Apress, 2018.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	1	-	-	-	-	-	-	-	-	2
6	3	-	1	-	-	-	-	-	-	-	-	-	-	2
Avg.	3	-	1	-	1	-	-	-	-	-	-	-	-	2

1-low, 2-medium, 3-high

COURSE CODE	PYTHON PROGRAMMING FOR IoT APPLICATIONS	L	T	P	C
		2	0	2	3

MODULE I INTRODUCTION TO PYTHON 6

Basic Syntax Variable and Data Types Operator: int, float, boolean, string, and list -Variables, expressions, statements, tuple assignment, precedence of operators, comments -Modules and functions, function definition and use, flow of execution, parameters and arguments.

MODULE II CONTROL FLOW & FUNCTIONS 6

Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else) - Iteration: state, while, for, break, continue, pass - Fruitful functions: return values, parameters, local and global scope, function composition, recursion - Strings: string slices, immutability, string functions and methods, string module - Lists as array s- Lists, Tuples, Dictionaries.

MODULE III LISTS, TUPLES, DICTIONARIES & FILE HANDLING 6

Lists - List Operations – Mutation – Aliasing - Cloning – Tuple assignment - Tuple as return value - Dictionaries: Operations and methods - Advanced list processing - List comprehension – Variables **Files and exception Handling :** text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages.

MODULE IV CLASSES AND INHERITANCE 6

Object Oriented Programming - Class Instances - Class and object- Attributes -Inheritance –Overloading - Overriding - Data hiding- ***An Extended Example***: Building a Class - Visualizing the Hierarchy - Adding another Class - Using Inherited Methods – Grade book – Generators.

MODULE V PROGRAMMING THE RASPBERRY PI 3 USING PYTHON 6

Programming General Purpose Input / Output (GPIO) port pins -Interfacing seven segment LED and LCD Display , servomotor - Real time Monitoring & Data logging System using I2C protocol - Email notifier using Gmail SMTP server -Data Acquisition and control for Industrial/ Home Automation using MQTT Protocol.

PRACTICAL EXPERIMENTS

Developing programs using Python Language to the following topics

- Programs using simple statements, data types and expressions
- Input/output and conditional statements in scripts
- Different operator and conversion functions.
- Conditionals and Iterative loops.
- To implement Real-time applications using Lists and Tuples.
- To implement Real-time applications using Sets and Dictionaries.
- To control the brightness of LED using PWM techniques
- To implement Weather monitoring system by interfacing analog and digital sensors with Raspberry pi
- To control the speed and direction of DC motors using Raspberry pi

- To implement water level detection system using Raspberry pi

COURSE OUTCOMES

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

CO1: interpret the programming concepts of Python to develop simple computational programs.
CO2: develop Python programs using conditionals & loops and functions.
CO3: infer the datatypes of python language and utilize it for developing solutions for real time applications.
CO4: make use of Python lists, tuples & dictionaries for data manipulation and file handling
CO5: apply the concepts of classes and inheritance of Object Oriented Programming to develop python based applications.
CO6: develop Raspberry pi based applications using Input/output devices, sensors and actuators.

TOTAL : 60(30+30) PERIODS

TEXT BOOKS:

1. "Think Python: How to Think Like a Computer Scientist" by Allen B. Downey, 2nd Edition, Shroff/O'Reilly Publishers, 2016.
2. "Learn Raspberry Pi Programming with Python" by Wolfram Donat, ebook, Apress Publishers, May 2014.

REFERENCES:

1. "Introduction to Computer Science using Python: A Computational Problem-Solving Focus" by Charles Dierbach, Wiley India Edition, 2013.
2. "Python Programming with Raspberry Pi" by Sai Yamanoor & Srihari Yamanoor, 1st Edition, Packt Publishing, 2017.
3. "Introduction to Computation and Programming Using Python" by John V Guttag, 1st Edition, MIT Press, 2013.
4. "An Introduction to Python" by Guido van Rossum and Fred L. Drake Jr., 1st Edition, Network Theory Ltd., 2011.
5. "Programming the Raspberry Pi: Getting Started with Python" by Simon Monk, 1st Edition, McGraw-Hill, 2013.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2	2	-	-	-	-	-	-	-	-	-	-	3
2	3	2	2	-	-	-	-	-	-	-	-	-	-	3
3	3	2	2	-	-	-	-	-	-	-	-	-	-	3
4	3	2	2	-	-	-	-	-	-	-	-	-	-	3
5	3	2	2	-	-	-	-	-	-	-	-	-	-	3
6	3	2	2	-	-	-	-	-	-	-	-	-	-	3
Avg.	3	2	2	-	-	-	-	-	-	-	-	-	-	3

1-low, 2-medium, 3-high

COURSE CODE	NANO SENSORS AND APPLICATIONS	L	T	P	C
		3	0	0	3

MODULE I NANO SENSORS **9**

Nano science and Nanotechnology - Definition of sensor parameters and characteristics - Evolution of Semiconductor-based Micro sensors- Definition and Classification of Nano sensors, Examples of Nano sensors.

MODULE II MATERIALS FOR NANO SENSORS **9**

Classification of Nanoparticles – Core/Shell-structured Nanoparticles- Optical Properties of Bulk Metals and Metallic Nanoparticles - Quantum Dots- Carbon Nanotubes –Nanoporous Materials.

MODULE III NANO BIOSENSORS **9**

Nanoparticle-based Electrochemical Biosensors - CNT-based Electrochemical Biosensors - Functionalization of CNTs for Biosensor Fabrication - Nanotube and Nanowire-based FET Nano biosensors - Cantilever- based Nano biosensors.

MODULE IV NANOTECHNOLOGY ENABLED DEVICES **9**

Scanning Tunnelling Microscope, Atomic Force Microscope, Mechanical Nanosensors, Thermal Nanosensors, Optical Nanosensors, Magnetic Nanosensors – Gas Sensors-based on Nanomaterials – Metallic Nanoparticle-based Gas Sensors- MQ-2, 3,4,6,7,135 Gas Sensors.

MODULE V APPLICATIONS OF NANO SENSORS **9**

Soil moisture Nanosensors - Nanosensors for pesticide detection in soil- Nanosensors for intelligent food packaging – Electrochemical Nanosensors for blood glucose analysis - Nanomaterials for Groundwater Remediation- Injectable Nanoparticles for Efficient Drug Delivery.

COURSE OUTCOMES

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

CO1: interpret the technology and materials used for nano sensors
CO2: illustrate the characteristics, evolution and classification of nanosensors
CO3: classify the nanoparticles and infer the properties of nanomaterials
CO4: interpret the functionalization of biosensors based on nanostructured materials
CO5: infer the working of nanotechnology enabled devices and applications of nano sensors
CO6: make use of nano biosensors and devices for real time applications

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Nanosensors: Physical, Chemical and Biological" by Vinod Kumar Khanna, Taylor & Francis, 2016.
2. "Nanostructured Materials: Processing, Properties and Applications" by Carl C. Koch, Jaico Publishing House, 2006.

REFERENCES:

1. "Nanosensors for Smart Agriculture" by Adil Denizli, Ashok Kumar Nadda, Ghulam Yasin, Susai Rajendran, Tuan Anh Nguyen, Elsevier Science, 2021.
2. "Nanosensors for Chemical and Biological Applications" by Kevin C. Honeychurch, Elsevier Science, 2014.
3. "Environmental Nanotechnology: Applications and Impacts of Nanomaterials" by Mark R. Wiesner, Jean-Yves Bottero, McGraw Hill Professional, 2007.
4. "Nanoparticle Technology for Drug Delivery" by Ram B. Gupta, Uday B. Kompella, Taylor & Francis, 2006.
5. "Nanomaterials for Biosensors" by Challa S. S. R. Kumar, Wiley-VCH Verlag GmbH & Co. KGaA, 2007.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	3	-	-	-	-	2	-	-	-	-	-	-	-	2
6	3	-	-	-	-	3	-	-	-	-	-	1	-	2
Avg.	3	-	-	-	-	2.5	-	-	-	-	-	1	-	2

1-low, 2-medium, 3-high

COURSE CODE	SMART SENSORS AND APPLICATIONS FOR IoT	L	T	P	C
		3	0	0	3

MODULE I STRAIN AND PRESSURE SENSORS **9**

Static and dynamic characteristics of an instrumentation system– Principles and classification of transducers – Electrical transducers– basic requirements of transducers- Resistance strain gauge – piezoelectric pressure gauge – characteristics – Electronic circuits for strain gauge – load cells – Interferometry – Pressure gauges: Aneroid capacitance pressure gauge– Ionization gauge.

MODULE II DISPLACEMENT, FORCES AND TORQUE MEASUREMENT **9**

Resistive potentiometer: Linear, circular L.V.D.T. – variable inductance and capacitive sensors: The Parallel Plate Capacitive Sensor, Stretched Diaphragm Variable Capacitance Transducer – Piezo electrical transducers– Accelerometer systems–Proximity sensors– synchros and resolvers–Torque and Position Sensors.

MODULE III LIGHT RADIATION SENSORS **9**

Color temperature – light flux – photosensors – photomultiplier – photoresistor and photoconductors – photodiodes – phototransistors – photovoltaic devices – fiber optic applications – light transducers – solid-state transducers – liquid crystal displays.

MODULE IV SMART SENSORS **9**

Primary Sensors – humidity sensors – thermocouples – Resistance thermometers – fluid velocity sensors – Excitation – Amplification– Filters – Converters – Compensation – Information Coding Process – Data Communication – Standards for Smart Sensor Interface – The Automation.

MODULE V INTERNET OF THINGS APPLICATIONS **9**

Tyre and water monitoring using pressure sensors–Elevator using displacement sensors – Intruder alarms, Automatic ticket gates using proximity sensors – Humidity Measurement, Monitoring Room Temperature, Fire detection using temperature sensors–Street light monitoring using light radiation sensors – Smart Home, Automobile theft control, Air Quality Monitoring using smart sensors.

COURSE OUTCOMES

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

CO7: Summarize the working principles of strain, pressure sensors, displacement, forces and torque.
CO8: Explain the static, dynamic characteristics of instrumentation systems.
CO9: Describe the principles of operation of synchros and resolvers.
CO10: Identify the working of different types of light radiation sensors.
CO11: Using the humidity sensors, develop systems for monitoring room temperature, humidity, and fire detection.

CO12: Make use of light radiation sensors to monitor street lights, smart sensors to monitor air quality, automobile theft control, and smart homes.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Sensors and Transducers" by Patranabis D, 2nd Edition, Prentice Hall of India, 2005.
2. "Sensors and Transducers" by Ian R. Sinclair, 3rd Edition, Newnes Publishers, 2001.

REFERENCES:

1. "Measurement Systems, Application and Design" by Ernest O. Doebelin, Dhanesh N. Manik, 6th Edition, McGraw Hill, 2007.
2. "Experimental Methods for Engineers" by Jack P. Holman, 7th Edition, McGraw Hill, USA, 2012.
3. "Transducers, Sensors and Detectors" by Robert G. Seippel, Reston Publishing Company, USA, 1983.
4. "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications" by Rahul Dubey, 1st Edition, Cengage India Publication, 2019.
5. "Make Sensors" by Terokarvinen, Kemo, Karvinen, Villey Valtokari, 1st Edition, Maker Media, 2014.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
2	3	-	-	-	-	-	-	-	-	-	-	-	-	2
3	3	-	-	-	-	-	-	-	-	-	-	-	-	2
4	3	-	-	-	-	-	-	-	-	-	-	-	-	2
5	2	2	-	-	-	-	-	-	-	-	-	-	-	2
6	2	2	-	-	-	2	-	-	-	-	-	1	-	2
Avg.	2.7	2	-	-	-	2	-	-	-	-	-	1	-	2

1-low, 2-medium, 3-high

COURSE CODE	IoT EDGE COMPUTING	L	T	P	C
		3	0	0	3

MODULE I NEW COMPUTING PARADIGMS **9**

Relevant Technologies-Fog and Edge Computing - Completing the Cloud-Hierarchy of Fog and Edge Computing-Business Models-Opportunities and Challenges **-** Integrating IoT, Fog and Cloud Infrastructures.

MODULE II NETWORK SLICES IN 5G, FOG, EDGE, AND CLOUDS **9**

Network Slicing-Network Slicing in Software-Defined Clouds-Network Slicing Management in Edge and Fog- Internet of Vehicles: Architecture, Protocol and Security Seven layered model architecture for Internet of Vehicles- IoV: Network Models.

MODULE III MIDDLEWARE FOR FOG AND EDGE COMPUTING: DESIGN ISSUES **9**

Need for Fog and Edge Computing Middleware-Design Goals-State-of-the-Art Middleware Infrastructures-System Model-Proposed Architecture-Case Study Example.

MODULE IV TECHNOLOGIES IN FOG COMPUTING **9**

Fog Data Management-Motivating Example: Smart Building-Predictive Analysis with Fog Torch Machine Learning in Fog Computing - Data Analytics in the Fog - Data Analytics in the Fog Architecture-Configurations.

MODULE V APPLICATIONS **9**

Exploiting Fog Computing in Health Monitoring-Smart Surveillance Video Stream Processing at the Edge for Real-Time Human Objects Tracking - Fog Computing Model for Evolving Smart Transportation Applications.

COURSE OUTCOMES

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

CO1: explain the principles of Fog and Edge Computing, Network Slicing in 5G, and their integration with Cloud computing and IoT

CO2: interpret the concepts of Fog and Edge Computing & their integration with IoT and Cloud infrastructures

CO3: infer the concepts of Network Slicing Management in Edge and Fog Computing and architecture, protocols, and security in the Internet of Vehicles (IoV)

CO4: apply the key concepts in designing various middleware for Fog and Edge Computing

CO5: examine the technologies of Fog Computing and apply these technologies in fields such as health monitoring, smart surveillance, and intelligent transportation systems

CO6: utilize the appropriate middleware design in Fog/Edge Computing to develop real-time applications

TOTAL : 45 PERIODS

TEXT BOOKS:

1. "Internet of Things: A Hands-on Approach" by Arshdeep Bahga and Vijay Madisetti, 1st edition, Universities Press, 2014.
2. "Fog and Edge Computing: Principles and Paradigms" by Rajkumar Buyya and Satish Narayana Srirama, 1st edition, John Wiley & Sons, 2019.

REFERENCES:

1. "Internet of Things – From Research and Innovation to Market Deployment" by Ovidiu Vermesan, Peter Friess, 1st edition, River Publishers, 2014.
2. "Hands-on Artificial Intelligence for IoT" by Amita Kapoor, 1st edition, Packt Publishing, 2019.
3. "The Internet of Things Enabling Technologies, Platforms, and Use Cases" by Pethuru Raj, Anupama C. Raman, 1st edition, CRC Press (Taylor & Francis Group), 2017.
4. "Internet of Things: Challenges and Opportunities" by Subhas Chandra Mukhopadhyay, 1st edition, Springer, 2015.
5. "Getting Started with Raspberry Pi" by Matt Richardson & Shawn Wallace, 1st Edition, O'Reilly Media Press, 2012.

CO-PO & PSO MAPPING

CO	PO												PSO	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3													2
2	3													2
3	3													2
4	3	2												2
5	3	2												2
6	3	2												2
Avg.	3	2												2

1-low, 2-medium, 3-high