GOVERNMENT COLLEGE OF TECHNOLOGY

(An Autonomous Institution affiliated to Anna University)

Coimbatore - 641 013

Curriculum For

B.E. Electronics and Communication Engineering

(Full Time)

2022

Regulations

OFFICE OF THE CONTROLLER OF EXAMINATIONS

GOVERNMENT COLLEGE OF TECHNOLOGY

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VISION AND MISSION OF THE INSTITUTION

VISION

To emerge as a centre of excellence and eminence by imparting futuristic technical education in keeping with global standards, making our students technologically competent and ethically strong so that they can readily contribute to the rapid advancement of society and mankind**.**

MISSION

- To achieve academic excellence through innovative teaching and learning practices.
- To enhance employability and entrepreneurship.
- To improve the research competence to address societal needs.
- To inculcate a culture that supports and reinforces ethical, professional behaviours for a harmonious and prosperous society.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATIONENGINEERING

VISION AND MISSION OF THE DEPARTMENT

VISION

The vision of ECE department is to become pioneer in higher learning and research and to produce creative solution to societal needs.

MISSION

1. To provide excellence in education, research and public service.
2. To provide quality education and to make the students entrepreneur and employable.
3. Continuous upgradation of techniques for reaching heights of excellence in a global perspective.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATIONENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Program Educational Objectives (PEO's) of Electronics and Communication Engineering are

PEO1: Graduates apply their knowledge of mathematics and science to identify, analyze and solveproblems in the field of Electronics and develop sophisticated communication systems.

PEO2: Graduates exhibit their innovative ideas and management skills to meet the day to day technicalchallenges.

PEO3: Graduates embody a commitment to professional ethics, diversity and social awareness in their professional career.

PEO4: Graduates exhibit a desire for life-long learning through technical training and professional activities.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATIONENGINEERING

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

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 solution 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 culture, societal and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretations 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 access societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environmental and sustainability:** Understanding 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 and finance principles and apply these to one's own work, as a member and leader in a team, to manage projects and 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.

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DEPARTMENT OF ELECTRONICS AND COMMUNICATIONENGINEERING

PROGRAMME SPECIFIC OUTCOMES (PSOs)

PSO1: Graduates will be able to understand and apply the concepts of Electronics andCommunication Engineering in the field of Microelectronics, Signal processing, Communication/Networking, Embedded and VLSI Systems.

PSO2: Graduates will be able to design and utilize advanced Hardware and Software tools toanalyze and implement subsystems/processes for real time applications**.**

PSO3: Graduates will be able to apply domain knowledge to enhance research in the field ofEmbedded Systems, VLSI Systems and Communication Engineering.

GOVERNMENT COLLEGE OF TECHNOLOGY, COIMBATORE – 641 013
B.E.ELECTRONICS AND COMMUNICATION ENGINEERING (FULL TIME)

FIRST SEMESTER

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
	22LMC1Z0	INDUCTION PROGRAMME	MC	-	-	-	-	-	-	0
1	22LHS1Z1	தமிழர் மரபு HERITAGE OF TAMILS	HSMC	40	60	100	1	0	0	1
2	22LHS1Z2	PROFESSIONAL ENGLISH	HSMC	40	60	100	2	1	0	3
3	22LBS1Z1	LINEAR ALGEBRA AND CALCULUS	BS	40	60	100	3	1	0	4
4	22LBS1Z2	ENGINEERING PHYSICS	BS	40	60	100	3	0	0	3
5	22LES101	PROGRAMMING IN C	ES	40	60	100	3	0	0	3
6	22LMC1Z1	ENVIRONMENTAL SCIENCE AND ENGINEERING	MC	40	60	100	3	0	0	0
PRACTICAL										
7	22LHS1Z3	CAMBRIDGE ENGLISH	HSMC	60	40	100	0	0	2	1
8	22LBS1Z3	PHYSICS LABORATORY	BS	60	40	100	0	0	3	1.5
9	22LES1Z2	WORKSHOP PRACTICE	ES	60	40	100	0	0	3	1.5
10	22LES103	PROGRAMMING IN C LABORATORY	ES	60	40	100	0	0	3	1.5
TOTAL				**480**	**520**	**1000**	**15**	**2**	**11**	**19.5**

SECOND SEMESTER

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1	22LHS2Z4	தமிழரும் தொழில் நுட்பமும் TAMILS AND TECHNOLOGY	HSMC	40	60	100	1	0	0	1
2	22LHS2Z5	VALUES AND ETHICS	HSMC	40	60	100	3	0	0	3
3	22LBS204	DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS	BS	40	60	100	3	1	0	4
4	22LBS205	SEMICONDUCTOR PHYSICS	BS	40	60	100	3	0	0	3
5	22LBS206	APPLIED CHEMISTRY	BS	40	60	100	3	0	0	3
6	22LES204	BASICS OF ELECTRICAL ENGINEERING	ES	40	60	100	3	0	0	3
PRACTICAL										
7	22LBS2Z7	CHEMISTRY LABORATORY	BS	60	40	100	0	0	3	1.5
8	22LES2Z5	ENGINEERING GRAPHICS	ES	60	40	100	1	0	4	3
TOTAL				**320**	**380**	**700**	**15**	**2**	**7**	**21.5**

THIRD SEMESTER

SI. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1.	22LES306	CIRCUIT THEORY	ES	40	60	100	3	1	0	4
2.	22LES307	DATA STRUCTURES (Common to EEE, ECE & CSE Branches)	ES	40	60	100	3	0	0	3
3.	22LPC301	SIGNALS AND SYSTEMS	PC	40	60	100	3	1	0	4
4.	22LPC302	ANALOG CIRCUITS	PC	40	60	100	3	0	0	3
5.	22LPC303	DIGITAL CIRCUITS DESIGN	PC	40	60	100	3	0	0	3
6.	22LPC304	ELECTROMAGNETIC WAVES AND WAVEGUIDES	PC	40	60	100	3	0	0	3
PRACTICAL										
7.	22LES308	DATA STRUCTURES LABORATORY (Common to ECE & CSE Branches)	ES	60	40	100	0	0	3	1.5
8.	22LPC305	ELECTRONIC CIRCUITS AND SIMULATION LABORATORY	PC	60	40	100	0	0	3	1.5
TOTAL				**360**	**440**	**800**	**18**	**2**	**6**	**23**

FOURTH SEMESTER

SI. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1.	22LBS408	PROBABILITY AND RANDOM PROCESS	BS	40	60	100	3	1	0	4
2.	22LPC406	ANALOG INTEGRATED CIRCUITS	PC	40	60	100	3	0	0	3
3.	22LPC407	ANALOG COMMUNICATION	PC	40	60	100	3	0	0	3
4.	22LPC408	DIGITAL SIGNAL PROCESSING	PC	40	60	100	3	0	0	3
5.	22LPC409	NETWORKS AND TRANSMISSION LINES	PC	40	60	100	3	0	0	3
	THEORY WITH PRACTICAL COMPONENT									
6.	22LPC410	MICROPROCESSOR AND MICROCONTROLLER	PC	50	50	100	3	0	2	4
PRACTICAL										
7.	22LES409	ENGINEERING EXPLORATION FOR ELECTRONICS ENGINEERING	ES	100	-	100	0	0	3	1.5
8.	22LPC411	ANALOG AND DIGITAL IC LABORATORY	PC	60	40	100	0	0	3	1.5
9.	22LPC412	DIGITAL SIGNAL PROCESSING LABORATORY	PC	60	40	100	0	0	3	1.5
TOTAL				**470**	**430**	**900**	**18**	**1**	**11**	**24.5**

FIFTH SEMESTER

SI. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1.	22LPC513	CONTROL SYSTEM ENGINEERING	PC	40	60	100	3	0	0	3
2.	22LPC514	DIGITAL COMMUNICATION	PC	40	60	100	3	0	0	3
3.	22LPC515	EMBEDDED COMPUTING	PC	40	60	100	3	0	0	3
4.	22LPC516	COMPUTER ARCHITECTURE AND ORGANIZATION	PC	40	60	100	3	0	0	3
5.	22LPE$XX	PROFESSIONAL ELECTIVE I	PE	40	60	100	3	0	0	3
6.	22LMC5Z2	CONSTITUTION OF INDIA (Common to all branches)	MC	40	60	100	3	0	0	0
PRACTICAL										
7.	22LPC517	ANALOG AND DIGITAL COMMUNICATION LABORATORY	PC	60	40	100	0	0	3	1.5
8.	22LPC518	EMBEDDED COMPUTING LABORATORY	PC	60	40	100	0	0	3	1.5
TOTAL				**160**	**440**	**600**	**18**	**0**	**6**	**18**

SIXTH SEMESTER

SI. No	Course Code	0043ourse Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1.	22LPC619	OPTICAL FIBER COMMUNICATION	PC	40	60	100	3	0	0	3
2.	22LPC620	ANTENNAS AND WAVE PROPAGATION	PC	40	60	100	3	0	0	3
3.	22LPC621	VLSI DESIGN	PC	40	60	100	3	0	0	3
4.	22LPC622	COMPUTER NETWORKS (Common to ECE, CSE, IT)	PC	40	60	100	3	0	0	3
5.	22LPE$XX	PROFESSIONAL ELECTIVE II	PE	40	60	100	3	0	0	3
6.	22#OE$XX	OPEN ELECTIVE I/ PROFESSIONAL ELECTIVE VII	OE	40	60	100	3	0	0	3
PRACTICAL										
7.	22LPC623	VLSI DESIGN LABORATORY	PC	60	40	100	0	0	3	1.5
8.	22LPC624	DATA COMMUNICATION AND COMPUTER NETWORKS LABORATORY	PC	60	40	100	0	0	3	1.5
9.	22LES610	DESIGN THINKING FOR ELECTRONICS AND COMMUNICATION ENGINEERING	ES	100	-	100	0	0	3	1.5
TOTAL				**420**	**480**	**900**	**18**	**0**	**9**	**22.5**

SEVENTH SEMESTER

SI. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1.	22LHS706	MANAGEMENT THEORY AND PRACTICE	HSMC	40	60	100	3	0	0	3
2.	22LPC725	MICROWAVE AND RF ENGINEERING	PC	40	60	100	3	0	0	3
3.	22LPC726	WIRELESS COMMUNICATION	PC	40	60	100	3	0	0	3
4.	22LPE$XX	PROFESSIONAL ELECTIVE III	PE	40	60	100	3	0	0	3
5.	22LPE$XX	PROFESSIONAL ELECTIVE IV	PE	40	60	100	3	0	0	3
6.	22#OE$XX	OPEN ELECTIVE II/ PROFESSIONAL ELECTIVE VIII	OE	40	60	100	3	0	0	3
PRACTICAL										
7.	22LPC727	ADVANCED COMMUNICATION SYSTEMS LABORATORY	PC	60	40	100	0	0	4	2
8.	22LEE701	ENGINEERING PROJECTS IN COMMUNITY SERVICE	EEC	60	40	100	0	0	4	2
TOTAL				**360**	**440**	**800**	**18**	**0**	**8**	**22**

EIGHTH SEMESTER

SI. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
THEORY										
1.	22LPE$XX	PROFESSIONAL ELECTIVE V	PE	40	60	100	3	0	0	3
2.	22LPE$XX	PROFESSIONAL ELECTIVE VI	PE	40	60	100	3	0	0	3
PRACTICAL										
3.	22LEE802	CAPSTONE PROJECT	EEC	60	40	100	0	0	16	8
TOTAL				**140**	**160**	**300**	**6**	**0**	**16**	**14**

Total Credits: 165 Industrial Training/ Internship: 4

Total: 169

Note:
Internship of four consecutive weeks or two 2 consecutive weeks which are completed during the vacation of fourth (and/or) fifth (and/or) sixth semester shall be considered here.

S.No.	Course Category	Credits per Semester									Total credits	Total Credits in%	Credits as per AICTE Model Curricula
		I	II	III	IV	V	VI	VII	VIII	Internship			
1.	HS/HSMC	5	4					3			12	7.10	12
2.	BS	8.5	11.5		4						24	14.20	25
3.	ES	6	6	8.5	1.5						22	13.02	24
4.	PC			14.5	19	15	15	8			71.5	42.31	48
5.	PE					3	3	6	6		18	10.65	18
6.	OE						3	3			6	3.55	18
7.	EEC						1.5	2	8	4	15.5	9.17	15
8.	MC	0				0					2		
TOTAL		**19.5**	**21.5**	**23**	**24.5**	**18**	**22.5**	**22**	**14**	**4**	**169**	**100**	**160**

2022R Verticals

Vertical I **High Speed Communications**	**Vertical II** **RF Technologies**	**Vertical III** **Signal and Image Processing**	**Vertical IV** **VLSI Design (Minor & Open to ECE Students)**	**Vertical V** **Bio Medical Technologies**	**VerticalVI** **Embedded Systems and IOT**	**Vertical VII** **Diversified Elective Group (Not for specialization& Honors)**
22LPE$01 Information Theory and Coding	22LPE$09 Electromagnetic Interference and Compatibility	22LPE$17 Advanced Digital Signal Processing	22LPE$25 Digital IC Design	22LPE$33 Biosensors	22LPE$41 Introduction to Internet of Things	22LPE$49 Automotive Electronics
22LPE$02 High Speed Networks	22LPE$10 Electromagnetic Radiation Hazards and Safety	22LPE$18 Image Processing	22LPE$26 Analog IC Design	22LPE$34 Bio Medical Instrumentation Systems	22LPE$42 Introduction to MEMS	22LPE$50 Electronic Circuit Design *(Common to EEE, ECE& EIE)*
22LPE$03 Error Control Coding	22LPE$11 Advanced Radiation Systems	22LPE$19 Speech Signal Processing	22LPE$27 Low Power VLSI	22LPE$35 Medical imaging systems	22LPE$43 Smart Sensors	22LPE$51 Electronic System Design and Productization *(Common to EEE, ECE& EIE)*
22LPE$04 AdHoc and Wireless Sensor networks	22LPE$12 Satellite Communication	22LPE$20 VLSI Signal Processing	22LPE$28 ASIC Design	22LPE$36 Bio Informatics for Bio Medical Engineers	22LPE$44 Industrial Internet of Things *(Common to ECE& EIE)*	22LPE$52 Introduction to Power Electronics
22LPE$05 Software Defined Radio	22LPE$13 Microwave Integrated Circuits	22LPE$21 Non linear Signal Processing	22LPE$29 System on Chip Design	22LPE$37 Bio telemetry and Telemedicine	22LPE$45 Embedded Operating Systems	22LPE$53 High Speed Electronics
22LPE$06 Massive MIMO And Millimeter wave Systems	22LPE$14 Smart Antennas	22LPE$22 Neural Networks and Deep Learning	22LPE$30 Programming FPGA using HDLs	22LPE$38 Bio Medical Signal Processing	22LPE$46 Embedded Processors-I	22LPE$54 Artificial Intelligence and Machine Learning
22LPE$07 Optical Communication Networks	22LPE$15 RF system Design	22LPE$23 Computer Vision Algorithms and Applications	22LPE$31 VLSI Testing and Design for Testability	22LPE$39 Wearable Technologies	22LPE$47 Embedded Processors-II	
22LPE$08 Evolution of 4G/5G Technologies	22LPE$16 RF Transceivers	22LPE$24 Digital Signal Processors	22LPE$32 Design for Verification using Universal Verification Methodology	22LPE$40 Hospital Safety and Management	22LPE$48 Nano Electronics	
			22LPE$20 VLSI Signal Processing		22LPE$49 Automotive Electronics	

PROFESSIONAL ELECTIVE (PE)

Vertical I: HIGH SPEED COMMUNICATIONS

Sl. No	Course Code	Course Title	Category	CA Marks	End sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22LPE$01	INFORMATION THEORY AND CODING	PE	40	60	100	3	0	0	3
2	22LPE$02	HIGH SPEED NETWORKS	PE	40	60	100	3	0	0	3
3	22LPE$03	ERROR CONTROL CODING	PE	40	60	100	3	0	0	3
4	22LPE$04	ADHOC AND WIRELESS SENSOR NETWORKS	PE	40	60	100	3	0	0	3
5	22LPE$05	SOFTWARE DEFINED RADIO	PE	40	60	100	3	0	0	3
6	22LPE$06	MASSIVE MIMO AND MILLIMETER WAVE SYSTEMS	PE	40	60	100	3	0	0	3
7	22LPE$07	OPTICAL COMMUNICATION NETWORKS	PE	40	60	100	3	0	0	3
8	22LPE$08	EVOLUTION OF 4G/5G TECHNOLOGIES	PE	40	60	100	3	0	0	3

PROFESSIONAL ELECTIVE (PE)

Vertical II: RF TECHNOLOGIES

Sl. No	Course Code	Course Title	Category	CA Marks	End sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22LPE$09	ELECTROMAGNET IC INTERFERENCE AND COMPATIBILITY	PE	40	60	100	3	0	0	3
2	22LPE$10	ELECTROMAGNETIC RADIATION HAZARDS AND SAFETY	PE	40	60	100	3	0	0	3
3	22LPE$11	ADVANCED RADIATION SYSTEMS	PE	40	60	100	3	0	0	3
4	22LPE$12	SATELLITE COMMUNICATION	PE	40	60	100	3	0	0	3
5	22LPE$13	MICROWAVE INTEGRATED CIRCUITS	PE	40	60	100	3	0	0	3
6	22LPE$14	SMART ANTENNAS	PE	40	60	100	3	0	0	3
7	22LPE$15	RF SYSTEM DESIGN	PE	40	60	100	3	0	0	3
8	22LPE$16	RF TRANSCEIVERS	PE	40	60	100	3	0	0	3

PROFESSIONAL ELECTIVE (PE)

Vertical III: SIGNAL AND IMAGE PROCESSING

Sl. No	Course Code	Course Title	Category	CA Marks	End sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22LPE$17	ADVANCED DIGITAL SIGNAL PROCESSING	PE	40	60	100	3	0	0	3
2	22LPE$18	IMAGE PROCESSING	PE	40	60	100	3	0	0	3
3	22LPE$19	SPEECH SIGNAL PROCESSING	PE	40	60	100	3	0	0	3
4	22LPE$20	VLSI SIGNAL PROCESSING	PE	40	60	100	3	0	0	3
5	22LPE$21	NON LINEAR SIGNAL PROCESSING	PE	40	60	100	3	0	0	3
6	22LPE$22	NEURAL NETWORKS AND DEEP LEARNING	PE	40	60	100	3	0	0	3
7	22LPE$23	COMPUTER VISION ALGORITHMS AND APPLICATIONS	PE	40	60	100	3	0	0	3
8	22LPE$24	DIGITAL SIGNAL PROCESSORS	PE	40	60	100	3	0	0	3

PROFESSIONAL ELECTIVE (PE)

Vertical IV: VLSI DESIGN

Sl. No	Course Code	Course Title	Category	CA Marks	End sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22LPE$25	DIGITAL IC DESIGN	PE	40	60	100	3	0	0	3
2	22LPE$26	ANALOGIC DESIGN	PE	40	60	100	3	0	0	3
3	22LPE$27	LOW POWER VLSI	PE	40	60	100	3	0	0	3
4	22LPE$28	ASIC DESIGN	PE	40	60	100	3	0	0	3
5	22LPE$29	SYSTEM ON CHIP DESIGN	PE	40	60	100	3	0	0	3
6	22LPE$30	PROGRAMMING FPGA USING HDLs	PE	40	60	100	3	0	0	3
7	22LPE$31	VLSI TESTING AND DESIGN FOR TESTABILITY	PE	40	60	100	3	0	0	3
8	22LPE$32	DESIGN FOR VERIFICATION USING UNIVERSAL VERIFICATION METHODOLOGY	PE	40	60	100	3	0	0	3
9	22LPE$20	VLSI SIGNAL PROCESSING	PE	40	60	100	3	0	0	3

PROFESSIONAL ELECTIVE (PE)

VERTICAL V: BIO MEDICAL TECHNOLOGIES

Sl. No	Course Code	Course Title	Category	CA Marks	End sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22LPE$33	BIOSENSORS	PE	40	60	100	3	0	0	3
2	22LPE$34	BIO MEDICAL INSTRUMENTATION SYSTEMS	PE	40	60	100	3	0	0	3
3	22LPE$35	MEDICAL IMAGING SYSTEMS	PE	40	60	100	3	0	0	3
4	22LPE$36	BIOINFORMATICS FOR BIO MEDICAL ENGINEERS	PE	40	60	100	3	0	0	3
5	22LPE$37	BIO TELEMETRY AND TELEMEDICINE	PE	40	60	100	3	0	0	3
6	22LPE$38	BIO MEDICAL SIGNAL PROCESSING	PE	40	60	100	3	0	0	3
7	22LPE$39	WEARABLE TECHNOLOGIES	PE	40	60	100	3	0	0	3
8	22LPE$40	HOSPITAL SAFETY AND MANAGEMENT	PE	40	60	100	3	0	0	3

PROFESSIONAL ELECTIVE (PE)

VERTICAL VI: EMBEDDED SYSTEMS AND IOT

Sl. No	Course Code	Course Title	Category	CA Marks	End sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22LPE$41	INTRODUCTION TO INTERNET OF THINGS	PE	40	60	100	3	0	0	3
2	22LPE$42	INTRODUCTION TO MEMS	PE	40	60	100	3	0	0	3
3	22LPE$43	SMART SENSORS	PE	40	60	100	3	0	0	3
4	22LPE$44	INDUSTRIAL INTERNET OF THINGS *(Common to ECE & EIE)*	PE	40	60	100	3	0	0	3
5	22LPE$45	EMBEDDED OPERATING SYSTEMS	PE	40	60	100	3	0	0	3
6	22LPE$46	EMBEDDED PROCESSORS - I	PE	40	60	100	3	0	0	3
7	22LPE$47	EMBEDDED PROCESSORS - II	PE	40	60	100	3	0	0	3
8	22LPE$48	NANO ELECTRONICS	PE	40	60	100	3	0	0	3
9	22LPE$49	AUTOMOTIVE ELECTRONICS	PE	40	60	100	3	0	0	3

PROFESSIONAL ELECTIVE (PE)

VERTICAL VII: DIVERSIFIED ELECTIVE GROUP
(Not for specialization& Honors)

Sl. No	Course Code	Course Title	Category	CA Marks	End sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22LPE$49	AUTOMOTIVE ELECTRONICS	PE	40	60	100	3	0	0	3
2	22LPE$50	ELECTRONIC CIRCUIT DESIGN *(Common to EEE, ECE& EIE)*	PE	40	60	100	3	0	0	3
3	22LPE$51	ELECTRONIC SYSTEM DESIGN AND PRODUCTIZATION *(Common to EEE, ECE& EIE)*	PE	40	60	100	3	0	0	3
4	22LPE$52	INTRODUCTION TO POWER ELECTRONICS	PE	40	60	100	3	0	0	3
5	22LPE$53	HIGH SPEED ELECTRONICS	PE	40	60	100	3	0	0	3
6	22LPE$54	ARTIFICIAL INTELLIGENCE AND MACHINELEARNING	PE	40	60	100	3	0	0	3

OPEN ELECTIVES (OE)

Sl. No	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1.	22COE$01	DISASTER MANAGEMENT AND MITIGATION	OE	40	60	100	3	0	0	3
2.	22COE$02	WATER SANITATION AND HEALTH	OE	40	60	100	3	0	0	3
3.	22MOE$03	NANOTECHNOLOGY AND SURFACE ENGINEERING	OE	40	60	100	3	0	0	3
4.	22MOE$04	INDUSTRIAL SAFETY MANAGEMENT	OE	40	60	100	3	0	0	3
5.	22EOE$05	RENEWABLE POWER GENERATION SYSTEMS	OE	40	60	100	3	0	0	3
6.	22EOE$06	SMART GRID TECHNOLOGY	OE	40	60	100	3	0	0	3
7.	22LOE$07	CMOS VLSI DESIGN	OE	40	60	100	3	0	0	3
8.	22LOE$08	MOBILE COMMUNICATION	OE	40	60	100	3	0	0	3
9.	22POE$09	RAPID PROTOTYPING	OE	40	60	100	3	0	0	3
10	22POE$10	MANAGERIAL ECONOMICS	OE	40	60	100	3	0	0	3
11.	22NOE$11	MEASUREMENT AND CONTROL	OE	40	60	100	3	0	0	3
12.	22NOE$12	INDUSTRIAL AUTOMATION	OE	40	60	100	3	0	0	3
13.	22SOE$13	PROGRAMMING IN JAVA	OE	40	60	100	3	0	0	3
14.	22SOE$14	NETWORK ESSENTIAL	OE	40	60	100	3	0	0	3
15.	22I0E$15	VIDEO CREATION AND EDITING	OE	40	60	100	3	0	0	3
16.	22IOE$16	DIGITAL MARKETING	OE	40	60	100	3	0	0	3
17.	22BOE$17	PRINCIPLES OF FOOD TECHNOLOGY	OE	40	60	100	3	0	0	3
18.	22BOE$18	BIOLOGY FOR ENGINEERS	OE	40	60	100	3	0	0	3

VALUE ADDED COURSES (VA) (ONE CREDIT)

Sl. No.	Course Code	Course Title	Category	CA Marks	End Sem Marks	Total Marks	Hours/Week			
							L	T	P	C
1	22LVA$04	SCIENCE OF CREATIVITY	EEC	100	-	100	1	0	0	1
2	22LVA$05	PERSONAL LEADERSHIP	EEC	100	-	100	1	0	0	1
3	22LVA$06	SCRIPTING LANGUAGES	EEC	100	-	100	1	0	0	1
4	22LVA$07	ANDROID APPLICATION DEVELOPMENT	EEC	100	-	100	1	0	0	1
5	22LVA$08	WEB DESIGNING	EEC	100	-	100	1	0	0	1
6	22LVA$09	LONG TERM EVOLUTION	EEC	100	-	100	1	0	0	1
7	22LVA$10	AVIONICS	EEC	100	-	100	1	0	0	1
8	22LVA$11	MILLIMETER WAVE COMMUNICATION	EEC	100	-	100	1	0	0	1
9	22LVA$12	TELEMATICS	EEC	100	-	100	1	0	0	1
10	22LVA$13	E-COMMERCE SECURITY	EEC	100	-	100	1	0	0	1
11	22LVA$14	SIMULATION TECHNIQUES	EEC	100	-	100	1	0	0	1
12	22LVA$15	INTRODUCTION TO CLOUD COMPUTING	EEC	100	-	100	1	0	0	1
13	22LVA$16	PCB DESIGN AND PROTOTYPING	EEC	100	-	100	0	0	2	1
14	22LVA$17	DESIGN OF COMMUNICATIONSYSTEMS	EEC	100	-	100	0	0	2	1
15	22LVA$18	APTITUDE - I	EEC	100	-	100	1	0	0	1
16	22LVA$19	APTITUDE - II	EEC	100	-	100	1	0	0	1
17	22LVA$20	APTITUDE - III	EEC	100	-	100	1	0	0	1
18	22LVA$21	MICROSTRIP ANTENNA DESIGN	EEC	100	-	100	1	0	0	1
19	22LVA$22	BATTERY MANAGEMENT SYSTEM	EEC	100	-	100	1	0	0	1
20	22LVA$23	E- VEHICLE	EEC	100	-	100	1	0	0	1
21	22LVA$24	PRODUCT DESIGN, MANUFACTURING AND TROUBLESHOOTING	EEC	100	-	100	1	0	0	1
22	22LVA$25	DIGITAL IMAGE PROCESSING AND COMPUTER VISION LABORATORY	EEC	100	-	100	0	0	2	1
23	22LVA$26	TRANSFORMS FOR COMMUNICATION ENGINEERING - I	EEC	100	-	100	1	0	0	1
24	22LVA$27	TRANSFORMS FOR COMMUNICATION ENGINEERING - II	EEC	100	-	100	1	0	0	1
25	22LVA$28	VIRTUAL LABORATORY ON DIGITAL VLSI DESIGN	EEC	100	-	100	0	0	2	1

GOVERNMENT COLLEGE OF TECHNOLOGY
(An Autonomous Institution Affiliated to Anna University)
Coimbatore–641013.
ELECTRONICS AND COMMUNICATION ENGINEERING

22LMC1Z0	INDUCTION PROGRAMME	SEMESTER I

Details of the Programme:

Day 0: College Admission

Day1: Orientation Programme

Day2 Onwards: Induction Programme

Activities:
Physical activity,
Playground Events,
Yoga Practices,
Literary, Proficiency modules,
Team Building,
Lectures by Eminent people,
Familiarization to department,
Branch oriented information,
Motivational speakers,
Talent exposure,
Quiz completion,
Visit to local areas….etc.

22LHS1Z1	**தமிழர் மரபு Heritage of Tamils** (Common to all Branches)	**SEMESTER I**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**HSMC**	**1**	**0**	**0**	**1**

UNIT – I	**LANGUAGE AND LITERATURE**	**3 Periods**
Language Families in India - Dravidian Languages – Tamil as a Classical Language - Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature- Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.		
UNIT – II	**HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE**	**3 Periods**
Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role ofTemples in Social and Economic Life of Tamils.		
UNIT – III	**FOLK AND MARTIAL ARTS**	**3 Periods**
Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leather puppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.		
UNIT – IV	**THINAI CONCEPT OF TAMILS**	**3 Periods**
Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature- Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.		
UNIT – V	**CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE**	**3 Periods**
Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.		
Contact Periods: **Lecture: 15 Periods** **Tutorial:0 Periods** **Practical:0 Periods** **Total: 15 Periods**		

TEXT BOOK:

1	தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித்தமிழ் – முனைவர் இல.சுந்தரம் . (விகடன் பிரசுரம்).
3	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

REFERENCES:

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

22LHS1Z1	தமிழர் மரபு Heritage of Tamils (Common to all Branches)	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	HSMC	1	0	0	1

அலகு I	மொழி மற்றும் இலக்கியம்	3 Periods
இந்திய மொழிக் குடும்பங்கள்- திராவிட மொழிகள்- தமிழ் ஒரு செம்மொழி- தமிழ் செவ்விலக்கியங்கள் –சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை-சங்க இலக்கியத்தில் பகிர்தல் அறம்-திருக்குறளில் மேலாண்மைக் கருத்துக்கள்-தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்தசமயங்களின் தாக்கம்-பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள்-சிற்றிலக்கியங்கள்-தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி-தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.		
அலகு II	மரபு – பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை–சிற்பக் கலை	3 Periods
நடுகல் முதல் நவீன சிற்பங்கள் வரை – ஐம்பொன் சிலைகள்– பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள்-பொம்மைகள் – தேர் செய்யும் கலை – சுடுமண் சிற்பங்கள் – நாட்டுப்புறத் தெய்வங்கள் – குமரிமுனையில் திருவள்ளுவர் சிலை – இசைக் கருவிகள் – மிருதங்கம் , பறை, வீணை, யாழ் , நாதஸ்வரம் – தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.		
அலகு III	நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்	3 Periods
தெருக்கூத்து, கரகாட்டம்-வில்லுப்பாட்டு-கணியான் கூத்து-ஒயிலாட்டம்-தோல்பாவைக் கூத்து-சிலம்பாட்டம் –வளரி-புலியாட்டம் -தமிழர்களின் விளையாட்டுகள்.		
அலகு IV	தமிழர்களின் திணைக் கோட்பாடுகள்	3 Periods
தமிழகத்தின் தாவரங்களும், விலங்குகளும் – தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் – தமிழர்கள் போற்றிய அறக்கோட்பாடு –சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் –சங்ககால நகரங்களும் துறை முகங்களும் – சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி – கடல் கடந்த நாடுகளில் சோழர்களின் வெற்றி.		
அலகு V	இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு	3 Periods
இந்திய விடுதலைபோரில் தமிழர்களின் பங்கு – இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் – சுயமரியாதை இயக்கம் – இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு – கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.		
Contact Periods: **Lecture: 15 Periods Tutorial:0 Periods Practical:0 Periods Total: 15 Periods**		

TEXT BOOK:

1	தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித்தமிழ் – முனைவர் இல.சுந்தரம் . (விகடன் பிரசுரம்).
3	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

REFERENCES:

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

22LHS1Z2	PROFESSIONAL ENGLISH (Common to all Branches)	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	HSMC	2	1	0	3

Course Objectives	1. To engage learners in meaningful language activities to improve their LSRW skills 2. To enhance learners' awareness of general rules of writing for specific audiences 3. To help learners understand the purpose, audience, contexts of different types of writing 4. To develop analytical thinking skills for problem solving in communicative contexts 5. To demonstrate an understanding of job applications and interviews for internship and placements	
UNIT – I	**FUNDAMENTALS OF COMMUNICATION**	**9 Periods**
Listening –Listening to Personal Introduction and Filling a form Speaking - Self Introduction; Introducing someone in a formal context Reading -Reading Biographies/ Autobiographies and E-mails relevant to technical contexts. Writing - Writing Biographies/ Autobiographies; Drafting Professional E-mails. Grammar - Present Tense (Simple Present, Present Progressive, Present Perfect, Present Perfect Continuous); Parts of Speech Vocabulary - Word Formation with Prefixes; Antonyms; Portmanteau Words		
UNIT – II	**SUMMATION AND PROBLEM SOLVING**	**9 Periods**
Listening - Listening to Short-Stories / Personal Experiences/Watching Movies. Speaking - Narrating Personal Experiences / Events and Short Stories Reading - Reading Travelogues and Books. Writing - Report on an event (Field Trip, Industrial Visit, Educational Tours etc.), Review on Books and Movies. Grammar –Past Tense (Simple Past, Past Progressive, Past Perfect, Past Perfect Continuous); Impersonal Passive Vocabulary - Word Formation with suffixes; Synonyms; Phrasal Verbs.		
UNIT– III	**DESCRIPTION OF A PROCESS / PRODUCT**	**9 Periods**
Listening - Listening to Digital Marketing Advertisements for Product /Process Descriptions Speaking –Describing/Interpreting a Picture; Giving instructions to use the product. Reading – Reading Advertisements, Gadget Reviews; User Manuals. Writing - Writing Definitions; Product /Process Description; Transcoding; Content Writing Grammar -Future Tense(Simple Future, future continuous, Future Perfect, Future Perfect Continuous); If Clauses Vocabulary - Homonyms; Homophones, One Word Substitutes.		
UNIT– IV	**EXPRESSION**	**9 Periods**
Listening – Listening to/Watching Formal Job interviews or Celebrity Interviews Speaking – Participating in a Face to Face or Virtual Interview (Job/Celebrity Interview), virtual interviews Reading – Company profiles, Statement of Purpose, (SOP), Excerpts of interview with professionals from Newspaper, Magazine and other Resources Writing – Job / Internship Application – Cover letter & Resume Grammar – Question types: 'Wh' / Yes or No/ and Tags; Subject- Verb Agreement. Vocabulary – Idiomatic Expressions		
UNIT – V	**PUBLIC SPEAKING**	**9 Periods**
Listening – Listening to Ceremonious Speeches on You Tube and Jotting down phrases Speaking – Delivering Welcome Address; Introducing the Chief-Guest; Proposing Vote of Thank and Felicitation Reading – Excerpts of Speeches from Newspaper, Magazines and Motivational Books Writing – Drafting a Welcome Address, Introduction to the Chief-Guest, Vote of Thanks and Felicitation Grammar –Common Errors Vocabulary – Commonly Confused Words		
Contact Periods: **Lecture: 30 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK

1	***"English for Science & Technology"*** *Cambridge University Press, 2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.*
2	***"Communicative English",*** *Global Publishers, Chennai 2017 by Dr.J.Anbazhagan Vijay*

REFERENCES

1	*Raman.Meenakshi,Sharma.Sangeeta(2019). "****Professional English".*** *Oxford University Press. New Delhi.*
2	***"Learning to Communicate"*** *– Dr. V. Chellammal, Allied Publishing House, New Delhi,2003*
3	***"Using English"****, Orient Blackswan, Chennai, 2017 by Board of Editors*
4	***"OER"****(Authentic Open Educational Resources)*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Participate in a basic communicative task.	K3
CO2	Analyse problems in order to arrive at feasible solutions and communicate them orally and in the written format.	K3
CO3	Describe a product or process or mechanism.	K2
CO4	Present their opinions in a planned and logical manner, and draft effective resumes in context of job search.	K3
CO5	Deliver speeches at formal functions.	K3

COURSE ARTICULATION MATRIX:
a) CO and PO Mapping:

COs/POs	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	PSO 3
CO1	-	-	1	-	-	2	-	-	3	3	-	-	-	-	-
CO2	-	1	1	-	-	2	-	-	1	3	-	1	-	-	-
CO3	-	-	-	1	-	-	-	-	-	3	-	-	-	-	-
CO4	-	-	1	-	-	-	-	-	2	3	-	-	-	-	-
CO5	-	-	-	-	-	-		-	2	2	-	-	-	-	-
22LHS1Z2	**-**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**2**	**3**	**-**	**1**	**-**	**-**	**-**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping :	
CO1	3.3.2, 6.1.1, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2.
CO2	2.1.1, 2.2.3, 2.2.4, 3.1.2, 6.2.1, 9.2.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 12.3.1, 12.3.2.
CO3	4.1.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2.
CO4	3.3.2, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2.
CO5	9.2.2, 9.2.3, 9.2.4, 10.1.1, 10.1.3, 10.2.1, 10.2.2.

ASSESSMENT PATTERN – THEORY:

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	-	12	88	-	-	-	100
CAT2	-	18	82	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	-	100	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	100	-	-	-	100
ESE	-	20	80	-	-	-	100

22LBS1Z1	LINEAR ALGEBRA AND CALCULUS (Common to all Branches)	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	BS	3	1	0	4

Course Objectives	1. To acquire knowledge of system of equations, eigenvalues, eigenvectors, diagonalization of matrices and reduction of quadratic forms to canonical forms. 2. To obtain the knowledge of analyze the functions using Limits and derivative recognize the appropriate tools of differential calculus to solve applied problems. 3. To obtain the knowledge of definite and improper integration and recognize the appropriate tools of Integral Calculus to solve applied problems 4. To develop the skills in solving the functions of several variables by partial derivatives. 5. To acquire knowledge of multiple integration and related applied problems in various geometry	
UNIT – I	**LINEAR ALGEBRA**	**9+3 Periods**
Consistency of System of Linear Equations - Eigen values and eigenvectors - Diagonalization of matrices by orthogonal transformation - Cayley-Hamilton Theorem - Quadratic to canonical forms.		
UNIT – II	**DIFFERENTIAL CALCULUS**	**9+3 Periods**
Limit and continuity of function - Rolle's theorem - Mean value theorems - Taylor's and Maclaurin's theorems. Application of Differential Calculus: Radius of curvature, Centre of curvature, Circle of curvature and Evolutes of a curve.		
UNIT – III	**INTEGRAL CALCULUS**	**9+3 Periods**
Evaluation of definite integral by trigonometric substitution - Convergence and Divergence of improper integrals - Beta & Gamma functions and their properties - Applications of definite integrals to evaluate surface areas and volume of revolution (Cartesian coordinates only).		
UNIT – IV	**PARTIAL DERIVATIVES AND ITS APPLICATIONS**	**9+3 Periods**
Partial derivatives - total derivative - Taylor's series – Jacobians - Maxima, minima and saddle points - Method of Lagrange multipliers.		
UNIT – V	**MULTI VARIABLE INTEGRAL CALCULUS**	**9+3 Periods**
Double integral - Area as double integral - change of order of integration in double integrals - Triple Integrals - Volume as Triple Integral. Change of variables: Cartesian to polar, Spherical polar coordinates, Cylindrical polar coordinates.		
Contact Periods : **Lecture: 45 Periods** **Tutorial: 15 Periods** **Practical: 0 Periods** **Total: 60 Periods**		

TEXT BOOK

1	*Veerarajan T., **"Engineering Mathematics I"**, Tata McGraw-Hill Education(India)Pvt. Ltd, New Delhi,2015.*
2	*David C.Lay, **"Linear Algebra and Its Application"**, Pearson Publishers, 6th Edition, 2021.*

REFERENCES

1	*B.S.Grewal, **"Higher Engineering Mathematics"**, Khanna Publishers, 44th Edition, 2017.*
2	*Howard Anton, **"Elementry Linear Algebra"**, 11th Edition, Wiley Publication, 2013.*
3	*Narayanan.S and Manicavachagom Pillai. T.K. – **"Calculas Vol I and Vol II",** S.chand & Co, Sixth Edition, 2014.*
4	*H.K. Dass, **"Advance Engineering Mathematics"**, S. Chand and company, Eleventh Edition, 2015.*
5	*Jain R.K. and Iyengar S.R.K., **"Advanced Engineering Mathematics"**, Narosa Publicaitons, Eighth Edition, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Solve the linear system of equations, diagonalize matrix by orthogonal transformation and reduce quadratic form to canonical form.	K5
CO2	Compare and contrast the ideas of continuity and differentiability and use them to solve engineering problems.	K5
CO3	Acquire fluency in integration of one variable and apply them to find surface area and volumes.	K5
CO4	Apply the techniques of partial derivatives in functions of several variables.	K5
CO5	Use multiple integration for finding area, surface and volume of different geometry.	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping:

COs/POs	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	PSO 3
CO1	3	3	1	1	-	-	-	-	-	-	-	1	1	-	1
CO2	3	3	1	1	-	-	-	-	-	-	-	1	1	-	1
CO3	3	3	1	1	-	-	-	-	-	-	-	1	1	-	1
CO4	3	3	1	1	-	-	-	-	-	-	-	1	1	-	1
CO5	3	3	1	1	-	-	-	-	-	-	-	1	1	-	1
22LBS1Z1	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping:	
CO1	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.2.1, 3.3.1, 4.1.1, 4.1.2, 12.2.1.
CO2	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.2.1, 3.3.1, 4.1.1, 4.1.2, 12.2.1.
CO3	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.2.1, 3.3.1, 4.1.1, 4.1.2, 12.2.1.
CO4	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.2.1, 3.3.1, 4.1.1, 4.1.2, 12.2.1.
CO5	1.1.1, 1.1.2, 2.1.1, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.2.1, 3.3.1, 4.1.1, 4.1.2, 12.2.1.

ASSESSMENT PATTERN – THEORY:							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	30	10	-	-	100
CAT2	20	40	30	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	30	10	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	30	10	-	-	100
ESE	20	40	30	10	-	-	100

22LBS1Z2	ENGINEERING PHYSICS (Common to all Branches)	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	BS	3	0	0	3

Course Objectives	1. To understand the basics about crystal systems and defects. 2. To understand the principle, characteristics, working and applications of laser and optical fiber. 3. To solve problems in bending of beams. 4. To solve quantum mechanical problems with the understanding of Quantum Principles. 5. To understand the properties, production and applications of ultrasonic waves.	
UNIT – I	**CRYSTAL PHYSICS**	**9 Periods**
Introduction – Crystalline and amorphous materials – Lattice – Unit Cell –Crystal system - Bravais lattices – Miller indices – Reciprocal lattice - d spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – Coordination number – Packing factor for SC, BCC, FCC, and HCP structures – Crystal defects – Point, line and surface defects.		
UNIT – II	**LASER PHYSICS AND FIBER OPTICS**	**9 Periods**
Introduction- Principle of laser action - characteristics of laser - Spontaneous emission and Stimulated emission –Einstein's coefficients - population inversion – methods of achieving population inversion –Optical Resonator - Types of Lasers – Principle, construction and working of CO_2 Laser - applications of laser. Introduction – Basic Principles involved in fiber optics- Total internal reflection–Propagation of light through optical fiber –Derivation for Numerical Aperture and acceptance angle - fractional index change.		
UNIT – III	**PROPERTIES OF MATTER**	**9 Periods**
Elasticity- Hooke's law- stress-strain diagram - Factors affecting elasticity – Moment (Q) - Couple (Q) – Torque (Q) – Beam - Bending moment - Depression of a cantilever – Twisting Couple- Young's modulus by uniform bending - I shaped girders.		
UNIT – IV	**QUANTUM PHYSICS AND APPLICATIONS**	**9 Periods**
Limitations of classical Physics - Introduction to Quantum theory - Dual nature of matter and radiation- de-Broglie wavelength in terms of voltage, energy, and temperature –Heisenberg's Uncertainty principle – verification – physical significance of a wave function- Schrödinger's Time independent and Time dependent wave equations –- Particle in a one dimensional potential well - Scanning Electron Microscope (SEM)- Transmission Electron Microscope (TEM).		
UNIT – V	**ULTRASONICS**	**9 Periods**
Introduction - properties of ultrasonic waves - production of ultrasonic waves - Magnetostriction effect- Magnetostriction generator- Piezoelectric effect- Piezoelectric generator- Acoustic grating - Determination of wavelength and velocity of ultrasonic waves- cavitation - applications- ultrasonic drilling- ultrasonic welding- ultrasonic soldering and ultrasonic cleaning- Non- destructive Testing- Pulse echo system.		
Contact Periods : **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*K. Rajagopal, **"Engineering Physics"**, PHI Learning Private Limited, 2015.*
2	*P. K. Palanisamy, **"Engineering Physics-I"**, Scitech publications Private Limited, 2015.*
3	*M. Arumugam, **"Engineering Physics"**, Anuradha Publishers, 2010.*

REFERENCES:

1	*Arthur Beiser, **"Concepts of Modern Physics"**, Tata McGraw-Hill, 2010.*
2	*D. Halliday, R. Resnick and J. Walker, **"Fundamentals of Physics"**, 6th Edition, John Wiley and Sons, 2001.*
3	*William T. Silfvast, **"Laser Fundamentals"**, 2nd Edition, Cambridge University Press, New York 2004.*
4	*M. N. Avadhanulu and P.G. Kshirsagar, **"A Textbook of Engineering Physics"**, S. Chand and Company Ltd, 2010.*
5	*R. K. Gaur and S. L. Gupta, **"Engineering Physics",** Dhanpat Rai Publishers, 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the crystal structure and analyse the type of defect	K4
CO2	Explain the principle, characteristics, working and applications of laser and optical fiber, Analyse and solve problems in laser and optical fiber	K4
CO3	Solve problems in bending of beams , Apply the knowledge in construction of buildings	K3
CO4	Explain the importance of quantum mechanics Solve problems in basic quantum physics, Apply the wave equations in real time problems	K3
CO5	Explain the properties and production of ultrasonic waves Apply ultrasonic waves for industrial problems	K3

COURSE ARTICULATION MATRIX:
a) CO and PO Mapping:

COs/POs	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	PSO 3
CO1	2	2	-	-	-	-	-	-	-	-	-	-	1	1	1
CO2	3	1	-	-	-	-	-	-	-	-	-	-	1	1	1
CO3	3	2	-	-	-	-	-	-	-	-	-	-	1	1	1
CO4	2	2	-	-	-	-	-	-	-	-	-	-	1	1	1
CO5	2	1	-	-	-	-	-	-	-	-	-	-	1	1	1
22LBS1Z2	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping:	
CO1	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.2.3, 2.3.1, 2.4.1.
CO2	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.3.1, 2.4.1.
CO3	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.1, 2.2.3, 2.2.4, 2.3.1, 2.4.1.
CO4	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.2.3, 2.3.1, 2.4.1.
CO5	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.3.1, 2.4.1.

ASSESSMENT PATTERN – THEORY:

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	30	15	15	10	-	100
CAT2	30	30	15	15	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	40	20	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	40	40	20	-	-	-	100
ESE	30	30	15	15	10	-	100

22LES101	**PROGRAMMING IN C** (Common to all Branches except MECH & PRODN)	**SEMESTER I**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**ES**	**3**	**0**	**0**	**3**

Course Objectives	1. To study the basic concepts of computer and programming fundamentals. 2. To understand the data types in C , flow control statements, Arrays, Functions Pointers, Structures, Unions and File concepts in C.	
UNIT – I	**COMPUTER AND PROGRAMMING FUNDAMENTALS**	**9 Periods**
Computer fundamentals – Evolution, classification, Anatomy of a computer: CPU, Memory, I/O –Introduction to software –Classification of programming languages – Compiling –Linking and loading a program – Introduction to OS – Types of OS.		
UNIT – II	**DATATYPES AND FLOW OF CONTROL**	**9 Periods**
Structured programming – Algorithms – Structure of a C program – Variables – Data types – Operators and expressions – Input and Output statements – Tokens –Type Conversion – Control statements.		
UNIT – III	**ARRAYS AND FUNCTIONS**	**9 Periods**
1D Arrays– 2D Arrays – Multidimensional Arrays – Strings – String handling functions – Functions – Recursion – Array as function arguments – Storage Classes – Enumerations.		
UNIT – IV	**POINTERS**	**9 Periods**
Introduction to pointers – Pointers arithmetic – call by reference – Relationship between Array and Pointers – Relationship between String and pointers – pointers to pointers – array of pointers – pointers to an array – Dynamic memory allocation – Arguments to main().		
UNIT – V	**STRUCTURES AND UNIONS, FILE OPERATIONS**	**9 Periods**
Preprocessor directives – Structures – Unions – Bit fields – Opening and closing a file – Working with file of records – Random access to file of records.		
Contact Periods : **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK

1	*Pradip Dey, Manas Ghosh,* ***"Computer Fundamentals and Programming in C",*** *Second Edition, Oxford University Press, 2018.*

REFERENCES

1	*Al Kelley, Ira Pohl* ***,"A Book on C- Programming in C*** *",Fourth Edition, Addison Wesley, 2001.*
2	*Herbert Schildt ,* ***"C: The Complete Reference****", Fourth Edition, McGraw Hill Education, 2017*
3	*Yashavant P.Kanetkar,* ***" Let Us C",*** *15th edition,BPB Publications,2016.*
4	*Brian W. Kernighan and Dennis Ritchie,* ***"The C Programming Language",*** *Second Edition, Prentice Hall Software Series, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Articulate the basics of computer and evolution of programming languages.	K1
CO2	Write simple C programs using appropriate data types and control statements	K3
CO3	Write C programs using arrays , functions and enumerations	K3
CO4	Use pointers effectively to develop programs	K3
CO5	Create user defined data types using structures & union and effectively manipulate them in file operations.	K6

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping:

COs/POs	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	PSO 3
CO1	1	3	1	-	-	-	-	-	-	-	-	1	3	3	3
CO2	1	3	1	-	-	-	-	-	-	-	-	1	3	3	3
CO3	1	3	1	-	-	-	-	-	-	-	-	1	3	3	3
CO4	1	3	1	-	-	-	-	-	-	-	-	1	3	3	3
CO5	1	3	1	-	-	-	-	-	-	-	-	1	3	3	3
22LES101	**1**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**3**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping:

CO1	1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.3, 12.2.1.
CO2	1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.3, 3.2.3, 3.3.1, 12.1.2.
CO3	1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.3, 3.2.3, 3.3.1, 12.1.2.
CO4	1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.3, 3.2.3, 3.3.1, 12.1.2.
CO5	1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.3, 3.2.3, 3.3.1, 12.1.2.

ASSESSMENT PATTERN – THEORY:							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	20	30	-	-	-	100
CAT2	20	30	50	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	-	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	100	-	-	-	100
ESE	20	30	50	-	-	-	100

22LMC1Z1	**ENVIRONMENTAL SCIENCE AND ENGINEERING** (Common to all Branches)					**SEMESTER I**
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**MC**	**3**	**0**	**0**	**0**

Course Objectives	1. To study the modern agriculture related problems, natural resources and its harnessing methods. 2. To study the interrelationship between living organism and environment. 3. To educate the people about causes of pollutions and its controlling methods. 4. To impart the knowledge of various environmental threats and its consequences. 5. To study the various water conservation methods, Act, Population policy, Welfare programs.	
UNIT – I	**ENVIRONMENTAL ENERGY RESOURCES**	**9 Periods**
Food-effects of modern agriculture, fertilizers, pesticides, eutrophication & biomagnifications-Energy resources: renewable resources - Hydro Energy, Solar & Wind. Non-renewable resources – Coal and Petroleum - harnessing methods.		
UNIT – II	**ECO SYSTEM AND BIODIVERSITY**	**9 Periods**
Eco system and its components - biotic and abiotic components. Biodiversity: types and values of biodiversity, hot spots of biodiversity, endangered and endemic species, conservation of biodiversity: In situ and ex situ conservation. Threats to biodiversity-destruction of habitat, habit fragmentation, hunting, over exploitation and man-wildlife conflicts. The IUCN red list categories.		
UNIT – III	**ENVIRONMENTAL POLLUTION**	**9 Periods**
Air pollution, classification of air pollutants – sources, effects and control of gaseous pollutants SO_2, NO_2, H_2S, CO, CO_2 and particulates. Water pollution - classification of water pollutants, organic and inorganic pollutants, sources, effects and control of water pollution. Noise pollution - decibel scale, sources, effects and control.		
UNIT – IV	**ENVIRONMENTAL THREATS**	**9 Periods**
Global warming-measure to check global warming - impacts of enhanced Greenhouse effect, Acid rain- effects and control of acid rain, ozone layer depletion- effects of ozone depletion, disaster management - flood, drought, earthquake and tsunami.		
UNIT – V	**SOCIAL ISSUES AND ENVIRONMENT**	**9 Periods**
Water conservation, rain water harvesting, e-waste management, Pollution Control Act, Wild life Protection Act. Population growth- exponential and logistic growth, variation in population among nations, population policy. Women and Child welfare programs. Role of information technology in human and health, COVID-19 - effects and preventive measures.		
Contact Periods : **Lecture:45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total:45 Periods**		

TEXT BOOK:

1	*Sharma J.P.,* ***"Environmental Studies"****, 4th Edition, University Science Press, New Delhi 2016.*
2	*Anubha Kaushik and C.P.Kaushik****, "Environmental Science and Engineering"****, 7th Edition, New Age International Publishers, New Delhi, 2021.*

REFERENCES:

1	*A K De,* ***"Environmental Chemistry"****, 8th Edition, New Age International Publishers, 2017.*
2	*G. Tyler Miller and Scott E. Spoolman,* ***"Environmental Science"****, Cengage Learning India Pvt, Ltd, Delhi, 2014.*
3	*Erach Bharucha,* ***"Textbook of Environmental Studies"****, Universities Press(I) Pvt, Ltd, Hyderabad, 2015.*
4	*Gilbert M.Masters****, "Introduction to Environmental Engineering and Science"****, 3rd Edition, Pearson Education, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recognize and understand about the various environmental energy resources and the effective utility of modern agriculture.	K2
CO2	Acquire knowledge about the interaction of biosphere with environment and conservation methods of bio diversity.	K2
CO3	Be aware of the sources of various types of pollution, their ill effects and preventive methods.	K2
CO4	Identify and take the preventive measures to control the environmental threats and effects of Global warming, Ozone depletion, Acid rain, and natural disasters.	K2
CO5	Demonstrate an idea to save water and other issues like COVID -19.	K2

COURSE ARTICULATION MATRIX:
a) CO and PO Mapping:

COs/POs	**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**	**PSO 3**
CO1	2	1	1	1	-	-	3	-	-	-	-	-	1	-	1
CO2	-	-	1	-	-	-	3	-	-	-	-	-	-	-	-
CO3	2	1	1	1	-	-	3	-	-	-	-	-	1	-	1
CO4	2	1	1	1	-	-	3	-	-	-	-	-	-	-	-
CO5	-	1	1	1	-	2	3	-	-	-	-	-	-	-	-
22LMC1Z1	**2**	**1**	**1**	**1**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping:	
CO1	1.2.1, 1.4.1, 2.1.2, 2.3.1, 3.1.5, 3.2.1, 4.3.1, 7.1.1, 7.1.2, 7.2.1.
CO2	3.1.5, 7.1.1, 7.1.2, 7.2.1.
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.3.1, 3.1.5, 3.2.1, 4.1.3, 4.3.1, 7.1.1, 7.1.2, 7.2.1.
CO4	1.2.1, 1.4.1, 2.1.2, 2.3.1, 3.1.5, 4.1.3, 4.3.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2.
CO5	2.1.2, 2.2.2, 3.1.5, 4.1.3, 4.3.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2.

ASSESSMENT PATTERN – THEORY:							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	20	20	-	-	100
CAT2	20	40	20	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	20	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	20	20	-	-	100
ESE	20	40	20	20	-	-	100

22LBS1Z3	**PHYSICS LABORATORY** (Common to all Branches)	**SEMESTER I**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**BS**	**0**	**0**	**3**	**1.5**

Course Objectives	1. To impart practical knowledge on the concept of properties of matter and utilize the experimental techniques to measure the properties 2. To impart practical knowledge on the modulii of elasticity 3. To analyze the properties of semiconductors 4. To learn practically the basic electronic concepts of transistor and logic gates 5. To realize the principle, concepts and working of a solar cell and study the properties of ferromagnetic material 6. To understand the concept of quantum physics
S. No.	**LABORATORY EXPERIMENTS**
1.	Determination of refractive index of the glass and given liquid – Spectrometer diffraction method
2.	Determination of Planck's constant
3.	Determination of Young's Modulus of the material in the form of bar – Cantilever Bending - Koenig's Method
4.	a) Particle size determination using diode laser b) Determination of numerical aperture and acceptance angle in an optical fiber
5.	Hall effect - Determination of semiconductor parameters
6.	Determination of band gap of semiconductor material
7.	Determination of velocity of sound and compressibility of the given liquid-Ultrasonic Interferometer
8.	Determination of moment of inertia of disc and rigidity modulus of a wire-Torsional pendulum
9.	Transistor characteristics
10.	Solar cell characteristics
11.	Determination of Hysteresis losses in a Ferromagnetic material-B-H curve unit
12.	Logic Gates – Verification and Construction
Contact Periods: **Lecture: 0 Periods** **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**	

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Determine refractive index and compressibility of liquids, micro size of particles and numerical aperture of an optical fibre	K5
CO2	Measure the Young's and rigidity modulii of the given material	K5
CO3	Determine the bandgap of a given semiconductor material and identify the type of semiconductor and its carrier concentration through Hall measurement	K5
CO4	Analyze the characteristics of transistor and verify the truth table of logic gates	K4
CO5	Measure the efficiency of a solar cell and energy loss associated with the ferromagnetic material by plotting B-H curve	K5
CO6	Determine the Planck's constant and work function	K5

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping:

COs/POs	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	PSO 3
CO1	3	2	-	-	-	-	-	-	-	-	-	-	2	1	1
CO2	3	2	-	-	-	-	-	-	-	-	-	-	2	1	1
CO3	3	2	-	-	-	-	-	-	-	-	-	-	2	1	1
CO4	3	2	-	-	-	-	-	-	-	-	-	-	2	1	1
CO5	3	2	-	-	-	-	-	-	-	-	-	-	2	1	1
CO6	3	2	-	-	-	-	-	-	-	-	-	-	2	1	1
22LBS1Z3	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping:

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.4.1, 2.4.2, 2.4.3, 2.4.4.
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.4.1, 2.4.2, 2.4.3, 2.4.4.
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.4.1, 2.4.2, 2.4.3, 2.4.4.
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.4.1, 2.4.2, 2.4.3, 2.4.4.
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.4.1, 2.4.2, 2.4.3, 2.4.4.
CO6	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.4.1, 2.4.2, 2.4.3, 2.4.4.

22LES1Z2	**WORKSHOP PRACTICE** (Common to all Branches)	**SEMESTER I**

PREREQUISTES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**ES**	**0**	**0**	**3**	**1.5**

Course Objectives	1. To make various basic prototypes in the carpentry trade such as Half Lap joint, Lap Tee joint, Dovetail joint, Mortise & Tenon joint. 2. To make various welding joints such as Lap joint, Lap Tee joint, Edge joint, Butt joint and Corner joint. 3. To make various moulds in foundry such as Cube, Straight pipe, V pulley, and Conical bush. 4. To make various components using sheet metal such as Tray, Frustum of cone and Square box. 5. To understand the working and identify the various components of CNC Machines

LIST OF EXPERIMENTS			
1. Introduction to use of tools and equipment's in Carpentry, Welding, Foundry and Sheet metal			
2. Safety aspects in Welding, Carpentry, Foundry and sheet metal.			
3. Half Lap joint and Dovetail joint in Carpentry.			
4. Welding of Lap joint and Butt joint and T-joint.			
5. Preparation of Sand mould for Cube, Conical bush, Pipes and V pulley			
6. Fabrication of parts like Tray, Frustum of cone and Square box in sheet metal			
7. CNC Machines demonstration and lecture on working principle.			
8. Electrical wiring and simple house wiring.			
Contact periods:			
Lecture: 0 Periods	**Tutorial: 0 Periods**	**Practical: 45 Periods**	**Total: 45 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Safely Use tools and equipment's used in Carpentry, Welding, Foundry and Sheet metal to create basic joints.	K2
CO2	Prepare sand mould for various basic pattern shapes.	K3
CO3	Fabricate parts like Tray, Frustum of cone and Square box in sheet metal.	K3
CO4	Practice on the Welding and Carpentry	K3
CO5	Demonstrate the working of CNC Machines.	K2

COURSE ARTICULATION MATRIX:
a) CO and PO Mapping:

CO/ PO	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	PSO 3
CO1	2	2	3	2	1	3	1	2	3	3	2	3	-	-	-
CO2	2	2	3	2	1	3	3	2	3	3	2	3	-	-	-
CO3	2	2	3	2	1	3	3	2	3	3	2	3	1	1	1
CO4	2	2	3	2	1	3	3	2	3	3	2	3	-	-	-
CO5	2	2	3	2	3	-	-	2	3	3	2	2	1	1	1
22LES1Z2	2	2	3	2	2	3	2	2	3	3	2	3	**1**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping:

CO1	1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1,3.3.2, 3.4.1, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 5.2.2, 5.3.2, 6.1.1,6.2.1,7.1.2, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4,9.3.1,10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.3.1, 12.1.1, 12.2.2, 12.3.1, 12.3.2.
CO2	1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1,3.3.2, 3.4.1, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 5.2.2, 5.3.2, 6.1.1,6.2.1,7.1.2, 7.1.1, 7.2.2, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.3.1, 12.1.1, 12.2.2, 12.3.1, 12.3.2.
CO3	1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1,3.3.2, 3.4.1, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 5.2.2, 5.3.2, 6.1.1,6.2.1,7.1.2, 7.1.1, 7.2.2, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.3.1, 12.1.1, 12.2.2, 12.3.1, 12.3.2.
CO4	1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1,3.3.2, 3.4.1, 4.1.1, 4.1.4, 4.2.1, 4.3.1, 5.2.2, 5.3.2, 6.1.1,6.2.1,7.1.2, 7.1.1, 7.2.2, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.3.1, 12.1.1, 12.2.2, 12.3.1, 12.3.2.
CO5	1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1,3.3.2, 3.4.1, 4.1.1, 4.1.4, 4.2.1, 4.3.1,5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.2, 7.1.1, 7.2.2, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.3.1, 12.2.2, 12.3.1, 12.3.2.

22LES103	PROGRAMMING IN C LABORATORY (Common to all Branches except MECH & PRODN)	SEMESTER I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	0	0	3	1.5

Course Objectives	To understand the concepts like Data types, Flow control statements, Functions, Arrays, command line arguments, Pointer, Dynamic memory allocation, Preprocessor Directives, Structures ,Unions and Files in C

EXERCISES ILLUSTRATING THE FOLLOWING CONCEPTS:			
1	Operators, Expressions and IO formatting		
2	Decision Making and Looping		
3	Arrays and Strings		
4	Functions and Recursion		
5	Pointers		
6	Dynamic Memory Allocation		
7	Command line arguments		
8	Preprocessor Directives		
9	Structures		
10	Unions		
11	Files		
12	Mini Project		
Contact periods:			
Lecture: 0 Periods	**Tutorial: 0 Periods**	**Practical: 45 Periods**	**Total: 45 Periods**

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Use appropriate data types and flow control statements to write C programs	K6
CO2	Write C programs using arrays , functions and command line arguments	K6
CO3	Write C programs using pointers, dynamic memory allocation and preprocess or directives	K6
CO4	Implement user defined data types using structures & union and effectively manipulate them in file operations.	K6
CO5	Develop simple applications using C	K6

COURSE ARTICULATION MATRIX :
a) CO and PO Mapping:

COs/POs	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	PSO 3
CO1	2	3	1	1	-	-	-	-	-	-	-	-	3	3	3
CO2	2	3	1	1	-	-	-	-	-	-	-	-	3	3	3
CO3	2	3	1	1	-	-	-	-	-	-	-	-	3	3	3
CO4	2	3	1	1	-	-	-	-	-	-	-	-	3	3	3
CO5	2	3	2	1	-	-	-	-	3	3	-	-	3	3	3
22LES103	**2**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**1**	**1**	**-**	**-**	**3**	**3**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping:

CO1	1.1.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.2.3, 3.3.1, 4.1.1, 4.1.2, 4.2.1.
CO2	1.1.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.2.3, 3.3.1, 4.1.1, 4.1.2, 4.2.1.
CO3	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.2.3, 3.3.1, 4.1.1, 4.1.2, 4.2.1.
CO4	1.1.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.2.3, 3.3.1, 4.1.1, 4.1.2, 4.2.1.
CO5	1.1.1, 1.2.1, 1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.1.6, 3.2.3, 3.3.1.

22LHS2Z4	தமிழரும் தொழில் நுட்பமும் **TAMILS AND TECHNOLOGY** (Common to all Branches)	**SEMESTER II**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**HSMC**	**1**	**0**	**0**	**1**

UNIT – I	**WEAVING AND CERAMIC TECHNOLOGY**	**3 Periods**
Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW)– Graffiti on Potteries.		
UNIT – II	**DESIGN AND CONSTRUCTION TECHNOLOGY**	**3 Periods**
Designing and Structural construction House & Designs in household materials during Sangam Age- Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple)- Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.		
UNIT – III	**MANUFACTURING TECHNOLOGY**	**3 Periods**
Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins as source of history - Minting of Coins – Beads making-industries Stone beads -Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.		
UNIT – IV	**AGRICULTURE AND IRRIGATION TECHNOLOGY**	**3 Periods**
Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea - Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society.		
UNIT – V	**SCIENTIFIC TAMIL & TAMIL COMPUTING**	**3 Periods**
Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.		
Contact Periods: **Lecture: 15Periods** **Tutorial:0 Periods** **Practical:0Periods** **Total: 15Periods**		

TEXT BOOK:

1	தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித்தமிழ் – முனைவர் இல.சுந்தரம் . (விகடன் பிரசுரம்).
3	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

REFERENCES:

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

22LHS2Z4	தமிழரும் தொழில் நுட்பமும் TAMILS AND TECHNOLOGY (Common to all Branches)	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	HSMC	1	0	0	1

Course Objectives	

அலகு I	நெசவு மற்றும் பானைத் தொழில்நுட்பம்	3 Periods

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

அலகு II	வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம்	3 Periods

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும்– சிலப்பதிகாரத்தில் மேடைஅமைப்பு பற்றிய விவரங்கள் – மாமல்லபுரச் சிற்பங்களும், கோவில்களும்-சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் – நாயக்கர் காலக் கோயில்கள்-மாதிரிகட்டமைப்புகள் பற்றி அறிதல் , மதுரை மீனாட்சிஅம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் – செட்டிநாட்டு வீடுகள் – பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக்

அலகு III	உற்பத்தித் தொழில் நுட்பம்	3 Periods

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

அலகு IV	வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம்	3 Periods

அணை, ஏரி, குளங்கள் , மதகு – சோழர்காலக் குமுழித்தூம்பின் முக்கியத்துவம் – கால்நடை பராமரிப்பு – கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் – வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் – கடல்சார்அறிவு – மீன்வளம் – முத்து மற்றும் முத்துக்குளித்தல் – பெருங்கடல் குறித்த பண்டைய அறிவு –அறிவுசார் சமூகம்.

அலகு V	அறிவியல் தமிழ் மற்றும் கணினித்தமிழ்	3 Periods

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

Contact Periods: **Lecture: 15Periods Tutorial: 0 Periods Practical:0Periods Total: 15Periods**

TEXT BOOK:

1	தமிழக வரலாறு – மக்களும் பண்பாடும் – கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித்தமிழ் – முனைவர் இல.சுந்தரம் . (விகடன் பிரசுரம்).
3	கீழடி – வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு)
4	பொருநை – ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு)

REFERENCES:

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

22LHS2Z5	VALUES AND ETHICS (Common to all Branches)	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	HSMC	3	0	0	3

Course Objectives	1. To understand and appreciate the ethical issues faced by an individual in profession, society and polity 2. To learn about Engineering Ethics and case studies 3. To understand the negative health impacts of certain unhealthy behaviors 4. To appreciate the need and importance of physical, emotional health and social health 5. To get familiar with the global issues	
UNIT– I	**BEING GOOD AND RESPONSIBLE**	**9 Periods**
Morals, Values and Ethics - Integrity - Work Ethics - Service Learning - Civic Virtue - Respect for Others - Living Peacefully - Caring - Sharing - Honesty - Courage - Valuing Time - Cooperation - Commitment - Empathy - Self-Confidence - Character		
UNIT– II	**ENGINEERING AS SOCIAL EXPERIMENTATION**	**9 Periods**
Engineering Ethics: Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Models of Professional Roles. Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – Case studies: Chernobyl disaster and Titanic disaster		
UNIT– III	**ADDICTION AND HEALTH**	**9 Periods**
Peer pressure - Alcoholism: Ethical values, causes, impact, laws, prevention – Ill effects of smoking - Prevention of Suicides; Sexual Health: Prevention and impact of pre-marital pregnancy and Sexually Transmitted Diseases. Drug Abuse: Abuse of different types of legal and illegal drugs: Ethical values, causes, impact, laws and prevention		
UNIT– IV	**PROFESSIONAL ETHICS**	**9 Periods**
Abuse of Technologies: Hacking and other cyber crimes, Addiction to mobile phone usage, Video games and Social networking websites		
UNIT– V	**GLOBAL ISSUES**	**9 Periods**
Multinational corporations - Environmental ethics - computer ethics - weapons development - engineers as managers - consulting engineers - engineers as expert witnesses and advisors - Code of Conduct – Corporate Social Responsibility		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Mike W Martin and Roland Schinzinger, “**Ethics in Engineering**”, McGraw-Hill, New York, 4th Edition, 2017.*
2	*Govindarajan M, Natarajan S and Senthil Kumar VS, “**Engineering Ethics**”, Prentice Hall of India, New Delhi, 2013.*

REFERENCES:

1	*Dhaliwal, K.K, "**Gandhian Philosophy of Ethics: A Study of Relationship between his Presupposition and Precepts"**, Writers Choice, New Delhi, India,2016.*
2	*Jayshree suresh, B.S.Raghavan,"**Human values and professional ethics**," S.Chand&;company Ltd, New Delhi, 2nd Edition, 2007.*
3	*L.A. and Pagliaro, A.M, **"Handbook of Child and Adolescent Drug and Substance Abuse: Pharmacological, Developmental and Clinical Considerations",** Wiley Publishers, U.S.A 2012.*
4	*Pandey, P. K(2012), **"Sexual Harassment and Law in India"**, Lambert Publishers, Germany 2012.*
5	*Kiran D.R, "**Professional ethics and Human values**," Tata McGraw Hill, New Delhi, 2007.*
6	*Edmund G See Bauer and Robert L Barry, "**Fundamentals of Ethics for Scientists and Engineers**",Oxford University Press, Oxford, 2001.*
7	*David Ermann and Michele S Shauf, "**Computers, Ethics and Society**", Oxford University Press, 2003.*
8	*Govindarajan M, Natarajan S, Senthil Kumar V. S, **"Engineering Ethics"**, Prentice Hall of India, New Delhi, 2004.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Follow sound morals and ethical values scrupulously to prove as good citizens	K3
CO2	Assess the relevance of ethics and morals in engineering and to learn case studies	K3
CO3	Describe the concept of addiction and how it will affect the physical and mental health	K2
CO4	Identify ethical concerns while using advanced technologies	K2
CO5	Judge the code of conduct, Environmental ethics and computer ethics	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping:

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS01**	**PS02**	**PS03**
CO1	-	-	-	-	-	3	3	3	3	3	3	-	-	-	1
CO2	-	-	-	-	-	3	1	3	3	-	-	-	-	-	1
CO3	-	-	-	-	-	3	1	3	3	2	3	-	-	-	1
CO4	-	-	-	-	-	3	3	3	3	1	3	1	-	-	1
CO5	-	-	-	-	-	3	3	3	3	-	1	3	-	-	1
22LHS2Z5	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping :	
CO1	6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1, 11.3.1.
CO2	6.1.1, 6.2.1, 7.1.1, 8.1.1, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1.
CO3	6.1.1, 6.2.1, 7.1.1, 8.1.1, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.2.1, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1, 11.3.1.
CO4	6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1, 11.3.1, 11.3.2, 12.1.1.
CO5	6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 11.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2.

ASSESSMENT PATTERN – THEORY:

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	30	20	20	-	-	100
CAT2	30	30	20	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	30	20	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	30	20	20	-	-	100
ESE	30	30	20	20	-	-	100

22LBS204	DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS (Common to all Branches except CSE & IT)	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	BS	3	1	0	4

Course Objectives	1. To gain knowledge of methods to solve higher order differential equations with constant and variable coefficients. 2. To be familiar with forming partial differential equations and solving partial differential equations of standard types of first order and homogeneous linear differential equations. 3. To be familiar with numerical interpolation, numerical differentiation and numerical integration. 4. To acquire the knowledge of numerical solution to first order ordinary differential equations using single and multi step techniques. 5. To gain the knowledge of numerical solution to second order partial differential equations using explicit and implicit methods.	
UNIT – I	**ORDINARY DIFFERENTIAL EQUATIONS**	**9+3 Periods**
Higher order linear differential equations with constant coefficients -variable coefficients: Cauchy-Euler equation, Cauchy-Legendre equation-Method of variation of parameters-Simultaneous first order linear equations with constant coefficients.		
UNIT – II	**PARTIAL DIFFERENTIAL EQUATIONS**	**9+3 Periods**
Formation of partial differential equations – First order partial differential equations – Standard types and Lagrange's type – Homogeneous linear partial differential equation of second and higher order with constant coefficients.		
UNIT – III	**INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION**	**9+3 Periods**
Solution of polynomial and transcendental equations: Newton-Raphson method-Interpolation with equal interval: Newton's forward and backward difference formulae-Interpolation with unequal intervals: Lagrange's formulae-Numerical Differentiation: Newton's formulae-Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.		
UNIT – IV	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**9+3 Periods**
First order ordinary differential equations: Taylor's series method-Euler and modified Euler's methods-Runge-Kutta method of fourth order -Milne's and Adam's predicator-corrector methods.		
UNIT – V	**NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS**	**9+3 Periods**
Partial differential equations: Finite difference method for two dimensional Laplace equation and Poisson equation- Implicit and explicit methods for one dimensional heat equation (Bender-Schmidt and Crank-Nicholson methods)-Finite difference explicit method for wave equation.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 15 Periods** **Practical: 0 Periods** **Total: 60 Periods**		

TEXT BOOK

1	*Veerarajan.T,* ***"Engineering Mathematics"****, Revised Edition 2018, McGraw Hill Education (India) Private Limited*
2	*P. Kandasamy, K. Thilagavathy, K. Gunavathi,* ***" Numerical Methods"****, S. Chand & Company, 3rd Edition, Reprint 2013.*

REFERENCES

1	*B.S.Grewal, **" Higher Engineering Mathematics"**, Khanna Publishers, New Delhi, 44th Edition, 2018.*
2	*SrimantaPal, **"Numerical Methods Principles, Analyses and Algorithms"**, Oxford University Press, New Delhi, 1st Edition 2009.*
3	*Raisinghania.M..D, **"Ordinary And Partial Differential Equations"**, 20th Edition, S. Chand Publishing,2020*
4	*S.S. Sastry, **"Introductory methods of numerical analysis"**, PHI, New Delhi, 5th Edition, 2015.*
5	*Ward Cheney, David Kincaid, **"Numerical Methods and Computing,** Cengage Learning**,** Delhi, 7th Edition 2013.*
6	*S. Larsson, V. Thomee, **"Partial Differential Equations with Numerical Methods"**, Springer, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Solve higher order linear differential equation with constant and variable coefficients and simultaneous differential equation.	K5
CO2	Form partial differential equations and find solutions of first and higher order partial differential equations.	K5
CO3	Obtain approximate solutions for transcendental equations and problems on interpolation, differentiation, integration.	K5
CO4	Find the numerical solutions of first order ordinary differential equations using single and multi step techniques.	K5
CO5	Solve second order partial differential equations using explicit and implicit methods.	K5

COURSE ARTICULATION MATRIX:
a) CO and PO Mapping:

COs/POs	**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**	**PSO 3**
CO1	3	3	-	1	-	-	-	-	-	-	-	1	3	2	3
CO2	3	3	-	1	-	-	-	-	-	-	-	1	3	2	3
CO3	3	3	-	1	-	-	-	-	-	-	-	1	3	2	3
CO4	3	3	-	1	-	-	-	-	-	-	-	1	3	2	3
CO5	3	3	-	1	-	-	-	-	-	-	-	1	3	2	3
22LBS204	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**2**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping:	
CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 4.1.1, 12.2.1.
CO2	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 4.1.1, 12.2.1.
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 4.1.1, 12.2.1.
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 4.1.1, 12.2.1.
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 4.1.1, 12.2.1.

ASSESSMENT PATTERN – THEORY:

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	20	20	-	-	100
CAT2	20	40	20	20	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	20	20	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	20	20	-	-	100
ESE	20	40	20	20	-	-	100

22LBS205	SEMICONDUCTOR PHYSICS	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	BS	3	0	0	3

Course Objectives	1. To understand the properties of conducting materials 2. To understand the properties of semiconductors 3. To analyze the PN Junction diode 4. To compare the characteristics of transistor, JFET and MOSFET and their applications 5. To analyze the different types of biasing in BJT and FET	
UNIT – I	**CONDUCTING MATERIALS**	**9 Periods**
Classical Free electron theory of metals – Postulates – Electrical and Thermal conductivity of metals – Derivation of Wiedeman – Franz law – Lorentz number – Drawbacks of Classical theory – Fermi distribution function- Effect of temperature – Density of energy states in metals (derivation) – Carrier concentration in metals- Fermi energy at 0K		
UNIT – II	**SEMICONDUCTORS**	**9 Periods**
Properties of semiconductors – elemental and compound semiconductors - Direct and indirect band gaps - Intrinsic and extrinsic semiconductors - Fermi level - Carrier concentration in intrinsic semiconductor - Dependence of Fermi level on temperature – Electrical conductivity – band gap determination – extrinsic semiconductors – Carrier concentration in P-type and N-type semiconductors		
UNIT – III	**PN JUNCTION AND SEMICONDUCTOR DIODES**	**9 Periods**
Review of PN junction diode (Qualitative) - VI Characteristic of a PN junction diode- Forward characteristic-Reverse characteristic- Diode current equation-Transition or space charge capacitance-Diffusion capacitance-Effect of temperature on PN junction diodes- Junction diode switching characteristics -PN diode applications.		
UNIT – IV	**TRANSISTORS**	**9 Periods**
Review of BJT (Qualitative) -Transistor current components-Eber moll's model of transistor-Transistor as an amplifier –Common Emitter Connection-Characteristics of Common Emitter Connection-Input and Output characteristics- Analysis of cut-off and saturation regions- FET-Operation and Characteristics of JFET, FET as a Voltage variable resistor, Metal oxide semiconductor field effect transistor (MOSFET)-Enhancement and Depletion mode MOSFET-High electron mobility transistors (HEMT) and single electron transistors (Qualitative)		
UNIT – V	**BIASING OF BJT AND FET**	**9 Periods**
Bias Stability –Need for biasing-Q point or operating point –DC load line – AC load line-thermal runaway-stability factor- Methods of Transistor biasing - Fixed bias or Base resistor method-Collector to base bias or biasing with feedback resistor - Bias compensation methods-Thermistor and sensistor compensation techniques - FET biasing methods: Self bias-Voltage divider bias		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*P.K.Palanisamy* ***"Engineering Physics-II",*** *Scitech Publications(India)pvt.Ltd, 2015.*
2	*S. M. Sze,* ***"Semiconductor Devices: Physics and Technology"****, Wiley 2015.*

REFERENCES

1	*V. K. Mehta and Rohit Mehta, **"Principles of Electronics"**, S. Chand & Company Ltd., 2020.*
2	*Dr.R.S.Sedha, **"A Text book of Applied Electronics"**, S .Chand & Company limited, 2019.*
3	*Dr. V.Rajendran, **"Material Science"**, Tata McGraw-Hill Publications, 2012.*
4	*William D Callister Jr., and David G. Rethwisch , **"Materials science & Engineering : An introduction"** , Wiley, 2014.*
5	*Charles Kittel, **"Introduction to Solid State Physics"**, Wiley, 2019.*
6	*S.Salivahanan, N.Suresh Kumar **"Electronic Devices and Circuits"**, McGraw Hill Education (India) Private Limited, 2017.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the properties of conducting materials	K2
CO2	Explain the characteristics of semiconducting materials	K2
CO3	Analyze the PN junction diode and its applications	K4
CO4	Analyze the characteristics of Transistor, JFET and MOSFET	K4
CO5	Interpret the biasing in transistor, JFET and MOSFET	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping:

COs/POs	**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**	**PSO 3**
CO1	2	-	-	-	-	-	-	-	-	-	-	-	2	1	2
CO2	2	-	-	-	-	-	-	-	-	-	-	-	2	1	2
CO3	2	1	-	-	-	-	-	-	-	-	-	-	2	1	2
CO4	2	1	1	-	-	-	-	-	-	-	-	-	2	1	2
CO5	2	1	1	-	-	-	-	-	-	-	-	-	2	1	2
22LBS205	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping:	
CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.2.3, 2.2.4, 2.4.1, 2.4.2, 2.4.3, 2.4.4.
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.2.3, 2.2.4, 2.4.1, 2.4.2, 2.4.3, 2.4.4.
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.4.1, 2.4.2, 2.4.3, 2.4.4.
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.2.2.
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.2.2.

ASSESSMENT PATTERN – THEORY:

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	30	30	10	10	-	100
CAT2	30	30	30	10	10	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	40	20	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	40	40	20	-	-	-	100
ESE	30	30	20	10	10	-	100

22LBS206	APPLIED CHEMISTRY (Common to EEE,ECE,EIE,CSE and IT Branches)	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	BS	3	0	0	3

Course Objectives	1. To know about the second law of thermodynamics and its various functions. 2.To understand the concept of electrochemistry, primary, secondary batteries, construction and its uses. 3. To understand the basic principles of corrosion, mechanism and its protection methods. 4. To acquire basic knowledge about the nanoparticles, its preparations, properties, types and applications in various field. 5.To impart the knowledge of preparations of single crystal, wafer preparation, P-N junction formation by various methods.	
UNIT – I	**CHEMICAL THERMODYNAMICS**	**9 Periods**
The Second law of thermodynamics-Concepts of entropy, Work and free energy functions - Maxwell's relationships for reversible and irreversible process - Gibbs Helmholtz equation – Partial molar free energy-Chemical potential-Gibb's Duhem Equation, Clausius - Clapeyron equation.		
UNIT – II	**ELECTRO CHEMISTRY AND STORAGE DEVICES**	**9 Periods**
Cells–Electro chemical cell and electrolytic cell – electrodes– electrode potentials – standard oxidation and reduction potentials-Hydrogen and Calomel electrodes- EMF series and its significance. Batteries - Types of batteries- Primary - Zn/MnO_2 and $Li/SOCl_2$ - Construction, working and applications. Secondary batteries- Lead acid battery and lithium-ion battery – $Li\text{-}TiS_2$- Construction, working and Applications.		
UNIT – III	**CORROSION**	**9 Periods**
Corrosion-Definition -Classifications: Chemical Corrosion and Electro chemical corrosion mechanism-Pilling Bedworth rule–Galvanic series and its importance- preventing methods-Cathodic protection (sacrificial anode and impressed current conversion method). Protective Coatings-Inorganic coating-surface preparation-Electro plating method applied to Cr and Ni, Organic coating- paints - constituents and its functions.		
UNIT – IV	**NANO MATERIALS**	**9 Periods**
Nanomaterials and bulk materials; Size-dependent properties (Optical, Electrical and Mechanical); Types of nanomaterials: Definition- properties and uses of nanoparticle, nanorod and nanotube. Preparation of nanomaterials: chemical vapour deposition, electrochemical deposition. Applications of nanomaterials in medicine and electronics.		
UNIT – V	**FABRICATION**	**9 Periods**
Silicon for IC chips - single crystal – preparation by Czochralski and float zone processes- wafer preparation, P-N junction formation – Ion implantation. Diffusion and epitaxial growth techniques - Insulator layer by oxidation- Printing of circuits by photolithography – masking and electron beam methods- etching by chemical and electrochemical methods.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Jain. P.C. and Monica Jain,* ***"Engineering Chemistry"****, DhanpatRai Publications Pvt Ltd, New Delhi, 16th Edition,2017.*
2	*S.S. Dara****, "A text book of Engineering Chemistry"****, S. Chand Publishing, 12th Edition, 2018.*

REFERENCES:

1	*Dara. S.S, Umarae,* ***"Text book of Engineering Chemistry"****, S. Chand Publications, 2013.*
2	*M.S.Tyagi,* ***"Introduction to semiconductor materials and devices"****, WileyIndia, 2012.*
3	*B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday****, "Textbook of nanoscience and nanotechnology"****, Universities Press-IIM Series in Metallurgy and Materials Science, 2018.*
4	*B.R Puri, L.R Sharma & M. S. Pathania,* ***"Principles of Physical Chemistry" Nagin .S****Chand and Co., 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyze the applications of thermodynamics and its various functions.	K3
CO2	Implement the new ideas related to batteries which find uses in the society including engineering fields.	K3
CO3	Identify the corrosion mechanisms and its controlling methods.	K3
CO4	Applying the concepts of nanoscience and nanotechnology in the synthesis of nanomaterials for engineering applications.	K3
CO5	Construct the silicon chips and their fabrication methods and to apply in preparation of electrical and electronic instruments.	K3

COURSE ARTICULATION MATRIX:
a) CO and PO Mapping:

COs/POs	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	PSO 3
CO1	2	1	1	-	1	-	-	-	-	-	-	-	-	-	-
CO2	2	1	1	-	1	-	-	-	-	-	-	-	2	1	2
CO3	1	1	1	1	1	2	1	-	-	-	-	-	-	-	-
CO4	1	1	1	1	1	-	-	-	-	-	-	-	2	1	2
CO5	1	1	1	1	1	-	-	-	-	-	-	-	2	1	2
22LBS206	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping:	
CO1	1.1.1, 1.2.1, 2.2.1, 2.1.3, 2.3.1, 3.2.2, 5.1.1.
CO2	1.1.2, 1.2.1, 2.3.1, 3.2.2, 5.1.1.
CO3	1.2.1, 2.3.1, 3.2.2, 4.1.1, 4.3.1, 5.1.1, 6.1.1, 7.1.1.
CO4	1.2.1, 2.2.2, 2.3.1, 3.2.2, 4.1.1, 4.3.1, 5.1.1, 5.1.2, 7.1.1.
CO5	1.2.1, 2.3.1, 3.2.2, 4.1.2, 5.1.1.

ASSESSMENT PATTERN – THEORY:

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	40	20	10	-	-	100
CAT2	30	40	20	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	40	20	10	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	40	20	10	-	-	100
ESE	30	40	20	10	-	-	100

22LES204	BASICS OF ELECTRICAL ENGINEERING	SEMESTER II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	3	0	0	3

Course Objectives	1 To study the basic concepts of electric circuits, measuring instruments and electric installations. 2 To understand the fundamental of energy conversion, construction, principle of operation, characterization of DC machines and AC machines	
UNIT – I	**FUNDAMENTALS OF ELECTRICAL SYSTEMS**	**9 Periods**
DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor - Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor - Three phase supply system – star and delta connection – power calculation		
UNIT – II	**DC MACHINES AND TRANSFORMERS**	**9 Periods**
DC Machines: Construction, Principle of operation, Voltage and power equations and Types, Characteristics and Applications of DC generators and motors. Single phase Transformers – Construction-principle of Operation-Equivalent circuit, losses, Regulation and efficiency - Auto transformer – Construction and operation		
UNIT – III	**INDUCTION MOTORS AND SYNCHRONUS MACHINES**	**9 Periods**
Induction Motors: Construction, Principle of operation, Types, Speed Torque Characteristics and Applications of Single phase and Three phase Induction motors – Synchronous Generator : Construction-Principle-EMF Equation-Synchronous Motor–Construction and Principle of operation-Starting methods-Applications		
UNIT – IV	**ELECTRICAL AND ELECTRONIC INSTRUMENTS**	**9 Periods**
Functional elements of an instrument – Static and Dynamic Characteristics – Errors in measurements - Types of instruments - Operating principles of Moving coil, Moving iron Instruments (Ammeter and Voltmeters), Dynamometer type watt meters and Induction type Energy meters – Standards and Calibrations – Cathode Ray Oscilloscope – Digital Storage Oscilloscope.		
UNIT – V	**ELECTRICAL INSTALLATIONS AND ENERGY CONSERVATION**	**9 Periods**
Importance of neutral and earthing, basic house wiring -tools and components, different types of wiring - basic safety measures at home and industry – Batteries – Principle, Charging and Discharging characteristics, types and applications, Energy efficient lamps - Energy billing. Introduction to UPS and SMPS		
Contact Periods : **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	Mittle V.N and Aravind Mittal, **“Basic Electrical Engineering”**, Tata Mc Graw Hall, Second Edition, New Delhi, 2005.
2	D.P.Kothari, LJ Nagarath, **“Basic Electrical Engineering”**, Tata McGraw Hall 2010
3	A.K. Sawhney, **“A Course in Electrical & Electronics Measurement & Instrumentation”**, Dhanpat Rai and Cu, 2004.

REFERENCES:

1	Nagsarkar T.K and Sukhfia M.S **“Basic Electrical Engineering”,** Oxford Press, 2005.
2	E. Hughes, **“Electrical and Electronics Technology”**, Pearson 2010
3	Mohmood Nahvi and Joseph A.Edmininister, **“Electric Circuits”,** Shaum Outline series, McGraw Hill, Sixth edition, 2014
4	Premkumar N and Gnanavadivel J, **“Basic Electrical and Electronics Engineering”**, Anuradha Publishers, 4^{th} Edition, 2008.
5	S.L. UPPAL, **“Electrical Wiring Estimation and Costing”**, Khanna Publishers , New Delhi 2006.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Investigate the basic concepts of AC and DC power systems.	K2
CO2	Infer and Interpret the construction and working principles of DC machines and Transformer.	K3
CO3	Classify and select the AC machines based on constructions working principles.	K3
CO4	Interpret the working principles of electronic measuring instruments.	K4
CO5	Implement the different components involved in house electric system.	K5

COURSE ARTICULATION MATRIX:
a) CO and PO Mapping:

COs/POs	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	PSO 3
CO1	1	1	1	1	-	-	-	-	-	-	-	-	1	-	-
CO2	1	-	-	1	-	-	-	1	-	-	-	-	1	-	-
CO3	1	-	1	-	-	-	-	-	-	1	-	-	1	-	-
CO4	2	1	1	-	-	-	1	-	-	-	-	-	1	-	-
CO5	-	-	1	1	-	-	-	-	-	-	-	-	1	-	-
22LES204	**1**	**1**	**1**	**1**	**-**	**-**	**1**	**1**	**-**	**1**	**-**	**-**	**1**	**-**	**-**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping:	
CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.2, 3.3.1, 3.3.2, 3.4.3,4.1.1, 4.3.3, 6.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2.
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.3.1, 3.3.2, 3.4.3, 4.1.1, 4.3.1,6.1.1, 8.1.1.
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.4.4, 3.1.3, 3.1.4, 3.2.1, 3.3.1, 6.1.1, 10.3.1, 12.2.1, 12.2.2, 12.3.1
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.2, 3.1.3, 3.1.4, 3.2.1, 3.2.2, 4.1.2, 4.1.3, 7.2.1.
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3,2.3.1, 2.3.2, 3.1.3, 3.1.4, 3.2.1, 3.2.2, 3.3.2, 4.1.2, 4.1.3, 4.3.3, 12.2.2, 12.3.1, 12.3.2.

ASSESSMENT PATTERN – THEORY :							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	40	-	-	-	100
CAT2	35	35	20	10	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	25	25	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	25	25	40	10	-	-	100
ESE	35	35	20	10	-	-	100

22LBS2Z7	**CHEMISTRY LABORATORY** (Common to all Branches)	**SEMESTER II**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**BS**	**0**	**0**	**3**	**1.5**

COURSE OBJECTIVES:	* To inculcate the practical applications of Chemistry to students and make them apply in the fields of engineering and technology.

LIST OF EXPERIMENTS	
1.	Estimation of hardness by EDTA method.
2	Conductometric titration of mixture of strong acid and weak acid using strong base.
3.	Estimation of chloride by Argentometric method.
4.	Potentiometric titration of ferrous iron by dichromate.
5.	Determination of Saponification value of an oil.
6.	Estimation of Iron by Spectrophotometry.
7.	Estimation of Dissolved Oxygen.
8.	Estimation of HCl by pH titration.
9.	Estimation of Copper in brass sample.
10.	Estimation of Manganese in Pyrolusite ore.
11.	Anodiziation of aluminium.
12.	Determination of corrosion rate and inhibitor efficiency of mild steel in acid media by weight loss method.

Contact Periods:			
Lecture: 0 Periods	**Tutorial: 0 Periods**	**Practical: 45 Periods**	**Total: 45 Periods**

REFERENCE BOOKS:

1	*A.O. Thomas, **"Practical Chemistry"**, Scientific Book Centre, Cannanore, 2006.*
2	*Vogel's **"Text book of Quantitative Analysis"**, Jeffery G H, Basset J. Menthom J, Denney R.C., 6th Edition, EBS, 2009.*

COURSE OUTCOMES: Upon the completion of the course, the student will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the quality of water samples with respect to their hardness and DO.	K3
CO2	Determine the amount of metal ions through potentiometric and spectroscopic techniques.	K3
CO3	Infer the strength of acid, mixtures of acids by pH meter and conductivity cell.	K3
CO4	Estimate the chloride, manganese and copper from various samples.	K3
CO5	Interpret the corrosion rate determination and anodizing method.	K2

COURSE ARTICULATION MATRIX:															
a) CO and PO Mapping:															
COs/POs	**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**	**PSO 3**
CO1	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	2	1	-	1	-	-	-	-	-	-	-	-	-	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO5	2	1	1	1	-	-	1	-	-	-	-	-	-	-	-
22LBS2Z7	**2**	**1**	**1**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping:	
CO1	1.1.1, 1.2.1, 2.3.1, 3.1.5.
CO2	1.1.1, 1.2.1, 1.3.1, 2.1.2.
CO3	1.1.1, 1.2.1, 2.1.3, 4.1.3.
CO4	1.2.1, 1.3.1, 2.3.1.
CO5	1.1.1, 1.2.1, 1.3.1, 2.3.1, 3.1.5, 4.2.1, 7.1.1.

22LES2Z5	**ENGINEERING GRAPHICS** (Common to all Branches)	**SEMESTER II**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**ES**	**1**	**0**	**4**	**3**

Course Objectives	1. To Understand the geometrical constructions. 2. To Study the various types of projections. 3. To Identify different section of solids. 4. To Perform the development of surfaces and view of solids. 5. To Familiarize with CAD packages.	
UNIT – I	**GEOMETRICAL CONSTRUCTIONS AND PLANE CURVES**	**(3+12 Periods)**
Principles of Engineering Graphics and their significance - Basic geometrical constructions. Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Drawing of tangents and normal to the above curves.		
UNIT – II	**ORTHOGRAPHIC PROJECTIONS**	**(3+12 Periods)**
Introduction to Orthographic Projection - Conversion of pictorial views to orthographic views. Projection of points - Projection of straight lines with traces - Projection of planes (polygonal and circular surfaces) inclined to both the principal planes.		
UNIT – III	**PROJECTION AND SECTION OF SOLIDS**	**(3+12 Periods)**
Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids, when the axis is inclined to both the principal planes by rotating object method. Sectioning of prisms, pyramids, cylinder and cone in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section.		
UNIT – IV	**DEVELOPMENT OF SURFACES AND ISOMETRIC PROJECTIONS**	**(3+12 Periods)**
Development of lateral surfaces of simple and sectioned solids – prisms, pyramids, cylinder and cone. Principles of isometric projection – isometric scale – isometric projections of simple solids and truncated solids - prisms, pyramids, cylinder, cone- combination of two solid objects in simple vertical positions.		
UNIT – V	**COMPUTER AIDED DRAFTING**	**(3+12 Periods)**
Introduction to computer aided drafting package to make 2D Drawings. Object Construction: Page layout – Layers and line types – Creating, editing and selecting the geometric objects. Mechanics: Viewing, annotating, hatching and dimensioning the drawing – Creating blocks and attributes. Drafting: Create 2D drawing. A number of chosen problems will be solved to illustrate the concepts clearly. (Demonstration purpose only, not to be included in examination).		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 60 Periods Total: 75 Periods**		

TEXT BOOKS:

1	*K.Venugopal, **"Engineering Graphics"**, New Age International (P) Limited, 2016.*
2	*K.V.Natarajan, **"A text book of Engineering Graphics"**, Dhanalakashmi Publishers, Chennai, 2016.*

REFERENCES:

1	*K.L.Narayana and P.Kannaiah, **"Text book on Engineering Drawing"**, 2nd Edition, SciTech Publications (India) Pvt. Ltd, Chennai, 2009.*
2	*N.S.Parthasarathy and Vela Murali, **"Engineering Graphics"**, Oxford University Press, New Delhi, 2015.*
3	*K.R.Gopalakrishna, **"Engineering Drawing" (Vol. I&II combined),** Subhas Publications, Bangalore, 2014.*
4	*Basant Agarwal and C.M.Agarwal, **"Engineering Drawing"**, Tata McGraw Hill Publishers, New Delhi, 2013.*
5	*Kevin Lang and Alan J.Kalameja, **"AutoCAD 2012 Tutor for Engineering Graphics"**, Cengage Learning Publishers, 1st Edition, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Acquire on representing solids as per international standards.	K3
CO2	Impart knowledge on different types of projections.	K3
CO3	Generate and interrupt the true shape of section.	K3
CO4	Develop the various surfaces according to the standards.	K3
CO5	Know the concept of computers in drafting engineering diagrams.	K6

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping:

CO/ PO	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	PSO 3
CO1	3	1	1	1	1	2	-	3	1	3	1	3	-	-	-
CO2	3	1	1	1	1	2	-	3	1	3	1	3	-	-	-
CO3	3	1	1	1	1	2	-	3	1	3	1	3	-	-	-
CO4	3	1	1	1	1	2	-	3	1	3	1	3	-	-	-
CO5	3	1	1	1	1	2	-	3	1	3	1	3	1	1	1
22LES2Z5	**3**	**1**	**1**	**1**	**1**	**2**	**-**	**3**	**1**	**3**	**1**	**3**	**1**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping:

CO1	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.3, 2.4.2, 3.1.2, 3.1.4, 3.2.1, 4.3.3, 5.1.1, 6.2.1, 8.1.1, 8.2.1, 8.2.2, 9.2.1, 9.2.4, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.1, 12.2.1, 12.2.2, 12.3.1, 12.3.2.
CO2	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.3, 2.4.2, 3.1.2, 3.1.4, 3.2.1, 4.3.3, 5.1.1, 6.2.1, 8.1.1, 8.2.1, 8.2.2, 9.2.1, 9.2.4, 10.1.1, 10.1.2, 10.2.1, 10.3.1, 10.3.2, 11.3.1, 12.1.1, 12.2.1, 12.2.2, 12.3.1, 12.3.2.
CO3	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.3, 2.4.2, 3.1.2, 3.1.4, 3.2.1, 4.3.3, 5.1.1, 6.2.1, 8.1.1, 8.2.1, 8.2.2, 9.2.1, 9.2.4, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.1, 12.2.1, 12.2.2, 12.3.1, 12.3.2.
CO4	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.3, 2.4.2, 3.1.2, 3.1.4, 3.2.1 ,4.3.3, 5.1.1, 6.2.1, 8.1.1 , 8.2.1, 8.2.2, 9.2.1, 9.2.4, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.1, 12.2.1, 12.2.2, 12.3.1, 12.3.2.
CO5	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.3, 2.4.2, 3.1.2, 3.1.4, 3.2.1, 4.3.3, 5.1.1, 6.2.1, 8.1.1, 8.2.1, 8.2.2, 9.2.1, 9.2.4, 10.1.1, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.1, 12.2.1, 12.2.2, 12.3.1, 12.3.2.

22LES306	CIRCUIT THEORY	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	3	1	0	4

Course Objectives	To understand the DC and AC circuit analysis and Network topology of electrical circuits.	
UNIT – I	**DC CIRCUIT ANALYSIS**	**12 Periods**
Basic Components of electric Circuits, Charge, current, Voltage and Power, Voltage and Current Sources, Ohms Law, Kirchoff's Current Law, Kirchoff's voltage law, Single Node, Pair Circuit, series and Parallel Connected Independent Sources, Resistors in Series and Parallel, voltage and current division, Nodal analysis, Mesh analysis.		
UNIT – II	**NETWORK THEORY AND DUALITY**	**12 Periods**
Superposition, Thevenin and Norton Equivalent Circuits, Maximum Power Transfer, Delta-Wye Conversion. Duals, Dual circuits. Analysis using dependent current sources and voltage sources		
UNIT – III	**SINUSOIDAL STEADY STATE ANALYSIS**	**12 Periods**
Sinusoidal Steady State analysis , Characteristics of Sinusoids, The Complex Forcing Function, Phasor, Phasor relationship for R, L, and C, Impedance and Admittance, Phasor Diagrams, AC Circuit Power Analysis, Instantaneous Power, Average Power, Apparent Power and Power Factor, Complex Power.		
UNIT – IV	**TRANSIENTS AND RESONANCE IN RLC CIRCUIT**	**12 Periods**
Basic RL and RC Circuits, The Source- Free RL Circuit, The Source-Free RC Circuit, RL,RC&RLC Circuits driven by unit step function, Frequency Response, Parallel Resonance, Series Resonance, Quality Factor.		
UNIT – V	**COUPLED CIRCUITS AND TOPOLOGY**	**12 Periods**
Magnetically Coupled Circuits, mutual Inductance, Linear Transformer, Ideal Transformer, An introduction to Network Topology, Trees and General Nodal analysis, Links and Loop analysis.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

TEXT BOOK

1	*Sudhakar and Shyammohan S Palli "**Circuits and Networks Analysis and Synthesis**"McGraw Hill Publishing Company 2017.*
2	*Joseph Edminister and MahmoodNahvi, "**Electric Circuits**", Schaum's Outline Series, Tata McGraw Hill Publishing Company, New Delhi, Fifth Edition Reprint 2016.*

REFERENCES

1	*David Bell, "**Fundamentals of Electric Circuits**", Oxford University press, 7thEdition, 2009.*
2	*John O Mallay, Schaum's Outlines "**Basic Circuit Analysis**", The McGraw Hill companies, 2nd Edition, 2011*
3	*Charles K. Alexander & Mathew N.O.Sadiku, "**Fundamentals of Electric Circuits**", McGrawHill, 2nd Edition, 2003.*
4	*AbhijitChakrabarti,"**CircuitTheoryAnalysis&Synthesis**",7th RevisedEdition,DhanpathRai&Sons, NewDelhi,2018*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the basic concepts of circuit analysis such as Kirchoff's laws, mesh current and node voltage analysis of electric circuits.	K2
CO2	To apply suitable network theorems and analyze the electrical circuits	K3
CO3	To analyse sinusoidal steady state response of R, L and C circuits	K4
CO4	To analyse the transient response for of RC, RL and RLC circuits and frequency response of parallel and series resonance circuits.	K4
CO5	Explain the coupled circuits and network topologies	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping															
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	2	1	2	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	1	3	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	1	3	2	-	-	-	-	-	-	-	3	-	-
CO4	3	3	1	3	2	-	-	-	-	-	-	-	3	-	-
CO5	3	3	1	3	2	-	-	-	-	-	-	-	3	-	-
22LES306	3	3	1	3	2	-	-	-	-	-	-	-	3	-	-
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.3,2.2.4,2.4.1,2.4.2,3.2.2,4.1.2,4.1.3,4.1.4,4.2.1,4.3.1
CO2	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.3,2.2.4,2.4.1,2.4.2,3.2.2,3.3.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,3.1.6,3.2.3,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4,5.1.1,5.1.2,5.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,3.1.6,3.2.3,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4,5.1.1,5.1.2,5.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,3.1.6,3.2.3,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4,5.1.1,5.1.2,5.2.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total 100 %**
CAT1	10	40	10	40			100
CAT2	10	40	10	40			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	10	40	10	40			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	10	40	10	40			100
ESE	10	40	10	40			100

22LES307	DATA STRUCTURES *(Common to EEE, ECE & CSE Branches)*	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	3	0	0	3

Course Objectives	The objective of the course is to enable the students to analyze the time complexity of an algorithm, Understand and Use List, Stack, Queue, Tree and graph Data structures and effectively use sorting and searching Techniques.	
UNIT – I	**INTRODUCTION AND ABSTRCT DATATYPES**	**9 Periods**
Algorithm Analysis: Calculation of Running Time – Abstract Data Type- List ADT: Array implementation of List, Linked Lists, Doubly Linked List, Circularly Linked Lists- Cursor implementation of Linked List		
UNIT – II	**STACK AND QUEUE ADT**	**9 Periods**
Stack ADT: Stack Model, Implementation of stacks, Applications: Balancing Symbols, Postfix expression evaluation, Infix to postfix conversion, Function Calls – Queue ADT: Queue Model, Implementation of Queues, Applications.		
UNIT – III	**TREE ADT**	**9 Periods**
Preliminaries – Implementation of Trees – Tree Traversals – Binary Tree: Implementation, Expression Tree – Search Tree ADT – AVL Trees - BTrees – Red Black Trees.		
UNIT – IV	**GRAPH ALGORITHMS**	**9 Periods**
Definitions – Representation of Graphs – Traversal- Topological sort – Shortest Path Algorithms: Dijkstra's Algorithm – Network Flow Problem – Minimum Spanning Tree: Prim's and Kruskal's algorithm.		
UNIT – V	**SORTING AND SEARCHING**	**9 Periods**
Sorting: Insertion Sort – Shell Sort – Heap Sort – Merge Sort – Quick Sort – Bucket Sort – External Sorting: Simple Algorithm, Multi way merge, Poly Phase Merge – Searching : Linear Search – Binary Search – Hashing : Hash Functions– Collision Resolution: Separate Chaining – Open Addressing – Linear Probing– Quadratic Probing – Double Hashing – Rehashing.		
Contact Periods: **Lecture: 45 Period Tutorial:0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK

1	*Mark Allen Weiss "Data Structures and Algorithm Analysis in C" Second Edition, Pearson Education Limited, 2002.*

REFERENCES

1	*Thomas H. Cormen , Charles E. Leiseron, Ronald L.Rivest, Clifford Stein, "Introduction to Algorithms", Third Edition, PHI learning Pvt. Ltd., 2011.*
2	*SartajSahni, "Data Structures, Algorithms and applications in C++", Second Edition, Universities Press, 2005.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Analyze the time complexity of various algorithms	K4
CO2	Define and use list, stack and queue Data Structures	K3
CO3	Define and use Tree Data Structure	K3
CO4	Define and use Graph Data Structure	K4
CO5	Use appropriate sorting and searching Techniques	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs	**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**	**PSO 3**
CO1	2	1	2	1								1	3	3	2
CO2	2	2	2	2	2	2				1		1	3	3	2
CO3	2	2	2	2	2	2				1		1	3	3	2
CO4	2	2	2	2	2	2				1		1	3	3	2
CO5	2	2	1	1								1	3	3	2
22LES307	2	2	2	2	2	2				1		1	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.3.1, 1.4.1,2.1.2, 2.2.2, 2.3.1,2.4.1,3.1.6,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,4.2.2,4.3.1,12.2.2.
CO2	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2
CO3	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2
CO4	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2
CO5	1.3.1,1.4.1,2.1.2.2.1,2.2.3,2.3.1,2.4.4,3.1.3,3.1.6, 3 .2.3, 3.3.2, 4.1.2, 4.2.1,4.3.1,6.1.1, 10.3.1, 11.2.1, 12.1.1,12.2.2,12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	30	50				100
CAT2	20	30	50				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	30	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	30	50				100
ESE	20	30	50				100

22LPC301	SIGNALS AND SYSTEMS	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	1	0	4

Course Objectives	To analyze the Continuous Time signals and systems using Fourier and Laplace Transforms and Discrete Time signals and systems using DTFT and Z-Transforms	
UNIT – I	**INTRODUCTION TO SIGNALS AND SYSTEMS**	**12 Periods**
Introduction to Continuous Time (CT) signals and Discrete Time (DT) signals - step, ramp, impulse, exponential, sinusoidal signals, Representation of DT signals by impulses- signal operations- classification of CT and DT signals –periodic and aperiodic signals, random signals, energy and power signals, even and odd signals- linear time invariant CT systems and DT systems- basic system properties: linear time invariant, causality, BIBO stability.		
UNIT – II	**ANALYSIS OF CONTINUOUS TIME SIGNALS**	**12 Periods**
Fourier series analysis- spectrum of Continuous Time signals- properties of continuous time Fourier series, Fourier transform of continuous time aperiodic signals and periodic signals, properties of continuous time Fourier transform. Fourier and Laplace Transforms in signal Analysis.		
UNIT – III	**LINEAR TIME INVARIANT–CONTINUOUS TIME SYSTEMS**	**12 Periods**
Differential Equation- CT system representations by differential equations -Block diagram representation-impulse response, convolution integrals- Frequency response of systems characterized by Differential Equations- Fourier and Laplace transforms in analysis of LTI systems.		
UNIT – IV	**ANALYSIS OF DISCRETE TIME SIGNALS**	**12 Periods**
Baseband Sampling of CT signals- Aliasing, Reconstruction of CT signal from DT signal, Discrete Time Fourier series representation of DT periodic signals – Properties – Representation of DT aperiodic signals by Discrete Time Fourier Transform (DTFT) – Properties – Z Transforms-properties.		
UNIT – V	**LINEAR TIME INVARIANT –DISCRETE TIME SYSTEMS**	**12 Periods**
Difference Equations-Block diagram representation-ImpulseResponse-Convolution sum -DTFT and Z Transform analysis of Recursive & Non-Recursive systems – Frequency response of systems characterized by Difference –Equations.		
Contact Periods: **Lecture: 45 Periods Tutorial: 15 Periods Practical: 0 Periods Total: 60 Periods**		

TEXT BOOK:

1	*Alan V.Oppenheim, Alan S.Willsky and S.HamidNawab, "**Signals & Systems**", Prentice-Hall of India, Second Edition, 2011*
2	*Simon Haykin and Barry Van Veen, "**Signals and Systems**", Wiley India, New Delhi, 2010*

REFERENCES

1	*1. H P Hsu, RakeshRanjan, "**Signals and Systems**", Tata McGraw Hill, 7th Reprint, 2010*
2	*Edward W. Kamen, Bonnie S. Heck, "**Fundamentals of Signals and Systems Using the Web and MATLAB**", Pearson Prentice Hall, 2007*
3	*John Alan Stuller, "**An Introduction to Signals and Systems**", Thomson, 2008*
4	*M.J.Roberts,"**Signalsand Systems, Analysis Using Transform Methods and MATLAB**", Tata McGraw Hill (India), 2nd Edition, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply various operations on signals and understand the System properties.	**K3**
CO2	Analyze frequency components of CT signals and understand the Importance of frequency domain analysis.	**K4**
CO3	Apply convolution integral and differential equation in Analyzing CT LTI systems	**K3**
CO4	Analyze the effect of sampling and frequency content of DT signals through DTFT and Z transform.	**K4**
CO5	Apply convolution Sum and difference equation in analyzing DT LTI systems	**K3**

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

Cos/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO 1	3	2	2	1	-	-	-	-	-	-	-	-	3	1	1
CO 2	3	2	2	1	-	-	-	-	-	-	-	-	2	1	1
CO 3	3	1	1	-	-	-	-	-	-	-	-	-	3	1	1
CO 4	3	3	1	-	-	-	-	-	-	-	-	-	3	1	1
CO 5	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
22LPC301	3	2	2	1	-	-	-	-	-	-	-	-	3	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1, 2.4.1,3.1.1, 3.1.4,3.1.5, 3.3.2, 3.4.1, 4.1.1
CO2	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1, 2.4.1, 3.1.1, 3.1.4,3.1.5, 3.3.2, 3.4.1, 4.1.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4,3.1.4
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.2, ,2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3,2.4.4,3.1.4,3.1.6
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 3.1.1, 3.1.4,3.3.2,3.4.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	40	20			100
CAT2	20	20	40	20			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	30	40				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	30	40				100
ESE	20	30	40	10			100

22LPC302	ANALOG CIRCUITS	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To understand the characteristics functions and frequency response of basic Electronic circuits	
UNIT – I	**BJT AND FET AMPLIFIER**	**9 Periods**
Small Signal Hybrid π equivalent circuit of BJT, Early effect, Analysis of CE, CC and CB amplifiers, - AC Load Line Analysis- Darlington Amplifier - Bootstrap technique - Cascade, Cascode configurations. FET AMPLIFIERS Small Signal Hybrid π equivalent circuit of FET and MOSFET - Analysis of CS, CD and CG amplifiers- BiCMOS circuits.		
UNIT – II	**FREQUENCY RESPONSE OF BJT AND FET AMPLIFIERS**	**9 Periods**
General Frequency Considerations- Low and High Frequency response of BJT and FET amplifiers – short circuit current gain - cut off frequency – fα, fβ and unity gain bandwidth – Miller Effect Capacitance- Multistage Frequency Effects.		
UNIT – III	**FEEDBACK AMPLIFIERS AND OSCILLATORS**	**9 Periods**
Feedback Concepts– effect of feedback on gain stability, distortion, bandwidth, input and output impedances. Types of feedback amplifiers-stability, Gain and Phase margins-Frequency compensation. OSCILLATORS: Barkhausen criterion for oscillation, Hartley and Colpitt's oscillators, Clapp oscillator, Ring oscillators and crystal oscillators.		
UNIT – IV	**TUNED AMPLIFIERS AND WAVE SHAPING CIRCUITS**	**9 Periods**
Small signal tuned amplifiers – Analysis of capacitor coupled single tuned amplifier, double tuned amplifier and effect of cascading single tuned and double tuned amplifiers on bandwidth, Stagger tuned amplifiers , Stability of tuned amplifiers – Neutralization. WAVE SHAPING CIRCUITS: Pulse circuits –RC integrator and differentiator circuits – diode clampers and clippers - UJT Oscillator.		
UNIT – V	**POWER SUPPLIES AND POWER AMPLIFIERS**	**9 Periods**
Linear mode power supply – Half wave and Full wave Rectifiers, Filters, Voltage regulators. Over voltage protection - Switched mode power supply (SMPS) - Regulated DC Power Supply, Power amplifiers- Class A, Class B, Class AB, Class C-Power MOSFET-Temperature Effect- Class AB Power amplifier using MOSFET.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK

1	*Robert L. Boylestad and Louis Nasheresky, "**Electronic Devices and Circuit Theory**", 11th Edition, Pearson Education, 2013.*
2	*Floyd, **Electronic Devices**, Ninth Edition, Pearson Education, 2012.*

REFERENCES

1	*Donald. A. Neamen, **Electronic Circuits Analysis and Design**, 3rd Edition, McGraw Hill Education (India) Private Ltd., 2010.*
2	*Millman J, Halkias.C.andSathyabradaJit, **Electronic Devices and Circuits**, 4th Edition, McGraw Hill Education (India) Private Ltd., 2015.*
3	*Salivahanan and N. Suresh Kumar, **Electronic Devices and Circuits**, 4th Edition, ,McGraw Hill Education (India) Private Ltd., 2017.*
4	*David A. Bell, **Electronic Devices & Circuits**, 5th Edition, Oxford University Press, 2008.*
5	*Anwar A. Khan and Kanchan K. Dey, **A First Course on Electronics**, PHI, 2006.*
6	*Rashid M, **Microelectronics Circuits**, Thomson Learning, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the Working principles, characteristics and applications of BJT and FET amplifiers.	K2
CO2	Explain the Frequency response characteristics of BJT and FET amplifiers	K2
CO3	Describe the performance of Feedback Amplifiers and Oscillators	K2
CO4	Analyze the operation of Tuned Amplifiers and Wave Shaping circuits	K4
CO5	Evaluate the working principles of Power supplies and Power Amplifiers.	K5

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO 3**
CO1	3	2	1	2	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	1	3	-	-	-	-	-	-	-	-	3	-	-
CO3	3	2	1	3	-	-	-	-	-	-	-	-	3	-	-
CO4	3	3	1	3	-	-	-	-	-	-	-	-	3	-	-
CO5	3	3	1	3	-	-	-	-	-	-	-	-	3	-	-
22LPC302	3	3	1	3	-	-	-	-	-	-	-	-	3	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.3,2.2.3,2.2.4,2.4.1,2.4.2,3.2.2,4.1.2,4.1.4,4.2.1,4.3.1
CO2	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.3,2.2.4,2.4.1,2.4.2,3.2.2,3.3.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.3.1,2.3.1,2.4.1,2.4.2,3.1.6,3.2.3,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.3.1,2.3.2,2.4.1,2.4.2,3.1.6,3.2.3,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.3,2.2.1,2.2.2,2.2.3,2.3.12.3.2,2.4.1,2.4.2,3.1.6,3.2.3,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total 100%**
CAT1		50	10	20	20		100
CAT2		50	10	20	20		100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50	10	20	20		100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	10	20	20		100
ESE		50	10	20	20		100

22LPC303	DIGITAL CIRCUITS DESIGN	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To introduce the theoretical and circuit aspects of Digital Electronics which is the backbone for the basics of the hardware aspects of Digital system	
UNIT – I	**DIGITAL FUNDAMENTALS**	**9 periods**
Number Systems – Decimal, Binary, Octal, Hexadecimal, 1's and 2's complements, Codes – Binary, BCD, Excess 3, Gray, Alphanumeric codes, Boolean theorems, Logic gates, Universal gates, Sum of products and product of sums, Min terms and Max terms, Karnaugh map Minimization and Quine-McCluskey method of minimization. Introduction to Verilog HDL.		
UNIT – II	**COMBINATIONAL CIRCUIT DESIGN**	**9 periods**
Design of Half and Full Adders, Half and Full Subtractors, Binary Parallel Adder – Carry look ahead Adder, BCD Adder, Binary Multiplier, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder, Priority Encoder.		
UNIT – III	**SYNCHRONOUS SEQUENTIAL CIRCUITS**	**9 periods**
Flip flops – SR, JK, T, D, Master/Slave. FF operation and excitation tables, Triggering of FF, Analysis and design of clocked sequential circuits – Moore/Mealy models, state minimization, state assignment, circuit implementation – Design of Counters- Ripple Counters: Binary, BCD, Modulo n, Up/Down counters-Counter for Random Sequence - Shift registers: -UniversalShiftRegister–Synchronouscounters-Ringcounter–Johnsoncounter.		
UNIT – IV	**ASYNCHRONOUS SEQUENTIAL CIRCUITS**	**9 periods**
Analysis and Design of Asynchronous Sequential Circuits-Reduction of Flow Tables- Stable and Unstable states, state reduction, output specifications, cycles and races, race free assignments, Hazards: Essential Hazards, Pulse mode sequential circuits, Design of Hazard free circuits- Clock skews.		
UNIT – V	**MEMORY AND PROGRAMMABLE LOGIC DEVICES**	**9 periods**
Basic memory structure – ROM -PROM – EPROM – EEPROM –EAPROM, RAM – Static and dynamic RAM - Programmable Logic Devices – Programmable Logic Array (PLA) - Programmable Array Logic (PAL) – Field Programmable Gate Arrays (FPGA) - Implementation of combinational logic circuits using PLA, PAL,CPLD's. TTL and CMOS Logic families.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK

1	*M.MorrisR.ManoandMichaelD.Ciletti,"***DigitalDesign***"4thEdition,PearsonEducation,2011.*
2	*M.MorrisR.ManoandMichaelD.Ciletti,"***DigitalDesign:WithanIntroductiontotheVerilogHDL***", 5thEdition,PearsonEducation,2013.*

REFERENCES :

1	*Charles H.Roth."**Fundamentals of Logoc Design**", 6thEdition,Thomson Learning, 2013*
2	*Thomas L. Floyd, "**Digital Fundamentals**",10thEdition,Pearson Education Inc,2011*
3	*S.Salivahanan and S.Arivazhagan"**Digital Electronics**", Ist Edition, Vikas Publishing House pvt Ltd,2012.*
4	*Anil K.Maini "**Digital Electronics**", Wiley, 2014.*
5	*Soumitra Kumar Mandal" **Digital Electronics**", McGraw Hill Education Private Limited,2016.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand number Systems and digital fundamentals.	K2
CO2	Design Combinational circuits used in digital systems.	K3
CO3	Design Synchronous sequential circuits in digital system.	K3
CO4	Analyze and design Explain Asynchronous sequential circuits in digital system.	K4
CO5	Describe memory device and implement the combinational circuits using programmable logic devices.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	1	2	-	3	3	-	-	-	-	-	3	1	-
CO2	3	3	2	3	-	-	-	-	-	-	-	-	3	1	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-	3	1	-
CO4	3	3	1	3	-	-	-	-	-	-	-	-	3	1	-
CO5	3	3	1	3	3	-	-	-	-	-	-	-	3	-	-
22LPC303	3	3	1	3	3	-	-	-	-	-	-	-	3	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.2.1,1.3.1,1.4.1,2,1.1,2.1.3,2.2.3,2.2.4,2.4.1,2.4.2,3.2.2,4.1.2,4.1.4,4.2.1,4.3.1
CO2	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.4,2.4.1,2.4.2,3.2.2,3.3.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1, 4.3.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,3.1.6,3.2.3,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,3.1.6,3.2.3, 4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.1,2.4.1,2.4.2,3.1.6,3.2.3, 4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	30	10			
CAT2	30	30	30	10			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	30	30	10			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	30	30	10			100
ESE	30	30	30	10			100

22LPC304	ELECTROMAGNETIC WAVES AND WAVESGUIDES	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To Gain knowledge in static electric and magnetic field principles and related laws governing them, the concepts of Electromagnetic wave propagation in free space and media , and analyze the characteristics of wave propagation in parallel plate, rectangular and circular waveguides.	
UNIT – I	**ELECTROSTATIC FIELDS**	**9 Periods**
Vector analysis- Orthogonal co-ordinate systems-Coulomb's Law-Electric field intensity-Field due to continuous Volume charge distribution-Field due to line charge-Field due to sheet of charge-Electric flux-Gauss law-Application of Gauss law- Divergence theorem-Electric scalar potential-Equipotential surface-Poisson's and Laplace equations-Capacitance of parallel plate-Capacitance of Coaxial cable-Parallel wire capacitance-Boundary conditions-Energy stored in electric field-Energy density.		
UNIT – II	**STEADY MAGNETIC FIELDS**	**9 Periods**
Biot-Savat's Law-Ampere's circuital law-Magnetic flux and flux density-Scalar and Vector potential-Force on a moving charge and differential current element-Magnetic Boundary conditions-Magnetic circuit-Faraday's law of electromagnetic inductance-Inductance and Mutual inductance-Inductance of transmission line-Energy stored in magnetic field-Energy density.		
UNIT – III	**ELECTROMAGNETIC WAVES**	**9 Periods**
Displacement current-Maxwell's equation-Equation of continuity-Inconsistency of Ampere's law-Wave motion in free space- Uniform plane waves-Sinusoidal time variations-Conductors and Dielectrics-Propagation in good conductors and Good dielectrics-Skin effect-Polarization-Reflection and Refraction of plane waves-Reflection by a conductor –Normal and Oblique incidence-Reflection by a Dielectric-Reflection at the surface of a conducting medium-Surface impedance-Poynting Theorem- power loss in a plane conductor.		
UNIT – IV	**GUIDED WAVES AND RECTANGULAR WAVEGUIDES**	**9 Periods**
General solutions for TE and TM waves-Waves between parallel planes of perfect conductors-Velocities of wave propagation- Attenuation in parallel plate waveguide-Wave impedance of TE and TM waves in a parallel plate waveguide-Types of waveguides-Mode theory of a Rectangular waveguide(TE and TM waves)-Characteristics of TE and TM waves-Impossibility of TEM waves in rectangular waveguides-Dominant mode -Wave impedances of TE and TM waves - Characteristic impedance of a waveguide-Attenuation factor -Excitation of various modes-Quality Factor.		
UNIT – V	**CIRCULAR WAVEGUIDES, CAVITY RESONATORS AND WAVEGUIDE COMPONENTS**	**9 Periods**
Bessel functions-TE and TM modes in circular Waveguides-Wave impedances-Dominant mode-Field configuration- Comparison of Circular and Rectangular waveguides-Excitation of modes-Microwave cavity resonators-Rectangular and Circular cavity resonators-Q factor of a cavity resonator for the TE 101 mode-Cavity excitation and tuning-Applications- TEM wave in co-axial lines-Waveguide components.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*William H.Hayt,"**Engineering Electromagnetics**", Tata McGraw-Hill,2011.*
2	*Edward.C.Jordan, Keith.G.Balmai,, "**Electromagnetic Waves and Radiating Systems**", Prentice Hall of India,1995*

REFERENCES:

1	*S.Baskaran, "**Transmission Lines and Waveguides**", Scitech Publications(India) PVT.LTD,Chennai,2011*
2	*David K.Cheng , "**Field and Wave Electromagnetics**"', Pearson Edition ,1999.*
3	*UmeshShinha,"**Electromagnetic Theory and its Applications**",Satya Prakashan,1996.*
4	*Gangadhar.K.A,"**FieldTheory**"Khanna Publishers,2002.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the knowledge to the solutions of problems relating to Electric field	K3
CO2	Apply the knowledge of static magnetic field principles to the solutions of problems relating to magnetic field.	K3
CO3	Understand the concepts of Electromagnetic wave propagation in free space and media.	K2
CO4	Compare the characteristics of wave propagation in parallel plate, rectangular and circular waveguides.	K2
CO5	Explain the concepts of cavity resonators.	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

Cos/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	2	2	1	-	-	-	-	-	-	-	-	3	1	1
CO 2	3	2	2	1	-	-	-	-	-	-	-	-	2	1	1
CO 3	3	1	1	-	-	-	-	-	-	-	-	-	3	1	1
CO 4	3	3	1	-	-	-	-	-	-	-	-	-	3	1	1
CO 5	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
22LPC304	3	2	2	1	-	-	-	-	-	-	-	-	3	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1, 2.4.1,3.1.1, 3.1.4,3.1.5, 3.3.2, 3.4.1, 4.1.1
CO2	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1, 2.4.1, 3.1.1, 3.1.4,3.1.5, 3.3.2, 3.4.1, 4.1.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4,3.1.4
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.2, ,2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3,2.4.4,3.1.4,3.1.6
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 3.1.1, 3.1.4,3.3.2,3.4.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20				100
CAT2	40	40	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	40	20				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	40	40	20				100
ESE	40	40	20				100

22LES308	DATA STRUCTURES LABORATORY *(Common to ECE & CSE Branches)*	SEMESTER III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	0	0	3	1.5

Course Objectives	The objective of the course is to Implement linear data structures and nonlinear data structures, use appropriate data structures and implement appropriate sorting and searching techniques.

LIST OF EXPERIMENTS

1. Implementation of Stack Operations using array and Linked List
2. Implementation of Queue operations using array and Linked List
3. Application of stacks in Recursion and Infix to postfix conversion
4. Application of Queue in Simulation of FCFS and Round Robin Scheduling
5. Implementation of Linear list, circularly linked list and Doubly linked list.
6. Application of Linked List in Polynomial Manipulations
7. Implementation of binary tree operations
8. Implementation of Tree Traversal Algorithms
9. Implementation of Graph Traversal Algorithms
10. Implementation of Minimum Spanning Algorithms
11. Implementation of hashing techniques.
12. Implementation of sorting techniques.
13. Implementation of searching techniques.

Contact Periods:
Lecture: 0 Period Tutorial:0Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Implement queue and stack data structures using arrays and Linked Lists	K5
CO2	Implement Tree Data structure and perform tree traversals.	K5
CO3	Implement traversal on Graph Data structure.	K5
CO4	Implement hashing Techniques	K6
CO5	Implement sorting and searching Techniques.	K6

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

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

22LES308	3	2	2	3	3	2	-	-	-	2	-	2	-	2	-
b) CO and Key Performance Indicators Mapping															
CO1	1.1.1,1.3.1, 1.4.1,2.1.2, 2.2.2, 2.3.1,2.4.1,3.1.6,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,4.2.2,4.3.1,12.2.2.														
CO2	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2														
CO3	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2														
CO4	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2														
CO5	1.3.1,1.4.1,2.1.2.2.1,2.2.3,2.3.1,2.4.4,3.1.3,3.1.6, 3 .2.3, 3.3.2, 4.1.2, 4.2.1,4.3.1,6.1.1, 10.3.1,11.2.1, 12.1.1,12.2.2,12.3.2														

22LPC305	ELECTRONIC CIRCUITS AND SIMULATION LABORATORY	SEMESTER III

PREREQUISITES		CATEGORY	L	T	P	C
NIL		PC	0	0	3	1.5
Course Objectives	To gain hands on experience in designing electronic circuits and simulation					

DESIGN AND ANALYSIS THE FOLLOWING EXPERIMENTS	
1	Diode and Transistor Characteristics
2	Half wave and Full wave Rectifier
3	Stability of Q point
4	Single stage RC Coupled CE amplifier
5	Wave Shaping Circuits
6	Characteristics of FET
7	RC phase shift oscillator
8	Colpitt's Oscillator
9	Characteristics of UJT
10	Characteristics of SCR
11	Schmitt Trigger circuit
12	Multivibrator
13	MOS CS amplifier with resistive load, diode connected load, current source load
14	MOS current mirrors

Contact Periods:

Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understanding stability of amplifier circuits	K2
CO2	Analyze various types of amplifier circuits	K2
CO3	Design of oscillators and power amplifiers	K3
CO4	Design of Multivibrators and Schmitt Trigger circuit	K3
CO5	Design and simulate MOS amplifiers and current mirrors	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO1	3	2	1	2	-	-	-	-	-	-	-	-	3	1	1
CO2	3	2	1	3	-	-	-	-	-	-	-	-	3	1	1
CO3	3	3	1	3	-	-	-	-	-	-	-	-	3	1	1
CO4	3	3	1	3	-	-	-	-	-	-	-	-	3	1	1
CO5	3	3	1	3	2	-	-	-	-	-	-	-	3	1	1
22LPC305	3	3	1	3	2	-	-	-	-	-	-	-	3	1	1
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.2.3,2.2.4,2.4.1,2.4.2,3.2.2,4.1.2,4.1.3,4.1.4,4.2.1,4.3.1
CO2	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.2.3,2.2.4,2.4.1,2.4.2,3.2.2,3.3.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,3.1.6,3.2.3,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,3.1.6,3.2.3,4.1.1, 4.1.2,4.1.3,4.2.1,4.3.3,4.3.4
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,3.1.6,3.2.3,4.1.1, 4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4,5.2.1,5.3.1,5.3.2

22LBS408	PROBABILITY AND RANDOM PROCESS	SEMESTER IV

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	BS	3	1	0	4

Course Objectives	To provide students with the foundations of probability, random variables, statistical methods and analysis techniques used in various applications in engineering and science problems of process and predictions based on processes.	
UNIT – I	**PROBABILITY AND RANDOM VARIABLES**	**12 Periods**
Probability: Probability Axioms-Conditional Probability-Independent Events-Total Probability-Baye's Theorem. Random variables: Distribution Functions-Expectation and Moments-Moment Generating Function.		
UNIT – II	**SPECIAL PROBABILITY DISTRIBUTIONS**	**12 Periods**
Binomial Distribution, Poisson Distribution, Geometric Distribution, Exponential Distribution, Uniform Distribution, Erlang Distribution, Normal Distribution, Functions of Random Variables.		
UNIT – III	**MULTIPLE RANDOM VARIABLES**	**12 Periods**
Joint Probability Distribution-Marginal Probability Distribution-Conditional Probability Distribution-Covariance-Correlation and Regression-Transformation of Random Variables-Central Limit Theorem		
UNIT – IV	**RANDOM PROCESS**	**12 Periods**
Classification of Random Process-Strict Sense Stationary Process-Wide Sense Stationary Process-Ergodic Random Process-Poisson Process-Markov Chains-Transition Probabilities		
UNIT – V	**LINEAR SYSTEM WITH RANDOM INPUTS**	**12 Periods**
Power Spectral Density Function-Properties-Wiener-Khinchine Theorem. Linear System-Properties-Linear System with Random Inputs-Unit Impulse Response of the System.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 15 Periods** **Practical: 0 Periods** **Total: 60 Periods**		

TEXT BOOK :

1	***Veerarajan T***., *"**Probability-Statistics and Random Processes**",McGraw Hill Education (India)Pvt Ltd., New Delhi, Third Edition,2017.*
2	***Fundamentals of Applied Probability and Random Process, Oliver C. Ibe****A Print of Elsevier Second Edition*

REFERENCES

1	*Gupta S.C and Kapoor V.K., "**Fundamentals of Mathematical Statistics**", Sultan Chand & Sons, New Delhi, 2015.*
2	*Hwei Hsu, "Schaum's**outline series of Theoryand Problems of Probability andRandom Process**", Tata McGraw Hill Publishing Co., New Delhi, 2015.*
3	*Kandasamy, Thilagavathy and Gunavathy, "**Probability, Random Variables and RandomProcess"**, S.Chand& Co, Ramnagar, New Delhi, Reprint 2013*
4	*Roy D Yates, "**Probability and Stochastic Processes a friendly introduction for Electrical**and Computer engineers", John Wiley & sons, third edition 2015*
5	*Peyton Z.Peebles, Jr. "**Probability, Random Variables, and Random Signal Principles**" McGraw Hill Education (India)Pvt Ltd., New Delhi, Fourth Edition.*
6	*Athanasios Papoulis and Unnikrishna Pillai S , "**Probability, Random Variables andStochastic Processes**", Tata McGraw 38 Hill, New Delhi, 2011*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the knowledge of basic probability concepts in engineering problems	K3
CO2	Identify various standard probability distributions and apply them in real life phenomena.	K3
CO3	Find correlation and regression for two dimensional random variables	K3
CO4	Analyze engineering problems with random process when time and probability occur	K3
CO5	Evaluate the Power Spectral Density of various stationary random processes	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	-	2	-	-	-	-	-	-	-	1	2	-	1
CO2	3	3	-	2	-	-	-	-	-	-	-	1	2	-	1
CO3	3	3	-	2	-	-	-	-	-	-	-	1	2	-	1
CO4	3	3	-	2	-	-	-	-	-	-	-	1	2	-	1
CO5	3	3	-	2	-	-	-	-	-	-	-	1	2	-	1
22LBS408	3	3	-	2	-	-	-	-	-	-	-	1	2	-	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.1, 2.4.2, 2.4.3, 4.1.1, 4.3.1, 4.3.2, 4.3.3, 12.2.1
CO2	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.1, 2.4.2, 2.4.3, 4.1.1, 4.3.1, 4.3.2, 4.3.3, 12.2.1
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.1, 2.4.2, 2.4.3, 4.1.1, 4.3.1, 4.3.2, 4.3.3, 12.2.1
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.1, 2.4.2, 2.4.3, 4.1.1, 4.3.1, 4.3.2, 4.3.3, 12.2.1
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.1, 2.4.2, 2.4.3, 4.1.1, 4.3.1, 4.3.2, 4.3.3, 12.2.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	40	40				100
Individual Assessment 1	10	40	50				100
Individual Assessment 2	10	40	50				100
ESE	20	40	40				100

22LPC406	ANALOG INTEGRATED CIRCUITS	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	• To understand the characteristics and applications of Operational amplifiers, data converters and operation and applications of special function ICs.	
UNIT – I	**BASICS OF OPERATIONAL AMPLIFIERS**	**9 Periods**
Differential amplifier-Differential mode gain, common mode gain and CMRR -current mirror-Widlar current mirror - Building blocks of 741 operational amplifier-I/O stages, gain stage and level translator stage of 741op-amp -Characteristics of an Ideal and practical - Operational Amplifier-Op-amp parameters, DC & AC performance characteristics- frequency response – frequency compensation.		
UNIT – II	**APPLICATIONS OF OPERATIONAL AMPLIFIERS**	**9 Periods**
Linear applications: voltage follower - inverting, non-inverting amplifiers-summing, scaling, averaging amplifiers-instrumentation amplifiers-difference amplifier **Nonlinear applications**: Integrator-differentiator-precision half wave & full wave rectifiers- peak detector-sample & hold circuit-log & anti-log amplifiers. **Open loop applications**: Comparator-zero crossing detector-Window detector-Schmitt trigger.		
UNIT – III	**OSCILLATORS AND MULTIVIBRATORS**	**9 Periods**
Barkhausen criterion- loop gain -Design of Oscillators: RC phase shift oscillator- Wien bridge oscillator-– Square wave generator - Triangular wave generator-Saw tooth wave generator - IC 555 timer: Functional block diagram and description of Astable & Mono-stable multi-vibrators using IC555 –Applications: Missing pulse detector, PWM, FSK generator, Schmitt trigger.		
UNIT – IV	**ACTIVE FILTERS AND DATA CONVERTERS**	**9 Periods**
Active filters - Sallen-Key filter structure- Design of I order and II order Butterworth filters: Low pass, High pass, Band pass filters- Switched capacitor filter- Data Converters: D/A converter – specifications - weighted resistor type, Voltage Mode and Current-Mode R 2R Ladder types - switches for D/A converters, high speed sample-and-hold circuits- A/D Converters – specifications - Flash type – Counter type - Successive Approximation type - Dual Slope type A/D converters.		
UNIT – V	**PLL AND SPECIAL FUNCTION ICS**	**9 Periods**
Operation of the basic PLL, Closed loop analysis, Voltage controlled oscillator, Monolithic PLL IC 565, application of PLL for AM detection, FM detection, FSK demodulation and Frequency synthesizing -IC Voltage regulators – Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator - Voltage to Frequency converter- Audio Power amplifier IC.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*D.RoyChoudhry and Shail Jain, **"Linear Integrated Circuits"**, New Age International Pvt. Ltd.,4th Edition 2010*
2	*Ramakant A. Gayakwad, **"OP-AMPs and Linear Integrated Circuits"**, 4th Edition, Prentice Hall / Pearson Education, 2015.*

REFERENCES:

1	*Sergio Franco,* ***"Design with Operational Amplifiers and Analog Integrated Circuits"****, 4th Edition, Tata McGraw-Hill, 2014*
2	*Gray and Meyer,* ***"Analysis and Design of Analog Integrated Circuits",*** *Wiley International, 2009.*
3	*S.Salivahanan and V.S. Kanchana Bhaaskaran,* ***"Linear Integrated Circuits",*** *Tata McGraw Hill Publishing company Ltd, 1st Edition, 2009.*
4	*Somanathan Nair,* ***"Linear Integrated Circuits, Analysis, Design and Applications",*** *Wiley India Publishers, 1st Edition, 2009*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain DC & AC characteristics and Building blocks of OP AMP.	K2
CO2	Explain Linear, Nonlinear and open loop applications of OP AMP	K2
CO3	Design and construct oscillators and Multi-vibrators.	K3
CO4	Design and analyze active filters and data converters using OP AMP	K3
CO5	Describe the operation & applications of PLL and special function ICs	K2

a) CO and PO Mapping

COs/POs	**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**	**PSO 3**
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LPC406	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1, 4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1, 4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1, 4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1, 4.1.1,4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1, 4.1.1,4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20				100
CAT2	40	40	20				100
Assignment 1	20	40	40				100
Assignment 2	20	40	40				100
Quiz 1	20	40	40				100
Quiz 2	20	40	40				100
Other mode of internal assessments, if any							
ESE	40	40	20				100

22LPC407	ANALOG COMMUNICATION	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To understand the concepts of Analog modulation schemes and to impart knowledge about baseband signal processing techniques.	
UNIT – I	**AMPLITUDE MODULATION SYSTEMS**	**9 Periods**
Need for modulation - Amplitude Modulation –DSBFC, DSBSC, SSB, VSB – Modulation index, Spectra, Power relations and Bandwidth Requirements – AM Generation and detection- DSBSC Generation and detection - SSB Generation and detection - VSB Generation –Hilbert transform, Comparison of AM systems. Block diagram of AM broadcasting transmitters- Low Level and High Level transmitters .		
UNIT – II	**ANGLE MODULATION SYSTEMS**	**9 Periods**
Phase and Frequency Modulation - Single tone, Narrow Band and Wideband FM – Modulation index, Spectra, Power relations and Transmission Bandwidth - FM Generation: Direct method and Indirect method of FM Generation- Demodulation of FM Signal-Balanced Slope detector - FM Discriminator - PLL as FM Demodulator – Stereo FM- FM Transmitter.		
UNIT – III	**NOISE THEORY**	**9 Periods**
Gaussian Process - Central limit theorem – Noise sources and types – Noise Figure- Noise temperature – Noise in cascaded systems – Representation of Narrow band noise – In-phase and Quadrature components – Envelope and Phase components – Properties of Narrow band noise		
UNIT – IV	**PERFORMANCE OF CW MODULATION SYSTEMS**	**9 Periods**
Super heterodyne Radio receiver and its characteristic; SNR; Noise in DSBSC systems using coherent detection; Noise in AM system using envelope detection- Noise in FM system-Capture effect - FM threshold effect; Pre-emphasis and De-emphasis in FM; Comparison of performances, FDM.		
UNIT – V	**SAMPLING & WAVEFORM CODING**	**9 Periods**
Low pass sampling theorem – Aliasing - Signal Reconstruction-Quantization - Uniform & Non uniform quantization - quantization noise - Pulse Modulation-PAM, PPM, PDM, PCM – Prediction filtering and DPCM - Delta Modulation – Delta Sigma Modulation -ADPCM & ADM principles - Linear Predictive Coding – TDM - Digital Multiplexers.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS

1	*Simon Haykin,* ***"Communication Systems",****John Wiley & sons, NY, 4th Edition, 2001*
2	*Kennedy G,* ***"Electronic Communication systems",*** *Tata McGraw Hill, New Delhi, 2009.*

REFERENCES

1	*B.P.Lathi,* ***"Modern Digital and Analog Communication Systems",****3rd Edition, Oxford University Press, 2007.*
2	*Dennis Roddy & John Coolen–****"Electronic Communication" (IV Ed.),*** *Prentice Hall of India, 2014.*
3	*H P Hsu, Schaum Outline Series -* ***"Analog and Digital Communications"*** *TMH 2006.*
4	*Herbert Taub& Donald L Schilling –* ***"Principles of Communication Systems" (3rd Edition) –*** *Tata McGraw Hill, 2008.*
5	*J.G.Proakis, M.Salehi,* ***"Fundamentals of Communication Systems",*** *Pearson Education 2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply transforms for signal modulation techniques.	K3
CO2	Develop the architecture of communication system for analog modulation techniques	K3
CO3	Explore the different types of noise sources	K2
CO4	Apply the concepts of random process in the analysis of performance of AM and FM systems	K4
CO5	Discuss the process of sampling, quantization and coding that are fundamentals to the digital transmission of analog signals	K2

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

Cos /POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	3	2	2	1	-	-	-	-	-	-	-	-	3	1	1
CO 2	3	2	2	1	-	-	-	-	-	-	-	-	2	1	1
CO 3	3	1	1	-	-	-	-	-	-	-	-	-	3	1	1
CO 4	3	3	1	-	-	-	-	-	-	-	-	-	3	1	1
CO 5	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
22LPC407	3	2	2	1	-	-	-	-	-	-	-	-	3	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1, 2.4.1,3.1.1, 3.1.4,3.1.5, 3.3.2, 3.4.1, 4.1.1
CO2	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1, 2.4.1, 3.1.1, 3.1.4,3.1.5, 3.3.2, 3.4.1, 4.1.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4,3.1.4
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.2, ,2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3,2.4.4,3.1.4,3.1.6
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 3.1.1, 3.1.4,3.3.2,3.4.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Rememberi ng (K1) %**	**Understandi ng (K2) %**	**Applyin g (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creat ing (K6) %**	**Total 100 %**
CAT1	20	50	30				100
CAT2	20	30	30	20			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1			50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	50				100
ESE	20	40	30	10			100

22LPC408	DIGITAL SIGNAL PROCESSING	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	To study DFT, digital filter design algorithms, finite word length effects , multi rate signal processing and architecture of Digital signal processor.	
UNIT – I	**DISCRETE FOURIER TRANSFORM**	**9 Periods**
Review of discrete-time signals and systems - DFT and its properties, FFT algorithm-Decimation in Time Algorithm - Decimation in Frequency - Computation of Inverse DFT using FFT and its application to convolution. Sectioned convolution –Overlap add and overlap save methods.		
UNIT – II	**INFINITE IMPULSE RESPONSE DIGITAL FILTERS**	**9 Periods**
Design of analog Butterworth and Chebyshev Filters – Frequency transformation in analog domain -Design of IIR digital filters - Impulse invariance technique, Bilinear transformation – Realization of IIR filters - Direct, cascade and parallel forms.		
UNIT – III	**FINITE IMPULSE RESPONSE DIGITAL FILTERS**	**9 Periods**
Symmetric and Anti-symmetric FIR filters – Linear phase FIR filters – FIR Design using Fourier series method - window method– rectangular, Hamming and Hanning windows – Frequency sampling method – Realization of FIR filters – Linear phase, Traversal structures-comparison of FIR and IIR filters.		
UNIT – IV	**FINITE WORD LENGTH EFFECTS AND MULTI-RATE SIGNAL PROCESSING**	**9 Periods**
Fixed point and floating-point number representations – Comparison – Quantization Error - Quantization Noise Power -Finite word length effects -Signal scaling - Introduction to Multi-rate signal processing-Decimation –Interpolation –multistage implementation- Applications		
UNIT – V	**DIGITAL SIGNAL PROCESSOR**	**9 Periods**
Harvard and modified Harvard architectures - architecture of C6X processors – Features of C67X processor – Internal architecture – CPU – General Purpose register files – Functional Units and operation – data paths – Control registers - Functional Units and instructions – Parallel and pipeline operations – Interrupts		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*John G Proakis and Manolakis, "**Digital Signal Processing Principles, Algorithms and Applications**", Pearson, Fourth Edition, 2007.*
2	*B. Venkataramani, M. Bhaskar, "**Digital Signal Processor Architecture, Programming and Applications**", Second Edition, 2011.*

REFERENCES

1	*Johny R. Johnson, "**Introduction to Digital Signal Processing**", PHI, 2008*
2	*E.C. Ifeachor and B.W. Jervis, "**Digital signal processing – A Practical approach**", Prentice Hall, 2011*
3	*S.K. Mitra, "**Digital Signal Processing, A Computer Based approach**", Tata McGrawHill, 2011 fourth international edition*
4	*Monson H. Hayes, "**Statistical Digital Signal Processing and Modeling**", John Wiley and Sons Inc., New York, 2006.*
5	*RulphChassaing, "**Digital Signal Processing and Applications with the C6713 and C6416DSK**", A JOHN WILEY & SONS, INC., PUBLICATION, 2005*
6	*P. P. Vaidyanathan, "**Multirate Systems and Filter Banks**", Prentice Hall, 1992.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Solve problems using DFT & FFT algorithms	K3
CO2	Design and realize digital IIR filters	K3
CO3	Design and realize digital FIR filters	K3
CO4	Understand finite word length effects and have an exposure to Multirate signal processing and its applications.	K2
CO5	Explain Digital signal Processor families and architecture	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

Cos /POs	**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**	**PSO 3**
CO 1	3	2	2	1	-	-	-	-	-	-	-	-	3	1	1
CO 2	3	2	2	1	-	-	-	-	-	-	-	-	2	1	1
CO 3	3	1	1	-	-	-	-	-	-	-	-	-	3	1	1
CO 4	3	3	1	-	-	-	-	-	-	-	-	-	3	1	1
CO 5	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
22LPC408	3	2	2	1	-	-	-	-	-	-	-	-	3	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1, 2.4.1,3.1.1, 3.1.4,3.1.5, 3.3.2, 3.4.1, 4.1.1
CO2	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1, 2.4.1, 3.1.1, 3.1.4,3.1.5, 3.3.2, 3.4.1, 4.1.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4,3.1.4
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.2, ,2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3,2.4.4,3.1.4,3.1.6
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 3.1.1, 3.1.4,3.3.2,3.4.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total00 %**
CAT1	30	40	30				100
CAT2	30	40	30				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	50				100
ESE	30	40	30				100

22LPC409	NETWORKS AND TRANSMISSION LINES	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objectives	• To understand the basic concepts of two port networks, synthesis network and familiarize the concepts of transmission lines	
UNIT – I	**TWO PORT NETWORKS**	**9 Periods**
Two Port Network Parameters: Z, Y, ABCD and Hybrid Parameters – Interconnection of networks: Cascade, Series, Parallel - Symmetrical networks: T and pi equivalent of two port network–characteristic impedance and propagation constant-Asymmetrical networks: Image and Iterative impedances-Image transfer constant and iterative transfer constant		
UNIT – II	**PASSIVE NETWORKS**	**9 Periods**
Constant K filters – m derived filters – Composite filters – Design procedures - Series and shunt equalizer - Symmetrical and asymmetrical attenuators - T and pi sections.		
UNIT – III	**PASSIVE NETWORK SYNTHESIS**	**9 Periods**
Hurwitz polynomials–positive real functions-Driving point function synthesis–LC immittance functions-RC impedance/admittance functions-RL admittance/impedance functions-Foster and Cauerforms of RC,RL and LC networks		
UNIT – IV	**TRANSMISSION LINE THEORY**	**9 Periods**
Line parameters and transmission constants-Transmission line equation-Physical significance of the equation-Infinite line-Input and transfer impedance-Waveform distortion-Distortion less lineLoading-Reflection phenomena-Reflection loss and insertion loss-Skin and proximity effect-T and pi equivalent of transmission lines.		
UNIT – V	**LINE AT RADIO FREQUENCIES**	**9 Periods**
Parameters of open wire line and co-axial line at high frequencies – Standing waves-Standing wave ratio- Input impedance of open and short circuited lines- Relation between VSWR and reflection coefficient-Quarter wave transformer- Single and double stub matching- Smith chart and its applications		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS

1	*Sudhahar.A, ShyammohanS.P, "**Circuits and Networks: Analysis and Synthesis**", Tata McGraw Hill, New Delhi, Fourth Edition,2010.*
2	*John D. Ryder, "**Networks, Lines and Fields**", PHI, 2nd edition, 2009.*

REFERENCES

1	*Umesh Sinha,"**Transmission Lines and Network**", Satya Prakashan Publishing Company, New Delhi,2012.*
2	*S.P. Ghosh and A.K. Chakraborty, "**Network Analysis and Synthesis**", McGraw Hill, 1st edition 2010*
3	*Roy, Choudhury D., "**Networks and Systems,**" New Age International Publishers, 2nd edition reprint , 2014*
4	*M.E. VanValkenburg,"**Network Analysis**, INDIA PEARSON,"3rd edition, 2015*
5	*G.S.N. Raju "**Electromagnetic Field theory and Transmission lines**", Pearson Education, First Edition 2005*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Compute the network parameters and recollect the symmetrical and asymmetrical networks.	K2
CO2	Design the various passive networks.	K3
CO3	Synthesize an electric network using driving point functions.	K3
CO4	Derive the transmission line equation and loading effect.	K3
CO5	Illustrate the line behaviour at radio frequencies and stub matching techniques.	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs /POs	**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**	**PSO 3**
CO 1	3	2	2	1	-	-	-	-	-	-	-	-	2	1	2
CO 2	3	2	2	1	-	-	-	-	-	-	-	-	2	1	2
CO 3	3	1	1	-	-	-	-	-	-	-	-	-	2	1	2
CO 4	3	3	1	-	-	-	-	-	-	-	-	-	2	1	1
CO 5	3	2	1	-	-	-	-	-	-	-	-	-	2	2	2
22LPC409	3	2	2	1	-	-	-	-	-	-	-	-	2	2	2

b) CO and Key Performance Indicators Mapping		
CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1, 2.4.1,3.1.1, 3.1.4,3.1.5, 3.3.2, 3.4.1, 4.1.1	
CO2	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1, 2.4.1, 3.1.1, 3.1.4,3.1.5, 3.3.2, 3.4.1, 4.1.1	
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4,3.1.4	
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.2, ,2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3,2.4.4,3.1.4,3.1.6	
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 3.1.1, 3.1.4,3.3.2,3.4.1	

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Tota l00 %**
CAT1	30	70					100
CAT2	30	40	30				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		70	30				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	50				100
ESE	30	40	30				100

22LPC410	MICROPROCESSOR AND MICROCONTROLLER	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	2	4

COURSE OBJECTIVES:	This Course deals about the basic 16-bit (8086) processor and an 8-bit (8051) controller, their architecture, internal organization and their functions, interfacing an external device with the processors/controllers.
UNIT I: 8086 PROCESSOR	9 + 6 Periods
Introduction to 8086 - Microprocessor architecture - Addressing modes -Instruction set and assembler directives -Assembly language programming- Modular Programming- Linking and Relocation- Stacks -Procedures -Macros -Interrupts and interrupt service routines - Byte and String Manipulation.	
UNIT II : 8086 BUS STRUCTURE	9 + 6 Periods
8086 signals - Basic configurations - System bus timing -System design using 8086 I/O programming- Introduction to Multiprogramming- System Bus Structure-Multiprocessor configurations-Coprocessor, Closely coupled and loosely Coupled configurations.	
UNIT III: I/O INTERFACING	9 + 6 Periods
Memory Interfacing and I/O interfacing -Parallel communication interface -Serial communication interface - D/A and A/D Interface -Timer- Keyboard /display controller -Interrupt controller-DMA controller -Programming and applications- Case studies: Traffic Light control, LED display , LCD display, Keyboard display interface and Alarm Controller.	
UNIT IV: MICROCONTROLLER	9 + 6 Periods
Architecture of 8051- Special Function Registers(SFRs) - I/O Pins, Ports and Circuits - Instruction set -Addressing modes -Assembly language Programming.	
UNIT V: INTERFACING MICROCONTROLLER	9 + 6 Periods
Programming 8051 Timers -Serial Port Programming -Interrupt Programming -LCD & Keyboard Interfacing- ADC, DAC & Sensor Interfacing - External Memory Interface- Stepper Motor and Waveform generation - Comparison of Microprocessor, Microcontroller, PIC and ARM processors.	
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 30 Periods Total: 75 Periods**	

List of Experiments for Lab Component

Intel 8086 (16 bit Micro Processor)

1.Study experiment on various Addressing modes of 8086 Microprocessor.

2.a) Block move.

b) Simple Arithmetic operations.

3.a) Choosing Smallest/ largest number from an array of binary numbers.

b) Sorting of an array of binary numbers.

4.a) Code Conversion (Eg. ASCII to Packed BCD form).

b) Addition of an array of BCD numbers stored in packed form.

5.a) Multiplying two 3x3 matrices.

b) Generation of Prime numbers.

6.Identification & displaying the activated key using DOS & BIOS function calls.

Intel 8051 (8 bit Microcontroller)

7.Detection of key closure (connected to a port line) by polling technique.

8.Delay generation using i) Nested loop ii) Timers.

9.Counting of external event occurrence through port line.

10.LCD interfacing.

11.Generation of different waveforms using DAC (0808).

Text Books:

1.	*Ramesh S. Gaonkar,"**Microprocessor Architecture Programming and Applications with 8085**", Fifth Edition, Penram International Publishing 2010.*
2.	*DoughlasV.Hall, "**Microprocessors and Interfacing, Programming and Hardware**", Tata McGraw Hill,2012.*

Reference Books:

1.	*Sunil Mathur&Jeebananda Panda, "**Microprocessor and Microcontrollers**", PHI Learning Pvt. Ltd, 2016.*
2.	*V.CarlHamacher, Zvonko G. Varanesic and Safat G. Zaky, "**Computer Organisation**", McGraw-Hill Inc, 2002.*
3.	*John P.Hayes, "**Computer architecture and Organisation**", Tata McGraw-Hill Third edition, 1998.*

COURSE OUTCOMES:

Upon completion of the course, the students will have:

COURSE OUTCOMES: On completion of the course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Recall and apply the basic concepts of 8086 processor and have obtained an Training in practical knowledge through Laboratory experiments.	K2
CO2	Have gained knowledge about the 8086 Bus structure and have obtained an Training in practical knowledge through Laboratory experiments.	K2
CO3	Have gained knowledge about the I/O Interfacing and have obtained an Training in practical knowledge through Laboratory experiments.	K2
CO4	An ability to demonstrate about the 8051 Microcontroller architecture and have obtained an Training in practical knowledge through Laboratory experiments.	K3
CO5	Have acquired knowledge about the Microcontroller interfacing and have obtained an Training in practical knowledge through Laboratory experiments.	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs /POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	2	2	-	3	1	-	-	-	-	-	-	-	1	-	1
CO 2	1	2	-	3	1	2	-	-	-	-	-	-	-	-	1
CO 3	2	2	-	2	1	-	-	-	-	-	-	-	-	-	1
CO 4	2	2	-	2	1	-	-	-	-	-	-	-	-	-	1
CO 5	2	2	-	2	1	-	-	-	-	-	-	-	-	-	1
22LPC410	2	2	-	3	1	1	-	-	-	-	-	-	1	-	1

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.4.1,2.4.4,4.1.1,4.1.2,4.1.4,5.1.1
CO2	1.1.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.4.1,2.4.2,2.4.4,4.1.1,4.3.1,5.1.1,5.1.2
CO3	1.1.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.3.1,2.4.2,2.4.4,4.3.1,4.3.3
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,4.1.1,4.3.4
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,4.1.1, 4.3.1,4.3.3,4.3.4,5.1.1,5.1.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total 100%
CAT1	30%	70%					100%
CAT2	20%	80%					100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30%	70%					100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		70%	30%				100%
ESE		80%	20%				100%

22LES409	ENGINEERING EXPLORATION FOR ELECTRONICS ENGINEERING	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	ES	0	0	3	1.5

Course Objectives	To provide an introduction to the engineering field for designing the basic modules of useful for everyday life.	
Module – I	**Introduction**	**15 Periods**
Introduction to Engineering and Engineering study: Difference between science and engineeirng, scientist and engineer needs and wants, various disciplines of engineering, some misconceptions of engineering, expectation for the 21st centuary engineer and Graduate Attribuites.		
Module– II	**Engineering Design**	**15 Periods**
Engineering Requirement, Knowledge within Engineering Disciplines, Engineering advancements, Problem definition, Idea generation through brain storming and researching, solution creation through evaluating and communicating, text/analysis, Engineering Ethics, final solution and design improvement.		
Module– III	**Engineering Disciplines**	**15 Periods**
Construction of power supply- Voltage regulators – Implementation of Modulators and Demodulators using discrete components –Implementation of Radio Receiver - Designing of ALU using digital ICs – Design of Single stage operational amplifier.		
Contact Periods: **Lecture: 0 Periods** **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**		

REFERENCES:

1	*Ryan A Brown, Joshua W. Brown and Michael Berkihiser: "**Engineering Fundamentals: Design, Principles and Careers**",Goodheart-Willcox Publisher, Second edition, 2014.*
2	*SaeedMoaveni, "**Engineering Fundamentals: An Introduction to Engineering**", Cengage learning, Fourth Edition, 2011.*

COURSE OUTCOMES: On completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand introduction to engineering and engineering study	K2
CO2	Discuss the concept of need, constraints, objective(s) and create the problem statement.	K3
CO3	Design, develop and implement the concepts of the given problem statement.	K3
CO4	Analyze the basic design problems in electronics and communication engineering.	K5
CO5	Identify the importance of teamwork in exploring the project.	K5

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	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	PSO 3
CO1	3	2	1	-	-	3	3	2	3	3	3	3	2	1	2
CO2	3	2	2	3	3	3	-	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	-	1	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	-	1	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	-	1	3	3	3	3	3	3	3
22LES409	3	3	3	3	3	3	1	2	3	3	3	3	3	3	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping (Times New Roman, Size 11)

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 3.1.4, 3.1.5, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 3.1.1, 3.1.2, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 8.1.1, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – CDIO

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
Exercise 1		25	25	25	25		100
Exercise 2		25	25	25	25		100
Exercise 3		25	25	25	25		100
Exercise 4		25	25	25	25		100
Exercise 5		25	25	25	25		100
Model Lab		25	25	25	25		100
Other mode of internal assessments, if any							-
ESE		25	25	25	25		100

22LPC411	ANALOG AND DIGITAL IC LABORATORY	SEMESTER IV

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

COURSE OBJECTIVES

To Design and construct analog circuits using ICs 741,723 and 555 , Digital Circuits using Logic gates, Flip Flops and MSI devices and coding digital circuits using HDL.

ANALOG IC EXPERIMENTS

1. DC and AC Characteristics of OP-AMP
2. Simple Applications of OP-AMP – Inverting and non-inverting Amplifier, Voltage Follower, Adder, Integrator and Differentiator.
3. Design and testing of Oscillators, Comparator and Schmitt Trigger Circuit.
4. Design and Testing of Voltage regulators using IC 723.
5. Design and Testing of Astable and mono-stable Multivibrator using 555 TimerIC.
6. Design and testing of Active Filters.

DIGITAL IC EXPERIMENTS

7. Design and implementation of combinational circuits using basic gates for arbitrary functions, code converters.
8. Design and implementation of Half/Full Adder and Subtractor using Logic Gates.
9. Design and implementation of combinational circuits using MSI devices:
10. (i) 4 – bit binary adder / subtractor(ii) Parity generator / checker (iii) Magnitude Comparator (iv) Application using multiplexers (v) Counters
11. Verification of Flip-Flops
12. Design and Testing of Shift register, synchronous and asynchronous Counters
13. Coding Combinational and Sequential circuits using HDL

Lecture: 0Periods Tutorial:0Periods Practical:45Periods Total:45Periods

REFERENCES

1	*D.RoyChoudhryandShail Jain,* ***"Linear Integrated Circuits",*** *New Age International Pvt. Ltd.,4th Edition 2010*
2	*Ramakant A. Gayakwad,* ***"OP-AMPs and Linear Integrated Circuits",*** *4th Edition, Prentice Hall / Pearson Education, 2015.*
3	*Morris Mano,* ***"Digital Design*** *",4th Edition, Pearson Education, 2011*
4	*A.Anand Kumar,* ***"Fundamentals of Digital Circuits",*** *2nd Edition, PHI Learning Pvt. Ltd, NewDelhi,2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Familiarization with characteristics and applications of Op-amp	K2
CO2	Ability to design circuits using IC 723 and IC555 Timer.	K3
CO3	Implement simplified combinational circuits using logic gates	K2
CO4	Design and Implement combinational and sequential circuits	K3
CO5	Implement combinational and sequential logic circuits using HDL	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	2	2	-	-	-	-	-	-	-	1	3	-	1
CO2	3	3	2	2	-	-	-	-	-	-	-	1	3	-	1
CO3	3	3	2	2	-	-	-	-	-	-	-	1	3	-	1
CO4	3	3	2	2	-	-	-	-	-	-	-	1	3	-	1
CO5	3	3	2	2	3	-	-	-	-	-	-	1	3	-	1
22LPC411	3	3	2	2	1	-	-	-	-	-	-	1	3	-	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4, 3.1.1,3.1.2,3.1.6,3.2.2,3.3.1,4.1.1,4.1.4,4.2.1,4.3.3, 12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4, 3.1.1,3.1.2,3.1.6,3.2.2,3.3.1, 4.1.1,4.1.4,4.2.1,4.3.3, 12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4, 3.1.1,3.1.2,3.1.6,3.2.2,3.3.1, 4.1.1,4.1.4,4.2.1,4.3.3, 12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4, 3.1.1,3.1.2,3.1.6,3.2.2,3.3.1, 4.1.1,4.1.4,4.2.1,4.3.3, 12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4, 3.1.1,3.1.2,3.1.6,3.2.1,3.2.2,3.3.1, 4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.1 5.1.1,5.1.2,5.2.2,5.3..1,5.3.2 ,12.2.2

22LPC412	DIGITAL SIGNAL PROCESSING LABORATORY	SEMESTER IV

PREREQUISITES:	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

COURSE OBJECTIVES:

- To Develop DSP algorithms for signal processing and test them using Software and implement in Digital Signal Processor.

PRACTICALS	**LIST OF EXPERIMENTS USING SOFTWARE:** 1.Genaretion of basic signals 2. Computation of FFT of a signal- Spectral Analysis 3. Linear and circular convolution 4. Design of FIR filters –windowing technique 5. Design of IIR filters – Butterworth, Chebychev using – Impulse invariance and Bilinear Transform 6. Coefficient and Quantization effects on Direct form and cascade form realization of IIR filter 7.Multirate Signal Processing **USING DIGITAL SIGNAL PROCESSOR** 1. Generation of Basic Signals 2. Implementation of convolution 3. Sampling of input signal and display 4. Computation of FFT 5. Implementation of FIR filter 6. Implementation of IIR filter

Contact Periods:			
Lecture: 0 Periods	**Tutorial: 0 Periods**	**Practical: 45 Periods**	**Total: 45 Periods**

Reference books:

1.	*John G Proakis and Manolakis, "**Digital Signal Processing Principles, Algorithms and Applications**", Pearson, Fourth Edition, 2009.*
2.	*B. Venkataramani, M. Bhaskar, "**Digital Signal Processor Architecture, Programming and Applications**", Second Edition, 2011*

COURSE OUTCOMES Upon completion of the course, the students will able to:		Bloom's Taxonomy Mapped
CO1	Apply convolution and FFT concepts in analyzing LTI systems through programming	K3
CO2	Write program to design IIR digital filters.	K3
CO3	Ability to write program to design FIR digital filters.	K3
CO4	Realize coefficient and quantization effects and significance of various sampling rates.	K4
CO5	Familiarization with DSP starter kit programming using simple examples	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

Cos /POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	3	2	2	1	-	-	-	-	-	-	-	-	3	1	1
CO 2	3	2	2	1	-	-	-	-	-	-	-	-	2	1	1
CO 3	3	1	1	-	-	-	-	-	-	-	-	-	3	1	1
CO 4	3	3	1	-	-	-	-	-	-	-	-	-	3	1	1
CO 5	3	2	1	-	-	-	-	-	-	-	-	-	3	1	1
22LPC412	3	2	2	1	-	-	-	-	-	-	-	-	3	1	1
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1, 2.4.1,3.1.1, 3.1.4,3.1.5, 3.3.2, 3.4.1, 4.1.1
CO2	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1, 2.4.1, 3.1.1, 3.1.4,3.1.5, 3.3.2, 3.4.1, 4.1.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4,3.1.4
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.2, ,2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3,2.4.4,3.1.4,3.1.6
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1., 2.1.1,2.1.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 3.1.1, 3.1.4,3.3.2,3.4.1

22LPC513	CONTROL SYSTEM ENGINEERING	SEMESTER V

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objective	To acquire knowledge in the modeling of the system, analyze time and frequency response, stability and state variables of the system.	
UNIT – I	**MODELING OF CONTROL SYSTEMS**	**9 Periods**
Basic Elements of Control System - Open loop and Closed loop systems - Differential equation - Transfer function, Modeling of Electric systems, Translational and rotational mechanical systems - Block diagram reduction Techniques - Signal flow graph – Mason's gain formula.		
UNIT – II	**TIME RESPONSE ANALYSIS**	**9 Periods**
Time response analysis - First Order Systems - Impulse and Step Response analysis of second order systems - Steady state errors - P, PI, PD and PID Controllers.		
UNIT – III	**FREQUENCY RESPONSE ANALYSIS**	**9 Periods**
Frequency Response - Bode Plot, Polar Plot, Nyquist Plot - Series, Parallel, series-parallel Compensators – Design of Lead, Lag and Lead Lag Compensators.		
UNIT – IV	**STABILITY ANALYSIS**	**9 Periods**
Stability - Routh-Hurwitz Criterion, Root Locus Technique- Construction of Root Locus - Application of Root Locus Diagram - Nyquist Stability Criterion – Relative Stability.		
UNIT – V	**STATE SPACE ANALYSIS**	**9 Periods**
Concepts of State variable and State space model - State space representation of Continuous Time systems - Transfer function from State model - State transition matrix - Kalman's test of Controllability and Observability.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS :

1	*Norman Nise* ***"Control Systems Engineering"****, Wiley Publishers, 7th Edition, 2020.*
2	*A.Nagoor Kani,* ***"Control Systems",*** *RBA Publications, 3rd Edition, 2015.*

REFERENCES:

1	*A.Nagoor Kani, "**Advanced Control Theory**", CBS Publishers and Distributors, 3rd Edition, 2020.*
2	*M.Gopal, "**Control System – Principles and Design**", Tata McGraw Hill, 4th Edition, 2012*
3	*Ogata K, "**Modern Control Engineering**", PHI Publishers, 5th Edition, 2010.*
4	*Richard C. Dorf & Robert H. Bishop, "**Modern Control Systems**", Prentice Hall, 12th edition, 2010.*
5	*B. C. Kuo, "**Digital Control Systems**", Oxford University Press, 2/e, Indian Edition, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the differential equation and transfer function of the system	**K2**
CO2	Analyze time response specifications	**K4**
CO3	Analyze the frequency domain response	**K4**
CO4	Examine the stability of the system	**K3**
CO5	Develop state space model of the system	**K3**

COURSE ARTICULATION MATRIX

a)CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	-	-	-	-	-	-	-	2	2	1	1
CO2	3	3	2	2	-	-	-	-	-	-	-	2	2	1	1
CO3	3	3	2	1	-	-	-	-	-	-	-	2	2	2	1
CO4	3	3	1	3	-	-	-	-	-	-	-	2	2	2	1
CO5	3	3	2	3	-	-	-	-	-	-	-	2	2	-	1
22LPC513	**3**	**3**	**2**	**2**	-	-	-	-	-	-	-	**2**	**2**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b)CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.1.5,4.1.2,
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 3.3.2,3.4.1,3.4.2,4.1.2,4.1.4
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.3.2, 3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 3.1.5,3.2.1,3.3.2, 3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	40	30			100
CAT2	10	30	30	30			100
Assignment 1	10	20	40	30			100
Assignment 2	10	30	30	30			100
Quiz 1	30	40	30				100
Quiz 2	20	50	30				100
ESE	10	20	30	40			100

22LPC514	DIGITAL COMMUNICATION	SEMESTER V

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objective	To understand the various source coding theorems, Channel coding theorem using information theory, impart knowledge in the basics of error control coding, spread spectrum techniques, baseband and pass band digital transmission.	
UNIT – I	**INFORMATION THEORY**	**9 Periods**
Measure of information – Entropy – Source coding theorem – Discrete memoryless channels– Lossless, deterministic, noiseless channel - BEC, BSC – Mutual information – Channel capacity – Shannon Hartley law - Arithmetic coding –Shannon-Fano coding, Huffman Coding, Run length coding, LZW algorithm.		
UNIT – II	**ERROR CONTROL CODING TECHNIQUES**	**9 Periods**
Channel coding theorem – Linear block codes – Hamming codes – Cyclic codes – Convolutional codes – Viterbi decoding.		
UNIT – III	**BASEBAND TRANSMISSION**	**9 Periods**
Line codes - Properties - Power Spectral Density of Unipolar / Polar RZ & NRZ – Bipolar NRZ - Manchester- ISI – Nyquist criterion for distortion less transmission – Pulse shaping –Correlative coding – Eye pattern – Equalization.		
UNIT – IV	**BANDPASS SIGNALING**	**9 Periods**
Introduction to Band Pass Sampling theorem - Geometric representation of signals - ML detection - Correlator and matched filter detection- Generation and detection, BER and Power spectral Density of BPSK, BFSK,QPSK,MSK- Structure of non-coherent receivers generation and detection of BFSK, DPSK – Comparison- M-ary PSK, M-ary FSK - Principles of QAM.		
UNIT – V	**SYNCHRONISATION AND SPREAD SPECTRUM TECHNIQUES**	**9 Periods**
Carrier, frame and symbol/Chip synchronization techniques, Spread Spectrum - PN Sequences,Direct Sequence and Frequency Hopping Spread Spectrum Systems, BER Analysis, Processing gain and Jamming Margin.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*S. Haykin, "**Digital Communications**", John Wiley, 2018.*
2	*B.P.Lathi, **"Modern Digital and Analog Communication Systems",** Third edition, Oxford University Press 2007.*

REFERENCES:

1	*S.P.Eugene Xavier, **"Statistical theory of Communication",** New Age International Private Limited, 2008.*
2	*H P Hsu, Schaum Outline Series, "**Analog and Digital Communications**", TMH 2006.*
3	*J.G Proakis, "**Digital Communication**", Fifth edition, Tata Mc Graw Hill Company, 2008.*
4	*Herbert Taub & Donald L Schilling ,"**Principles of Communication Systems**", Third Edition,Tata McGraw Hill, 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Relate the notion of Entropy and mutual information to source coding theorem and channel capacity	K3
CO2	Apply error control coding techniques to find the error detection and correction capability of codes	K3
CO3	Summarize the various baseband processing techniques	K2
CO4	Explain the spectral characteristics of band pass signaling schemes and their noise performance	K2
CO5	Describe the concept of synchronization, spread spectrum systems	K1

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	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	PSO 3
CO1	3	3	1	2	-	-	-	-	-	1	-	3	2	2	2
CO2	3	3	1	2	-	-	-	-	-	1	-	3	2	2	2
CO3	3	3	1	1	-	-	-	-	-	1	-	3	2	1	2
CO4	3	3	1	1	-	-	-	-	-	1	-	3	2	1	2
CO5	3	3	1	1	-	-	-	-	-	1	-	3	2	1	2
22LPC514	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**3**	**2**	**1**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.1.1, 4.3.3, 4.3.4, 10.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 3.1.1, 3.1.6, 4.1.1, 10.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.1.1, 10.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 4.1.1, 10.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.1, 3.2.3, 4.1.1, 4.1.4, 7.1.1, 10.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	30	40				100
CAT2	30	30	40				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	30	40				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	30	40				100
ESE	30	40	30				100

22LPC515	EMBEDDED COMPUTING	SEMESTER V

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objective	To learn the basic concepts of embedded systems, ARM CORTEX M4 processor, interfacing concept and programming and real time operating system.	
UNIT – I	**INTRODUCTION TO EMBEDDEDSYSTEM DESIGN**	**9 Periods**
Complex systems and microprocessors - Characteristics and challenges of embedded computing system – Embedded system design process – Requirements, Specification, Architectural Design, Designing Hardware and Software Components, System Integration,- Formalism for system Design -Structural Description, Behavioral Description, Design example: Model train controller, Alarm Controller.		
UNIT – II	**ARM CORTEX M4**	**9 Periods**
Introduction to cortex M4 – Features-ARM Architecture –Block diagram- operation modes and states-Registers-memory system-Exception and Interrupts-Instruction Set – Low Power Characteristics		
UNIT – III	**EMBEDDED PROGRAMMING**	**9 Periods**
Components for embedded programs- Models of programs- Assembly, linking and loading – Compilation techniques- Program level performance analysis – Software performance optimization – Program level energy and power analysis and optimization – Analysis and optimization of program size- Program validation and testing.		
UNIT – IV	**INTERFACING WITH ARM CORTEX**	**9 Periods**
ARM Cortex STM32F controller-Configuring GPIO Ports-Switches and LEDs-LCD Display -ADC-DAC- Pulse width Modulation- DMA -Serial Communication USART.		
UNIT – V	**RTOS BASED EMBEDDED SYSTEM DESIGN**	**9 Periods**
Operating System Basics-Types of Operating Systems-Tasks, Process and Threads-Multiprocessing and Multitasking-Task Scheduling –Inter process Communication mechanisms -Evaluating Operating system Performance-Power Optimization Strategies for Process.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS :

1	Marilyn Wolf, "Computers as Components - Principles of Embedded Computing System Design",Third Edition "Morgan Kaufmann Publisher,2012.
2	Raj Kamal, "Embedded Systems-Architecture, Programming and Design", 3 edition, TMH.2015

REFERENCES:

1	https://www.st.com/resource/en/reference_manual/dm0031020-stm32f405-415-stm32f407-advanced-arm-based-32-bitmcus-stmicroelectronics.pdf
2	1.Shibu K.V, "Introduction to Embedded Systems", McGraw Hill.2014.
3	Dr. Mark Fisher, ARM Cortex M4 Cook Book, Packt Publishing, 2016.
4	Lyla, "Embedded Systems", Pearson, 2013. 5. David E. Simon, "An Embedded Software Primer", Pearson Education, 2000.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the concepts of embedded systems.	K1
CO2	Interpret the Architecture and features of ARM CORTEX controller	K2
CO3	Explain the interfacing of ARM Cortex	K2
CO4	Illustrate the code for constructing a system	K3
CO5	Demonstrate the concepts of Real Time operating system	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	2	-	-	-	-	-	-	-	-	-	1	3	1	1
CO 2	3	3	3	3	3	-	-	-	-	-	-	1	3	1	1
CO 3	3	3	3	3	3	-	-	-	-	-	-	1	3	1	1
CO 4	3	3	3	3	3	-	-	-	-	-	-	1	3	1	1
CO 5	3	3	3	3	3	-	-	-	-	-	-	1	3	1	1
22LPC515	**3**	**3**	**3**	**3**	**3**	-	-	-	-	-	-	**1**	**3**	**1**	**1**

b)CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.2, 2.4.3, 3.1.1, 3.1.2, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total 100 %
CAT1	30%	30%	40%				100%
CAT2	30%	30%	40%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30%	30%	40%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30%	30%	40%				100%
ESE	30%	30%	40%				100%

22LPC516	COMPUTER ARCHITECTURE AND ORGANIZATION	SEMESTER V

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objective	To compute the basic arithmetic structure, pipelined execution, parallelism and multi-core processors along with the memory hierarchies, cache memories and virtual memories and different ways of communication with I/O devices.	
UNIT – I	**BASIC STRUCTURE OF A COMPUTER**	**9 Periods**
Functional units-Basic operational concepts- Performance-Instructions: Language of the Computer – Operations, Operands – Instruction and instruction sequencing – Logical operations –decision making – Addressing and addressing modes		
UNIT – II	**ARITHMETIC FOR COMPUTERS**	**9 Periods**
Arithmetic and Logic Unit (ALU) -Addition and Subtraction –Multiplication and Division algorithms – Floating Point Representation – Floating Point addition and subtraction algorithms.		
UNIT – III	**PROCESSOR AND CONTROL UNIT**	**9 Periods**
A Basic MIPS implementation – Building a Data path – Control Implementation Scheme – Pipelining– Pipelined data path and control – Handling Data Hazards & Control Hazards.		
UNIT – IV	**PARALLELISM**	**9 Periods**
Parallel processing challenges – Flynn's classification – SISD, MIMD, SIMD, SPMD and Vector Architectures – Hardware multithreading – Multi-core processors and other Shared Memory Multiprocessors - Introduction to Graphics Processing Units, Clusters, Message-Passing Multiprocessors.		
UNIT – V	**MEMORY AND I/O SYSTEMS**	**9 Periods**
Memory Hierarchy – memory technologies – cache memory – measuring and improving cacheperformance – virtual memory, TLB's – Accessing I/O Devices – Interrupts – Direct Memory Access– Bus structure – Bus operation – Arbitration – Interface circuits – Introduction to Standard Serial Communication Protocols like RS232, USB connector types.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Morris Mano ," Computer Architecture Systems"Third Edition,Pearson,2017.*
2	*B.Govindarajalu,"Computer Architecture and Organisation-Design Principles and Applications"Second edition,2017*

REFERENCES:

1	*William Stallings, "**Computer Organization and Architecture – Designing for Performance**",Eighth Edition, Pearson Education, 2010*
2	*Carl Hamacher, Zvonko Vranesic, SafwatZaky, "**Computer Organization**", McGraw-Hill, Fifth Edition, Reprint 2012*
3	*John P. Hayes, "**Computer Architecture and Organization**", Third Edition, Tata McGraw Hill,2012*
4	*John L. Hennessey and David A. Patterson, "**Computer Architecture – A Quantitative Approach**", Morgan Kaufmann / Elsevier Publishers, Fifth Edition, 2012*
5	*Behrooz Parahami, "**Computer Architecture**", Oxford University Press, Eighth Impression, 2011*
6	*David A. Patterson and John L. Hennessy, "**Computer Architecture-A Quantitative Approach**",Elsevier, a division of reed India Private Limited, Fifth edition, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the basics structure of computers, operations and instructions.	K2
CO2	Design arithmetic and logic unit in a computer.	K3
CO3	Describe the concepts of Data path and Control Path.	K3
CO4	Discuss the pipelined execution and parallel processing architectures.	K2
CO5	Illustrate the various memory systems and I/O communication	K2

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO 11	PO 12	PS O1	PSO 2	PSO 3
CO 1	3	1	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 2	3	3	2	-	-	-	-	-	-	-	-	-	1	-	-
CO 3	3	3	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 4	3	3	1	-	-	-	-	-	-	-	-	-	1	-	-
CO 5	3	3	1	1	-	-	-	-	-	-	-	-	1	-	-
22LPC516	**3**	**3**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.4.1,3.1.1,3.1.4
CO2	1.1.1,1.1.2,1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1, 3.1.4,3.1.6,3.2.1,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2
CO3	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.4,3.3.1, 3.3.2,3.4.2
CO4	1.1.,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.4,3.3.1,3.3.2, 3.4.1,3.4.2
CO5	1.1.1,1.1.2,1.3.1,1.4.1,.1,2.1.2,2.1.3,2.2.1,2.2.2,,2.2.4,,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.4,3.1.5,3.3.1, 3.3.2,3.4.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluatin g(K5) %	Creatin g(K6) %	Total %
CAT1	40	40	20				100
CAT2	40	40	20				100
CAT3	30	30	40				100
Assignment 1	30	30	40				100
Assignment 2	30	30	40				100
Quiz 1							
Quiz 2	40	40	20				100
Other mode ofinternal assessments, if any	40	40	20				100
ESE	30	30	40				100

22LMC5Z2	CONSTITUTION OF INDIA *(Common to All Branches)*	SEMESTER V

PREREQUISITES	CATEGORY	L	T	P	C
NIL	MC	3	0	0	0

Course Objective	The objective of the course is to familiarize the students on the role, powers and functions of Indian government. Also understand the recent acts in India.	
UNIT - I	**INTRODUCTION AND EMERGENCY PROVISIONS**	**9 Periods**
Historical Background: The Company rule, The Crown rule - Constituent Assembly: Composition, Objectives - Preamble and Salient features of the Indian Constitution - Fundamental Rights, Fundamental Duties, Directive Principles of state policy, Emergency Provisions - National Emergency, President Rule, Financial Emergency.		
UNIT - II	**SYSTEM OF GOVERNMENT**	**9 Periods**
Parliamentary system: merits, demerits, reasons for adopting parliamentary system – Federal system:Evaluation of federal features –Centre-State relations: Legislative, Administrative and Financial relations – Local Government: Panchayat Raj and urban local government.		
UNIT - III	**UNION AND STATE GOVERNMENT**	**9 Periods**
President of India: Election, Powers and functions - Prime Minister and Cabinet: Structure and functions – Governor: Powers and functions - Chief Minister and Council of Ministers: Functions.		
UNIT - IV	**ORGANS OF GOVERNANCE AND RECENT ACTS**	**9 Periods**
Parliament: Lok Sabha and Rajya Sabha, Composition and powers - State Legislative Assembly and Legislative Council: Composition and powers - Judicial System in India: Structure and features - Supreme Court and High Court: Composition, Jurisdiction, Recent acts in significance-RTI, Citizenship act, POCSO Act.		
UNIT - V	**POLITICAL DYNAMICS**	**9 Periods**
Political parties: Party system, Recognition of National and State parties – Elections: Electoral system and reforms – Pressure groups – National Integration: Obstacles, National Integration Council – Foreign Policy: Principles and Objectives.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*National portal of India, "**The Constitution of India**" (Full Text),https://legislative.gov.in/constitution-of-india*
2	*Dr.B.R.Ambedkar, "**The Constitution of India",** Sudhir Prakashan, 2020.*

REFERENCES:

1	*Durga Das Basu, "**Introduction to the Constitution of India**, LexisNexis, 2022*
2	*P.M.Bakshi, "**The Constitution of India"**, LexisNexis, 2020*
3	*Subash C Kashyap, "**Our Parliament"**, National Book Trust, 2021*
4	*Subash C Kashyap, "**Our Political System**", National Book Trust, 2011*

COURSE OUTCOMES Upon Completion of the course, the students will be able to		Bloom's Taxonomy Mapped
CO1	Know the evolution of Indian Constitution and its basic premises.	K1
CO2	Explain the system of governance in India.	K2
CO3	Describe the structure of Union and State Governments	K2
CO4	Obtain the knowledge of functions of Legislature and Judiciary	K1
CO5	Know the political system of India	K1

COURSE ARTICULATION MATRIX

a)CO/PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	1	-	1	1	-	-	-	-	-	-
CO3	-	-	-	-	-	2	-	1	1	-	-	-	-	-	-
CO4	-	-	-	-	-	1	-	1	2	-	-	-	-	-	-
CO5	-	-	-	-	-	2	-	2	1	-	-	-	-	-	-
22LMC5Z2	-	-	-	-	-	**2**	-	**1**	**1**	-	-	-	**-**	**-**	**-**

1 – Slight, 2 – Moderate, 3 – Substantial

b)CO and Key Performance Indicators mapping

CO1	6.1.1,6.2.1,8.1.1,8.2.1,8.2.2,9.1.2
CO2	6.1.1,6.2.1,8.1.1,8.2.1,8.2.2,9.1.2
CO3	6.1.1,6.2.1,8.1.1,8.2.1,8.2.2
CO4	6.1.1,6.2.2,9.1.2,9.2.1
CO5	6.2.2,8.1.1,8.2.2,9.1.2,9.2.1

ASSESSMENT PATTERN - THEORY

Test/Bloom's Category	Remembering (K1)%	Understanding (K2) %	Applying (K3)%	Analyzing (K4)%	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50	50	-	-	-	-	100
CAT2	50	50	-	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	50	50	-	-	-	-	100
ESE	50	50	-	-	-	-	100

22LPC517	ANALOG AND DIGITAL COMMUNICATION LABORATORY	SEMESTER V

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objective	To understand the role of each module present in the communication link that includes various Analog modulation and Digital modulation techniques, Source coding theorems, Line coding schemes, Error control coding techniques, Spread spectrum techniques and Equalizer
PRACTICALS	**Simulation using MATLAB/SIMULINK/ SDR equivalent (OR) Hardware** **List of Experiments:** 1. Amplitude Modulation and Demodulation 2. Frequency Modulation and Demodulation 3. ASK, FSK, PSK and DPSK schemes 4. Natural sampling and Flat top sampling 5. Time Division Multiplexing 6. Pulse Code Modulation and Demodulation 7. Delta Modulation and Demodulation 8. Line coding schemes. 9. Error control coding using Linear Block Codes and Convolutional codes 10. Shannon Fano coding and Huffmann coding 11. Code Division Multiplexing 12. Equalization – Zero Forcing & LMS algorithms
Contact Periods: **Lecture: 0 Periods** **Tutorial: 0 Periods** **Practical: 45 Periods** **Total: 45 Periods**	

REFERENCES:

1	*John G.Proakis, **"Contemporary Communication Systems Using MATLAB",** 3rd Edition, Cengage learning, 2013.*
2	*Wayne Tomasi, **"Laboratory Manual to Electronic Communications Systems"Pearson, 2000.***
3.	*https://forums.ni.com/t5/Curriculum-and-Labs-for/Analog-Digital-Communications-Systems-with-LabVIEW-Experiments/ta-p/3513761*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Ability to experimentally analyze the performance of various kinds of Analog modulation techniques and Digital modulation techniques used in communication systems	K4
CO2	Ability to experimentally analyze the performance of sampling, Time Division Multiplexing and line coding formats in Digital communication systems	K4
CO3	Ability to experimentally analyze the performance of various kinds of error control coding schemes used in Digital communication systems	K4
CO4	Ability to understand the code division multiplexing and equalizer performance by applying various equalization algorithms	K4
CO5	Ability to experimentally analyze the performance of various kinds of source coding techniques used in Digital communication systems	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs / POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	3	3	1	1	3	1	3	1	2	3
CO2	3	3	1	2	2	2	1	1	1	3	-	3	1	2	3
CO3	3	3	1	2	2	2	1	2	1	3	1	3	1	2	3
CO4	3	3	1	2	2	-	1	1	1	3	1	3	1	2	3
CO5	3	3	1	2	2	2	1	2	1	3	1	3	1	2	3
22LPC517	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**3**	**1**	**3**	**1**	**2**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2,2.2.3,2.2.4,2.3.1,2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.3, 5.1.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.2.2, 8.2.2, 9.1.1, 9.1.2, 10.1.1, 10.1.2, 10.1.3, 10.2.2, 10.3.1,10.3.2, 11.2.1, 12.1.1,12.1.2, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.4.2, 4.1.1, 4.2.1, 4.3.3, 5.1.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.2.2, 8.2.2, 9.1.1, 9.1.2, 10.1.1, 10.1.2. 10.1.3, 10.2.2, 10.3.1, 10.3.2, 11.2.1, 12.1.1, 12.1.2, 12.2.2,12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.1, 4.1.1, 4.3.3, 4.3.4, 5.1.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.2.2, 8.1.1, 8.2.2, 9.1.1, 9.1.2, 10.1.1, 10.1.2. 10.1.3, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 12.1.1, 12.1.2, 12.2.2,12.3.1, 12.3.2
CO4	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.1, 3.2.3, 4.1.1, 4.1.4, 4.3.3, 5.1.1, 5.2.2, 5.3.1, 5.3.2, 6.2.1, 7.1.1, 7.2.2, 8.2.2, 9.1.1, 9.1.2, 10.1.1, 10.1.2. 10.1.3, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 12.1.1, 12.1.2, 12.2.2,12.3.1, 12.3.2
CO5	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.1, 4.1.1, 4.3.3, 4.3.4, 5.1.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.2.2, 8.1.1, 8.2.2, 9.1.1, 9.1.2, 10.1.1, 10.1.2. 10.1.3, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 12.1.1, 12.1.2, 12.2.2,12.3.1, 12.3.2

22LPC518	EMBEDDED COMPUTING LABORATORY	SEMESTER V

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objective	To apply the theoretical concepts of ARM processor in real time.
PRACTICALS	**LIST OF EXPERIMENTS** The following programs are to be implemented in ARM processor: 1. To configure and control General Purpose Input/output (GPIO) port pins. 2. Interfacing 8 Bit LED and Switch. 3. Implementation of Buzzer Interface on IDE environment. 4. Display a message in a 2 line x 16 Characters LCD display. 5. Time delay demonstration using built in Timer / Counter feature on IDE environment. 6. Simple interrupt handler and setting up a timer. 7. Interfacing ADC and DAC. 8. Generation of PWM. 9. Interfacing Matrix Keypad. 10. Implementation of Real Time clock. 11. Interfacing Temperature sensor. 12. Serial Data Transfer. Mini Project using ARM processor. .
Contact Periods: **Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods**	

REFERENCES:

1	*Andrew N.Sloss Dominic Symes Chris Wright, "ARM System Developer's Guide Designing and Optimizing System Software", Elsevier Inc 2010.*
2	*JosephYiu ,"The Definitive Guide to the ARM Cortex-M" , Elsevier- Newness, 2014*

COURSE OUTCOMES: Upon completion of the course, the students will be able to :		**Bloom's Taxonomy Mapped**
CO1	Develop an ARM CORTEX M4 based Assembly Language Programs	K2
CO2	Develop embedded C programs to implement the functions of On-chip peripherals of ARM CORTEX M4 processor.	K3
CO3	Demonstrate C programs to interface ADC and DAC	K4
CO4	Develop embedded C programs to handle interrupts and timer in ARM processor.	K4
CO5	Demonstrate real time clock and serial data transfer.	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	2	1	2	-	-	-	-	3	1	-	1	3	1	1
CO 2	3	3	2	3	-	-	-	-	3	1	-	1	3	1	1
CO 3	3	3	2	3	-	-	-	-	3	1	-	1	3	1	1
CO 4	3	3	2	3	-	-	-	-	3	1	-	1	3	1	1
CO 5	3	3	2	-	-	-	-	-	3	1	-	1	3	1	1
22LPC518	**3**	**3**	**2**	**3**	-	-	-	-	**3**	**1**	-	**1**	**3**	**1**	**1**

b)CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 3.1.3, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.4.1, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3

22LPC619	OPTICAL FIBER COMMUNICATION	SEMESTER VI

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objective	To acquire knowledge about the optical communication systems and optical fibers, optical transmitter, receiver and to learn about advanced technologies in optical systems.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Evolution of fiber optical system -Elements of Optical Fiber Systems –EM Spectrum, Total Internal Reflection - Choice of operating wavelength- Mode theory of Circular Wave Guides–Single Mode Fiber, Multi-mode Fiber – Step index fiber, Graded Index Fiber–Numerical Aperture-Signal degradation in fibers–Dispersion, Attenuation, Bending loss and propagation loss - Advantages andapplications of fiber optic transmission systems.		
UNIT – II	**OPTICAL SOURCES**	**9 Periods**
Spontaneous and Stimulated emission - Optical sources- Light Emitting Diode (LED)–V-I characteristics of LED - Laser Diode – V-I and P-I characteristics of Laser Diode - Ruby laser – He- Ne laser – Splicing technique – Optical fiber connectors and couplers –Transmitter Design.		
UNIT – III	**OPTICAL DETECTORS**	**9 Periods**
Photo detectors–Photodiode and V-I characteristics of Photodiode, Avalanche photomultiplier tubes-Photo detector noise –Signal to Noise ratio - Detector response time-BER calculation - Power budgetand Rise time budget.		
UNIT – IV	**SYSTEM CONFIGURATIONS**	**9 Periods**
Optical amplifiers – Erbium Doped Fiber Amplifier (EDFA), Raman Amplifier- Multiplexing strategies – Wavelength Division Multiplexing (WDM) - Dense Wavelength Division Multiplexing(DWDM).		
UNIT – V	**ADVANCES IN OPTICAL FIBER SYSTEMS**	**9 Periods**
Synchronous Optical Network / Synchronous Digital Hierarchy (SONET/SDH) –Wavelength Routing Networks - Optical switches - Optical fiber LAN link – Optical CDMA - Optical networkingtechnology in enterprise.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS:

1	*Keiser G, "**Optical Fiber Communications**", McGraw Hill, New Delhi, Fifth edition, 2014.*
2	*John M. Senior, "**Optical Fiber Communications Principles and Practice**", PHI, New Delhi,Third edition, 2009.*

REFERENCES:

1	*G.P. Agrawal, "**Fiber optic Communication Systems**", John Wiley and sons, Fourth Edition,2011.*
2	*Franz J.H. Jain V.K, "**Optical Communication, Components and systems**", Narosa publications, New Delhi, 2000.*
3	*Gower, J "**Optical Communication Systems**", PHI, New Delhi, Second edition, Fifth reprint,2001.*
4	*K. Mynbaev and Lowell L Scheiner, "**Fiber Optic Communication Technology**", Prentice Hall 2001.*
5	*V.S.Bagad, "**Optical Fiber Communication**", Technical Publications, Pune, Fifth edition, 2023.*

COURSE OUTCOMES: Upon completion of the course, the students will be able:		Bloom's Taxonomy Mapped
CO1	Recognize the structures, types of optical fibers and applications of optical Communication systems.	K2
CO2	Explain the principles of optical sources and can able to design optical transmitter.	K3
CO3	Apply the ideologies of optical detectors and analyze the functioning of optical receivers.	K3
CO4	Acquire knowledge about the losses in the fiber and to analyze the functioning of optical components.	K2
CO5	Illustrate the advances in optical fiber system.	K2

COURSE ARTICULATION MATRIX

a)CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	-	-	-	2	-	-	-	-	2	3	3	1
CO2	-	-	2	3	2	-	-	-	-	-	-	2	3	3	-
CO3	-	-	-	-	3	-	-	2	-	-	-	2	3	2	1
CO4	2	2	2	-	-	-	2	-	-	-	-	2	2	2	1
CO5	3	-	2	3	2	-	-	-	-	-	-	2	3	2	1
22LPC619	2	2	2	3	3	-	2	2	-	-	-	**2**	3	2	1

1 – Slight, 2 – Moderate, 3 – Substantial

b)CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.1.5,4.1.2, 5.1.1,5.1.2,5.2.1,5.2.2,7.1.1,7.1.2,7.2.1,7.2.2,12.1.1,12.1.1
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.1.5,4.1.2, 5.1.1,5.1.2,5.2.1,5.2.2,7.1.1,7.1.2,7.2.1,7.2.2,12.1.1,12.1.2, 12.2.1,12.2.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.1.5,4.1.2, 5.1.1,5.1.2,5.2.1,5.2.2,7.1.1,7.1.2,7.2.1,7.2.2,12.1.1,12.1.2,12.2.1,12.2.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.1.5,4.1.2, 5.1.1,5.1.2,5.2.1,5.2.2,7.1.1,7.1.2,7.2.1,7.2.2,12.1.1,12.1.2,12.2.1,12.2.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.1.5,4.1.2, 5.1.1,5.1.2,5.2.1,5.2.2,7.1.1,7.1.2,7.2.1,7.2.2,12.1.1,12.1.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	40	30			100
CAT2	10	30	30	30			100
Assignment 1	10	20	40	30			100
Assignment 2	10	30	30	30			100
Quiz 1	30	40	30				100
Quiz 2	20	50	30				100
Other mode of internal assessments, if any							
ESE	10	20	30	40			100

22LPC620	ANTENNAS AND WAVE PROPAGATION	SEMESTER VI

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objective	To design and analyze various types of antennas and arrays, learn measurements of antenna parameters and understand characteristics of a wave propagation in free space.	
UNIT – I	**FUNDAMENTALS OF RADIATION**	**9 Periods**
Antenna Parameters: Radiation mechanism- current distribution on a thin wire antenna- Radiation Pattern, Beam solid angle, Radiation intensity, Radiation Power density, Directivity, Gain, Effective aperture, Effective height, Polarization, Bandwidth, Beam width, antenna impedance, Duality of Antennas. **Radiation:** Retarded potentials - Radiation fields of oscillating dipole, Power radiated by a current element, short antennas, Radiation from Half wave Dipole.		
UNIT – II	**ANTENNA ARRAYS**	**9 Periods**
Two element array – N-element Linear arrays, Pattern multiplication, Effect of earth on Vertical Patterns, Broad side array, End fire array, Evaluation of null directions and maxima, amplitude distributions - Binomial arrays, – Log periodic dipole array – Phased array - Yagi-Uda array – Folded Dipole – Impedance matching .		
UNIT – III	**APERTURE AND SLOT ANTENNAS**	**9 Periods**
Induction and Equivalence Theorems – Field of a secondary source – Radiation from open end of a co-axial line – Radiation through an Aperture – Fraunhofer and Fresnel Diffraction – Radiation from Electromagnetic Horns – Rectangular Horn Antennas – Conical Horn Antenna – Slot antennas –Patterns of Slot Antennas in Flat Sheets- Edge Diffraction – Babinet Principle –Impedance of Complementary Sheets –Impedance of Slot Antennas .		
UNIT – IV	**SPECIAL ANTENNAS**	**9 Periods**
Helical Antennas – Design of Monofilar Axial mode and normal mode Helical antenna – loop antennas-Power radiated, Radiation Resistance and directivity Reflector Antennas – flat sheets and corner reflector – Paraboloidal reflector – Feed methods –- Micro-stripe Antennas – Cell tower Trees – Base station Antennas - Mobile station Antennas.		
UNIT – V	**WAVE PROPAGATION AND ANTENNA MEASUREMENTS**	**9 Periods**
Modes of propagation - Structure of atmosphere - Characteristics of different ionized regions - Sky wave propagation - Effects of the earth's magnetic field on ionospheric radio wave propagation - Virtual height - Maximum usable frequency - Critical angle - Skip distance - Space wave propagation - Duct propagation.Measurement of Radiation Pattern - Beam Width - Gain - Directivity - Polarization-Input impedance - SWR method –Reflection coefficient-VSWR–Antenna Test Ranges: Elevated ranges-Ground reflection ranges- Anechoic chambers & absorbing materials-Compact Antenna Test Ranges.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Edward C. Jordon , Keith G. Balmain* ***"Electromagnetic Waves and Radiating Systems"*** *Pearson 2nd Edition,2015*
2	*Prasad.K.D,* ***"Antennas and Wave Propagation",*** *Sathya Prakashan, 3rd Edition, 2009*

REFERENCES:

1	*Constantine A. Balanis,* ***"Antenna Theory-Analysis and Design",*** *3rd edition, Wiley-India, 2010*
2	*R.E.Collin,* ***"Antennas and Radio wave Propagation",*** *McGraw Hill,2002*
3	*.Jhon D Kraus,****"Antennas"****2nd Edition McGraw Hill, 1988*
4	*H.Sizun* ***"Radio Wave Propagation for Telecommunication Applications",*** *First Indian Reprint, Springer Publications, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain and analyze the radiation characteristics of dipole.	K2
CO2	Discuss the design and radiation pattern of antenna arrays.	K3
CO3	Describe and analyze Aperture and Slot antennas	K3
CO4	Describe the radiation characteristics and design of special antennas.	K2
CO5	Explain the various modes of radio wave propagations and measurement procedure of antenna parameters.	K2

COURSE ARTICULATION MATRIX:

a)CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO 2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO 3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO 4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO 5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LPC620	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**1**

b)CO and Key Performance Indicators Mapping

CO 1	1.2.1, 2.1.3, 2.2.2, 2.2.3, 4.1.1, 4.1.2
CO 2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.4, 10.1.1, 10.1.2, 10.1.3, 10.2.1
CO 3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.4, 10.1.1, 10.1.2, 10.1.3, 10.2.1
CO 4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.4, 10.1.1, 10.1.2, 10.1.3, 10.2.1
CO 5	1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.4.1, 2.4.2, 2.4.4, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.4, 10.1.1, 10.1.2, 10.1.3, 10.2.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20				100
CAT2	40	40	20				100
Assignment 1	30	30	40				100
Assignment 2	30	30	40				100
Quiz 1	30	30	40				100
Quiz 2	30	30	40				100
Other mode of internal assessments, if any							
ESE	40	40	20				100

22LPC621	VLSI DESIGN	SEMESTER VI

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objective	To introduce various aspects of CMOS logic and CMOS logic networks to realize the VLSI system components	
UNIT – I	**CMOS LOGIC DESIGN**	**9 Periods**
VLSI Design Flow - MOSFET Switches - Basic Logic Gates in CMOS - Complex Logic Gates in CMOS - Transmission Gate Circuits - Stick Diagram and Layout Design Rules - Layout of Basic Structures - Physical structure of MOSFETs - CMOS Layers – FinFET – VI Charateristics of FinFET.		
UNIT – II	**CHARACTERISTICS AND ANALYSIS OF CMOS LOGIC**	**9 Periods**
MOS Threshold Voltage Equation - nFET Current-Voltage Equations - The FET RC Model - DC Characteristics of the CMOS Inverter - Switching Characteristics - Power Dissipation - Transient Response - Analysis of Complex Logic Gates.		
UNIT – III	**DESIGNING HIGH-SPEED CMOS LOGIC NETWORKS**	**9 Periods**
Gate delays - driving large capacitive loads - Logical effort – Advanced Logic Circuits: Pseudo-NMOS - Tri-state - clocked CMOS- dynamic and dual rail logic – Domino logic - CPL – DCVSPG – DPL. Timing Issues : Timing Classification Of Digital System, Synchronous Design.		
UNIT – IV	**VLSI CLOCKING AND TESTING**	**9 Periods**
VLSI clocking: CMOS clocking styles - Pipelined systems - Clock generation and distribution. VLSI testing -need for testing - manufacturing test principles - design strategies for test - chip level and system level test techniques.		
UNIT – V	**TIMING ANALYSIS AND SUB-SYSTEM DESIGN**	**9 Periods**
Time borrowing- Master slave flip flop - Flop timing parameters – Max and Min delay of flop based systems – Flop min delay constraint – Latch Max and Min delay constraints – Latch Timing analysis and skew – time borrowing. Verilog structures - Multiplexers - Binary Decoders – Comparators – Priority Encoders – Latches - Flip-Flops and Registers – SRAM - DRAM and Flash Memories.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Uyemura, John P, "**Introduction to VLSI Circuits and Systems**", Wiley & Sons, 8th Reprint 2009*
2	*N. Weste et. al., "**CMOS VLSI Design**", Third Edition, Pearson Education,2013.*

REFERENCES:

1	*Jan M. Rabaey, "**Digital Integrated Circuits: A Design Perspective**", PHI, Second Edition, 2012.*
2	*R. Jacob Baker, "**CMOS: Circuit Design, Layout, and Simulation**", Wiley-IEEE, Revised Second Edition, 2008.*
3	*Pucknell, "**Basic VLSI Design**", Prentice Hall, 2006.*
4	*Sung-Mo Kang & Yusuf Leblebici, "**CMOS Digital Integrated Circuits Analysis And Design**", Mcgraw-Hill, 2022.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Construct the complex logic circuits with MOSFETs	K3
CO2	Explain the characteristics and analyze the characteristics of CMOS logic	K2
CO3	Design the high-speed CMOS Logic Networks	K3
CO4	Use clocking styles to design basic VLSI system and illustrate the testing principles for the device under test.	K3
CO5	Design the basic digital blocks and understand the advanced technologies.	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	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	PSO 3
CO1	3	3	2	-	-	2	-	-	-	2	-	3	3	1	2
CO2	3	2	1	-	-	2	-	-	-	2	-	3	2	1	2
CO3	3	3	2	-	-	2	-	-	-	2	-	3	3	1	2
CO4	3	3	2	-	-	2	-	-	-	2	-	3	3	1	2
CO5	3	3	2	-	-	2	-	-	-	2	-	3	3	1	2
22LPC621	**3**	**3**	**2**	-	-	**2**	-	-	-	**2**	-	**3**	**3**	**1**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.4, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20				100
CAT2	40	40	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	50				100
ESE	40	40	20				100

22LPC622	COMPUTER NETWORKS *(Common to ECE, CSE, IT branches)*	SEMESTER VI

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objective	Upon completion of the course, the students will be familiar with, 1. The division of network functionalities into layers 2. The component required to build different types of networks 3. Identifying the solution for the functionalities in each layer.	
UNIT – I	**INTRODUCTION AND PHYSICAL LAYER**	**9 Periods**
Overview of how the Internet works: browser, webserver, URL, domain name, IP address, packets, Hubs, Bridges, Switches.Overview of the design principles of the Internet: packet switching vs circuit switching, store-and forward networks, layering for modularity. Introduction to the various layers in the Internet. Introduction to performance metrics: end-to-end throughput, delay, jitter and drop rates in a network. Statement of Little's Law. How performance is measured. Physical layer: signalto-noise ratio, bit error rate, modulation, multipath interference. Data Transmission – Transmission Media – Signal Encoding Techniques – Multiplexing – Spread Spectrum		
UNIT – II	**DATA LINK LAYER**	**9 Periods**
Medium access protocols: Polling vs. contention-based: TDM, Aloha, CSMA/CD. Data Link Layer: Mechanisms for error detection/recovery: Parity checks, CRC and data link layer protocols. Switched LANs: L2 addressing and ARP– Virtual LAN (VLAN) –Ethernet frame structure, Wireless LAN (802.11)		
UNIT – III	**NETWORK LAYER**	**9 Periods**
Network Layer: Network architecture and performance: Network topology; Router architecture: queueing and switching. Performance evaluation of a network link: traffic characteristics, performance measures, Kendall's notation. IP Protocol: - Need for an Internet address, and its design. Hierarchical IP addressing, Subnetting, IPv4 and IPv6, structure of IP datagram, IP forwarding. Routing protocols: Link state routing. Distance vector routing: count-to-infinity, routing convergence. Structure of the Internet: end-user organizations and ISPs. difference between intra-domain (OSPF) and inter-domain (BGP) routing, Congestion Avoidance in Network Layer		
UNIT – IV	**TRANSPORT LAYER**	**9 Periods**
Transport Layer: Importance of the transport layer; end-to-end principle. Transport layer protocols: TCP and UDP, process-to process delivery, multiplexing, port numbers, header structure - Reliable transmission of packets over an unreliable network: sequence numbers, ACKs, timeout, retransmissions. Stop and wait, and sliding window - TCP connection setup and teardown - Flow control and congestion control at the transport layer. Differences between the two. Overview of TCP congestion control: Slow start and reaction to timeouts - TCP congestion control: Slow start; congestion avoidance using loss-based and delay-based control. Introduction to Quality of services (QOS).		
UNIT – V	**APPLICATION LAYER**	**9 Periods**
Application Layer: Internet names, how DNS works, Application layer protocols: HTTP, SMTP, SNMP, web applications. Security attacks and defences: DMZ, firewalls. Peer-to-peer applications. P2P file distribution. Audio and video streaming. Challenges of streaming over best effort IP		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	A.S. Tanenbaum and D.J. Wetherall, **"*Computer Networks*"**, 5th edition, Pearson, 2013.
2	J.F. Kurose and K.F. Ross, **"*Computer networking: a top-down approach*"**, 6th edition, Pearson, 2017.

REFERENCES:

1	*Larry L. Peterson, Bruce S. Davie, "Computer Networks: A Systems Approach", Fifth Edition, Morgan Kaufmann Publishers Inc., 2011.*
2	*William Stallings, "Data and Computer Communications", Eighth Edition, Pearson Education, 2011.*

3	*Behrouz A. Forouzan and Firouz Mosharraf, "Computer Networks a Top Down Approach", Tata McGraw-Hill, 2011.*
4	*R. Jain, The art of computer systems performance analysis, Wiley India, 1991*
5	*S.K. Bose, An Introduction to Queueing Systems, Springer Science + Business Media New York, 2012*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Summarize layering as a means of tackling complexity, layering applied to the Internet	K2
CO2	Explain protocols as a structured means of reliable communications	K3
CO3	Explain the architecture principles that have enabled the orders of magnitude expansion of the Internet	K3
CO4	Explain networked applications and their protocols, their installation, operation and performance tuning	K3
CO5	Choose the required functionality at each layer for a given application and trace the flow of information from one node to another node in the network.	K3

COURSE ARTICULATION MATRIX

a)CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO 1	2	2	2	2	-	-	-	1	-	-	-	-	1	2	2
CO 2	2	2	2	2	-	-	-	1	-	-	-	-	1	2	2
CO 3	2	2	2	2	-	-	-	1	-	-	-	-	1	2	2
CO 4	2	2	2	2	-	-	-	1	-	-	-	-	1	2	2
CO 5	2	3	3	3	-	-	-	1	-	-	-	-	1	2	2
22LPC622	**2**	**3**	**3**	**3**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**1**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.2.1, 2.1.1, 2.1.2, 3.1.1, 3.1.2, 4.1.1, 4.2.1, 8.1.1
CO2	1.1.1, 1.2.1, 2.1.1, 2.1.2, 3.1.1, 3.1.2, 4.1.1, 4.2.1, 8.1.1
CO3	1.1.1, 1.2.1, 2.1.1, 2.1.2, 3.1.1, 3.1.2, 4.1.1, 4.2.1, 8.1.1
CO4	1.1.1, 1.2.1, 2.1.1, 2.1.2, 3.1.1, 3.1.2, 4.1.1, 4.2.1, 8.1.1
CO5	1.1.1, 1.2.1, 2.1.1, 2.1.2, 2.3.1, 3.1.1, 3.1.2, 3.4.1, 4.1.1, 4.2.1, 4.2.2, 8.1.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	30	40	-	-	-	100
CAT2	30	30	40	-	-	-	100
Assignment 1	30	20	40	5	5	-	100
Assignment 2	30	20	30	10	5	5	100
ESE	30	30	40	-	-	-	100

22LPC623	VLSI DESIGN LABORATORY	SEMESTER VI

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	3	1.5

Course Objective	To design, simulate and analyze digital circuits using Verilog HDL.

LIST OF EXPERIMENTS:

1. Study of basic combinational circuits, code converters, adders, multipliers and ALUs.
2. Study of sequential circuits, flipflops, memories, shift registers and counters.
3. Design of FSM for an application using Verilog.
4. Layout & Circuit Simulation of CMOS Inverter and Universal logic gates and perform the transient analysis.
5. Design and implementation of 6T SRAM cell, 1T and 3T DRAM cell and NAND based and NOR based ROM array.
6. Simulation and layout of basic gates and Flip-Flop. Analyze the impact of supply voltage and temperature.
7.Design of Integrated Circuits(ICs).

* **Use EDA Tools/Implement on FPGA**

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

REFERENCES:

1	*J Bhasker, "**A verilog HDL Primer**", BS Publication, 2017*
2	*Charles H.Roth, "**Fundamentals of Logic Design**", Cengage, 2019*
3	*N. Weste et. al., "**CMOS VLSI Design**", Third Edition, Pearson Education,2013.*
4	*R. Jacob Baker, "**CMOS: Circuit Design, Layout, and Simulation**", Wiley-IEEE, Revised Second Edition, 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Design, simulate and implement the combinational circuits on FPGA using EDA tool.	K3
CO2	Design, simulate and implement the sequential circuits on FPGA using EDA tool.	K3
CO3	Design FSM for an application and implement on FPGA.	K3
CO4	Perform the layout, schematic analysis and power calculation of the circuits.	K3
CO5	Analyze the design of VLSI circuits.	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping:

COs/POs	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	2	-	-	3	3	-	3	3	3	3
CO2	3	3	3	3	3	2	-	-	3	3	-	3	3	3	3
CO3	3	3	3	3	3	2	-	-	3	3	-	3	3	3	3
CO4	3	3	3	3	3	2	-	-	3	3	-	3	3	3	3
CO5	3	3	3	3	3	2	-	-	3	3	-	3	3	3	3
22LPC623	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**3**	**3**	**-**	**3**	**3**	**3**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

22LPC624	DATA COMMUNICATION AND COMPUTER NETWORKS LABORATORY	SEMESTER VI

PREREQUISITES	CATEGORY	L	T	P	C
COMPUTER NETWORKS	PC	0	0	3	1.5

Course Objective	To analyze and implement the computer networking protocols and algorithms.

LIST OF EXPERIMENTS:

1. Practical implementation of different types of network cables.
2. Analyze the Performance of various network topologies in LAN.
3. Construct the Wireless LAN and make the PC Communicate Wirelessly.
4. Construct the VLAN and make the PC Communicate among VLAN.
5. Construct a simple LAN and understand the operation of Address Resolution Protocol(ARP).
6. Simulate the operation of Routing Information Protocol (RIP).
7. Simulate the operation of ALOHA Protocol.
8. Simulate the operation of Slotted ALOHA Protocol.
9. Simulate the operation of Slotted ALOHA Protocol.
10. Simulate the operation of AODV (An Ad-hoc On Demand Distance Vector) Routing.
11. Simulate the operation of Dynamic Source Routing (DSR).
12. Miniproject

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

REFERENCES:

1	Computer Integrated Design and Manufacturing – Mark Henderson & Philip Wolfe, Bedworth McGraw hill inc, 1991, First Edition.
2	Kurose, Ross (2014), Computer Networking: A top down approach, Sixth Edition, Pearson Education, India.
3	Murthy,C.Siva Ram and B.S.Manoj. Adhoc Wireless networks: Archutecture and Protocols,Pearson Education ,2004.
4	Tanenbanum,A.S,2033,Computer Networks,Peaarson Education,India.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Demonstrate the Various protocols in LAN and VLAN.	K3
CO2	Apply the concept of Routing information protocol.	K3
CO3	Construct the LAN to implement Address Resolution Protocol (ARP).	K3
CO4	Translate conceptual ideas on ALOHA protocols.	K3
CO5	Implement the concepts of Vector Routing.	K3

COURSE ARTICULATION MATRIX

a)CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	1	1	1	3	3	-	-	-	-	-	-	1	1	2	2
CO 2	1	1	1	3	3	-	-	-	-	-	-	1	1	2	2
CO 3	1	1	1	3	3	-	-	-	-	-	-	1	1	2	2
CO 4	1	1	1	3	3	-	-	-	-	-	-	1	1	2	2
CO 5	1	1	1	3	3	-	-	-	-	-	-	1	1	2	2
22LPC624	**1**	**1**	**1**	**3**	**3**	-	-	-	-	-	-	**1**	**1**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2
CO2	4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2
CO3	4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2
CO4	4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2
CO5	4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2

22LES610	DESIGN THINKING FOR ELECTRONICS AND COMMUNICATION ENGINEERING					SEMESTER VI
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**ES**	**0**	**0**	**3**	**1.5**

Course Objectives	To provide the new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products which useful for a student in preparing for an engineering career.

Unit 1: An Insight to Learning
Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting

Unit 2: Remembering Memory
Understanding the Memory process, Problems in retention, Memory enhancement techniques

Unit 3: Emotions: Experience & Expression
Understanding Emotions: Experience & Expression, Assessing Empathy, Application with Peers

Unit 4: Basics of Design Thinking
Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test

Unit 5: Being Ingenious & Fixing Problem
Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving

Unit 6: Process of Product Design
Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and functions, Assignment – Engineering Product Design

Unit 7: Prototyping & Testing
What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing

Unit 8: Celebrating the Difference
Understanding Individual differences & Uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences

Unit 9: Design Thinking & Customer Centricity
Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design

Unit 10: Feedback, Re-Design & Re-Create
Feedback loop, Focus on User Experience, Address "ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – "Solving Practical Engineering Problem through Innovative Product Design & Creative Solution".

Contact Periods:
Lecture: 0 Periods Tutorial: 0 Periods Practical: 45 Periods Total: 45 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Compare and classify the various learning styles and memory techniques and Apply them in their engineering education	K3
CO2	Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products	K4
CO3	Develop new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products	K3
CO4	Propose real-time innovative engineering product designs and Choose appropriate frameworks, strategies, techniques during prototype development	K4
CO5	Perceive individual differences and its impact on everyday decisions and further Create a better customer experience	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	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	PSO 3
CO1	3	3	3	3	3	3	-	-	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	-	-	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	-	-	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	-	-	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	-	-	3	3	3	3	3	3	3
22LES610	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**3**	**3**	**3**	**3**	**3**	**3**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

22LHS706	MANAGEMENT THEORY AND PRACTICE	SEMESTER VII

PREREQUISITES	CATEGORY	L	T	P	C
NIL	HSMC	3	0	0	3

Course Objective	To develop an understanding of the "relationship" aspect of management and to face the difficulties in management of people and other resources.	
UNIT – I	**BASICS OF MANAGEMENT THOUGHT**	**9 Periods**
Evolution of Management – Definition – Levels – Principles - Differences with administration - Roles of Managers-Social Responsibility of Business - External environment of business - Management Ethics.		
UNIT – II	**PLANNING**	**9 Periods**
Nature-Importance-Types-Steps-Management by Objectives-Strategic planning process-Decision making- Types of decisions- Steps in rational decision making – Decision making under uncertainty.		
UNIT – III	**ORGANIZING**	**9 Periods**
Formal and Informal organization- Span of Management- Departmentalization -Line and Staff authority, Decentralization and Delegationof authority- Effective organization and organization culture.		
UNIT – IV	**STAFFING AND LEADING**	**9 Periods**
Importance and need for staffing- Recruitment – Sources, internal and external sources of recruitment, Leadership theories and its characteristics, Functions of a Leader, Communication – Importance, Purpose, Process, Barriers, Principles of effective communication.		
UNIT – V	**CONTROLLING**	**9 Periods**
Steps in a Control Process, Need for control system, Benefits of Control, Feedback loop of Management control – Types of Control techniques - Overall and Preventive control.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS :

1	*Harold Koontz, Weihrich, **“Essential of Management”,** 11th Edition, Tata McGraw Hill New Delhi 2020.*
2	*Tripathy P.C and Reddy P.N “**Principles of Management**”, 7th Edition, McGraw Hill 2021.*

REFERENCES:

1	*Joseph Massie, **“Essentials of Management”,** Prentice Hall of India, New Delhi 2010.*
2	*Prasad, L.M., **“Principles and Practice of Management”,** Sultan Chand and Sons, New Delhi 2010.*
3	*Stoner, Freeman and Gilbert, **Management**, 6th Edition, Pearson Education, New Delhi, 2018*
4	*R.K. Chopra and Puneet Mohan, **“Principles & Practice Of Management”,** Sun India Publications, 2020.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Explain basic terminology and concepts for Management theory.	**K2**
CO2	Handle planning and decision making under uncertainity.	**K3**
CO3	Demonstrate the ability to apply selected Management frameworks to real world business situations for problem-solving purposes.	**K3**
CO4	Illustrate the leadership theories and effective communication.	**K2**
CO5	Demonstrate business caliber online communications and proficient participation in group discussion forums.	**K2**

COURSE ARTICULATION MATRIX:

a)CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	2	3	3	3	3	3	1	2	1	-	-
CO2	-	-	-	-	2	3	3	3	2	3	1	3	1	-	-
CO3	-	-	-	-	-	2	3	3	3	-	-	3	1	2	1
CO4	-	-	-	-	2	3	3	-	3	2	1	-	1	2	-
CO5	-	-	-	-	2	-	3	3	3	3	1	2	1	-	1
22LHS706	**-**	**-**	**-**	**-**	**2**	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b)CO and Key Performance Indicators Mapping

CO1	5.1.1,5.1.2,6.1.1,6.2.1, 7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,9.2.2,9.2.3,10.1.1,10.1.2,10.2.1,10.2.2,12.1.1,12.1.2, 12.2.1,12.2.1,12.3.1,12.3.2
CO2	5.1.1,5.1.2,5.2.1,5.2.2,6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,10.1.1, 10.1.2,10.2.1,10.2.2,12.1.1,12.1.2,12.2.1,12.2.1,12.3.1,12.3.2
CO3	5.1.1,5.1.2,5.2.1,5.2.2,6.1.1,6.2.1, 7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.19.1.2,9.2.1,9.2.2,9.2.3,10.1.1, 10.1.2,10.2.1,10.2.2,12.1.1,12.1.2,12.2.1,12.2.1,12.3.1,12.3.2
CO4	5.1.1,5.1.2,5.2.1,5.2.2,6.1.1,6.2.1, 7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3, 10.1.1,10.1.2,10.2.1,10.2.2,12.1.1,12.1.2,12.2.1,12.2.1,12.3.1,12.3.2
CO5	5.1.1, 5.1.2, 5.2.1, 5.2.2,6.1.1, 6.2.1, 7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,9.2.2,9.2.3,10.1.1,10.1.2,10.2.1,10.2.2, 12.1.1,12.1.2,12.2.1,12.2.1,12.3.1,12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	40	30			100
CAT2	10	30	30	30			100
Assignment 1	10	20	40	30			100
Assignment 2	10	30	30	30			100
Quiz 1	30	40	30				100
Quiz 2	20	50	30				100
Other mode of internal assessments, if any							
ESE	10	20	30	40			100

22LPC725	MICROWAVE AND RF ENGINEERING	SEMESTER VII

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objective	To analyze the microwave networks behavior, understand the function of microwave active and passive devices and acquire knowledge on matching networks and RF amplifiers.	
UNIT – I	**MICROWAVE SOURCES AND AMPLIFICATION**	**9 Periods**
Microwave frequencies (IEEE Standards) – High frequency limitations of conventional tubes - Microwave Vacuum Tubes: Reflex Klystron Oscillator – Two cavity Klystron amplifier –TWT amplifier - Active RF Devices: Gunn effect diode - Gunn Oscillator – Tunnel diode – Schottky diode- PIN diode - Varactor diode		
UNIT – II	**MICROWAVE NETWORK ANALYSIS AND PASSIVE DEVICES**	**9 Periods**
S-Parameters - Formulation of Scattering (S) matrix - Properties of S parameters -Testing of reciprocal and lossless networks – Properties of ferromagnetic materials, principle of faraday's rotation, isolator, circulator and phase Shifter.		
UNIT – III	**MICROWAVE POWER DIVIDERS**	**9 Periods**
S-matrix analysis of E-Plane Tee, H-Plane Tee, Magic Tee, Two-hole directional coupler. T junction and resistive power divider, branch line coupler (equal & unequal), Rat Race Coupler. Microstrip transmission Lines: effective dielectric constant-characteristic impedance-losses-Quality factor.		
UNIT – IV	**IMPEDANCE MATCHING AND TUNING**	**9 Periods**
Smith chart – Concept of impedance matching -Quarter-wave transformer - Smith Chart solutions to matching with lumped elements (L networks), Micro strip Line Matching Networks, single stub tuning.		
UNIT – V	**RF AMPLIFIERS AND MEASUREMENTS**	**9 Periods**
Characteristics of amplifier, Two port power gains, stability of amplifier-Test for stability - design of single stage amplifier for maximum gain - Introduction to Mixers. Microwave measurements: Guide wavelength, frequency, impedance and VSWR. Case Study: Microwave Oven		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS:

1	*David M. Pozar, "**Microwave Engineering**", Wiley India (P) Ltd, New Delhi, 4th edition, 2012.*
2	*Annapurna Das and Sisir K Das, "**Microwave Engineering**", Tata McGraw Hill Publishing Company Ltd, New Delhi, 2017.*

REFERENCES:

1	*Samuel Y. Liao, "**Microwave Devices and Circuits**", Prentice Hall of International Ltd, 4th edition, 2009.*
2	*Reinhold Ludwig and Gene Bogdanov, "**RF Circuit Design: Theory and Applications**", Pearson Education Inc., 2nd edition, 2011.*
3	*S. Rao, "**Microwave Engineering**", Prentice Hall of India, 2nd edition, 2015.*
4	*Thomas H Lee, "**Planar Microwave Engineering: A Practical Guide to Theory, Measurements and Circuits**", Cambridge University Press, 2004.*
5	*Robert E Colin, "**Foundations for Microwave Engineering**", John Wiley & Sons, 2010*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the various sources of microwave generation and amplification procedures.	K2
CO2	Formulate S matrix of microwave components and test for its various properties	K3
CO3	Discuss the function and role of microwave power divider networks	K2
CO4	Design impedance matching networks using Smith chart	K4
CO5	Describe the operation of RF amplifiers and discuss the procedure of microwave measurements.	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LPC725	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40		40			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	40				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40		40			100
ESE	20	30	20	30			100

22LPC726	WIRELESS COMMUNICATION	SEMESTER VII

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	3	0	0	3

Course Objective	To understand the Cellular Architecture, concept behind mobile propagation, various multipath mitigation techniques, multi antenna and Wireless systems.	
UNIT – I	**CELLULAR ARCHITECTURE**	**9 Periods**
Introduction to 2G Cellular Networks and 3G Wireless Networks – Cellular Concept: Introduction – Frequency Reuse – Channel Assignment Strategies – Handoff Strategies – Interference and System Capacity – Trunking and Grade of Service – Improving Coverage and Capacity in Cellular Systems. Multiple Access Techniques: FDMA, TDMA, CDMA, OFDMA.		
UNIT – II	**MOBILE RADIO PROPAGATION**	**9 Periods**
Free Space Propagation Model –Reflection – Ground Reflection Model – Diffraction – Scattering – Practical Link Budget Design – Small Scale Multipath Propagation – Time dispersion Parameters – Coherence Bandwidth – Doppler Spread and Coherence Time – Fading Effects due to Multipath Time Delay Spread and Doppler Spread.		
UNIT – III	**MULTIPATH MITIGATION TECHNIQUES**	**9 Periods**
Equalization – Adaptive Equalizer – Linear and Nonlinear Equalization – Zero Forcing Algorithm – LMS Algorithm – Recursive Least Square Algorithm – Diversity: Micro and Macro Diversity – Combination of Signals – Error Probability in Fading Channels with Diversity Reception – RAKE Receiver.		
UNIT – IV	**MULTIANTENNA SYSTEMS**	**9 Periods**
Smart Antennas - Multiple Input Multiple Output Systems - System Model - Channel State Information - Capacity - Impact of the Channel Layered Space Time Structure - Diversity -Tradeoffs between Diversity, Beamforming Gain and Spatial Multiplexing - Multiuser MIMO - Performance Limits - Scheduling - Linear Precoding – Uplink and Downlink - Closed-Loop Systems and Quantized Feedback - Base Station Cooperation - NOMA in Single input single output and Multi input and Multi Output Systems.		
UNIT – V	**WIRELESS SYSTEMS**	**9 Periods**
Global System for Mobile Communications - System Overview - Air Interface - Logical and Physical Channel – Synchronization – Coding - Establishing a Connection and Handover - WiMAX/IEEE 802.16 - System Overview - Modulation and Coding - Logical and Physical Channels - Multiple-Antenna Techniques - Link Control - Wireless Local Area Network – Introduction to 4G and 5G communication systems.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45Periods**		

TEXT BOOKS:

1	*Rappaport,T.S., "**Wireless communications**", Second Edition, Pearson Education, 2010.*
2	*Andreas.F. Molisch, "**Wireless Communications**", Second Edition, John Wiley, India, 2011.*

REFERENCES:

1	*Simon Haykin, Michael Moher, David Koilpillai, **"Modern Wireless Communications"**,First Edition, Pearson Education 2013.*
2	*David Tse and Pramod Viswanath, "**Fundamentals of Wireless Communication**", Cambridge University Press, 2005.*
3	*Jochen Schiller, **"Mobile Communications**", Second Edition, Pearson Education 2012*
4	*Upena Dalal, **"Wireless Communication**", Oxford University Press, 2009.*
5	*Vincent W. S. Wong, Robert Schober, Derrick Wing Kwan Ng, Li-Chun Wang, **"Key Technologies for 5G Wireless Systems",** Cambridge University Press, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Characterize wireless channels and understand the concept of cellular system	K3
CO2	Describe the mobile radio propagation.	K2
CO3	Compare multipath mitigation techniques and interpret their performance	K3
CO4	Design and implement systems with transmit/receive diversity and MIMO systems and analyze their performance	K2
CO5	Conversant with the latest trends in Wireless Systems.	K2

COURSE ARTICULATION MATRIX

a)CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
CO1	3	3	1	1	-	-	-	-	-	1	-	2	2	1	1
CO2	3	3	1	2	-	-	-	-	-	1	-	3	2	2	2
CO3	3	3	2	2	-	-	-	-	-	1	-	3	3	2	2
CO4	3	3	2	1	-	-	-	-	-	1	-	3	3	2	2
CO5	3	3	1	-	-	-	-	-	-	1	-	3	2	1	1
22LPC726	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**3**	**2**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.1.1, 4.3.3, 4.3.4, 10.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 3.1.1, 3.1.6, 4.1.1, 10.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.1.1, 10.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 4.1.1, 10.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1,12.3.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.1, 3.2.3, 4.1.1, 4.1.4, 7.1.1, 10.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20				100
CAT2	40	40	20				100
Assignment 1	30	30	40				100
Assignment 2	30	30	40				100
Quiz 1	30	30	40				100
Quiz 2	30	30	40				100
ESE	40	40	20				100

22LPC727	ADVANCED COMMUNICATION SYSTEMS LABORATORY	SEMESTER VII

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PC	0	0	4	2

Course Objective	To acquire knowledge on Gunn diode characteristics, characteristics of Klystron tube; study the various parameters of Microwave components and VSWR measurement, learn Spectrum Analyzer measurement, simulate microstrip antenna radiation characteristics and learn RFcharacterization using Network analyzer.
PRACTICALS	**List of Experiments:** 1. Determination of Gunn Diode Characteristics. 2. Determination of Mode Characteristics of a ReflexKlystron. 3. Characteristics of circulator, directional couplers and magic tee. 4. Measurement of frequency, guide wavelength, unknown impedance,VSWR and Reflection coefficient. 5. Design and Simulation of monopole and dipole antennas using EMSolver tool. 6. Design and Simulation of microstrip antennas using EM Solver tool 7. Design and Simulation of antenna arrays using EM Solver tool. 8. Parametric measurement of RF devices using Network Analyzer. 9. Study the performance of RF transmitter and receiver link usingSpectrum analyzer 10. Study of propagation and bending loss in optical fiber 11. Measurement of numerical aperture of optical fiber 12. Characteristics of LED and photo detector 13. V-I and P-I characteristics of LASER diode
Contact Periods: **Lecture: 0 Periods**	**Tutorial: 0 Periods** **Practical: 60 Periods** **Total: 60 Periods**

REFERENCES:

1	*David M. Pozar, "**Microwave Engineering**", Wiley India (P) Ltd, New Delhi, 4th edition, 2012.*
2	*Annapurna Das and Sisir K Das, "**Microwave Engineering**", Tata McGraw Hill Publishing Company Ltd, New Delhi, 2017.*
3	*John D Kraus, Ronald J Marhefka. "**Antennas and Wave Propagation**", 4th edition,Tata McGrawHill, 2013.*
4	*Microwave Engineering Laboratory manual of ECE Department of GCT.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Measure GUNN diode and Klystron Mode characteristics.	K4
CO2	Measure characteristics of microwave passive components	K4
CO3	Perform parametric measurements using spectrum and network analyzers	K4
CO4	Simulate and analyze microstrip antennas and arrays	K4
CO5	Measure the characteristics of optical fiber and laser.	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PS O3**
CO1	3	2	1	1	-	-	-	-	3	-	-	1	3	1	1
CO2	3	2	1	1	-	-	-	-	3	2	-	2	3	1	1
CO3	3	3	1	1	2	-	-	-	3	2	-	2	3	1	1
CO4	3	3	1	1	2	-	-	-	3	2	-	2	3	1	1
CO5	3	3	1	1	-	-	-	-	3	-	-	1	3	1	1
22LPC727	**3**	**3**	**1**	**1**	**2**	**-**	**-**	**-**	**3**	**2**	**-**	**2**	**3**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.3.1, 1.4.1,2.1.2, 2.2.2, 2.3.1,2.4.1,3.1.6,3.2.2,3.2.3, 3.3.1,3.3.2,3.4.1, 4.2.2,4.3.1, 12.2.2.
CO2	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1 .3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2
CO3	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1 .3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2
CO4	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1 .3,4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2
CO5	1.3.1,1.4.1,2.1.2.2.1,2.2.3,2.3.1,2.4.4,3.1.3,3.1.6, 3 .2.3, 3.3.2, 4.1.2, 4.2.1,4.3.1,6.1.1, 10.3.1,11.2.1, 12.1.1,12.2.2,12.3.2

22LEE701	ENGINEERING PROJECTS IN COMMUNITY SERVICE	SEMESTER VII

PREREQUISITES	CATEGORY	L	T	P	C
ENGINEERING EXPLORATION FOR ELECTRONICS ENGINEER LATERAL AND DESIGN THINKING	EEC	0	0	4	2

Course Objective	To provide an environment where teams of students can exercise their engineering skills by being exposed to realistic systems and customers and at the same time helping their community.
Problem identification – Identifying the issues within the community **-**Preliminary survey - Preparing a questionnaire, formats and survey forms. - A preliminary survey including the socio-economic conditions of the allotted habitation - Different types of surveys, tools and techniques for collecting the information. - Analysis of collected data and mapping of issues with the solutions available. - Based on the survey and the specific requirements of the habitation, Community Awareness Campaigns – Identifying the factors – Normalization of factors and finding the path way for problem solution – Selection of problem from the community and mapping of issues - Planning for working: Aim, objective and scope, time line - Application of engineering knowledge and tools for solutions Validation of the solution by supervising the execution of solution - Measuring the attainment of the solution: Feedback from community	
Contact periods: **Lecture: 0 Period Tutorial: 0 Period Practical: 60 Periods Total: 60 Periods**	

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify engineering related problems in the community.	K2
CO2	Analyze and Design different solutions to solve the problems of community.	K4
CO3	Apply economical solution to those problems in the field.	K4
CO4	To understand complexity and ambiguity	K1
CO5	Connections with professionals and community members for learning and career opportunities	K2

COURSE ARTICULATION MATRIX:

CO and PO Mapping

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	-	2	2	-	1	2	1	-	2	-	1	-	1	1	1
CO2	-	2	2	-	1	2	1	-	2	-	1	-	1	1	1
CO3	-	2	2	-	1	2	1	-	2	-	1	-	1	1	1
CO4	-	2	2	-	1	2	1	-	2	2	1	-	1	1	1
CO5	-	2	2	-	1	2	1	-	2	2	1	-	1	1	1
22LEE701	-	**2**	**2**	-	**1**	**2**	**1**	-	**2**	-	**1**	-	**1**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

22LEE802	CAPSTONE PROJECT	SEMESTER VIII

PREREQUISITES	CATEGORY	L	T	P	C
ENGINEERING EXPLORATION FOR ELECTRONICS ENGINEER LATERAL AND DESIGN THINKING ENGINEERING PROJECTS IN COMMUNITY SERVICE	EEC	0	0	16	8

Course Objective	To expose students to work on real time problems and challenges independently and develop the technical dissertation presentation and writing

Contact periods:
Lecture: 0 Period   Tutorial: 0 Period   Practical: 240 Periods   Total: 240 Periods

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify the problems and challenges in real time scenario as a team.	K2
CO2	Reviewing the relevant literature and specify the methodology and requirements.	K2
CO3	Design and develop the innovative methodology with relevant Hardware/Software for sustainable environment.	K3
CO4	Implement, demonstrate, interpret the results with presentation and report writing ethically.	K4
CO5	Establish compatibility, adaptability with developing methodology and technology	K5

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	1	1	2	2	3	-	-	3	3	-	3	2	2	3
CO2	1	1	-	1	2	-	-	-	3	3	-	2	1	1	2
CO3	3	-	3	3	3	2	3	-	3	3	-	3	3	2	3
CO4	3	1	1	2	1	2	2	3	3	3	3	3	2	1	3
CO5	1	1	1	1	-	3	3	1	-	-	3	3	1	1	1
22LEE802	2	1	1	2	2	2	2	1	2	2	1	3	2	1	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 3.1.1, 3.1.2, 3.1.6, 4.1.1, 4.1.4, 4.2.1, 5.1.1, 5.2.1, 5.3.1, 6.1.1, 6.2.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1,2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.2.1, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 4.1.2, 5.1.1, 5.2.1, 5.3.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1,2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, , 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2,9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1,2, 10.1.3, 10.2.1, 0.2.2, 10.3.1, 10.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 2.4.2, 2.4.3, 2.4.4, 3.4.2, 4.3.2, 4.3.3, 4.3.4, 5.3.1, 5.3.2, 6.2.1, 7.1.1, 7.1.2, 8.1.1, 8.2.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1,2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.4.1, 2.2.3, 2.2.4, 3.3.2, 4.3.4, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 11.1.1, 11.1.2, 11.2.1, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

VERTICALS -I
HIGH SPEED COMMUNICATIONS

22LPE$01	INFORMATION THEORY AND CODING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To study the several source coding, techniques, entropy in the context of data compression and Network information theory.	
UNIT – I	**QUANTITATIVE STUDY OF INFORMATION**	**9 Periods**
Basic inequalities, Entropy, Kullback - Leibler distance, Mutual information, Bounds on entropy,Fisher information, Cramer Rao inequality, Second law of thermodynamics, Sufficient statistic, Entropy rates of a Stochastic process.		
UNIT – II	**SOURCE CODING: TEXT, AUDIO AND SPEECH**	**9 Periods**
Text: Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm – Audio: Perceptual coding, Masking techniques, Psychoacoustic model, MEG Audio layers I,II,III, Dolby AC3 - Speech: Channel Vocoder, Linear Predictive Coding.		
UNIT – III	**COMPRESSION TECHNIQUES**	**9 Periods**
Principles – Text compression – Static Huffman Coding – Dynamic Huffman coding – Arithmetic coding – Image Compression – Graphics Interchange format – Tagged Image File Format –Digitized documents – Introduction to JPEG standards		
UNIT – IV	**AUDIO AND VIDEO CODING**	**9 Periods**
Linear Predictive coding – code excited LPC – Perceptual coding, MPEG audio coders – Dolby audio coders – Video compression – Principles – Introduction to H.261 & MPEG Video standards.		
UNIT – V	**NETWORK INFORMATION THEORY**	**9 Periods**
Gaussian multiple user channels, Multiple access channel, Encoding of correlated sources,Broadcast channel, Relay channel, Source coding and rate distortion with side information,General multi-terminal networks.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS :

1	R Bose, “*Information Theory, Coding and Cryptography*”, TMH 2007.
2	Fred Hassall, “*Multimedia Communications: Applications, Networks, Protocols and Standards*”, Pearson Education Asia, 2002

REFERENCES:

1	K Sayood, “*Introduction to Data Compression*” 3/e, Elsevier 2006..
2	S Gravano, “*Introduction to Error Control Codes*”, Oxford University Press 2007
3	Amitabha Bhattacharya, “*Digital Communication*”, TMH 2006
4	Thomas Cover, Joy Thomas, *"Elements of Information Theory",* Wiley, 2006.
5	David Mackay,*"Information Theory, Interference &Learning Algorithms*", Cambridge University,Press, Ist Edition, 2002.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Discuss the basic information theoretic concepts	K2
CO2	Apply the fundamentals of information theory to source coding	K3
CO3	Summarize the principle of compression techniques	K2
CO4	Explain the concepts of audio and video coder	K2
CO5	Describe the fundamentals of Network information theory	K2

COURSE ARTICULATION MATRIX:

a)CO and PO Mapping

Cos /POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO12	PSO1	PSO2	PSO 3
CO1	3	3	1	2	-	-	-	-	-	1	-	3	2	2	2
CO2	3	3	1	2	-	-	-	-	-	1	-	3	2	2	2
CO3	3	3	1	2	-	-	-	-	-	1	-	3	2	2	2
CO4	3	3	1	2	-	-	-	-	-	1	-	3	2	2	2
CO5	3	3	1	2	-	-	-	-	-	1	-	3	2	2	2
22LPE$01	**3**	**3**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**3**	**2**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.3.3, 4.3.4, 10.1.1, 12.1.1,12.1.2, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.3.3, 4.3.4, 10.1.1, 12.1.1,12.1.2, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.3.3, 4.3.4, 10.1.1, 12.1.1,12.1.2, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.3.3, 4.3.4, 10.1.1, 12.1.1,12.1.2, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.3.3, 4.3.4, 10.1.1, 12.1.1,12.1.2, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	50	20				100
CAT2	30	50	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	40	20				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	60	20				100
ESE	40	40	20				100

22LPE$02	HIGH SPEED NETWORKS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To highlight the features of different technologies involved in High Speed networking and their performance	
UNIT – I	**HIGH SPEED NETWORKS**	**9 Periods**
Frame Relay Networks – Asynchronous transfer mode – ATM Protocol Architecture, ATM logical Connection, ATM Cell – ATM Service Categories – AAL, High Speed LANs: Fast Ethernet, Gigabit Ethernet, Fiber Channel – Wireless LANs: applications, requirements – Architecture of 802.11		
UNIT – II	**CONGESTION AND TRAFFIC MANAGEMENT**	**9 Periods**
Queuing Analysis- Queuing Models – Single Server Queues – Effects of Congestion – Congestion Control – Traffic Management – Congestion Control in Packet Switching Networks – Frame Relay Congestion		
UNIT – III	**TCP AND ATM CONGESTION CONTROL**	**9 Periods**
TCP Flow control – TCP Congestion Control – Retransmission – Timer Management – Exponential RTO backoff – KARN's Algorithm – Window management – Performance of TCP over ATM. Traffic and Congestion control in ATM – Requirements – Attributes – Traffic Management Frame work, Traffic Control – ABR traffic Management – ABR rate control, RM cell formats, ABR Capacity allocations – GFR traffic management.		
UNIT – IV	**INTEGRATED AND DIFFERENTIATED SERVICES**	**9 Periods**
Integrated Services Architecture – Approach, Components, Services- Queuing Discipline, FQ, PS, BRFQ, GPS, WFQ – Random Early Detection, Differentiated Services.		
UNIT – V	**PROTOCOLS FOR QOS SUPPORT**	**9 Periods**
RSVP – Goals and Characteristics, Data Flow, RSVP operations, Protocol Mechanisms –Multiprotocol Label Switching – Operations, Label Stacking, Protocol details – RTP –Protocol Architecture, Data Transfer Protocol, RTCP.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*William Stallings, **"HIGH SPEED NETWORKS AND INTERNETS"**, Pearson Education, Second Edition, 2002.*
2	*Irvan Pepelnjk, Jim Guichard, Jeff Apcar, **"MPLS and VPN architecture",** Cisco Press, Volume 1 and 2, 2003.*

REFERENCES:

1	*Jean warland and Pravin Wadaja, **"High Performance Communication Networks"**, 2nd Edition, Jean Harcourt Asia Pvt. Ltd.,2001.*
2	*Andrew S. Tanenbaum, "Computer networks", PHI Private limited, new Delhi*
3	*Abhijit S. Pandya, Ercan Sea, **"ATM Technology for Broad Band Telecommunication Networks",** CRC Press, New York, 2004.*
4	*Tere Parnell, **"Guide to Building High-speed Networks",** Osborne/McGraw-Hill, 1998, 0072119578, 9780072119572.*
5.	*Sumit Kasera, Pankaj Sethi, **" ATM Networks",** Tata Mc Graw- Hill, New Delhi , 2000*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Familiarize about ATM and Frame relay	K2
CO2	Discuss the effects of congestion and identify the different Queueing models	K3
CO3	Identify techniques to support real-time traffic and congestion control	K2
CO4	Describe the integrated and differentiated services	K2
CO5	Interpret protocols for different levels of quality of service (QoS)	K1

COURSE ARTICULATION MATRIX:

a)CO and PO Mapping														
Cos /POs	**PO 1**	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	2	2	1	-	-	-	-	-	-	-	-	2	2	1	1
CO2	3	2	1	-	-	-	-	-	-	-	-	1	2	1	-
CO3	3	2	1	-	-	-	-	-	-	-	-	1	2	1	-
CO4	2	1	1	-	-	-	-	-	-	-	-	1	2	1	-
CO5	2	1	1	-	-	-	-	-	-	-	-	1	2	1	-
22LPE$02	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	1
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.1, 2.2.2,2.2.3, ,2.3.1, 3.1.1, 3.1.4, 12.1.1, 12.2.1, 12.2.2, 12.3.1
CO2	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.3.1, 2.4.4, 3.1.1, 3.1.6, 3.3.1, 12.1.1, 12.2.1, 12.2.2, 12.3.1
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.3.1, 2.4.4, 3.1.1, 3.1.6, 3.3.1, 12.1.1, 12.2.1, 12.2.2, 12.3.1
CO4	1.1.1, 1.4.1, 2.3.1, 2.3.2, 3.1.6, 3.3.1, 3.4.2, 12.1.1, 12.2.1, 12.2.2, 12.3.1
CO5	1.1.1, 1.4.1, 2.3.1, 2.3.2, 3.1.6, 3.3.1, 3.4.2, 12.1.1, 12.2.1, 12.2.2, 12.3.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	30	60	10				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	40	20				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	60	20				100
ESE	40	40	20				100

22LPE$03	ERROR CONTROL CODING

PREREQUISITES	CATEGORY	L	T	P	C
DIGITAL COMMUNICATION	PE	3	0	0	3

Course Objective	To provide a comprehensive introduction to error correction coding, including both classical block- and trellis-based codes and the recent developments in Space time codes, iteratively decoded codes such as turbo codes and low-density parity-check codes.	
UNIT – I	**LINEAR BLOCK CODES AND CONVOLUTIONAL CODES**	**9 Periods**
Review of modern algebra - Galois fields - Linear block codes - encoding and decoding - Cyclic codes - Nonbinary codes. Convolutional codes - Generator sequences - Structural properties - ML decoding - Viterbi decoding- Sequential decoding.		
UNIT – II	**LDPC CODES**	**9 Periods**
LDPC Codes: Construction and Notation - Tanner Graph - Decoding of LDPC Codes - EXIT Chart for LDPC codes - Irregular LDPC codes - LDPC codes in 5G.		
UNIT – III	**TRELLIS CODES**	**9 Periods**
Modulation codes - Trellis coded modulation - Lattice type Trellis codes - Geometrically uniform trellis codes - Decoding of modulation codes.		
UNIT – IV	**TURBO CODES**	**9 Periods**
Turbo codes - Turbo decoder – Interleaver - MAP and log MAP decoders – Iterative turbo decoding - Optimum decoding of turbo codes.		
UNIT – V	**SPACE TIME CODES**	**9 Periods**
Space-time codes - MIMO systems - Space-time block codes (STBC) – decoding of STBC-Space-time trellis codes-Decoding of Space-time Trellis codes.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*S.Lin&D.J.Costello, "**Error Control Coding (2/e)**", Pearson, 2005.*
2	*Tood.K.Moon "**Error Correcting Codes**" A John Wiley &Sons, INC, Publication*

REFERENCES:

1	*B.Vucetic&J.Yuan, "**Turbo codes**", Kluwer, 2000.*
2	C.B.Schlegel&L.C.Perez, "**Trellis and Turbo Coding**", Wiley,2004.
3	*B.Vucetic&J.yuan, "**Space-Time Coding**", Wiley, 2003.*
4	*H. Jafarkhani, **"Space-time coding: Theory & Practice"**, Cambridge University Press, 2005.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Examine the arithmetic of Galois fields as well as linear block, cyclic, and convolutional codes	K3
CO2	Discuss the construction of LDPC codes	K2
CO3	Explain the encoding and decoding of Trellis coded modulation	K2
CO4	Apply the encoding and decoding methods of Turbo codes	K3
CO5	Apply the encoding and decoding methods of Space time codes	K3

COURSE ARTICULATION MATRIX:

CO and PO Mapping														
Cos /POs	**PO 1**	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	2	-	-	-	-	-	1	-	3	2	2	2
CO2	3	3	1	2	-	-	-	-	-	1	-	3	2	2	2
CO3	3	3	1	2	-	-	-	-	-	1	-	3	2	2	2
CO4	3	3	1	2	-	-	-	-	-	1	-	3	2	2	2
CO5	3	3	1	2	-	-	-	-	-	1	-	3	2	2	2
22LPE$03	**3**	**3**	**1**	**2**	-	-	-	-	-	**1**	-	**3**	**2**	**2**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.3.3, 4.3.4, 10.1.1, 12.1.1,12.1.2, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.3.3, 4.3.4, 10.1.1, 12.1.1,12.1.2, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.3.3, 4.3.4, 10.1.1, 12.1.1,12.1.2, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.3.3, 4.3.4, 10.1.1, 12.1.1,12.1.2, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1,2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.3.3, 4.3.4, 10.1.1, 12.1.1,12.1.2, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	50	20				100
CAT2	30	50	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	40	30				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	40	30				100
ESE	40	40	20				100

22LPE$04	ADHOC AND WIRELESS SENSOR NETWORKS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	OBJECTIVES: To learn about the issues and challenges in the design of wireless Adhoc networks and sensor networks.	
UNIT – I	**MAC AND ROUTING IN ADHOC NETWORKS**	**9 Periods**
Introduction – Issues and challenges in Adhoc networks – MAC Layer Protocols for wireless Adhoc networks – Contention-Based MAC protocols – MAC Protocols Using Directional Antennas – Multiple-Channel MAC Protocols – Power-Aware MAC Protocols – Routing in Adhoc Networks – Design Issues – Proactive, Reactive and Hybrid Routing Protocols.		
UNIT – II	**TRANSPORT AND QOS IN ADHOC NETWORKS**	**9 Periods**
TCP challenges and Design Issues in AdHoc Networks – Transport protocols for Adhoc networks – Issues and Challenges in providing QoS – MAC Layer QoS solutions – Network Layer QoS solutions – QoS Model.		
UNIT – III	**MAC AND ROUTING IN WIRELESS SENSOR NETWORKS**	**9 Periods**
Introduction – Applications – Challenges – Sensor network architecture – MAC Protocols for wireless sensor networks – Low duty cycle protocols and wakeup concepts – Contention- Based protocols – Schedule-Based protocols – IEEE 802.15.4 Zigbee – Topology Control – Routing Protocols.		
UNIT – IV	**TRANSPORT AND QOS IN WIRELESS SENSOR NETWORKS**	**9 Periods**
Data-Centric and Contention-Based Networking – Transport Layer and QoS in Wireless Sensor Networks – Congestion Control in network processing – Operating systems for wireless sensor networks – Examples.		
UNIT – V	**SECURITY IN ADHOC AND SENSOR NETWORKS**	**9 Periods**
Security Attacks – Key Distribution and Management – Intrusion Detection – Software based Anti-tamper techniques – Water marking techniques – Defence against routing attacks - Secure Adhoc routing protocols – Broadcast authentication WSN protocols – TESLA – Biba – Sensor Network Security Protocols – SPINS.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*C. Siva Ram Murthy and B. S. Manoj, **"Ad Hoc Wireless Networks Architectures and Protocols"**, Pearson Education, 2006*
2	*HolgerKarl , Andreas willig,**"Protocol and Architecture for Wireless Sensor Networks",** John wiley publication, Jan 2005.*

REFERENCE BOOKS:

1	*Subir Kumar Sarkar, T G Basavaraju, C Puttamadappa, **"Ad Hoc Mobile Wireless Networks",**Auerbach Publications, 2008.*
2	*Carlos De MoraisCordeiro, Dharma PrakashAgrawal, **"Ad Hoc and Sensor Networks: Theory and Applications",** World Scientific Publishing,(2nd Edition) 2011.*
3	*WaltenegusDargie, Christian Poellabauer, **"Fundamentals of Wireless Sensor Networks Theory and Practice",** John Wiley and Sons, 2010*
4	*Xiang-Yang Li ,**"Wireless Ad Hoc and Sensor Networks: Theory and Applications"**, 7th edition, Cambridge university Press,2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Describe MAC protocols and Routing in Adhoc networks	K2
CO2	Discuss Transport layer protocols and QOS in Adhoc networks	K3
CO3	Explain MAC protocols and Routing in Sensor networks	K2
CO4	Discuss Transport layer protocols and QOS in Sensor networks	K3
CO5	Identify the possible security issues in Adhoc and sensor networks	K2

COURSE ARTICULATION MATRIX:

CO and PO Mapping														
COs/POs	**PO 1**	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	2	2	1	-	-	-	-	-	-	-	2	2	2	1	1
CO2	2	1	1	-	-	-	-	-	-	-	2	2	2	1	1
CO3	2	2	1	-	-	-	-	-	-	-	2	2	2	1	1
CO4	2	1	1	-	-	-	-	-	-	-	2	2	2	1	1
CO5	2	1	1	1	-	2	3	2	-	-	-	3	2	1	1
22LPE$04	**2**	**1**	**1**	**1**	**-**	1	**1**	**1**	**-**	**-**	**2**	**2**	**2**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.2.3, 2.2.4, 2.3.2, 3.1.1, 3.1.5, 3.1.6, 11.1.1, 11.2.1, 12.1.1, 12.1.2, 12.3.1
CO2	1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.2.2, 2.3.2, 3.1.4, 3.2.3, 11.1.1, 11.2.1, 12.1.1, 12.1.2, 12.3.1
CO3	1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.2.3, 2.2.4, 2.3.2, 3.1.4, 3.1.5, 3.1.6, 11.1.1, 11.2.1, 12.1.1, 12.1.2, 12.3.1
CO4	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.2, 2.3.2, 3.1.4, 3.2.3, 11.1.1, 11.2.1, 12.1.1, 12.1.2, 12.3.1
CO5	1.1.1, 1.2.1, 1.4.1, 2.1.1, 3.1.1, 3.1.5, 4.1.1, 6.1.1, 7.1.1, 7.1.2, 7.2.2, 8.1.1, 8.2.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	20	60	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	40	30				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	40	30				100
ESE	30	50	20				100

22LPE$05	**SOFTWARE DEFINED RADIO**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objectives	To provide a comprehensive introduction to Software Defined Radio and Cognitive Radio concepts	
UNIT – I	**INTRODUCTION TO SOFTWARE-DEFINED RADIO AND COGNITIVE RADIO**	**9 Periods**
Evolution of Software Defined Radio (SDR) and Cognitive radio: goals, benefits, definitions, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations.		
UNIT – II	**SDR ARCHITECTURE**	**9 Periods**
Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules.		
UNIT – III	**COGNITIVE RADIO BASICS**	**9 Periods**
Marking radio self-aware, cognitive techniques – position awareness, environment awareness in Cognitive radios, optimization of radio resources, Artificial Intelligence Techniques.		
UNIT – IV	**COGNITIVE RADIO ARCHITECTURE**	**9 Periods**
Cognitive Radio - functions, components and design rules, Cognition cycle - orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on SDR Architecture.		
UNIT – V	**NEXT GENERATION WIRELESS NETWORK**	**9 Periods**
XG Network architecture, spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Joseph MitolaIII,"**Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering**", John Wiley & Sons Ltd. 2000.*
2	*Bruce A. Fette, "**Cognitive Radio Technology**", Elsevier, 2009.*

REFERENCES:

1	Simon Haykin, "***Cognitive Radio: Brain –Empowered Wireless Communications***", IEEE Journal on selected areas in communications, Feb 2005.
2	Thomas W.Rondeau, Charles W. Bostain, "***Artificial Intelligence in Wireless Communication***", ARTECH HOUSE .2009.
3	Markus Dillinger, Kambiz Madani, Nancy Alonistioti, "***Software Defined Radio***", John Wiley, 2003.
4	Huseyin Arslan, "***Cognitive Radio, SDR and Adaptive System***", Springer, 2007.
5	Alexander M. Wyglinski, Maziarnekovee, Y. Thomas Hu, "***Cognitive Radio Communication and Networks***", Elsevier, 2010.
6	Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, ShantidevMohanty, "***Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey***" Elsevier Computer Networks, May 2006.

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Summarize requirements, benefits for Software Defined Radio and Cognitive Radio	K2
CO2	Describe the architecture of SDR	K2
CO3	Explain the basics of Cognitive radio	K2
CO4	Discuss the architecture of Cognitive radio	K3
CO5	Explain the wireless networks based on Cognitive radios	K2

COURSE ARTICULATION MATRIX:

CO and PO Mapping															
COs/POs	**PO 1**	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	1	1	1	1	-	-	-	-	-	-	-	3	1	1	1
CO2	1	2	1	2	-	-	-	-	-	-	-	3	1	1	2
CO3	2	1	1	2	-	2	1	-	-	-	-	3	2	1	2
CO4	1	2	1	2	-	-	-	-	-	-	-	3	1	1	2
CO5	1	2	1	1	-	2	-	-	-	-	-	3	1	1	1
22LPE$05	**1**	**2**	**1**	**2**	**-**	**1**	1	**-**	**-**	**-**	**-**	**3**	**1**	**1**	**2**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.4.1, 2.1.1, 2.2.2, 2.2.3, 2.3.2, 3.1.1, 3.1.4, 4.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1
CO2	1.4.1, 2.1.1, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 3.1.1, 3.2.1, 3.1.4, 4.1.2, 4.1.3, 4.2.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1
CO3	1.1.2, 1.4.1, 2.1.1, 2.2.2, 2.2.3, 2.3.2, 3.1.1, 4.1.1, 4.1.2, 4.2.2, 6.2.1, 7.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1
CO4	1.3.1, 1.4.1, 2.1.1, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, , 3.1.1, 3.2.1, , 4.1.2, 4.1.3, 4.2.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1
CO5	1.4.1, 2.1.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, , 3.1.1, 3.2.1, , 4.1.2, 4.1.3, 4.2.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	20	60	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	40	30				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	40	30				100
ESE	30	50	20				100

22LPE$06	MASSIVE MIMO AND MILLIMETER WAVE SYSTEMS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To learn the importance of improving capacity of wireless channel using MIMO, Massive MIMO, principle of millimeter waves and millimeter transceivers.	
UNIT – I	**INTRODUCTION**	**9 Periods**
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.		
UNIT – II	**MIMO DIVERSITY AND SPATIAL MULTIPLEXING**	**9 Periods**
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.		
UNIT – III	**MASSIVE MIMO SYSTEM**	**9 Periods**
Introduction - MIMO for LTE, Capacity of massive MIMO, Pilot Design for massive MIMO, Resource allocation and transceivers design, Base band and RF implementation, Channel Models.		
UNIT – IV	**MILLIMETER WAVES**	**9 Periods**
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.		
UNIT – V	**TRANSCEIVERS FOR MILLIMETER WAVES**	**9 Periods**
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.		
Contact Periods: **Lecture: 45 PeriodsTutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*.David Tse and Pramod Viswanath, "**Fundamentals of Wireless Communication**", Cambridge University Press 2005.*
2	*Kao-Cheng Huang, Zhaocheng Wang**," Millimeter Wave Communication Systems",** Wiley, 2011.*

REFERENCES:

1	*Sergey M. Smolskiy Author, Leonid A. Belov and Victor N. Kochemasov, **"Handbook of RF, Microwave, and Millimeter-Wave Components"**, Artech House Microwave Library, 2012.*
2	*Hamid Jafarkhani, "**Space - Time Coding: Theory and Practices**", Cambridge University Press 2005.*
3	*Tolga M. Duman, Ali Ghrayeb, "**Coding for MIMO Communication Systems**" John Wiley & Sons, Ltd 2007.*
4	*Mohinder Jankiraman, **"Space-time codes and MIMO systems",** Artech House, Boston, London . www.artech house.com, ISBN 1-58053-865-7-2004.*
5.	*Paulraj Rohit Nabar, Dhananjay Gore, **"Introduction of space time wireless communication systems"**, Cambridge University Press, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Summarize the various methods for improving capacity of wireless channel using MIMO	K2
CO2	Discuss various diversity techniques and spatial multiplexing techniques in MIMO	K3
CO3	Describe Massive MIMO concepts	K2
CO4	Explain the concepts and challenges of millimeter wave communication	K2
CO5	Describe the transmitter and receiver types in millimeter wave communication	K2

COURSE ARTICULATION MATRIX:

CO and PO Mapping															
COs/POs	**PO 1**	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	1	1	-	-	2	-	-	-	-	3	2	1	1
CO2	3	3	1	1	-	-	2	-	-	-	-	3	2	1	1
CO3	3	3	1	1	-	-	2	-	-	-	-	3	2	1	1
CO4	3	3	1	1	-	-	2	-	-	-	-	3	2	1	1
CO5	3	3	1	1	-	-	2	-	-	-	-	3	2	1	1
22LPE$06	**3**	**3**	**1**	**1**	-	-	**2**	-	-	-	-	**3**	**2**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.1.6, 4.1.1, 4.1.4, 7.1.1, 7.1.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.1.6, 4.1.1, 4.1.4, 7.1.1, 7.1.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.1.6, 4.1.1, 4.1.4, 7.1.1, 7.1.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.1.6, 4.1.1, 4.1.4, 7.1.1, 7.1.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.1.6, 4.1.1, 4.1.4, 7.1.1, 7.1.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	30	60	10				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	40	20				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	60	20				100
ESE	40	40	20				100

22LPE$07	OPTICAL COMMUNICATION NETWORKS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To provide an overview of the various Optical system components, physical layer design and networking issues related to optical networks	
UNIT – I	**INTRODUCTION TO OPTICAL NETWORKS AND COMPONENTS**	**9 Periods**
Introduction to Optical Networks: Telecommunications Networks Architecture, Services, circuit switching and packet switching, Optical Networks - Optical Packet Switching, Transmission Basics - Network Evolution, Nonlinear Effects: Self-phase Modulation, Cross-phase Modulation, Four Wave mixing – Solitons - Components: Couplers, Isolators and Circulators, Multiplexers and Filters, Optical Amplifiers, Transmitters, Detectors, Switches, Wavelength Converters.		
UNIT – II	**TRANSMISSION SYSTEM ENGINEERING**	**9 Periods**
Transmission System Engineering: System Model, Power Penalty, Transmitter, Receiver, Optical Amplifiers, Crosstalk, Dispersion, Wavelength Stabilization, Overall Design Considerations.		
UNIT – III	**CLIENT LAYERS OF THE OPTICAL LAYER AND NETWORK SURVIVABILITY**	**9 Periods**
SONET/SDH - Optical Transport Network- Generic Framing Procedure – Ethernet – IP – Multiprotocol Label Switching – Resilient packet ring – Storage area networks. Basic Concepts - Protection in SONET/SDH - Protection in the Client Layer – Service Classes Based on Protection- Optical Layer Protection Schemes - Interworking between Layers.		
UNIT – IV	**WDM NETWORK ELEMENTS AND WDM NETWORK DESIGN**	**9 Periods**
Optical Line Terminals – Optical Line Amplifiers – Optical Add/ Drop Multiplexers – Optical Cross connects. **Cost Trade-Offs:** Detailed Ring Network Example – LTD and RWA Problems – Dimensioning Wavelength-Routing Networks – Statistical Dimensioning Models – Maximum Load Dimensioning Models.		
UNIT – V	**PHOTONIC PACKET SWITCHING AND ACCESS NETWORKS**	**9 Periods**
Optical Time Division Multiplexing – Synchronization - Header Processing – Buffering - Burst Switching Network Architecture Overview – Enhanced HFC - Fiber to the Curb (FTTC).		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Rajiv Ramaswami and Kumar Sivarajan, Galen H. Sasaki,* ***"Optical Networks A Practical Perspective",*** *3rd Edition, Morgan - Kaufmann Publishers,2010.*
2	*Optical Networks, Third Generation Transport Systems, Uyless Black, Pearson, 2002.*

REFERENCES:

1	*Max Ming-Kang Liu,* ***"Principles and Applications of Optical Communication",*** *Tata McGraw Hill Education Pvt., Ltd., New Delhi.*
2	*Thomas E. Stern, Georgios Ellinas, Krishna Bala,* ***"Multiwavelength Optical Networks – Architecture, Design and control"****, Cambridge University Press, 2nd Edition, 2009.*
3	*Rajiv Ramaswami and Kumar N. Sivarajan,* ***"Optical Networks : A Practical Perspective",*** *Harcourt Asia Pte Ltd., Second Edition 2006.*
4	*P.E. Green, Jr.,* ***"Fiber Optic Network",*** *Prentice Hall, NJ, 1993.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify the technology underlying optical networks and different components needed to build an optical network	K2
CO2	Explain transmission systems engineering design considerations	K3
CO3	Describe Client layers of optical network and optical layer protection	K2
CO4	Discuss WDM network elements and WDM network design models.	K2
CO5	Explain access networks architecture and photonic packet switching	K2

COURSE ARTICULATION MATRIX:

CO and PO Mapping

COs/POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO3
CO1	1	1	1	-	-	-	-	-	-	-	-	3	1	1	1
CO2	2	1	1	-	-	-	-	-	-	-	2	2	2	1	1
CO3	2	2	1	-	-	-	-	-	-	-	2	2	2	1	1
CO4	2	2	1	-	-	-	-	-	-	-	2	2	2	1	1
CO5	2	1	1	-	-	-	-	-	-	-	-	2	2	1	1
22LPE$07	**2**	**1**	**1**	-	-	-	-	-	-	-	**1**	**2**	**2**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.4.1, 2.1.1, 2.2.2, 2.2.3, 2.3.1, 3.1.1, 3.1.6, 3.2.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1
CO2	1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.2.2, 2.3.2, 3.1.4, 3.2.3, 11.1.1, 11.2.1, 12.1.1, 12.1.2, 12.3.1
CO3	1.2.1, 1.4.1, 2.1.1, 2.1.2, 2.2.3, 2.2.4, 2.3.2, 3.1.1, 3.1.5, 3.1.6, 11.1.1, 11.2.1, 12.1.1, 12.1.2, 12.3.1
CO4	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.3, 2.2.4, 2.3.2, 3.1.1, 3.1.5, 3.1.6, 11.1.1, 11.2.1, 12.1.1, 12.1.2, 12.3.1
CO5	1.1.1, 1.4.1, 2.3.1, 2.3.2, 3.1.6, 3.3.1, 3.4.2, 12.1.1, 12.2.1, 12.2.2, 12.3.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	30	60	10				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	40	20				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	60	20				100
ESE	40	40	20				100

22LPE$08	EVOLUTION OF 4G /5G TECHNOLOGIES

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To understand the challenges of 4G , 5G technology and explore the architecture of 4G, understand the 5G Modulation Schemes and different types of multiple access techniques in 5G	
UNIT – I	**INTRODUCTION TO 4G**	**9 Periods**
Introduction – 4G vision – 4G features and challenges - Applications of 4G – 4G Technologies, Multicarrier Modulation: OFDM principle- Modulation, Cyclic Prefix - Windowing, PAPR, OFDM in LTE, Time and Frequency Synchronization, SC-FDE - Smart antenna techniques.		
UNIT – II	**SYSTEM ARCHITECTURE OF LTE**	**9 Periods**
OFDM with FDMA, TDMA, CDMA, OFDMA, SC-FDMA, OFDMA and SC-FDMA in LTE, IMS Architecture, Advanced Broadband Wireless Access and Services, MVNO.		
UNIT – III	**EVOLUTION OF 5G NETWORKS**	**9 Periods**
Introduction to 5G, vision and challenges, 5G NR – New Radio – air interface of 5G, radio access, Ultra-Dense Network Architecture and Technologies for 5G- Concept and Challenges of UDN, GPP HeNB Architecture, Key Technologies of UDN- Flexible Networking, Multi-RATs Coordination.		
UNIT – IV	**5G MODULATION SCHEMES**	**9 Periods**
Introduction to Equalization- types - Filter-bank based multi-carrier (FBMC), Universal filtered multi carrier (UFMC), Generalized frequency division multicarrier (GFDM) - Principles, Transceiver Block diagram, Frame structure, Resource structure, allocation, mapping, MIMO-GFDM.		
UNIT – V	**MULTIPLE ACCESS TECHNIQUES IN 5G**	**9 Periods**
NOMA – Principle- Superposition Coding, Successive Interference Cancellation, Power Domain NOMA, Sparse Code NOMA- types, Power Domain Sparse Code NOMA and IDMA Relaying: Cooperative NOMA- Benefits and Challenges, Half duplex relaying, Full duplex relaying, Amplify and forward relaying, Decode and forward relaying, Decode and forward relaying with PLNC, BER Analysis, Capacity Analysis.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Arunabha Ghosh, Jan Zhang, Jefferey Andrews, Riaz Mohammed,* ***"Fundamentals of LTE"*** *Pearson education (Formerly Prentice Hall, Communications Engg and Emerging Technologies), ISBN-13: 978-0-13-703311-9, 2011.*
2	*Afif Osseiran, Jose.F.Monserrat and Patrick Marsch,* ***"5G Mobile and Wireless Communications Technology"****, Cambridge University Press, 2016.*

REFERENCES:

1	*Xiang, W; Zheng, K; Shen, X.S;* ***"5G Mobile Communications",*** *Springer, 2016.*
2	*'HarriHolma and Antti Toskala ,* ***"LTE for UMTS Evolution to LTE-Advanced"****,Second Edition - 2011, John Wiley & Sons, Ltd. Print ISBN: 9780470660003.*
3	*UMTS' Pierre Lescuyer and Thierry Lucidarme* ***,"EVOLVED PACKET SYSTEM (EPS) ; THE LTE AND SAE EVOLUTION OF 3G",*** *2008, John Wiley & Sons, Ltd. Print ISBN:978-0-470-05976-0.*
4	*Stefania Sesia, IssamToufik, and Matthew Baker,* ***"LTE – The UMTS Long Term Evolution ; From Theory to Practice"****, 2009 John Wiley & Sons Ltd, ISBN 978-0-470-69716-0.*
5	*Saad Z Asif,* ***"5G Mobile Communication,Concepts and Challenges",*** *CRC Press.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Comprehend the 4G technology	K2
CO2	Discuss the significance of 4G technology and its architecture	K2
CO3	Describe the evolution of 5G networks	K2
CO4	Characterize the different 5G potential Candidate Waveforms	K3
CO5	Explain the different 5G multiple access Schemes	K2

COURSE ARTICULATION MATRIX:

CO and PO Mapping															
COs/POs	**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**	**PSO 3**
CO1	3	1	1	-	-	-	-	-	-	-	-	3	2	1	2
CO2	2	1	1	-	-	-	2	-	-	-	-	3	2	1	2
CO3	3	1	1	-	-	-	-	-	-	-	-	3	2	1	2
CO4	3	1	1	1	-	-	2	-	-	-	-	3	2	1	2
CO5	3	1	1	-	-	-	2	-	-	-	-	3	2	1	2
22LPE$08	**3**	**1**	**1**	1	-	-	**1**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	2
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.2.1, 2.2.3, 2.3.1, 3.1.1, 3.1.6, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1
CO2	1.3.1, 1.4.1, 2.1.1, 2.2.3, 2.3.1, 3.1.1, 3.1.6, 3.2.2, 7.1.1, 7.1.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.2.1, 2.2.3, 2.3.1, 3.1.1, 3.1.6, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.2.3, 2.3.1, 3.1.1, 3.1.6, 3.2.2, 4.1.1, 7.1.1. 7.1.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.2.3, 2.3.1, 3.1.1, 3.1.6, 3.2.2, 7.1.1. 7.1.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	60	20				100
CAT2	30	60	10				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	40	20				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	60	20				100
ESE	40	40	20				100

VERTICAL-II
RF TECHNOLOGIES

22LPE$09	ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**

Course Objectives	To acquire knowledge on the fundamentals of Electromagnetic Interference, its measurements, control techniques and design of EMC in PCBs.	
UNIT – I	**EMI ENVIRONMENT**	**9 Periods**
EMI and EMC concepts and definitions-Sources of EMI-conducted and radiated EMI-Transient EMI- Time domain Vs Frequency domain EMI-Units of measurement parameters.		
UNIT – II	**EMI COUPLING PRINCIPLES AND STANDARDS**	**9 Periods**
Conducted-Radiated and Transient Coupling-Common Impedance Ground Coupling-Radiated Common Mode and Ground Loop Coupling-Radiated Differential Mode Coupling-Near Field Cable to Cable Coupling-Power Mains and Power Supply coupling-Units of specifications-Civilian standards - FCC, CISPR, IEC, EN, Military standards - MIL STD 461D/462		
UNIT – III	**EMI MEASUREMENTS**	**9 Periods**
EMI Test Instruments and Systems-EMI Shielded Chamber-Open Area Test Site-TEM Cell-Sensors and Injectors and Couplers-Test beds for ESD and EFT.		
UNIT – IV	**EMI CONTROL TECHNIQUES**	**9 Periods**
Shielding-Filtering-Grounding-Bonding-Isolation Transformer-Transient Suppressors-Cable Routing-Signal Control-Component Selection and Mounting		
UNIT – V	**EMC DESIGN OF PCBS**	**9 Periods**
PCB Traces Cross Talk-Impedance Control-Power Distribution Decoupling-Zoning-Motherboard Designs and Propagation Delay Performance Models.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*V.P.Kodali, **"Engineering Electromagnetic Compatibility: Principles, Measurements, Technologies, and Computer Models"**, s.Chand & Co., New Delhi, 2011.*

REFERENCES :

1	*Clayton R.Paul, **"Introduction to Electromagnetic compatibility"**, John Wiley & Sons, 2nd edition, 2006.*
2	*Henry W.Ott, **"Noise Reduction Techniques in Electronic Systems"**, John Wiley and Sons, New York, 2008.*
3	***"Electromagnetic Interference and Compatibility"**, IIT-Delhi, IMPACT Series, Modules 1-9.*
4	*Bernhard Keiser, **"Principles of Electromagnetic Compatibility"**, Artech house, 3rd Ed, 2006..*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concepts of EMI and EMC	K2
CO2	Discuss various coupling principles and standards	K2
CO3	Explain different types of EMI measurement techniques	K2
CO4	Describe the various EMI control techniques	K2
CO5	Apply the Electromagnetic Compliance procedure for PCB design	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	PO1	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	PSO 3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LPE$09	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	50	10				100
CAT2	40	50	10				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	50	10				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	40	50	10				100
ESE	40	50	10				100

22LPE$10	ELECTROMAGNETIC RADIATION HAZARDS AND SAFETY

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To understand the sources of EM radiation, biological effects of EM radiation, Safety measures and RF site surveys.	
UNIT – I	**SOURCES OF ELECTROMAGNETIC RADIATION**	**9 Periods**
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.		
UNIT – II	**BIOLOGICAL EFFECTS**	**9 Periods**
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.		
UNIT – III	**INCIDENT AND INTERNAL FIELD DOSIMETRY**	**9 Periods**
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.		
UNIT – IV	**SAFETY AND REGULATION**	**9 Periods**
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.		
UNIT – V	**RADIO FREQUENCY SITE SURVEYS**	**9 Periods**
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.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Riadh W.Y. Habash, "**Electromagnetic Fields and Radiation: Human Bioeffects and Safety**", 1st Edition, CRC Press, 2018*
2	*Patrick Staebler,"**Human Exposure to Electromagnetic Fields: From Extremely Low Frequency (ELF) to Radiofrequency**", John Wiley & Sons, 2017.*

REFERENCES:

1	*Andrew W. Wood, Ken Karipidis, "**Non-ionizing Radiation Protection: Summary of Research and Policy Options**", John Wiley & Sons, 2017.*
2	*Colin J. Martin, David G. Sutton, "**Practical Radiation Protection in Healthcare**", Oxford University Press, 2015.*
3	*Martin Roosli "**Epidemiology of Electromagnetic Fields**",1st Edition, CRC Press, 2014.*
4	*Peter Stavroulakis, "**Biological Effects of Electromagnetic Fields: Mechanisms, Modeling, Biological Effects, Therapeutic Effects, International Standards, Exposure Criteria**" Springer Science & Business Media, 2014.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the various sources of Electromagnetic radiation	K2
CO2	Discuss and self-aware about the various biological effects arises due to the exposure of EM radiation	K2
CO3	Aware and recall the incident and internal field radiation dosage	K3
CO4	Discuss the international safety guidelines and regulations	K2
CO5	Elaborate the surveying methods of RF sites	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LPE$10	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,,4.1.1,4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	50	10				100
CAT2	40	50	10				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	50	10				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	40	50	10				100
ESE	40	50	10				100

22LPE$11	ADVANCED RADIATION SYSTEMS					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
ANTENNA AND WAVE PROPOAGATION		**PE**	**3**	**0**	**0**	**3**

Course Objective	To have knowledge on the principles of radiating systems, analysis and design of antenna arrays, synthesis of antennas and analysis of special antennas.	
UNIT – I	**ANTENNA FUNDAMENTALS**	**9 Periods**
Retarded vector potential-– Radiation mechanism – Current distribution on a thin wire antenna – Types of antennas - Antenna parameters - Linear, elliptical and circular polarization - N-element linear array – Radiation pattern -Major lobes- Side lobes –Null directions – Beamwidth -Directivity calculations.		
UNIT – II	**ANTENNA SYNTHESIS**	**9 Periods**
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.		
UNIT – III	**FRACTAL ANTENNAS**	**9 Periods**
Fractal antenna geometries-Iterated function systems-Fractal antenna elements-Fractal antenna arrays-Antenna arrays based on fractal and aperiodic tilings		
UNIT – IV	**MICROSTRIP ANTENNAS**	**9 Periods**
Advantages and trade-off-material consideration-Methods of analysis and design-Excitation methods-Dual polarization & circular polarization techniques-Broadband and dual band techniques-Antenna miniaturization techniques		
UNIT – V	**MOBILE HAND-SET ANTENNAS**	**9 Periods**
Impact on antenna design-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-Measurement of handset antennas-Future trends		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Balanis.A, **"Antenna Theory -Analysis and Design"**, John Wiley and Sons, New York, 4th Edition, 2016.*
2	*Constantine A.Balanis, **"Modern Antenna Handbook"**, John Wiley and Sons, 2013.*

REFERENCES :

1	*John.L.Volakis, **"Antenna Engineering Handbook"**, 5th Edition, McGraw Hill, 2018.*
2	*John D Kraus, Ronald J Marhefka, Ahmad S Khan, **"Antennas for all applications"**, 3rd Edition , John Wiley and Sons, New York, 2012.*
3	*Edward C. Jordan, Keith G. Balmain **"Electromagnetic Waves and Radiating Systems"**, 2nd Edition, Prentice Hall of India, 2015.*
4	*Warren L. Stutzman and Gary A. Thiele, **"Antenna Theory and Design"**, 3rd Edition, John Wiley and Sons, New York, 2012.*
5	*Theodore S. Rappaport, **"Smart Antennas: Adaptive Arrays, Algorithms, & Wireless Position Location"**, IEEE Press, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the concept of radiation, analyze and design antenna arrays for given specifications	K4
CO2	Synthesize antennas for known excitations and outputs	K4
CO3	Discuss the development of fractal structures from unit element	K2
CO4	Analyse and design rectangular and circular microstrip antennas	K4
CO5	Describe the various types of mobile hand-set antennas	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LPE$11	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1, 4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1, 4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1, 4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1, 4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1, 4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40		40			100
CAT2	20	40		40			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40		40			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40		40			100
ESE	20	40		40			100

22LPE$12	SATELLITE COMMUNICATION					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**

Course Objective	To identify the different orbital parameters and the subsystems involved in designing space segment and explain the different multiplexing techniques used in satellite systems for various applications.	
UNIT – I	**SATELLITE ORBITS AND TRAJECTORIES**	**9 Periods**
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.		
UNIT – II	**SPACE SEGMENT**	**9 Periods**
Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Station keeping, Thermal control and Propulsion, communication subsystems, Telemetry, Tracking and command-Transponders Antenna Subsystem.		
UNIT – III	**LINK DESIGN**	**9 Periods**
Basic transmission theory - System Noise temperature and G/T ratio – Noise figure and noise temperature- G/T ratio 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.		
UNIT – IV	**MULTIPLE ACCESS AND CODING TECHNIQUES**	**9 Periods**
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.		
UNIT – V	**APPLICATIONS**	**9 Periods**
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.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Dennis Roddy, "**Satellite Communications**", 4th Edition, Mc Graw Hill, 2017.*
2	*Pratt T, Bostian C and Allnutt J, "**Satellite Communications**", John Wiley and Sons, 3rd Edition, 2021.*

REFERENCES:

1	*Pritchard W L, Suyderhoud H G and Nelson R A, "**Satellite Communication System Engineering**", 2nd Edition, Prentice Hall, 2013.*
2	*Anil K. Mani, Varsha Agrawal, "**Satellite technology: Principles and Applications**", 2nd Edition, Wiley India Pvt.Ltd., 2015.*
3	*Tri. T. Ha, "**Digital Satellite Communications**", 2nd Edition, McGraw Hill, 2017.*
4	*Madhavendra Richharia, Leslie David Westbrook, "**Satellite systems for Personal Applications**", John Wiley, 2010.*
5	*Manojit Mithra , "**Satellite Communication**", Prentice Hall,2005.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify the different orbital parameters and summarize the types of satellite orbits and determine the orbital parameters.	K3
CO2	Classify the different subsystems used in satellite communication to build a space segment.	K2
CO3	Determine the link design for the signal-to-noise ratio.	K3
CO4	Explain the different multiplexing techniques used in satellite systems for various applications.	K2
CO5	Apply the link design for signal-to-noise ratio and multiplexing techniques for various satellite applications.	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LPE$12	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	50	30				100
CAT2	20	50	30				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	50	30				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	50	30				100
ESE	20	50	30				100

22LPE$13	MICROWAVE INTEGRATED CIRCUITS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To have a depth knowledge on building blocks of microwave integrated circuits.	
UNIT – I	**PLANAR TRANSMISSION LINES AND COMPONENTS**	**9 Periods**
Review of Transmission line theory – S parameters-Transmission line equations – reflection coefficient – VSWR – Microstrip lines: Structure, waves in microstrip, Quasi-TEM approximation, Coupled lines: Even mode and odd mode analysis – Microstrip discontinuities and components – Strip line – Slot line – Coplanar waveguide		
UNIT – II	**IMPEDANCE MATCHING NETWORKS**	**9 Periods**
Circuit Representation of two port RF/Microwave Networks: Low Frequency Parameters, High Frequency Parameters, Transmission Matrix, ZY Smith Chart, Design of Matching Circuits using Lumped Elements, Matching Network Design using Distributed Elements		
UNIT – III	**MICROWAVE FILTER DESIGN**	**9 Periods**
Basic RLC Series and Parallel resonators – RF Filter design using Insertion Loss method: Butterworth, Chebyshev and Linear Phase: LPF, HPF, BPF, BSF- Normalisation for Frequency and Type – Impedance Normalisation		
UNIT – IV	**MICROWAVE AMPLIFIER DESIGN**	**9 Periods**
Characteristics of microwave transistors – Two Port Power Gains - Stability considerations - Input and Output Stability circles – Unconditional Stability – Design for Maximum Gain and Specified Gain – Broadband Amplifier design		
UNIT – V	**MICROWAVE OSCILLATOR DESIGN**	**9 Periods**
Oscillators:Oscillation conditions – Basic oscillator model – Feedback oscillator design –High frequency oscillator configurations – Voltage controlled oscillator – Gunn element oscillator - Design and stability considerations of Microwave Transistor Oscillators – Microwave Integrated Circuits overview- Types of MIC – Design of MMIC		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Thomas H Lee, "**Planar Microwave Engineering: A Practical Guide to Theory, Measurements and Circuits**", Cambridge University Press, 2004.*
2	*Reinhold Ludwig and Gene Bogdanov, "**RF Circuit Design: Theory and Applications**", Pearson Education Inc., 2nd edition, 2011.*

REFERENCES:

1	*Jia Sheng Hong, M. J. Lancaster, "**Microstrip Filters for RF/Microwave Applications**", John Wiley & Sons, 2011*
2	*David M. Pozar, "**Microwave Engineering**", Wiley India (P) Ltd, New Delhi, 4th edition, 2012.*
3	*Annapurna Das and Sisir K Das, "**Microwave Engineering**", Tata McGraw Hill Publishing Company Ltd, New Delhi, 2017.*
4	*Samuel Y. Liao, "**Microwave Devices and Circuits**", Prentice Hall of International Ltd, 4th edition, 2009.*
5	*Robert E Colin, "**Foundations for Microwave Engineering**", John Wiley & Sons, 2010*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain design constraints of planar transmission lines	K2
CO2	Design impedance matching networks for MICs	K4
CO3	Design microwave filters for given specifications	K4
CO4	Design microwave amplifiers to meet out the requirements	K4
CO5	Design oscillator circuit and monolithic MICs	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	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	PSO 3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LPE$13	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	20		60			100
CAT2	20	20		60			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	20		60			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	20		60			100
ESE	20	20		60			100

22LPE$14	SMART ANTENNAS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To understand basics of smart antennas, spatial temporal characteristics for different channel models and gain knowledge on DOA estimation techniques.	
UNIT – I	**INTRODUCTION TO SMART ANTENNAS**	**9 Periods**
Antenna gain-Phased array antenna-power pattern-beam steering-degree of freedom-optimal antenna-adaptive antennas-smart antenna: key benefits of smart antenna technology-wide band smart antennas		
UNIT – II	**SPATIAL PROCESSING FOR WIRELESS SYSTEMS**	**9 Periods**
Spatial processing for wireless systems. Adaptive antennas. Beam forming networks, Digital radio receiver techniques and software radios.		
UNIT – III	**SPATIAL PROCESSING FOR CDMA SYSTEMS**	**9 Periods**
Coherent and non-coherent CDMA spatial processors. Dynamic re-sectoring, Range and capacity extension – multi-cell systems.		
UNIT – IV	**SPATIO – TEMPORAL CHANNEL MODELS**	**9 Periods**
Environment and signal parameters. Geometrically based single bounce elliptical model. Optimal spatial filtering – adaptive algorithms for CDMA. Multi-target decision – directed algorithm.		
UNIT – V	**DIRECTION OF ARRIVAL ESTIMATION METHODS**	**9 Periods**
DOA estimation – conventional and subspace methods. ML estimation techniques. Estimation of the number of sources using eigen decomposition. Direction finding and true ranging PL systems. Elliptic and hyperbolic PL systems. TDOA estimation techniques.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*J.C.Liberti and T.S.Rappaport, **Smart Antennas for Wireless Communication**, Prentice Hall ,2012.*
2	*Lal Chand Godara, **"Smart Antennas",** 1st edition, C.R.C Press, 2018.*

REFERENCES:

1	*Warren L Stutzman, Gary A.Thiele, **" Antenna Theory and Design"** Mc Graw Hill, 3rd edition, ", John Wiley & Sons, 2013*
2	*Balanis.A, **"Antenna Theory Analysis and Design",** John Wiley and Sons, New York, 4th Edition, 2016.*
3	*R.Janaswamy, **Radio Wave Propagation and Smart Antennas for Wireless Communication**, Kluwer, 2008.*
4	*John.L.Volakis, **"Antenna Engineering Handbook"**, 5th Edition, McGraw Hill, 2018.*
5	*Constantine A.Balanis, **"Modern Antenna Handbook"**, John Wiley and Sons, 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the fundamentals of smart antennas	K2
CO2	Discuss various spatial processing techniques for wireless systems	K2
CO3	Explain CDMA specific spatial processing techniques	K2
CO4	Discuss channel modeling techniques for smart antennas	K2
CO5	Apply various methods to estimate direction of arrival (DOA)	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	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	PSO 3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LPE$14	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	50	10				100
CAT2	40	50	10				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	50	10				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	40	50	10				100
ESE	40	50	10				100

22LPE$15	RF SYSTEM DESIGN					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
MICROWAVE INTEGARTED CIRCUITS		**PE**	**3**	**0**	**0**	**3**

Course Objective	To analyse and design of RF transmission, RF amplifiers, mixers and various sub-systems of RF Section of a Receiver.	
UNIT – I	**INTRODUCTION TO RF TECHNOLOGY**	**9 Periods**
Issues in RF design - Electromagnetic Spectrum - RF behavior of passive components - Basic concepts in RF Design: Time Variance – Effects of nonlinearity – Noise - sensitivity - dynamic range –Quality factor – Scattering Parameters - MOSFET behaviour at RF frequencies		
UNIT – II	**LOW NOISE AMPLIFIER DESIGN**	**9 Periods**
LNA Topologies: Common Source stage with inductive load – Common Source stage with resistive feedback – Common Gate stage – Variants of common gate LNA – Noise cancelling LNAs – Gain switching – Band switching – High IP_2 LNAs - Design of LNA		
UNIT – III	**MIXER CIRCUIT DESIGN**	**9 Periods**
Performance parameters – Mixer noise figure – Single balance & double balanced mixers – Passive down conversion mixers – LO self-mixing – Active down conversion mixers – Conversion gain – Noise in active mixers – linearity – Single ended mixer design		
UNIT – IV	**POWER AMPLIFIER DESIGN**	**9 Periods**
Effect of high currents – Efficiency – Power amplifier classifications: Class A, Class B, Class C, Class E and Class F power amplifiers – Single ended and differential power amplifiers –– Large signal impedance matching - Design of Power amplifiers.		
UNIT – V	**RF FRONT END DESIGN**	**9 Periods**
RF Front End and Tuner building blocks - RF directional couplers – RF Power dividers – Rate-race coupler - Hybrid couplers - Complete RF Tuner design considerations.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Behzad Razavi, "**RF Microelectronics**", Prentice Hall publisher, 2th edition, 2013.*
2	*Reinhold Ludwig and Gene Bogdanov, "**RF Circuit Design: Theory and Applications**", Pearson Education Inc., 2nd edition, 2011.*

REFERENCES:

1	*Hooman Darabi, "**Radio-Frequency Integrated Circuits and Systems"**, Cambridge University Press, 1st edition, 2015.*
2	*David Pozar, **"Microwave and RF Wireless Systems",** Wiley, 2010.*
3	Stephan A Mass, ***"Non-Linear Microwave and RF circuits",*** Artech House, Second Edition, 2013.
4	*George D. Vendelin, Anthony M. Pavio, Ulrich L. Rohde**, "Microwave Circuit Design Using Linear and Nonlinear Techniques",** John Wiley, 2015.*
5	*Gu, Qizheng, "**RF System Design of Transceivers for Wireless Communications**", Springer, 2010*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Formulate, analyze and solve design problems in RF passive components	K3
CO2	Comprehend the design concepts of LNAs	K4
CO3	Explain operating principles and design concepts of mixers	K3
CO4	Design RF power amplifiers for the given conditions	K4
CO5	Analyze and solve problems on RF front end circuits	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LPE$15	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	20	20	40			100
CAT2	20	20	20	40			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	20	20	40			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	20	20	40			100
ESE	20	20	20	40			100

22LPE$16	RF TRANSCEIVERS					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
MICROWAVE INTEGRATED CIRCUITS **RF SYSTEM DESIGN**		**PE**	**3**	**0**	**0**	**3**

Course Objective	To understand the working of various components of RF transmitter and receiver systems.	
UNIT – I	**FUNDAMENTAL CONCEPTS IN TRANSCEIVER DESIGN**	**9 Periods**
Linear Systems and Transformations – Nonlinear systems – Noise – RF system design parameters – Modulation accuracy – Transmitter systems parameters – P1dB – IP3 – PAPR – Power back off – ACPR – EVM – Linearization of RF power amplifiers.		
UNIT – II	**TRANSMITTER DESIGN**	**9 Periods**
MIMO transmission schemes – MIMO transceiver architectures: Antenna selection architecture – Frequency division multiplexing architecture – Time division multiplexing architecture – Code division multiplexing architecture – Antenna crosstalk – Nonlinear crosstalk – Impairment and distortion compensation.		
UNIT – III	**RECEIVER DESIGN**	**9 Periods**
Receiver architectures – Smart antenna receiver architectures – MIMO receiver architectures – Capacity reduction of MIMO system due to frontend – RF interference on MIMO receivers – MIMO test bed design.		
UNIT – IV	**RF IMPAIRMENTS IN MIMO TRANSCEIVERS**	**9 Periods**
Phase noise in MIMO transceivers – DC offset in MIMO transceivers – I/Q imbalance in MIMO transceivers - BER analysis		
UNIT – V	**SINGLE RF FRONT END MIMO TRANSCEIVERS**	**9 Periods**
RF front end MIMO using antenna selection – Single RF front end MIMO using FDM, TDM and CDM – Single RF front end MIMO using a parasitic antenna		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Abbas Mohammadi and Fadhel M. Ghannouchi, "**RF Transceiver Design for MIMO Wireless Communications**", Springer, 2012.*

REFERENCES:

1	*Harvey Lehpamer, **"Transmission System Design Handbook for Wireless Networks"**, Artech House, 2012*
2	*David Pozar, **"Microwave and RF Wireless Systems",** Wiley, 2010.*
3	Stephan A Mass, ***"Non-Linear Microwave and RF circuits",*** Artech House, Second Edition, 2013.
4	*George D. Vendelin, Anthony M. Pavio, Ulrich L. Rohde**, "Microwave Circuit Design Using Linear and Nonlinear Techniques",** John Wiley, 2015.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the fundamental concepts used in RF transceivers design	K2
CO2	Elaborate the design procedures of transmitter circuits	K3
CO3	Recall the design procedures of receiver circuits	K2
CO4	Discuss the impairments in MIMO transceivers	K2
CO5	Describe the formation of RF front end of MIMO transceivers.	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping															
COs/ POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PS O2**	**PSO 3**
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LPE$16	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	50	30				100
CAT2	20	50	30				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	50	30				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	50	30				100
ESE	20	50	30				100

VERTICAL-III
SIGNAL AND IMAGE PROCESSING

22LPE$17	ADVANCED DIGITAL SIGNAL PROCESSING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To Understand the concepts of Random Signal Processing, Signal Modeling, Spectral and Linear Estimation, Adaptive filtering and Linear estimation.	
UNIT – I	**DISCRETE RANDOM SIGNAL PROCESSING**	**9 Periods**
Discrete Random Processes- Ensemble Averages, Stationary processes, Bias and Estimation, Auto covariance, Autocorrelation, Parseval's theorem, Wiener-Khintchine relation, White noise, Power Spectral Density, Spectral factorization, Filtering Random Processes.Solution to Prony's normal equation,		
UNIT – II	**SPECTRUM ESTIMATION**	**9 Periods**
Non-Parametric methods - Correlation method - Co-variance estimator - Performance analysis of estimators – Unbiased consistent estimators - Periodogram estimator- Barlett spectrum estimation - Welch estimation - Model based approach - AR, MA, ARMA Signal modeling - Parameter estimation using Yule-Walker method.		
UNIT – III	**LINEAR ESTIMATION AND PREDICTION**	**9 Periods**
Maximum likelihood criterion - Efficiency of estimator - Least mean squared error criterion - Wiener filter -Discrete Wiener Hoff equations- Recursive estimator -Kalman Filter-Linear prediction, Prediction error -Whitening filter, Inverse filter- Levinson recursion, Lattice realization, Levinson recursion algorithm for solving Toeplitz system of equations.		
UNIT – IV	**ADAPTIVE FILTERS**	**9 Periods**
FIR Adaptive filters - Newton's steepest descent method -Adaptive filters based on steepest descent method - Wiener Hoff LMS Adaptive Algorithm-Adaptive channel equalization - Adaptive echo cancellation - Adaptive noise cancellation - RLS Adaptive filters - Exponentially weighted RLS - Sliding window RLS - Simplified IIR LMS Adaptive filter.		
UNIT – V	**MULTIRATE DIGITAL SIGNAL PROCESSING**	**9 Periods**
Mathematical description of change of sampling rate- Interpolation and Decimation - Continuous time model- Direct digital domain approach- Decimation by integer factor- Interpolation by an integer factor - Single and multistage realization- Poly phase realization-Applications to sub band coding - Wavelet transform and filter bank implementation of wavelet expansion of signals.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Monson H. Hayes, "**Statistical Digital Signal Processing and Modeling**",1st Edition. John Wiley and Sons Inc., New York, 2006.*
2	*Simon Haykin, "**Adaptive Filter Theory**", 4th Edition,Prentice Hall, Englehood Cliffs, NJ1986.*

REFERENCES:

1	*Sophoncles J. Orfanidis, "**Optimum Signal Processing** ",2nd Edition, McGraw-Hill, 2000.*
2	*John G. Proakis, Dimitris G. Manolakis, "**Digital Signal Processing**", 3rd Edition,Prentice Hall of India,New Delhi, 2005.*
3	*S. Kay," **Modern Spectrum Estimation Theory and Application**", Prentice Hall, Englehood Cliffs, Nj.Pearson Education,1988.*
4	*P. P. Vaidyanathan, "**Multirate Systems and Filter Banks**", Prentice Hall, Pearson Education,1992.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Have in-depth knowledge on random signal and its spectrum estimation.	K2
CO2	Design different Minimum Mean Square Error filters and model for prediction and Estimation	K3
CO3	Design LMSE Filters	K3
CO4	Design Adaptive Filters	K3
CO5	Design multirate DSP systems	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

	PO 1	PO 2	PO3	PO 4	PO 5	PO6	PO 7	PO8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2	PSO 3
CO 1	3	2	1	1	-	-	-	-	-	-	-	-	2	1	-
CO 2	3	3	1	1	-	-	-	-	-	-	-	-	2	1	-
CO 3	3	3	2	1	-	3	-	-	-	-	-	-	3	2	-
CO4	3	3	1	1	-	3	-	-	-	-	-	-	2	1	-
CO5	3	3	2	1	-	3	-	-	-	-	-	-	3	2	-
22LPE$17	**3**	**3**	**1**	**1**	-	**2**	-	-	-	-	-	-	**2**	**1**	-

b)CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.1, 2.4.1, 2.4.3, 2.4.4, 3.1.6, 4.1.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.1.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 4.1.2, 6.1.1, 6.2.1
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 4.1.2, 6.1.1, 6.2.1
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 4.1.2, 6.1.1, 6.2.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	40				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	40				100
ESE	20	40	40				100

22LPE$18	IMAGE PROCESSING

PREREQUISITES:	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To understand the basics of digital imaging and image transforms and to gain knowledge about various image processing techniques.	
UNIT - I	**DIGITAL IMAGE FUNDAMENTALS**	**9 Periods**
Digital image processing system- Elements of Visual perception- Mach-B and effect - Image Acquisition - Image Sensors, Vidicon and Digital Camera working principle-Image Sampling and Quantization- Pixels Relationships -Basics of Color image processing - Color Models.		
UNIT – II	**IMAGE TRANSFORMS**	**9 Periods**
2D transforms-Discrete Fourier Transform - Discrete Cosine Transform -Walsh, Hadamard, Slant, Haar, KLT, SVD Transforms, Discrete Wavelet transform. Properties and applications of Image Transforms.		
UNIT – III	**IMAGE ENHANCEMENT AND RESTORATION**	**9 Periods**
Gray level transformations - Histogram techniques -Spatial domain filters for image smoothing and sharpening - Frequency domain filters- - Image restoration- Degradation model- Noise models - Mean filters - Order statistics - Adaptive filters - Inverse filtering - Wiener filtering - Unconstrained and Constrained restoration.		
UNIT – IV	**IMAGE SEGMENTATION AND REPRESENTATION**	**9 Periods**
Detection of Discontinuities - Edge detection-Edge linking and boundary detection-Region growing, Region splitting and Merging –Watershed algorithm - Boundary representation – Chain Code – Polygonal approximation, signature, boundary segments – Boundary description – Shape number – Fourier Descriptor, Moments- Regional Descriptors.		
UNIT – V	**IMAGE COMPRESSION**	**9 Periods**
Need for data compression– Huffman coding - 1D, 2D Run Length Encoding-Shift Codes-Arithmetic Coding-Vector Quantization-Block Truncation Coding- Transform based coding–Compression standards -JPEG 2000–EZW– SPIHT.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Rafael C. Gonzales, Richard E. Woods, "**Digital Image Processing**", Third Edition, Pearson Education, 2010.*
2	*Anil Jain K. "**Fundamentals of Digital Image Processing**", PHI Learning Pvt. Ltd., 2011.*

REFERENCES:

1	*Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "**Digital Image Processing Using MATLAB**", Third Edition Tata McGraw Hill Pvt. Ltd., 2011.*
2	*Sinha G. R, Patel, B. C., "**Medical Image Processing: Concepts And Applications**", Prentice Hall, 2014.*
3	*Willliam K Pratt, "**Digital Image Processing**", John Willey, 2002.*
4	*Malay K. Pakhira, "**Digital Image Processing and Pattern Recognition**", First Edition, PHI Learning Pvt. Ltd., 2011*

COURSE OUTCOMES: Upon completion of the course, the students will have the ability to:		Bloom's Taxonomy Mapped
CO1	Explain the Digital Image fundamentals.	**K2**
CO2	Apply Image Transforms to image processing applications.	**K3**
CO3	Explain efficient Image enhancement and Restoration algorithms.	**K2**
CO4	Illustrate on Image segmentation and representation schemes.	**K3**
CO5	Describe basic image coding schemes and image compression standards.	**K3**

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	2	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 2	3	2	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 4	3	2	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 5	3	2	2	2	-	-	-	-	-	-	-	-	3	2	1
22LPE$18	**3**	**2**	**2**	**2**	-	-	-	-	-	-	-	-	**3**	**2**	**1**

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.3.1,1.4.1,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.3,2.4.4,3.1.1,3.1.5,3.1.6,3.2.1,3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.3,2.4.4,3.1.1,3.1.5,3.1.6,3.2.1,3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1
CO3	1.1.1,1.1.2,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.3,2.4.4,3.1.1,3.1.5,3.1.6,3.2.1,3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1
CO4	1.1.1,1.1.2,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.3,2.4.4,3.1.1,3.1.5,3.1.6,3.2.1,3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1
CO5	1.1.1,1.1.2,1.3.1,1.4.1,2.1.2,2.1.3,2.2.3,2.3.1,2.3.2,2.4.1,2.4.3,2.4.4,3.1.1,3.1.5,3.1.6,3.2.1,3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	40				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	40				100
ESE	20	40	40				100

22LPE$19	SPEECH SIGNAL PROCESSING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To learn the basic concepts and speech Analysis, analyze the quality and properties of speech signal, speech recognition and speech synthesis.	
UNIT – I	**SPEECH FUNDAMENTALS**	**9 Periods**
Basic Concepts: Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.		
UNIT – II	**SPEECH ANALYSIS**	**9 Periods**
Speech Analysis: Features, Feature Extraction and Pattern Comparison Techniques: Speech distortion measures – mathematical and perceptual – Log Spectral Distance, Cepstral Distances, Weighted Cepstral Distances and Filtering, Likelihood Distortions, Spectral Distortion using a Warped Frequency Scale, LPC, PLP and MFCC Coefficients, Time Alignment and Normalization – Dynamic Time Warping, Multiple Time–Alignment Paths.		
UNIT – III	**SPEECH MODELING**	**9 Periods**
Speech Modeling: Hidden Markov Models: Markov Processes, HMMs – Evaluation, Optimal State Sequence – Viterbi Search, Baum-Welch Parameter Re-estimation, Implementation issues.		
UNIT – IV	**SPEECH RECOGNITION**	**9 Periods**
Speech Recognition: Architecture of a large vocabulary continuous speech recognition system – acoustics and language models – ngrams, context dependent sub-word units; Applications and present status.		
UNIT – V	**SPEECH SYNTHESIS**	**9 Periods**
Speech Synthesis: Text-to-Speech Synthesis: Concatenative and waveform synthesis methods, subword units for TTS, intelligibility and naturalness – role of prosody, Applications and present status. Speech Coding Standards-An overview of ITU-T G.726, G.728 and G.729standards.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Lawrence Rabiner and Biing-Hwang Juang, "**Fundamentals of Speech Recognition**", Pearson Education, 2003*
2	*Daniel Jurafsky and James H Martin, "**Speech and Language Processing – An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition**", Pearson Education*

REFERENCES:

1	*Steven W. Smith, "**The Scientist and Engineer's Guide to Digital Signal Processing**", California Technical Publishing.*
2	*Thomas F Quatieri, "**Discrete-Time Speech Signal Processing – Principles and Practice**", Pearson Education.*
3	*Claudio Becchetti and Lucio Prina Ricotti, "**Speech Recognition**", John Wiley and Sons, Wiley-India Edition,1999.*
4	*Ben gold and Nelson Morgan, "**Speech and audio signal processing**", processing and perception of speech and music, Wiley- India Edition, 2006 .*

COURSE OUTCOMES: Upon completion of the course, the students will have the ability to:		Bloom's Taxonomy Mapped
CO1	Explain the basic concepts of speech Analysis.	K2
CO2	Analyze the quality and properties of speech signal.	K3
CO3	Describe the speech signal models.	K2
CO4	Analyze on speech recognition	K3
CO5	Analyze on Speech synthesis	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	1	1	2	-	-	-	-	-	-	-	-	2	1	1
CO 2	3	3	2	3	1	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	2	3	1	-	-	-	-	2	-	-	3	2	2
CO4	3	3	2	3	1	2	-	-	-	2	-	-	3	2	2
CO5	3	3	2	3	1	2	-	-	-	2	-	-	3	2	2
22LPE$19	**3**	**3**	**2**	**3**	**1**	**1**	-	-	-	**1**	-	-	**3**	**2**	**2**

b)CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 3.1.3, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.6, 3.2.1, 3.2.3, 3.4.1, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total 100%
CAT1	20	40	40				100
CAT2	20	40	40				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	40				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	40				100
ESE	20	40	40				100

22LPE$20	VLSI SIGNAL PROCESSING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To understand the concepts of pipelining and parallel processing in FIR, IIR filters, Bit Level Arithmetic Architecture and synchronous, asynchronous pipelining.	
UNIT – I	**INTRODUCTION TO DSP SYSTEMS, PIPELINING AND PARALLEL PROCESSING OF FIR FILTERS.**	**9 Periods**
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		
UNIT – II	**RETIMING, ALGORITHMIC STRENGTH REDUCTION**	**9 Periods**
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		
UNIT – III	**FAST CONVOLUTION, PIPELINING AND PARALLEL PROCESSING OF IIR FILTERS**	**9 Periods**
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 power-of- 2 decomposition, Clustered look-ahead pipelining, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.		
UNIT – IV	**BIT-LEVEL ARITHMETIC ARCHITECTURES**	**9 Periods**
Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and carrysave multipliers, Design of Lyon's bit-serial multipliers using Horner's rule, bit-serial FIRfilter, CSD representation, CSD multiplication using Horner's rule for precision improvement, Distributed Arithmetic fundamentals and FIR filters.		
UNIT – V	**NUMERICAL STRENGTH REDUCTION, SYNCHRONOUS, WAVE AND ASYNCHRONOUS PIPELINING**	**9 Periods**
Numerical strength reduction – subexpression elimination, multiple constant multiplication, iterative matching, synchronous pipelining and clocking styles, clock skew in edge-triggered singlephase clocking, two-phase clocking, wave pipelining, Asynchronous pipelining, bundled data versus dual rail protocol		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Keshab K. Parhi, "**VLSI Digital Signal Processing Systems, Design and implementation**", Wiley, Interscience, 2007.*
2	*U. Meyer – Baese, "**Digital Signal Processing with Field Programmable Gate Arrays**", Springer, Second Edition, 2004*

REFERENCES:

1	*Kung S. Y, H. J. While House, T. Kailath, "**VLSI and Modern Signal Processing**", Prentice Hall,1985.*
2	*Jose E. France, YannisTsividis, "**Design of Analog – Digital VLSI Circuits for Telecommunications and Signal Processing**", Prentice Hall, 1994.*
3	*Samir Palnitkar, **"Verilog HDL-A guide to Digital Design and synthesis,"***Second edition Pearson, Education in South Asia 2013.
4	*J.G. Proakis, Manolakis,"**Digital Signal Processing**", Prentice-Hall, 4th Edition, 2006*
5	*Medisetti V. K, "**VLSI Digital Signal Processing**", IEEE Press (NY), USA, 1995.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Apply Pipelining and Parallel Processing for DSP algorithms and FIR filters.	K3
CO2	Implement the algorithmic strength reduction techniques in filterstructures	K4
CO3	Apply the pipelining and parallel processing concepts in IIR filters	K3
CO4	Discuss Bit level Arithmetic Architectures	K2
CO5	Illustrate the clocking styles, synchronous and Asynchronous protocols suitable for VLSI Architectures.	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

	PO 1	PO2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	1	1	2	-	-	-	-	-	-	-	-	2	1	1
CO 2	3	3	2	3	1	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	2	3	1	-	-	-	-	2	-	-	3	2	2
CO4	3	3	2	3	1	2	-	-	-	2	-	-	3	2	2
CO5	3	3	2	3	1	2	-	-	-	2	-	-	3	2	2
22LPE$20	**3**	**3**	**2**	**3**	**1**	**1**	-	-	-	**1**	-	-	**3**	**2**	**2**

b)CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 3.1.3, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.6, 3.2.1, 3.2.3, 3.4.1, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	40				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	40				100
ESE	20	40	40				100

22LPE$21	NON LINEAR SIGNAL PROCESSING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To understand the basic concepts of Statistical characteristics, Nonlinear filter , Polynomial filter, Algorithms and Application of Nonlinear filters.	
UNIT – I	**LINEAR SIGNAL PROCESSING AND STATISTICAL PRELIMINARIES**	**9 Periods**
Random Variables and Distributions – Estimation – Point Estimation – Maximum likelihood, Estimators – M-Estimators – L-Estimators – R-Estimators – Scale Estimation - Noise Models.		
UNIT – II	**INTRODUCTION TO NON-LINEAR FILTERS**	**9 Periods**
Nonlinear filters – Measures of robustness – Order Statistics Filters – Median filters and their characteristics – Impulse noise filtering by median filters – Recursive and weighted median filters –Decision based filters – Switched Median filters.		
UNIT – III	**ADAPTIVE NONLINEAR AND POLYNOMIAL FILTERS**	**9 Periods**
Definition of Polynomial filters-Wiener filters-Robust estimation of scale-Adaptive filter based on local Statistics-Decision directed filters-Adaptive L Filters-Comparison of Adaptive nonlinear filters-Neural networks for Nonlinear filter.		
UNIT – IV	**ALGORITHMS**	**9 Periods**
Sorting and Selection Algorithm – Running Median Algorithm – Bitonic sort – Bubble sort and its variant – Shellsort – Quick sort – Bucket and Sample sort – Enumeration sort and Radix sort.		
UNIT – V	**NON LINEAR FILTER SCHEMES**	**9 Periods**
Basic structure for order statistics filtering –Systolic array implementation – Wave front array Implementation – General nonlinear filter structure – Signal dependent noise filtering – Computational complexity of general nonlinear filter model –Nonlinear Edge Detection–Implementation of decision logics.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Gonzalo R. Arce,"**Nonlinear Signal Processing: A Statistical Approach**", Wiley Interscience, 2004.*
2	*Loannis Pitas, Anastasios N. Venetsanopoulos,"**Nonlinear digital filters: principles and applications**", Springer, 1990 – Technology & Engineering.*

REFERENCES:

1	*S. K Mitra, "**Nonlinear Image Processing** ", Academic Press, 2000.*
2	*Jianwu Xu, "**Nonlinear Signal Processing Based on Reproducing**" Kernel Hilbert Space, Lambert Academic Publications ,2010*
3	*Kenneth E. Barner, Gonzalo R. Arce," **Nonlinear Signal and Image Processing**" ,WileyInterscience, 1st edition 2003.*
4	*W. J. Fitzgerald, R. L. Smith, A. T. Walden,"**Nonlinear and Nonstationary Signal Processing**", Cambridge University Press,2001*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain Maximum Likelihood estimation, point and scale estimation.	K2
CO2	Have in depth in knowledge Nonlinear filter	K2
CO3	Design Polynomial filters	K3
CO4	Analyze different sorting algorithms.	K3
CO5	Develop different architecture schemes for nonlinear filters.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	1	-	1	-	-	-	-	-	-	-	-	2	1	0
CO 2	3	3	1	2	-	-	-	-	-	-	-	-	2	2	1
CO 3	3	3	1	2	-	-	-	-	-	2	-	-	2	2	1
CO4	3	3	1	2	-	-	-	-	-	2	-	-	2	2	1
CO5	3	3	1	2	-	-	-	-	-	2	-	-	2	2	1
22LPE$21	**3**	**3**	**1**	**2**	-	-	-	-	-	**1**	-	-	**2**	**2**	**1**

b)CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.3, 2.3.1, 2.4.1, 2.4.3, 4.1.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 4.1.2, 4.2.2, 4.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 4.1.2, 4.2.2, 4.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 4.1.2, 4.2.2, 4.3.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 4.1.2, 4.2.2, 4.3.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.2, 3.2.3, 4.1.2, 4.2.2, 4.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total 100%
CAT1	20	40	40				100
CAT2	20	40	40				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	40				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	40				100
ESE	20	40	40				100

22LPE$22	NEURAL NETWORKS AND DEEP LEARNING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To cover the fundamentals of neural networks as well as some advanced topics such as recurrent neural networks, long short term memory cells and convolutional neural networks.	
UNIT – I	**Basics of Neural Networks**	**9 Periods**
Basic Neural Network: Perceptron; Multi-layer Perceptron; Back propagation; Stochastic gradient descent; Universal approximation theorem; Applications in imaging such as for denoising.		
UNIT – II	**Autoencoders**	**9 Periods**
Autoencoders: Autoencoder; Denoising auto-encoder; Sparse auto-encoder; Variational autoencoder; Applications in imaging such as segnet and image generation		
UNIT – III	Convolutional Neural Networks (CNN)	**9 Periods**
CNN Architectures – Convolution – Pooling Layers – Transfer Learning – Image Classification using Transfer Learning – Recurrent and Recursive Nets – Recurrent Neural Networks – Deep Recurrent Networks – Recursive Neural Networks –LeNet, Alex Net**-** Applications.		
UNIT – IV	**Deep Generative Models and Adversarial Network**	**9 Periods**
Deep Generative Models: Restricted Boltzmann machine; Deep Boltzmann machine; Recurrent Image Density Estimators (RIDE); Pixel RNN and Pixel CNN; Plug-and-Play generative networks. Generative Adversarial Network (GAN): GAN; Deep Convolutional GAN; Conditional GAN; Applications.		
UNIT – V	**Applications of Deep Learning**	**9 Periods**
Images segmentation – Object Detection – Automatic Image Captioning – Image generation with Generative adversarial networks – Video to Text with LSTM models – Attention models for Computer Vision – Case Study: Named Entity Recognition – Opinion Mining using Recurrent Neural Networks – Parsing and Sentiment Analysis using Recursive Neural Networks – Sentence Classification using Convolutional Neural Networks – Dialogue Generation with LSTMs.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Ian J. Goodfellow, Yoshua Bengio, Aaron Courville, **"Deep Learning"**, MIT Press, 2017.*
2	*Navin Kumar Manaswi, **"Deep Learning with Applications Using Python"**, Apress, 2018.*

REFERENCES:

1	*Phil Kim, **"Matlab Deep Learning: With Machine Learning, Neural Networks and Artificial Intelligence"**, Apress, 2017.*
2	*Ragav Venkatesan, Baoxin Li, **"Convolutional Neural Networks in Visual Computing",** CRC Press, 2018.*
3	*Francois Chollet, **"Deep Learning with Python"**, Manning Publications, 2018.*
4	*Stanford CS231n, **"Convolutional Neural Networks for Visual Recognition"**, http://cs231n.stanford.edu/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the basics of neural network	K3
CO2	Explain the auto decoders and CNN	K2
CO3	Gain knowledge on Deep Generative Models and Adversarial Network	K3
CO4	Apply the knowledge of deep learning to application	K3
CO5	Explain real world applications such as object recognition and Computer Vision, image and video processing, text analytic and other types of classifiers.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	2	-	1	1	-	-	-	-	-	-	-	-	2	1	-
CO 2	3	3	3	3	-	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	3	3	-	-	-	-	-	-	-	-	3	2	1
CO4	3	3	3	3	-	-	-	-	-	-	-	-	3	2	1
CO5	-	1	1	1	-	-	-	-	-	-	-	-	1	1	-
22LPE$22	**2**	**2**	**2**	**2**	-	-	-	-	-	-	-	-	**2**	**2**	**1**

b)CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 3.1.6, 3.2.1, 3.2.2, 4.1.2, 4.1.3
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4
CO5	2.2.4, 3.1.6, 4.1.2, 4.1.3

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total 100%**
CAT1	20	40	40				100
CAT2	20	40	40				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	40				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	40				100
ESE	20	40	40				100

22LPE$23	COMPUTER VISION ALGORITHMS AND APPLICATIONS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To Understand the fundamentals of Digital Image Processing, acquire knowledge on image fusion techniques	
UNIT – I	**FUNDAMENTALS OF DIGITAL IMAGE PROCESSING**	**9 Periods**
Review- Elements of visual perception, brightness, contrast, hue, saturation, mach band effect.2D image transforms- DFT, DCT, KLT, and SVD. Review of morphological image processing		
UNIT – II	**FEATURE EXTRACTION**	**9 Periods**
First and second order edge detection operators, Phase congruency, Localized feature extraction detecting image curvature, shape features Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Auto correlation, Co-occurrence features, run length features, Fractal model-based features, Gabor filter, wavelet features		
UNIT – III	**IMAGE REGISTRATION**	**9 Periods**
Preprocessing, Feature selection-points, lines, regions and templates Feature correspondence- Point pattern matching, Line matching, region matching Template matching. Transformation functions- Similarity transformation and Affine Transformation. Resampling Nearest Neighbour and Cubic Splines.		
UNIT – IV	**IMAGE FUSION**	**9 Periods**
Image Fusion-Overview of image fusion, pixel fusion, Multi resolution based fusion discrete wavelet transform, Curvelet transform. Region based fusion		
UNIT – V	**3D IMAGE VISUALIZATION**	**9 Periods**
Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, multiply connected surfaces, Image processing in 3D, Measurements on 3D images.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, **"Digital Image Processing Using MATLAB"**, Third Edition Tata McGraw Hill Pvt. Ltd., 2011.*
2	*Anil Jain K. **"Fundamentals of Digital Image Processing"**, PHI Learning Pvt. Ltd., 2011.*

REFERENCES:

1	*ArdeshirGoshtasby, "2**D and 3D Image registration for Medical, Remote Sensing and Industrial Applications**",John Wiley and Sons,2005.*
2	*John C.Russ, "**The Image Processing Handbook**", 7th Edition ,CRC Press,2007*
3	*Mark Nixon, Alberto Aguado, "**Feature Extraction and Image Processing**", Academic Press, 2008.*
4	*Rick S.Blum, Zheng Liu," **Multisensor image fusion and its Applications**",Taylor& Francis,2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Illustrate the fundamentals of Digital Image Processing	K2
CO2	Describe features extraction from Images.	K2
CO3	Apply the concepts of Image Registration Techniques for Pattern Matching	K3
CO4	Illustrate various image Fusion techniques	K2
CO5	Explain 3D image Visualization	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-
CO 2	3	2	1	2	3	-	-	-	-	-	-	-	2	2	1
CO 3	3	2	1	3	3	-	-	-	-	-	-	-	2	2	1
CO4	3	2	1	3	3	-	-	-	-	-	-	-	2	2	1
CO5	3	2	1	3	3	-	-	-	-	-	-	-	2	2	1
22LPE$23	**3**	**2**	**1**	**2**	**2**	-	-	-	-	-	-	-	**2**	**2**	**1**

b)CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.2, 3.1.5
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 4.1.2, 4.2.2, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 5.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.3, 2.4.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 4.1.2, 4.1.4, 4.2.2, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 5.3.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.3, 2.4.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 4.1.2, 4.1.4, 4.2.2, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 5.3.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.3, 2.4.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 4.1.2, 4.1.4, 4.2.2, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 5.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understandin g (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20				100
CAT2	40	40	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	40	40	20				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	40	40	20				100
ESE	40	40	20				100

22LPE$24	DIGITAL SIGNAL PROCESSORS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To understand the architecture of TMS32007x and various DSP Algorithms	
UNIT – I	**FUNDAMENTALS OF PROGRAMMABLE DSPs**	**9 Periods**
Von Neumann , Harvard Architecture, Modified Harvard and VLIW Architecture - Modified Bus Structures and Memory access in P-DSPs- Multiple access memory , Multi-ported memory ,Pipelining - Special Addressing modes in P- DSPs - On chip Peripherals- Computational accuracy in DSP processor- MAC		
UNIT – II	**TMS320C67x DSP ARCHITECTURE**	**9 Periods**
TMS320 DSP Family Overview- TMS320C6000 DSP Family Overview- TMS320C67x DSP Features- TMS320C67x DSP Architecture - Central Processing Unit (CPU),Internal Memory ,Memory and Peripheral		
UNIT – III	**TMS320C67x CPU DATA AND CONTROL PATHS**	**9 Periods**
General-Purpose Register Files -Functional Units - Register File Cross -Memory, Load, and Store Paths- Data Address Paths -Control Register File- Instruction Operation and Execution- Parallel Operations- Conditional Operations- Resource Constraints- Addressing Modes- Instruction Compatibility		
UNIT – IV	**TMS320C67x PIPELINE AND INTERRUPTS**	**9 Periods**
Pipeline Operation- Pipeline Execution of Instruction Types- Functional Unit Constraints- Performance Considerations- Interrupts -Overview- Globally Enabling and Disabling Interrupts- Individual Interrupt Control- Interrupt Detection and Processing- Performance Considerations- Programming Considerations		
UNIT – V	**IMPLEMENTATION OF BASIC DSP ALGORITHMS**	**9 Periods**
Study of time complexity of DFT and FFT algorithm, Use of FFT for filtering long data sequence,IIR and FIR Filters,Interpolation, Decimation , wavelet filter		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Avtar Singh and S. Srinivasan* ***"Digital Signal Processing",*** *Thomson Publications, 2004.*
2	*Lapsley et al. S. Chand & Co* ***"DSP Processor Fundamentals, Architectures & Features "***,*Wiley India Edition ,2000.*

REFERENCES:

1	*B. Venkata Ramani and M. Bhaskar,* ***"Digital Signal Processors, Architecture, Programming and Applications" ,*** *TMH, 2004.*
2	*Jonatham Stein* ***"Digital Signal Processing*** *", John Wiley, 2005*
3	*Avtar Singh and S. Srinivasan, "****Digital Signal Processing – Implementations using DSP Microprocessors****", cengage Learning India PrivateLimited, Delhi 2012*
4	***Programming and Applications****" – Tata McGraw – Hill Publishing Company Limited. NewDelhi, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Illustrate the Fundamentals of Programmable DSPs	K2
CO2	Describe various components of DSP Architecture	K2
CO3	Explain TMS320C67x CPU Data and control paths	K2
CO4	Describe various concepts of Pipelining and Interrupts	K2
CO5	Develop various DSP Algorithms	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	1	1	-	-	-	-	-	-	-	-	-	2	1	1
CO 2	3	2	2	3	2	-	-	-	-	1	-	-	3	2	1
CO 3	3	2	3	3	2	-	-	-	-	1	-	-	3	3	1
CO4	3	3	3	3	2	-	-	-	-	1	-	-	3	3	1
CO5	3	3	3	3	2	-	-	-	-	1	-	-	3	3	1
22LPE$24	**3**	**2**	**2**	**2**	**2**	-	-	-	-	**1**	-	-	**3**	**2**	**1**

b)CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.3.1, 3.1.4, 3.1.5
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 10.1.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 10.1.1
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 10.1.1
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 10.1.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understandin g (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Tota l %
CAT1	40	40	20				100
CAT2	40	40	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	40				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	40				100
ESE	40	40	20				100

VERTICAL-IV
VLSI DESIGN

22LPE$25	DIGITAL IC DESIGN					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
DIGITAL SYSTEM DESIGN		**PE**	**3**	**0**	**0**	**3**

Course Objective	To discuss various aspects of CMOS transistor level circuit design.	
UNIT – I	**MOS TRANSISTOR**	**9 Periods**
Introduction: Chip design complexity - Design Flow. PN Junction – MOS Capacitor Threshold Voltage - MOS transistor current expression – Body effect and I-V plots- Short channel transistors – Channel length modulation – Drain induced Barrier lowering – Sub-threshold leakage – Substrate and gate leakage – PMOS transistor – Transistor Capacitance.		
UNIT – II	**CMOS INVERTER**	**9 Periods**
CMOS inverter construction – Voltage transfer characteristics – Load line analysis – Trip point for short and long channel device inverter – Noise margin analysis – Long channel device inverter – Pass transistors – NMOS transistor ON resistance and Fall Delay. Transient Response – Dynamic Power – Short circuit power – Leakage power and Transistor stacks - Staking effect and sleep transistors.		
UNIT – III	**CMOS COMBINATIONAL DESIGN**	**9 Periods**
Implementing any Boolean logic function: Examples. Gate sizing – Logic gate capacitance – Gate delay - Parasitic delay – Logical effort – Gate delay – Path delay calculation and optimization formulation – Buffer insertion – Input ordering and asymmetric gates – Skewed gates. Pseudo NMOS logic – Pseudo NMOS inverter – Pseudo NMOS logical effort and CVSL – Dynamic gates and input Monotonicity – Domino logic and week keepers – Transmission gate logic.		
UNIT – IV	**ADDER AND MULTIPLIER SUB-SYSTEM DESIGN**	**9 Periods**
Ripple adder – Full adder circuit implementation – Full adder optimization - Carry skip adder – Carry select adder - Linear and square root carry select adder – Two's complement sign extension – Array multiplier – Timing analysis – Carry save multiplier – Signed multiplication.		
UNIT – V	**TIMING ANALYSIS**	**9 Periods**
Time borrowing- Master slave flip flop - Flop timing parameters –Max and Min delay of flop based systems – Flop min delay constraint –Verilog structures - Multiplexers - Binary Decoders – Comparators – Priority Encoders – Latches - Flip-Flops and Registers – SRAM - DRAM and Flash Memories.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Jan M. Rabaey, "**Digital Integrated Circuits: A Design Perspective**", PHI, Second Edition, 2012. 2009*
2	*N. Weste et. al., "**CMOS VLSI Design**", Third Edition, Pearson Education, 2013.*

REFERENCES:

1	*Uyemura, John P, "**Introduction to VLSI Circuits and Systems**", Wiley & Sons, 8th Reprint*
2	*R. Jacob Baker, "**CMOS: Circuit Design, Layout, and Simulation**", Wiley-IEEE, Revised Second Edition, 2008.*
3	*Pucknell, "**Basic VLSI Design**", Prentice Hall, 2006.*
4	*Sung-Mo Kang & Yusuf Leblebici, "**CMOS Digital Integrated Circuits Analysis And Design**", Mcgraw-Hill, 2022.*
5	*https://archive.nptel.ac.in/courses/108/106/108106158/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Characterize the MOS transistor and the key parameters.	K3
CO2	Evaluate CMOS inverter, dynamic and leakage power dissipated in a circuit	K2
CO3	Design a CMOS combinational circuit to perform a certain functionality.	K3
CO4	Describe the adder and multiplier unit.	K3
CO5	Calculate the maximum (worst case) operating frequency of the designed circuit	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	2	-	-	-	2	-	3	3	1	2
CO2	3	2	1	-	-	2	-	-	-	2	-	3	2	1	2
CO3	3	3	2	-	-	2	-	-	-	2	-	3	3	1	2
CO4	3	3	2	-	-	2	-	-	-	2	-	3	3	1	2
CO5	3	3	2	-	-	2	-	-	-	2	-	3	3	1	2
22LPE$25	3	3	2	-	-	2	-	-	-	2	-	3	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.4, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20				100
CAT2	40	40	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	50				100
ESE	40	40	20				100

22LPE$26	ANALOG IC DESIGN

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To develop MOS based Analog VLSI circuits and analyse their performance.	
UNIT – I	**MOS DEVICE MODELS**	**9 Periods**
Basic MOS Device Physics – General Considerations, MOS I/V Characteristics, Second Order effects, MOS Device models. Short Channel Effects and Device Models. Single Stage Amplifiers – Basic Concepts, Common Source Stage, Source Follower, Common Gate Stage, Cascode Stage.		
UNIT – II	**MOS AMPLIFIERS**	**9 Periods**
Differential Amplifiers – Single Ended and Differential Operation, Basic Differential Pair, Common- Mode Response, Differential Pair with MOS loads, Gilbert Cell. Frequency Response of Amplifiers – General Considerations, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage.		
UNIT – III	**CURRENT MIRRORS AND NOISE**	**9 Periods**
Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors, Differential Pair Passive and Active Current Mirrors. Noise – Types of Noise, Representation of Noise in circuits, Noise in single stage amplifiers, Noise in Differential Pairs.		
UNIT – IV	**CMOS OPERATIONAL AMPLIFIERS**	**9 Periods**
Feedback Amplifiers – General Considerations, Feedback Topologies, Effect of Loading. Operational Amplifiers – General Considerations, One Stage Op Amps, Two Stage Op Amps, Gain Boosting, Common-Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, Noise in Op Amps. Stability and Frequency Compensation.		
UNIT – V	**D/A - A/D CONVERTERS**	**9 Periods**
Ideal A/D and D/A converters, Quantization noise, Signed codes. D/A converter: Current scaling, Voltage scaling and Charge scaling D/A converters - Serial D/A converters - Serial A/D converters, Parallel - High performance A/D converters. Band gap References, PLL :Simple PLL, Charge Pumps PLL.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*B.Razavi, "**Design of Analog CMOS Integrated Circuits**", McGraw Hill Edition 2006, 33rd reprint 2016.*
2	*Paul. R.Gray, Robert G. Meyer, "**Analysis and Design of Analog Integrated Circuits**", Wiley, (4/e), 2001.*

REFERENCES:

1	*D. A. Johns and K. Martin, "**Analog Integrated Circuit Design**", Wiley,1997.*
2	*R. Jacob Baker, "**CMOS Circuit Design, Layout, and Simulation**", Wiley, (3/e),2010.*
3	*P.E.Allen, D.R. Holberg, "**CMOS Analog Circuit Design**", Oxford University Press,2012.*
4	*Paul R. Gray, Paul J. Hurst, Stephen H. Lewis, Robert G. Meyer, "**Analysis and Design of Analog Integrated Circuits**", 5th Edition, Wiley, 2009*
5	*Grebene, "**Bipolar and MOS Analog Integrated circuit design**", John Wiley & sons, Inc., 2003*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Characterize and model MOS transistors	K2
CO2	Operate MOS transistors in amplifiers with different characteristics	K3
CO3	Explain the different current mirrors and the noise involved in amplifiers	K2
CO4	Design and analyze operational amplifier circuits based on MOS transistors	K4
CO5	Explain the D/A and A/D converters suitable for analog design	K2

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO
CO1	3	2	2	-	-	2	-	-	-	2	-	3	3	1	2
CO2	3	2	2	-	-	2	-	-	-	2	-	3	3	1	2
CO3	3	2	1	-	-	2	-	-	-	2	-	3	2	1	2
CO4	2	1	2	-	-	2	-	-	-	2	-	3	2	1	2
CO5	2	1	2	-	-	2	-	-	-	2	-	3	2	1	2
22LPE$26	3	2	2	-	-	2	-	-	-	2	-	3	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.2, 1.2.1, 1.4.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.2, 1.2.1, 1.4.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20				100
CAT2	40	40	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		40	40	20			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	50				100
ESE	40	40	20				100

22LPE$27	LOW POWER VLSI

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To understand the low power design at architecture, algorithm and system level design.	
UNIT – I	**INTRODUCTION & SIMULATION POWER ANALYSIS**	**9 Periods**
Need for low power VLSI chips, sources of power dissipation Device & technology impact on low power, impact of technology scaling, technology & device innovation, Power estimation, SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static power, gate level capacitance estimation, architecture level analysis, Monte-Carlo simulation		
UNIT – II	**PROBABILISTIC POWER ANALYSIS & CIRCUIT LEVEL, LOGIC LEVEL DESIGN**	**9 Periods**
Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy, low power design, Power consumption in circuits, Flip-Flops & Latches design, high capacitance nodes, low power digital cells library, Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic.		
UNIT – III	**LOW POWER ARCHITECTURE & SYSTEMS**	**9 Periods**
Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components, low power memory design, Low-Power ROM and RAM Technologies.		
UNIT – IV	**LOW POWER CLOCK DISTRIBUTION**	**9 Periods**
Power dissipation in clock distribution, single driver vs distributed buffers, zero skew vs tolerable skew, chip & package co-design technique of clock network.		
UNIT – V	**ALGORITHM & ARCHITECTURAL LEVEL METHODOLOGIES**	**9 Periods**
Introduction, design flow, algorithmic level analysis & optimization, architectural level estimation & synthesis		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Kaushik Roy and Sharat Prasad, "**Low-Power CMOS VLSI Circuit Design**", Wiley, 2000*
2	*Gary K. Yeap, "**Practical Low Power Digital VLSI Design**", KAP, 2002*

REFERENCES:

1	*Rabaey, Pedram, "**Low power design methodologies**", Kluwer Academic, 1997*
2	*A.P.Chandrakasan, R.W.Broadersen, "**Low Power Digital CMOS Design**", Kluwer, Springer US, 2012.*
3	*Sung-Mo Kang, Yusuf Leblebici, "**CMOS Digital Integrated Circuits – Analysis and Design**", TMH, 2011.*
4	*G. Narendra and A. Chandrakasan, "**Leakage in Nanometer CMOS Technologies**", Springer, 2005.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the need of low power and simulation power analysis	K2
CO2	Analyze the probabilistic power analysis and circuit, logic level design	K3
CO3	Infer low power architecture & systems	K2
CO4	Illustrate the low power clock distribution	K2
CO5	Explain algorithm and architectural level methodologies for low power	K2

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	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	PSO 3
CO1	3	2	2	-	-	2	-	-	-	2	-	3	3	1	2
CO2	3	2	2	-	-	2	-	-	-	2	-	3	3	1	2
CO3	3	2	1	-	-	2	-	-	-	2	-	3	2	1	2
CO4	3	1	2	-	-	2	-	-	-	2	-	3	3	1	2
CO5	3	1	2	-	-	2	-	-	-	2	-	3	3	1	2
22LPE$27	3	2	2	-	-	2	-	-	-	2	-	3	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20				100
CAT2	40	40	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	50				100
ESE	40	40	20				100

22LPE$28	ASIC DESIGN					
PREREQUISITES		CATEGORY	L	T	P	C
NIL		PE	3	0	0	3

Course Objective	To gain knowledge on the fundamentals of ASIC design, programmable ASIC's, logical synthesis, simulation and testing of ASIC	
UNIT – I	**OVERVIEW OF ASIC AND PLD**	**9 Periods**
Types of ASICs - Design flow - CAD tools used in ASIC Design - Programming Technologies: Antifuse - Static RAM - EPROM and EEPROM technology, Programmable Logic Devices: ROMs and EPROMs - PLA - PAL. Gate Arrays - CPLDs and FPGA.		
UNIT – II	**PROGRAMMABLE ASICs**	**9 Periods**
Programmable ASIC logic cells for ACTEL and XILNX - DC & AC inputs and outputs- Clock and Powerinputs – I/O blocks, Programmable ASIC architecture - -Xilinx 4000- ACTEL's ACT-1,2,3 and their speed performance, Altera MAX 9000 –Altera Flex 8000/1000 - Spartan II and Virtex II FPGAs - Apex and Cyclone FPGAs.		
UNIT – III	**ASIC PHYSICAL DESIGN**	**9 Periods**
System Partitioning - Partitioning methods – Interconnect delay models and measurement ofdelay - Floor planning - Placement – Routing: Global routing - Detailed routing - Special routing - Circuit extraction – DRC		
UNIT – IV	**LOGIC SYNTHESIS, SIMULATION AND TESTING**	**9 Periods**
Design systems - Logic Synthesis - Verilog and VHDL synthesis - Types of simulation -Boundary scan test - Fault simulation - Automatic test pattern generation.		
UNIT – V	**HIGH PERFORMANCE ALGORITHMS FOR ASICS/ SOCS.**	**9 Periods**
High performance algorithms for ASICS/ SoCs as case studies – Canonic Signed Digit Arithmetic, KCM, Distributed Arithmetic, High performance digital filters for sigma-delta ADC, USB controllers, OMAP.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*M.J.S.Smith , "**Application - Specific Integrated Circuits**", Pearson,2014.*
2	*Steve Kilts, "**Advanced FPGA Design**", Wiley Inter-Science, 2007.*

REFERENCES:

1	*Roger Woods, John McAllister, Dr. Ying Yi, Gaye Lightbod, "**FPGA-based Implementation of Signal Processing Systems**", Wiley, 2008.*
2	*S.H. Gerez, "**Algorithms for VLSI Design Automation**", John Wiley & Sons, 2008.*
3	*Douglas J. Smith, "**HDL Chip Design**", Madison, AL, USA: Doone Publications, 1996.*
4	*Jose E. France, YannisTsividis, "**Design of Analog - Digital VLSI Circuits for Telecommunication and Signal Processing**", Prentice Hall,1994.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the ASIC design flow and programming technologies	K2
CO2	Discuss the programmable ASIC's	K2
CO3	Analyze the design trade off in various partitioning, placement and floorplanning.	K3
CO4	Illustrate the logical synthesis , simulation and testing aspects of ASIC	K2
CO5	Apply the high performance algorithm in ASIC and its applications.	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	2	-	-	-	2	-	3	2	1	2
CO2	3	1	1	-	-	2	-	-	-	2	-	3	2	1	2
CO3	3	2	1	-	-	2	-	-	-	2	-	3	2	1	2
CO4	3	1	1	-	-	2	-	-	-	2	-	3	2	1	2
CO5	3	2	2	-	1	2	-	-	-	2	-	3	3	1	2
22LPE$28	3	2	1	-	1	2	-	-	-	2	-	3	2	1	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.2.2, 3.3.2, 3.4.1, 3.4.2, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50%	50%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50%	50%				100%
ESE	40%	40%	20%				100%

22LPE$29	SYSTEM ON CHIP DESIGN

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To understand the concepts of SoC design and design flow.	
UNIT – I	**INTRODUCTION TO SOC AND PROCESSORS**	**9 Periods**
Introduction: Driving Forces for SoC - Components of SoC - Design flow of SoC Hardware/Software nature of SoC - Design Trade-offs - SoC Applications System-level Design: Processor selection-Concepts in Processor Architecture: Instruction set architecture (ISA), elements in Instruction Handing-Robust processors: Vector processor, VLIW, Superscalar, CISC, RISC—Processor evolution: Soft and Firm processors, Custom Designed processors- on-chip memory		
UNIT – II	**INTERCONNECT CUSTOMIZATION AND CONFIGURATION**	**9 Periods**
Interconnection: On-chip Buses: basic architecture, topologies, arbitration and protocols, Bus standards: AMBA, Core Connect, Wishbone, Avalon - Network-on chip: Architecture topologies-switching strategies - routing algorithms flow control, Quality-of-Service- Reconfigurability in communication architectures.		
UNIT – III	**MODERN IP BASED VLSI DESIGN**	**9 Periods**
IP based system design: Introduction to IP Based design, Types of IP, IP across design hierarchy, IP life cycle, Creating and using IP - Technical concerns on IP reuse – IP integration - IP evaluation on FPGA prototypes.		
UNIT – IV	**IMPLEMENTATION OF SOC**	**9 Periods**
SOC implementation: Study of processor IP, Memory IP, wrapper Design - Real-time operating system (RTOS), Peripheral interface and components, High-density FPGAs - EDA tools used for SOC design.		
UNIT – V	**SOC TESTING**	**9 Periods**
SOC testing: Manufacturing test of SoC: Core layer, system layer, application layer-P1500 Wrapper Standardization-SoC Test Automation (STAT).		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Michael J.Flynn, Wayne Luk, "**Computer system Design: Systemon-Chip**", Wiley-India, 2012*
2	*Youn-Long Steve Lin, "**Essential Issues in SOC Design: Designing complex systems-on-chip**",Springer, 2006*

REFERENCES:

1	*Wayne Wolf, "**Modern VLSI Design – IP based Design",** Prentice Hall, 4th Edition, 2008.*
2	*W.H.Wolf, "**Computers as Components: Principles of Embedded Computing System Design**", Elsevier, 2008.*
3	*Patrick Schaumont "**A Practical Introduction to Hardware/Software Co-design**", 2nd Edition, Springer, 2012.*
4	*Sudeep Pasricha, Nikil Dutt, "**On Chip Communication Architectures: System on Chip Interconnect**", Morgan Kaufmann Publishers, 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the overall System on Chip (SoC) design flow and system level design selection of processor.	K2
CO2	Analyze the system level design interconnections and customization architectures of all the modules.	K3
CO3	Explain and evaluate the IP based system design in order to reduce the design cost and time	K3
CO4	Implement and apply the IP based design for SoC	K2
CO5	Apply the testing knowledge on SoC.	K2

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO 2	PS O3
CO1	3	1	1	-	-	2	-	-	-	2	-	3	2	1	2
CO2	3	2	1	-	-	2	-	-	-	2	-	3	2	1	2
CO3	3	2	2	-	-	2	-	-	-	2	-	3	3	1	2
CO4	3	1	2	-	-	2	-	-	-	2	-	3	3	1	2
CO5	3	2	2	-	1	2	-	-	-	2	-	3	3	1	2
22LPE$29	3	2	2	-	1	2	-	-	-	2	-	3	3	`1	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping:

CO1	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.2.3, 3.3.2, 3.4.1, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 3.1.4, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50%	50%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50%	50%				100%
ESE	40%	40%	20%				100%

22LPE$30	PROGRAMMING FPGA USING HDLs

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To code digital function in Verilog HDL and System Verilog as synthesizable and non-synthesizable	
UNIT – I	**INTRODUCTION TO VERILOG, GATE AND DATAFLOW MODELING**	**9 Periods**
Hierarchical Modeling – Basic concepts – Modules and ports - Gate Level Modeling - Dataflow Modeling.		
UNIT – II	**BEHAVIORAL MODELING AND TASKS**	**9 Periods**
Behavioral Modeling, Switch Level Modeling, Tasks and Functions: Difference between tasks and functions, declaration, invocation, Useful Modeling Techniques.		
UNIT – III	**SYSTEM VERILOG**	**9 Periods**
Introduction, System Verilog declaration spaces, System Verilog Literal Values and Built-in Data Types, System Verilog User-Defined and Enumerated Types, system Verilog Arrays, Structures and Unions.		
UNIT – IV	**SYSTEM VERILOG MODELING**	**9 Periods**
System Verilog Procedural Blocks, Tasks and Functions, System Verilog Procedural Statements, Modeling Finite State Machines with System Verilog.		
UNIT – V	**INTERFACES AND DESIGN MODEL**	**9 Periods**
System Verilog Interfaces, A Complete Design Modeled with System Verilog, Behavioral and Transaction Level Modeling.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total:45 Periods**		

TEXT BOOKS:

1	*Samir Palnitkar, "**Verilog HDL**", 2nd Edition, Pearson Education, 2009.*
2	*Stuart Sutherland, Simon Davidmann, Peter Flake, Foreword by Phil Moorby, "**System Verilog For Design Second Edition A Guide to Using System Verilog for Hardware Design and Modelling**", Springer 2006.*

REFERENCES:

1	*T.R. Padmanabhan, B Bala Tripura Sundari, "**Design through Verilog HDL**", Wiley 2009.*
2	*ZainalabdienNavabi, "**Verilog Digital System Design**", TMH, 2nd Edition, 2005.*
3	*System Verilog 3.1a, Language Reference Manual, Accellera, 2004*
4	*Dr. S Ramachandran, "**Digital VLSI Systems Design A Design Manual for Implementation of Projects on FPGAs and ASICs using Verilog**", Springer, 2014.*
5	*Chris Spear, "**Systemverilog for verification a guide to learning the testbench Language Features**", Springer 2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the verilog coding and simulate any digital function using Verilog HDL	K2
CO2	Develop modeling based on tasks and functions using Verilog HDL code	K3
CO3	Explain the system verilog modeling	K2
CO4	Develop modeling based on FSM using system verilog HDL code	K3
CO5	Apply good coding techniques on system verilog interfaces and complete design model	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	3	1	1	2	-	-	-	2	-	3	3	2	2
CO2	3	2	3	1	1	2	-	-	-	2	-	3	3	2	2
CO3	3	2	3	1	1	2	-	-	-	2	-	3	3	2	2
CO4	3	2	3	1	1	2	-	-	-	2	-	3	3	2	2
CO5	3	2	3	1	1	2	-	-	-	2	-	3	3	2	2
22LPE$30	**3**	**2**	**3**	**1**	**1**	**2**	-	-	-	**2**	-	**3**	**3**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.3.1, 4.3.3, 5.1.1, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.3.1, 4.3.3, 5.1.1, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.3.1, 4.3.3, 5.1.1, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.3.1, 4.3.3, 5.1.1, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.3.1, 4.3.3, 5.1.1, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50%	50%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50%	50%				100%
ESE	40%	40%	20%				100%

22LPE$31	VLSI TESTING AND DESIGN FOR TESTABILITY

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To gain the basic knowledge on fault modeling and to get exposure to testability approaches and test vector generation algorithms for memory and logic circuits	
UNIT – I	**BASICS OF TESTING AND FAULT MODELING**	**9 Periods**
Role of testing in VLSI Design flow, Testing at different levels of abstraction, Fault, error, defect, diagnosis, yield, Types of testing, Rule of Ten, Defects in VLSI chip. Modelling basic concepts, Functional modelling at logic level and register level, structure models, logic simulation, delay models. Various types of faults, Fault equivalence and Fault dominance in combinational sequential circuits		
UNIT – II	**FAULT DIAGNOSIS**	**9 Periods**
Fault simulation applications, General fault simulation algorithms- Serial, and parallel, Deductive fault simulation algorithms.		
UNIT – III	**TEST GENERATION FOR COMBINATIONAL AND SEQUENTIAL CIRCUITS**	**9 Periods**
Combinational circuit test generation, Structural Vs Functional test, ATPG, Fault table method- Path sensitization method – Boolean difference method - Tolerance techniques –Fault in PLA – Test generation - Difference between combinational and sequential circuit testing.		
UNIT – IV	**TESTABILITY**	**9 Periods**
D-algorithm procedure, Problems, PODEM Algorithm. Problems on PODEM Algorithm. FAN Algorithm. Problems on FAN algorithm, Comparison of D, FAN and PODEM Algorithms. SCOAP, Design for Testability, Ad-hoc design, Generic scan based design.		
UNIT – V	**SELF-TEST AND TEST ALGORITHMS**	**9 Periods**
Classical scan based design, System level DFT approaches Test pattern generation for BIST, Circular BIST. BIST Architectures. Testable memory design-Test algorithms.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*M.L. Bushnell and V.D. Agrawal, "**Essentials of Electronic Testing for Digital, Memory andMixed-Signal VLSI Circuits**", Springer, 2014.*
2	*M. Abramovici, M.A. Breuer and A.D. Friedman, "**Digital Systems and Testable Design**", Jaico Publishing House, 11th edition, 2011.*

REFERENCES:

1	*A.L. Crouch, "**Design Test for Digital IC's and Embedded Core Systems**", Beijing China Electric Power Press, 2010.*
2	*P.K. Lala, "**Digital Circuit Testing and Testability**", Academic Press, 2002.*
3	Stroud, "**A Designer's Guide to Built-in Self-Test**", Kluwer Academic Publishers, 2002
4	*Parag K. Lala, "**Fault Tolerant and Fault Testable Hardware Design",** B S Publications, 2002.*
5	*M. Abramovici, M. Breuer, and A. Friedman, "**Digital Systems Testing and Testable Design**", IEEE Press, 1990.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the significance of testable design	K2
CO2	Identify the fault coverage using fault simulation algorithms	K2
CO3	Generate the test vectors for combinational and sequential circuits	K3
CO4	Test the combinational and sequential circuit using test generation algorithms	K3
CO5	Describe the self-test and test algorithms	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	1	2	-	-	-	2	-	3	3	2	2
CO2	3	2	2	1	1	2	-	-	-	2	-	3	3	2	2
CO3	3	2	2	1	1	2	-	-	-	2	-	3	3	2	2
CO4	3	2	2	1	1	2	-	-	-	2	-	3	3	2	2
CO5	3	2	2	1	1	2	-	-	-	2	-	3	3	2	2
22LPE$31	3	2	2	1	1	2	-	-	-	2	-	3	3	2	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping (Times New Roman, Size 11)

CO1	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.3.3, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.3, 3.4.1, 3.4.2, 4.3.3, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.3.3, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.3.3, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.3.3, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50%	50%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50%	50%				100%
ESE	40%	40%	20%				100%

22LPE$32	DESIGN FOR VERIFICATION USING UNIVERSAL VERIFICATION METHODOLOGY

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To provide the complete understanding on Universal Verification Methodology (UVM) testing, UVM verification and an experience on self checking UVM test benches	
UNIT – I	**INTRODUCTION**	**9 Periods**
Overview- The Typical UVM Testbench Architecture- The UVM Class Library-Transaction-Level Modeling (TLM) -Overview- TLM, TLM-1, and TLM-2.0 -TLM-1 Implementation- TLM-2.0 Implementation		
UNIT – II	**DEVELOPING REUSABLE VERIFICATION COMPONENTS**	**9 Periods**
Modeling Data Items for Generation - Transaction-Level Components - Creating the Driver - Creating the Sequencer - Connecting the Driver and Sequencer -Creating the Monitor - Instantiating Components- Creating the Agent - Creating the Environment -Enabling Scenario Creation -Managing of Test-Implementing Checks and Coverage		
UNIT – III	**UVM USING VERIFICATION COMPONENTS**	**9 Periods**
Creating a Top-Level Environment- Instantiating Verification Components - Creating Test Classes - Verification Component Configuration - Creating and Selecting a User-Defined Test – Creating Meaningful Tests- Virtual Sequences- Checking for DUT Correctness- Scoreboards- Implementing a Coverage Model		
UNIT – IV	**UVM USING THE REGISTER LAYER CLASSES**	**9 Periods**
Using The Register Layer Classes - Back-Door Access -Special Registers -Integrating a Register- Model in a Verification Environment- Integrating a Register Model- Randomizing Field Values- Pre-Defined Sequences		
UNIT – V	**ASSIGNMENT IN TESTBENCHES**	**9 Periods**
Assignment, APB: Protocol, Test bench Architecture, Driver and Sequencer, Monitor, Agent and Env; Creating Sequences, Building Test, Design and Testing of Top Module.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Kathleen A Meade & Sharon Rosenberg, "A **Practical Guide to Adopting the Universal Verification Methodology (UVM)**", Lulu Press, Second Edition, 2013.*
2	*Ray Salemi, **"The UVM Primer- A Step-By-Step Introduction to the Universal Verification Methodology"**, Boston Light Press, 2013.*

REFERENCES:

1	*https://www.udemy.com/learn-ovm-UVM/*
2	*http://www.testbench.in/ut_00_index.html*
3	*http://www.testbench.in/ot_00_index.html*
4	*https://www.accellera.org/images/downloads/standards/UVM/UVM_users_guide_1.2.pdf*
5	*Chris Spear & Greg Tumbush, **"System Verilog for Verification"**, Springer, Third Edition, 2012.*
6	*http://www.verificationguide.com*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the basic concepts of UVM	K2
CO2	Develop the actual and reusable verification components.	K3
CO3	Create and instantiate verification components for UVM	K3
CO4	Generate the register layer classes.	K3
CO5	Code test benches using UVM	K2

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	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	PSO 3
CO1	3	2	2	1	1	2	-	-	-	2	-	3	3	2	2
CO2	3	2	2	1	1	2	-	-	-	2	-	3	3	2	2
CO3	3	2	2	1	1	2	-	-	-	2	-	3	3	2	2
CO4	3	2	2	1	1	2	-	-	-	2	-	3	3	2	2
CO5	3	2	2	1	1	2	-	-	-	2	-	3	3	2	2
22LPE$32	**3**	**2**	**2**	**1**	**1**	**2**	-	-	-	**2**	-	**3**	**3**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.3, 3.4.1, 3.4.2, 4.3.3, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.3.3, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.3.3, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.3.3, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 2.4.3, 3.1.4, 3.1.6, 3.2.3, 3.4.1, 3.4.2, 4.3.3, 5.1.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40%	40%	20%				100%
CAT2	40%	40%	20%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50%	50%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50%	50%				100%
ESE	40%	40%	20%				100%

VERTICAL- V
BIO MEDICAL TECHNOLOGIES

22LPE$33	BIOSENSORS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To focus on biosensors and transducers associated with measurement of physiological phenomena, like pressure, displacement, flow, volume.	
UNIT - I	**TRANSDUCERS IN MEDICINE**	**9 Periods**
Classification of transducers, characteristic of transducers, Temperature transducers: Resistance temperature detector (RTD), Thermistor, strain gauge transducers, semiconductor transducers, catheter tip transducers, Piezoelectric transducer, Photoelectric transducers: photo-emissive tubes, photovoltaic cell, photoconductive cell, photodiodes, Flow transducers: magnetic, resistive and ultrasonic.		
UNIT – II	**ELECTRODES**	**9 Periods**
Biopotential Electrodes - Electrode electrolyte interface, polarization, polarizable and nonpolarizable electrodes, Electrode Behavior and, Circuit Models, Electrode-skin Interface and Motion Artifact, Body-Surface Recording Electrodes, Internal Electrodes: Needle & wire electrodes, Electrode Arrays, Microelectrodes: Metal supported metal, micropipette, microelectronic, properties of microelectrodes.		
UNIT – III	**CHEMICAL BIOSENSORS**	**9 Periods**
Chemical Biosensors Blood gas and Acid-Base Physiology, Electrochemical sensors, reference electrode, pH, pO2, pCO2 electrodes, Ion-Selective Field-Effect Transistor (ISFET), Noninvasive Blood-Gas Monitoring, Blood Glucose Sensors. Transcuteneous arterial oxygen tension & carbon dioxide tension monitoring enzyme electrode.		
UNIT – IV	**OPTICAL SENSOR AND RADIATION DETECTORS**	**9 Periods**
Principles of optical sensors, optical fiber sensors, Indicator mediated transducers, optical fiber temperature sensors, Proportional counter, Gas-ionisation chamber, Geiger counters, Scintillation detectors.		
UNIT – V	**BIOLOGICAL SENSORS**	**9 Periods**
Sensors / receptors in the human body, basic organization of nervous system-neural mechanism, Chemoreceptor: hot and cold receptors, barro receptors, sensors for smell, sound, vision, Ion exchange membrane electrodes, enzyme electrode, glucose sensors, immune sensors, Basic principles of MOSFET biosensors & BIOMEMS, Smart sensors.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*R. S. Khandpur, "Handbook of Biomedical Instrumentation", 2014, Third Edition, Tata McGraw Hill.*
2	*S.C. Cobbold, "Transducers for Biomedical Measurements", 2012, First Edition, Prentice Hall.*

REFERENCES:

1	*Carr& Brown, "Introduction to Biomedical Equipment Technology Pearson Edn", Asia. 2000, Fourth Edition.*
2	*Rao &Guha,"Principles of Medical Electronics & Biomedical Instrumentation", University Press, India, 2010, First Edition.*
3	*Iberall& Guyton, "Regulation & Control in Physiological System", Instruments Soc.USA,2009*
4	*A.V.S. De Renck, "Touch Heat & Pain", 2009, First Edition, Churchill Ltd. London. Wiley*

COURSE OUTCOMES: Upon completion of the course, the students will have the ability to :		Bloom's Taxonomy Mapped
CO1	Explain the applications of various sensors and transducers available for physiological and cellular measurements.	**K2**
CO2	Discuss and design the different types of sensors, electrodes, signal conditioning circuits for acquiring and recording various physiological parameters.	**K3**
CO3	Gain knowledge about the working of Chemical Biosensors.	**K2**
CO4	Narrate the operation of optical sensors and radiation detectors.	**K2**
CO5	Depict the Principle of working of various Biological Sensors.	**K2**

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

	PO 1	PO2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	2	2	3	-	-	-	-	-	-	-	-	3	2	1
CO 2	3	2	2	3	3	-	-	-	-	-	-	-	3	3	1
CO 3	3	2	2	3	3	-	-	-	-	-	-	1	3	3	1
CO 4	2	2	2	3	3	-	-	-	-	-	-	1	2	3	1
CO 5	2	3	2	3	3	-	-	-	-	-	-	1	2	3	1
22LPE$33	**3**	**3**	**2**	**3**	**3**	-	-	-	-	-	-	**1**	**3**	**3**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b)CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.2.2,2.2.3,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.4,3.1.6,3.2.3,3.3.1, 3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4.
CO2	1.1.1,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.4,3.1.6,3.2.3,3.3.1,3.3.2, 3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2.
CO3	1.1.1,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.2,2.4.2,2.4.3,2.4.4,3.1.1,3.1.4,3.1.6,3.2.3,3.3.1,3.3.2,3.4.1, 3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,12.3.2
CO4	1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.2,2.4.3,2.4.4,3.1.1,3.1.4,3.1.6,3.2.3,3.3.1,3.3.2,3.4.1, 3.4.2,4.1.1,4.1.2,4.1.3,4.1.4.4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,12.1.1
CO5	1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.2,2.4.3,2.4.4,3.1.1,3.1.4,3.1.6,3.2.3,3.3.1,3.3.2, 3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,12.2.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total 100%
CAT1		30%	70%				100%
CAT2		80%	20%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		70%	30%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		70%	30%				100%
ESE		80%	20%				100%

22LPE$34	BIO MEDICAL INSTRUMENTATION SYSTEMS

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To understand the basic theory of Bio potential Electrodes and to design the Bio potential amplifiers for acquisition of bio signals and its Measurements.	
UNIT - I	**BIOPOTENTIAL ELECTRODES**	**9 Periods**
Origin of bio potential and its propagation. Electrode-electrolyte interface, electrode– skin interface, half-cell potential, impedance, polarization effects of electrode – non polarizable electrodes. Types of electrodes - surface, needle and micro electrodes and their equivalent circuits. Recording problems - measurement with two electrodes.		
UNIT – II	**BIOPOTENTIAL MEASUREMENT**	**9 Periods**
Bio signal characteristics– frequency and amplitude ranges. ECG – Einthoven‘s triangle, standard 12 lead system, block diagram. Measurements of heart sounds - PCG. EEG – 10-20 electrode system, unipolar, bipolar and average mode, Functional block diagram. EMG – unipolar and bipolar mode, block diagram, EOG and ERG.		
UNIT – III	**BIOPOTENTIAL AMPLIFIER**	**9 Periods**
Need for bio-amplifier - single ended bio-amplifier, differential bio-amplifier – right leg driven ECG amplifier. Band pass filtering, isolation amplifiers – transformer and optical isolation - isolated DC amplifier and AC carrier amplifier. Artifacts and removal.		
UNIT – IV	**NON ELECTRICAL PHYSIOLOGICAL PARAMETER MEASUREMENT**	**9 Periods**
Temperature, respiration rate and pulse rate measurements, Plethysmography, Pulse oximetry, Blood Pressure: direct methods - Pressure amplifiers - systolic, diastolic, mean detector circuit, indirect methods - auscultatory method, oscillometric method, ultrasonic method. Blood flow - Electromagnetic and ultrasound blood flow measurement. Cardiac output measurement- Indicator dilution, dye dilution and thermo dilution method.		
UNIT – V	**BIOCHEMICAL MEASUREMENT**	**9 Periods**
Biochemical sensors - pH, pO2 and pCO2, Ion selective Field Effect Transistor (ISFET), immunologically sensitive FET (IMFET), Blood glucose sensors - Blood gas analyzers, colorimeter, flame photometer, spectrophotometer, blood cell counter, auto analyzer.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS:

1	*Joseph J. Carr and John M. Brown, "Introduction to Biomedical equipment technology", 4th Edition, 2014, Pearson Education.*
2	*John G.Webster, "Medical Instrumentation Application and Design", 4th Edition, 2009, John Wiley and Sons, New York.*

REFERENCES:

1	*Khandpur R.S, "Handbook of Biomedical Instrumentation", 3 rd Edition, 2014, Tata McGraw Hill, New Delhi.*
2	*L.A Geddes and L.E.Baker, "Principles of Applied Biomedical Instrumentation", 3 rd Edition, Reprint 2008, John Wiley and Sons*
3	*Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Biomedical Instrumentation and Measurements, 2nd Edition, 2015, Pearson Education India.*
4	*Myer Kutz, "Standard Handbook of Biomedical Engineering & Design", 2009, Second Edition, McGraw-Hill Publisher.*

COURSE OUTCOMES: Upon completion of the course, the students will have the ability to :		**Bloom's Taxonomy Mapped**
CO1	Describe the electrode behavior and circuit models.	K1
CO2	Discuss the fundamentals of Bio potential recording.	K2
CO3	Design various bio amplifiers.	K3
CO4	Measure and analyze various nonelectrical physiological parameters.	K3
CO5	Measure and analyze various biochemical parameters.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3	2	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 2	3	2	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	2	2	-	-	-	-	-	-	-	1	3	2	1
CO 4	3	2	2	2	-	-	-	-	-	-	-	1	3	2	1
CO 5	3	2	2	2	-	-	-	-	-	-	-	1	3	2	1
22LPE$34	**3**	**3**	**2**	**2**	-	-	-	-	-	-	-	**1**	**3**	**2**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b)CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.3.1,1.4.1,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.3,2.4.4,3.1.1,3.1.5,3.1.6,3.2.1,3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.3,2.4.4,3.1.1,3.1.5,3.1.6,3.2.1,3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1
CO3	1.1.1,1.1.2,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.3,2.4.4,3.1.1,3.1.5,3.1.6,3.2.1,3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.112.1.1,12.2.2
CO4	1.1.1,1.1.2,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.3,2.4.4,3.1.1,3.1.5,3.1.6,3.2.1,3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,12.1.2,12.2.1
CO5	1.1.1,1.1.2,1.3.1,1.4.1,2.1.2,2.1.3,2.2.3,2.3.1,2.3.2,2.4.1,2.4.3,2.4.4,3.1.1,3.1.5,3.1.6,3.2.1,3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.112.1.2,12.2.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total 100%**
CAT1	30%	70%					100%
CAT2		20%	80%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30%	70%					100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		70%	30%				100%
ESE	40%	40%	20%				100%

22LPE$35	MEDICAL IMAGING SYSTEMS					
PREREQUISITES:		CATEGORY	L	T	P	C
NIL		PE	3	0	0	3

Course Objective	To understand the principle of operation of different Medical imaging techniques.	
UNIT - I	**X – RAYS**	**9 Periods**
Principle and production of soft X – Rays, X- ray machine and digital radiography, principles of Angiography and Fluoroscopic Techniques, digital subtraction angiography, mammography		
UNIT – II	**CT AND ULTRASOUND IMAGING**	**9 Periods**
CT principle- Multi section Radiography, Computerized Axial Tomography, Type of Detection, image reconstruction, Spiral CT, Transverse Tomography,3D Imaging. Ultrasonic frequency for medical application, different modes of Display A, B and M, ultrasonic probes, Real time echo and 2D scanner.		
UNIT – III	**COMPUTER AIDED TOMOGRAPHY**	**9 Periods**
Need for sectional images, Principles of sectional scanning, Method of convolution and Back Propagation, Methods of reconstruction, Multislice CT, artifacts.		
UNIT – IV	**OPTICAL SENSOR AND RADIATION DETECTORS**	**9 Periods**
Principle of MRI, MRI instrumentation, Imaging Different Sections of the Body, Tissue Characterization, MR Spectroscopy, Functional MRI. Alpha, Beta, Gamma Emission, different types of Radiation Detectors, Functions of Gamma Camera, PET, SPECT, PET/CT, PET/MRI.		
UNIT – V	**ASSESSMENT PARAMETERS**	**9 Periods**
Global parameter assessment, spatial – frequency assessment, Image – processing assessment, Observer assessment, Image discrimination models, figure of merit, Comparing model to human Performance.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS

1	*Richard L. Van Metter, Jacob Beutel, Harold L. Kundel, Handbook of Medical Imaging, Volume 1. Physics and Psychophysics, SPIE, 2000 First Edition.*
2	*Chesney D. N., Chesney M. O. Radio graphic imaging, 1989, Fourth Edition, CBS Publications, New Delhi.*

REFERENCES:

1	*Donald W. McRobbice, Elizabeth A. Moore, Martin J. Grave and Martin R. Prince MRI from Picture to proton, Cambridge University press, Second edition, New York 2007.*
2	*Frederick W Kremkau, Diagnostic Ultrasound Principles & Instruments, Saunders Elsevier, 2005, Sixth Edition.*
3	*Jerry L. Prince, Jnathan M. Links, Medical Imaging Signals and Systems- Pearson Education Inc. 2014, Sixth Edition.*
4	*Peggy, W., Roger D. Ferimarch, MRI for Technologists, Second Edition, 2000, , McGraw Hill, New York.*

COURSE OUTCOMES: Upon completion of the course, the students will have the ability to :		Bloom's Taxonomy Mapped
CO1	Explain the functionalities and applications of X ray in medicine.	K1
CO2	Narrate the image acquisition procedures using CT.	K2
CO3	Depict the suitable projection methods for anatomy and biology specific.	K2
CO4	Discuss the applications of magnetic field in the field of medicine.	K3
CO5	Explain the assessment method to quantify the presence of noise in the image.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	3	1	2	-	-	-	-	-	-	-	-	2	2	1
CO 2	3	3	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	2	3	-	-	-	-	-	-	-	-	3	2	1
CO 4	3	3	1	2	-	-	-	-	-	-	-	1	2	2	1
CO 5	3	3	1	3	-	-	-	-	-	-	-	1	2	2	1
22LPE$35	**3**	**3**	**2**	**3**	-	-	-	-	-	-	-	**1**	**3**	**2**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b)CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.5,3.3.2,3.4.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.5,3.1.6,3.3.1,3.3.2,3.4.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1
CO3	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.5,3.2.2,3.3.1,3.3.2,3.4.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.4
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.5,3.3.2,3.4.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,12.1.2
CO5	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.5,3.3.2,3.4.1,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.4,12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total 100%
CAT1	30%	70%					100%
CAT2		20%	80%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30%	70%					100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		70%	30%				100%
ESE		80%	20%				100%

22LPE$36	BIOINFORMATICS FOR BIO MEDICAL ENGINEERS

PREREQUISITES :	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To be familiar with the Bioinformatics tools and Modelling Techniques.	
UNIT - I	**INTRODUCTION**	**9 Periods**
Need for Bioinformatics technologies – Overview of Bioinformatics technologies Structural bioinformatics – Data format and processing – Secondary resources and applications – Role of Structural bioinformatics - Biological Data Integration System		
UNIT – II	**DATAWAREHOUSING AND DATAMINING IN BIOINFORMATICS**	**9 Periods**
Bioinformatics data – Data warehousing architecture – data quality – Biomedical data analysis – DNA data analysis – Protein data analysis – Machine learning – Neural network architecture and applications in bioinformatics		
UNIT – III	**MODELING FOR BIOINFORMATICS**	**9 Periods**
Hidden markov modeling for biological data analysis – Sequence identification –Sequence classification – multiple alignment generation – Comparative modeling –Protein modeling – genomic modeling – Probabilistic modeling – Bayesian networks – Boolean networks - Molecular modeling – Computer programs for molecular modeling.		
UNIT – IV	**PATTERN MATCHING AND VISUALIZATION**	**9 Periods**
Gene regulation – motif recognition – motif detection – strategies for motif detection – Visualization –Fractal analysis – DNA walk models – one dimension – two dimension – higher dimension – Game representation of Biological sequences – DNA, Protein, Amino acid sequences.		
UNIT – V	**MICROARRAY ANALYSIS**	**9 Periods**
Microarray technology for genome expression study – image analysis for data extraction – preprocessing – segmentation – gridding – spot extraction – normalization, filtering – cluster analysis – gene network analysis – Compared Evaluation of Scientific Data Management Systems – Cost Matrix – Evaluation model - Benchmark – Tradeoffs		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS

1	*Yi-Ping Phoebe Chen Edition, "BioInformatics Technologies", , 2007.First Edition, First Indian Reprint, Springer Verlag.*
2	*Bryan Bergeron, "Bio Informatics Computing", Second Edition, 2003, Pearson Education.*

REFERENCES:

1	*Arthur M Lesk, "Introduction to Bioinformatics", Second Edition, Press, 2004, Oxford University.*
2	*Thomas Dandekar , Meik Kunz, "Bioinformatics",Springer, 2023.*

COURSE OUTCOMES: Upon completion of the course, the students will have the ability to :		Bloom's Taxonomy Mapped
CO1	Explain the basic concepts of Bio informatics	K1
CO2	Illustrate the Various techniques used in Data mining	K2
CO3	Model the Bio informatics system.	K3
CO4	Gain knowledge about pattern matching and visualization	K2
CO5	Describe about Micro array analysis	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

	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	PSO 3
CO 1	2	1	1	2	-	-	-	-	-	-	-	-	2	1	1
CO 2	2	2	1	2	-	-	-	-	-	-	-	-	2	1	1
CO 3	3	3	2	3	-	-	-	-	-	-	-	1	3	2	1
CO 4	1	2	1	2	-	-	-	-	-	-	-	-	1	1	1
CO 5	2	2	2	3	-	-	-	-	-	-	-	1	2	2	1
22LPE$36	**2**	**2**	**2**	**3**	-	-	-	-	-	-	-	**1**	**2**	**2**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b)CO and Key Performance Indicators Mapping

CO1	1.1.2,1.4.1,2.1.3,2.3.1,2.4.1,2.4.2,3.1.1,3.3.2,3.4.1,4.1.2,4.1.3,4.2.1
CO2	1.1.1,1.1.2,2.1.2,2.1.3,2.3.1,2.4.1,2.4.2,3.1.1,3.1.6,3.3.2,3.4.1,4.1.2,4.1.3,4.1.4,4.2.1
CO3	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,3.1.1,3.1.6,3.2.1,3.2.2, 3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,12.1.1
CO4	1.1.2,2.1.2,2.1.3,2.2.2,2.3.1,2.4.1,2.4.2,2.4.3,3.1.1,3.3.2,3.4.1,4.1.2,4.1.3,4.2.1
CO5	1.1.1,1.1.2,1.3.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,3.1.1,3.1.6,3.2.1,3.2.2,3.2.3,,3.3.1, 3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.2,12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total 100%
CAT1	30%	70%					100%
CAT2		80%	20%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30%	70%					100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		70%	30%				100%
ESE		80%	20%				100%

22LPE$37	BIO TELEMETRY AND TELEMEDICINE

PREREQUISITES:	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To familiarize students with basic concepts of Biotelemetry & Telemedicine and to apply the concepts.	
UNIT - I	**BASICS OF TELEMETRY**	**9 Periods**
Introduction, fundamental of RF telemetry, basic telemetry, system components of coding resolution, pulse code modulation, PCM multiplexing and conversion, PCM data transmission, PCM PSD system. Theoretical comparison of telemetry systems, sub modulation methods, power efficiency of combined systems, Practical constraint of telemetry methods optimized power efficiency.		
UNIT – II	**BIOTELEMETRY**	**9 Periods**
Measurement of Blood pressure – Direct Methods and Indirect Methods -Temperature - Respiration rate - Heart rate measurement - Apnea detectors -Oximetry -Pulse oximeter, Ear oximeter - Computerized patient monitoring system– Bedside, Central Monitoring system – Biotelemetry: Basics components, and its different types.		
UNIT – III	**TELEMEDICINE AND HEALTH**	**9 Periods**
History and Evolution of telemedicine, Functional diagram of telemedicine system, Telemedicine, Telehealth, Tele care, Organs of telemedicine, Global and Indian scenario, Ethical and legal aspects of Telemedicine - Confidentiality, Social and legal issues, Safety and regulatory issues, Advances in Telemedicine.		
UNIT – IV	**TELEMEDICAL TECHNOLOGY**	**9 Periods**
Principles of Multimedia - Text, Audio, Video, data, Data communications and networks, PSTN,POTS, ANT, ISDN, Internet, Air/ wireless communications: GSM satellite, and Micro wave, Modulation techniques, Types of Antenna, Integration and operational issues, Communication infrastructure for telemedicine – LAN and WAN technology. Satellite communication. Mobile hand held devices and mobile communication. Internet technology and telemedicine using world wide web (www). Video and audio conferencing. Clinical data – local and centralized.		
UNIT – V	**TELEMEDICAL APPLICATIONS**	**9 Periods**
Telemedicine access to health care services – health education and self care. · Introduction to robotics surgery, telesurgery. Telecardiology, Teleoncology, Telemedicine in neurosciences, Electronic Documentation, e-health services security and interoperability., Telemedicine access to health care services – health education and self care, Business aspects - Project planning and costing, Usage of telemedicine.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOKS

1	*Fundamentals of Remote Sensing – by George Joseph, second Edition, 2005, Universities press.*
2	*Khandpur R.S, "Hand-book of Biomedical Instrumentation", 2nd Edition, 2003,Tata McGraw Hill.*

REFERENCES:

1	*Wootton, R., Craig, J., Patterson, V. (Eds.), "Introduction to Telemedicine. Royal Society of Medicine" Press Ltd, 2006, Second Edition, Taylor & Francis.*
2	*Rao &Guha,"Principles of Medical Electronics & Biomedical Instrumentation", University Press, India. O'Carroll, P.W., Yasnoff, W.A., Ward, E., Ripp, L.H., Martin, E.L. (Eds), Springer, 2003, First Edition, "Public Health Informatics and Information Systems".*
3	*Ferrer-Roca, O., Sosa - Iudicissa, M. (Eds.), Handbook of Telemedicine. IOS Press (Studies in Health Technology and Informatics, Volume 54, 2002.*
4	*Simpson, W. Video over IP. A practical guide to technology and applications, 2006, first Edition, Focal Press Elsevier.*

COURSE OUTCOMES: Upon completion of the course, the students will have the ability to:		**Bloom's Taxonomy Mapped**
CO1	Describe basic Telemetry, Biotelemetry & Telemedicine system/ subsystems.	K2
CO2	Explain the application of Biotelemetry & Telemedicine in modern healthcare technology.	K2
CO3	Identify and describe modern telemedical technologies.	K2
CO4	Explain the Tele medicine Technology.	K3
CO5	Apply the tele medicine principles.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

	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**	**PSO 3**
CO 1	2	1	1	1	-	-	-	-	-	-	-	-	2	1	-
CO 2	2	1	0	1	-	-	-	-	-	-	-	-	1	1	-
CO 3	3	2	2	3	-	-	-	-	-	-	-	-	3	2	1
CO 4	2	1	2	2	-	-	-	-	-	-	-	1	2	1	1
CO 5	2	1	0	3	-	-	-	-	-	-	-	1	1	1	1
22LPE$37	**3**	**2**	**1**	**2**	-	-	-	-	-	-	-	**1**	**2**	**2**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.2,1.4.1,2.1.3,2.2.2,3.1.1,4.1.2,4.1.3
CO2	1.1.2,1.4.1,2.2.2,3.1.1,4.1.2,4.1.3
CO3	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.3.1,2.4.1,3.1.1,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4
CO4	1.1.2,1.3.1,1.4.1,2.1.2,2.1.3,2.2.2,2.4.1,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,12.1.1
CO5	1.1.2,1.4.12.2.2,4.1.2,4.1.3,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total 100%**
CAT1		70%	30%				100%
CAT2		80%	20%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		70%	30%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		70%	30%				100%
ESE		80%	20%				100%

22LPE$38	BIO MEDICAL SIGNAL PROCESSING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To Identify the fundamentals of Biomedical signals and its spectral analysis, and to design adaptive filtering techniques for cancelling noise and investigate wavelets involved in classification of bio-signals.	
UNIT – I	**Signals and Systems**	**9 Periods**
Characteristics of dynamic Biomedical signals-ECG, EEG, EMG – Noises-Random, Structured and Physiological noises – Filters – IIR and FIR filters.		
UNIT – II	**Spectrum Estimation**	**9 Periods**
Spectral Estimation – Blackman Tukey method – Periodogram – Model based estimation – Application in heart rate variability, PCG signals.		
UNIT – III	**Spectrum Analysis**	**9 Periods**
Spectrum – Power Spectral Density function – Cross Spectral Density and Coherence function – Cepstrum and Homomorphic filtering – Estimation of mean of finite time signals.		
UNIT – IV	**Time Series Analysis**	**9 Periods**
Time series analysis – Linear prediction models – Process order estimation – Lattice representation – Non-stationary process – Fixed segmentation – Adaptive segmentation – Application in EEG, PCG signals – Time varying analysis of Heart-rate variability – Model based ECG simulator.		
UNIT – V	**Wavelet Detection and Bio-signal Classification**	**9 Periods**
Wavelet detection in ECG – Structural features – Matched filtering – Adaptive wavelet detection – Detection of overlapping wavelets – Signal classification and recognition – Statistical signal classification – Linear discriminant function – Direct feature selection and ordering.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Rangaraj, M. Rangayyan, "Biomedical Signal Processing", 2014,1st edition, IEEE press, New York.*
2	*W. J. Tompkins, ed., Biomedical Signal Processing; Prentice Hall, 1995.*

REFERENCES

1	*N. Vyas, "Biomedical Signal Processing", 2011, 1st edition, University Science Press, New Delhi.*
2	*E.N. Bruce, Biomedical Signal Processing and Signal Modelling, Second edition, 2001,John Wiley and Sons.*
3	*M. Akay: Wavelets and Time frequency methods for Biomedical signal Processing; IEEE Press, 1995.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Gain knowledge about the characteristics of Biomedical signals.	K2
CO2	Acquire knowledge in the spectral analysis of Biosignals.	K2
CO3	Gain knowledge about the time series analysis of Biosignals.	K2
CO4	Discuss the Spectrum of Biosignals.	K3
CO5	Analyse the Biosignal Classification.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

	PO 1	PO2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO 3
CO 1	2	-	1	1	-	-	-	-	-	-	-	-	2	1	-
CO 2	3	3	3	3	-	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	3	3	-	-	-	-	-	-	-	1	3	2	1
CO 4	3	3	3	3	-	-	-	-	-	-	-	1	3	2	1
CO 5	-	1	1	1	-	-	-	-	-	-	-	1	1	1	1
22LPE$38	**3**	**2**	**3**	**3**	-	-	-	-	-	-	-	**1**	**3**	**2**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,3.1.6,3.2.1,3.2.2,4.1.2,4.1.3
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.6, 3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.6, 3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,12.1.1
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.6, 3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,12.2.2
CO5	2.2.4,3.1.6,4.1.2,4.1.3,12.3.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total 100%**
CAT1		70%	30%				100%
CAT2		80%	20%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		70%	30%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		70%	30%				100%
ESE		80%	20%				100%

22LPE$39	WEARABLE TECHNOLOGIES					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**

Course Objective	To have a basic knowledge of wireless health systems and to study about its applications.	
UNIT – I	**SENSORS**	**9 Periods**
Need for wearable systems, Sensors for wearable systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Radiant thermal sensor, Wearable motion sensors, CMOS –Based Biosensors, E-Textiles, Bio compatibility.		
UNIT – II	**SIGNAL PROCESSING**	**9 Periods**
Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, light weight signal processing, Rejection of irrelevant information, Datamining.		
UNIT – III	**ENERGY HARVESTING FOR WEARABLE DEVICES**	**9 Periods**
Solar cell, Vibration based, Thermal based, Human body as a heat source for power generation, Hybrid thermoelectric photovoltaic energy harvests, Thermopiles.		
UNIT – IV	**WIRELESS HEALTH SYSTEMS**	**9 Periods**
Need for wireless monitoring, Definition of Body Area Network, BAN and Healthcare, Technical Challenges-System security and reliability, BAN Architecture – Introduction, Wireless communication techniques.		
UNIT – V	**APPLICATIONS OF WEARABLE SYSTEMS**	**9 Periods**
Medical Diagnostics, Medical Monitoring-Patients with chronic disease, Hospital patients, Elderly patients, Multi parameter monitoring, Neural recording, Gait analysis, Sports Medicine, Smart Fabrics.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

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

REFERENCES

1	*Hang,Yuan-Ting, "Wearable medical sensors andsystems",Springer-2014, First Edition.*
2	*Mehmet R. Yuce, Jamil Y. Khan, "Wireless Body Area Networks Technology, Implementation and Applications", 2012, First Edition ,Pan Stanford Publishing Pvt. Ltd, Singapore.*
3	*Guang-ZhongYang (Ed.), "Body Sensor Networks, "Springer,2006, Second Edition.*
4	*Andreas Lymberis, Danilo de Rossi ,'Wearable eHealth systems for Personalized Health Management - State of the art and future challenges ' IOS press, The Netherlands,2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain about the sensor and signal processing requirement of wearable systems.	K2
CO2	Analyze the communication and security aspects.	K3
CO3	Elucidate the level of energy involvement in wearable systems.	K2
CO4	Summarize the concepts of Body area networks.	K2
CO5	Build and analyze of some biomedical equipment.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping															
	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**	**PSO 3**
CO 1	3	2	1	-	-	-	-	-	-	-	-	-	2	1	-
CO 2	3	3	3	3	-	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	3	3	-	-	-	-	-	-	-	-	3	2	1
CO 4	2	2	1	-	-	-	-	-	-	-	-	1	2	1	-
CO 5	3	3	3	3	-	-	-	-	-	-	-	1	3	2	1
22LPE$39	**3**	**3**	**3**	**2**	-	-	-	-	-	-	-	**1**	**3**	**2**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.4,3.1.6
CO2	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.3,3.1.4,3.1.6,3.2.1, 3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4
CO3	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.3,3.1.4,3.1.5,3.1.6, 3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4
CO4	1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.3,3.1.4,3.1.6,12.2.2
CO5	1.1.1,1.1.2,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.3,3.1.4,3.1.5,3.1.6, 3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,12.3.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total 100%**
CAT1		70%	30%				100%
CAT2		80%	20%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		70%	30%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		70%	30%				100%
ESE		80%	20%				100%

22LPE$40	HOSPITAL SAFETY AND MANAGEMENT					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**PE**	**3**	**0**	**0**	**3**

Course Objective	To understand the fundamentals of hospital administration and management and to learn the quality and safety aspects in hospitals.	
UNIT – I	**HOSPITAL ADMINISTRATION**	**9 Periods**
Distinction between Hospital and Industry, Challenges in Hospital Administration – Hospital Planning-Equipment Planning – Functional Planning - Current Issues in Hospital Management – Telemedicine - Bio-Medical Waste Management.		
UNIT – II	**HUMAN RESOURCE MANAGEMENT IN HOSPITAL**	**9 Periods**
Principles of HRM – Functions of HRM – Profile of HRD Manager – Tools of HRD –Human Resource Inventory – Manpower Planning. Different Departments of Hospital, Recruitment, Selection, Training Guidelines –Methods of Training – Evaluation of Training – Leadership grooming and Training, Promotion – Transfer, Communication – nature, scope, barriers, styles and modes of communication.		
UNIT – III	**MARKETING RESEARCH PROCESS**	**9 Periods**
Marketing information systems - assessing information needs, developing & disseminating information - Market Research process - Other market research considerations – Consumer Markets & Consumer Buyer Behaviour - Model of consumer behaviour - The buyer decision process - Model of business buyer behavior – Major types of buying situations - WTO and its implications.		
UNIT – IV	**HOSPITAL INFORMATION SYSTEMS & SUPPORTIVE SERVICES**	**9 Periods**
Management Decisions and Related Information Requirement - Clinical Information Systems - Administrative Information Systems - Support Service Technical Information Systems –Medical Transcription, Medical Records Department – Central Sterilization and Supply Department – Pharmacy– Food Services - Laundry Services.		
UNIT – V	**QUALITY AND SAFETY ASPECTS IN HOSPITAL**	**9 Periods**
Quality system – Elements, implementation of quality system, Documentation, Quality auditing, International Standards ISO 9000 – 9004 – Features of ISO 9001 – ISO 14000 – Environment Management Systems. NABA, JCI, NABL. Security – Loss Prevention – Fire Safety – Alarm System – Safety Rules. Health Insurance & Managing Health Care – Medical Audit – Hazard and Safety in a hospital Setup.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*R.C.Goyal, "Hospital Administration and Human Resource Management", PHI – Fourth Edition, 2006.*
2	*G.D.Kunders, "Hospitals – Facilities Planning and Management – TMH, New Delhi – Fifth Reprint 2007.*

REFERENCES

1	*Arnold D. Kalcizony & Stephen M. Shortell, "Health Care Management", 6th Edition Cengage Learning, 2011.*
2	*Norman Metzger, "Handbook of Health Care Human Resources Management", 2nd edition Aspen Publication Inc. Rockville, Maryland, USA, 1990.*
3	*Peter Berman "Health Sector Reform in Developing Countries" - Harvard University Press, 1995.*
4	*William A. Reinke "Health Planning for Effective Management" - Oxford University Press.1988*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the principles of Hospital administration.	K2
CO2	Describe the importance of Human resource management	K2
CO3	Applying various marketing research techniques.	K3
CO4	Gain Knowledge about the Information management systems and its uses.	K2
CO5	Depict the safety procedures followed in hospitals.	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

	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	PSO 3
CO 1	-	-	-	-	-	3	3	3	-	-	-	3	-	-	1
CO 2	-	-	-	-	-	3	3	3	-	-	-	3	-	-	1
CO 3	-	-	-	-	-	3	3	3	-	-	-	3	-	-	1
CO 4	-	-	-	-	-	3	3	3	-	-	-	3	-	-	1
CO 5	-	-	-	-	-	3	3	3	-	-	-	3	-	-	1
22LPE$40	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	6.1.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2
CO2	6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2
CO3	6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2
CO4	6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2
CO5	6.1.1,6.2.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total 100%
CAT1		70%	30%				100%
CAT2		80%	20%				100%
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		70%	30%				100%
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		70%	30%				100%
ESE		80%	20%				100%

VERTICAL-VI
EMBEDDED SYSTEM AND IOT

22LPE$41	INTRODUCTION TO INTERNET OF THINGS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To learn the fundamentals of Internet of Things and apply the concept of Internet of Things in real world scenario.	
UNIT – I	**FUNDAMENTALS OF IOT**	**9 Periods**
Introduction - Characteristics - Physical design - Protocols-Logical design - Enabling technologies - IoT levels - Domain specific IoTs - IoT vs M2M		
UNIT – II	**IOT DESIGN METHODOLOGY**	**9 Periods**
IoT System Management with NETCONF-YANG, SNMP, NETOPEER - IoT design methodology - Specifications - Integration and Application Development.		
UNIT – III	**IOT COMPONENTS**	**9 Periods**
Sensors and Actuators: Definition, Types of Sensors, Types of Actuators - Examples and Working - Communication modules - Zigbee- Wi-Fi- RFID Principles and Components.		
UNIT – IV	**BUILDING IOT WITH HARDWARE PLATFORMS**	**9 Periods**
Platform - Arduino Board details, IDE programming – Raspberry Pi – Interfaces and Raspberry Pi with Python Programming.		
UNIT- V	**CASE STUDIES AND ADVANCED TOPICS**	**9 Periods**
Various Real time applications of IoT- Home Automation – Smart Cities - Environment - Agriculture - Connecting IoT to cloud -Cloud storage for IoT - Designing a RESTful web API - Amazon Web services for IoT - Data Analytics for IoT - Software & Management Tools for IoT		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*ArshdeepBahga, Vijay Madisetti,* ***"Internet of Things-A hands-on approach",*** *Universities Press,2015*
2	Olivier Hersent, David Boswarthick, and Omar Elloumi, — ***"The Internet of Things: Key Applications and Protocols"***, Wiley Publications-2011

REFERENCES:

1	*Marco Schwartz, —**Internet of Things with the Arduino Yun,** Packt Publishing.*
2	*Hakima Chaouchi "**The Internet of Things: connecting objects to the web**" John Wiley & Sons, 2013*
3	*Massimo Banzi**- Getting Started with Arduino** · O'Reilly Media Publishing, 3rd Edition, 2015*
4	*Matt Richardson and Shawn Wallace- **Getting Started with Raspberry Pi**- O'Reilly Media Publishing, 3rd Edition, 2016*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the main concepts, key technologies, strength and limitations of IoT.	K1
CO2	Design and analyze various IOT applications	K3
CO3	Analyze IoT Components	K2
CO4	Design a portable IoT using Arduino/Equivalent boards and relevant protocols	K3
CO5	Apply data analytics and use cloud offerings related to real time scenario.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/ POs	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	PSO 3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
22LPE$41	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1, 4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1, 4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	70	20				100
CAT2	10	70	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	10	70	20				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	10	70	20				100
ESE	10	70	20				100

22LPE$42	INTRODUCTION TO MEMS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To learn the fabrication process in MEMS and acquire knowledge on various sensors and actuators	
UNIT I	**INTRODUCTION**	**9 Periods**
History of Micro Electro Mechanical Systems (MEMS) – MEMS Materials: Silicon and other materials - Intrinsic Characteristics of MEMS – Energy Domains and Transducers– Silicon based MEMS processes – New Materials – Review of Electrical and Mechanical concepts in MEMS – Stress and strain analysis – Flexural beam bending- Torsional deflection.		
UNIT II	**MEMS FABRICATION**	**9 Periods**
MEMS fabrication processes: Review of IC fabrication process. Micromachining: Bulk Micromachining - Dry and Wet etching - Surface micromachining - Deposition, Evaporation, Sputtering, Epitaxial growth - Deep Reaction ion etching - Advanced Lithography - LIGA process -Multi User MEMS Process.		
UNIT III	**ELECTROSTATIC SENSORS**	**9 Periods**
Electrostatic sensors – Parallel plate capacitors – Applications – Interdigitated Finger capacitor – Comb drive devices – Micro Grippers – Micro Motors – Thermal Sensing and Actuation – Thermal expansion – Thermal couples – Thermal resistors – Thermal Bimorph – Magnetic Actuators –Micromagnetic components – Actuation using Shape Memory Alloys.		
UNIT IV	**MAGNETOSTATIC SENSORS**	**9 Periods**
Piezoresistive sensors – Piezoresistive sensor materials – Stress analysis of mechanical elements – Applications to Inertia, Pressure, Tactile and FLow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia , Acoustic, Tactile and Flow sensors.		
UNIT-V	**APPLICATION CASE STUDIES**	**9 Periods**
Application case studies: MEMS Scanners and Retinal Scanning Displays (RSD), Grating LightValve (GLV), Digital Micromirror Devices (DMD), Optical switching, Capacitive Micromachined Ultrasonic Transducers (CMUT), Air bag system, Micromotors, Scanning Probe Microscopy.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Chang Liu, "**Foundations of MEMS**", Pearson Education Inc., 2nd edition 2006.*
2	*Stephen D Senturia, "**Microsystem Design**", Springer Publication,1st edition 2000*

REFERENCES:

1	*Julian W.Gardner, Vijay K.Varadan, Osama O. AwadelKarim, "**Micro sensors MEMS and SmartDevices**", John Wiby& sons Ltd., 1st edition 2001.*
2	*Mohamed Gad – el – Hak, "**MEMS Handbook**", CRC Press, 2nd edition 2002.*
3	*Rai - Choudhury P. "**MEMS and MOEMS Technology and Applications**", PHI Learning Private Limited, 1st edition 2009*
4	*Sabrie Solomon, "**Sensors Handbook**," 2nd edition McGraw Hill, 1998.*
5	*Marc F Madou, "**Fundamentals of Micro Fabrication**", CRC Press, 2nd Edition, 2002.*
6	*Tai Ran Hsu, "**MEMS & Micro systems Design and Manufacture**" 2nd edition Tata McGrawHill, New Delhi, 2002.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the basic concepts of MEMS.	K2
CO2	Describe the process involved in MEMS fabrication.	K2
CO3	Summarize the different electrostatic sensors	K3
CO4	Analyse the various magnetostatic sensors.	K3
CO5	Illustrate the case studies of MEMS.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/ POs	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	PSO 3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LPE$42	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50				100
CAT2	20	30	50				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	30	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	30	50				100
ESE	20	30	50				100

22LPE$43	SMART SENSORS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To learn the different types of sensors, smart sensors, interfacing sensors with MCU and their applications.	
UNIT – I	**DISPLACEMENT, FORCE AND PRESSURE SENSORS**	**9 Periods**
Definition, Classification & selection of sensors, Measurement of displacement using Potentiometer, LVDT & Optical Encoder, Measurement of force using strain gauge, Measurement of pressure using LVDT based diaphragm & piezoelectric sensor.		
UNIT – II	**TEMPERATURE, POSITION, FLOW AND LEVEL SENSORS**	**9 Periods**
Thermocouple & RTD, Concept of thermal imaging, Measurement of position using Hall effect sensors, Proximity sensors: Inductive & Capacitive, Use of proximity sensor as accelerometer and vibration sensor, Flow Sensors: Ultrasonic & Laser, Level Sensors: Ultrasonic & Capacitive.		
UNIT – III	**SMART SENSORS**	**9 Periods**
General Structure of smart sensors & its components, Characteristic of smart sensors: Self calibration, Self-testing & self-communicating, Application of smart sensors: Automatic robot control & automobile engine control.		
UNIT – IV	**INTERFACING SENSOR INFORMATION AND MCU**	**9 Periods**
Amplification and Signal Conditioning, Integrated Signal Conditioning, Digital conversion, MCU Control MCUs for Sensor Interface, Techniques and System Consideration, Sensor Integration.		
UNIT – V	**COMMUNICATION FOR SMART SENSORS**	**9 Periods**
Automotive Protocols - Industrial Networks - Home Automation - MCU Protocols - Wireless Data Communications- RF Sensing, Telemetry. Standards: IEEE 1451, STIM, Smart Plug-and-Play.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*D.Patranabis, -**Sensors and Transducers,** Second Edition, Prentice Hall of India, 2005.*
2	*Randy Frank, -**Understanding Smart Sensors**, Third Edition, Artech House Publishers, 2013.*

REFERENCES:

1	*Jacob Fraden, **"Hand Book of Modern Sensors: physics, Designs and Applications"**, 2015, 3rd edition, Springer, New York.*
2	*Jon. S. Wilson, **"Sensor Technology Hand Book"**, 2011, 1st edition, Elsevier, Netherland.*
3	*Sabrie Solomon, "**Sensors Handbook**," 2nd edition, McGraw Hill, 1998.*
4	*Y.L. Lin, **"Smart Sensors and Systems",** 2nd edition, Springer, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Recall the various displacement, force and pressure sensors.	K2
CO2	Exploit the temperature, position, flow and level sensors.	K2
CO3	Interpret the smart sensors and their applications.	K2
CO4	Interface sensor information and MCU.	K3
CO5	Summarize the communication protocols for smart sensors.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

	PO 1	PO2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	-	-	1	-	-	-	-	-	-	-	-	1	-	-
CO 2	3	-	1	1	-	-	-	-	-	-	-	-	1	-	-
CO 3	3	3	3	3	3	-	-	-	-	-	-	-	1	-	-
CO 4	3	3	3	3	3	-	-	-	-	-	-	-	1	-	-
CO 5	3	3	3	3	3	-	-	-	-	-	-	-	1	-	-
22LPE$43	**3**	**2**	**2**	**2**	**2**	-	-	-	-	-	-	-	**1**	-	-

b)CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 3.1.3, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.4.1, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.2, 4.3.1, 4.3.2, 4.3.4
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50				100
CAT2	20	30	50				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	30	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	30	50				100
ESE	20	30	50				100

22LPE$44	**INDUSTRIAL INTERNET OF THINGS** *(Common to ECE and EIE)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To impart students the underpinning knowledge on the architecture, key technology enablers, protocols, and Artificial Intelligence for Industrial IoT and their use cases.	
UNIT - I	**INTRODUCTION TO IIOT**	**9 Periods**
Digitization, Digitalization and Digital Transformation - Cyber Physical Systems - IIoT vs. IoT - ISA 95 Framework & Layers – Introduction to Industry 4.0 and its evolution- IIoT Key technologies enablers : Cyber Security, Cloud Computing, Edge Computing, and Data mining - Benefits of IIoT - IIoT concerns and risks		
UNIT – II	**IIoT ARCHITECTURE**	**9 Periods**
IIoT Architecture: IIOT Requirements - Introduction to Sensors- Characteristics- Categories- Smart Sensor- Actuators - Overview of Service-oriented architecture-based device integration - Role of Key technologies for IIoT: Augmented Reality and Virtual Reality		
UNIT – III	**COMMUNICATION PROTOCOLS FOR IIOT**	**9 Periods**
IEEE 802.15.4: ZigBee, Wireless HART, MiWi, 6LoWPAN, ISA100.11a - Z Wave, Bluetooth, BLE, NFC, RFID - Wireless Sensor nodes with Bluetooth, WiFi, and LoRa Protocols - MQTT, WebSocket, and HTTP Protocols- sensor networks, and multimedia sensor networks		
UNIT – IV	**AI and IIoT**	**9 Periods**
IIoT Analytics - Steps in Data Analytics - IIoT Basic operation using AI, ML and DL - Overview of IoT platforms for industries: Adafruit, Thingspeak and ThingWorx.		
UNIT – V	**INDUSTRIAL IOT USECASES**	**9 Periods**
IoT applications for industry: Future Factory Concepts, Brownfield IoT, Value Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas Industry- Opinions on IoT Application and Value for Industry.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Sudip Misra, Chandana Roy, Anandarup Mukherjee,* ***"Introduction to Industrial Internet of Things and Industry 4.0"****, CRC Press, 1st edition, 2021*
2	*ArshdeepBahga, Vijay Madisetti,* ***"Internet of Things-A hands-on approach"****, Universities Press, 1st edition, 2015.*

REFERENCES:

1	*Andrew Minteer,* ***"Analytics for the Internet of Things (IoT): Intelligent analytics for your intelligent devices"****, Packt Publishing, first edition, July 2017.*
2	*Olivier Hersent, David Boswarthick, and Omar Elloumi, "****The Internet of Things: Key Applications and Protocols****", Wiley Publications, 1st edition, 2011*
3	*Alasdair Gilchrist,* ***"Industry 4.0: The Industrial Internet of Things",*** *1st edition, Apress, 2017.*
4.	*Shriram K. Vasudevan, Abhishek S. Nagarajan, R. M. D. Sundaram,* **"Internet of Things",** *Wiley Publications, 2nd Edition,2020*

COURSE OUTCOMES Upon Completion of the course, the students will be able to		Bloom's Taxonomy Mapped
CO1	Discuss the IoT, IIoT differences and key technology enablers for IIoT	K2
CO2	Demonstrate the understanding of the architecture of IIoT	K2
CO3	Assimilate various protocols used for IIoT	K2
CO4	Comprehend the role of AI in IIoT based system	K2
CO5	Identify IoT use cases in various industries and recognize the IoT project implementation modalities	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	-	3	2	-	-	-	-	3	2	-	-	3	1	1
CO2	2	-	3	2	-	-	-	-	3	2	-	-	3	1	1
CO3	2	-	3	2	-	-	-	-	3	2	-	-	3	1	1
CO4	2	-	3	2	-	-	-	-	3	2	-	-	3	1	1
CO5	2	-	3	2	-	-	-	-	3	2	-	-	3	1	1
22LPE$44	2	-	3	2	-	-	-	-	3	2	-	-	**3**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1 1.4.1, 2.2.2, 2.2.4, 2.3.2, 3.1.1, 4.1.1, 4.1.3, 4.1.4, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.3.1, 9.3.2, 10.1.1.1, 10.1.2
CO2	1.2.1 1.4.1, 2.2.2, 2.2.4, 2.3.2, 3.1.1, 4.1.1, 4.1.3, 4.1.4, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.3.1, 9.3.2, 10.1.1.1, 10.1.2
CO3	1.2.1 1.4.1, 2.2.2, 2.2.4, 2.3.2, 3.1.1, 4.1.1, 4.1.3, 4.1.4, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.3.1, 9.3.2, 10.1.1.1, 10.1.2
CO4	1.2.1 1.4.1, 2.2.2, 2.2.4, 2.3.2, 3.1.1, 4.1.1, 4.1.3, 4.1.4, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.3.1, 9.3.2, 10.1.1.1, 10.1.2
CO5	1.2.1 1.4.1, 2.2.2, 2.2.4, 2.3.2, 3.1.1, 4.1.1, 4.1.3, 4.1.4, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.3.1, 9.3.2, 10.1.1.1, 10.1.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	90					100
CAT2	10	90					100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50	40	10			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	40	10			100
ESE	10	90					100

22LPE$45	EMBEDDED OPERATING SYSTEMS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To learn the concepts of real time operating System, real time communication and databases.	
UNIT – I	**INTRODUCTION TO REAL TIME OPERATING SYSTEM**	**9 Periods**
Introduction - Example of Real time applications - Structure of a Real time system - Characterization of Real time systems and tasks - Hard and Soft timing constraints - Design challenges - Performance metrics - Prediction of Execution time: Source code analysis, Cache and Pipeline issues - Programming Languages for Real Time System.		
UNIT – II	**THREADS AND TASKS**	**9 Periods**
Real time OS - Threads – Kernel - Structure of Microkernel - Tasks and Process - Timing Requirements on Processes- CPU Metrics - Process State and Scheduling - Inter process Communication Mechanisms – Context Switching – Task Synchronization - Software interrupt.		
UNIT – III	**TASK SCHEDULING AND ALGORITHMS**	**9 Periods**
Task assignment - Task allocation algorithms: Event driven Scheduling - Rate-Monotonic Scheduling, Earliest-Deadline First Scheduling - Clock driven scheduling – Table driven scheduling, Cyclic Schedulers - Fault tolerant Scheduling.		
UNIT – IV	**REAL TIME COMMUNICATION**	**9 Periods**
Real Time Communication Network - Topologies and architecture issues-protocols - Contention based, Token based, Polled bus, Deadline based protocol, Fault tolerant routing. RTP and RTCP.		
UNIT – V	**REAL TIME DATABASES**	**9 Periods**
Real time Databases - Transaction priorities - Concurrency control issues - Disk scheduling algorithms - Two phase approach to improve predictability.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*C.M. Krishna, Kang G. Shin – " **Real Time Operating Systems**", 4th edition, International Edition, McGraw Hill Companies, Inc., New York ,2013.*
2	*Rajib Mall, **"Real-Time Systems: Theory and Practice**", 1st edition, Pearson, 2008.*

REFERENCES:

1	*Philip A. Laplante and Seppo J. Ovaska, "Real Time Operating Systems Design and Analysis: Tools for the Practitioner'', IV Edition IEEE Press, Wiley. 2013.*
2	*Jane W.S. Liu, **"Real Time Operating Systems",** II Edition Pearson Education India, 2000.*
3	*Marilyn Wolf, — **"Computers as Components - Principles of Embedded Computing System Design",** Third Edition —Morgan Kaufmann Publisher (An imprint from Elsevier), 2012.*
4	*Alan Holt and Chi-Yu Huang, **"Embedded Operating Systems: A Practical Approach"** 2nd edition , Springer, 2014.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the fundamental concepts of RTOS.	K2
CO2	Interpret the mechanisms of threads and tasks.	K2
CO3	Analyze various task scheduling mechanisms and algorithms.	K3
CO4	Summarize the real time communication protocols.	K3
CO5	Relate the handling of real time databases.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
22LPE$45	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1, 4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1, 4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1, 4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1, 4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1,4.2.1, 4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50				100
CAT2	20	30	50				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	50				100
ESE	20	30	50				100

22LPE$46	EMBEDDED PROCESSORS - I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To learn the basic concepts of PIC and MSP430 microcontroller and interfacing various peripherals with PIC and MSP430 microcontrollers.	
UNIT – I	**EMBEDDED SOFTWARE TOOLS**	**9 Periods**
Software development tools- editor, assembler, compiler, cross-compiler and simulator, Hardware development tools- development board, device programmer, in-circuit emulator and debuggers. Embedded C Programming, data types and variables, data type modifiers, storage Class modifiers, C statements, structures and operations, pointers, libraries, in-line assembly programming, optimizing and testing embedded C programs.		
UNIT – II	**PIC CONTROLLER**	**9 Periods**
PIC 16F877- architecture, memory technologies, timing circuits, power-up and reset, parallel ports, ADC, interrupt, PWM, counters and timers, instruction set and assembly language programming.		
UNIT – III	**INTERFACING WITH PIC**	**9 Periods**
Human and physical interfaces- switches to keyboard, LED display, liquid crystal display, Actuators and sensors, PWM, serial communication protocols (UART, I2C, SPI), programming interrupt, timers and counter.		
UNIT – IV	**MSP430 CONTROLLER**	**9 Periods**
MSP430 – Introduction to Architecture - Embedded C Programming in MSP430 – GPIO Pins & Configuration Timers, Capture, & PWM DAC- ADCs –Memory System-Flash Memory-DMA.		
UNIT – V	**INTERFACING WITH MSP430**	**9 Periods**
USCI Port –SPI mode - I2C Mode-UART Mode & RS232 Low Power Mode Operation- Interfacing-Input Devices-Output Devices-DC Motor-Stepper Motor- Alarm interface.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*John B. Peatman, **"Design with PIC Microcontroller"**, 1st edition, Pearson Education, 2002.*
2	*John H. Davies, **"MSP430 Microcontrollers Basics",** 1st edition, Elsevier Limited 2008.*

REFERENCES:

1	*Tim Wilmshurst, **"Designing Embedded Systems with PIC microcontrollers-Principles and Applications"**, 1st edition, Newnes Publications, 2007.*
2	*Martin Bates, **"Interfacing PIC microcontrollers-Embedded Design by Interactive Simulation"**, Newnes Publication, 2st edition, 2006.*
3	*Steven Barrett, Daniel Pack, **"Microcontroller Programming and Interfacing TI MSP430, Part 1"**, Morgan and Claypool, 2st edition, 2011.*
4	*Brock J. LaMeres, **"Embedded Systems Design Using the MSP430FR2355 LaunchPadTM",** 1st edition, Springer International Publishing, 2020.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the various embedded software tools.	K2
CO2	Explain the fundamental blocks of PIC microcontroller.	K2
CO3	Interface Peripherals with PIC microcontroller.	K3
CO4	Exploit the fundamental blocks of MSP430 microcontroller.	K2
CO5	Interface Peripherals with MSP430 microcontroller.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/ POs	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	PSO 3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
22LPE$46	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50				100
CAT2	20	30	50				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	30	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	30	50				100
ESE	20	30	50				100

22LPE$47	EMBEDDED PROCESSORS - II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objectives	To learn the basic concepts of ARM processor, instruction set and developing real time applications using ARM.	
UNIT – I	**ARM PROCESSOR FUNDAMENTALS**	**9 Periods**
The RISC design philosophy-ARM design philosophy-Embedded system hardware- AMBA bus protocol, Embedded system software-Applications-ARM core data flow model-Registers- CPSR-Pipeline-Characteristics-ARM 3 stage Pipeline and 5 stage Pipeline-ARM instruction execution-Exceptions, Interrupts and Vector Table.		
UNIT – II	**ARM AND THUMB INSTRUCTION SET**	**9 Periods**
ARM Instruction-Data processing instructions, Branch instructions, Load Store instructions, SWI instruction-Loading Instructions-Conditional Execution. Thumb Instruction-Thumb Registers-ARM Thumb interworking-Branch instruction, Data processing instruction, Single/multiple load store instruction, Stack instruction, SWI instruction.		
UNIT – III	**ARM APPLICATION DEVELOPMENT**	**9 Periods**
Introduction to Real time implementation with ARM – Exception Handling – Interrupts – Interrupt handling schemes- Firmware and boot loader – Free RTOS Embedded Operating Systems concepts –Example on ARM core : ARM9 processor		
UNIT – IV	**CACHES AND MMU**	**9 Periods**
Memory Hierarchy and Cache Memory – Cache Architecture - Cache Policy – Co-Processor and Caches – Flushing and Cleaning Cache Memory – Cache Lockdown – Caches and Software Performance. MMU: Moving from an MPU to an MMU – Virtual Memory – Details of ARM MMU – Caches and Write Buffer – Co-Processor and MMU configuration.		
UNIT – V	**DESIGN WITH ARM MICROCONTROLLERS**	**9 Periods**
Assembler Rules and Directives- Simple ASM/C programs- Hamming Code- Division-Negation- Simple Loops – Look up table- Block copy- subroutines-Application - Stepper Motor-Real time clock.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Andrew N. Sloss Dominic Symes Chris Wright, "**ARM System Developer's Guide Designing and Optimizing System Software**", 1st edition Elsevier Inc 2010.*
2	*Steve Furber, **"ARM system on chip architecture"**, Second Edition, Pearson Education, 2015.*

REFERENCES:

1	*William Hohl, **"ARM Assembly Language: Fundamentals and Techniques",** Second Edition, CRC Press, 2015.*
2	*David Seal, **"ARM Architecture Reference Manual"**, Second Edition, Addison-Wesley, 2001.*
3	*Warwick A.Smith, **"C Programming for Embedded Microcontrollers",** 1st Edition, Elektor Publishing, 2009.*
4	*Jonathan W. Valvano, **"Embedded Microcomputer Systems, Real Time Interfacing",** Thomas Learning, 2000.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the basic concepts of ARM processor.	K2
CO2	Summarize the ARM and THUMB instruction set.	K3
CO3	Develop the real time ARM based application.	K2
CO4	Interpret the concepts of caches and MMU.	K2
CO5	Design the ARM microcontroller-based systems.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	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	PSO 3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	1	1
22LPE$47	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50				100
CAT2	20	30	50				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		70	30				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		70	30				100
ESE	20	30	50				100

22LPE$48	NANO ELECTRONICS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To understand the concepts of Nano electronic devices, fabrication and measurement techniques, tunneling and superconducting devices.	
UNIT – I	**INTRODUCTION TO NANO TECHNOLOGY**	**9 Periods**
Microelectronics towards biomolecule electronics - Particles and waves - Wave-particle duality - Wave mechanics - Schrödinger wave equation-Wave mechanics of particles: Atoms and atomic orbitals - Materials for nano electronics- Semiconductors- Crystal lattices: Bonding in crystals- Electron energy bands- Semiconductor hetero structures- Lattice-matched and pseudomorphic hetero structures - Inorganic-organic hetero structures - Carbon nanomaterials: nanotubes and fullerene		
UNIT – II	**FABRICATION AND MEASUREMENT TECHNIQUES**	**9 Periods**
Growth, fabrication, and measurement techniques for nanostructures- Bulk crystal and heterostructure growth- Nanolithography, etching, and other means for fabrication of nanostructures and nano devices Techniques for characterization of nanostructures- Spontaneous formation and ordering of nanostructures- Clusters and nano crystals- Methods of nanotube growth- Chemical and biological methods for nano scale fabrication- Fabrication of nano-electromechanical systems.		
UNIT – III	**PROPERTIES OF NANO MOLECULES**	**9 Periods**
Dielectrics-Ferroelectrics-Electronic Properties and Quantum Effects-Magneto electronics – Magnetism and Magneto transport in Layered Structures-Organic Molecules – Electronic Structures, Properties, and Reactions-Neurons – The Molecular Basis of their Electrical Excitability-Circuit and System Design Analysis by Diffraction and Fluorescence Methods-Scanning Probe Techniques.		
UNIT – IV	**NANO STRUCTURE DEVICES**	**9 Periods**
Electron transport in semiconductors and nanostructures- Time and length scales of the electrons in solids-Statistics of the electrons in solids and nanostructures- Density of states of electrons in nanostructures- Electron transport in nanostructures-Electrons in traditional Low-dimensional structures Electrons in quantum wells-Electrons in quantum wires- Electrons in quantum dots- Nanostructure devices.		
UNIT – V	**LOGIC DEVICES AND APPLICATIONS**	**9 Periods**
Logic Devices-Silicon MOSFETs-Ferroelectric Field Effect Transistors-Quantum Transport Devices Based on Resonant Tunneling-Single-Electron Devices for Logic Applications-Superconductor Digital Electronics-Quantum Computing Using Superconductors-Carbon Nanotubes for Data Processing Molecular Electronics		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS :

1	*Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio,* ***"Introduction to Nanoelectronics: Science, Nano technology, Engineering, and Applications"****, Cambridge University Press 2011.*
2	*Supriyo Datta,* ***"Lessons from Nano electronics: A New Perspective on Transport"****, World Scientific 2012.*

REFERENCES :

1	*George W. Hanson,* ***"Fundamentals of Nano electronics"****, Pearson 2009*
2	*Korkin, Anatoli; Rosei, Federico (Eds.),* ***"Nano electronics and Photonics"****, Springer 2008*
3	*Mircea Dragoman, Daniela Dragoman,* ***"Nano electronics: principles and devices"****, CRC Press 2006*
4	*Karl Goser, Peter Glösekötter, Jan Dienstuhl,* ***"Nano electronics and Nano systems: From Transistors to Molecular and Quantum Devices"****, Springer 2004.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the basics of nanotechnology.	K1
CO2	Describe the different fabrications methods.	K2
CO3	Explain the behavior of nano materials and related structures.	K2
CO4	Identify the significance of nanostructure devices and logic circuits.	K3
CO5	Discuss the different superconducting devices.	K2

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LPE$48	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2,3.3.1,4.1.1, 4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	30	50				100
CAT2	20	30	50				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		70	30				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		70	30				100
ESE	20	30	50				100

VERTICAL -VII
DIVERSIFIED ELECTIVE GROUP

22LPE$49	AUTOMOTIVE ELECTRONICS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To acquire in-depth knowledge of an embedded system in automotive electronics and to learn the various vehicle communication protocols.	
UNIT – I	**ELECTRONICS IN AUTOMOTIVE SYSTEMS**	**9 Periods**
Overview of Automotive Mechanical systems- Need for Automotive Electronics System – Overview of vehicle electronic systems - Basic electrical components and their operation in an automobile- Power train subsystem: Starting systems, Charging systems, Ignition systems, Electronic fuel control - Chassis subsystem: ABS, TCS and ESP - Comfort and safety subsystems: Night vision, airbags, Seatbelt Tensioners, Cruise Control- Lane-departure-warning, Parking.		
UNIT – II	**HARDWARE AND SOFTWARE MODULES**	**9 Periods**
Hardware module - Introduction to an embedded board -components - Software Module: IDE - Getting started: Creating new project, creating new files, adding files to project, compile, build, debug and simulation of a project.		
UNIT – III	**EMBEDDED SYSTEM PROGRAMMING AND DEBUGGING**	**9 Periods**
Embedded System Programming - Up-loaders- ISP - ROM Emulators - In-Circuit Emulators - Debug Interfaces: BDM and JTAG.		
UNIT – IV	**EMBEDDED SYSTEM IN AUTOMOTIVE APPLICATIONS**	**9 Periods**
Engine management systems - Gasoline/ Diesel systems, various sensors used in system - Electronic transmission control - Vehicle safety system - Electronic control of braking and traction- Body electronics - Infotainment systems - Navigation systems - System level tests - Software calibration using engine and vehicle dynamometers - Environmental tests for Electronic Control Unit.		
UNIT – V	**EMBEDDED SYSTEM COMMUNICATION PROTOCOLS**	**9 Periods**
Introduction to control networking - Communication protocols in embedded systems - SPI, I 2C, USB - Vehicle communication protocols - Introduction to CAN, LIN, FLEXRAY, MOST, KWP2000.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Denton.T, "**Automobile Electrical and Electronic Systems**", Edward Arnold Publishers, 4th Edition 2012.*
2	*Nicholas Navit, "**Automotive Embedded System Handbook**", CRC press, 2009.*

REFERENCES:

1	*Robert Bosch GmbH, "**Automotive Handbook**", John Wiley & Sons, 6th Edition, 2004.*
2	*Knowles.D, "**Automotive Electronic and Computer Controlled Ignition Systems**", Prentice Hall,1998.*
3	*William B. Ribbens, "**Learning Automotive Electronics**", Newnes Publishing, 6th Edition 2003*
4	*Joerg Schaeuffele, Thomas Zurawka - "**Automotive Software Engineering- Principles, Processes, Methods and Tools**", SAE Publications,2005.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyse electrical and electronic components used in an automotive systems.	K2
CO2	Design and implement projects using Embedded hardware and software.	K3
CO3	Explore programming and debugging skills.	K3
CO4	Apply knowledge of an embedded system in automotive electronics.	K2
CO5	Explain embedded system and vehicle communication protocols.	K2

COURSE ARTICULATION MATRIX

a)CO and PO Mapping														
COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	1	1	-	-	-	-	-	-	-	2	2	1	1
CO2	3	3	2	2	-	-	-	-	-	-	-	2	2	1	1
CO3	3	3	2	1	-	-	-	-	-	-	-	2	2	2	1
CO4	3	3	1	3	-	-	-	-	-	-	-	2	2	2	1
CO5	3	3	2	3	-	-	-	-	-	-	-	2	2	-	1
22LPE$49	**3**	**3**	**2**	**2**	-	-	-	-	-	-	-	**2**	**2**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.1.5,4.1.2,
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 3.3.2,3.4.1,3.4.2,4.1.2, 4.1.4
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.3.2, 3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 3.1.5,3.2.1,3.3.2, 3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	30			100
CAT2	10	30	30	30			100
Assignment 1	10	20	40	30			100
Assignment 2	10	30	30	30			100
Quiz 1	30	40	30				100
Quiz 2	20	50	30				100
ESE	10	20	30	40			100

22LPE$50	**ELECTRONIC CIRCUIT DESIGN** **(*Common to EEE, ECE & EIE Branches)***

PREREQUISITES	CATEGORY	L	T	P	C
NIL	**PE**	**3**	**0**	**0**	**3**

Course Objective	To impart knowledge of the electronic circuit design from power supplies to SoCs including the connectivity solutions and their static and dynamic behaviour through Simulation	
UNIT – I	**INTRODUCTION TO SENSORS, POWER SUPPLY, SWITCH AND DRIVERS**	**9 Periods**
Introduction: Sensors - Connectivity Solutions - AI/ML - HW requirements - Design Challenges. Non-ideal behavior of Components – Resistors, Capacitors; Inductors; Ferrite Beads; Fundamentals of BJT, MOSFET and IGBT gate driver circuits - Effect of Impedance mismatch and Signal Quality. Linear and Switching regulators- Buck and Boost Converters - Stability, Performance, Dynamic Behavior - EMI Filters - high-side and low-side switches - H-bridge - Current Sensing Techniques.		
UNIT – II	**DATA CONVERTERS AND I/O INTERFACES**	**9 Periods**
Digital IOs; PWM, Frequency Inputs; Data conversion; Quantization; Reference Voltages; Sampling Time; Resolution; ADC Errors – Non-linearity; Offset; Gain; Noise - Dynamic Range – ENOB - Parasitic capacitance - Channel cross-talk - ADC/DAC interface.		
UNIT – III	**SYSTEM ON CHIP**	**9 Periods**
Need for SoC - Components of a SoC - Heterogeneous processing cores : microprocessors, DSPs, hardware processing engines like audio, video, accelerators, memories, and I/O interfaces - System level On-chip Communication Architectures – Bus and NoC based, Application Specific Hardware Accelerators – GPU, Neural, MMA - device management, memory hierarchy, and data movement, virtualization - security, and power - Challenges and optimization of Interconnects, Partitioning and Mapping of a software function to hardware - Power/Performance/Area Trade Offs vs Reliability - Safety and Security Features - Interfaces – External Memory, I/O, ADC/DAC, UART, CAN, Ethernet, USB, MIPI; Insight into SoC Design Process (from RTL to Chip, Requirements and Design Iteration) - Dealing with Design Complexity (Buying IP and Reconfiguration).		
UNIT – IV	**PMICs AND WIRED COMMUNICATIONS**	**9 Periods**
Need for PMIC – On Chip Power Management, State Machine, Compensation Techniques - Voltage and Frequency Scaling - Applications; Examples – PF8101 (NXP), TPS659119-Q1 (TI), MAX20430 (Maxim) - Input and Output Supply Ranges - Power Sequence – Supervisory - Watchdog Operation. High Speed Links – Transmitter, Channel, Receiver - Common Mode Rejection – Serializer, De-Serializer - Controller Area Networks (CAN) - Ethernet (Automotive)- Universal Serial Bus (USB) - Camera Interfaces (FPD or GMSL) - Power over Data Link (PoDL).		
UNIT – V	**WIRELESS COMMUNICATIONS**	**9 Periods**
Fundamentals of RF-Transmission Lines, Resonators, Antennas, Wave Propagation, Transmitters, Receivers - Digital Modulation Techniques - Channel Impairments - MIMO; WLAN; Bluetooth; Cellular – LTE/5G - Navigation Systems - Identification Systems-NFC, RFID; UWB.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical:0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Ke-Horng Chen, **"Power Management for Integrated Circuit Design"**, Wiley, 2016*
2	*Michael.J. Flynn and Wayne Luk, **"Computer System Design: System-On-Chip, Hoboken, New Jersey"**, Wiley, 2011*
3	*G. Manganaro, **"Advanced Data Converters. Cambridge"**, Cambridge Univ. Press, 2012*

REFERENCES:

1	*W. A. Kester, **"Data Conversion Handbook"**, Amsterdam, Elsevier Newnes, 2005*
2	*Beuchat R D, et.al, **"Fundamentals of System-on-Chip Design on Arm Cortex-M Microcontrollers, Arm Education Media"**, Arm Education Media, 2021*
3	*Joseph Yiu, **"System-on-Chip Design with Arm Cortex-M Processors"**, Reference Book, Cambridge, ARM Education Media, 2019*

4	*Mona M. Hella, and Patrick Mercier, Eds., **"Power management integrated circuits"**, CRC Press, 2016*
5	*Forouzan B A, **"Data Communications and Networking"**, McGraw-Hill, 5th ed. India, 2017*
6	*Qizheng GU, **"RF System Design of Transceivers for Wireless Communications"**, Springer, 2015*
7	*Maniktala S, **"Power over ethernet interoperability"**, McGraw-Hill, New York, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the performance of sensors and power supplies, switches and drivers	K2
CO2	Determine the suitable data converters and I/O interfaces for specific requirement	K3
CO3	Describe the functions of components in system on chip	K2
CO4	Choose and explain the functional blocks for PMICs and WIRED COMMUNICATIONS	K3
CO5	Analyse different wireless communication technologies	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**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**	**PSO3**
CO1	3	2	2	1	1	2	2	1	-	-	1	1	3	3	3
CO2	2	2	1	2	1	-	-	-	-	-	-	2	2	2	2
CO3	2	2	1	-	1	-	-	-	-	-	1	2	2	2	2
CO4	3	2	2	1	1	2	2	1	-	-	1	1	2	2	2
CO5	3	2	2	1	1	2	2	1	-	-	1	1	2	2	2
22LPE$50	**3**	**2**	**1**	**1**	**1**	**2**	**2**	**1**	**-**	**-**	**1**	**2**	**2**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 3.1.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.4.2, 4.1.2, 4.1.3, 5.1.1, 5.2.1, 6.2.1, 7.1.1, 7.1.2, 8.2.1, 11.1.1, 12.1.1, 12.1.2
CO2	1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.2.2, 2.2.4, 2.3.1, 2.4.3, 3.1.4, 3.1.6, 3.2.3, 3.3.1, 4.1.2, 4.1.3, 4.1.4, 5.1.1, 12.1.1, 12.1.2, 12.2.2, 12.3.2
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.2.2, 2.2.4, 2.3.1, 2.3.2, 3.1.4, 3.1.6, 5.1.1, 5.2.1, 11.1.1, 12.1.1, 12.1.2, 12.2.2
CO4	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 3.1.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.4.2, 4.1.2, 4.1.3, 5.1.1, 5.2.1, 6.2.1, 7.1.1, 7.1.2, 8.2.1, 11.1.1, 12.1.1, 12.1.2
CO5	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 3.1.3, 3.1.4, 3.1.6, 3.2.1, 3.2.2, 3.4.2, 4.1.2, 4.1.3, 5.1.1, 5.2.1, 6.2.1, 7.1.1, 7.1.2, 8.2.1, 11.1.1, 12.1.1, 12.1.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40	-	-	-	100
CAT2	10	40	50	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	30	40	30	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	40	40	20	-	-	100
ESE	20	40	40	-	-	-	100

22LPE$51	**ELECTRONIC SYSTEM DESIGN AND PRODUCTIZATION** *(Common to EEE, ECE & EIE)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To introduce broad knowledge for the design, development, fabrication of electronic products, printed circuit boards and systems and its reliability and product safety	
UNIT - I	**PCB DESIGN, RULES, AND MANUFACTURABILITY**	**9 Periods**
PCB Technology – Component Packaging, Layer Stackup, Via Technology, HDI Concept; PCB Materials – Grades and Specification, example - FR4, Weaving Concept, Low Loss & High Performance Materials, Mechanical and Thermal Properties; Layer Stackup – Copper Foil, Pre-pegs and Base Material (Core), Dimensional Stability, CAF Growth; PCB Design Process – Influence from Package types, Material Choices, Fabrication Methods, Lead-free Assembly; Current Capacity; Thermal Signatures, File Format, Rule Checks – ERC and DRC, Power, Ground, and Signal Trace Consideration; Choice of CAD tools; IPC Standards for PCB – Introduction.		
UNIT - II	**ELECTROMAGNETIC COMPATIBILITY AND COMPLIANCE**	**9 Periods**
Introduction – History of Accidents, Impact of Technology Evolution, Importance of EMC and Regulations; EMC Concepts – Conducted, Radiated, Emissions, Susceptibility/Immunity; EMC Control Methods – Impedance Matching, Resonances, Balancing, Filtering, ESD Protection, Shielding, Grounding; PCB Design; Enclosure Design; EMC Prediction using Simulations; EMC Compliance – CISPR Test Setups, IEC Test Standards; Government Regulatory Requirements – FCC, RED, UNCECR10.		
UNIT - III	**THERMAL MANAGEMENT FOR ELECTRONICS**	**9 Periods**
Introduction, Heat Transfer Theory; Concept of thermal resistance; Use of datasheets; Passive and Active Cooling – Forced Air, Liquid, Thermo Electric Cooling; Aspects of Heat Sink Design; Thermal Modeling and Measurement – CFD; Heat Management in Automotive Applications.		
UNIT - IV	**DESIGN FOR RELIABILITY AND MANUFACTURING**	**9 Periods**
Basic Concepts – Quality and Reliability Assurance; Analysis during the Design Phase; Qualification tests for Components and Assemblies; Design guidelines for Reliability and Maintainability; Statistical Quality Control and Reliability Tests; Check lists for Design Reviews; Design FMEA/DRBFM; MTBF Calculation.		
UNIT - V	**PRODUCT SAFETY, SECURITY, COMPLIANCE AND CERTIFICATION**	**9 Periods**
Need for Product Safety; Examples – Automotive; CE/ISO/IEC/BIS; Safety Education: Products-Hazards-Age; Voltage Faults – Surge, Ringing, Polarity reversal, Current fault – short circuit, Inrush, Reverse; Thermal – Over temperature, thermal protection; Battery Safety Standards; Product Construction Requirements; Resistance to Fire and Flame Rating; Human Factors – Ergonomic Hazards; Safety Instructions - Cautions and Warnings. Regulatory compliance – Product Specific - EMC, Safety, and RF; Substance Regulation – RoHS, WEEE, REACH etc; Labeling, Documentation, Marking, Packaging and Testing; Industry Compliance – Industry specific; Technical documentation; EU declaration of conformity; Regional (states, districts) Specific compliance – data security and material; Usage Instructions; Traceability; IATF 16949; ISO 9000; ISO140000; ASPICE; GDPR. Process of Certification : ISO/IEC 17065 Conformity Assessment; ISO 17011; Certifying Bodies; Standards; Marking/Certificate; Accreditation Bodies; IAF, FCC, CE, BIS, NABL.		
Contact Periods: 45 Periods **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Clyde F. Coombs and Happy Holden , "**Printed Circuits Handbook**", 7th Edition, McGraw Hill, 2016*
2	*Clayton R. Paul, "**Introduction to Electromagnetic Compatibility**", Wiley , 2nd Edition, 2010;*
3	*T. Yomi Obidi, "**Thermal Management in Automotive Applications**", SAE International, 1st Edition, 2015.*

REFERENCES:

1	*Wilson, P, "**The Circuit Designer's Companion**", Oxford Newnes, 3rd Edition, 2011*
2	*Terence Rybak and Mark Stefafika, "**Automotive EMC**", Kluwer Academic Publishers, 1st Edition, 2003.*
3	*Ralph Remsburg, "**Thermal Design of Electronic Equipment**", CRC Press, 1st Edition, 2001*
4	*Alessandro Birolini, "**Reliability Engineering: Theory and Practice**", Springer, 8 th Edition, 2017.*
5	*Jan Swart,"**Electrical Product Compliance and Safety Engineering**", Artech House, 1st Edition, 2017.*
6	*J. Doherty, "**Wireless and Mobile Device Security**", Jones and Bartlett Learning, 2nd Edition, 2021.*

COURSE OUTCOMES Upon Completion of the course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Elaborate the PCB design process and the manufacturability requirements	K2
CO2	Enunciate the electromagnetic compatibility required for a product and its standards	K3
CO3	Outline the thermal management strategies required for automotive applications	K2
CO4	Analyze a design for its failure modes; and design a reliable, safe product and compute its failure rate or MTBF	K4
CO5	Identify and fulfill all requirements for the product compliance and certification considering EMC, RF, safety and security	K3

COURSE ARTICULATION MATRIX

a)CO/PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	3	2	-	1	2	1	-	-	-	-	-	2	1	1
CO2	3	3	2	-	1	2	1	-	-	-	-	-	2	1	1
CO3	3	3	2	-	1	2	1	-	-	-	-	-	2	1	1
CO4	3	3	2	2	1	2	1	-	-	-	-	-	2	1	1
CO5	3	3	2	2	1	2	1	-	-	-	-	-	2	1	1
22LPE$51	**3**	**3**	**2**	**1**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**1**

b)CO and3 Key Performance Indicators mapping

CO1	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3,2.2.1,2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 5.1.1, 6.1.1, 7.1.1
CO2	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3,2.2.1,2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 5.1.1, 6.1.1, 7.1.1
CO3	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3,2.2.1,2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 5.1.1, 6.1.1, 7.1.1
CO4	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 4.1.1, 4.1.2, 4.2.1, 5.1.1, 6.1.1, 7.1.1
CO5	1.1.1, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 4.1.1, 4.1.2, 4.2.1, 5.1.1, 6.1.1, 7.1.1

ASSESSMENT PATTERN - THEORY

Test/Bloom's Category	Remembering (K1)%	Understanding (K2) %	Applying (K3)%	Analyzing (K4)%	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		60	40				100
CAT2		40	40	20			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		40	40	20			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		40	40	20			100
ESE		40	40	20			100

22LPE$52	INTRODUCTION TO POWER ELECTRONICS

PREREQUISITES	CATEGORY	L	T	P	C
ANALOG CIRCUITS	PE	3	0	0	3

Course Objective	To acquire knowledge about the power converters for various loads, to implement the power converters for the drives and to study the series & parallel connections and protection circuits.	
UNIT – I	**SEMICONDUCTOR POWER DEVICES**	**9 Periods**
SCR characteristics - Two transistor analogy - Methods of turning on and turning off - Other members of SCR family - Series and parallel connection of SCRs - Thyristor protection. Other semiconductor devices: Power MOSFETs, GTOs, IGBT.		
UNIT – II	**CONTROLLED RECTIFIERS AND AC VOLTAGE CONTROLLERS**	**9 Periods**
Single Phase Controlled rectifiers- Half wave controlled rectifier with R load and Full wave controlled rectifier with R load - AC Voltage controllers, Single phase cycloconverter.		
UNIT – III	**DC CHOPPER AND AC CHOPPER**	**9 Periods**
DC Chopper : Elementary chopper with an active switch and diode, Duty ratio and Average voltage- Step-up, step down & step up-down chopper, chopper configuration – AC Chopper.		
UNIT – IV	**SINGLE PHASE INVERTER**	**9 Periods**
Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, Series inverter, Parallel inverter and Bridge inverter - Current source inverter.		
UNIT – V	**APPLICATIONS**	**9 Periods**
DC motor drives-Induction and Synchronous motor drives - Switched reluctance and brushless motor drives - Solid state relays - Microelectronic relays.		
Contact Periods: **Lecture: 45 Periods Tutorial:0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*P.C. Sen, "**Power Electronics**", Tata McGraw-Hill, 2017.*
2	*Muhammad H.Rashid, "**Power Electronics - Circuits, Devices and Applications**", 3rd Edition, Prentice Hall ofIndia, 2004.*

REFERENCES:

1	*S.N. Singh, **Text Book of Power Electronics**, DhanpathRai & Co., New Delhi, 2000.*
2	*M.D.Singh, K.B. Khanchandani, "**Power Electronics**", Tata McGraw-Hill, 1998.*
3	*B.K.Bose, "**Modern Power Electronics**", Jaico Publishing House, 1999.*
4	*Ned Mohan, Tore M.Undeland, William P.Robbins, "**Power Electronics, Converters, Applications and Design**", John Wiley & Sons, 1994.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Understand the details of switching devices	**K2**
CO2	Analyze use of thyristors in different types of rectifier circuits and Controllers	**K4**
CO3	Analyze the operation of DC-DC up – down choppers	**K4**
CO4	Apply the different modulation techniques to the operation of single-phase voltage source inverters	**K3**
CO5	Apply the operation of thyristors to various applications	**K3**

COURSE ARTICULATION MATRIX														
a)CO-PO Mapping														
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	3	3	1	1	-	-	-	-	-	-	-	2	2	1	1
CO2	3	3	2	2	-	-	-	-	-	-	-	2	2	1	1
CO3	3	3	2	1	-	-	-	-	-	-	-	2	2	2	1
CO4	3	3	1	3	-	-	-	-	-	-	-	2	2	2	1
CO5	3	3	2	3	-	-	-	-	-	-	-	2	2	-	1
22LPE$52	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial															

b)CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.1.5,4.1.2,12.1.1,12.1.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1, 12.1.1,12.1.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 3.3.2,3.4.1,3.4.2,4.1.2,4.1.4,12.1.1,12.1.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.3.2, 3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,12.1.1,12.1.2,12.1.1,12.1.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 3.1.5,3.2.1,3.3.2, 3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1, 12.1.1,12.1.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	10	20	40	30			100
CAT2	10	30	30	30			100
Assignment 1	10	20	40	30			100
Assignment 2	10	30	30	30			100
Quiz 1	30	40	30				100
Quiz 2	20	50	30				100
Other mode of internal assessments, if any							
ESE	10	20	30	40			100

22LPE$53	HIGH SPEED ELECTRONICS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	The course aims to give exposure on the band diagram, characteristics of hetero junction devices and fabrication techniques.	
UNIT – I	**SEMICONDUCTOR MATERIALS CHARACTERISTICS**	**9 Periods**
Review of Crystal Structure: Crystal structure of important semiconductors (Si, GaAs, InP) - electrons in periodic lattices - energy band diagram - carrier concentration and carrier transport phenomenon - electrical - optical - thermal and high field properties of semiconductors.		
UNIT – II	**HOMOJUNCTION DEVICES**	**9 Periods**
Homojunction Devices (BJT and FET): Structure - band diagram - operation - I–V and C–V characteristics (analytical expressions) - small signal switching models.		
UNIT – III	**MOS DEVICES**	**9 Periods**
MOS Diode: Structure - band diagram - operation - C–V characteristics - effects of oxide charges - avalanche injection - high field effects and breakdown; Heterojunction Based MOSFET: Band diagram - structure - operation - I– V and C–V characteristics (analytical expressions) - MOSFET breakdown and punch through - subthreshold current - scaling down; Alternate High k-dielectric Materials: HF–MOSFETs - SOI MOSFET - buried channel MOSFET - charge coupled devices.		
UNIT – IV	**ADVANCED DEVICES**	**9 Periods**
HBT and HEMT Devices: AlGaAs/ GaAs, InP and SiGe based HBT and HEMT structure - band diagram - operation - I–V and C–V characteristics (analytical expressions) - small signal switching models - benefits of heterojunction transistor for high speed applications.		
UNIT – V	**FABRICATION AND CHARACTERIZATION TECHNIQUES**	**9 Periods**
Crystal Growth and Wafer Preparation: Epitaxy - diffusion - ion implantation - dielectric film deposition and oxidization techniques - masking and lithography techniques (optical, e-beam and other advanced lithography techniques) - metallization - bipolar and MOS integration techniques - interface passivation techniques; Characterization Techniques: Four probe and hall effect measurement - I–V and C–V for dopant profile characterization and DLTS.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS :

1	*Nandita Das Gupta and Amitava Das Gupta, **"Semiconductor Devices: Modeling and Technology"**, Prentice Hall of India, 2004.*
2	*Doering R and Nishi Y, **"Handbook of Semiconductor Manufacturing Technology"**, 2nd ed. Boca Raton, FL: CRC Press, Taylor & Francis Group, 2008*

REFERENCES:

1	*Wolf S and Tauber RN, **"Silicon processing for the VLSI era Volume 1 – Process Technology"**, 2nd ed. Sunset Beach, CA: Lattice Press, 2000.*
2	*M. S. Tyagi, **"Introduction to Semiconductor Materials and Devices"**, John Wiley and Sons, 2008. Hall,1998*
3	*S. M. Sze, **"Physics of Semiconductor Devices"**, 3 rd edition, John Wiley and Sons, 2007*
4	*J. Singh, **"Semiconductor Devices: Basic Principles"**, John Wiley and Sons, 2007.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the characteristics of semiconductor materials and the structure of metal semiconductor devices	**K2**
CO2	Analyse the characteristics of Homojunction devices	**K4**
CO3	Explain the technology of MOS	**K2**
CO4	Design the fabrication techniques.	**K3**
CO5	Apply the MOS integration techniques.	**K3**

COURSE ARTICULATION MATRIX

a)CO-PO Mapping

COs/POs	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	PSO 3
CO1	3	3	2	1	3	-	-	-	-	-	-	1	2	1	2
CO2	3	2	2	1	1	-	-	-	-	-	-	2	2	3	2
CO3	3	3	3	2	1	-	-	-	-	-	-	1	1	-	-
CO4	3	1	2	2	1	-	-	-	-	-	-	2	2	1	1
CO5	3	2	2	2	1	-	-	-	-	-	-	3	1	1	1
22LPE$53	**3**	**2**	**2**	**2**	**1**	-	-	-	-	-	-	**2**	**2**	**2**	**2**

b)CO and Key Performance Indicators mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3, 2.2.4,2.3.1,2.3.2, 2.4.1,2.4.2,3.1.5, 3.1.1,3.1.2,3.2.1,3.2.2, 4.1.2, , 4.1.2, , 4.1.3, 4.1.4, , 4.2.1, , 4.2.2, , 4.2.3, , 4.3.1, 4.3.2, 4.3.3, 5.1.1,5.2.1,5.2.3,12.1.1,12.1.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4, 2.3.1,2.3.2,2.4.1, 2.4.2,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1, 5.1.1,5.2.1,5.2.3, 12.1.1,12.1.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 3.3.2,3.4.1,3.4.2,4.1.2,4.1.4, 5.1.1,5.2.1,5.2.3, 12.1.1,12.1.2
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.3.2, 3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,5.1.1,5.2.1,5.2.3, 12.1.1,12.1.2
CO5	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 3.1.5,3.2.1,3.3.2, 3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1, 5.1.1,5.2.1,5.2.3, 12.1.1,12.1.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	20	40	30			100
CAT2	10	30	30	30			100
Assignment 1	10	20	40	30			100
Assignment 2	10	30	30	30			100
Quiz 1	30	40	30				100
Quiz 2	20	50	30				100
Other mode of internal assessments, if any							
ESE	10	20	30	40			100

22LPE$54	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	PE	3	0	0	3

Course Objective	To Learn the basic concepts of Problem solving, Probabilistic reasoning, Supervised Learning, Ensemble Technique, Neural Networks.	
UNIT – I	**PROBLEM SOLVING**	**9 Periods**
Introduction to AI - AI Applications - Problem solving agents – search algorithms – uninformed search strategies – Heuristic search strategies – Local search and optimization problems – adversarial search – constraint satisfaction problems (CSP).		
UNIT – II	**PROBABILISTIC REASONING**	**9 Periods**
Acting under uncertainty – Bayesian inference – naïve bayes models. Probabilistic reasoning – Bayesian networks – exact inference in BN – approximate inference in BN – causal networks.		
UNIT – III	**SUPERVISED LEARNING**	**9 Periods**
Introduction to machine learning – Linear Regression Models: Least squares, single & multiple variables, Bayesian linear regression, gradient descent, Linear Classification Models: Discriminant function – Probabilistic discriminative model - Logistic regression, Probabilistic generative model – Naive Bayes, Maximum margin classifier – Support vector machine, Decision Tree, Random forests.		
UNIT – IV	**ENSEMBLE TECHNIQUES AND UNSUPERVISED LEARNING**	**9 Periods**
Combining multiple learners: Model combination schemes, Voting, Ensemble Learning - bagging, boosting, stacking, Unsupervised learning: K-means, Instance Based Learning: KNN, Gaussian mixture models and Expectation maximization.		
UNIT – V	**NEURAL NETWORKS**	**9 Periods**
Perceptron - Multilayer perceptron, activation functions, network training – gradient descent optimization – stochastic gradient descent, error back propagation, from shallow networks to deep networks –Unit saturation (aka the vanishing gradient problem) – ReLU, hyperparameter tuning, batch normalization, regularization, dropout.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	Stuart Russell and Peter Norvig, "**Artificial Intelligence** – A Modern Approach", Fourth Edition, Pearson Education, 2021.
2	Ethem Alpaydin, "**Introduction to Machine Learning**", MIT Press, Fourth Edition, 2020.

REFERENCES:

1	Dan W. Patterson, "**Introduction to Artificial Intelligence and Expert Systems**", Pearson Education,2007
2	Kevin Night, Elaine Rich, and Nair B., "**Artificial Intelligence**", McGraw Hill, 2008
3	Christopher M. Bishop, "**Pattern Recognition and Machine Learning**", Springer, 2006.
4	Tom Mitchell, "**Machine Learning**", McGraw Hill, 3rd Edition,1997.
5	Charu C. Aggarwal, "**Data Classification Algorithms and Applications**", CRC Press, 2014
6	Ian Goodfellow, Yoshua Bengio, Aaron Courville, "**Deep Learning**", MIT Press, 2016

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Use appropriate search algorithms for problem solving	K2
CO2	Apply reasoning under uncertainty	K3
CO3	Build supervised learning models	K2
CO4	Build ensembling and unsupervised models	K2
CO5	Build deep learning neural network models	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

	PO 1	PO2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	3	3	1	2	-	-	-	-	-	-	-	-	2	2	1
CO 2	3	3	2	2	-	-	-	-	-	-	-	-	3	2	1
CO 3	3	3	2	3	-	-	-	-	-	-	-	-	3	2	1
CO4	3	3	1	2	-	-	-	-	-	-	-	-	2	2	1
CO5	3	3	1	3	-	-	-	-	-	-	-	-	2	2	1
22LPE$54	**3**	**3**	**1**	**2**	-	-	-	-	-	-	-	-	**2**	**2**	**1**

b)CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.3.2, 3.4.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.1.6, 3.3.1, 3.3.2, 3.4.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.2.2, 3.3.1, 3.3.2, 3.4.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4
CO4	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.3.2, 3.4.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.3.2, 3.4.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.3, 4.3.4

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	40	40				100
CAT2	20	40	40				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	40				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	40	40				100
ESE	20	40	40				100

22COE$01	**DISASTER MANAGEMENT AND MITIGATION** *(Common to All Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**OE**	**3**	**0**	**0**	**3**

Course Objective	To impart knowledge to create appropriate planning, preparation and response for emergency treatment in disaster situation	
UNIT – I	**INTRODUCTION TO DISASTERS**	**9 Periods**
Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Classification, Causes, Impacts - Global Trends in Disasters: Urban Disasters, Pandemics, Complex Emergencies, Climate Change- Dos and Don'ts during various types of Disasters.		
UNIT – II	**HAZARDS AND RISK VULNERABILITY**	**9 Periods**
Hazard Identification and Hazard Profiling - Hazard Analysis - Types of hazards - Natural and technological Components of Risk- likelihood and Consequence, Trends and Computation of likelihood and Consequence. Risk Evaluation – Purpose, Risk Acceptability, Alternatives, Personnel. Political/ Social, Economic. Vulnerability-Physical Profile, Social Profile, Environmental Profile, Economic Profile - Factors Influencing Vulnerability, Risk Perception.		
UNIT – III	**MITIGATION AND PREPAREDNESS**	**9 Periods**
Mitigation - Types, Obstacles, Assessment and Selection of Mitigation options, Emergency Response capacity, Incorporating Mitigation into Development and Relief Projects. Preparedness- Government Preparedness, Public Preparedness, Media as a Public educator. Obstacles to public education and preparedness.		
UNIT – IV	**RESPONSE AND RECOVERY**	**9 Periods**
Response the Emergency- Pre disaster, post disaster, Provision of Water, Food and Shelter, Volunteer Management, Command, Control and Coordination. Recovery- Short Term and Long-term Recovery- Components of Recovery- Planning, Coordination, Information, Money and Supplies, Allocation of Relief Funds, Personnel. Types of Recovery- Government, Infrastructure, Debris Removal Disposal and Processing, Environment, Housing, Economic and Livelihood, Individual, Family and Social Recovery- Special Considerations in Recovery.		
UNIT – V	**DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES**	**9 Periods**
Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and implementation and review – ISO 45001-Strucure and Clauses-Case Studies.		
Contact Periods: **Lecture: 45 Periods Tutorial: 00 Periods Practical: 00 Periods Total: 45 Periods**		

TEXT BOOKS :

1	*Singhal J.P.* ***"Disaster Management",*** *Laxmi Publications, 2010.*
2	*Tushar Bhattacharya,* ***"Disaster Science and Management",*** *McGraw Hill India Education Pvt. Ltd., 2012.*

REFERENCES:

1	*Govt. of India: Disaster Management Act , Government of India, New Delhi, 2005.*
2	*Government of India, National Disaster Management Policy,2009.*
3	*Gupta Anil K, Sreeja S. Nair.* ***"Environmental Knowledge for Disaster Risk Management"****, NIDM, New Delhi, 2011*
4	*Kapur Anu Vulnerable India:* ***A Geographical Study of Disasters****, IIAS and Sage Publishers, New Delhi, 2010*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Identify the types of disasters, causes and their impact on environment and society	K2
CO2	Assess vulnerability and various methods of risk reduction measures as well as mitigation.	K2
CO3	Comprehend the mitigation and preparedness process.	K2
CO4	Describe about response and recovery process during disaster.	K2
CO5	Perform disaster damage assessment and management.	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	1		1		2	3	3	2	2	2		3	2		2
CO2	1		1		2	3	3	2	2	2		3	2		2
CO3	1		1		2	3	3	2	2	2		3	2		2
CO4	1		1		2	3	3	2	2	2		3	2		2
CO5	1		1		2	3	3	2	2	2		3	2		2
22COE$01	1		1		2	3	3	2	2	2		3	2		2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1, 3.1.5, 5.1.1, 5.2.1, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 8.1.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 10.1.1, 10.1.2, 10.1.3
CO2	1.2.1, 3.1.5, 5.1.1, 5.2.1, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, **7.2.2,** 8.1.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 10.1.1, 10.1.2, 10.1.3
CO3	1.2.1, 3.1.5, 5.1.1, 5.2.1, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 10.1.1, 10.1.2, 10.1.3
CO4	1.2.1, 3.1.5, 5.1.1, 5.2.1, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 10.1.1, 10.1.2, 10.1.3
CO5	1.2.1, 3.3.6, 5.1.1, 5.2.1, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.1, 9.1.2, 9.2.1, 10.1.1, 10.1.2, 10.1.3

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	25	50	25	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	25	50	25	-	-	100
ESE	30	30	40	-	-	-	100

22COE$02	**WATER SANITATION AND HEALTH** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objective	To understand the overview of Environment, Health and Safety (EHS) in industries and related Indian regulations, types of Health hazards, effect, assessment and control methods and EHS Management System	
UNIT – I	**INTRODUCTION**	**9 Periods**
Need for developing Environment, Health and Safety systems in work places- International initiatives, National Policy and Legislations on EHS in India - Regulations and Codes of Practice - Role of Trade Union Safety Representatives – Ergonomics.		
UNIT – II	**OCCUPATIONAL HEALTH AND HYGIENE**	**9 Periods**
Definition of occupational health and hygiene - Categories of health hazards – Exposure pathways and human responses–Exposure Assessment-occupational exposure limits - Hierarchy of control measures - Role of personal protective equipment and the selection criteria.		
UNIT – III	**WORKPLACE SAFETY AND SAFETY SYSTEMS**	**9 Periods**
Features of Satisfactory and Safe design of work premises – good housekeeping - lighting and color, Ventilation and Heat Control, Noise, Chemical and Radiation Safety – Electrical Safety – Fire Safety – Safety at Construction sites, ETP – Machine guarding – Process Safety, Working at different levels.		
UNIT – IV	**HAZARDS AND RISK MANAGEMENT**	**9 Periods**
Safety appraisal – Job Safety Analysis-Control techniques – plant safety inspection – Accident investigation - Analysis and Reporting – Hazard and Risk Management Techniques –Onsite and Offsite emergency Plans. Employee Participation- Education and Training- Case Studies.		
UNIT – V	**ENVIRONMENTAL HEALTH AND SAFETY MANAGEMENT**	**9 Periods**
Concept of Environmental Health and Safety Management – Elements of Environmental Health and Safety Management Policy and implementation and review – ISO 45001-Strucure and Clauses-Case Studies.		
Contact Periods: **Lecture: 45 Periods Tutorial: 00 Periods Practical: 00 Periods Total: 45 Periods**		

TEXT BOOKS:

1	***Industrial Health and Safety Acts and Amendments****, by Ministry of Labour and Employment, Government of India.*
2	*Dr.K.U.Mistry, Siddharth Prakashan,* ***"Fundamentals of Industrial Safety and Health"****, 2012*

REFERENCES:

1	*Bill Taylor,* ***"Effective Environmental, Health, and Safety Management Using the Team Approach",*** *Culinary and Hospitality Industry Publications Services, 2005.*
2	*Nicholas P.Cheremisinoff and Madelyn L. Graffia,* ***"Environmental and Health and Safety Management"****, William Andrew Inc. NY, 1995.*
3	*Brian Gallant,* ***"The Facility Manager's Guide to Environmental Health and Safety"*** *, Government Inst Publ., 2007.*
4	*https://archive.nptel.ac.in/courses/114/106/114106017/*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Outline the needs for EHS in industries and related Indian regulations	K2
CO2	Assess the various types of Health hazards, effect, assessment and control methods	K2
CO3	Identity the various safety systems in working environments	K2
CO4	Select the methodology for preparation of Emergency Plans and Accident investigation	K3
CO5	Describe the EHS Management System and its elements	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2		1		3	3	3	2	1		2		1	1	
CO2	2		1		3	3	3	2	1		2		1	1	
CO3	2		1		3	3	3	2	1		2		1	1	
CO4	2		1		3	3	3	2	1		2		1	1	
CO5	2		1		2	3	3	2	1		2		1	1	
22COE$02	2		1		3	3	3	2	1		2		1	1	

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1, 1.3.1, 3.1.4, 3.1.5, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.2, 11.1.1, 11.2.1.
CO2	1.2.1, 1.3.1, 3.1.4, 3.1.5, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.2, 11.1.1, 11.2.1.
CO3	1.2.1, 1.3.1, 3.1.4, 3.1.5, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.2, 11.1.1, 11.2.1.
CO4	1.2.1, 1.3.1, 3.1.4, 3.1.5, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.2, 11.1.1, 11.2.1.
CO5	1.2.1, 1.3.1, 3.1.4, 3.1.5, 5.1.1, 5.2.1, 5.2.2, 5.3.1, 6.1.1, 6.2.1, 7.1.2, 7.2.1, 7.2.2, 8.1.1, 8.2.2, 9.1.2, 11.1.1, 11.2.1.

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	40	20	-	-	-	100
CAT2	40	40	20	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	25	50	25	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	25	50	25	-	-	100
ESE	30	30	40	-	-	-	100

22MOE$03	**NANOTECHNOLOGY AND SURFACE ENGINEERING** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To educate the production techniques and characterization techniques of nano materials and to familiarize about the surface modification techniques using nano materials.	
UNIT – I	**ELEMENTS OF NANO-SCIENCE AND NANOTECHNOLOGY**	**(9 Periods)**
Engineering scale of nanotechnology, different classes of nano-materials, synthesis of nano-materials, fabrication and characterization of nanostructures, Engineering applications-Cosmetics and Consumer Goods, Nano Sensor, Nano catalysts, Water Treatment and the Environment, Paints, Food and Agriculture Industry.		
UNIT – II	**NANOTECHNOLOGY AND CERAMICS**	**(9 Periods)**
Introduction, Vapor Condensation Methods, Sputtering, Laser Method, Spray Pyrolysis, Thermo Chemical /Flame Decomposition of metal organic Precursors methods		
UNIT – III	**CHARACTERIZATION OF NANOMATERIALS**	**(9 Periods)**
X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy, UV / Visible Spectroscopy.		
UNIT – IV	**SURFACE ENGINEERING**	**(9 Periods)**
Introduction to surface engineering, Scope of surface engineering for different engineering materials, Surface Preparation methods such as Chemical, Electrochemical, Mechanical: Sand Blasting, Shot peening, Shot blasting, Hydro-blasting, Vapor Phase Degreasing etc., Coatings: Classification, Properties and applications of Various Coatings.		
UNIT – V	**SURFACE MODIFICATION TECHNIQUES**	**(9 Periods)**
Surface modification by use of directed energy beams, Plasma, Sputtering & Ion Implantation. Surface modification by Friction stir processing. Surface composites.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*G. Cao, **"Nanostructures and Nanomaterials: Synthesis",** Properties and Applications by Imperial College Press, 2nd edition, 2011.*
2	*Keith Austin "**Surface Engineering Hand Book"**, London : Kogan Page, 1998*

REFERENCES:

1	*Gregory Timp, "**Nanotechnology",** Springer, 2012*
2	*Dheerendra Kumar Dwivedi, **"Surface Engineering: Enhancing Life of Tribological Components"**, Springer, 2018*
3	*D. Phil Woodruff,**"Modern Techniques of Surface Science**", Cambridge University Press, 2016*
4	*Sulabha K. Kulkarni ,**"Nanotechnology: Principles and Practices**", Springer, 2019*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Choose appropriate nano material and its manufacturing method.	K1
CO2	Select most suitable technique to deposit a layer of nano material on ceramic surface.	K2
CO3	Identify appropriate techniques to characterize nano materials.	K2
CO4	Select surface preparation, coating techniques and predict their combinational effect for engineering applications.	K2
CO5	Adopt different techniques to modify surfaces and make surface composites as per requirement.	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	0	1	2	1	1	0	0	0	0	0	0	0	2	2	3
CO2	0	1	2	1	1	0	0	0	0	0	0	0	2	2	3
CO3	0	1	2	1	1	0	0	0	0	0	0	0	2	2	3
CO4	0	2	2	1	1	0	0	0	0	0	1	0	2	3	3
CO5	0	1	2	1	1	0	0	0	0	0	1	0	3	2	3
22MOE$03	0	1	2	1	1	0	0	0	0	0	1	0	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	2.2.2, 2.2.3, 2.2.4, 2.3.1, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 4.1.1, 4.3.4, 5.1.2
CO2	2.2.2, 2.2.3, 2.2.4, 2.3.1, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 4.1.1, 4.3.4, 5.1.2
CO3	2.2.2, 2.2.3, 2.2.4, 2.3.1, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 4.1.1, 4.3.4, 5.1.2
CO4	2.1.1, 2.1.2, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 4.1.1, 4.3.4, 5.1.2, 5.3.1, 11.3.1
CO5	2.2.2, 2.2.3, 2.2.4, 2.3.1, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 4.1.1, 4.3.4, 5.1.2, 5.3.1, 11.3.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50	50					100
CAT2	30	70					100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	50					100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	70					100
ESE	40	60					100

22MOE$04	**INDUSTRIAL SAFETY MANAGEMENT** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To learn the techniques of industrial safety and management to implement and solve safety problems in engineering.	
UNIT – I	**ENVIRONMENT AND SAFETY PHILOSOPHY**	**(9 Periods)**
Henrichs Axioms Of Industrial Safety - Concepts Of Safety – Ethics of environmental conservation – Environmental Impact Assessment – Environmental economics – Safety philosophy – Planning for safety – Organising for safety – Directing for safety - Role of Occupier and Factory Manager, Factory Safety Committee, Structure and Functions and Working Tenure Details		
UNIT – II	**SAFETY APPRAISAL AND CONTROL TECHNIQUES**	**(9 Periods)**
Plant and equipment safety appraisal techniques – Laws and regulation – Hazards and Risks – Major accident hazard control – Importance of Disaster management		
UNIT – III	**ACCIDENT PREVENTION AND SAFETY MANAGEMENT**	**(9 Periods)**
Incident - Accident - Injury - Dangerous occurrence - Unsafe Act - Unsafe Conditions - Hazards - Error, Oversight - Mistake , Near Miss - Measurement of safety performance - Key elements of Safety Management system (ISO 14001, OHSAS 18001 etc.). ILO Legislations – Convention and Recommendation concerning Safety, Health and Environment – Objectives of Health, Safety and Environment Policy, Responsibility for Implementation of HSE Policy.		
UNIT – IV	**SAFETY MANAGEMENT IN INDUSTRIES**	**(9 Periods)**
Safe Guarding of machines – Manual handling and storage of materials – Mechanical handling of materials – Hand tools and portable power tools – Electrical hazards – Earth , insulation and continuity tests – Industrial lighting – Safety of pressure vessels – Ventilation and heat control – Housekeeping – Special precautions - Safety in Construction Industry – Safety in Engineering Industry – Safety in Chemical Industries – Safety in Textile Industries – Safety in Dock and Port – Transportation Safety – Safety in Fire and explosive industries.		
UNIT – V	**INDUSTRIAL HYGIENE AND POLLUTION CONTROL**	**(9 Periods)**
Industrial Hygiene – Air sampling – Noise and vibration – Industrial physiology - Occupational health – Personal Protective Equipment's – Pollution Control strategies.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Akhil Kumar Das, **"Principles of Industrial Safety Management":Understanding the Ws of Safety at Work"** PHI Learning , 2021*
2	*Jain R K and Sunil.S.Rao, **"Industrial Safety Health and Environment Management System"**, Seventh reprint, Khanna publishers, 2023.*

REFERENCES:

1	*Prathibha Bansal and Anupama Prashar, **"Industrial safety and Environment"**, S.K.Kattaria Sons, 2005.*
2	*A.K.Gupta, **"Industrial safety and Environment"**, Laxmi Publication Pvt Limited, 2008.*
3	***"Accident Prevention Manual For Industrial Operations"**, N.S.C Chicago, 13th Edition 2009.*
4	*Dan Petersen, **"Techniques of Safety Management"**, Americal Society of Safety Emgineers, 4th edition, 2003.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand Environment and safety philosophy.	K1
CO2	Frame Safety appraisal and control technique to create safety management.	K2
CO3	Follow accident prevention procedure to solve safety problem.	K2
CO4	Implement safety management for Industries.	K3
CO5	Follow Industrial Hygiene and Pollution control	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	0	1	3	0	0	0	0	0	0	0	3	1	2
CO2	3	3	0	1	2	0	0	0	0	0	0	0	3	2	2
CO3	3	3	0	0	3	0	0	0	0	0	0	0	3	1	2
CO4	3	3	0	1	2	0	0	0	0	0	0	0	3	2	2
CO5	3	3	0	0	3	0	0	0	0	0	0	0	3	1	2
22MOE$04	3	3	0	1	3	0	0	0	0	0	0	0	3	1	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.3, 2.2.1, 2.2.3, 2.2.4, 2.4.4, 4.3.4, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2
CO2	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.3, 2.4.4, 4.1.4, 5.1.2, 5.2.1, 5.3.1, 5.3.2
CO3	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.3, 2.4.4, 5.1.1, 5.1.2, 5.2.1, 5.3.1, 5.3.2
CO4	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.3, 2.4.4, 4.1.4, 5.1.2, 5.2.1, 5.3.1, 5.3.2
CO5	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.4.3, 2.4.4, 5.1.1, 5.1.2, 5.2.1, 5.3.1, 5.3.2

ASSESSMENT PATTERN

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	70	20	10				100
CAT2	50	30	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	60	40					100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	50	30	20				100
ESE	50	30	20				100

22EOE$05	**RENEWABLE POWER GENERATION SYSTEMS** *(Common to All Branches)*					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		OE	3	0	0	3
Course Objectives	To understand energy scenarios, energy sources and their utilization, society's present needs and future energy demands, the principles of renewable energy conversion systems					
UNIT – I	**ENERGY SCENARIO**					**9 Periods**
Principles of renewable energy; energy and sustainable development, fundamentals and social implications. worldwide renewable energy availability, renewable energy availability in India, brief descriptions on solar energy, wind energy, tidal energy, wave energy, ocean thermal energy, biomass energy, geothermal energy, oil shale. Introduction to Internet of energy (IOE).						
UNIT – II	**SOLAR ENERGY**					**9 Periods**
Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Solar radiation Measurements- Pyrheliometers, Pyrometer, Sunshine Recorder. Solar Thermal systems: Flat plate collector; Solar distillation; Solar pond electric power plant. Solar electric power generation- Principle of Solar cell, Photovoltaic system for electric power generation, advantages, Disadvantages and applications of solar photovoltaic system.						
UNIT – III	**WIND AND BIOMASS ENERGY**					**9 Periods**
Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, Basic components of wind energy conversion system (WECS); Classification of WECS- Horizontal axis- single, double and multi blade system. Vertical axis- Savonius and Darrieus types. Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies -fixed dome; Urban waste to energy conversion; Biomass gasification (Downdraft).						
UNIT – IV	**TIDAL AND OCEAN THERMAL ENERGY**					**9 Periods**
Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, advantages and limitations. Ocean Thermal Energy Conversion: Principle of working, OTEC power stations in the world, problems associated with OTEC.						
UNIT – V	**GREEN ENERGY**					**9 Periods**
Introduction, Fuel cells: Classification of fuel cells – H_2; Operating principles, Zero energy Concepts. Benefits of hydrogen energy, hydrogen production technologies (electrolysis method only), hydrogen energy storage, applications of hydrogen energy, problem associated with hydrogen energy.						
Contact Periods: (Times New Roman, Size 11, BOLD, Sentence case) **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**						

TEXT BOOK (Maximum 2):

1	G D Rai, Non Conventional Energy sources, Khanna Publication, Fourth Edition, 2009
2	Boyle, "Renewable Energy – Power For A Sustainable Future", Oxford, 2012

REFERENCES (Minimum 4 and Maximum 6):

1	S Rao,B.B.Parulekhar, "Energy Technology 3/e: Nonconventional, Renewable and Conventional", Khanna Publishers, 1994
2	G. N. Tiwari,"Solar Energy - Fundamentals, Design, Modelling and Applications", 2002
3	Gilbert M. Masters, "Renewable and Efficient Electric Power Systems" Wiley,2005
4	Shobh Nath Singh, "Non-Convention Energy Resources", Pearson, 2018

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Describe the environmental aspects of renewable energy resources in comparison with various conventional energy systems, their prospects and limitations.	K2
CO2	Summarize the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, electric power generation.	K2
CO3	Apply the conversion principles of wind and tidal energy for the production of electric power generation	K3
CO4	Apply the concept of biomass energy resources and green energy for developing sustainable electric power generation set-up	K3
CO5	Analyze the basic knowledge of ocean thermal energy conversion and hydrogen energy and hence design & evaluate the power generation system	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	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	PSO 3
CO1	3	3	3	3	3	3	3	-	-	-	-	3	3	3	2
CO2	3	3	3	3	3	3	3	-	-	-	-	3	3	3	2
CO3	3	3	3	3	3	3	3	-	-	-	-	3	3	3	2
CO4	3	3	3	3	3	3	3	-	-	-	-	3	3	3	2
CO5	3	3	3	3	3	3	3	-	-	-	-	3	3	3	2
22EOE $05	3	3	3	3	3	3	3	-	-	-	-	3	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3, 2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3, 4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2, 7.2.1,7.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3, 2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3, 4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2, 7.2.1,7.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3, 2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3, 4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2, 7.2.1,7.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3, 2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3, 4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2, 7.2.1,7.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3, 2.4.4,3.1.1,3.1.2,3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.1,4.1.2,4.1.3, 4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2, 7.2.1,7.2.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2.

ASSESSMENT PATTERN – THEORY							
Test / Bloom’s Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	20	30	30			100
CAT2	20	20	30	30			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	20	30	30			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	20	30	30			100
ESE	20	20	30	30			100

22EOE$06	**SMART GRID TECHNOLOGY** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	To provide a comprehensive understanding of Smart Grid Technology, including its components, functions, applications and implications for Energy Management and Distribution.	
UNIT – I	**BASICS OF POWER SYSTEMS**	**9 Periods**
Basics of Power Systems: Load and Generation - Power Flow Analysis- Economic Dispatch and Unit Commitment Problems. Smart Grid: Definition – Applications- Government and Industry- Standardization		
UNIT – II	**SMART GRID COMMUNICATIONS**	**9 Periods**
Two-way Digital Communications Paradigm - Network Architectures - IP-based Systems - Power Line Communications - Advanced Metering Infrastructure		
UNIT – III	**WIDE AREA MEASUREMENT**	**9 Periods**
Sensor Networks - Phasor Measurement Units- Communications Infrastructure- Fault Detection and Self-Healing Systems -Applications and Challenge		
UNIT – IV	**SECURITY AND PRIVACY**	**9 Periods**
Cyber Security Challenges in Smart Grid - Load Altering Attacks- False Data Injection Attacks- Defense Mechanisms - Privacy Challenges- Cyber Security Standards		
UNIT – V	**ECONOMICS AND MARKET OPERATIONS**	**9 Periods**
Introduction, Reasons for restructuring / deregulation of power industry, Understanding the restructuring process - Entities involved. The market place mechanisms-Energy and Reserve Markets- Market Power - Generation Firms- Locational Marginal Prices- Financial Transmission Rights		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*Janaka Ekanayake, Nick Jenkins, KithsiriLiyanage "***Smart Grid Technologies and applications"** *John Wiley Publishers Ltd., 2012.*
2	*P. Venkatesh, B.V. Manikandan, S. Charles Raja, A. Srinivasan "***Electrical Power Systems- Analysis, Security and Deregulation"** *PHI Learning Private Limited, New Delhi, 2012.*

REFERENCES

1	*Lars T. Berger, Krzysztof Iniewski "***Smart Grid applications, Communications and Security***" John Wiley Publishers Ltd., 2012.*
2	*Yang Xiao,* **"Communication and Networking in Smart Grids",** *CRC Press Taylor and Francis Group, 2012.*
3	*Caitlin G. Elsworth,* **"The Smart Grid and Electric Power Transmission"**, *Nova Science Publishers Inc, August 2010*
4	*Lars T. Berger, Krzysztof Iniewski "***Smart Grid applications, Communications and Security***" John Wiley Publishers Ltd., 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Recollect the fundamentals of conventional power systems and learn the concept of smart grid	K1
CO2	Interpret the role of communication Technologies in a smart grid	K2
CO3	Apply the state-of-the-art measurement and protection techniques for reliable grid	K3
CO4	Utilize the techniques for ensuring safety and security of the smart grid	K3
CO5	Analyze the economical aspects of the smart grids	K4

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	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	PSO 3
CO1	2	2	2	2	2	2	2	-	-	1	1	-	3	2	1
CO2	3	3	1	2	2	-	-	-	-	2	3	2	3	2	1
CO3	3	3	1	2	2	-	-	-	-	2	3	2	3	3	2
CO4	3	3	1	2	2	3	2	2	1	-	-	3	3	3	2
CO5	3	2	2	2	2	-	2	2	-	1	3	3	3	3	2
22EOE $06	3	3	1	2	2	3	2	2	1	2	3	3	3	3	2

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1,1.3.1,1.4.1,2.3.1,2.3.2,2.4.4,3.1.3,3.1.6,3.2.1,4.1.4,4.2.1,4.3.4,5.1.1,5.3.1,6.1.1,7.1.1,7.2.2,10.1.1, 10.3.1,11.1.1
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.13.2.2, 3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2,10.1.1,10.2.2,10.3.1,11.1.1,11.2.1,11.3.1, 11.3.2,12.3.1,12.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.13.2.2, 3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2,10.1.1,10.2.2,10.3.1,11.1.1,11.2.1,11.3.1, 11.3.2,12.3.1,12.3.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.13.2.2, 3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,8.2.2,9.1.2,7.2.1,7.2.2,6.2.1,6.1.1,5.3.2,5.3.1,5.3.212.1.2,12.2.2, 12.3.2,
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.2,2.1.3,2.2.1,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.6,3.2.13.2.2, 3.2.3,4.1.1,4.1.3,4.1.4,5.1.1,5.2.1,5.3.1,12.1.2,12.2.2,12.3.2

ASSESSMENT PATTERN

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	10	30	40	20			100
CAT2	10	30	40	20			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		30	30	20	20		100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		30	30	20	20		100
ESE	10	30	40	20			100

22LOE$07	**CMOS VLSI DESIGN** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	To introduce various aspects of CMOS logic design in combinational and sequential circuit to design CMOS VLSI system components	
UNIT – I	**CMOS LOGIC DESIGN**	**9 Periods**
Inverter- CMOS Logic Gates: Compound Gates – Pass Transistors and Transmission Gates –Tristated – Multiplexers –CMOS Fabrication and Layout: Fabrication Process – Layout Design rule–Gate Layouts–Stick Diagrams–Design Partitioning.		
UNIT – II	**MOS TRANSISTOR THEORY**	**9 Periods**
Introduction – Long Channel I-V Characteristics – C-V Characteristics – Non-ideal I-V Effects –DC Transfer Characteristics – CMOS Technologies – Sources of Power Dissipation - DynamicPower–Static Power.		
UNIT – III	**COMBINATIONAL CIRCUIT DESIGN**	**9 Periods**
Circuit Families: Static CMOS–Ratioed Circuits–Cascode Voltage Switch Logic–Dynamic Circuits–Pass Transistor Circuits. Silicon-on-Insulator Circuit Design–Subthreshold Cirucit Design.		
UNIT – IV	**SEQUENTIAL CIRCUIT DESIGN**	**9 Periods**
Sequential static circuits–Circuit design of latched and flip-flops–Sequencing dynamic circuits –Synchronizers–Wave pipelining -VLSI clocking: CMOS clocking styles-Pipelined systems-Clock generation and distribution.		
UNIT – V	**DESIGN OF VLSI SYSTEMS**	**9 Periods**
System Specifications – Structural Gate Level Modeling – Switch Level Modeling – Behavioral and RTL Modeling-Addition/subtraction–Comparators–counters––Multiplexers-BinaryDecoders – Comparators – Priority Encoders – Latches - Flip-Flops and Registers – SRAM –DRAM–ROM.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*N. Weste and David Money Harris, "**CMOS VLSI Design**", Fourth Edition, PearsonEducation,2011*
2	*Uyemura, John P, "**Introduction to VLSI Circuits and Systems**", Wiley & Sons, 8th Reprint 2009*

REFERENCES:

1	*JanM.Rabaey,"**Digital Integrated Circuits :A Design Perspective**",PHI,SecondEdition,2012.*
2	*R.Jacob Baker,"**CMOS:Circuit Design, Layout,and Simulation**",Wiley-IEEE,Revised Second Edition,2008.*
3	*Pucknell,"**Basic VLSI Design**",PrenticeHall,2006.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Realize the CMOS logic design	**K2**
CO2	Explain the basic MOS transistor theory and power dissipation in CMOS logic.	**K2**
CO3	Develop combinational circuit design of CMOS logic	**K3**
CO4	Interpret sequential circuit design of CMOS logic	**K2**
CO5	Model the digital system using Hardware Description Language	**K2**

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	**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**	**PSO 3**
CO1	3	3	2	-	-	2	-	-	-	2	-	3	3	1	3
CO2	3	2	1	-	-	2	-	-	-	2	-	3	2	1	2
CO3	3	3	2	-	-	2	-	-	-	2	-	3	3	1	3
CO4	3	3	2	-	-	2	-	-	-	2	-	3	3	1	3
CO5	3	3	2	-	-	2	-	-	-	2	-	3	3	1	3
22LOE$07	**3**	**3**	**2**	-	-	**2**	-	-	-	**2**	-	**3**	**3**	**1**	**3**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.4, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 3.1.4, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 6.1.1, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	40	40	20				100
CAT2	40	40	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	50				100
ESE	40	40	20				100

22LOE$08	MOBILE COMMUNICATION

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objective	To understand and recall the mobile radio propagation, cellular architectures, equalization and diversity techniques, digital modulation techniques and various wireless network standards.	
UNIT – I	**MOBILE RADIO PROPAGATION**	**9 Periods**
Review of free-space propagation - Radio Wave Propagation in wireless environment - 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.		
UNIT – II	**CELLULAR CONCEPT**	**9 Periods**
Hexagonal cell-Cell clustering-Frequency Reuse-Static and dynamic channel assignment strategies - Handoff Strategies - Interference and System Capacity - Trunking - Capacity in Cellular Systems. Multiple Access Techniques: FDMA, TDMA, CDMA, OFDMA.		
UNIT – III	**MULTIPATH MITIGATION TECHNIQUES**	**9 Periods**
Equalization – Adaptive equalization: Linear and Non-Linear equalization, - Diversity – Micro and Macro diversity - Diversity combining techniques - Rake receiver- MIMO Coding: Alamouti Scheme (Qualitative)		
UNIT – IV	**MODULATION TECHNIQUES**	**9 Periods**
Modulation in cellular wireless systems: Binary Phase Shift Keying (BPSK) – QPSK –Orthogonal QPSK-Minimum Shift Keying-Gaussian Minimum Shift Keying - Multicarrier modulation: Orthogonal Frequency Division Multiplexing (OFDM) -PAPR reduction –Windowed OFDM - Filtered OFDM		
UNIT – V	**WIRELESS NETWORKS**	**9 Periods**
Second Generation Cellular Standard: GSM - Third Generation Cellular standards: CDMA - WCDMA- Fourth Generation Cellular Standards: 4G LTE – LTE Advanced – 5G Network – Near Field Communication (NFC) systems – Wireless LAN technology – Hyper LAN – Bluetooth technology – Ultra Wideband (UWB) communication - Introduction to 60 GHz mmWave.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Theodore S. Rappaport, "Wireless communications", 2nd Edition, Pearson Education, 2010*
2	*Mischa Schwartz, "Mobile Wireless Communications", 1st Edition, Cambridge University Press, 2010*

REFERENCES:

1	*Suvra Sekhar Das and Ramjee Prasad, "Evolution of air interface towards 5G Radio Access Technology and Performance Analysis", River Publishers,2018*
2	*David Tse, Pramod Viswanath, "Fundamentals of Wireless Communication", 1st Edition, Cambridge University Press, 2006.*
3	*Andreas.F. Molisch, "Wireless Communications", 2nd Edition, Wiley, 2011.*
4	*Aditya K Jagannatham, "Principles of Modern Wireless Communication Systems Theory and Practice", 1st Edition, McGraw Hill Education (India) Private Limited, 2017*
5	*William Stallings, "Wireless Communications and networks", 2nd Edition, Pearson, 2009.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Interpret the concepts of radio propagation and fading channel models in wireless communication	**K3**
CO2	Interpret the functionalities of various cellular concepts and multiple access techniques and solve problems in channel assignment and traffic intensity in cellular system	**K4**
CO3	Explain various equalization and diversity combining techniques used in multipath propagation	**K2**
CO4	Discuss the need for digital and multicarrier modulation techniques used in modern cellular system	**K2**
CO5	Recall the functionalities of various wireless networks used in day-today life.	**K2**

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
CO5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1
22LOE$08	3	2	1	1	-	-	-	-	-	-	-	1	3	-	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2, 3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2, 3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2, 3.3.1,4.1.1,4.2.1,4.3.3, 12.1.1,12.2.2
CO4	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2, 3.3.1,4.1.1,4.2.1,4.3.3,12.1.1,12.2.2
CO5	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1,3.1.2, 3.3.1,4.1.1,4.2.1,4.3.3,12.1.1,12.2.2

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	20	20			100
CAT2	50	50					100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	40	20	20			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	50	50					100
ESE	20	40	20	20			100

22POE$09	**RAPID PROTOTYPING** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To educate the students with fundamental and advanced knowledge in the field of Rapid Prototyping technology and associated Aerospace, Architecture, Art, Medical and Industrial applications.	
UNIT- I	**INTRODUCTION**	**(9 Periods)**
Overview - Need - Development of Rapid Prototyping (RP) Technology: Rapid Prototyping - Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. RP Process Chain, Benefits, Applications: Building Printing, Bio Printing, Food Printing, Electronics Printing, Automobile, Aerospace, Healthcare.		
UNIT- II	**VAT POLYMERIZATION AND MATERIAL EXTRUSION**	**(9 Periods)**
Photo polymerization: Stereo lithography Apparatus (SLA) - Materials -Process - top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Material Extrusion: Fused Deposition Modelling (FDM) - Process-Materials -Applications and Limitations.		
UNIT- III	**POWDER BED FUSION AND BINDER JETTING**	**(9 Periods)**
Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism - Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits - Limitations - Applications.		
UNIT- IV	**MATERIAL JETTING AND DIRECTED ENERGY DEPOSITION**	**(9 Periods)**
Material Jetting: Multi jet Modelling- Materials - Process - Benefits - Applications. Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery - Materials –Benefits -Applications.		
UNIT- V	**SHEET LAMINATION AND DIRECT WRITE TECHNOLOGY**	**(9 Periods)**
Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding - Materials - Application and Limitation. Ink-Based Direct Writing (DW): Nozzle Dispensing Processes, Inkjet Printing Processes, Aerosol DW - Applications of DW.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "**Additive manufacturing technologies**". 3rd edition Springer Cham, Switzerland, 2021.*
2	*Andreas Gebhardt and Jan-Steffen Hötter "**Additive Manufacturing: 3D Printing for Prototyping and Manufacturing**", Hanser publications, United States, 2015.*

REFERENCES:

1	*Andreas Gebhardt, **"Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing"**, Hanser Gardner Publication, Cincinnati., Ohio, 2011.*
2	*Milan Brandt, **"Laser Additive Manufacturing: Materials, Design, Technologies, and Applications"**, Woodhead Publishing., United Kingdom, 2016.*
3	*Amit Bandyopadhyay and Susmita Bose, **"Additive Manufacturing"**, 1st Edition, CRC Press., United States, 2015.*

4	*Kamrani A.K. and Nasr E.A., **"Rapid Prototyping: Theory and practice"**, Springer., United States ,2006.*
5	*Liou, L.W. and Liou, F.W., **"Rapid Prototyping and Engineering applications: A tool box for prototype development"**, CRC Press., United States, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Discuss the development of RP technology and how RP technology propagated into various businesses and developing opportunities.	K3
CO2	Demonstrate the Vat polymerization and material extrusion processes and its applications.	K3
CO3	Elaborate the process and applications of powder bed fusion and binder jetting.	K3
CO4	Evaluate the advantages, limitations, applications of material jetting and directed energy deposition processes.	K3
CO5	Describe the sheet lamination and direct write technology.	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PSO 2**	**PSO 3**
CO1	2	2	2	0	2	0	3	0	3	3	3	3	0	0	0
CO2	2	2	3	2	3	0	3	0	3	3	1	2	0	0	0
CO3	2	2	3	2	3	0	3	0	3	3	1	2	0	0	0
CO4	2	2	3	2	3	0	3	0	3	3	1	2	0	0	0
CO5	2	2	3	2	3	3	3	0	3	3	1	3	0	0	0
22POE$09	**2**	**2**	**3**	**2**	**3**	**1**	**3**	**0**	**3**	**3**	**2**	**3**	**0**	**0**	**0**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.3, 5.2.2, 5.3.1, 5.3.2, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1, 11.3.1, 11.3.2, 12.1.1, 12.1.2, 12.2.2, 12.3.1, 12.3.2.
CO2	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.2, 12.2.2, 12.3.1, 12.3.2.
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.2, 12.2.2, 12.3.1, 12.3.2.
CO4	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.2, 12.2.2, 12.3.1, 12.3.2.
CO5	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.2.1, 4.3.1, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.3.1, 12.1.1, 12.1.2, 12.2.2, 12.3.1, 12.3.2.

ASSESSMENT PATTERN– THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	15	52	33	-	-	-	100
CAT2	15	68	17	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	-	50	50	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	-	-	100	-	-	-	100
ESE	9	75	16	-	-	-	100

22POE$10	**MANAGERIAL ECONOMICS** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	*To introduce the fundamental economic principles necessary for production managers	
UNIT- I	**FUNDAMENTALS OF MANAGERIAL ECONOMICS**	**(9 Periods)**
Introduction to Economics - Scope of Managerial Economics - General Foundations of Managerial Economics: Economic Approach, Working of Economic System and Circular Flow of Activities - Economics and Business Decisions: Relationship between Economic Theory and Managerial Economics - Role of managerial Economics in Decision making - Concept of Economic Rationality - Opportunity Cost - Marginal and Incremental approach.		
UNIT- II	**DEMAND ANALYSIS**	**(9 Periods)**
Demand and Supply - Determinants of Demand - Demand Estimation and Forecasting - Price Elasticity of Demand - Price Elasticity- Factors Affecting Price Elasticity - Cross Price Elasticity - Income Elasticity of Demand - Advertisement or Promotional Elasticity - Elasticity of Supply.		
UNIT- III	**DEMAND THEORY**	**(9 Periods)**
Utility Analysis - Total and Marginal Utility - Law of Diminishing marginal utility - Indifference curve analysis - Consumer Equilibrium - Consumer Surplus - Price effect, Substitution Effect and Income Effect.		
UNIT- IV	**THEORY OF PRODUCTION AND COST**	**(9 Periods)**
The Production Function - Profit-Maximizing Input Usage - Isoquants and Isocosts – CostMinimization and Optimal Input Substitution - The Cost Function - Breakeven analysis,Contribution analysis - Long-run Costs and Economies of Scale - Multiple Cost Functions andEconomies of Scope - Learning curve.		
UNIT- V	**THEORY OF MARKET AND PRICING**	**(9 Periods)**
Forms of Markets: Meaning and Characteristics - Market Equilibrium: Practical Importance, Market Equilibrium and Changes in Market Equilibrium. Pricing Functions: Market Structures - Pricing and output decisions under different competitive conditions: Monopoly Monopolistic completion and Oligopoly.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK:

1	*Maheshwari.Y* ***"Managerial Economics",*** *Prentice Hall of India, 2012*
2	*Thomas and Maurice* ***"Managerial Economics: Concept and Applications",*** *McGrawHill, 2005*

REFERENCES:

1	*D.N. Dwivedi,* ***"Managerial Economics",*** *Vikas Publishing house, 2015*
2	*Christopher R Thomas, S Charles Maurice,* ***"Managerial economics",*** *Mcgraw Hill, 2014*
3	*M. A. Beg, "****Managerial Economics****",Global Professional Publishing Ltd, 2010*
4	*K.C. Sankaranarayanan, "****Managerial Economics****", CBS, 2015*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain fundamentals of managerial economics	K2
CO2	Discuss the dynamics of Demand	K3
CO3	Explain about various theories of demand	K3
CO4	Discuss about the factors influencing production	K4
CO5	Describe about the theory of market and pricing method	K4

COURSE ARTICULATION MATRIX:

	a) CO and PO Mapping													
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PS O1**	**PSO 2**	**PSO 3**
CO1	1	2	1	3	1	3	3	0	1	3	3	3	0	1	2
CO2	1	3	2	3	1	3	3	0	1	3	3	3	0	1	2
CO3	1	3	2	3	1	3	3	0	1	3	3	3	0	1	2
CO4	1	3	2	3	1	3	3	0	1	3	3	3	1	1	2
CO5	1	3	2	3	1	3	3	0	1	3	3	3	0	1	2
22POE$10	**1**	**3**	**2**	**3**	**1**	**3**	**3**	**0**	**1**	**3**	**3**	**3**	**0**	**1**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.2.1, 2.1.2, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.4.4, 3.1.1, 3.1.3, 3.1.5, 3.2.3, 3.3.1, 3.4.1, 4.1.1, 4.1.2, 4.3.4, 5.2.1, 5.3.1, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.3, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.4, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.3.1, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.3, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.4, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.3.1, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO4	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.3, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.4, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.3.1, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO5	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.2, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.3, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.4, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.1.1, 7.1.2, 7.2.1, 7.2.2, 9.2.1, 9.3.1, 10.1.1, 10.1.2, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 11.3.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

ASSESSMENT PATTERN– THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	50		-	-	-	100
CAT2	50	50		-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	33.33	33.33	33.33	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	33.33	33.33	33.33	-	-	-	100
ESE	42	42	16	-	-	-	100

22NOE$11	**MEASUREMENT AND CONTROL** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

COURSE OBJECTIVE	To teach about the concepts of variable sensors for industrial parameter measurement and to impart knowledge on automatic control system	
UNIT - I	**INTRODUCTION TO MEASUREMENTS**	**9 Periods**
Elements of measurement system - Classification of Instruments – Static and dynamic characteristics of a measurement system - Errors in measurement - Calibration of instruments.		
UNIT - II	**STRAIN AND DISPLACEMENT MEASUREMENT**	**9 Periods**
Strain: Types of strain gauges, theory of operation, strain gauge materials, strain gauge circuits and applications. Displacement: Resistive potentiometer: Linear, circular and helical – LVDT - RVDT - Capacitance transducers – Piezoelectric transducers – Hall Effect devices - Proximity sensors.		
UNIT - III	**PRESSURE AND TEMPERATURE MEASUREMENT**	**9 Periods**
Pressure: Mechanical devices: Diaphragm, bellows, and bourdon tube - Electrical devices: Variable resistance, inductance and capacitance transducers. Temperature: Resistance type temperature sensors: RTD , Thermocouples, Thermopiles and Thermistor - Laws of thermocouple – Radiation methods for temperature measurement.		
UNIT - IV	**FLOW AND LEVEL MEASUREMENT**	**9 Periods**
Flow: Variable head type flow meters: Orifice plate, Venturi tube, Flow nozzle, Pitot tube - Variable area type: Rotameter - Turbine flow meter - Electromagnetic flow meter - Ultrasonic flow meter. Level: Resistive, inductive and capacitive techniques – Ultrasonic methods – Air purge system .		
UNIT - V	**AUTOMATIC CONTROL SYSTEM**	**9 Periods**
Elements of control system – Concept of open loop and closed loop systems – Mathematical modelling - Controllers – Brief idea of Proportional, Derivative and Integral Modes – Pneumatic Controller – Hydraulic Controller.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*A.K. Sawhney, Puneet Sawhney, **"A Course in Mechanical Measurements and Instrumentation & Control"** Dhanpat Rai & Co, 2012.*
2	*S. K. Singh, "**Industrial Instrumentation and Control**", McGraw Hill Publication, 3rd Edition, 2016.*

REFERENCES:

1	*William Bolton, "**Instrumentation and Control Systems**," Newnes, Publication, 3rd Edition, 2021.*
2	*E. D. Doeblin, **"Measurement Systems: Application and Design"**, McGraw Hill Publication, 6th Edition, 2017.*
3	*E.W. Golding and F.C. Widdis, **"Electrical Measurements and Measuring Instruments"** A.H.Wheeler and Co., 5th Edition, 2011.*
4	*Alan S. Morris, **"Measurement and Instrumentation Principles"**, Butterworth-Heinemann Publications, 3rd Edition, 2011.*

COURSE OUTCOMES Upon Completion of the course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Describe the methods of measurement and classification of measuring instruments.	K2
CO2	Suggest suitable sensor for the measurement of strain and displacement.	K2
CO3	Explain the construction and working of transducers for pressure and temperature measurement.	K2
CO4	Elucidate the characteristics of flow and level measuring instruments.	K2

CO5	Elaborate the concept of automatic control system.	K2

COURSE ARTICULATION MATRIX

a) CO/PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	2	2	-	-	-	-	-	-	-	-	-	3	2
CO2	3	2	2	2	-	-	-	-	-	-	-	-	-	3	2
CO3	3	2	2	2	-	-	-	-	-	-	-	-	-	3	2
CO4	3	2	2	2	-	-	-	-	-	-	-	-	-	3	2
CO5	3	3	3	2	-	-	-	-	-	-	-	-	-	3	3
22NOE$11	**3**	**3**	**3**	**2**	-	-	-	-	-	-	-	-	-	**3**	**2**

b) CO and Key Performance Indicators mapping

CO1	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.2, 4.1.3, 4.1.4
CO2	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2,2.2.3, 2.3.1, 2.3.2, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 4.1.2, 4.1.3, 4.1.4
CO3	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2
CO4	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2,2.2.3, 2.2.4, 2.3.1, 2.3.2, 3.1.5, 3.1.6, 3.3.2, 3.4.1, 3.4.2, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2
CO5	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2

ASSESSMENT PATTERN - THEORY

Test/Bloom's Category	Remembering (K1)%	Understanding (K2) %	Applying (K3)%	Analyzing(K4)%	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	40	60					100
CAT2	40	60					100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	30	70					100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	30	70					100
ESE	40	60					100

22NOE$12	**INDUSTRIAL AUTOMATION** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

COURSE OBJECTIVE	To elaborate on the basic concept of automation, including the necessary components and various automation controllers utilized in industrial automation.	
UNIT - I	**INTRODUCTION TO AUTOMATION**	**9 Periods**
Automation overview – Requirement of automation systems – Architecture of industrial automation system –Industrial bus systems: Modbus and Profibus.Introduction to Industry 4.0 and its evolution.		
UNIT - II	**AUTOMATION COMPONENTS**	**9 Periods**
Sensors for temperature – Pressure – Force – Displacement - Speed – Flow- level – Humidity and pH measurement. Actuators – Process control valves –Power electronic drives: DIAC- TRIAC –power MOSFET – IGBT. Introduction to DC and AC servo drives for motion control.		
UNIT - III	**PROGRAMMABLE LOGIC CONTROLLERS**	**9 Periods**
PLC Hardware – power supplies and isolators –Relays – Switches -Seal-in circuits – PLC programming – ladder diagram – sequential flow chart – PLC communication and networking – PLC selection – PLC installation – Advantages – Application of PLC to process control industries and Robotics.		
UNIT - IV	**DISTRIBUTED CONTROL SYSTEM**	**9 Periods**
Overview of DCS – DCS hardware – DCS software configuration – DCS communication – DCS supervisory computer tasks – DCS integration with PLC and Computers.		
UNIT - V	**SUPERVISORY CONTROL AND DATA ACQUISITION SYSTEMS**	**9 Periods**
Introduction - Supervisory Control and Data Acquisition Systems – SCADA HMI Essentials – SCADA Components – SCADA Configuration and Software – HMI hardware and software.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS:

1	*Frank D. Petruzella, "**Programmable Logic Controllers**", 5th Edition, McGraw Hill, 2016.*
2	*S.K. Singh "**Industrial Instrumentation and Control**", 3rd Edition, McGraw Hill Companies, 2004.*

REFERENCES:

1	*Sudip Misra, Chandana Roy, Anandarup Mukherjee, "**Introduction to Industrial Internet of Things and Industry 4.0**", CRC Press, 1st edition, 2021*
2	*Bela G Liptak, "**Process software and digital networks – Volume 3**", 4th Edition, CRC press, 2012.*
3	*Romily Bowden, "**HART application guide and the OSI communication foundation**",1999.*
4	*John.W. Webb Ronald A Reis, "**Programmable Logic Controllers - Principles and Applications**", Prentice Hall Inc., 5th Edition, 2003.*
5	*M. P. Lukcas, "**Distributed Control Systems**", Van Nostrand Reinhold Co., 1986.*

COURSE OUTCOMES Upon Completion of the course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Elaborate the basic architecture of automation systems and Industry 4.0.	K2
CO2	Describe the various automation components and industrial bus system involved in industrial automation	K2
CO3	Construct ladder logic diagram using PLC basic functions, timer and counter functions for simple applications	K3
CO4	Illustrate the functionary components and supervisory control of DCS with relevant diagrams	K2
CO5	Describe the basics of SCADA technology.	K2

COURSE ARTICULATION MATRIX

a) CO/PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	-	-	-	-	-	-	1	3	3
CO2	3	2	1	-	-	-	-	-	-	-	-	-	1	3	3
CO3	3	3	2	2	-	-	-	-	1	-	-	2	1	3	3
CO4	3	2	2	-	-	-	-	-	-	-	-	-	1	3	3
CO5	3	2	`1	-	-	-	-	-	-	-	-	-	1	3	3
22NOE$12	3	3	2	1	-	-	-	-	1	-	-	1	1	3	3

b) CO and Key Performance Indicators mapping

CO1	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.3,3.1.1, 3.1.2, 3.1.3, 3.3.1,3.3.2.
CO2	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.3,3.1.1, 3.1.2, 3.1.3, 3.3.1,3.3.2.
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.3,3.1.1, 3.1.2, 3.1.3, 3.3.1,3.3.2, 4.1.1, 4.1.2, 4.2.1, 4.2.2, 9.1.1, 9.1.2, 10.1.1, 10.1.2, 10.1.3, 12.1.1, 12.1.2.
CO4	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.3,3.1.1, 3.1.2, 3.1.3, 3.3.1,3.3.2.
CO5	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.3,3.1.1, 3.1.2, 3.1.3, 3.3.1,3.3.2.

ASSESSMENT PATTERN - THEORY

Test/Bloom's Category	Remembering (K1)%	Understanding (K2) %	Applying (K3)%	Analyzing(K4)%	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	20	60	20				100
CAT2	20	60	20				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	60	20				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	60	20				100
ESE	20	60	20				100

22SOE$13	**PROGRAMMING IN JAVA** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	The objective of this course is to provide students with the essential Java constructs necessary for developing an object-oriented program.	
UNIT – I	**FUNDAMENTALS OF JAVA PROGRAMMING**	**9 Periods**
History and Evolution of Java- Overview of java– Operators- Control Structures– Methods- Classes and Objects– Inheritance- Packages and Interfaces- Exception Handling.		
UNIT – II	**THREADS , I/O AND STRING HANDLING**	**9 Periods**
Multi threaded Programming– Enumeration- Auto boxing– Annotations- String Handling-Input/Output: Exploring java.io		
UNIT – III	**EVENT HANDLING**	**9 Periods**
Introducing the AWT: working with windows- graphics and text- Using AWT controls- Layout Manager - Menus - Introducing Swing		
UNIT – IV	**IMAGING AND DATABASE CONNECTIVITY**	**9 Periods**
Imaging: Creating- loading and displaying- Image observer- Double buffering- Media tracker- Image producer– consumer– filters– animation- Java Database Connectivity		
UNIT – V	**NETWORKING**	**9 Periods**
Networking – Remote Method Invocation – Java Beans –Java servlets		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOKS

1	*Herbert Schildt, "Java, **The Complete Reference** ", Tata McGrawHill, 12th Edition, 2022*

REFERENCES

1	*Deitel .H.M and Deitel.P.J, " **Java: How to Program** ", Pearson Education Asia, 9th Edition 2011*
2	*Lay.S&Horstmann Gary Cornell, " **Core Java Vol I** ", The Sun Microsystems & press Java Series, 9th Edition, 2012*
3	*NPTEL Course : "**PROGRAMMING IN JAVA"*** ***https://archive.nptel.ac.in/courses/106/105/106105191/***

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Write simple java programs using fundamental concepts of java like control structures, inheritance, packages, interfaces and exception handling	K4
CO2	Write java program using multithreading and string handling	K3
CO3	Write java programs for managing events and to access database	K4
CO4	Write java programs to display and manipulation of graphical images	K3
CO5	Develop client server programs using RMI and servlets	K3

COURSE ARTICULATION MATRIX:

a) CO/PO Mapping

COs / POs	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	PSO 3
CO1	2	2	2	2	1	0	0	0	0	2	0	0	1	2	2
CO2	2	1	2	2	1	0	0	0	0	2	0	0		2	3
CO3	2	1	2	2	1	0	0	0	0	2	0	0	1	2	3
CO4	2	1	2	2	1	0	0	0	0	2	0	0	1	2	3
CO5	2	1	2	2	1	0	0	0	0	2	0	2	1	2	3
22SOE$13	2	2	2	2	1	0	0	0	0	2	0	1	1	2	3

b) CO and Key Performance Indicators Mapping	
CO1	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.2.1, 2.2.3, 2.2.4, 2.4.3, 3.1.5, 3.1.6, 3.2.2, 3.3.1, 3.3.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.2, 5.2.2,10.1.1,10.1.2,10.1.3
CO2	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.4.3, 3.1.5, 3.1.6, 3.2.2, 3.3.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.2, 5.2.2,10.1.1,10.1.2,10.1.3
CO3	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.4.3, 3.1.5, 3.1.6, 3.2.2, 3.3.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.2, 5.2.2,10.1.1,10.1.2,10.1.3
CO4	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.4.3, 3.1.5, 3.1.6, 3.2.2, 3.3.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.2, 5.2.2,10.1.1,10.1.2,10.1.3
CO5	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.4.3, 3.1.5, 3.1.6, 3.2.2, 3.3.2, 4.1.1, 4.1.2, 4.1.3, 4.2.1, 4.3.1, 4.3.2, 5.1.1, 5.2.2,10.1.1,10.1.2,10.1.3,12.1.1,12.2.1,12.2.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1		30	40	30			100
CAT2	10	30	40	20			100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1			70	30			100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2			50	50			100
ESE		30	40	30			100

22SOE$14	NETWORK ESSENTIALS *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	The objective of the course is to understand the basics of networking and able to configure and troubleshoot switches and routers.	
UNIT – I	**INTRODUCTION**	**9 Periods**
Introduction to Computer Networks - Goals and advantages of Computer Networks - Network Topologies – Basic networking devices – Protocols – the need for a layered architecture - The OSI Model and the TCP/IP reference model – the Ethernet LAN – Home Networking – Assembling an office LAN – Testing and Troubleshooting a LAN – Physical layer cabling: Twisted pair and Fiber optics		
UNIT – II	**WIRELESS NETWORKING**	**9 Periods**
Importance of Wireless Networking – IEEE 802.11 Wireless LANs – Bluetooth- WIMAX – RFIDs – Securing the Wireless LANs – Configuring a Point to Multipoint Wireless LAN – Interconnecting network LANs – Switch, Bridges and Routers. Interconnecting LANs with the router, Configuring the network interface-Auto negotiation		
UNIT – III	**ADDRESSING AND ROUTING FUNDAMENTALS**	**9 Periods**
IPv4 and IPv6 addressing – Subnet masks – CIDR blocks – configuration of a router – Console port connection - user EXEC mode – Privileged EXEC mode - Configuration of a switch – Static VLAN configuration - Spanning Tree protocol – Network Management – Power over Ethernet		
UNIT – IV	**ROUTING PROTOCOLS**	**9 Periods**
Static Vs Dynamic Routing Protocols – Distance vector Routing – Link State Routing – Hybrid Routing – Configuring RIP - Network Services – DHCP, DNS - Analyzing Internet Traffic.		
UNIT – V	**TROUBLESHOOTING AND NETWORK SECURITY**	**9 Periods**
Analyzing Computer Networks – FTP data packets – Analyzing Campus Network data traffic – Troubleshooting the router and switch interface, Troubleshooting fiber optics – Intrusion – DOS – Security software and hardware.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*Jeffrey S.Beasley Piyasat Nilkaew "**Network Essentials**" 3 rd Edition, Pearson, 2018*
2	*Larry L. Peterson and Bruce S. Davie "**Computer Networks, A Systems Approach**" 5 th edition, Morgan Kaufmann Publishers Inc, 2014.*

REFERENCES :

1	*Behrouz A. Forouzan, "**Data Communications and Networking with TCP/IP Protocol Suite**", Sixth Edition TMH, 2022.*
2	*James F. Kurose, Keith W. Ross, "**Computer Networking, A Top-Down Approach Featuring the Internet**", Eighth Edition, Pearson Education, 2021.*
3	*Ying-Dar Lin, Ren-Hung Hwang, Fred Baker, "**Computer Networks: An Open Source Approach**", McGraw Hill, 2012.*
4	*Nader F. Mir, "**Computer and Communication Networks**", Second Edition, Prentice Hall, 2014.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Identify topologies and types of Computer Networks and enumerate the layers of the OSI model and TCP/IP	K2
CO2	Explain the significance of wireless networks and configure a Wireless LAN	K3
CO3	Configure a switcher and a router	K3
CO4	Describe basic routing algorithms and network services	K3
CO5	Troubleshoot the router and switch interface	K3

a) CO and PO Mapping

COs / POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3
CO1	2	3				1							1	2	
CO2	2	3				1							1	2	
CO3	2	3		2	2	1							1	2	
CO4	2	3		2	2	1							1	2	
CO5	2	3		2	2	1							1	2	
22SOE$14	2	3		2	2	1							1	2	

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.3.1, 1.4.1, 2.1.2, 2.2.2, 2.4.4, , 4.1.2, 5.1.1, 5.1.2,5.2.1, 5.2.2, 5.3.2, 6.1.1, 6.1.2
CO2	1.3.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3,2.2.4, 4.1.2, 5.1.1, 5.1.2,5.2.1, 5.2.2, 5.3.2, 6.1.1, 6.1.2
CO3	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3,2.2.4, 4.1.1, 4.1.2, 5.1.1, 5.1.2,5.2.1, 5.2.2, 5.3.2, 6.1.1, 6.1.2
CO4	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3,2.2.4, 4.1.1, 4.1.2, 5.1.1, 5.1.2,5.2.1, 5.2.2, 5.3.2, 6.1.1, 6.1.2
CO5	1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3,2.2.4, 4.1.1, 4.1.2, 5.1.1, 5.1.2,5.2.1, 5.2.2, 5.3.2, 6.1.1, 6.1.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	30	35	35				100
CAT2	10	45	45				100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1		50	50				100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2		50	50				100
ESE	10	40	50				100

22IOE$15	**VIDEO CREATION AND EDITING** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	Upon completion of the course the students will be familiar with the principles and techniques of video creation and editing, video production equipment and software, visual storytelling and video production, planning, executing, and editing video projects. also able to foster critical thinking and creativity in developing and executing video projects.	
UNIT – I	**INTRODUCTION TO VIDEO CREATION AND EDITING**	**9 Periods**
Overview of video creation and editing -Brief history of video and film production -Understanding visual storytelling: developing documentary and dramatic projects- introduction to digital and film systems		
UNIT – II	**PRE-PRODUCTION**	**9 Periods**
Developing a concept and idea - Scriptwriting and storytelling -The Digital image - Film systems and cameras -The film image - Case Study : Non linear editing system		
UNIT – III	**PRODUCTION**	**9 Periods**
Camera operation and techniques: The video camcorder- The Lens - Lighting and sound recording techniques - Directing actors and crew -Conducting interviews -Shooting the movie - Case Study : Professional video zoom lenses		
UNIT – IV	**POST-PRODUCTION**	**9 Periods**
Picture and Dialogue editing - Editing digital video -sound editing and mixing -Color grading and correction-Sound editing and mixing – working with film in post production Case Study : Digital Audio Recording		
UNIT – V	**DISTRIBUTION AND PROMOTION**	**9 Periods**
Presenting the project - funding sources - budgets- business arrangements- legal and copyright issues- distribution and marketing - publicity and the marketing campaigns-building and sustaining a career -Case Study : Creating a short movie.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*Steven Ascher and Edward Pincus,The Filmmaker's Handbook: A Comprehensive Guide for the Digital Age,Fifth edition Penguin Publishing Group, 2012*

REFERENCES :

1	*Walter Murch,**In the Blink of an Eye: A Perspective on Film Editing**", Silman-James Press,2001*
2	*Karel Reisz and Gavin Millar,**The Technique of Film Editing**",second edition ,Taylor and Francis Group 2017*
3	*Ken Dancyger, **The technique of film and video editing** , fifth edition , Elsevier 2011.*
4	*Chris Kenworthy,Digital video production cookbook, OReillyMedia ,2006*
5	*Mark Brindle, The Digital Filmmaking Handbook ,Quercus Publishing, 2014*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Demonstrate an understanding of the history and evolution of video production and editing.	2
CO2	Develop and execute a concept, script, and storyboard for a video project	3
CO3	Plan and prepare for a video shoot, including casting, location scouting, and budgeting.	3
CO4	Edit and assemble video footage using basic and advanced editing techniques.	2
CO5	Promote and distribute the final video on various platforms.	1

a) Course Articulation Matrix

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	2	1	1	1	0	0	0	0	0	0	0	0	1	1
CO2	1	2	3	2	3	0	0	0	0	0	0	0	1	1
CO3	1	2	1	3	3	0	1	0	3	1	2	0	1	1
CO4	1	2	2	2	3	3	0	0	3	1	2	0	1	1
CO5	1	2	2	2	3	3	1	3	3	3	2	0	1	1
22IOE$15	1	2	2	2	2	1	1	1	2	1	1	0	1	1

1– Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO	Key Performance Indicators
CO1	1.1.1,1.2.1,1.31,2.1.1,2.1.2,2.2.4,2.4.1,3.1.4,3.4.1,4.1.3,
CO2	1.1.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.4.3,3.1.1,3.1.2,3.1.3,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.4.1,3.4.2,4.1.1,4.1.3,4.2.1,4.3.1,4.3.2,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,
CO3	1.1.1,2.1.1,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.2,2.4.3,3.2.1,3.2.2,3.3.1,3.4.2,4.1.1,4.1.3,4.1.4,4.2.2,4.3.1,4.3.2,4.3.3,,5.1.1,5.1.2,5.2.1,5.2.2,5.3.2,7.1.1,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,10.1.1,11.2.1,11.3.1,11.3.2
CO4	1.1.1,2.1.1,2.1.3,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.2,2.4.3,3.2.1,3.2.2,3.3.1,,3.3.2,3.4.2,4.1.1,4.1.3,4.2.1, ,4.3.1,4.3.2,5.1.1,5.1.2,5.2.1,5.2.2,5.3.2,6.1.1,6.1.2,,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,10.1.1,11.3.1,11.3.2
CO5	1.1.1 , 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4 2.3.2, 2.4.3, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.2, 4.1.1, 4.1.3, 4.3.1, 4.3.2, 4.3.3, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 6.2.1, 7.12, 8.1.1, 8.2.1,8.2.2, , 9.1.1, 9.1.2, 9.2.1,9.2.2, 9.2.3,9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3,10.2.1, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.1.2, 11.2.1

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	30	40				100
CAT2	30	30	40				100
Assignment 1	30	30	40				100
Assignment 2	30	30	40				100
Other mode of internal assessments, if any	--	--	--	--	--	--	--
ESE	30	30	40				100

22IOE$16	DIGITAL MARKETING *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To give insight on the framework to analyze, strategies and plan digital marketing and communication activities for typical marketing situations. Familiarize with the key tools and techniques of digital marketing that are popularly used by professionals in the real world of digital marketing and help them develop the ability to formulate and analyze key metrics to evaluate the performance of typical digital marketing efforts.	
UNIT – I	**INTRODUCTION TO DIGITAL MARKETING**	**9 Periods**
Basics of Digital Marketing - online marketplace analysis: digital marketing environment - consumer choice and digital influence online consumer behavior-competitors -suppliers- new channel structures - rate of environment change - economic force-political force -legal force - social force- cultural force.		
UNIT – II	**DIGITAL MARKETING STRATEGY DEVELOPMENT**	**9 Periods**
Digital marketing strategy - The impact of digital media and technology on the marketing mix: product- price-place-promotion -people, process and physical evidence - relationship marketing using digital platforms: the challenge of customer engagement - customer lifecycle management		
UNIT – III	**DIGITAL MARKETING IMPLEMENTATION AND PRACTICE**	**9 Periods**
Delivering the online customer experience: planning website design and redesign projects - initiation of the website project - defining site or app requirement - designing the user experience - development and testing of content - site promotion or traffic building - campaign planning for digital media		
UNIT – IV	**MARKETING COMMUNICATIONS USING DIGITAL MEDIA CHANNELS**	**9 Periods**
Search engine marketing - online public relations - affiliated marketing - interactive display advertising -email marketing and mobile text messaging- social media and viral marketing - offline promotion techniques		
UNIT – V	**EVALUATION OF DIGITAL CHANNEL PERFORMANCE**	**9 Periods**
Create a performance management system - performance metric framework - tools and techniques for collecting metrics -customer experience and content management - online consumer behavior- online retailing - customer acquisition in B2B marketing -online inter-organizational trading		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK :

1	*Dave Chaffey Fiona Ellis-Chadwick, Digital Marketing,sixth edition, 2016*

REFERENCES :

1	*Puneet singh Bhatia, Fundamentals of Digital Marketing , Pearson India Education services,2017*
2	*Mathur, Vibha, Arora, Saloni,"DigitalMarketing",PHI Learning Pvt. Ltd.,2020*
3	*Ian Dodson, The Art of Digital Marketing: The Definitive Guide to Creating Strategic, Targeted, and Measurable Online Compaigns, Wiley 2016*
4	*Dr.Shakti Kundu, Digital Marketing Trends and Prospects:Develop an effective Digital Marketing strategy with SEO, SEM, PPC, Digital Display Ads & Email Marketing techniques,BPB PUBN,2021*
5	*Seema Gupta , Digital Marketing,Third Edition, McGraw Hill 2022*
6.	*Simon Kingsnorth, Digital Marketing Strategy:An Integrated Approach to Online Marketing, Kogan page,2022*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Explain the role and importance of digital marketing in a rapidly changing business landscape	K1
CO2	Discuss the key elements of a digital marketing strategy	K2
CO3	Demonstrate advanced practical skills in common digital marketing tools such as Social media and Blogs	K2
CO4	Demonstrate advanced practical skills in common digital marketing tools such as SEM	K2
CO5	understand online consumer behavior and influence the extent to which individuals are likely to engage with the digital marketplace	K2

Course Articulation Matrix

COs / POs	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
CO1	1	1	2	2									2	2
CO2	1	1	2	2									2	2
CO3	1	1	2	2	3								2	2
CO4	1	1	2	2	3	2	3	3	3	3	3	3	2	2
CO5	1	1	2	2	1		3	3	3	3	3	3	2	2
22IOE$16	1	1	2	2	1	1	1	1	1	1	1	1	2	2

1– Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,2.1.1,2.1.2,3.1.1,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,4.1.1,4.1.3,4.2.1,4.3.3,
CO2	1.1.1,2.1.1,2.1.2,3.1.1,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,4.1.1,4.1.3,4.2.1,4.3.3,
CO3	1.1.1,2.1.1,2.1.2,3.1.1,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,4.1.1,4.1.3,4.2.1,4.3.3,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2
CO4	1.1.1,2.1.1,2.1.2,3.1.1,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,4.1.1,4.1.3,4.2.1,4.3.3, 5.1.1,5.1.2,5.2.1, 5.2.2,5.3.1,5.3.2,6.1.1,7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1, 10.1.1, 10.1.2,10.1.3,10.2.1,10.2.2,10.3.1,10.3.2, 11.1.1,11.1.2,11.2.1,11.3.1,11.3.2,12.1.1,12.1.2, 12.2.1,12.2.2,12.3.1,12.3.2
CO5	1.1.1,2.1.1,2.1.2,3.1.1,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,4.1.1,4.1.3,4.2.1,4.3.3, 5.1.1,5.1.2,5.2.1, 7.1.1,7.1.2,7.2.1,7.2.2,8.1.1,8.2.1,8.2.2,9.1.1,9.1.2,9.2.1,9.2.2,9.2.3,9.2.4,9.3.1, 10.1.1,10.1.2,10.1.3, 10.2.1,10.2.2,10.3.1,10.3.2,11.1.1,11.1.2,11.2.1,11.3.1,11.3.2,12.1.1,12.1.2,12.2.1,12.2.2,12.3.1,12.3.2

ASSESSMENT PATTERN – THEORY (Times New Roman, Size 11)

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	30	30	40				100
CAT2	30	30	40				100
Assignment 1	30	30	40				100
Assignment 2	30	30	40				100
Other mode of internal assessments, if any	--	--	--	--	--	--	--
ESE	30	30	40				100

22BOE$17	**PRINCIPLES OF FOOD TECHNOLOGY** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	OE	3	0	0	3

Course Objectives	To learn about the various food constituents and its additives. To learn about various microbes associated with food. To learn about different food processing and preservation techniques.	
UNIT – I	**FOOD AND ENERGY**	**9 Periods**
Constituents of food – carbohydrates, lipids, proteins, water, vitamins and minerals, dietary sources, role and functional properties in food, contribution to organoleptic and textural characteristics.		
UNIT – II	**FOOD BORNE DISEASES**	**9 Periods**
Classification – food infections – bacterial and other types; food intoxications and poisonings– bacterial and non-bacterial; food spoilage – factors responsible for spoilage, spoilage of vegetable, fruit, meat, poultry, beverage and other food products.		
UNIT – III	**FOOD ADDITIVES**	**9 Periods**
Classification, intentional and non-intentional additives, functional role in food processing and preservation; food colourants – natural and artificial; food flavours; enzymes as food processing aids.		
UNIT – IV	**FOOD PRESERVATION**	**9 Periods**
Principles involved in the use of sterilization, pasteurization and blanching, thermal death curves of microorganisms, canning; frozen storage-freezing characteristics of foods, microbial activity at low temperatures, factors affecting quality of foods in frozen storage; irradiation preservation of foods.		
UNIT – V	**FOOD PACKAGING**	**9 Periods**
Types of packaging material and containers; Interactions between packaging and foods; Packing - meat, dairy, fresh fruits and vegetables, beverages and confectionaries; Food packaging closure and sealing system; Nutrition labelling and legislative requirements.		
Contact Periods: **Lecture: 45 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 45 Periods**		

TEXT BOOK

1	*T.P. Coultate , **Food – The Chemistry Of Its Components**, 6th Edn. Royal Society,London, 2015.*
2	*W.C. Frazier And D.C. Westhoff , **Food Microbiology**, 4th Ed., Mcgraw-Hill Book Co., NewYork 2013.*

REFERENCES

1	*Srinivasan Damodaran and Kirk L. Parkin., "Fennema's Food Chemistry", CRC Press, 5 thedition. 2017.*
2	*Fellows P.J, "Food Processing Technology: Principles and Practices", Woodhead Publishing 4 th edition,2016·*
3	*B. Sivasanker , Food Processing And Preservation, Prentice-Hall Of India Pvt. Ltd. New Delhi 2002.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	learn different constituents present in food and microorganism involved in processing of food.	K1
CO2	learn principles and different preservations techniques of food can also be known.	K1
CO3	learn techniques involved in modern food processing and impact of the process on food quality.	K2
CO4	Explain various preservation and packaging techniques for food product	K2
CO5	Describe the relationship between food and microorganism that basis for fermentation and preservation	K2

a) Course Articulation Matrix														
COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	-	-	1	-	-	-	-	2	3	-	-	1	3
CO2	1	-	-	-	-	-	-	-	-	3	-	-	1	3
CO3	1	-	-	2	-	2	-	-	-	3	-	-	1	3
CO4	1	-	1	-	-	-	-	-	-	3	-	-	1	3
CO5	1	-	2	-	-	-	-	-	-	3	-	-	1	3
22BOE$17	1	-	1	1	-	2	-	-	2	3	-	-	1	3
1 – Slight, 2 – Moderate, 3 – Substantial														

b) CO and Key Performance Indicators Mapping	
CO1	1.4.2, 2.1.3
CO2	1.4.1, 3.1.3
CO3	1.4.4, 2.1.4
CO4	1.4.1, 2.1.3,3.4.2
CO5	1.4.1,2.2.1

ASSESSMENT PATTERN – THEORY							
Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	50	50	-	-	-	-	100
CAT2	60	40	-	-	-	-	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	50	50	-	-	-	-	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	50	50	-	-	-	-	100
ESE	50	50	-	-	-	-	100

22BOE$18	**BIOLOGY FOR ENGINEERS** *(Common to All Branches)*

PREREQUISITES	CATEGORY	L	T	P	C
NIL	**OE**	**3**	**0**	**0**	**3**

Course Objectives	1. Understand and interpret commonly reported statistical measures published in healthcare research 2. Analyze the different type of data using appropriate statistical software 3. Demonstrate a good understanding of descriptive statistics and graphical tools 4. Explain fundamental concepts of estimation and hypothesis testing and be confident when interpreting P values and confidence intervals	
UNIT – I	**BASICS OF CELL BIOLOGY**	**9 periods**
An overview of cells – origin and evolution of cells-cell theory-classification of cells – prokaryotic cells and eukaryotic cells; Structure of prokaryotic and eukaryotic cells and their organelles comparison of prokaryotic and eukaryotic cells; Transport across membranes – diffusion - active and passive diffusion.		
UNIT – II	**BASICS OF MICROBIOLOGY**	**9 periods**
Classification of microorganism-microscopic examination of microorganisms; Structural organization and multiplication of bacteria-viruses-algae and fungi; Microorganism used for the production of penicillin-alcohol and vitamin B-12.		
UNIT – III	**HUMAN ANATOMY AND PHYSIOLOGY**	**9 periods**
Basics of human anatomy-tissues of the human body-epithelial-connective-nervous and muscular; Nervous system-Respiratory System-Circulatory system and Digestive system.		
UNIT – IV	**BIO MOLECULES AND IMMUNE SYSTEM**	**9 periods**
Introduction to Biochemistry-classification-structure and properties of carbohydrates- proteins- lipids and nucleic acids; Innate and acquired immunity; Types of immune responses.		
UNIT-V	**APPLIED BIOLOGY FOR ENGINEERS**	**9 periods**
Overview of biosensors - glucometer applications-medicine; Microarray analysis to diagnose the cancer; Microbial production of biofuels; Applications of stem cells.		
Contact Periods: **Lecture: 45 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 45 Periods**		

TEXT BOOK

1	*Darnell J, Lodish H, Baltimore D. **"Molecular Cell Biology"**, W.H.Freeman; 8th Edition, 2016.*
2	*Pelczar MJ, Chan ECS and Krein NR, **"Microbiology"**, Tata McGraw Hill, 5thEdition, New Delhi.2001.*
3	*Wulf Cruger and Anneliese Cruger, **"A Textbook of Industrial Microbiology"**, Panima Publishing Corporation, 2nd Edition, 2000.*

REFERENCES

1	*David L. Nelson and Michael M Cox, **"Lehninger's Principles of Biochemistry"**, Macmillan Worth Publisher, 4th edition, 2004.*
2	*Brain R.Eggins , **"Chemical Sensors and Biosensors"**, John Wiley & Sons, 2002.*
3	*Anton Moser, **"Bioprocess Technology, Kinetics and Reactors"**, Springer, Berlin (Verlag),1st edition, 1998*
4	*Kuby J, **"Immunology"**, WH Freeman & Co., 7th edition, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		Bloom's Taxonomy Mapped
CO1	Understand the functions of cell and their structural organization	K1
CO2	Describe the mechanisms and role of cell in immune system	K1
CO3	Get familiarized biomolecules and human anatomy system	K2
CO4	Illustrate the applications of microbes in industrial process	K3
CO5	Apply the engineering concepts in biology	K3

a) Course Articulation Matrix

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	-	1	-	-	-	2	2	2	-	-	1	2	2	2
CO2	1	-	-	1	1	-	-	2	3	3	2	2	1	3
CO3	1	1	-	-	-	-	-	1	1	-	-	-	1	3
CO4	-	-	-	-	1	-	-	2	3	3	1	1	1	3
CO5	-	2	-	1	3	-	-	-	-	-	-	-	2	2
22BOE$18	1	1	-	1	2	2	2	2	3	3	2	2	2	3

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	2.2.2, 6.1.1, 7.1.2, 8.1.1, 11.1.1, 12.1.2
CO2	1.1.1, 4.2.1, 5.2.1, 8.1.1, 9.1.1,9.2.1,10.1.1, 10.1.2, 11.1.1, 12.1.2
CO3	1.1.1, 2.1.1, 8.1.1, 9.1.1
CO4	5.2.1, 8.1.1, 9.1.1,9.2.1,10.1.1, 10.1.2, 11.1.1, 12.1.2
CO5	1.1.1,2.2.2, 4.2.1, 5.2.1, 6.1.1,7.1.2, 8.1.1, 9.1.1,9.2.1,10.1.1, 10.1.2, 11.1.1, 12.1.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	Remembering (K1) %	Understanding (K2) %	Applying (K3) %	Analyzing (K4) %	Evaluating (K5) %	Creating (K6) %	Total %
CAT1	50	10	10	10	10	10	100
CAT2	50	10	10	10	10	10	100
Individual Assessment 1 /Case Study 1/ Seminar 1 / Project1	20	20	20	20	10	10	100
Individual Assessment 2 /Case Study 2/ Seminar 2 / Project 2	20	20	20	20	10	10	100
ESE	50	10	10	10	10	10	100

22LVA$04	SCIENCE OF CREATIVITY

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To create innovation in Medicine, Physics, Chemistry and in Engineering.	
UNIT – I	**NEUROLOGY OF CREATIVITY AND ENHANCEMENT**	**5 Periods**
Creativity: Definitions and Overview –Temporal lobes – Frontal Lobes – IQ Neurotransmitters - Limbic System and Creativity – Neurobiological model – Enhancing Creativity –Breaking down the big problem – developing own scientific creativity.		
UNIT – II	**CREATIVITY IN THEORETICAL PHYSICS AND CHEMISTRY**	**5 Periods**
Introduction - Focus on the essential to reveal the universal - equations -Analogies to develop radically new equations - Chemists and creativity - A model for in-class research experiences.		
UNIT – III	**CREATIVITY AND INNOVATION IN ENGINEERING**	**5 Periods**
Introduction - Creativity needed in engineering design - Importance of creativity and innovation for engineers beginning in education - Creativity and meta-cognitive abilities in engineering education - Central themes specific to engineering creativity - Measurement needs for engineering creativity - Engineering creativity measures - Creative engineering design measure - Current measurement contributions - Validity - Engineering Measures - Importance of Creative Engineering Design to STEM - Creativity for increasing enrolment in STEM.		
Contact Periods: **Lecture: 15 Periods** **Tutorial: 0 Periods** **Practical: 0 Periods** **Total: 15 Periods**		

TEXT BOOKS :

1	*Christine Charyton - **"Creativity and Innovation among Science and Art"**, 3rd Edition, Springer, 2015.*
2	*R. Keith Sawyer, **"Explaining Creativity: The Science of Human Innovation"**, 2nd Edition, Oxford, 2014.*

REFERENCES:

1	*Atul Yadav, **"Reclaim Your Creativity"**, 2nd Edition, Oxford, 2023.*
2	*Douglas P Newton, Sam Nolan and Simon Rees, "**Creative Thinking in University Physics Education**", IOP Publishing, Bristol, UK, 2nd Edition, 2022.*
3	*Anna Abraham, "**The Neuroscience of Creativity**" Cmbridge University Press, 1st Edition, 2016*
4	*Paul Bailey," **Creative Thinking**", 2nd edition, Speedy publishing LLC, 2019.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Enhance knowledge in Neurology	K2
CO2	Develop their understanding in theoretical physics and in chemistry.	K2
CO3	Create an innovation in Engineering.	K3

COURSE ARTICULATION MATRIX

a)CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	2	2	2	1	-	-	-	-	-	-	-	2	2	-	-
CO2	2	1	1	-	-	-	-	-	-	-	-	2	2	-	-
CO3	2	2	3	1	-	-	-	-	-	-	-	2	2	2	1
22LVA$04	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b)CO and Key Performance Indicators mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.1.5,4.1.2, 3.1.2,3.1.3,3.2.1.3.2.2,4.1.1,4.1.2,4.2.1,12.1.1,12.1.2,12.2.1,12.2.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1, 12.1.1,12.1.2,12.2.1,12.2.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 3.3.2,3.4.1,3.4.2,4.1.2,4.1.4, 12.1.1,12.1.2,12.2.1,12.2.2

22LVA$05	PERSONAL LEADERSHIP

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To develop skills for personal leadership.	
UNIT – I	**INTRODUCTION**	**5 Periods**
Meaning of personal leadership - Benefits of personal leadership - Aspects of effective leadership -How to find leadership - Find your Motivation - Follow your Mantra - Follow your Values – Reach your Goals - Continually Learn and Grow - Build Long - Term Relationships.		
UNIT – II	**SKILLS AND STRATEGIES**	**5 Periods**
Communication skills and styles - The nature of strategic leadership - Current strategies for success in a personal business environment and develop a personal plan to cultivate a durable, effective, personal leadership model		
UNIT – III	**BELIEFS, BEHAVIORS AND TOOLS**	**5 Periods**
Goals and Goal Setting - Beliefs - Mental models, Growth Vs Fixed Orientation, Optimism. Behaviors - Ingredients for growth, Handling disruptive emotions, Tapping intuition. Tools - Solitude, Affirmation and Visualization, Meditation.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOK

1	*Weiss, Joseph W. (2011) "**An Introduction to Leadership Diego: Bridge point Education**", Inc.*

REFERENCES

1	*Loehr & Schwartz, "**The Power of Full Engagement", Free** Press 2003.*
2	*Orlick, **"In Pursuit of Excellence",** (4th Edition) 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Build personal leadership.	K2
CO2	Develop a skills and strategies.	K1
CO3	Handle disruptive emotions.	K1

COURSE ARTICULATION MATRIX

a)CO-PO Mapping

COs/POs	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	PSO 3
CO1	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
CO2	-	-	-	-	-	2	1	-	-	-	1	-	-	-	-
CO3	-	-	-	-	-	2	1	-	-	-	1	-	-	-	-
22LVA$05	**-**	**-**	**-**	**-**	**-**	**2**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**	**-**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	7.1.1,7.2.1
CO2	6.1.1,6.2.1, 7.1.1,7.2.1
CO3	6.1.1,6.2.1, 7.1.1,7.2.1

22LVA$06	SCRIPTING LANGUAGES

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To describe the need of using scripting language programs and software automation using TCL	
UNIT – I	**TCL**	**5 Periods**
Characteristics and uses of scripting languages - TCL phenomena, Philosophy, Structure, Syntax, Parser, Variables and data in TCL, Control flow, Data structures, Simple input/output, Procedures, Working with Strings, Patterns, Files and Pipes, Example code.		
UNIT – II	**ADVANCED TCL**	**5 Periods**
Eval, source, exec and up-level commands, Libraries and packages, Namespaces, Trapping errors, Event-driven programs, Making applications 'Internet-aware', 'Nuts-and bolts' internet programming, Security issues, running untrusted code, The C interface.		
UNIT – III	**Toolkit (TK)**	**5 Periods**
TK Overview – TK Environment – TK Special Variables – TK Widgets – Basic Widgets – Layout Widgets – Selection Widgets – Canvas Widgets – Mega Widgets – Fonts – Images – Events – Windows Manager – Geometry Manager.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS:

1	*Brent Welch, Ken Jones and Jeff Hobbs., **"Practical Programming in Tcl and Tk"**, Fourth edition., 2020*
2	*John K. Ousterhout and Ken Jones, **"Tcl and the Tk Toolkit"**, Pearson Education, 2nd Edition, 2009*

REFERENCES:

1	*Clif Flynt, **"Tcl/Tk: A Developer's Guide"**, 2003, Morgan Kaufmann SerieS.*
2	*John Ousterhout, **"Tcl and the Tk Toolkit"**, 2nd Edition, 2009, Kindel Edition*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Apply the scripting language programming skills required for a particular code.	K2
CO2	Understand the basic level scripting language programming in TCL and advanced TCL.	K2
CO3	Apply the software automation using TCL-TK	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	2	1	1	-	-	-	-	2		2	3	2	2
CO2	3	3	2	1	1	-	-	-	-	2		2	3	2	2
CO3	3	3	2	1	1	-	-	-	-	2		2	3	2	2
22LVA$06	**3**	**3**	**2**	**1**	**1**	-	-	-	-	**2**		**2**	**3**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 3.1.4, 3.1.6, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.3, 5.1.1, 5.1.2, 10.1.1, 10.1.2, 10.1.3, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 3.1.4, 3.1.6, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.3, 5.1.1, 5.1.2, 10.1.1, 10.1.2, 10.1.3, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 3.1.4, 3.1.6, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.3, 5.1.1, 5.1.2, 10.1.1, 10.1.2, 10.1.3, 12.2.1, 12.2.2, 12.3.1, 12.3.2

22LVA$07	ANDROID APPLICATION DEVELOPMENT

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To build mobile applications for different applications using sensor data and IoT frameworks.	
UNIT – I	**IOT ECOSYSTEM**	**5 Periods**
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		
UNIT – II	**SENSOR DATA PROCESSING**	**5 Periods**
Sensor Data - Gathering and Data - Dissemination Mechanisms; Sensor Database system architecture; Sensor data - fusion mechanisms; Data - fusion Architectures and models.		
UNIT – III	**PROGRAMMING AND FRAMEWORKS**	**5 Periods**
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.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS:

1	*Kale, Vivek, "**Parallel Computing Architectures and APIs: IoT Big Data Stream Processing**", 1st edition, CRC Press, 2019.*
2	*Lea, Perry, "**Internet of Things for Architects: Architecting IoT solutions by implementing sensors, communication infrastructure, edge computing, analytics, and security**", 1st edition, Packt Publishing Ltd, 2018.*

REFERENCES:

1	*Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal, "**Mobile Computing**", 2nd Edition, Tata McGraw Hill Pub, 2010.*
2	*Meikang Qiu, Wenyun Dai, and Keke Gai, "**Mobile Applications Development With Android Technologies and Algorithms**", Chapman and Hall/CRC Publication, 2016.*
3	*Jon Duckett, Gilles Ruppert, and Jack Moore, "**JavaScript and Jquery: Interactive Front- End Web Development**", CreateSpace Independent Publishing Platform, 2017.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Interpret the application development platforms and mobile interface for IoT	K2
CO2	Categorize the sensor data for processing various models in IoT	K2
CO3	Interpret the IoT programming and framework for various applications	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	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	PSO 3
CO1	3	2	1	2	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	1	3	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	1	3	2	-	-	-	-	-	-	-	3	-	-
22LVA$07	**3**	**3**	**1**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.3,2.2.4,2.4.1,2.4.2,3.2.2,4.1.2,4.1.3,4.1.4, 4.2.1,4.3.1
CO2	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.3,2.2.4,2.4.1,2.4.2,3.2.2,3.3.1,4.1.1,4.1.2,4.1.3, 4.1.4,4.2.1,4.3.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,3.1.6, 3.2.3,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4,5.1.1,5.1.2,5.2.2

22LVA$08	WEB DESIGNING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To understand the concepts in Core Java, web designing and server site programming.	
UNIT – I	**INTRODUCTION TO CORE JAVA**	**5 Periods**
Core JAVA- Operator, Data type, Variable, Arrays, Methods & Classes, Inheritance, Package and Interface, Exception Handling, Multithread programming, I/O, Java Applet, String handling, Event handling, Introduction to Abstract Windowing Toolkit (AWT), AWT controls, Layout managers.		
UNIT – II	**WEB PAGE DESIGNING**	**5 Periods**
HTML: List, Table, Images, Frames, Forms, CSS, Document Type Definition (DTD), XML: DTD, XML schemes, Object Models, presenting and using XML, Using XML Processors: Document.		
UNIT – III	**SERVER SITE PROGRAMMING**	**5 Periods**
Introduction to Active Server Pages (ASP), Introduction to Java Server Page (JSP), JSP Application Design, JSP objects, Conditional Processing, Declaring variables and methods, Sharing data between JSP pages, Sharing Session and Application Data, Database Programming using JDBC, development of java beans in JSP.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS :

1	*Xavier, C, **"Web Technology and Design"**, New Age International, 2013 edition.*
2	*Margaret Levine Young, **"The Complete Reference Internet"**, TM, 2nd edition, 2002.*

REFERENCES:

1	*Deitel, **"Java for programmers"**, Pearson Education, 2nd edition, 2011.*
2	*Jessica Burdman, **"Collaborative Web Development"**, Addison Wesley publications,1999.*
3	*Horstmann, **"CoreJava"**, Addison Wesley,2015.*
4	*Bhave, **"Programming with Java"**, Pearson Education, 2008.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the core java and web development strategies	**K2**
CO2	Apply the knowledge of web page designing	**K3**
CO3	Develop server site using Java programming	**K4**

COURSE ARTICULATION MATRIX

a)CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	2	1	3	-	-	-	-	1	1	1	2	1	2
CO2	3	2	2	1	1	-	-	-	-	1	1	2	2	3	2
CO3	3	3	3	2	1	-	-	-	-	1	2	1	1	-	-
22LVA$08	**3**	**2**	**2**	**2**	**1**	-	-	-	-	**1**	**1**	**2**	**2**	**2**	**2**

1 – Slight, 2 – Moderate, 3 – Substantial

CO and Key Performance Indicators mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.1.5,4.1.2,
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,4.1.2,4.1.3,4.1.4,4.2.1,
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1,2.1.2,2.1.3, 2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2, 3.3.2,3.4.1,3.4.2,4.1.2,4.1.4

22LVA$09	LONG TERM EVOLUTION

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To acquire knowledge on LTE network architecture, protocols, scheduling, resource allocation and mobility management	
UNIT – I	**OVERVIEW AND CHANNEL STRUCTURE OF LTE**	**5 Periods**
Evolution of mobile broad band - Demand drivers for LTE- key requirements of LTE design - key enabling technologies and features of LTE - LTE network architecture - spectrum and migration plan for LTE - Radio interface protocols - Hierarchical channel structure of LTE - downlink OFDMA radio resources - uplink SC-FDMA radio resources.		
UNIT – II	**TRANSPORT CHANNEL PROCESSING**	**5 Periods**
Downlink Transport Channel Processing overview - down link shared channels-downlink control channels - broad cast channels - multicast channels - downlink physical signals -uplink Transport Channel Processing overview - Uplink shared channels - uplink control information - uplink reference channels-random access channels -H-ARQ in downlink and uplink.		
UNIT – III	**DATA FLOW, RADIO RESOURCE MANAGEMENT AND MOBILITY MANAGEMENT**	**5 Periods**
Scheduling and resource allocation - scheduling for VoIP - PDCP - MAC/RLC - Mobility management - Intercell interference coordination.		
Contact Periods: **Lecture: 15 Periods Tutorial:0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS

1	*Arunabha Ghosh, Jun Zhang , Jeffrey G. Andrews , Rias Muhamed* ***,"Fundamentals of LTE "*** *1st Edition by Prentice Hall*
2	*Christopher Cox* ***"An Introduction to LTE: LTE, LTE-Advanced, SAE, VoLTE and 4G Mobile Communications "*** *2nd Edition*

REFERENCES

1	*Erik Dahlman , Stefan Parkvall , Johan Skold* ***"4G: LTE/LTE-Advanced for Mobile Broadband"****1st Edition*
2	*Chris Johnson "****Long Term Evolution IN BULLETS"****, 2nd Edition*
3	*Martin Sauter* ***"From GSM to LTE-Advanced: An Introduction to Mobile Networks and Mobile Broadband"*** *2nd Edition*
4	*Stefania Sesia ,Issam Toufik , Matthew Baker* ***"LTE - The UMTS Long Term Evolution: From Theory to Practice "*** *2nd Edition*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain LTE network architecture and protocols.	K2
CO2	Describe Downlink Transport and Uplink Transport Channel Processing	K2
CO3	Interpret data flow and mobility management	K2

COURSE ARTICULATION MATRIX

a)CO-PO Mapping															
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	3	1	-	-	-	-	-	-	1	-	3	2	1	1
CO2	3	3	1	-	-	-	-	-	-	1	-	3	2	1	1
CO3	3	3	1	-	-	-	-	-	-	1	-	3	2	1	1
22LVA$09	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**3**	**2**	**1**	**1**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.1, 3.2.3, 4.1.1, 4.1.4, 7.1.1, 10.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.1, 3.2.3, 4.1.1, 4.1.4, 7.1.1, 10.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.1, 3.2.3, 4.1.1, 4.1.4, 7.1.1, 10.1.1, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

22LVA$10	AVIONICS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To understand the basics of Avionics and gain knowledge on Satellite navigation systems and Auto piloting.	
UNIT – I	**INTRODUCTION**	**5 Periods**
Role for Avionics in Civil and Military Aircraft systems - Avionics sub-systems and design - Avionics System/subsystem requirements - Importance of "ILITIES"- Avionics system architectures.		
UNIT – II	**NAVIGATION SYSTEMS**	**5 Periods**
Radio navigation - Inertial sensors - Gyroscopes, Accelerometers, Inertial navigation systems -Block Diagram - Platform and strap down INS - Satellite Navigation - GPS.		
UNIT – III	**AIR DATA SYSTEMS AND AUTOPILOT**	**5 Periods**
Air data quantities - Altitude, Airspeed, Mach no - Vertical speed - Total Air temperature – Stall Warning - Altitude warning - Autopilot - Basic principles - Longitudinal and Lateral autopilot, Virtual Cockpit.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS

1	*Albert Helfrick.D, "**Principles of Avionics**", Avionics communications Inc.,2012*
2	*Collinson,R.P.G, "**Introduction to Avionics**", Chapman and Hall,2011.*

REFERENCES

1	*Middleton,D.H, "**Avionics Systems**", Longman Scientific and Technical, Longman Group UK Ltd, England, 1989.*
2	*Spitzer, C.R. "**Digital Avionics Systems**", Prentice Hall, Englewood Cliffs, N.J., USA 1993.*
3	*Spitzer, C.R, "**The Avionics Handbook**", CR CPress, 2000.*
4	*Pallet, E.H.J, "**Aircraft Instruments and Integrated Systems**", Longman Scientific.1996*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe the fundamental of Avionics and Navigation systems	K1
CO2	Summarize the working principles of Radio and Satellite navigation systems	K2
CO3	Explain the Air data systems and Aircraft display	K1

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	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	PSO 3
CO1	2	3	1	2	-	2	-	-	-	-	-	3	1	-	-
CO2	2	3	1	1	1	2	-	1	-	-	-	-	1	-	-
CO3	3	2	1	-	-	2	-	-	-	1	-	2	1	-	-
22LVA$10	**2**	**3**	**1**	**1**	**1**	**1**	-	**1**	-	**1**	-	**2**	**1**	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.2,2.4.3,2.4.4,3.1.2,3.3.1,3.3.2, 4.3.3,6.1.1,12.1.1,12.1.2,12.2.1,12.2.2,12.3.2
CO2	1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.3.1,3.3.2, 4.1.1,4.3.1,5.2.1,6.1.1,8.1.1,
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.4.1,2.4.4,3.1.3,3.1.4,3.2.1, 3.3.1,6.1.1,10.3.1,12.2.1,12.2.2,12.3.1

22LVA$11	MILLIMETER WAVE COMMUNICATION

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To learn the principle of millimeter waves, millimeter transceivers and study the concepts of Millimeter wave antennas.	
UNIT – I	**MILLIMETER WAVE CHARACTERISTICS & TRANSCEIVERS**	**5 Periods**
Millimeter Wave Characteristics - Channel Performance at 60 GHz - Gigabit Wireless Communications Development of Millimeter Wave Standards - Coexistence with Wireless Backhaul - review of modulation for millimeter wave – OOK, PSK, FSK and QAM.		
UNIT – II	**MILLIMETER WAVE TRANSCEIVERS**	**5 Periods**
Millimeter wave transceivers- Millimeter Wave Link Budget - Transceiver Architecture -Transceiver Without Mixer - Receiver Without Local Oscillator - Millimeter Wave Calibration.		
UNIT – III	**MILLIMETER WAVE ANTENNAS**	**5 Periods**
Millimeter wave antennas - Path Loss and Antenna Directivity - Antenna Beam width - Maximum Possible Gain - Polarization - Beam Steering Antenna - Millimeter Wave Design Consideration .		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS

1	*Kao-Cheng Huang, Zhaocheng Wang, "***Millimeter wave communication systems",** *John Wiley & Sons, Hoboken, New Jersey, 2011.*
2	*"***Millimeter Wave Wireless Communications***" by Theodore S. Rappaport, Robert W. Heath Jr., Robert C. Daniels and James N. Murdock, 2014.*

REFERENCES

1	*Su-Khiong Yong, Pengfei Xia and Alberto Valdes-Garcia,* **"60GHz Technology for Gbps WLAN and WPAN: From Theory to Practice",** *Wiley 2010*
2	*Jonathan Wells,* **"Multi-Gigabit Microwave and Millimeter-Wave Wireless Communications",** *Artech House, 2010.*
3.	Millimeter Wave Technology By Prof. Mrinal Kanti Mandal, IIT Kharagpur https://onlinecourses.nptel.ac.in/noc21_ee76

COURSE OUTCOMES: Upon completion of the course, the students will be able to		**Bloom's Taxonomy Mapped**
CO1	Explain the concepts and challenges of millimeter wave communication	K2
CO2	Describe the transmitter and receiver types in millimeter wave communication	K2
CO3	Explain the characteristics of Millimeter wave antennas.	K2

COURSE ARTICULATION MATRIX

a)CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	-	-	2	-	-	-	-	3	2	1	1
CO2	3	3	1	1	-	-	2	-	-	-	-	3	2	1	1
CO3	3	3	1	1	-	-	2	-	-	-	-	3	2	1	1
22LVA$11	3	3	1	1	-	-	2	-	-	-	-	3	2	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.1.6, 4.1.1, 4.1.4, 7.1.1, 7.1.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.1.6, 4.1.1, 4.1.4, 7.1.1, 7.1.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.1, 2.4.3, 2.4.4, 3.1.1, 3.1.5, 3.1.6, 4.1.1, 4.1.4, 7.1.1, 7.1.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2

22LVA$12	TELEMATICS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To introduce the switching techniques in Telecommunication, to educate the various protocols in IP telephony and to illustrate the concept of digital cellular system.	
UNIT – I	**TELEPHONE SWITCHING**	**5 Periods**
Evolution of telecommunication – Switching system, Dialing mechanism, Electronic switching, Digital switching system, Stored Program Control(SPC) configuration, Architectural features, Centralized and distributed SPC, Enhanced services.		
UNIT – II	**SWITCHING NETWORKS**	**5 Periods**
Single stage and multistage switching network – Blocking probability: Lee's model for three stage – Time division time switching – Combinational switch ST, TS, STS, TST stages – Limitations of conventional mobile telephone system.		
UNIT – III	**DIGITAL CELLULAR SYSTEM AND IP TELEPHONY**	**5 Periods**
GSM – Different call flow sequences in GSM – North American CDMA cellular – VOIP, Low level protocols – RTP/RTCP/UDP – Voice activity detection and discontinuous transmission – IP telephony protocols – H.323 standard – Session Initiation Protocol (SIP) – Gateway location protocol – QoS requirements – Resource reservation protocol architecture.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS

1	*V. S. Bagad,* ***"Telematics",*** *Technical publications, Pune, First edition 2009.*
2	*Thiagarajan Viswanathan and Manav Bhatnagar,* ***"Telecommunication Switching Systems and Networks"***, *Second Edition, Prentice Hall of India, 2015.*

REFERENCES:

1	*Rappaport,T.S., "**Wireless Communications"**, Pearson Education, 2nd Edition 2009.*
2	*Simon Haykins & Michael Moher,* ***"Modern Wireless Communications",*** *Pearson Education, 3rd Edition, 2007.*
3	*Michael Moher,* ***"Wireless Communications",*** *Pearson Education,2nd Edition, 2010.*
4	*Andreas F. Molisch,* ***"Wireless Communications", Wiley***, *2nd Edition, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the basics of telecommunication.	K2
CO2	Illustrate the concepts of switching networks and telephony	K2
CO3	Describe the field of digital cellular system and protocols.	K2

COURSE ARTICULATION MATRIX

a)CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	-	-	-	-	-	-	-	-	-	-	2	2	-	-
CO2	3	-	-	-	-	2	2	2	-	-	-	2	2	-	-
CO3	-	-	-	-	3	-	-	-	-	-	-	2	2	2	1
22LVA$12	**2**	-	-	-	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**2**	**2**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b)CO and Key Performance Indicators mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 5.1.1,5.1.2,6.1.1,6.1.2,7.1.1,7.1.2,7.2.1,8.1.1,8.1.2,12.1.1,12.1.2,12.2.1,12.2.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 5.1.1,5.1.2,6.1.1,6.1.2,7.1.1,7.1.2,7.2.1,8.1.1,,12.1.1,12.1.2,12.2.1,12.2.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 5.1.1,5.1.2,6.1.1,6.1.2,7.1.1,7.1.2,8.1.1,12.1.1,12.1.2,12.2.1,12.2.2

22LVA$13	E-COMMERCE SECURITY					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
NIL		**EEC**	**1**	**0**	**0**	**1**

Course Objective	To get exposed to various threats and issues in e-commerce security.	
UNIT – I	**INTRODUCTION**	**5 Periods**
Security testing of an online banking service: The online banking system, The attack. Software security analysis - Data Gathering - Preliminary investigation, on-site visit, Analysis – Kickoff Meeting, Investigation, Risk mitigation - E-Commerce security environment.		
UNIT – II	**ISSUES AND THREATS**	**5 Periods**
Key dimensions of e-commerce security - Computer security - Classification of information assets -Basic security issues - Threats to e-commerce system: Threats to front-end system, back-end System, client-side, service-side and e-commerce transaction. Seven security threats to e-commerce Site.		
UNIT – III	**SOLUTIONS FOR SECURITY THREATS**	**5 Periods**
Solutions for e-commerce security system - Solutions for service-side and transaction security - Cryptography and Encryption - Public key cryptography - Digital certificates - Securing channels of Communication - Developing an e-commerce security plan.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS

1	*Anup K. Ghosh* ***"E-Commerce Security and Privacy"****, Springer science + Business Media,LLC, 2012.*
2	*Gordon E. Smith ,* ***"Control and Security of E-Commerce",*** *John Wiley & Sons Inc, 2004.*

REFERENCES

1	*Amir Manzoor,* ***"E-Commerce: An Introduction",*** *LAP LAMBERT Academic Publishing,2010.*
2	*Jean D'AmourHabiyaremye and Jules Miller, "E-****Commerce Security Threats",*** *GRIN Verlag publisher, 2013.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Describe online banking system and its security.	K1
CO2	Explain various issues and threats in security	K1
CO3	Apply various solutions for security threats	K2

COURSE ARTICULATION MATRIX

a) CO and PO Mapping															
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	-	1	1	-	1	2	2	2	1	3	2	1	1	-	-
CO2	-	1	1	-	1	2	2	2	1	3	2	1	1	-	-
CO3	-	1	1	-	1	2	2	2	1	3	2	1	1	-	-
22LVA$13	-	1	2	-	1	2	2	2	1	3	2	1	1	1	-
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	2.1.1,2.4.3,3.1.1,3.2.3,5.3.2,6.2.1,7.1.2,7.2.1,8.1.1,8.2.1,9.1.1,9.2.4,10.1.1,10.1.2,10.1.3,10.2.1,10.2.2,10.3.1,10.3.2,11.2.1,11.3.1,12.3.2
CO2	2.1.2,3.1.3,3.2.3,5.3.2,6.2.1,7.1.2,7.2.1,8.1.1,8.2.1,9.1.1,9.2.4,10.1.1,10.1.2,10.1.3,10.2.1,10.2.2,10.3.1,10.3.2,11.2.1,11.3.1,12.3.2
CO3	2.1.1,3.1.6,3.2.3,5.3.2,6.2.1,7.1.2,7.2.1,8.1.1,8.2.1,9.1.1,9.2.4,10.1.1,10.1.2,10.1.3,10.2.1,10.2.2,10.3.1,10.3.2,11.2.1,11.3.1,12.3.2

22LVA$14	SIMULATION TECHNIQUES

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To acquire knowledge on discrete event system simulation techniques and random number generation	
UNIT – I	**DISCRETE-EVENT SYSTEM SIMULATION**	**5 Periods**
Simulation - Simulation of Queueing Systems - General Principles - Concepts in Discrete-event Simulation – List Processing -Simulation Software (open source)		
UNIT – II	**HARDWARE AND SOFTWARE MODULES**	**5 Periods**
Statistical Models in Simulation – Useful Statistical Models – Discrete and Continues Distributions–Poison Process - Queueing Models- Characteristics - Simulating queuing models –Verification and Validation of Simulation Models –Calibration of models.		
UNIT – III	**RANDOM NUMBERS**	**5 Periods**
Random-Number Generation –Techniques for Generation – Tests - Random-Variate Generation – Inverse Transform Technique – Acceptance-Rejection Technique – Special Properties.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS:

1	*Jerry Banks, John S. Carson, Barry L. Nelson, David M. Nicol, "**Discrete-Event System Simulation**", 5th Edition, Prentice Hall, 2010*
2	*B.W. Kernighan and D.M. Ritchie, **"The C Programming Language",** 2nd Edition, Prentice Hall, 2012.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	explain discrete-event simulation techniques and	K2
CO2	discuss statistical analysis using hardware and softwares	K2
CO3	describe the procedure of random number generation	K2

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	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	PS O2	PSO 3
CO1	3	2	1	2	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	1	3	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	1	3	2	-	-	-	-	-	-	-	3	-	-
22LVA$14	3	3	1	3	2	-	-	-	-	-	-	-	3	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.3,2.2.4,2.4.1,2.4.2,3.2.2,4.1.2,4.1.3,4.1.4, 4.2.1,4.3.1
CO2	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.3,2.2.4,2.4.1,2.4.2,3.2.2,3.3.1,4.1.1,4.1.2,4.1.3,4. 1.4,4.2.1,4.3.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,3.1.6,3. 2.3,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4,5.1.1,5.1.2,5.2.2

22LVA$15	INTRODUCTION TO CLOUD COMPUTING

PREREQUISITES	CATEGORY	L	T	P	C
DATA COMMUNICATION NETWORKS	**EEC**	**1**	**0**	**0**	**1**

Course Objective	To gain knowledge on cloud computing, various issues in cloud computing and familiar with the lead players in cloud.	
UNIT – I	**CLOUD COMPUTING AND VIRTUALIZATION**	**5 Periods**
Introduction to Cloud Computing –Evolution of Cloud Computing –Cloud Characteristics - Basics of Virtualization- Implementation levels of Virtualization- Virtualization structures- Tools and mechanisms- Virtualization of CPU – Memory – I/O Devices – Desktop Virtualization – Server Virtualization.		
UNIT – II	**CLOUD INFRASTRUCTURES**	**5 Periods**
Service Oriented Architecture – NIST Cloud Computing Reference Architecture – laaS – PaaS – SaaS – Types of Clouds – Cloud Storage –Design Challenges in Cloud – Peer-to-Peer Architecture.		
UNIT – III	**PROGRAMMING MODELS**	**5 Periods**
Parallel and Distributed programming Paradigms – MapReduce – Hadoop – Mapping Applications – Google App Engine – Amazon AWS – Cloud Software Environments –Eucalyptus – Open Nebula – Open Stack- Cloud Security Overview.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS :

1	*Kai Hwang, Geoffrey C Fox, Jack G Dongarra,* ***"Distributed and Cloud Computing, From Parallel Processing to the Internet of Things"****, Morgan Kaufmann Publishers, 2012.*
2	*Toby Velte, Anthony Velte, Robert Elsenpeter,* ***"Cloud Computing - A Practical Approach"****, Tata McGraw-Hill Education Pvt. Ltd.,1st Edition,2009.*

REFERENCES:

1	*James E. Smith, Ravi Nair,* ***"Virtual Machines: Versatile Platforms for Systems and Processes"****, Elsevier/Morgan Kaufmann, 1st Edition, 2005.*
2	*Rajkumar Buyya, Christian Vecchiola, S.ThamaraiSelvi* ***, "Mastering Cloud Computing"****, Mcgraw Hill, 1st Edition,2013.*
3	*George Reese,* ***"Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)"****, O'Reilly, 1st Edition, 2009*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the cloud computing and Virtualization	**K2**
CO2	Identify the architecture and infrastructure of cloud models	**K3**
CO3	Describe the Cloud Programming Models	**K2**

COURSE ARTICULATION MATRIX:

a)CO-PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	1	1	1	1	-	-	-	-	-	-	-	-	1	1	-
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	1
CO3	3	2	3	3	2	-	-	-	-	-	-	-	3	3	1
22LVA$15	**2**	**2**	**2**	**2**	**1**	-	-	-	-	-	-	-	**2**	**2**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

CO and Key Performance Indicators mapping

CO1	1.3.1, 2.1.2, 3.1.5, 3.2.1, 3.3.1, 4.1.2
CO2	1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.3.1, 2.4.1, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.4.1, 4.1.1, 4.1.2, 4.2.1, 4.2.2, 4.3.1, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.4, 2.3.1, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2

22LVA$16	PCB DESIGN AND PROTOTYPING

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	2	1

Course Objective	To acquire knowledge on Circuit board designing in assembling and testing of PCB based electronics circuits and become familiar with the simulation software
PRACTICALS	**List of Experiments:** 1. Introduction to PCB Designing 2. Scope of PCB Designing 3. Hardware on Breadboard 4. Software Description 5. Design circuit on PCB software (Proteus/Multisim) 6. Schematic Layout 7. Board creation 8. Fabrication Process.
Contact Periods: **Lecture: 0 Periods Tutorial: 0 Periods Practical: 30 Periods Total:30 Periods**	

REFERENCES:

1	*R.S.Khandpur*, ***" Printed Circuit Boards: Design, Fabrication, Assembly andTesting",*** *Tata McGraw – Hill Education, 2005.*
2	*Jan Axelson,* ***" Making Printed Circuit Boards",*** *TAB Books, 1993.*
3.	*Charles Hamilton*, ***"A Guide to Printed Circuit Board Design", Butterworths & Co. Publishers,*** *2013.*
4	*Simon Monk & Duncan Amos*, ***"PCBs with Eagle",*** *McGraw –Hill Education, 2nd Edition, 2016.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Familiarize PCB Circuit Terminology	K2
CO2	Design a circuit and create a schematic Capture	K4
CO3	Become proficient with computer for drawing Schematic and PCB Layout and can be able to create new part and to Fabricate a Prototype PCB	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

Cos / POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	3	3	2	-	-	-	-	-	1	3	1	3	1	1	-
CO2	3	3	1	-	-	-	-	-	1	3	-	3	1	1	-
CO3	3	3	1	-	-	-	-	-	1	3	1	3	1	1	-
22LVA$16	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**1**	**3**	**1**	**1**	**-**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2,2.2.3,2.2.4,2.3.1,2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.4.2, 9.1.1, 9.1.2, 10.1.1, 10.1.2, 10.1.3, 10.2.2, 10.3.1,10.3.2, 11.2.1, 12.1.1,12.1.2, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.4.2, 9.1.1, 9.1.2, 10.1.1, 10.1.2. 10.1.3, 10.2.2, 10.3.1, 10.3.2, 11.2.1, 12.1.1, 12.1.2, 12.2.2,12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1,1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.6, 3.2.1, 9.1.1, 9.1.2, 10.1.1, 10.1.2. 10.1.3, 10.2.2, 10.3.1, 10.3.2, 11.1.1, 11.2.1, 12.1.1, 12.1.2, 12.2.2,12.3.1, 12.3.2

22LVA$17	DESIGN OF COMMUNICATION SYSTEMS

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	0	0	2	1

Course Objective	To introduce the student to visualize and analyze the Digital Communication concepts using MATLAB.	
UNIT – I	**DIGITAL MODULATION SCHEMES**	**10 Periods**
BPSK Modulation and Demodulation- BER vs. Eb/N0 for BPSK modulation over AWGN- Eb/N0 vs. BER for BPSK over Rayleigh Channel- Eb/N0 Vs BER for BPSK over Rician Fading Channel- QPSK Modulation and Demodulation- BER vs. Eb/N0 for QPSK modulation over AWGN- BER vs. Eb/N0 for 8-PSK Modulation over AWGN- Simulation of M-PSK modulations over AWGN -comparison of Digital Modulation techniques		
UNIT – II	**ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING**	**10 Periods**
Introduction to OFDM- Role of FFT/IFFT in OFDM- Role of Cyclic Prefix in OFDM- Simulation of OFDM system in MATLAB – BER Vs Eb/N0 for OFDM in AWGN channel		
UNIT – III	**SPREAD SPECTRUM COMMUNICATION**	**10 Periods**
Introduction to Spread Spectrum Communication- Codes used in CDMA- Maximum Length Sequences (m-sequences)- Preferred Pairs m-sequences generation for Gold Codes-Generation of Gold Codes and their cross-correlation.		
Contact Periods: **Lecture: 0 Periods Tutorial: 0 Periods Practical: 30 Periods Total: 30 Periods**		

REFERENCES:

1	*John Proakis, Masoud Saleh, **"Contemporary Communication Systems Using MATLAB"**, 3rd Edition, Cengage learning*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Simulate and test base band signaling schemes through implementation of Digital Modulation & demodulation Techniques and find their BER	K4
CO2	Simulate & validate the functionality of a OFDM	K4
CO3	Simulate & test spread spectrum communication	K4

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping

COs/ POs	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	2	1	1	-	-	-	-	3	-	-	1	3	1	1
CO2	3	2	1	1	-	-	-	-	3	2	-	2	3	1	1
CO3	3	3	1	1	2	-	-	-	3	2	-	2	3	1	1
22LVA$17	3	3	1	1	2	-	-	-	3	2	-	2	3	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.3.1, 1.4.1,2.1.2, 2.2.2, 2.3.1,2.4.1,3.1.6,3.2.2,3.2.3, 3.3.1,3.3.2,3.4.1, 4.2.2,4.3.1, 12.2.2.
CO2	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3, 4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2
CO3	1.3.1,1.4.1,2.1.1,2.1.2,2.2.2,2.2.3,2.4.2,2.4.4,3.1.1.,3.1.3,3.1.6,3.2.3,3.3.1,3.4.1,4.1.2,4.1.3, 4.2.2, 4.3.4,5.1.2,5.2.2,5.3.2,6.1.1,7.2.2,10.2.2,11.3.1,12.1.1,12.2.2,12.3.2

22LVA$18	APTITUDE - I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To improve aptitude, problem solving skills, reasoning ability and solving problems in individual and group.	
UNIT – I	**NUMBERS AND ARITHMETIC – I**	**5 Periods**
Types and Properties of Numbers, LCM, GCD, Fractions and decimals, Surds - Percentages,Profit and Loss, Simple Interest and Compound Interest, Clocks and Calendars.		
UNIT – II	**ALGEBRA – I**	**5 Periods**
Logarithms, Problems on ages, Races and Games, Problems on trains, Heights and distances.		
UNIT – III	**REASONING**	**5 Periods**
Logical Reasoning – Verbal Reasoning, Blood relations, Directions, Cubes and Dices, Analytical Reasoning.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOK

1	*Agarwal R.S – **“Quantitative Aptitude for Competitive Examinations”**, S.Chand Limited 2011*

REFERENCES

1	*Abhijit Guha, **“Quantitative Aptitude for Competitive Examinations”**, Tata McGraw Hill, 3rd Edition, 2011*
2	*Edgar Thrope, **“Test of Reasoning for Competitive Examinations”,** Tata McGraw Hill, 4th Edition, 2012*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom’s Taxonomy Mapped**
CO1	Explain numerical concepts and arithmetic skills.	K1
CO2	Describe algebraic manipulation.	K1
CO3	Develop reasoning skills and capability to work in team.	K2

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO 2	PSO 3
CO1	3	3	1	1	1	2	-	1	2	3	1	1	1	-	-
CO2	3	3	1	1	1	2	-	1	2	3	2	2	1	-	-
CO3	3	3	1	1	1	2	-	1	3	3	2	2	1	-	-
22LVA$18	**3**	**3**	**1**	**1**	**1**	**2**	-	**1**	**2**	**3**	**1**	**1**	**1**	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.4,3.1.1., 3.1.4,4.1.1,5.2.1,6.1.1,8.1.1,8.2.1,9.1.1,9.1.2,9.2.4,10.1.1,10.1.2,10.2.1,10.2.2,10.3.2,11.2.1,12.1.2,1 2.3.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.4,3.1.1., 3.1.4,4.1.1,5.1.2,5.2.1,5.3.2,6.1.1,8.1.1,8.2.1,9.1.1,9.1.2,9.2.2,9.2.3,9.2.4,10.1.1,10.1.2,10.2.1,10.3.1, 11.1.2,11.2.1,12.1.1,12.1.2,12.2.1,12.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.4,3.1.1., 3.1.4,4.1.1,5.1.2,5.2.1,5.3.2,6.1.1,8.1.1,8.2.1,9.1.1,9.1.2,9.2.2,9.2.3,9.2.4,10.1.1,10.1.2,10.2.1,10.3.1, 11.1.2,11.2.1,12.1.1,12.1.2,12.2.1,12.3.2

22LVA$19	APTITUDE - II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To improve aptitude, problem solving skills, reasoning ability and solving problems in teams.	
UNIT – I	**ARITHMETIC – II**	**5 Periods**
Ratios and Proportions - Averages - Mixtures and Solutions - Time, Speed and Distance - Time and Work, Probability - Discounts.		
UNIT – II	**ALGEBRA – II**	**5 Periods**
Quadratic Equations - Linear equations and inequalities - Problem on trains - Boats and Streams.		
UNIT – III	**MODERN MATHEMATICS**	**5 Periods**
Sets and Functions - Arithmetic and Geometric Sequences and Series - Permutations and Combinations - Data Interpretation - Bar charts, Pie charts and Data Sufficiency.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOK

1	*Agarwal R.S – **"Quantitative Aptitude for Competitive Examinations"**, S.Chand Limited 2011*

REFERENCES

1	*Abhijit Guha, **"Quantitative Aptitude for Competitive Examinations"**, Tata McGraw Hill, 3rd Edition, 2011*
2	*Edgar Thrope, **"Test of Reasoning for Competitive Examinations"**, Tata McGraw Hill, 4th Edition, 2012*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Develop Problem solving skills and reasoning ability.	K1
CO2	Communicate mathematical ideas effectively.	K1
CO3	Solve problems and capacity to work in group.	K3

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1	2	2	-	-	-	1	1	1	-	1	1	-	-	-
CO2	1	2	2	-	-	-	1	1	1	-	1	1	-	-	-
CO3	1	2	2	-	-	-	1	1	1	-	1	1	-	-	-
22LVA$19	1	2	2	-	-	-	1	1	1	-	1	1	-	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.4,3.1.1.,3.1.4,4.1.1,5.1.2,5.2.1,5.3.2,6.1.1,8.1.1,8.2.1,9.1.1,9.1.2,9.2.2,9.2.3,9.2.4,10.1.1,10.1.2,10.2.1,10.3.1,11.1.2,11.2.1,12.1.1,12.1.2,12.2.1,12.3.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1.,3.1.4,3.2.3,4.1.1,5.1.2,5.2.1,5.3.2,6.1.1,8.1.1,8.2.1,9.1.1,9.1.2,9.2.2,9.2.3,9.2.4,10.1.1,10.1.2,10.2.1,10.3.1,11.1.2,11.2.1,12.1.1,12.1.2,12.2.1,12.3.2
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.4,3.1.1.,3.1.4,3.2.3,4.1.1,5.1.2,5.2.1,5.3.2,6.1.1,8.1.1,8.2.1,9.1.1,9.1.2,9.2.2,9.2.3,9.2.4,10.1.1,10.1.2,10.2.1,10.3.1,11.1.2,11.2.1,12.1.1,12.1.2,12.2.1,12.3.2

22LVA$20	APTITUDE - III

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To enhance communication ability and improve their employability skills.	
UNIT – I	**NARRATION**	**5 Periods**
Video Profile- Tech Talk / Area of Interest / Extempore / Company Profile/Reading – Reading editorials; and Opinion Blogs/ Writing – Essay Writing		
UNIT – II	**PREPRATION AND PRACTICES**	**5 Periods**
Curriculum Vitae - Mock Interview.		
UNIT – III	**EFFECTIVE COMMUNICATION**	**5 Periods**
Group Discussion - Case Study.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

REFERENCES

1	*P.N.Joshi , **"Group Discussion on current topics"**, Ukain.*
2	*Acy Jackson ,Kathleen Geckeis, **"How to prepare your Curriculum Vitae"**, TMH, 2003 .*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Write definitions, descriptions, narrations and essays on various topics	**K2**
CO2	Draft effective resumes in the context of job search	**K2**
CO3	Develop communication skill effectively.	**K2**

COURSE ARTICULATION MATRIX

a) CO and PO Mapping

COs/POs	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	PSO 3
CO1	-	-	1	-	-	2	1	2	3	3	2	1	-	-	-
CO2	-	-	1	-	-	2	1	2	3	3	2	1	-	-	-
CO3	-	-	1	-	-	2	1	2	3	3	2	1	-	-	-
22LVA$20	-	-	**1**	-	-	**2**	**1**	**2**	**3**	**3**	**2**	**1**	-	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	3.1.1,6.2.1,7.2.1,8.1.1,8.2.1,9.1.1,9.1.2,9.2.2,9.2.3,9.2.4,10.1.1,10.1.2,10.1.3,10.2.1,10.2.2,10.3.1,10.3.2,11.2.1,11.2.2,12.3.1,12.3.2
CO2	3.1.3,6.2.1,7.2.1,8.1.1,8.2.1,9.1.1,9.1.2,9.2.2,9.2.3,9.2.4,10.1.1,10.1.2,10.1.3,10.2.1,10.2.2,10.3.1,10.3.2,11.2.1,11.2.2,12.3.1,12.3.2
CO3	3.1.3,6.2.1,7.2.1,8.1.1,8.2.1,9.1.1,9.1.2,9.2.2,9.2.3,9.2.4,10.1.1,10.1.2,10.1.3,10.2.1,10.2.2,10.3.1,10.3.2,11.2.1,11.2.2,12.3.1,12.3.2

22LVA$21	MICROSTRIP ANTENNA DESIGN

PREREQUISITES	CATEGORY	L	T	P	C
NIL	**EEC**	**1**	**0**	**0**	**1**

Course Objective	This course enables the students to acquire knowledge on basic microstrip Radiator models and provide design experience on microstrip antennas using mathematical equations.	
UNIT – I	**MICROSTRIP RADIATOR MODELS**	**5 Periods**
Microstrip Transmission Lines – Microstrip Discontinuities – Microstrip Patch Transmission Line Model – Microstrip Patch Radiation Patterns – Microstrip Patch Cavity Model – Integral and Differential Equation Model.		
UNIT – II	**SINGLE MICROSTRIP ELEMENT DESIGN**	**5 Periods**
Substrate Selection – Rectangular Element Analysis and Trade-off – Rectangular Element Design – Comparison to Measured Results – Rectangular Patch Radiation Patterns – Quarter wave Short circuited Patch – Patch with Cover Layer – Circular Patch Design.		
UNIT – III	**ADVANCED FEEDING TECHNIQUES**	**5 Periods**
Listing of Computer Programs – Electromagnetically Coupled patches – Aperture Coupled Patches – Coplanar Waveguide fed Patches – Other types of Printed Circuit Antennas		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS:

1	*Robert A. Sainati, "**CAD of Microstrip Antennas for Wireless Applications**", Artech House.*

REFERENCES:

1	*Ramesh Garg, Prakash Bhartia et.al., "**Microstrip Antenna Design Handbook**", Artech House, 2010.*
2	*Constantine A. Balanis, "**Antenna Theory-Analysis and Design**", 3rd edition, Wiley-India, 2010.*
3	*John D Kraus, Ronald J Marhefka. "**Antenna and Wave Propagation**", 4th edition, Tata McGraw Hill,2010.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire In-depth knowledge about Microstrip antenna radiation mechanism.	K2
CO2	Design Transmission line model based rectangular and circular Microstrip Antenna	K4
CO3	Justify the importance of Microstrip Antenna Feeding Techniques.	K2

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/ POs	**PO 1**	**PO 2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
CO1	3	2	1	2	-	-	-	-	-	-	-	-	3	-	-
CO2	3	2	1	3	-	-	-	-	-	-	-	-	3	-	-
CO3	3	3	1	3	2	-	-	-	-	-	-	-	3	-	-
22LVA$21	3	3	1	3	2	-	-	-	-	-	-	-	3	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.3,2.2.4,2.4.1,2.4.2,3.2.2,4.1.2,4.1.3,4.1.4, 4.2.1,4.3.1
CO2	1.1.1,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.3,2.2.4,2.4.1,2.4.2,3.2.2,3.3.1,4.1.1,4.1.2,4.1.3, 4.1.4,4.2.1,4.3.1
CO3	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.3.1,2.3.2,2.4.1,2.4.2,3.1.6, 3.2.3,4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.3.3,4.3.4,5.1.1,5.1.2,5.2.2

22LVA$22	BATTERY AND MANAGEMENT SYSTEM

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objectives	To understand the working and characteristics of different types of batteries and their management.	
UNIT – I	**ADVANCED BATTERIES**	**5 Periods**
Li-ion Batteries - Different formats, Chemistry, Safe operating area, Efficiency, Aging. Characteristics SOC, DOD, SOH. Balancing - Passive Balancing Vs Active Balancing. Other Batteries - NCM and NCA Batteries. NCR18650B specifications.		
UNIT – II	**BATTERY**	**5 Periods**
Battery Pack - Design, Sizing, Calculations, Flow chart, Real and Simulation Model. Peak power - Definition, Testing methods - Relationships with Power, Temperature and ohmic Internal Resistance - Cloud based and Local Smart charging.		
UNIT – III	**BATTERY MODELLING**	**5 Periods**
Battery Modelling Methods - Equivalent Circuit Models, Electrochemical Model, Neural Network Model. ECM Comparisons - Rint model, Thevenin model, PNGV model. State space Models Introduction - Battery Modelling software/simulation frameworks.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS:

1	*Jiuchun Jiang and Caiping Zhang, "**Fundamentals and applications of Lithium-Ion batteries in Electric Drive Vehicles**", Wiley, 2015..*
2	*Davide Andrea ,"**Battery Management Systems for Large Lithium-Ion Battery Packs**" ARTECH House, 2010.*

REFERENCES:

1	*Developing Battery Management Systems with Simulink and Model - Based Design - whitepaper.*
2	*Panasonic NCR18650B - DataSheet*
3	*Panasonic NCR18650B - DataSheet*
4	*CC2662R-Q1- IC DataSheet*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Acquire knowledge of different Li-ion Batteries performance	**K2**
CO2	Design a Battery Pack and make related calculations	**K3**
CO3	Demonstrate a Battery Model or Simulation	**K3**

COURSE ARTICULATION MATRIX

a)CO-PO Mapping															
COs/POs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO2**	**PSO3**
CO1	1	2	1	3	1	-	-	-	-	-	-	-	1	2	1
CO2	3	2	2	3	2	-	-	-	-	-	-	-	3	2	1
CO3	3	2	2	3	2	-	-	-	-	-	-	-	3	2	1
22LVA$22	**2**	**2**	**2**	**3**	**2**	-	-	-	-	-	-	-	**2**	**2**	**1**

CO and Key Performance Indicators Mapping

CO1	1.2.1, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 3.1.4, 4.1.1, 4.1.2, 4.1.4, 4.2.2, 4.3.1, 4.3.2, 5.1.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.6, 3.2.3, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.4, 5.1.1, 5.1.2, 5.2.1
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.3.2, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.3, 3.1.4, 3.1.5, 3.1.6, 3.2.3, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.2.2, 4.3.1, 4.3.2, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.3.2

ASSESSMENT PATTERN – THEORY

Test / Bloom's Category*	**Remembering (K1) %**	**Understanding (K2) %**	**Applying (K3) %**	**Analyzing (K4) %**	**Evaluating (K5) %**	**Creating (K6) %**	**Total %**
CAT1	20	40	40				100
CAT2	20	40	40				100
Assignment 1	20	40	40				100
Assignment 2	20	40	40				100
Other mode of internal assessments, if any							

22LVA$23	**E-VEHICLE**

PREREQUISITES	**CATEGORY**	**L**	**T**	**P**	**C**
NIL	**EEC**	1	**0**	**0**	1

Course Objective	To introduce the basic of Electric vehicle and automotive power strains	
UNIT – I	**ELECTRIC VEHICLES**	**5 Periods**
History, Basics of Electric Vehicles, Components of Electric Vehicle, General Layout of EV, EV classification : Battery Electric Vehicles (BEVs), Fuel-Cell Electric Vehicles (FCEVs) Comparison with Internal Combustion Engine: Technology, Advantages & Disadvantages of EV, National Policy for adoption of EVs, Overview of Tesla car.		
UNIT – II	**VEHICLE MECHANICS**	**5 Periods**
History of Vehicle Development, General Configuration of Automobile, Body and Chassis Fundamentals: General Packaging, Types of Structural System, Backbone Construction; Body and Chassis Materials. Automotive Powertrain Mechanical, Suspensions system, Steering System, NVH, Control System Integration and Implementation. Front-Wheel Drive (FWD) Powertrains, Rear-Wheel Drive Powertrains (RWD), Multi-Wheel Drive Powertrains (AWD and 4WD).		
UNIT – III	**TRANSMISSION SYSTEMS**	**5 Periods**
Transmission gears, Manual Transmission (MT), Automatic Transmission (AT), Automated Manual Transmissions (AMT) and Continuously Variable Transmissions (CVT); Manual Transmissions Powertrain Layout and Manual Transmission Structure, Power Flows and Gear Ratios, Manual Transmission Clutch and its structure. Drivetrain and Differential.		
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS:

1	*Behrooz Mashadi and David Crolla ,* ***"Vehicle Powertrain Systems"****, Wiley, 2012*
2	*Joseph Katz,* ***"Automotive Aerodynamics"****, Wiley, 2016*

REFERENCES:

1	*David C. Barton and John D. Fieldhouse,* ***"Automotive Chassis Engineering"****, Springer, 2018*
2	*David A. Crolla,* ***"Automotive Engineering Powertrain, Chassis System and Vehicle"****, Elsevier,2009*
3	*Yi Zhang and Chris Mi,* ***"Automotive Power Transmission Systems"****, Wiley, 2018*
4	*Ion Boldea,* ***"Linear Electric Machines, Drives, and MAGLEVs Handbook"****, CRC Press. 2013*
5	*Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay, and Ali Emadi,* ***"Modern Electric, Hybrid Electric, and Fuel Cell Vehicles",*** *CRC Press 2005*
6	*James Larminie and John Lowry,* ***"Electric Vehicle Technology Explained****", John Wiley, 2003*
7	*Iqbal Husain,* ***"Electric and Hybrid Vehicles- Design Fundamentals"****, CRC Press, 2005*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Explain the basic of Electric vehicles and its major parts.	K2
CO2	Define the functionality and working principles of different types of Automotive Powertrains	K2
CO3	Illustrate the working of various automotive transmission systems	K3

COURSE ARTICULATION MATRIX :

a) CO and PO Mapping

COs/POs	PO 1	PO 2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1	2	1	1	-	1	3	2	3	1	2	1	2	2	1	1
CO2	2	2	2	-	1	3	2	3	1	2	1	2	2	1	1
CO3	2	2	2	-	1	3	2	3	1	2	1	2	2	1	1
22LVA$23	**2**	**2**	**2**	-	**1**	**3**	**2**	**3**	**1**	**2**	**1**	**2**	**2**	**1**	**1**

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 3.1.4, 3.1.5, 5.1.1, 6.1.1, 6.2.1, 7.1.2, 7.2.2, 8.1.1, 8.2.1, 8.2.2, 9.1.2, 9.2.3, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 11.1.1, 12.1.2, 12.2.1, 12.2.2
CO2	1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.3.1, 2.4.1, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.4.1, 5.1.1, 6.1.1, 6.2.1, 7.1.2, 7.2.2, 8.1.1, 8.2.1, 8.2.2, 9.1.2, 9.2.3, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 11.1.1, 12.1.2, 12.2.1, 12.2.2
CO3	1.2.1, 1.3.1, 1.4.1, 2.1.2, 2.1.3, 2.2.2, 2.2.3, 2.4.1, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.2, 3.2.3, 3.3.1, 3.4.1, 5.1.1, 6.1.1, 6.2.1, 7.1.2, 7.2.2, 8.1.1, 8.2.1, 8.2.2, 9.1.2, 9.2.3, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 11.1.1, 12.1.2, 12.2.1, 12.2.2

22LVA$24	PRODUCT DESIGN,MANUFACTURING AND TROUBLESHOOTING

PREREQUISITES		CATEGORY	L	T	P	C
NIL		EEC	1	0	0	1
Course Objective	To develop competence with a set of tools and methods for product design anddevelopment, ability to create and coordinate multiple, interdisciplinary tasks in order to achieve a common objective.					
UNIT – I	**INTRODUCTION**					**5 Periods**
Characteristics of successful product development, Design and development of products, duration and cost of product development, the challenges of product development. Development Processes and Organizations, the front-end process, adopting the generic product development process, the AMF development process, product development organizations, the AMForganization.						
UNIT – II	**PRODUCT PLANNING**					**5 Periods**
The product planning process, identify opportunities. Evaluate and prioritize projects, allocateresources and plan timing, complete pre project planning, reflect all the results and the process						
UNIT – III	**IDENTIFYING CUSTOMER NEEDS**					**5 Periods**
Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results andthe process.						
Contact Periods: **Lecture: 15 Periods Tutorial: 0 Periods Practical: 0 Periods Total: 15 Periods**						

TEXT BOOKS

1	*Karl.T.Ulrich," **Product Design and Development**", Seventh edition ,Steven D Eppinger - Irwin McGrawHill,2020.*
2	*A C Chitale and R C Gupta ,"**Product Design and Manufacturing**", PH1, 3rd Edition, 2003*

REFERENCES

1	*Timjones. Butterworth Heinmann," **New Product Development** ",Oxford. UCI -1997.*
2	*Geoffery Boothroyd, Peter Dewhurst andWinston Knight,"**Product Design for Manufacture and Assembly**" – Third Edition, McGrawHill,2021.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**BL**
CO1	Understand the product design and development process.	K2
CO2	Apply creative thinking skills for idea generation.	K2
CO3	Depict the customer needs.	K2

a) CO and PO Mapping

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO1 1	PO1 2	PSO1	PSO2	PSO3
CO 1	3	3	3	-	3	3	3	-	-	-	-	-	1	1	1
CO 2	3	3	3	-	3	3	3	-	-	-	-	-	1	1	1
CO 3	3	3	3	-	3	3	3	-	-	-	-	-	1	1	1
22LVA$24	3	3	3	-	3	3	3	-	-	-	-	-	1	1	1

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2, 3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,5.1.,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1, 7.1.2,7.2.1,7.2.2
CO2	1.1.1,1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2, 3.1.3,3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,5.1.,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1, 7.1.2,7.2.1,7.2.2
CO3	1.1.2,1.2.1,1.3.1,1.4.1,2.1.1,2.1.2,2.1.3,2.2.1,2.2.2,2.2.3,2.2.4,2.3.1,2.3.2,2.4.1,2.4.2,2.4.3,2.4.4,3.1.1,3.1.2,3.1.3, 3.1.4,3.1.5,3.1.6,3.2.1,3.2.2,3.2.3,3.3.1,3.3.2,3.4.1,3.4.2,5.1.,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2,6.1.1,6.2.1,7.1.1,7.1.2, 7.2.1,7.2.2

22LVA$25	DIGITAL IMAGE PROCESSING AND COMPUTER VISION LABORATORY					
PREREQUISITES		**CATEGORY**	**L**	**T**	**P**	**C**
	DIGITAL IMAGE PROCESSING	**EEC**	**0**	**0**	**2**	**1**

Course Objectives	To Gain practical Experience in the Recent advances in algorithmic techniques, of Image processing, Geometric techniques and Machine learning Application for computer vision.

- Digital Image Processing
    - Image Formation
    - Image Filtering
    - Edge Detection
    - Principal Component Analysis
    - Corner Detection
    - SIFT
    - Applications: Large Scale Image Search
- Geometric Techniques in Computer Vision
    - Image Transformations
    - Camera Projections
    - Camera Calibration
    - Depth from Stereo
    - Two View Structure from Motion
    - Object Tracking
- Machine Learning for Computer Vision
    - Introduction to Machine Learning
    - Image Classification
    - Object Detection
    - Semantic Segmentation

Contact Periods:
Lecture: 0 Periods **Tutorial: 0 Periods** **Practical: 30 Periods** **Total: 30 Periods**

TEXT BOOKS

1	*Gonzalez R.C., Woods R.E.*, "**Digital Image Processing**", Fourth Edition, Pearson, 2017.
2	*RichardSzeliski* ,"**Computer Vision: Algorithms and Applications** ", Springer; 1st Edition. ISBN-10: 1848829345, ISBN-13: 978-1848829343.

REFERENCES

1	*Goodfellow and Yoshua Bengio, Aaron Courville.*" **Deep Learning** " , MIT Press, 2016.
2	*Daniel Lélis Baggio, Shervin Emami, David Millán Escrivá, Khvedchenia Ievgen, Naureen Mahmood, Jasonl Saragih, Roy Shilkrot," **Mastering OpenCV with Practical Computer Vision Projects**", Packt Publishing, ISBN-10: 1849517827, ISBN-13: 978-1849517829.*
3	*David Marr ,"Vision: A Computational Investigation into the Human Representation and Processing of Visual Information", MIT Press, ISBN-10: 0262514621, ISBN-13: 978- 0262514620.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		BL
CO1	Translate the geometric techniques in computer vision..	K3
CO2	Implement the concepts of image classification, object detection, and image segmentation.	K3
CO3	Demonstrate the concepts of Machine learning for computer vision..	K3

COURSE ARTICULATION MATRIX

a)CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO 1	-	-	-	3	3	-	-	-	-	-	-	-	1	-	-
CO 2	-	-	-	3	3	-	-	-	-	-	-	-	1	-	-
CO 3	-	-	-	3	3	-	-	-	-	-	-	-	1	-	-
22LVA$25	-	-	-	**3**	**3**	-	-	-	-	-	-	-	**1**	-	-

1 – Slight, 2 – Moderate, 3 – Substantial

b) CO and Key Performance Indicators Mapping

CO1	4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2
CO2	4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2
CO3	4.1.1,4.1.2,4.1.3,4.1.4,4.2.1,4.2.2,4.3.1,4.3.2,4.3.3,4.3.4,5.1.1,5.1.2,5.2.1,5.2.2,5.3.1,5.3.2

22LVA$26	TRANSFORMS FOR COMMUNICATION ENGINEERING - I

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To solve the problems using Continuous Time Fourier Series, Fourier Transform and Laplace Transform.	
UNIT – I	**CONTINUOUS TIME FOURIER SERIES**	**5 Periods**
Fourier series representation of Continuous Time Periodic signals – Covergence of the Fourier series - Properties of continuous time Fourier series.		
UNIT – II	**CONTINUOUS TIME FOURIER TRANSFORM**	**5 Periods**
Fourier transform representation of continuous time aperiodic signals - Covergence of Fourier transform – Fourier transform for periodic signals - Properties of continuous time Fourier transform -		
UNIT – III	**LAPLACE TRANSFORM**	**5 Periods**
Laplace Transform – Region of Convergence of Laplace Transform – Inverse Laplace Transform -Properties of Laplace Transform.		
Contact Periods: **Lecture: 15 Periods Tutorial:0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS

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

REFERENCES :

1	*B. P. Lathi, **"Principles of Linear Systems and Signals",** 2nd Edition, Oxford, 2009.*
2	*M. J. Roberts, **"Signals and Systems Analysis using Transform methods and MATLAB",** McGraw-Hill Education, 2018.*
3	*John Alan Stuller, **"An Introduction to Signals and Systems",** Thomson, 2007.*
4	*Hwei Hsu, **"Schaum's Outline Series Signals and systems",** Second Edition, TMH, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Solve Problems using Continuous time Fourier series	K3
CO2	Solve Problems using Continuous time Fourier Transform	K3
CO3	Solve Problems using Laplace Transform	K3

COURSE ARTICULATION MATRIX

a)CO-PO Mapping															
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**-**
CO2	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**-**
CO3	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**-**
22LVA$26	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.21.,1.3.1,1.4.1,2.1.2,2.2.3,2.3.1,2.4.1,2.4.3.12.1.1
CO2	1.1.1,1.21.,1.3.1,1.4.1,2.1.2,2.3.1,2.4.1,2.4.3.12.1.1
CO3	1.1.1,1.21.,1.3.1,1.4.1,2.1.2,,2.3.1,2.4.1,2.4.3.12.1.1

22LVA$27	TRANSFORMS FOR COMMUNICATION ENGINEERING - II

PREREQUISITES	CATEGORY	L	T	P	C
NIL	EEC	1	0	0	1

Course Objective	To solve the problems using Discrete Time Fourier Series, Discrete Time Fourier Transform and Z Transform.	
UNIT – I	**DISCRETE TIME FOURIER SERIES**	**5 Periods**
Fourier series representation of Discrete Time Periodic signals –Properties of Discrete time Fourier series.		
UNIT – II	**DISCRETE TIME FOURIER TRANSFORM**	**5 Periods**
Fourier transform representation of discrete time aperiodic signals– Fourier transform for periodic signals - Properties of Discrete Time Fourier Transform.		
UNIT – III	**Z TRANSFORM**	**5 Periods**
Z Transforms - Properties of Z Transform - Region of Convergence of Z Transform – Inverse Z Transform.		
Contact Periods: **Lecture: 15 Periods Tutorial:0 Periods Practical: 0 Periods Total: 15 Periods**		

TEXT BOOKS

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

REFERENCES :

1	*B. P. Lathi,* ***"Principles of Linear Systems and Signals",*** *2nd Edition, Oxford, 2009.*
2	*M. J. Roberts,* ***"Signals and Systems Analysis using Transform methods and MATLAB",*** *McGraw- Hill Education, 2018.*
3	*John Alan Stuller,* ***"An Introduction to Signals and Systems",*** *Thomson, 2007.*
4	*Hwei Hsu,* ***"Schaum's Outline Series Signals and systems",*** *Second Edition, TMH, 2011.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Solve Problems using Discrete time Fourier series	K3
CO2	Solve Problems using Discrete time Fourier Transform	K3
CO3	Solve Problems using Z Transform	K3

COURSE ARTICULATION MATRIX

a)CO-PO Mapping															
COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
CO1	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**-**
CO2	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**-**
CO3	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**-**
22LVA$27	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**1**	**-**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping	
CO1	1.1.1,1.21.,1.3.1,1.4.1,2.1.2,2.2.3,2.3.1,2.4.1,2.4.3.12.1.1
CO2	1.1.1,1.21.,1.3.1,1.4.1,2.1.2,2.3.1,2.4.1,2.4.3.12.1.1
CO3	1.1.1,1.21.,1.3.1,1.4.1,2.1.2,,2.3.1,2.4.1,2.4.3.12.1.1

22LVA$28	VIRTUAL LABORATORY ON DIGITAL VLSI DESIGN

PREREQUISITES	CATEGORY	L	T	P	C
DIGITAL CIRCUITS DESIGN VLSI DESIGN	EEC	0	0	2	1

Course Objective	To provide hands on design experience with virtual professional design (EDA) platforms on the principles of digital VLSI circuit design.
	LIST OF EXPERIMENTS: Characterization of the following digital VLSI circuits. 1. MOSFET/ CMOS Inverter. 2. Logic Gates. 3. Ring Oscillator. 4. 4x1 Multiplexer. 5. Latches. 6. Registers. **Tools and Hardware** : EDA Tool / Virtual simulator.
Contact Periods: **Lecture: 0 Periods Tutorial:0 Periods Practical: 30 Periods Total: 30 Periods**	

REFERENCES :

1	*J.M. Rabaey, A.Chandrakasan and B.Nikolic,* ***Digital Integrated Circuits*** *– A Design Perspective, 2nd ed., PHI, 2003*
2	*Weste, CMOS VLSI Design: A Circuits and Systems Perspective, 3rd edition, Pearson Education India, 2007*
3	*David A. Hodges, Horace G. Jackson, Resve Saleh, Analysis and Design of Digital Integrated Circuits in Deep Submicron Technology, 3rd international edition, McGraw Hill, 2004*
4	*Kang and Leblevici, CMOS Digital Integrated Circuits Analysis and design, 3rd ed., McGraw Hill 2003.*
5	*J.P. Uyemura, Introduction to VLSI Circuits and systems, John wiley & sons (Asia) Pte Ltd, 2002.*
6	*W. Wolf, Modern VLSI Design – system on chip design, 3ed, pearson Education, 2004.*

COURSE OUTCOMES: Upon completion of the course, the students will be able to:		**Bloom's Taxonomy Mapped**
CO1	Analyze the combinational digital VLSI circuits using Scripting Language.	K4
CO2	Analyze the sequential digital VLSI circuits using Scripting Language	K4
CO3	Expose on new technology and develop the digital circuits in Virtual EDA platform .	K3

COURSE ARTICULATION MATRIX:

a) CO and PO Mapping:

COs/POs	PO 1	PO 2	PO 3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CO1	3	3	3	3	3	2	-	-	3	3	-	3	3	3	3
CO2	3	3	3	3	3	2	-	-	3	3	-	3	3	3	3
CO3	3	3	3	3	3	2	-	-	3	3	-	3	3	3	3
22LVA$28	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**3**	**3**	**-**	**3**	**3**	**3**	**3**
1 – Slight, 2 – Moderate, 3 – Substantial															

b) CO and Key Performance Indicators Mapping

CO1	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO2	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 3.4.2, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2
CO3	1.1.1, 1.1.2, 1.2.1, 1.3.1, 1.4.1, 2.1.1, 2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.3.1, 2.3.2, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 3.1.1, 3.1.4, 3.1.5, 3.1.6, 3.2.1, 3.2.3, 3.3.1, 3.3.2, 3.4.1, 4.1.1, 4.1.2, 4.1.3, 4.1.4, 4.2.1, 4.3.1, 4.3.3, 4.3.4, 5.1.1, 5.1.2, 5.2.1, 5.2.2, 5.3.1, 5.3.2, 6.1.1, 9.1.1, 9.1.2, 9.2.1, 9.2.2, 9.2.3, 9.2.4, 9.3.1, 10.1.1, 10.1.2, 10.1.3, 10.2.1, 10.2.2, 10.3.1, 10.3.2, 12.1.1, 12.1.2, 12.2.1, 12.2.2, 12.3.1, 12.3.2