MUTHAYAMMAL ENGINEERING COLLEGE

An Autonomous Institution

(Approved by AICTE | Accredited by NBA & NAAC | Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

Curriculum/Syllabus

Programme Code : **EC**

Programme Name : **B.E - Electronics and Communication Engineering**

Regulation : **2023**

MUTHAYAMMAL ENGINEERING COLLEGE

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Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

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Rasipuram - 637 408, Namakkal Dist., Tamil Nadu.

Estd. 2000

Institution Vision & Mission

Institution Vision

- To be a Centre of Excellence in Engineering, Technology and Management on par with International Standards.

Institution Mission

- To prepare the students with high professional skills and ethical values.
- To impart knowledge through best practices.
- To instill a spirit of innovation through Training, Research and Development.
- To undertake continuous assessment and remedial measures.
- To achieve academic excellence through intellectual, emotional and social stimulation.

Institution Mission

Rural upliftment through Technical Education

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Board of Studies
Department of Electronics and Communication Engineering
Muthayammal Engineering College (Autonomous)
Rasipuram, Namakkal - 637 408.

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Department Vision & Mission

Department Vision

To empower the electronics and communication engineering students on basics and advanced technologies in both theoretical and experimental practices with research attitude and ethics.

Department Mission

- To impart need based in Electronics and communication engineering to meet the requirements of academic, industry and society
- To establish the state-of-art laboratories to prepare the students for facing the challenges ahead
- To prepare the students for employment, higher education and research oriented activities.

Program Educational Objectives

The Electronics and Communication Engineering Graduates should be able to

PEO1 : Graduate should be able to pursue as an Engineer with necessary conceptual, analytical and theoretical knowledge in the domain of Electronics and Communication Engineering

PEO2 : Graduate should be able to acquire the practical knowledge through basics and advanced laboratories in the field of Electronics and Communication Engineering

PEO3 : Graduate should be able to demonstrate the leadership skills through Entrepreneurship, Employment. And Higher studies and to practice ethical values for the benefit of Society and Environment

Program Specific Outcomes

PSO1 : Design and analyze electronic circuits and systems for various applications

PSO2 : Apply the acquired knowledge and analytical skills for modeling and simulation of advanced communication systems

PSO3 : Ascertain the use of software and hardware tools for developing variety of electronics and communication systems

Program Outcomes

PO1 : **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 : **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.

PO3 : **Design/Development solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 : **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 : **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.

PO6 : **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 : **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development

PO8 : **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 : **Individual and team work:** Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 : **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.

PO11 : Project management and finance: Demonstrate knowledge and understanding of the engineering management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 : Lifelong learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

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B.E-Electronics and Communication Engineering
Grouping of Courses

I. Humanities and Social Sciences including Management Courses (HS)

Sl.No.	Course Code	Course Title	Category	Contact Hours	Instruction Hours/Week/ Credit			
					L	T	P	C
1.	23HSS01	Technical and Communicative English – I	HS	3	3	0	0	3
2.	23HSS02	Technical and Communicative English – II	HS	3	3	0	0	3
3.	23HSS03	Technical English for Engineers	HS	2	2	0	0	2
4.	23HSS04	Communicative English for Engineers	HS	2	2	0	0	2
5.	23HSS05	Commercial English	HS	2	2	0	0	2
6.	23HSS06	Basics of Japanese Language	HS	2	2	0	0	2
7.	23HSS07	Basics of French	HS	2	2	0	0	2
8.	23HSS08	Heritage of Tamils	HS	1	1	0	0	1
9.	23HSS09	Tamils and Technology	HS	1	1	0	0	1

II. Basic Science Courses (BS)

1.	21BSS01	Engineering Physics	BS	3	3	0	0	3
2.	21BSS02	Physics Laboratory	BS	4	0	0	4	2
3.	21BSS03	Bio and Nanomaterial Sciences	BS	3	3	0	0	3
4.	21BSS04	Materials Science	BS	3	3	0	0	3
5.	21BSS05	Applied Physics	BS	3	3	0	0	3
6.	21BSS11	Engineering Chemistry	BS	3	3	0	0	3
7.	21BSS12	Chemistry Laboratory	BS	4	0	0	4	2
8.	21BSS13	Applied Chemistry	BS	3	3	0	0	3
9.	23BSS21	Algebra and Calculus	BS	4	3	1	0	4
10.	23BSS22	Advanced Calculus and Complex Analysis	BS	4	3	1	0	4
11.	23BSS23	Differential Equations and Vector Analysis	BS	4	3	1	0	4
12.	23BSS24	Transforms and Partial Differential Equations	BS	4	3	1	0	4
13.	23BSS25	Discrete Mathematics	BS	4	3	1	0	4
14.	23BSS26	Statistics and Queuing Model	BS	4	3	1	0	4

15.	23BSS27	Statistics and Numerical Methods	BS	4	3	1	0	4
16.	23BSS28	Numerical Methods	BS	4	3	1	0	4
17.	23BSS29	Probability and Random Processes	BS	4	3	1	0	4

III. General Engineering Science Courses (GES)

1.	23GES01	Programming for Problem Solving Using C	GES	3	3	0	0	3
2.	23GES02	Programming in C Laboratory	GES	3	0	0	2	1
3.	23GES03	Python Programming	GES	3	3	0	0	3
4.	23GES04	Computer Peripherals and Programming Essentials	GES	3	3	0	0	3
5.	23GES05	Python Programming Laboratory	GES	2	0	0	2	1
6.	23GES06	Electrical and Electronics Sciences	GES	3	3	0	0	3
7.	23GES07	CAD Laboratory	GES	3	0	0	4	2
8.	23GES08	Electric Circuits	GES	3	3	0	0	3
9.	23GES09	Engineering Mechanics for Electrical Engineers	GES	3	3	0	0	3
10.	23GES10	Engineering Graphics	GES	3	3	0	0	3
11.	23GES11	Engineering Drawing	GES	3	3	0	0	3
12.	23GES12	Mechanical and Building Sciences	GES	3	3	0	0	3
13.	23GES13	Data Structures using Python	GES	3	3	0	0	3
14.	23GES14	Electronics Product Design	GES	3	3	0	0	3
15.	23GES15	Manufacturing Processes	GES	3	3	0	0	3
16.	23GES16	Fundamentals of Civil Engineering	GES	3	3	0	0	3
17.	23GES17	Bioorganic Chemistry	GES	3	3	0	0	3
18.	23GES18	Basics Electrical and Electronics Engineering	GES	3	3	0	0	3
19.	23GES19	Engineering Mechanics	GES	3	3	0	0	3
20.	23GES20	Basics of Human Anatomy	GES	3	3	0	0	3
21.	23GES21	Engineering Practices Laboratory	GES	4	0	0	4	2
22.	23GES22	Computer Aided Building Drawing Laboratory	GES	4	0	0	4	2
23.	23GES23	Bioorganic Chemistry Laboratory	GES	4	0	0	4	2
24.	23GES24	Electric Circuits Laboratory	GES	2	0	0	2	1
25.	23GES25	Data Structures using Python Laboratory	GES	2	0	0	2	1
26.	23GES26	Digital Principles and System Design	GES	3	3	0	0	3
27.	23GES27	Digital Principles and System Design Laboratory	GES	2	0	0	2	1

IV. Professional Core (PC)

1.	23ECC01	Solid State Devices	PC	3	3	0	0	3
2.	23ECC02	Circuit Theory and Analysis	PC	3	3	0	0	3

3.	23ECC03	Analog Electronics	PC	3	3	0	0	3
4.	23ECC04	Digital System Design	PC	3	3	0	0	3
5.	23ECC05	Signals and Systems	PC	3	3	0	0	3
6.	23ECC06	Electromagnetic Fields	PC	3	3	0	0	3
7.	23ECC07	Control Engineering	PC	3	3	0	0	3
8.	23ECC08	Digital Signal Processing	PC	3	3	0	0	3
9.	23ECC09	Microcontrollers and Embedded Systems	PC	3	3	0	0	3
10.	23ECC10	Communication Systems	PC	3	3	0	0	3
11.	23ECC11	Transmission Line and Wave Guides	PC	3	3	0	0	3
12.	23ECC12	Integrated Circuits and Applications	PC	3	3	0	0	3
13.	23ECC13	Image Processing and Machine Learning	PC	3	3	0	0	3
14.	23ECC14	Antenna and RF Engineering	PC	3	3	0	0	3
15.	23ECC15	Wireless Communication Systems	PC	3	3	0	0	3
16.	23ECC16	CMOS VLSI Design	PC	3	3	0	0	3
17.	23ECC17	Microwave and Optical Engineering	PC	3	3	0	0	3
18.	23ECC18	MEMS and NEMS	PC	3	3	0	0	3
19.	23ECC19	Engineering Ethics and Human Values	PC	3	3	0	0	3
20.	23ECC20	Internet of Things	PC	3	3	0	0	3
21.	23ECC21	Artificial Intelligence and Data Science	PC	3	3	0	0	3
22.	23ECC22	Electronic Circuits Laboratory	PC	2	0	0	2	1
23.	23ECC23	Digital System Design Laboratory	PC	2	0	0	2	1
24.	23ECC24	Signal Processing Laboratory	PC	2	0	0	2	1
25.	23ECC25	Embedded Systems Laboratory	PC	2	0	0	2	1
26.	23ECC26	Communication Systems Laboratory	PC	2	0	0	2	1
27.	23ECC27	Image Processing and Machine Learning Laboratory	PC	2	0	0	2	1
28.	23ECC28	Integrated Circuits Laboratory	PC	2	0	0	2	1
29.	23ECC29	Antenna and RF Engineering Laboratory	PC	2	0	0	2	1
30.	23ECC30	Microwave and Optical Engineering Laboratory	PC	2	0	0	2	1
31.	23ECC31	CMOS VLSI Design Laboratory	PC	2	0	0	2	1

V. Professional Electives (PE)

VLSI Design Domain								
1.	23ECE01	Mixed Signal IC Design	PE	3	3	0	0	3
2.	23ECE02	Low Power VLSI Design	PE	3	3	0	0	3
3.	23ECE03	Reconfigurable Computing using FPGAs	PE	3	3	0	0	3
4.	23ECE04	IC Fabrication Technology	PE	3	3	0	0	3
5.	23ECE05	CAD for VLSI Design	PE	3	3	0	0	3

Embedded Systems Domain								
6.	23ECE06	System on Chip Design	PE	3	3	0	0	3
7.	23ECE07	Embedded and RTOS	PE	3	3	0	0	3
8.	23ECE08	Automotive Embedded Systems	PE	3	3	0	0	3
9.	23ECE09	Sensors and Actuators	PE	3	3	0	0	3
10.	23ECE10	Processor Architectures and Interfaces	PE	3	3	0	0	3
Communication Systems Domain								
11.	23ECE11	Massive MIMO Networks	PE	3	3	0	0	3
12.	23ECE12	Optical Communication	PE	3	3	0	0	3
13.	23ECE13	Millimeter Wave Communication	PE	3	3	0	0	3
14.	23ECE14	Information Theory and Coding	PE	3	3	0	0	3
15.	23ECE15	5G / 6G Technologies	PE	3	3	0	0	3
Robotics and Automation Domain								
16.	23ECE16	Underwater Navigation Systems	PE	3	3	0	0	3
17.	23ECE17	Robotic Process Automation	PE	3	3	0	0	3
18.	23ECE18	Natural Language Processing	PE	3	3	0	0	3
19.	23ECE19	Unmanned Aerial Vehicle	PE	3	3	0	0	3
20.	23ECE20	Virtual Reality and Augmented Reality	PE	3	3	0	0	3
Biomedical Systems Domain								
21.	23ECE21	Biomedical Engineering	PE	3	3	0	0	3
22.	23ECE22	Bioinformatics	PE	3	3	0	0	3
23.	23ECE23	Human Assist Devices	PE	3	3	0	0	3
24.	23ECE24	BioMEMS and Sensors	PE	3	3	0	0	3
25.	23ECE25	Body Area Networks	PE	3	3	0	0	3
Computer Architectures Domain								
26.	23ECE26	Computer Networks	PE	3	3	0	0	3
27.	23ECE27	Computer Architectures and Organizations	PE	3	3	0	0	3
28.	23ECE28	Human Computer Interfaces	PE	3	3	0	0	3
29.	23ECE29	Cyber Security and Privacy	PE	3	3	0	0	3
30.	23ECE30	Software Defined Networks	PE	3	3	0	0	3
Signal and Imaging Domain								
31.	23ECE31	Medical Imaging and Processing	PE	3	3	0	0	3
32.	23ECE32	Remote Sensing and GIS	PE	3	3	0	0	3
33.	23ECE33	Speech Recognization and Audio Processing	PE	3	3	0	0	3
34.	23ECE34	Multimedia Signal Processing	PE	3	3	0	0	3
35.	23ECE35	Computer Vision	PE	3	3	0	0	3
Industry and Management Domain								
36.	23ECE36	System Design For Sustainability	PE	3	3	0	0	3

37.	23ECE37	Innovation, Business Models and Entrepreneurship	PE	3	3	0	0	3
38.	23ECE38	Industry 4.0 and Industrial IoT	PE	3	3	0	0	3
39.	23ECE39	Knowledge Management	PE	3	3	0	0	3
40.	23ECE40	Project Management	PE	3	3	0	0	3

VI Employability Enhancement Courses (EEC)

1.	23ECP01	Mini Project	EEC	2	0	0	2	1
2.	23ECP02	Industrial Training	EEC	6	0	0	6	3
3.	23ECP03	Project Work	EEC	24	0	0	24	12
4.	23ECP04	Presentation Skill and Technical Seminar	EEC	2	0	0	2	1
5.	23ECP05	Innovative Practices	EEC	2	0	0	0	1
6.	23ECP06	Internship – I	EEC	0	0	0	0	1
7.	23ECP07	Internship – II	EEC	0	0	0	0	1
8.	23ECP08	Professional Skills for Electronics Engineers	EEC	2	0	0	2	1

VII Mandatory Courses (MC)

1.	23ECM01	Indian Constitution	MC	2	2	0	0	0
2.	23ECM02	Essence of Indian Traditional Knowledge	MC	2	2	0	0	0

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		L	T	P	C
23ECE01	**MIXED SIGNAL IC DESIGN**	**3**	**0**	**0**	**3**

Course Objective:

- To carried out by making extensive use Computer Aided Design (CAD) VLSI design tool
- To understand the operation of the CAD VLSI design tools
- To teach the concepts of floor planning
- To learn the concept of modeling a digital system using HDL
- To impart the knowledge of different types of modelling and synthesis

Course Outcomes:

23ECE01.CO1 Apply the concepts for mixed signal MOS circuit.

23ECE01.CO2 Analyze the characteristics of IC based CMOS filters.

23ECE01.CO3 Design of various data converter architecture circuits.

23ECE01.CO4 Analyze the signal to noise ratio and modeling of mixed signals.

23ECE01.CO5 Design of oscillators and phase lock loop circuit.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE01.CO1	x	x	x	x	x				x				x		
23ECE01.CO2	x	x	x	x	x				x			x	x		
23ECE01.CO3	x	x	x	x	x						x	x		x	x
23ECE01.CO4	x	x	x	x					x		x	x		x	x
23ECE01.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I SUBMICRON CMOS CIRCUIT DESIGN **9**

Submicron CMOS: Overview and Models, CMOS process flow, Capacitors and Resistors. Digital circuit design: The MOSFET Switch, Delay Elements, An Adder. Analog Circuit Design: Biasing, Op-Amp Design, Circuit Noise.

Unit-II INTEGRATOR BASED CMOS FILTERS **9**

Integrator Building Blocks- low pass filter, Active RC integrators, MOSFET-C Integrators, gm- C integrators, Discrete time integrators. Filtering Topologies: The Bilinear transfer function, The Biquadratic transfer function, Filters using Noise shaping.

Unit-III DATA CONVERTER ARCHITECTURES **9**

DAC Architectures- Resistor string, R-2R ladder Networks, Current Steering, Charge Scaling DACs, Cyclic DAC, and Pipeline DAC. ADC Architectures- Flash, Two-step flash ADC, Pipeline ADC, Integrating ADC's, Successive Approximation ADC.

Unit-IV DATA CONVERTER MODELING AND SNR 9

Sampling and Aliasing: A modeling approach, Impulse sampling, The sample and Hold, Quantization noise. Data converter SNR: An overview, Clock Jitter, Improving SNR using Averaging, Decimating filter for ADCs, Interpolating filter for DACs, Band pass and High pass sinc filters - Using feedback to improve SNR..

Unit-V OSCILLATORS AND PLL 9

LC oscillators, Voltage Controlled Oscillators. Simple PLL, Charge pumps PLLs, Non ideal effects in PLLs, Delay Locked Loops.

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	R.Jacob Baker	Algorithmic and Knowledge Based CAD for VLSI	Wiley	2008
2.	Behzad Razavi	Design of Analog CMOS Integrated Circuits	McGraw Hill	2016

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	R.Jacob Baker	CMOS Circuit Design, Layout and Sim-Ulation	Wiley	2009
2.	Razavi	Principles of data conversion system de-Sign	Wiley IEEE Press	1994
3.	Jacob Baker	CMOS Mixed-Signal circuit design	IEEE Press	2009
4.	Gregorian, Temes	Analog MOS Integrated Circuit for sig-nal processing	John Wiley & Sons	1986
5.	Baker, Li, Boyce	CMOS: Circuit Design, layout and Sim-Ulation	PHI	2000

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		L	T	P	C
23ECE02	**LOW POWER VLSI DESIGN**	**3**	**0**	**0**	**3**

Course Objective:

- To understand different sources of power dissipation in CMOS & MIS Structure
- To understand the different types of low power adders and multipliers
- To focus on synthesis of different level low power transforms
- To gain knowledge on power estimation techniques
- To understand synthesis for low power

Course Outcomes:

23ECE02.CO1 Explain different source of power dissipation and the factors involved in it

23ECE02.CO2 Discuss the power optimization techniques used in adder and multiplier circuit

23ECE02.CO3 Design low power circuits

23ECE02.CO4 Analyze power consumption in VLSI Circuits

23ECE02.CO5 Use software tools for designing low power circuits

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE02.CO1	x	x	x	x	x				x				x		
23ECE02.CO2	x	x	x	x	x				x			x	x		
23ECE02.CO3	x	x	x	x	x						x	x		x	x
23ECE02.CO4	x	x	x	x					x		x	x		x	x
23ECE02.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I POWER DISSIPATION **9**

Hierarchy of limits of power-Sources of Power Consumption-Physics of power dissipation in CMOS FET devices-Basic principles of low power design, power Dissipation in domino CMOS-Low power VLSI Design Limits

Unit-II POWER OPTIMIZATION **9**

Logic level power Optimization-Circuit level low power design-circuit techniques for reducing power consumption in adders and multipliers

Unit-III DESIGN OF LOW POWER CIRCUITS **9**

Computer Arithmetic techniques for low power system – reducing power consumption in memories-low power clock-inter connect and layout design – Advanced Techniques – special techniques

Unit-IV POWER ESTIMATION **9**

Power Estimation techniques – logic power estimation – Simulation power analysis –Probabilistic power analysis.

Unit-V SYNTHESIS AND SOFTWARE DESIGN FOR LOW POWER **9**

Synthesis for low power – Behavioral level transform – software design for low power

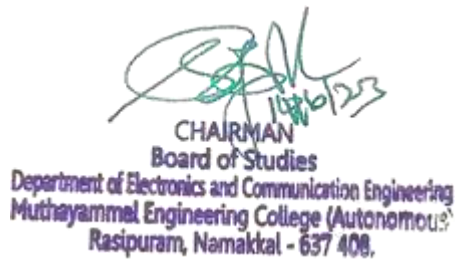
Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Kaushik Roy and S.C.Prasad	Low power CMOS VLSI circuit design	Wiely	2000
2.	Kiat Seng Yeo, Kaushik Roy	Low Voltage, Low Power VLSI Sub System	Tata McGraw Hill	2004

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Gary Yeap	Practical Low Power Digital VLSI De-Sign	Spring-er	1998
2.	Dimitrios Soudris, Chirstian Pignet, Costas Goutis	Designing CMOS Circuits for Low Power	Kluwer	2002
3.	J.B.Kulo and J.H Lou	Low voltage CMOS VLSI Circuits	Wiley	1999
4.	A.P.Chandrasekaran and R.W.Broadersen	Low power digital CMOS design	Kluwer	1995
5.	James B.Kulo, Shih-Chia Lin	Low voltage SOI CMOS VLSI devices and Circuits	John Wiley	2001



		L	T	P	C
23ECE03	**RECONFIGURABLE COMPUTING USING FPGAs**	**3**	**0**	**0**	**3**

Course Objective:

- To familiarize the need and role of reconfigurable processor
- To introduce the reconfigurable processor technologies
- To teach the salient features and architecture of FPGA
- To learn the concept of modeling a digital system using HDL
- To gain knowledge of Reconfigurable embedded processor for real time applications

Course Outcomes:

23ECE03.CO1 Explain the need of reconfigurable computing and hardware-software co design

23ECE03.CO2 Explain the significance of FPGA technology

23ECE03.CO3 Apply the concept of FPGA technology and understand FPGA Architecture

23ECE03.CO4 Design an application using Verilog HDL

23ECE03.CO5 Explain the upgradation on reconfigurable computing and SoC design

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE03.CO1	x	x	x	x	x								x		
23ECE03.CO2	x	x	x	x	x							x	x		
23ECE03.CO3	x	x	x	x	x						x	x		x	x
23ECE03.CO4	x	x	x	x	x				x		x	x		x	x
23ECE03.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I INTRODUCTION **9**

Introduction to reconfigurable processor-Reconfigurable Computing-Programming elements and Programming tools for reconfigurable processors, ASIC Design flow – Hardware / Software Co-design -FPGA Architecture overview -Recent trends in Reconfigurable processor and SoC

Unit-II FPGA TECHNOLOGIES **9**

FPGA Programming technology-Alternative FPGA Architecture: MUX Vs LUT based logic blocks-CLB Vs LAB Vs Slices – Fast Carry Chains – Embedded RAMs – Routing for FPGAs-Circuit and Architecture for low power FPGAs - physical design

Unit-III FPGA ARCHITECTURE **9**

Hybrid architectures- Communication - HW/SW partitioning - Soft-core microprocessors- System architectures - System design strategies - System services - Small-scale architectures - HPC architectures - HPEC architectures - System synthesis - Architectural design space explorations

Unit-IV VERILOG HDL DESIGN PROGRAMMING **9**

Basic Concepts : VLSI Design flow, Modeling – Structural Gate Level Modeling, Switch level modeling, Behavioral and RTL Modeling-Design Examples: Combinational Logic-Multiplexer , Binary Decoder, Comparator, Sequential Logic-Flip flops, Registers, Counters and Memory

Unit-V CASE STUDIES **9**

Signal and image processing - Bioinformatics - Security - Special Topics - Partial Reconfiguration - Numerical Analysis -Performance Analysis/Prediction - Fault Tolerance

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Nurmi,Jari(Ed.)	Processor Design System on Chip Computing for ASICs and FPGAs	Springer	2007
2.	Ian Grout	Digital System Design with FPGAs and CPLDs	Elsevier	2008

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Scott Hauck and Andre DeHon	Reconfigurable Computing :The theory and Practice of FPGA based Computation	Morgan Kauf-mann	2008
2.	Ron Sass and Anderew G.Schmidt	Embedded System design with platform FPGAs: Principles and Practices	Elsevier	2010
3.	Steve Kilts	Advanced FPGA Design: Architecture , Implementation and Organization	Wiley	2007
4.	Pierre Emmanuel Gaillardon	Reconfigurable Logic: Architecture, Tools and Applications	CRC Press	2015
5.	Joao Cardoso Michael Hunber	Reconfigurable Computing from FPGAs to Hardware/Software Codesign	Springer	2011

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23ECE04	IC FABRICATION TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

- To get the knowledge in device and integrated circuits (IC's) fabrication
- To understand the modules of device fabrication techniques
- To model integrated circuits based on processing parameters
- To modify integrated circuit fabrication processes to improve device performance
- To disseminate knowledge about novel VLSI devices

Course Outcomes:

23ECE04.CO1 Recognize the basic operation principles of semiconductor fabrication equipment

23ECE04.CO2 Explain the process modules available in IC fabrication

23ECE04.CO3 Design process flows of IC fabrication technologies

23ECE04.CO4 Evaluate effects of process parameters on final transistor characteristics

23ECE04.CO5 Apply the measurement skills for microelectronic devices and IC characterization

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE04.C01	x	x	x										x		
23ECE04.C02	x	x	x									x	x		
23ECE04.CO3	x	x	x	x	x						x	x		x	x
23ECE04.CO4	x	x	x	x	x				x		x	x		x	x
23ECE04.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I ENVIRONMENT AND CRYSTAL GROWTH FOR VLSI TECHNOLOGY 9

Environment: Semiconductor technology trend, Clean rooms, Wafer cleaning, **Semiconductor Substrate**: Phase diagram and solid solubility, Crystal structure, Crystal defects, Czochralski growth, Bridgman growth of GaAs, Float Zone growth, Wafer Preparation and specifications

Unit-II FABRICATION PROCESSES 9

Deposition: Evaporation, Sputtering and Chemical Vapor Deposition, **Epitaxy:** Molecular Beam Epitaxy, Vapor Phase Epitaxy, Liquid Phase Epitaxy, Evaluation of epitaxial layers, **Silicon Oxidation:** Thermal oxidation process, Kinetics of growth, Properties of Silicon Dioxide, Oxide Quality, high κ and low κ dielectrics, **Diffusion:** Nature of diffusion, Diffusion in a concentration gradient, diffusion equation, impurity behavior, diffusion systems, problems in diffusion, evaluation of diffused layers, **Ion Implantation:** Penetration range, ion implantation systems, process considerations, implantation damage and annealing

Unit-III LITHOGRAPHY **9**

Etching: Wet chemical etching, dry physical etching, dry chemical etching, reactive ion etching, ion beam techniques **Lithography**: Photoreactive materials, Pattern generation and mask making, pattern transfer, Electron beam, Ion beam and X-ray lithography **Device Isolation, Contacts and Metallization**: Junction and oxide isolation, LOCOS, trench isolation, Schottky contacts, Ohmic contacts, Metallization and Packaging **CMOS Process Flow**: N well, P-well and Twin tub Design rules, Layout of MOS based circuits (gates and combinational logic), Buried and Butting Contact

Unit-IV MEASUREMENTS, PACKAGING AND TESTING **9**

Semiconductor Measurements: Conductivity type, Resistivity, Hall Effect Measurements, Drift Mobility, Minority Carrier Lifetime and diffusion length **Packaging**: Integrated circuit packages, Electronics package reliability **Testing**: Technology trends affecting testing, VLSI testing process and test equipment, test economics and product quality

Unit-V MODELLING AND SYNTHESIS **9**

SOI Technology: SOI fabrication using SIMOX, Bonded SOI and Smart Cut, PD SOI and FD SOI Device structure and their features **GaAs Technologies**: MESFET Technology, Digital Technologies, MMIC technologies, MODFET and Optoelectronic Devices **Silicon Bipolar Technologies**: Second order effects in bipolar transistor, Performance of BJT, Bipolar processes and BiCMOS

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	S. M. Sze	Semiconductor devices: physics and technology	Wiley, 2nd ed	2002
2.	G. S. May, S. M. Sze	Fundamentals of semiconductor fabrication	Wiley	2003

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	James D. Plummer, Michael Deal and Peter B. Griffin	Silicon VLSI technology: fundamentals, practice and modeling	Prentice Hall	2000
2.	Stephen A. Campbell	The science and engineering of microelec- tronic fabrication	Oxford Univer- sity Press, 2nd ed.	2001
3.	Shubham Kumar, Ankaj Gupta	Integrated Circuit Fabrication	CRC Press	2021
4.	Dawon Kahng	Silicon Integrated Circuits: Advances in Materials and Device Research	Academic Press	-
5.	Chenming Hu	Modern Semiconductor Devices for Inte- grated Circuits	Pearson	2009

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		L	T	P	C
23ECE05	**CAD FOR VLSI DESIGN**	**3**	**0**	**0**	**3**

Course Objective:

- To gain knowledge on Computer Aided Design (CAD) VLSI design tool
- To understand the operation of the CAD VLSI design for VLSI design
- To teach the concepts of floor planning
- To learn the concept of modeling a digital system using HDL
- To impart the knowledge of different types of modelling and synthesis

Course Outcomes:

23ECE05.CO1 Demonstrate knowledge and understanding of fundamental concepts in CAD

23ECE05.CO2 Demonstrate knowledge of computational and optimization algorithms

23ECE05.CO3 Apply the concept of floor planning and understand the concepts

23ECE05.CO4 Establish capability for CAD tool development and enhancement.

23ECE05.CO5 Design Backend Process using CAD Tools

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE05.CO1	x	x	x	x	x				x				x		
23ECE05.CO2	x	x	x	x	x				x			x	x		
23ECE05.CO3	x	x	x	x	x						x	x		x	x
23ECE05.CO4	x	x	x	x	x				x		x	x		x	x
23ECE05.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I VLSI DESIGN METHODOLOGIES **9**

Introduction to VLSI Design methodologies - Review of Data structures and algorithms - Review of VLSI Design automation tools - Algorithmic Graph Theory and Computational Complexity – Tractable and Intractable problems general purpose methods for combinatorial optimization.

Unit-II DESIGN RULES **9**

Layout Compaction - Design rules - problem formulation - algorithms for constraint graph compaction-placement and partitioning - Circuit representation - Placement algorithms – partitioning

Unit-III FLOOR PLANNING **9**

Floor planning concepts - shape functions and floor plan sizing - Types of local routing problems -Area routing - channel routing - global routing - algorithms for global routing.

Unit-IV SIMULATION **9**

Simulation - Gate-level modeling and simulation - Switch-level modeling and simulation - Combinational Logic Synthesis - Binary Decision Diagrams - Two Level Logic Synthesis.

Unit-V MODELLING AND SYNTHESIS **9**

High level Synthesis - Hardware models - Internal representation - Allocation assignment and scheduling - Simple scheduling algorithm - Assignment problem - High level transformations.

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	S.H. Gerez	Algorithms for VLSI Design Automation	John Wiley & Sons	2002
2.	N.A. Sherwani	Algorithms for VLSI Physical Design Automation	Kluwer Academic Publishers	2002

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Gaynor E. Taylor, G. Russell	Algorithmic and Knowledge Based CAD for VLSI	Peter peregrinus ltd	2002
2.	De Micheli, G	Synthesis and Optimization of Digital Circuits	McGraw Hill	1994
3.	Devadas, S. A., Abhijith Ghosh, A., and Keutzer, K	Logic Synthesis	Kluwer Academic	1998
4.	Brunvand, E.,	Digital VLSI Chip Design with Ca- dence and Synopsys CAD Tools	Addison-Wesley	2010
5.	Nowick, S. M., Bhardwaj, K	Computer-Aided Design of Digital Systems	Columbia University	2016

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23ECE06	**SYSTEM ON CHIP DESIGN**	**3**	**0**	**0**	**3**

Course Objective:

- To learn System on chip fundamentals
- To gain knowledge on NOC design
- To learn the various Computation models of SOCs
- To understand the performance and power of electronics systems on chip
- To understand the real chip implementation

Course Outcomes:

23ECE06.CO1 Explain the design concepts of SoC

23ECE06.CO2 Explain the SoC models in computation and co design.

23ECE06.CO3 Explain communication and networking of SoC

23ECE06.CO4 Design low power NoC circuits

23ECE06.CO5 Apply the NoC/SoC concepts in real time chip implementation

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE06.CO1	x	x	x	x	x				x				x		
23ECE06.CO2	x	x	x	x	x				x			x	x		
23ECE06.CO3	x	x	x	x	x				x		x	x		x	x
23ECE06.CO4	x	x	x	x	x				x		x	x		x	x
23ECE06.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I INTRODUCTION **9**

Introduction to SoC Design., Platform-Based SoC Design., Multiprocessor SoC and Network on Chip, Low-Power SoC Design

Unit-II SYSTEM DESIGN WITH MODEL OF COMPUTATION AND CO-DESIGN **9**

System Models, Validation and Verification, Hardware/Software Codesign Application Analysis, Synthesis

Unit-III COMPUTATION–COMMUNICATION PARTITIONING AND NETWORK ON CHIP-BASED SOC **9**

Communication System: Current Trend, Separation of Communication and Computation. Communication-Centric SoC Design, Communication Synthesis, Network-Based Design, Network on Chip, Architecture of NoC

Unit-IV NOC DESIGN **9**

Practical Design of NoC, NoC Topology-Analysis Methodology, Energy Exploration, NoC Protocol Design, Low-Power Design for NoC: Low-Power Signaling, On-Chip Serialization, Low-Power Clocking, Low-Power Channel Coding, Low-Power Switch, Low-Power Network on Chip Protocol

Unit-V NOC /SOC CASE STUDIES **9**

Real Chip Implementation-BONE Series-,BONE 1-4, Industrial Implementations-,Intel's Tera-FLOP 80-Core NoC, Intel's Scalable Communication Architecture, Academic Implementations-FAUST, RAW;design case study of SoC – digital camera.

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Hoi-jun yoo, Kangmin Lee, Jun Kyoung kim,	Low power NoC for high performance SoC design	CRC press	2008
2.	Vijay K. Madisetti Chonlameth Arpikanondt	A Platform-Centric Approach to System-on-Chip (SOC) Design	Springer	2005

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Michael J. Flynn and Wayne Luk	Computer System Design: System-on- Chip	Wiley India Pvt. Ltd	2011
2.	Steve Furber	ARM System on Chip Architecture	Addison Wesley Professional	2000
3.	Ricardo Reis	Design of System on a Chip: Devices and Components	Springer	2004
4.	Jason Andrews	Co-Verification of Hardware and Software for ARM System on Chip Design	Newnes	2004
5.	Prakash Rashinkar, Peter Paterson and Leena Singh L	System on Chip Verification – Methodologies and Techniques	Kluwer Academic Publishers	2001

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23ECE07	**EMBEDDED AND RTOS**	**3**	**0**	**0**	**3**

Course Objective:

- To understand the basic concepts of embedded systems
- To provide different architectural features of embedded systems
- To understand the goal embedded systems in real time design applications
- To Understand the concepts of Real Time Operating System
- To understand the RTOS based system design

Course Outcomes:

23ECE07.CO1 Explain the basic concepts of embedded systems.

23ECE07.CO2 Illustrate the different architectural features of embedded systems

23ECE07.CO3 Identify the Embedded Firmware components.

23ECE07.CO4 Summarize the concepts of Real Time Operating System

23ECE07.CO5 Demonstrate the embedded system application

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE07.CO1	x	x	x	x	x								x		
23ECE07.CO2	x	x	x	x								x	x		
23ECE07.CO3	x	x		x	x				x		x	x		x	x
23ECE07.CO4	x	x	x	x					x		x	x		x	x
23ECE07.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I INTRODUCTION **9**

Introduction to Embedded Systems Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.

Unit-II TYPICAL EMBEDDED SYSTEM **9**

Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators.

Unit-III EMBEDDED FIRMWARE **9**

Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.

Unit-IV REAL TIME OPERATING SYSTEMS **9**

Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, asks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue.

Unit-V RTOS BASED EMBEDDED SYSTEM DESIGN **9**

Case Studies of RTOS RT Linux, MicroC/OS-II, Vx Works: Digital camera, washing machine, cell phones, home security systems, finger print identifiers, printers, automated teller machine, software modem, audio player.

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Shibu K.V	Introduction to Embedded Systems	Tata McGraw Hill	2009
2.	David E. Simon	An Embedded Software Primer	Pearson Education	2009

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Dr. K.V. K. K. Prasad	Embedded Real Time System: Concepts, Design and Programming	Dreamtech	2014
2.	Rajkamal	Embedded Systems: Architecture, Programming and Design	Tata McGraw Hill	2015
3.	Frank Vahid, Tony Givargis	Embedded System Design – A Unified Hardware/Software Introduction	John Wiley & Sons	2002
4.	Abraham Silberchatz, Peter B. Galvin, Greg Gagne	Operating System Principles	Wiley Student Edition	2015
5.	Qing Li	Real Time Concepts for Embedded Systems	Elsevier	2011

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23ECE08	**AUTOMOTIVE EMBEDDED SYSTEMS**	**3**	**0**	**0**	**3**

Course Objective:

- To understand the concepts of automotive system in industries
- To understand the sensors and actuator mechanisms
- To know the internal structure of microcontrollers
- To know the various communication system protocols for automotive applications
- To gain the knowledge on automotive control system

Course Outcomes:

23ECE08.CO1 Explain the automotive system and design cycle

23ECE08.CO2 Design automotive sensors and actuators circuits

23ECE08.CO3 Choose the proper microcontroller for automotive domain

23ECE08.CO4 Explain the communication protocols relevant to automotive domain

23ECE08.CO5 Design Automotive Control Systems using CAD tools

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE08.CO1	x												x		
23ECE08.CO2	x	x	x	x								x	x		
23ECE08.CO3	x	x	x	x							x	x		x	x
23ECE08.CO4	x	x	x	x	x						x	x		x	x
23ECE08.CO5	x	x	x	x	x						x	x		x	x

Unit-I AUTOMOTIVE SYSTEMS, DESIGN CYCLE AND AUTOMOTIVE INDUSTRY OVERVIEW 9

Overview of Automotive Industry: Leading players, automotive supply chain, Global challenges, Role of technology in Automotive Electronics and interdisciplinary design, Tools and processes. Introduction to Modern Automotive Systems and need for electronics in automobiles and application areas of electronic systems in modern automobiles, Spark and Compression Ignition Engines.

Unit-II AUTOMOTIVE SENSORS AND ACTUATORS 9

Systems Approach to Control and Instrumentation: Concept of a system, Analog and digital systems, Basic measurement systems, Analog and digital signal processing, Sensors, Sensor characteristics, Sensor response, Sensor error, Redundancy of sensors in ECUs, Avoiding redundancy, Sensor modeling, Smart Nodes.

Unit-III MICROCONTROLLER/MICROPROCESSOR IN AUTOMOTIVE DOMAIN 9

Critical review and overview of development within the automotive context of microprocessors, microcontrollers and digital signal processors (architecture of 8/16 bit microcontrollers with emphasis on Ports, Timer/Counters, Interrupts, Watchdog timers and PWM). Criteria to choose the right microcontroller/processor for various automotive applications. Understanding various architectural attributes relevant to automotive applications

Unit-IV COMMUNICATION PROTOCOLS, INFOTAINMENT SYSTEMS 9

Communication protocols: Overview of automotive communication protocols, CAN, LIN , Flex Ray, MOST , Ethernet, D2B and DSI, Communication interface with ECUs, Interfacing techniques and Interfacing with infotainment gadgets, Relevance of Protocols such as TCP/IP for automotive applications, Wireless LAN standards such as Bluetooth, IEEE 802.11x communication protocols for automotive applications. Infotainment Systems: Application of telematics in automotive domain, Global positioning systems (GPS) and General packet radio service (GPRS).

Unit-V AUTOMATIVE CONTROL SYSTEM AND MODEL BASED DEVELOPMENT 9

Automotive Control System & Model Based Development: Control system approach in Automotive Electronics, Analog and digital control methods, Modelling of linear systems, System responses, Modelling of Automotive Systems with simple examples. Model based Development: Introduction to MATLAB, Simulink and SIMSCAPE tool boxes.

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Williams. B. Ribbens	Understanding Automotive Electronics	Elsevier Science, Newnes	2003
2.	Robert Bosch	Automotive Electronics Handbook	John Wiley and Sons	2004

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Terence Rybak & Mark Stefika	Automotive Electromagnetic Compatibility (EMC)	Springer	2004
2.	Uwe Kieneke and Lars Nielsen	Automotive Control Systems: Engine, Driveline and Vehicle	Springer Verlag	2005
3.	Tom Denton	Advanced Automotive Diagnosis	Elsevier	2006
4.	G. Meyer, J. Valldorf and W. Gessner	Advanced Microsystems for Automotive Applications	Springer	2009
5.	Mehrdad Ebsani, Ali Emadi & Yimin Gao	Modern Electronic Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design	CRC Press	2009

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		L	T	P	C
23ECE09	**SENSORS AND ACTUATORS**	**3**	**0**	**0**	**3**

Course Objective:

- To know the characteristics of transducers and sensors
- To know the working of motion and pressure sensor
- To understand the working of force and magnetic sensor
- To understand the working of optical, pressure and temperature sensors
- To know the basics of signal conditioning and DAQ system

Course Outcomes:

23ECE09.CO1 Explain the automotive system and design cycle

23ECE09.CO2 Design automotive sensors and actuators circuits

23ECE09.CO3 Choose the proper microcontroller for automotive domain

23ECE09.CO4 Explain the communication protocols relevant to automotive domain

23ECE09.CO5 Design Automotive Control Systems using CAD tools

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE09.CO1	x	x	x	x									x		
23ECE09.CO2	x	x	x	x								x	x		
23ECE09.CO3	x	x	x	x	x						x	x		x	x
23ECE09.CO4	x	x	x	x	x						x	x		x	x
23ECE09.CO5	x	x	x	x	x						x	x		x	x

Unit-I INTRODUCTION **9**

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types

Unit-II MOTION, PROXIMITY AND RANGING SENSORS **9**

Motion Sensors – Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer.,– GPS, Bluetooth, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR). Recent Trends – Smart Pressure Transmitters

Unit-III FORCE, MAGNETIC AND HEADING SENSORS 9

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

Unit-IV OPTICAL, PRESSURE AND TEMPERATURE SENSORS 9

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

Unit-V SIGNAL CONDITIONING and DAQ SYSTEMS 9

Introduction, Functions of Signal Conditioning Equipment ,Amplification – Filtering – Sample and Hold circuits – Data Acquisition: Single channel and multi channel data acquisition – Data logging - applications - Automobile, Aerospace, Home appliances, Manufacturing, Environmental monitoring.

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Ernest O Doebelin	Measurement Systems – Applications and Design	McGraw-Hill International Edition	2009
2.	Sawney A K and Puneet Sawney	A Course in Mechanical Measurements and Instrumentation and Control	12th edition, Dhanpat Rai & Co, New Delhi	2013

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Patranabis D	Sensors and Transducers	PHI, New Delhi	2010
2.	John Turner and Martyn Hill	Instrumentation for Engineers and Scientists	Oxford Science Publications	1999
3.	Richard Zurawski	Industrial Communication Technology Handbook	CRC Press	2015
4.	D.V.S. Moorthy	Transducers and Instrumentation	Prentice Hall of India Pvt Ltd	2007
5.	Kalsi HS	Electronic Instrumentation	Tata McGraw Hill	2004

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23ECE10	**PROCESSOR ARCHITECTURES AND INTERFACES**	**3**	**0**	**0**	**3**

Course Objective:

- To understand the different processor architectures and interfaces
- To know about the various peripheral devices for embedded processors
- To get knowledge on programming languages for embedded systems
- To practice with embedded IDE software and embedded hardware
- To understand the Arduino architecture

Course Outcomes:

23ECE10.CO1 Understand MSP430 Microcontroller Architectures and Hardware Peripherals

23ECE10.CO2 Execute the Programming Languages on MSP430 Microcontroller

23ECE10.CO3 Implement Communication Peripherals on MSP430 Microcontroller

23ECE10.CO4 Identify ATmega328p Architecture Components and Interfaces

23ECE10.CO5 Experiment the given tasks using Arduino Embedded Boards

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE10.CO1	x	x	x	x	x								x		
23ECE10.CO2	x	x	x	x	x							x	x		
23ECE10.CO3	x	x	x	x	x						x	x		x	x
23ECE10.CO4	x	x	x	x	x						x	x		x	x
23ECE10.CO5	x	x	x	x	x						x	x		x	x

Unit-I MSP 430 ARCHITECTURES **9**

Small Microcontrollers – Software – MSP430: Functional Block Diagram, Memory, CPU, Addressing Modes, Instruction Set, Resets, Memory Mapped I/O, Clock Generator, Exceptions - C Programming Language - Assembly Language - Programming and Debugging - Light LEDs in C & Assembly Language - Read Input from a Switch.

Unit-II FUNCTIONS, INTERRUPTS, AND I/OS IN MSP430 **9**

Functions and Subroutines - Storage for Local Variables - Mixing C and Assembly Language – Interrupts - Interrupt Service Routines - Low-Power Modes of Operation – Digital I/Os - Switch Debounce - Interface between 3V and 5V Systems - Driving Heavier Loads – LCD – Timers: Watchdog Timer, Basic Timer1 – Timer-A, Timer- B.

Unit-III COMMUNICATIONS FOR MSP430 **9**

Communication Peripherals in the MSP430 - Serial Peripheral Interface – Thermometer Interface using SPI - Inter- integrated Circuit Bus – I2C Interfaces - State Machines for I^2C Communication - Asynchronous Serial Communication – UART

Unit-IV ATMEGA328P **9**

AVR ATmega328p Architecture – Arduino UNO Board – Arduino IDE – Sketch – C Language for Arduino – Numeric Variables and Arithmetic, Commands - Functions – Variables – Arrays and Strings - Experiments in C - Standard Arduino Library - C++ and Libraries.

Unit-V ARDUINO HARDWARE **9**

Data Storage: Constants, PROGMEM Directive, EEPROM, Clearing the Contents of EEPROM, Compression - LCD Displays - Arduino Ethernet - Arduino as a Web Server – Arduino Programming using Sensors.

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	John H. Davies	MSP430 Microcontroller Basics	Newnes Press	2008
2.	Simon Monk	Programming Arduino: Getting Started with Sketches	McGraw-Hil	2012

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	John H. Davies	MSP430 Microcontroller Basics	Newnes Press	2008
2.	Simon Monk	Programming Arduino: Getting Started with Sketches	McGraw-Hil	2012
3.	John H. Davies	MSP430 Microcontroller Basics	Newnes Press	2008
4.	Simon Monk	Programming Arduino: Getting Started with Sketches	McGraw-Hil	2012

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		L	T	P	C
23ECE11	**MASSIVE MIMO NETWORKS**	**3**	**0**	**0**	**3**

Course Objective:

- To gain knowledge about massive MIMO networks
- To understand the massive MIMO propagation channels
- To learn about channel estimation in single cell massive MIMO systems
- To understand channel estimation in multicell massive MIMO systems
- To comprehend the MIMO deployment for single cell and multicell deployment

Course Outcomes:

23ECE11.CO1 To gain knowledge and explain massive MIMO networks

23ECE10.CO2 Analyze massive MIMO propagation channels and their capacity bounds

23ECE11.CO3 Examine channel estimation techniques for single cell system

23ECE11.CO4 Analyze channel estimation techniques for multi cell system

23ECE11.CO5 Explain the concepts underlining the deployment of single and multicell massive MIMO system.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE11.CO1	x	x											x		
23ECE10.CO2	x	x	x	x	x							x	x		
23ECE11.CO3	x	x	x	x	x	x					x	x		x	x
23ECE11.CO4	x	x	x	x	x	x					x	x		x	x
23ECE11.CO5	x	x	x	x	x	x					x	x		x	x

Unit-I MASSIVE MIMO NETWORKS **9**

Definition of Massive MIMO, Correlated Rayleigh Fading, System Model for Uplink and Downlink, Basic Impact of Spatial Channel Correlation, Channel Hardening and Favorable Propagation, Local Scattering Spatial Correlation Model

Unit-II THE MASSIVE MIMO PROPAGATION CHANNEL **9**

Favorable Propagation and Deterministic Channels-Capacity Upper Bound-Distance from Favorable Propagation- Favorable Propagation and Linear Processing-Singular Values and Favorable Propagation, Favorable Propagation and Random Channels-Independent Rayleigh Fading-Uniformly Random Line-of-Sight (UR-LoS)-Independent Rayleigh Fading versus UR-LoS - Finite-Dimensional Channels

Unit-III SINGLE-CELL SYSTEMS **9**

Uplink Pilots and Channel Estimation - Orthogonal Pilots- De-Spreading of the Received Pilot Signal-MMSE Channel Estimation, Uplink Data Transmission - Zero-Forcing -Maximum-Ratio, Downlink Data Transmission- Linear Precoding-Zero-Forcing-Maximum-Ratio, Discussion Interpretation of the Effective

SINR Expressions- Implications for Power Control-Scaling Laws and Upper Bounds on the SINR - Near-Optimality of Linear Processing when M >> K - Net Spectral Efficiency - Limiting Factors: Number of Antennas and Mobility

Unit-IV MULTI-CELL SYSTEMS **9**

Uplink Pilots and Channel Estimation, Uplink Data Transmission - Zero-Forcing -Maximum-Ratio, Downlink Data Transmission -Zero-Forcing - Maximum-Ratio, Discussion -Asymptotic Limits with Infinite Numbers of Base Station Antennas - The Effects of Pilot Contamination - Non-Synchronous Pilot Interference

Unit-V CASE STUDIES **9**

Single-Cell Deployment Example: Fixed Broadband Access in Rural Area, Multi-Cell Deployment: Preliminaries and Algorithms, Multi-Cell Deployment Examples: Mobile Access - Dense Urban 172 Scenario - Suburban Scenario Minimum Per-Terminal Throughput Performance -Additional Observations - Comparison of Power Control Policies

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Thomas L. Marzetta, Erik G. Larsson, Hong Yang, Hien Quoc Ngo	Fundamentals of Massive MIMO	Cambridge University Press	2016
2.	Emil Björnson, Jakob Hoydis and Luca Sanguinetti	Massive MIMO Networks: Spectral, Energy, and Hardware Efficiency	Foundations and Trends	2017

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Long Zhao, Hui Zhao, Kan Zheng	Wei Xiang Massive MIMO in 5G Networks: Selected Applications	Springer	2018
2.	Leibo Liu, Guiqiang Peng, Shaojun Wei	Massive MIMO Detection Algorithm and VLSI Architecture	Springer	2019
3.	Shahid Mumtaz, Jonathan Rodri- guez, Linglong Dai	mmWave Massive MIMO A Paradigm for 5G	Elsevier	2017
4.	Andrea Goldsmith, Anthony Constantinides, and Arogyaswami Paulraj	MIMO Wireless Communications	Cambridge University Press	2010
5.	Rakhesh Singh Kshetrimayum	Fundamentals of MIMO Wireless Communications	Cambridge University Press	2017

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23ECE12	**OPTICAL COMMUNICATION**	**3**	**0**	**0**	**3**

Course Objective:

- To Study the various optical fiber modes, configuration of optical fibers
- To Study transmission characteristics of optical fibers
- Gain knowledge on the modulation techniques for millimeter wave communications
- To Explore various idea about optical fiber measurements and various coupling techniques
- To Enrich the knowledge about optical communication systems and networks

Course Outcomes:

23ECE12.CO1 Realize basic elements in optical fibers, different modes and configurations.

23ECE12.CO2 Analyze the transmission characteristics associated with dispersion and polarization techniques.

23ECE12.CO3 Design optical sources and detectors with their use in optical communication system

23ECE12.CO4 Construct fiber optic receiver systems, measurements and techniques.

23ECE12.CO5 Design optical communication systems and its networks.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE12.CO1	x	x	x	x									x		
23ECE12.CO2	x	x	x	x								x	x		
23ECE12.CO3	x	x	x	x	x						x	x		x	x
23ECE12.CO4	x	x	x	x	x						x	x		x	x
23ECE12.CO5	x	x	x	x	x						x	x		x	x

Unit-I INTRODUCTION TO OPTICAL FIBERS **9**

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

Unit-II SIGNAL DEGRADATION OPTICAL FIBERS **9**

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

Unit-III FIBER OPTICAL SOURCES AND COUPLING 9

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

Unit-IV FIBER OPTIC RECEIVER AND MEASUREMENTS 9

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

Unit-V OPTICAL NETWORKS AND SYSTEM TRANSMISSION 9

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

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	D.Roy Choudhry, Shail Jain	Linear Integrated Circuits	New Age International Pvt. Ltd	2018
2.	Sedra and Smith	Microelectronic Circuits	Oxford University press	2005

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Ramakant A. Gayakwad	OP-AMP and Linear ICs	Prentice Hall / Pearson Education	2015
2.	Millman and Halkias. C	Integrated Electronics,	TMH	2009
3.	S.Salivahanan& V.S. Kanchana Bhaskaran	Linear Integrated Circuits‖	TMH	2016

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23ECE13	**MILLIMETER WAVE COMMUNICATION**	**3**	**0**	**0**	**3**

Course Objective:

- Understand the fundamentals of millimeter wave devices and circuits
- Gain knowledge on the millimeter wave devices and circuits
- Gain knowledge on the modulation techniques for millimeter wave communications
- Understand the concepts of MIMO system of millimeter wave communication Know
- the concepts of antenna used for millimeter wave communication

Course Outcomes:

23ECE13.CO1 Explain the basic concept of millimeter wave communication

23ECE13.CO2 Explain the operation of millimeter wave devices and circuits

23ECE13.CO3 Utilize the modulation schemes for millimeter wave Communications

23ECE13.CO4 Outline MIMO system for millimeter wave communication

23ECE13.CO5 Select the antenna for millimeter wave communication

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE13.CO1	x	x	x	x									x		
23ECE13.CO2	x	x	x	x								x	x		
23ECE13.CO3	x	x	x	x	x		x				x	x		x	x
23ECE13.CO4	x	x	x	x	x		x	x			x	x		x	x
23ECE13.CO5	x	x	x	x	x		x	x			x	x		x	x

Unit-I BASIC CONCEPTS **9**

Millimeter wave characteristics- millimeter wave wireless, implementation challenges, Radio wave propagation for mm wave: Large scale propagation channel effects, small scale channel effects, Outdoor and Indoor channel models, Long Distance Path Loss Model - Link Budget- Development of MMW standards - Emerging applications of millimeter wave communications

Unit-II MILLIMETER WAVE DEVICES AND CIRCUITS **9**

Millimeter wave generation and amplification: Peniotrons, Ubitrons, Gyrotrons and Free electron lasers. HEMT, models for mm wave Transistors, transistor configurations, Analog mm wave components: Amplifiers, Mixers, VCO, PLL. Metrics for analog mm wave devices, Consumption factor theory, Trends and architectures for mm wave wireless, ADC's and DAC's

Unit-III MILLIMETER WAVE COMMUNICATIN SYSTEMS 9

Critical review and overview of development within the automotive context of microprocessors, microcontrollers and digital signal processors (architecture of 8/16 bit microcontrollers with emphasis on Ports, Timer/Counters, Interrupts, Watchdog timers and PWM). Criteria to choose the right microcontroller/processor for various automotive applications. Understanding various architectural attributes relevant to automotive applications

Unit-IV COMMUNICATION PROTOCOLS, INFOTAINMENT SYSTEMS 9

Communication protocols: Overview of automotive communication protocols, CAN, LIN , Flex Ray, MOST , Ethernet, D2B and DSI, Communication interface with ECUs, Interfacing techniques and Interfacing with infotainment gadgets, Relevance of Protocols such as TCP/IP for automotive applications, Wireless LAN standards such as Bluetooth, IEEE 802.11x communication protocols for automotive applications. Infotainment Systems: Application of telematics in automotive domain, Global positioning systems (GPS) and General packet radio service (GPRS).

Unit-V AUTOMATIVE CONTROL SYSTEM AND MODEL BASED DEVELOPMENT 9

Automotive Control System & Model Based Development: Control system approach in Automotive Electronics, Analog and digital control methods, Modelling of linear systems, System responses, Modelling of Automotive Systems with simple examples. Model based Development: Introduction to MATLAB, Simulink and SIMSCAPE tool boxes.

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	K.C. Huang, Z. Wang	Millimeter Wave Communication Systems	Wiley-IEEE Press	2011
2.	Theodore S. Rappaport	Millimeter Wave Wireless Communication	Prentice Hall	2014

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Duixian Liu, Ulrich Pfeiffer, Janusz Grzyb, Brian Gaucher	Advance Millimeter-wave Technologies- Antennas, Packaging and Circuits	John Wiley & Sons Inc	2009
2.	Gernot Hueber	Millimeter-Wave Circuits for 5G and Radar	Cambridge University Press	2019
3.	Saurabh Sinha,	Millimeter-Wave Antennas: Configurations and Applications	Springer	2016
4.	Xiang, W; Zheng, K; Shen, X.S	5G Mobile Communications	Springer	2016
5	Apostolos Georgiadis	Microwave and Millimeter Wave Circuits and Systems - Emerging Design, Technologies and Applications	Wiley-Blackwell	2012

		L	T	P	C
23ECE14	**INFORMATION THEORY AND CODING**	**3**	**0**	**0**	**3**

Course Objective:

- To understand the fundamentals of information theory
- To describe the source coding and compression techniques
- To gain knowledge on error detection and correction handling
- To understand error control coding using Block codes
- To describe error control coding using Convolutional Codes

Course Outcomes:

23ECE14.CO1 Explain the concept of amplitude modulation and detection schemes

23ECE14.CO2 Explain the source coding of text, audio, and speech signals through various coding and compression techniques

23ECE14.CO3 Write the source coding of image and video signals through various coding and compression techniques

23ECE14.CO4 Apply Block codes for error detection and correction

23ECE14.CO5 Apply convolutional codes for error detection and correction

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE14.CO1	x	x											x		
23ECE14.CO2	x	x	x	x	x							x	x		
23ECE14.CO3	x	x	x	x	x						x	x		x	x
23ECE14.CO4	x	x	x	x	x						x	x		x	x
23ECE14.CO5	x	x	x	x	x						x	x		x	x

Unit-I INFORMATION THEORY INFORMATION THEORY **9**

Information – Entropy, Information rate, classification of codes, Kraft McMillan inequality, Source coding theorem, Shannon-Fano coding, Huffman coding, Extended Huffman coding - Joint and conditional entropies, Mutual information - Discrete memory less channels – BSC, BEC – Channel capacity, Shannon limit.

Unit-II SOURCE CODING: TEXT, AUDIO AND SPEECH **9**

Text: Adaptive Huffman Coding, Arithmetic Coding, LZW algorithm – Audio: Perceptual coding, Masking techniques, Psychoacoustic model, MPEG Audio layers I, II, III, Dolby AC3 - Speech: Channel Vocoder, Linear Predictive Coding

Unit-III SOURCE CODING: IMAGE AND VIDEO 9

Image and Video Formats – GIF, TIFF, SIF, CIF, QCIF – Image compression: READ, JPEG – Video Compression: Principles-I, B, P frames, Motion estimation, Motion compensation, H.261, MPEG standard

Unit-IV ERROR CONTROL CODING: BLOCK CODES 9

Definitions and Principles: Hamming weight, Hamming distance, Minimum distance decoding - Single paritycodes, Hamming codes, Repetition codes – Linear block codes, Cyclic codes - Syndrome calculation, Encoder and decoder – CRC

Unit-V ERROR CONTROL CODING: CONVOLUTIONAL CODES 9

Convolutional codes – code tree, trellis, state diagram - Encoding – Decoding: Sequential search and Viterbi algorithm – Principle of Turbo coding

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	R Bose	Information Theory, Coding and Crptography	TMH	2007
2.	Fred Halsall	Multidedia Communications: Applications, Networks, Protocols and Standards	Perason Education Asia	2002

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	K Sayood	Introduction to Data Compression	3rd Edition, Elsevier	2006
2.	S Gravano	Introduction to Error Control Codes	Oxford University Press	2007
3.	Tom Richardson, Rüdiger Ur- banke	Modern Coding Theory	Cambridge University Press	2008
4.	Ron Roth	Introduction to Coding Theory	Cambridge University Press	2006
5.	Shu Lin and Daniel Costello	Error Control Coding: Fundamentals and Applications	Prentice-Hall International	2004

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		L	T	P	C
23ECE15	**5G / 6G TECHNOLOGIES**	**3**	**0**	**0**	**3**

Course Objective:

- To get acquainted with the fundamentals of 5G networks
- To study the processes associated with 5G architecture
- To study spectrum sharing and spectrum trading
- To learn the security features in 5G networks
- To know about 6G techniques e.g. massive MIMO. mmWave etc

Course Outcomes:

23ECE15.CO1 Explain the concepts of 5G networks

23ECE15.CO2 Comprehend the 5G architecture and protocols

23ECE15.CO3 Understand the dynamic spectrum management.

23ECE15.CO4 Describe the security aspects in 5G networks

23ECE15.CO5 Explain 6G Key Enabling Techniques

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE15.CO1	x	x											x		
23ECE15.CO2	x	x	x	x	x							x	x		
23ECE15.CO3	x	x	x	x	x	x					x	x		x	x
23ECE15.CO4	x	x	x	x	x	x					x	x		x	x
23ECE15.CO5	x	x	x	x	x	x					x	x		x	x

Unit-I 5G CONCEPTS AND CHALLENGES 5G CONCEPTS AND CHALLENGES 9

Need for 5G. 4G versus 5G, Next Generation core (NG-core), visualized Evolved Packet core (vEPC) - Fundamentals of 5G technologies, overview of 5G core network architecture,5G new radio and cloud technologies, Radio Access Technologies (RATs), EPC for 5G.

Unit-II NETWORK ARCHITECTURE AND THE PROCESSES 9

5G architecture and core, network slicing, multi access edge computing (MEC)visualization of 5G components, end-to-end system architecture, service continuity, relation to EPC, and edge computing. 5G protocols: 5G NAS, NGAP, GTP-U, IPSec and GRE.

Unit-III DYNAMIC SPECTRUM MANAGEMENT AND MM-WAVES 9

Mobility management, Command and control, spectrum sharing and spectrum trading, cognitive radio based on 5G, millimeter waves.

Unit-IV SECURITY IN 5G NETWORKS **9**

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

Unit-V 6G KEY ENABLERS **9**

Wireless energy harvesting, machine learning - visible light communication - Intelligent reflecting surface (IRS), Extremely Large Aperture Massive MIMO, etc- Wireless energy harvesting: Energy-rate trade-off Simultaneous wireless information and power transfer (SWIPT), time-switching, power splitting Wireless powered communication networks Outage probability and throughput.

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Stephen Rommer	5G Core networks: Powering Digitalization	Academic Press	2019
2.	Saro Velrajan	An Introduction to 5G Wireless Networks: Technology, Concepts and Use cases	Kindle	2020

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Jyrki. T.J.Penttinen	5G Simplified: ABCs of Advanced Mobile Communications	Kindle	2019
2.	Wan Lee Anthony	5G system Design: An end-to-end Perspective	Springer	2019
3.	R. Vannithamby and S. Talwar	Towards 5G: Applications, Requirements and Candidate Technologies	John Willey & Sons	2017
4.	Manish, M., Devendra, G., Pattanayak, P., Ha, N.	5G and Beyond Wireless Systems PHY Layer Perspective	Springer Series in Wireless Technology	2021
5.	M. Vaezi, Z. Ding, and H. V. Poor	Multiple Access techniques for 5G Wireless Networks and Beyond	Springer Nature	2019

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23ECE16	**UNDERWATER NAVIGATION SYSTEMS**	**3**	**0**	**0**	**3**

Course Objective:

- To understand the autonomy, sensing and navigation system
- To understand about various types of navigational equipment & sensors
- To understand the basic communication methods and signal losses, attenuation
- To understand the types of Acoustic transponders, Beacon and Responder
- To gain knowledge on underwater positioning system

Course Outcomes:

23ECE16.CO1 Explain the Underwater Navigation System

23ECE16.CO2 Outline the INS and its aiding sensor

23ECE16.CO3 Explain the challenges involved in underwater navigation

23ECE16.CO4 Describe how navigation system is integrated with manned and unmanned underwater vehicles

23ECE16.CO5 Explain the underwater positioning system

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE16.CO1	x	x	x	x	x								x		
23ECE16.CO2	x	x	x	x	x							x	x		
23ECE16.CO3	x	x	x	x	x				x		x	x		x	x
23ECE16.CO4	x	x	x	x	x				x		x	x		x	x
23ECE16.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I BASICS OF UNDEWATER COMMUNICATION **9**

Introduction to underwater acoustics, Understanding Thermoclines in Ocean Waters, subsea communication sensors, Instruments and applications, Sound propagation in the ocean – Sound Velocity Profiles (SVP) in the deep water and shallow water; Sound attenuation in the sea – absorption, scattering, transmission loss, reverberation, Snell's law, target strength; Laser communication and limitations.

Unit-II UNDERWATER NAVIGATION & ITS AIDING SENSOR AND DEVICES **9**

Different types of navigational sensors, Accelerometers, Fiber Optic Gyroscopes (FOGs), Ring Laser Gyroscope (RLG) types and Working principles, and their applications, Doppler Velocity Log, Error sources in subsea navigation, Calibration overview for subsea navigation. Attitude Heading and Reference Systems (AHRS) & IMU.

Unit-III ACOUSTIC POSITIONING SYSTEMS **9**

Subsea navigation possible solutions, Vehicle positioning, Acoustic Positioning systems, Short Base Line (SBL), Super Short Base Line (SSBL), Long Base line (LBL) Configurations and Positioning overview.

Unit-IV SUBSEA VEHICLE NAVIGATION **9**

Subsea navigation, Uses of subsea navigation, challenges of subsea navigation. Basics of underwater navigation, Types of underwater Navigations, Aided navigational systems, Inertial Navigational systems. Role of dead-reckoning navigation in subsea navigation, Kalman filters (XKF) and Invariant extended Kalman filters for navigation.

Unit-V CASE STUDY **9**

- Tethered vehicle deployment guidelines and preparedness.
- AUV /ROV based search operation requirements and planning.
- Tethered crawling vehicle sensors, data acquisition and maneuvering.
- Acoustic positioning system transponder deployment and recovery.
- Aided and unaided navigation system study.
- Understand the basic tools needed to effectively develop software for robotic platforms in a group environment, and resolve conflicts and adhere to group goals in the software cycle.

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	L.M.Brekhovskikh, Yu. P. Lysanov	Fundamentals of ocean acoustics	Springer	2003
2.	Amitava Bose, K. N. Bhat, Thomas Kurian	Fundamentals of Navigation and Inertial Sensors	PHI Learning	2014

REFERENCE BOOKS

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	P. H. Milne	Underwater Acoustic Positioning Systems	Gulf Publishing Company	1983
2.	Norvald Kjerstad	Electronic and Acoustic Navigation systems for Maritime Studies	NTNU Norwegian University of Science and Technology	2016
3.	Thor I. Fossen	Guidance and control of ocean vehicles	Wiley	1998
4.	Max J. Morgan	Dynamic Positioning of Offshore Vessels	PPC Books Division, Petroleum Pub- lishing Company	1978
5.	Laurie Tetley, David Calcutt	Electronic Navigation Systems	Taylor & Francis	2007

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23ECE17	ROBOTIC PROCESS AUTOMATION	L	T	P	C
		3	0	0	3

- To understand the basic concepts of Robotic Process Automation
- To expose to the key RPA design and development strategies and methodologies
- To learn the fundamental RPA logic and structure
- To explore the Exception Handling, Debugging and Logging operations in RPA
- To learn to deploy and maintain the software bot

Course Outcomes:

23ECE17.CO1 Describe RPA, where it can be applied and how it's implemented.

23ECE17.CO2 Describe the different types of variables, Control Flow and data manipulation techniques.

23ECE17.CO3 Identify and understand Image, Text and Data Tables Automation.

23ECE17.CO4 Describe how to handle the User Events and various types of Exceptions and strategies.

23ECE17.CO5 Explain the Deployment of the Robot and to maintain the connection.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE17.CO1	x	x	x	x									x		
23ECE17.CO2	x	x	x	x	x							x	x		
23ECE17.CO3	x	x	x	x	x	x			x		x	x		x	x
23ECE17.CO4	x	x	x	x		x			x		x	x		x	x
23ECE17.CO5	x	x	x	x	x	x			x		x	x		x	x

Unit-I INTRODUCTION TO ROBOTIC PROCESS AUTOMATION 9

Emergence of Robotic Process Automation (RPA), Evolution of RPA, Differentiating RPA from Automation - Benefits of RPA - Application areas of RPA, Components of RPA, RPA Platforms. Robotic Process Automation Tools - Templates, User Interface, Domains in Activities, Workflow Files.

Unit-II AUTOMATION PROCESS ACTIVITIES 9

Sequence, Flowchart & Control Flow: Sequencing the Workflow, Activities, Flowchart, Control Flow for Decision making. Data Manipulation: Variables, Collection, Arguments, Data Table, Clipboard management, File operations Controls: Finding the control, waiting for a control, Act on a control, UiExplorer, Handling Events.

Unit-III APP INTEGRATION, RECORDING AND SCRAPING 9

App Integration, Recording, Scraping, Selector, Workflow Activities. Recording mouse and keyboard actions to perform operation, Scraping data from website and writing to CSV. Process Mining.

Unit-IV EXCEPTION HANDLING AND CODE MANAGEMENT 9

Exception handling, Common exceptions, Logging- Debugging techniques, Collecting crash dumps, Error reporting. Code management and maintenance: Project organization, Nesting workflows, Reusability, Templates, Commenting techniques, State Machine.

Unit-V DEPLOYMENT AND MAINTENANCE 9

Publishing using publish utility, Orchestration Server, Control bots, Orchestration Server to deploy bots, License management, Publishing and managing updates. RPA Vendors - Open Source RPA, Future of RPA.

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Alok Mani Tripathi	Learning Robotic Process Automation: Create Software robots and automate business processes with the leading RPA tool – UiPath	Packt Publishing	2018
2.	Tom Taulli	The Robotic Process Automation Handbook: A Guide to Implementing RPA Systems	Apress publications	2020

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Frank Casale, Rebecca Dilla, Heidi Jaynes, Lauren Livingston	Introduction to Robotic Process Automation: a Primer, Institute of Robotic Process Automation	Amazon Asia-Pacific Holdings Private Limited	2018
2.	Richard Murdoch	Robotic Process Automation: Guide To Building Software Robots, Automate Repetitive Tasks & Become An RPA Consultant	Amazon Asia-Pacific Holdings Private Limited	2018
3.	A Gerardus Blokdyk	Robotic Process Automation Rpa A Complete Guide		2020

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		L	T	P	C
23ECE18	**NATURAL LANGUAGE PROCESSING**	**3**	**0**	**0**	**3**

Course Objective:

- To understand comprehend the key concepts of NLP
- To develop Language Modeling for various text corpora across the different languages
- To illustrate computational methods to understand language phenomena
- To understand the applications for text or information extraction / classification
- To gain knowledge on Machine translation techniques for translating a source to target language(s)

Course Outcomes:

23ECE18.CO1 Explain the concepts of NLP and identify the NLP challenges and issues

23ECE18.CO2 Explain the concept of Language Modeling for various text corpora

23ECE18.CO3 Explain the concept of language phenomena of word sense disambiguation

23ECE18.CO4 Develop algorithms for information extraction/summarization/classification.

23ECE18.CO5 Explain the different Machine translation techniques

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE18.CO1	x	x	x	x	x				x				x		
23ECE18.CO2	x	x	x	x	x				x			x	x		
23ECE18.CO3	x	x	x	x	x				x		x	x		x	x
23ECE18.CO4	x	x	x	x	x				x		x	x		x	x
23ECE18.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I **INTRODUCTION TO NLP INTRODUCTION TO NLP** **9**

Introduction to NLP: What is NLP? Why NLP is Difficult? History of NLP, Advantages of NLP, Disadvantages of NLP, Components of NLP, Applications of NLP, How to build an NLP pipeline? Phases of NLP, NLP APIs, NLP Libraries

Unit-II **LANGUAGE MODELING AND PART OF SPEECH TAGGING:** **9**

Unigram Language Model, Bigram, Trigram, N-gram, Advanced smoothing for language modeling, Empirical Comparison of Smoothing Techniques, Applications of Language Modeling, Natural Language Generation, Parts of Speech Tagging, Morphology, Named Entity Recognition

Unit-III **WORDS AND WORD FORMS:** **9**

Bag of words, skip-gram, Continuous Bag-Of-Words, Embedding representations for words Lexical Semantics, Word Sense Disambiguation, Knowledge Based and Supervised Word Sense Disambiguation.

Unit-IV TEXT ANALYSIS, SUMMARIZATION AND EXTRACTION: 9

Sentiment Mining, Text Classification, Text Summarization, Information Extraction, Named Entity Recognition, Relation Extraction, Question Answering in Multilingual Setting; NLP in Information Retrieval, Cross-Lingual IR

Unit-V MACHINE TRANSLATION: 9

Need of MT, Problems of Machine Translation, MT Approaches, Direct Machine Translations, Rule-Based Machine Translation, Knowledge Based MT System, Statistical Machine Translation (SMT), Parameter learning in SMT (IBM models) using EM), Encoder-decoder architecture, Neural Machine Translation.

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Jurafsky, David, and James H. Martin,	Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition	PEARSON Second edition	2008
2.	Christopher D., and Hinrich Schütze,	Foundations of Statistical Natural Language Processing, Manning,	MIT Press	1999

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	James Allen	Natural Language Understanding	The Benjamin/Cummings Publishing Company Inc..	2007
2.	Steven Bird, Ewan Klein, and Edward Loper	Natural Language Processing with Python – Analyzing Text with the Natural Language	Oreilly	2009

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		L	T	P	C
23ECE19	**UNMANNED AERIAL VEHICLE**	**3**	**0**	**0**	**3**

Course Objective:

- To expose students to concepts needed in modelling and analysing an unmanned system
- To expose students to the design and development of UAV
- To expose students to the type of payloads used in UAV
- To gain knowledge on path planning
- To understand the avionics hardware used in the UAV

Course Outcomes:

23ECE19.CO1 Explain UAV system

23ECE19.C O2 Explain the preliminary design requirements for an unmanned aerial vehicle

23ECE19.CO3 Identify different hardware for UAV

23ECE19.CO4 Perform system testing for unmanned aerial vehicles

23ECE19.CO5 Design micro aerial vehicle systems by considering practical limitations

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE19.CO1	x	x	x	x	x				x				x		
23ECE19.CO2	x	x	x	x	x				x			x	x		
23ECE19.CO3	x	x	x	x	x				x		x	x		x	x
23ECE19.CO4	x	x	x	x	x				x		x	x		x	x
23ECE19.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I **INTRODUCTION TO UAV** **9**

History of UAV –classification – Introduction to Unmanned Aircraft Systems--models and prototypes – System Composition-applications.

Unit-II **THE DESIGN OF UAV SYSTEMS** **9**

Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations Characteristics of Aircraft Types- Design Standards and Regulatory Aspects-UK,USA and Europe Design for Stealth--control surfaces-specifications.

Unit-III **WORDS AND WORD FORMS:** **9**

Autopilot – AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply processor, integration, installation, configuration, and testing.

Unit-IV COMMUNICATION PAYLOADS AND CONTROL 9

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range –modems-memory system-simulation-ground test-analysis-trouble shooting.

Unit-V THE DEVELOPMENT OF UAV SYSTEMS 9

Waypoints navigation-ground control software- System Ground Testing- System In-flight - Testing Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Paul G Fahlstrom, Thomas J Gleason	Introduction to UAV Systems	UAV Systems, Inc	1998
2.	Reg Austin	Unmanned Aircraft Systems UAV design, development and deployment	Wiley	2010

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Dr. Armand J. Chaput	Design of Unmanned Air Vehicle Systems	Lockheed Martin Aeronautics Company	2001
2.	Kimon P. Valavanis	Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy	Springer	2007
3.	Robert C. Nelson	Flight Stability and Automatic Control	McGraw-Hill, Inc	1998

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		L	T	P	C
23ECE20	**VIRTUAL REALITY AND AUGMENTED REALITY**	**3**	**0**	**0**	**3**

Course Objective:

- To impart the fundamental aspects and principles of AR/VR technologies.
- To know the hardware and software components of AR/VR enabled applications.
- To learn about the graphical processing units and their architectures
- To gain knowledge about AR/VR application development
- To know the technologies involved in the development of AR/VR based applications

Course Outcomes:

23ECE20.CO1 Understand the basic concepts of AR and VR

23ECE20.CO2 Understand the tools and technologies related to AR/VR

23ECE20.CO3 Know the working principle of AR/VR related Sensor devices

23ECE20.CO4 Design of various models using modeling techniques

23ECE20.CO5 Develop AR/VR applications in different domains

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE20.CO1	x	x	x	x	x				x	x			x		
23ECE20.CO2	x	x	x	x	x				x	x		x	x		
23ECE20.CO3	x	x	x	x	x				x	x	x	x		x	x
23ECE20.CO4	x	x	x	x	x				x	x	x	x		x	x
23ECE20.CO5	x	x	x	x	x				x	x	x	x		x	x

Unit-I **INTRODUCTION** **9**

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

Unit-II **VR MODELING** **9**

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

Unit-III VR PROGRAMMING **9**

VR Programming – Toolkits and Scene Graphs – World ToolKit – Java 3D – Comparison of World ToolKit and Java 3D.

Unit-IV APPLICATIONS **9**

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

Unit-V AUGMENTED REALITY **9**

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

Total Periods: 45

TEXT BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	Charles Palmer, John Williamson	Virtual Reality Blueprints: Create compelling VR experiences for mobile	Packt Publisher	2018
2.	Dieter Schmalstieg, Tobias Hollerer	Augmented Reality: Principles & Practice	Addison Wesley	2016

REFERENCE BOOKS :

S.No.	AUTHOR (S) NAME	TITLE OF THE BOOK	PUBLISHER	YEAR
1.	John Vince	Introduction to Virtual Reality	Springer-Verlag	2004
2.	William R. Sherman, Alan B. Craig	Understanding Virtual Reality – Interface, Application, Design	Morgan Kaufmann	2003

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		L	T	P	C
23ECE21	**BIOMEDICAL ENGINEERING**	**3**	**0**	**0**	**3**

Course Objective:

- To Understand the Human physiology and components of biomedical system
- To get exposed to electro physiological parameter measurements
- To get exposed to non-electro physiological parameter measurements
- To Understand the concept of medical imaging
- To Understand the principle of operation of Therapeutic equipment's

Course Outcomes:

23ECE21.CO1 Explain the Human physiology and components of biomedical system

23ECE21.CO2 Analyze the electro physiological parameter measurements

23ECE21.CO3 Analyze the non - electro physiological parameter measurements

23ECE21.CO4 Explain the medical imaging and biotelemetry systems

23ECE21.CO5 Explain the principles of operation of Therapeutic equipment's

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE21.CO1	x	x	x										x		
23ECE21.CO2	x	x	x	x								x	x		
23ECE21.CO3	x	x	x	x		x					x	x		x	x
23ECE21.CO4	x	x	x	x	x	x					x	x		x	x
23ECE21.CO5	x	x	x	x	x	x					x	x		x	x

Unit-I PHYSIOLOGY AND TRANSDUCERS 9

Cell and its structure - Resting and Action Potential - Nervous system: Functional organization of the nervous system - Structure of nervous system, neurons - synapse - transmitters and neural communication - Cardiovascular system - respiratory system , Basic components of a biomedical system .Transducers - selection criteria – Piezo electric, ultrasonic transducers ,Temperature measurements , Fibre optic temperature sensors.

Unit-II ELECTRO – PHYSIOLOGICAL MEASUREMENTS 9

Electrodes - Limb electrodes-floating electrodes - pregelled disposable electrodes - micro- needle and surface electrodes - Amplifiers: Preamplifiers- differential amplifiers- chopper amplifiers -Isolation amplifier. Physiological measurements-ECG, EEG, EMG, ERG - Lead systems and recording methods-Typical waveforms. Electrical safety in medical environment: shock hazards-leakage current.

Unit-III NON-ELECTRICAL PARAMETER MEASUREMENT 9

Measurement of blood pressure -Cardiac output -Heart rate-Heart sounds-Pulmonary function measurements – spirometer -Photo Plethysmography- Body Plethysmography-Blood Gas analyzers - pH of blood -measurement of blood pCO2, pO2, finger-tip oxymeter - ESR, GSR measurements

.

Unit-IV MEDICAL IMAGING AND BIOTELEMETRY 9

Radio graphic and fluoroscopic techniques -Computer tomography-Magnetic Resonance Imaging - Ultrasonography-A mode, B mode ,M mode- Endoscopy-Thermography-Different types of biotelemetry systems and patient monitoring-Wireless Telemetry, single channel, multi-channel, multi patient and implantable telemetry systems.

Unit-V ASSISTING AND THERAPEUTIC EQUIPMENTS 9

Pacemakers-External and internal pacemakers-Defibrillators-DC defibrillator, implantable defibrillators-Ventilators-Nerve and muscle stimulators -TENS-Surgical diathermy machine, safety aspects in Electro surgical units- Heart Lung machine- Audiometers-Dialysers-Lithotripsy.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	R.S.Khandpur	Hand Book of Bio-Medical instrumentation	Tata McGraw Hill Publishing Co Ltd	2004
2.	Leslie Cromwell, FredJ.Weibell, Erich A.Pfeiffer	Bio-Medical Instrumentation and Measurements	Pearson Education	2002

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	M.Arumugam	Bio-Medical Instrumentation	Anuradha Agencies	2003
2.	L.A. Geddes and L.E.Baker	Principles of Applied BioMedical Instrumentation	John Wiley & Sons	1975
3.	J.Webster	Medical Instrumentation	John Wiley & Sons	1995
4.	William R Hendee, E. Russell Ritenour	Medical Imaging Physics	John Wiley & Sons	2002
5.	Paul Suetens	Fundamentals of Medical Imaging	Cambridge University press	2009

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		L	T	P	C
23ECE22	**BIOINFORMATICS**	**3**	**0**	**0**	**3**

Course Objective:

- To launch the Bioinformatics core concepts to students
- To provide knowledge on Biological databases, sequence analysis
- To understand the Molecular clock theory
- To gain knowledge on Prediction of protein secondary structure.
- To learn the concepts of Systems Biology and Synthetic Biology

Course Outcomes:

23ECE22.CO1	Describe bioinformatics data and information resources
23ECE22.CO2	Apply computational based solutions for biological perspectives
23ECE22.CO3	Analyze the evolutionary relationship between the organisms
23ECE22.CO4	Outline the macromolecules structure prediction methods
23ECE22.CO5	Explain the applications of bioinformatics approach for drug discovery and genomics

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
23ECE22.CO1	x												x		
23ECE22.CO2	x	x	x	x	x							x	x		
23ECE22.CO3	x	x	x	x							x	x		x	x
23ECE22.CO4	x	x	x	x	x						x	x		x	x
23ECE22.CO5	x	x	x	x	x	x					x	x		x	x

Unit-I BIOLOGICAL DATABASES 9

Introduction to Bioinformatics and Computational Biology, Biological sequences, Classification of biological databases - Sequence Databases, Structure Databases, Genome specific databases, Special Databases and applications- Microarray, Metabolic pathway, motif, and domain databases, Data file formats.

Unit-II SEQUENCE ANALYSIS 9

Sequence Alignment- Homology vs Similarity, Similarity vs Identity. Types of Sequence alignment - Pairwise and Multiple sequence alignment, Global alignment, Local alignment, Dotplot, Alignment algorithms- Needleman wunsch and Smith and waterman algorithm, Substitution matrices- PAM, BLOSUM.Multiple Sequence Alignment-Application of multiple alignments, Viewing and editing of MSA and Scoring function.Database Similarity Searching- Basic Local Alignment Search Tool (BLAST), FASTA, PHI BLAST, PSI BLAST, BLAST algorithm.

Unit-III MOLECULAR PHYLOGENY 9

Phylogenetics Basics, Molecular clock theory, Ultrametric trees, Distance matrix methodsUPGMA,NJ, Character based methods-Maximum Parsimony. Methods of evaluating phylogenetic methods- boot strapping, jackknifing.

Unit-IV MACROMOLECULAR STRUCTURE ANALYSIS 9

Gene prediction, Conserved domain analysis, Protein structure visualization, Prediction of protein secondary structure, Tertiary structure prediction- Homology modeling, Threading, Ab-initio prediction. Validation of the predicted structure using Ramachandran plot, steriochemical properties, Structure- structure alignment

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Unit-V APPLICATIONS 9

Introduction to Systems Biology and Synthetic Biology, Microarray data analysis, DNA computing, Bioinformatics approaches for drug discovery, Applications of Bioinformatics in genomics and proteomics- Assembling the genome, STS content mapping for clone contigs, Functional annotation, Peptide mass fingerprinting

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Arthur K. Lesk	Introduction to Bioinformatics	Oxford University Press	2002
2.	Baxivanis and Foulette D	Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins	Wiely Indian Edition	2001

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	David W. Mount	Bioinformatics Sequence and Genome Analysis	Cold Spring Harbor Laboratory Press	2001

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		L	T	P	C
23ECE23	**HUMAN ASSIST DEVICES**	**3**	**0**	**0**	**3**

Course Objective:

- To study the role of machines that takes over the functions of the heart and lungs
- To study various mechanical techniques that help a non-functioning heart
- To learn the functioning of the unit which does the clearance of urea from the blood
- To understand the tests to assess the hearing loss
- To study about recent techniques used in modern clinical applications

Course Outcomes:

23ECE23.CO1 Explain the principles and construction of artificial heart

23ECE23.CO2 Understand various mechanical techniques that improve therapeutic technology

23ECE23.CO3 Explain the functioning of the membrane or filter that cleanses the blood.

23ECE23.CO4 Describe the tests to assess the hearing loss and development of wearable devices

23ECE23.CO5 Analyze and research on electrical stimulation and biofeedback techniques in rehabilitation

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE23.CO1	x	x	x	x	x								x		
23ECE23.CO2	x	x	x	x	x							x	x		
23ECE23.CO3	x	x	x	x	x						x	x		x	x
23ECE23.CO4	x	x	x	x	x						x	x		x	x
23ECE23.CO5	x	x	x	x	x						x	x		x	x

Unit-I HEART LUNG MACHINE AND ARTIFICIAL HEART 9

Condition to be satisfied by the H/L System. Different types of Oxygenators, Pumps, Pulsatile and Continuous Types, Monitoring Process, Shunting, The Indication for Cardiac Transplant, Driving Mechanism, Blood Handling System, Functioning and different types of Artificial Heart, Schematic for temporary bypass of left ventricle.

Unit-II CARDIAC ASSIST DEVICES 9

Assisted through Respiration, Right and left Ventricular Bypass Pump, Auxiliary ventricle, Open Chest and Closed Chest type, Intra Aortic Balloon Pumping, Prosthetic Cardiac valves, Principle of External Counter pulsation techniques.

Unit-III ARTIFICIAL KIDNEY 9

Indication and Principle of Haemodialysis, Membrane, Dialysate, types of filter and membranes, Different types of hemodialyzers, Monitoring Systems, Wearable Artificial Kidney, Implanting Type.

Unit-IV RESPIRATORY AND HEARING AIDS 9

Ventilator and its types-Intermittent positive pressure, Breathing Apparatus Operating Sequence, Electronic IPPB unit with monitoring for all respiratory parameters. Types of Deafness, Hearing Aids, SISI, masking techniques, wearable devices for hearing correction.

Unit-V RECENT TRENDS **9**

Transcutaneous electrical nerve stimulator, bio-feedback, Diagnostic and point-of-care platforms

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Gray E Wnek, Gray L Browlin	Encyclopedia of Biomaterials and Biomedical Engineering	Marcel Dekker Inc	2004
2.	John. G . Webster	Bioinstrumentation	John Wiley & Sons (Asia) Pvt Ltd	2004

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Joseph D.Bronzino	The Biomedical Engineering Handbook	CRC Press	2006
2.	Andreas.F. Von racum	Hand book of bio material evaluation	Mc-Millan publishers	1980
3.	D.S. Sunder	Rehabilitation Medicine	Jaypee Medical Publication	2010

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		L	T	P	C
23ECE24	**BIOMEMS AND SENSORS**	**3**	**0**	**0**	**3**

Course Objective:

- To Gain knowledge on components used for various biosensors and biosensor family
- To Understand the Principle of Different Types of Transducers
- To Gain knowledge on applications of biosensors in different field
- To Understand the driving force behind bio-medical applications
- To Understand the soft polymers and physical properties

Course Outcomes:

23ECE31.CO1 Explain various biosensors and their biomolecule ingredients
23ECE31.CO2 Describe the operation of Transducer used in Biosensors

23ECE31.CO3 Select proper Biosensors for the applications such as health care, agriculture and environment

23ECE31.CO4 Explain the biomems fabrication technique.

23ECE31.CO5 Explain the concept of microfluidic sensors and actuators.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE24.CO1	x		x	x			x			x			x		
23ECE24.CO2	x	x	x	x			x					x	x		
23ECE24.CO3	x	x	x	x			x			x	x	x		x	x
23ECE24.CO4	x		x	x						x	x	x		x	x
23ECE24.CO5	x	x	x	x						x	x	x		x	x

Unit-I SIGNALS AND SYSTEMS 9

Introduction: Biosensors- Advantages and limitations, various components of biosensors Biocatalysis based biosensors, Bioaffinity based biosensors & Microorganisms. based biosensors, Biologically active material and analyte. Types of membranes used in biosensor constructions.

Unit-II TRANSDUCERS IN BIOSENSORS 9

Various types of transducers; principles and applications - Calorimetric, Optical, Potentiometric / Amperometric, Conductometric / Resistometric, Piezoelectric, Semiconductor, Impedimetric, Chemiluminiscene - based Biosensors.

Unit-III APPLICATION AND USES OF BIOSENSORS 9

Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food. Biosensors for personal diabetes management, application of biosensors to environmental samples. Biochips and their application to genomics. Assembly of photonic biomolecular memory store; Information processing; commercial prospects for biomolecular computing systems.

Unit-IV INTRODUCTION TO BIOMEMS **9**

The driving force behind biomedical applications, bio-compatiability, Silicon fabrication: Hard fabrication considerations, lithography, etching techniques, Thin film deposition process, ion implantation, substrate bonding introduction, Biomaterials, soft lithography, micromolding, smart polymers & hydrogels, nanomedicine, thick film technologies, polymers, physicalproperties, copolymers

Unit-V MICROFLUIDIC PRINCIPLES & SENSORS **9**

Introduction, transport process, electrokinetic phenomena, microvalves, micromixers, micropumps, sensor principles & microsensors: Introduction, fabrication, basic sensors, optical fibres, piezoelectricity, SAW devices, electrochemical detection, applications to medicine.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Graham Ramsay	Commercial Biosensors	John Wiley and son,	1998
2.	Steven Salitreman	Fundamentals of BioMEMS & Medical Microdevices	Cengage Learning India	2006

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Alert Berg,	Miniaturized systems for chemical analysis & synthesis	Elsevier	2003
2.	Murthy D V S.	Transducers and Instrumentation,	Prentice Hal	1995
3.	Mauro Ferrari	Biomems and Biomedical Nanotechnology	Springer	2006
4.	Albert Folch	Introduction to BioMEMS	CRC Press	2003
5.	Steven S.Saliterman	Fundamental of BioMEMS and Microdrvices	SPIE Press	2005

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		L	T	P	C
23ECE25	**BODY AREA NETWORKS**	**3**	**0**	**0**	**3**

Course Objective:

- To know the hardware requirement of BAN
- To understand the communication and security aspects in the BAN
- To know the applications of BAN in the field of medicine
- To understand the need for medical device regulation and regulations
- To gain knowledge on patient monitoring systems

Course Outcomes:

23ECE25.CO1 Comprehend the role of BAN

23ECE25.CO2 Design a BAN for appropriate medical application

23ECE25.CO3 Explain the efficiency of communication and the security parameters

23ECE25.CO4 Explain the need for medical device regulation and regulations

23ECE25.CO5 Extend the concepts of BAN for medical applications

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE25.CO1	x	x	x	x	x								x		
23ECE25.CO2	x	x	x	x	x							x	x		
23ECE25.CO3	x	x	x	x	x						x	x		x	x
23ECE25.CO4	x	x	x	x	x						x	x		x	x
23ECE25.CO5	x	x	x	x	x						x	x		x	x

Unit-I INTRODUCTION **9**

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

Unit-II HARDWARE FOR BAN **9**

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

Unit-III WIRELESS COMMUNICATION AND NETWORK **9**

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

Unit-IV COEXISTENCE ISSUES WITH BAN **9**

Interferences – Intrinsic - Extrinsic, Effect on transmission, Counter measures- on physical layer and data link layer, Regulatory issues-Medical Device regulation in USA and Asia, Security and Self-protection-Bacterial attacks, Virus infection, Secured protocols, Self-protection.

Unit-V APPLICATIONS OF BAN **9**

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrythmias monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sandeep K.S. Gupta,Tridib Mukherjee, Krishna Kumar Venkata Subramanian	Body Area Networks Safety, Security, and Sustainability'	Cambridge University Press	2013
2.	Mehmet R. Yuce, Jamil Y.Khan	Wireless Body Area Networks Technology, Implementation, and Applications	Pan Stanford Publishing Pvt. Ltd.	2012

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Zhang, Yuan-Ting	Wearable Medical Sensors and Systems'	Springer	2013
2.	Guang-Zhong Yang	Body Sensor Networks''	Springer	2006
3.	Annalisa Bonfiglio, Danilo De Rossi	Wearable Monitoring Systems	Springer	2011

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		L	T	P	C
23ECE26	**COMPUTER NETWORKS**	**3**	**0**	**0**	**3**

Course Objective:

1 To understand the division of network functionalities into layers

2 To familiar with the components required to build different types of networks

3 To learn the flow control and congestion control algorithms

- To introduce advanced networking concepts and applications
- To understand the application layer services

Course Outcomes:

23ECE26.CO1 Explain basic of computer networks and OSI and TCP/IP model

23ECE26.CO2 Choose the media access techniques.

23ECE26.CO3 Explain various routing protocols.

23ECE26.CO4 Outline the functions and protocols of Transport layer.

23ECE26.CO5 Explain the various applications layer protocols

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE26.CO1	x	x	x		x								x		
23ECE26.CO2	x	x	x		x							x	x		
23ECE26.CO3	x	x	x	x	x				x		x	x		x	x
23ECE26.CO4	x	x	x	x	x	x			x		x	x		x	x
23ECE26.CO5	x	x	x	x	x	x			x		x	x		x	x

Unit-I FUNDAMENTALS AND CONCEPT OF LAYERING 9

Building a network – Requirements – Network Topologies - Layering and protocols – Internet Architecture – Network software – Performance – Interface & Service – Service Primitives. Reference models – OSI – TCP/IP.

Unit-II MEDIA ACCESS AND INTERNETWORKING 9

Media access control – Ethernet (802.3) – Wireless LANs – 802.11 – Bluetooth – Switching and bridging – Basic Internetworking (IP, CIDR, ARP, DHCP, ICMP).

Unit-III ROUTING 9

Network layer – Services – Ipv4 Addresses – Ipv6 addressing - Routing (RIP, OSPF, metrics) – Switch basics – Global Internet (Areas, BGP, IPv6) – Routing – Shortest path routing, Flooding, Distance Vector Routing, Link State Routing, RIP, OSPF, Routing for mobile hosts.

Unit-IV TRANSPORT LAYER 9

Network layer design issues, routing algorithms, Congestion control algorithms, Internetworking, the network layer in the internet (IPv4 and IPv6), Quality of Service.

Unit-V APPLICATION LAYER **9**

Principles of application layer protocols – DNS – SNMP - Electronic Mail (SMTP, POP3, IMAP, MIME) – HTTP – Web Services.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Larry L. Peterson, Bruce S. Davie	Computer Networks: A Systems Approach	Morgan Kaufmann Publishers	2011
2.	Kurose, Ross	Computer Networking: A top down approach	Pearson Education,	2010

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	James F. Kurose, Keith W. Ross	Computer Networking – A Top-Down Approach Featuring the Internet	Pearson Education,	2009
2.	A. S. Tanenbaum	Computer Networks	Pearson Education/ PHI	2003
3.	Ying-Dar Lin, Ren-Hung Hwang, Fred Baker	Computer Networks: An Open Source Approach	McGraw Hill Publisher,	2011
4.	Behrouz A. Forouzan	Data communication and Networking	Tata McGraw Hill	2011
5.	William Stallings	Computer Networking with Internet Protocols	Prentice-Hall	2004

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23ECE27	**COMPUTER ARCHITECTURES AND ORGANIZATIONS**	**3**	**0**	**0**	**3**

Course Objective:

1 To Brief the historical development of computing machines

2 To Understand the arithmetic algorithms to process data and ALU

3 To Focus on concepts of control unit design and pipelining

4 To Gain knowledge on the organization of main memory, cache memory

5 To Understand the system organization

Course Outcomes:

23ECE27.CO1	Describe the central processing unit focusing on instruction set design and data representation.
23ECE27.CO2	Explain the operation of Datapath unit
23ECE27.CO3	Explain the design of control unit
23ECE27.CO4	Illustrate various types of memory elements
23ECE27.CO5	Outline the Input/Output and system organization

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO2	PSO3
23ECE27.CO1	x	x											x		
23ECE27.CO2	x	x	x	x	x							x	x		
23ECE27.CO3	x	x	x	x	x						x	x		x	x
23ECE27.CO4	x	x			x						x	x		x	x
23ECE27.CO5	x	x	x	x	x						x	x		x	x

Unit-I INTRODUCTION TO COMPUTER ARCHITECTURE AND ORGANIZATION 9

Computing and Computers – Evolution of Computers – VLSI Era - System Design – Register Level, Processor Level, CPU Organization, and Data Representation, Fixed–point numbers, Floating Point Numbers, Instruction format and instruction types – Addressing modes, Basic I/O operations

Unit-II ARITHMETIC UNIT AND DATAPATH DESIGN 9

Addition and subtraction of signed numbers – Look ahead carry adder - Multiplication of positive numbers – Robertson algorithm, Booth's algorithm- Integer division – restoring and non-restoring division algorithms - Floating Point Arithmetic - Combinational and Sequential ALUs, Coprocessors.

Unit-III CONTROL UNIT DESIGN 9

Fundamental concepts – Execution of a complete instruction – Hardwired control – Micro programmed control – Microinstruction sequencing – Comparison between hardwired and microprogrammed control – Pipelining – Basic concepts, Pipeline Processing, Implementation of two-stage and four-stage instruction pipelining – Data hazards – Instruction hazards – Influence on Instruction sets – Data path and control consideration – Superscalar processors.

Unit-IV MEMORY SYSTEM **9**

Memory Hierarchy, Semiconductor Memories, RAM(Random Access Memory), Read Only Memory (ROM), Types of ROM, Cache Memory, Performance considerations, Virtual memory, Paging, Secondary Storage,RAID

Unit-V INPUT/OUTPUT AND SYSTEM ORGANIZATION **9**

Communication methods, Buses, Bus Control, Bus Interfacing, Bus arbitration, IO and system control – I/O Systems Speed, Size, Cost, Performance considerations- DMA- IO interface circuits, I/O channels - I/O Processor, multiprocessors, fault tolerance, RISC and CISC architecture.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Carl Hamacher,ZvonkoVranesic and SafwatZaky	Computer Organization	McGraw-Hill	2012
2.	John P.Hayes	Computer Architecture and Organization	McGraw Hill	2012

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	William Stallings	Computer Organization and Architecture – Designing for Performance	Pearson Education,	2012
2.	David A.Patterson and John L.Hennessy	Computer Organization and Design: The hardware / software interface	Morgan Kaufmann	2014
3.	P.Pal Chaudhuri	Computer organization and design	Prentice Hall of Indi	2008
4.	Miles J. Murdocca and Vincent P. Heuring	Principles of Computer Architecture	Prentice Hall,	2008
5.	M. Moris Mano	Computer System Architecture	3rd edition, Pearson/PHI	2006

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23ECE28	**HUMAN COMPUTER INTERFACES**	**3**	**0**	**0**	**3**

Course Objective:

- To Understand comprehend the key concepts of HCI
- To Learn human interaction with computer
- To know concepts of window
- To Design and develop HCI software process
- To understand cognitive models goal and task hierarchies

Course Outcomes:

23ECE28.CO1 Explain the concepts of HCI and identify the HCI challenges and issues

23ECE28.CO2 Explain the concept of human interaction with computer

23ECE28.CO3 Explain the concept of window

23ECE28.CO4 Develop algorithms for HCI software process

23ECE28.CO5 Explain the cognitive models goal and task hierarchies

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE28.CO1	x	x	x		x				x				x		
23ECE28.CO2	x	x	x		x				x			x	x		
23ECE28.CO3	x	x	x	x	x				x		x	x		x	x
23ECE28.CO4	x	x	x	x	x				x		x	x		x	x
23ECE28.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I INTRODUCTION 9

Importance of user Interface – definition, importance of good design. Benefits of good design. A brief history of Screen design. The graphical user interface – popularity of graphics, the concept of direct manipulation, graphical system, Characteristics, Web user – Interface popularity, characteristics- Principles of user interface

Unit-II HUMAN INTERACTION WITH COMPUTERS 9

Importance of human characteristics human consideration, Human interaction speeds, understanding business junctions. Screen Designing: Design goals – Screen planning and purpose, organizing screen elements, ordering of screen data and content – screen navigation and flow – Visually pleasing composition – amount of information – focus and emphasis – presentation information simply and meaningfully– information retrieval on web – statistical graphics – Technological consideration in interface design

Unit-III WINDOWS 9

New and Navigation schemes selection of window, selection of devices based and screenbased controls. Components – text and messages, Icons and increases – Multimedia, colors, uses problems, choosing colors

Unit-IV HCI IN THE SOFTWARE PROCESS 9

The software life cycle Usability engineering Iterative design and prototyping Design Focus: Prototyping in practice Design rationale Design rules Principles to support usability Standards Golden rules and heuristics HCI

patterns Evaluation techniques, Goals of evaluation, Evaluation through expert analysis, Evaluation through user participation, Choosing an evaluation method. Universal design, Universal design principles Multi-modal interaction

Unit-V COGNITIVE MODELS GOAL AND TASK HIERARCHIES 9

Design Focus: GOMS saves money Linguistic models The challenge of display-based systems Physical and device models Cognitive architectures Ubiquitous computing and augmented realities Ubiquitous computing applications research Design Focus: Ambient. Wood – augmenting the physical Virtual and augmented reality Design Focus: Shared experience Design Focus: Applications of augmented reality Information and data visualization Design Focus: Getting the size right

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Wilbert O Galitz,	The essential guide to user interface design	Wiley Publishing, Third edition	2007
2.	Alan Dix, Janet Fincay, Gre Goryd, Abowd, Russell Bealg	Human – Computer Interaction	Pearson Education	2004

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	D. R. Olsen	Human –Computer Interaction	Cengage Learning	2010
2.	Smith – Atakan	Human –Computer Interaction	Cengage Learning	2010

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23ECE29	**CYBER SECURITY AND PRIVACY**	**3**	**0**	**0**	**3**

Course Objective:

- To Learn to analyze the security of in-built cryptosystems.
- To Know the fundamental mathematical concepts related to security.
- To Develop cryptographic algorithms for information security.
- To Comprehend the various types of data integrity and authentication schemes
- To Understand cyber crimes and cyber security

Course Outcomes:

23ECE29.CO1	Explain the fundamentals of networks security, security architecture, threats and vulnerabilities
23ECE29.CO2	Apply the different cryptographic operations of symmetric cryptographic algorithms
23ECE29.CO3	Outline the different cryptographic operations of public key cryptography
23ECE29.CO4	Apply the various Authentication schemes to simulate different applications.
23ECE29.CO5	Explain the various cyber crimes and cyber security

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
23ECE29.CO1	x	x											x		
23ECE29.CO2	x	x	x	x	x							x	x		
23ECE29.CO3	x	x	x	x	x						x	x		x	X
23ECE29.CO4	x	x			x						x	x		x	X
23ECE29.CO5	x	x	x	x	x						x	x		x	X

Unit-I INTRODUCTION TO SECURITY **9**

Computer Security Concepts – The OSI Security Architecture – Security Attacks – Security Services and Mechanisms – A Model for Network Security – Classical encryption techniques: Substitution techniques, Transposition techniques, Steganography – Foundations of modern cryptography: Perfect security – Information Theory – Product Cryptosystem – Cryptanalysis.

Unit-II SYMMETRIC CIPHERS **9**

Number theory – Algebraic Structures – Modular Arithmetic - Euclid's algorithm – Congruence and matrices – Group, Rings, Fields, Finite Fields

SYMMETRIC KEY CIPHERS: SDES – Block Ciphers – DES, Strength of DES – Differential and linear cryptanalysis – Block cipher design principles – Block cipher mode of operation – Evaluation criteria for AES – Pseudorandom Number Generators – RC4 – Key distribution.

Unit-III ASYMMETRIC CRYPTOGRAPHY **9**

MATHEMATICS OF ASYMMETRIC KEY CRYPTOGRAPHY: Primes – Primality Testing – Factorization – Euler's totient function, Fermat's and Euler's Theorem – Chinese Remainder Theorem – Exponentiation and logarithm

ASYMMETRIC KEY CIPHERS: RSA cryptosystem – Key distribution – Key management – Diffie Hellman key exchange -– Elliptic curve arithmetic – Elliptic curve cryptography.

Unit-IV INTEGRITY AND AUTHENTICATION ALGORITHMS 9

Authentication requirement – Authentication function – MAC – Hash function – Security of hash function: HMAC, CMAC – SHA – Digital signature and authentication protocols – DSS – Schnorr Digital Signature Scheme – ElGamal cryptosystem – Entity Authentication: Biometrics, Passwords, Challenge Response protocols – Authentication applications – Kerberos

MUTUAL TRUST: Key management and distribution – Symmetric key distribution using symmetric and asymmetric encryption – Distribution of public keys – X.509 Certificates.

Unit-V CYBER CRIMES AND CYBER SECURITY 9

Cyber Crime and Information Security – classifications of Cyber Crimes – Tools and Methods – Password Cracking, Keyloggers, Spywares, SQL Injection – Network Access Control – Cloud Security – Web Security – Wireless Security

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	William Stallings	Cryptography and Network Security - Principles and Practice	Pearson Education	2017
2.	Nina Godbole, Sunit Belapure	"Cyber Security: Understanding Cyber crimes, Computer Forensics and Legal	Wiley	2011

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Behrouz A. Ferouzan, Debdeep Mukhopadhyay	Cryptography and Network Security	Tata Mc Graw Hill	2015
2	Charles Pfleeger, Shari Pfleeger, Jonathan Margulies	Security in Computing	Prentice Hall	2015

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23ECE30	SOFTWARE DEFINED NETWORKS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the need for SDN and its data plane operations
- To understand the functions of control plane
- To comprehend the migration of networking functions to SDN environment
- To explore various techniques of network function virt
- To comprehend the concepts behind network virtualize

Course Outcomes:

23ECE30.CO1	Describe the motivation behind SDN
23ECE30.CO2	Identify the functions of the data plane and control plane
23ECE30.CO3	Design and develop network applications using SDN
23ECE30.CO4	Orchestrate network services using NFV
23ECE30.CO5	Explain various use cases of SDN and NFV

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC30.CO1	x	x											x		
23ECC30.CO2	x	x	x	x	x							x	x		
23ECC30.CO3	x	x	x	x	x						x	x		x	x
23ECC30.CO4	x	x			x						x	x		x	x
23ECC30.CO5	x	x	x	x	x						x	x		x	x

Unit-I SDN: INTRODUCTION **9**

Evolving Network Requirements – The SDN Approach – SDN architecture - SDN Data Plane , Control plane and Application Plane

Unit-II SDN DATA PLANE AND CONTROL PLANE **9**

Data Plane functions and protocols – Open FLow Protocol - Flow Table - Control Plane Functions - Southbound Interface, Northbound Interface – SDN Controllers - Ryu, Open Day light, ONOS - Distributed Controllers

Unit-III SDN APPLICATIONS **9**

SDN Application Plane Architecture – Network Services Abstraction Layer – Traffic Engineering –

Measurement and Monitoring – Security – Data Center Networking

Unit-IV NETWORK FUNCTION VIRTUALIZATION 9

Network Virtualization - Virtual LANs – Open Flow VLAN Support - NFV Concepts – Benefits and Requirements – Reference Architecture

Unit-V NFV FUNCTIONALITY 9

NFV Infrastructure – Virtualized Network Functions – NFV Management and Orchestration – NFV Use cases – SDN and NFV

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
3.	William Stallings	Foundations of Modern Networking: SDN, NFV, QoE, IoT and Cloud	Pearson Education	2015
4.	Ken Gray, Thomas D. Nadeau	Network Function Virtualization	Morgan Kauffman	2016

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
6.	Thomas D Nadeau, Ken Gray	SDN: Software Defined Networks	O'Reilly Media	2013
7.	Fei Hu	Network Innovation through Open Flow and SDN: Principles and Design	CRC Press	2014
8.	Paul Goransson, Chuck Black Timothy Culver	Software Defined Networks: A Comprehensive Approach	Morgan Kaufmann Press	2016
9.	Oswald Coker, Siamak Azodolmolky	Software-Defined Networking with Open Flow	O'Reilly Media	2017

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23ECE31	**MEDICAL IMAGING AND PROCESSING**	**3**	**0**	**0**	**3**

Course Objective:

- To Learn digital image fundamentals and image enhancement
- To Understand the concept of Image Restoration and segmentation
- To Be familiar with X-Ray Magnetic Resonance and CT images
- To Learn to foundations for Medical Image Analysis
- To Understand the Speckle Images and Optical Microscopic

Course Outcomes:

23ECE31.CO1	Explain the fundamentals of image processing and image enhancement,
23ECE31.CO2	Apply image processing restoration techniques and segmentation methods
23ECE31.CO3	Apply X-Ray Magnetic Resonance and CT images.
23ECE31.CO4	Develop algorithms for machine leavening,
23ECE31.CO5	Explain the analysis of Speckle Images and Optical Microscopic Imaging

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE31.CO1	x	x	x						x				x		
23ECE31.CO2	x	x	x		x				x			x	x		
23ECE31.CO3	x	x	x	x	x				x		x	x		x	x
23ECE31.CO4	x	x	x	x	x				x		x	x		x	x
23ECE31.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I DIGITAL IMAGE FUNDAMALENTS AND IMAGE ENHANCEMENT 9

Introduction – Origin – Steps in Digital Image Processing – Components – Elements of Visual Perception Image Sampling and Quantization – Relationships between pixels - color image processing – RGB color model – **HSV and LAB** Color model, Image Transform –DCT Image enhancement Spatial Domain: Gray level transformations Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering – Frequency Domain: Introduction to Fourier Transform – Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters

Unit-II IMAGE RESTORATION AND IMAGE SEGMENTATION 9

Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering Segmentation: Detection of Discontinuities– Edge Linking and Boundary detection – Region based segmentation--**Morphological based boundary detection**

Unit-III X-RAY, MAGNETIC RESONANCE AND COMPUTERIZED TOMOGRAPHY IMAGES 9

Image formation in X-ray, Digital Angiography, Digital Mammography, magnetic resonance, Computerized Tomographic Reconstruction, PET, SPECT hybrid imaging, Image and volume registration

Unit-IV FOUNDATIONS FOR MEDICAL IMAGE ANALYSIS 9

Shape modelling, clustering, Texture, image statistics, Graph cuts, Supervised and unsupervised learning, learning Receiver operating characteristic curve, confusion Matrix, Linear Regression, Logistic Regression, Support Vector Machine (SVM) K-means clustering

Unit-V SPECKLE IMAGES AND OPTICAL MICROSCOPIC IMAGING 9

Image formation in ultrasound (US), A-/B-/M- mode imaging, doppler and tissue harmonic, Speckle reduction, beam steering, image compounding and filtering, Optical coherence tomography, frequency domain sensing, Cardiovascular and Ophthalmic imaging fluorescence and non-linear microscopy, Digital pathology and 3D microscopy

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rafael C. Gonzales, Richard E. Woods	Digital Image Processing.	Pearson education	2010
2	A.K. Jain	Fundamentals of Digital Image Processing.	Prentice Hall India	1988
3	I. Bankman	Handbook of Medical Image Processing and Analysis,	Springer Second edition	2008

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Madhuri.A. Joshi	Digital Image Processing an algorithmic approach	PHI Publisher	2006
2	S.Sridher	Digital Image Processing	Oxford University Press	2011
3	Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins,	Digital Image Processing using MATLAB	Tata McGraw Hill Pvt. Ltd.,	2011
4	Willliam K Pratt	Digital Image Processing	John Willey	2002
5	Malay K. Pakhira	Digital Image Processing and Pattern Recognition	PHI Learning Pvt. Ltd.	2011

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23ECE32	REMOTE SENSING AND GIS	L	T	P	C
		3	0	0	3

Course Objective:

- To Know the concepts of Remote Sensing, its interpreting Techniques
- To know the concept of Geographical Information System GIS
- To Understand the students managing the spatial Data Using GIS
- To To Understand the Spatial Data input and Editing
- To Understand Implementation of GIS interface for practical usage

Course Outcomes:

23ECE32.CO1 Describe different concepts and terms used in Remote Sensing and its data

23ECE32.CO2 Explain the Data conversion and Process in different coordinate systems of GIS interface

23ECE32.CO3 Evaluate the accuracy of Data and implementing a GIS

23ECE32.CO4 Describe different concepts of spatial data input and editing

23ECE32.CO5 Develop the applicability of RS and GIS for various applications

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE32.CO1	x	x	x	x					x				x		
23ECE32.CO2	x	x	x	x					x			x	x		
23ECE32.CO3	x	x	x	x	x				x		x	x		x	x
23ECE32.CO4	x	x	x	x	x				x		x	x		x	x
23ECE32.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I CONCEPTS OF REMOTE SENSING 9

Basics of remote sensing- elements involved in remote sensing, electromagnetic spectrum, remote sensing terminology & units, energy resources, energy interactions with earth surface features & atmosphere, atmospheric effects, satellite orbits, Sensor Resolution, types of sensors. Remote Sensing Platforms and Sensors, IRS satellites. Remote Sensing Data Interpretation Visual interpretation techniques, basic elements, converging evidence, interpretation for terrain evaluation, spectral properties of soil, water and vegetation. Concepts of Digital image processing, image enhancements, qualitative & quantitative analysis and pattern recognition, classification techniques and accuracy estimation.

Unit-II INTRODUCTION TO GIS 9

Introduction, History of GIS, GIS Components, GIS Applications in Real life, The Nature of geographic data, Maps, Types of maps, Map scale, Types of scale, Map and Globe, Co- ordinate systems, Map projections, Map transformation, Geo-referencing

Unit-III SPATIAL DATABASE MANAGEMENT SYSTEM 9

Introduction: Spatial DBMS, Data storage, Database structure models, database management system, entity-relationship model, normalization Data models and data structures: Introduction, GIS Data model, vector data structure, raster data structure, attribute data, geo-database and metadata

Unit-IV SPATIAL DATA INPUT AND EDITING 9

Data input methods – keyboard entry, digitization, scanning, conversion of existing data, remotely sensed data, errors in data input, Data accuracy, Micro and Macro components of accuracy, sources of error in GIS. Spatial Analysis: Introduction, topology, spatial analysis, vector data analysis, Network analysis, raster data analysis, Spatial data interpolation techniques

Unit-V IMPLEMENTING A GIS AND APPLICATIONS 9

Implementing a GIS: Awareness, developing system requirements, evaluation of alternative systems, decision making using GIS applications of GIS: GIS based road network planning, Mineral mapping using GIS, Shortest path detection using GIS, Hazard Zonation using remote sensing and GIS, GIS for solving multi criteria problems, GIS for business applications

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Thomas M. Lillesand and Ralph W. Kiefer,	Remote Sensing and Image Interpretation	Wiley Publishers, 7th Edition,	2015
2	Tor Bernhardsen	Geographic Information systems – An Introduction	Wiley India Publication, 3rd Edition, .	2010

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Satheesh Gopi, R. SathiKumar, N. Madhu	Advanced Surveying: Total Station, GIS and Remote Sensing	Pearson Education, 1st Edition.	2007
2	M. Anji Reddy	Text book of Remote Sensing and Geographical Information systems	BS Publications	2014

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23ECE33 SPEECH RECOGNIZATION AND AUDIO PROCESSING

L	T	P	C
3	0	0	3

Course Objective:

- To introduce the models for speech production
- To develop time and frequency domain techniques for estimating speech parameters
- To introduce a predictive technique for speech compression
- To understand speech recognition, synthesis and speaker identification
- To understand homomorphic speech analysis

Course Outcomes:

23ECC33.CO1 Explain the concepts of Speech production mechanism

23ECC33.CO2 Explain the concept of time domain methods for speech processing

23ECC33.CO3 Explain the concept of frequency domain techniques speech processing

23ECC33.CO4 Develop algorithms for speech recognition, synthesis and speaker identification

23ECC33.CO5 Explain the concepts of homomorphic speech analysis

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC33.CO1	x	x	x		x				x				x		
23ECC33.CO2	x	x	x		x				x			x	x		
23ECC33.CO3	x	x	x	x	x				x		x	x		x	x
23ECC33.CO4	x	x	x	x	x				x		x	x		x	x
23ECC33.CO5	x	x	x	x	x				x		x	x		x	x

Unit-I NATURE OF SPEECH SIGNAL **9**

Speech production mechanism, Classification of speech, sounds, nature of speech signal, models of speech production. Speech signal processing: purpose of speech processing, digital models for speech signal, Digital processing of speech signals, Significance, short time analysis

Unit-II TIME DOMAIN METHODS FOR SPEECH PROCESSING **9**

Time domain parameters of speech, methods for extracting the parameters, Zero crossings, Auto correlation function, pitch estimation.

Unit-III FREQUENCY DOMAIN METHODS FOR SPEECH PROCESSING **9**

Short time Fourier analysis, filter bank analysis, spectrographic analysis, Format extraction, pitch extraction, Analysis - synthesis systems

Unit-IV LINEAR PREDICTIVE CODING OF SPEECH 9

Formulation of linear prediction problem in time domain, solution of normal equations, Interpretation of linear prediction in auto correlation and spectral domains

Unit-V HOMOMORPHIC SPEECH ANALYSIS 9

Central analysis of speech, format and pitch estimation, Applications of speech processing - Speech recognition, Speech synthesis and speaker verification

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	L.R. Rabiner and R.E Schafer	Digital processing of speech signals	Prentice Hall	1978
2	J.L Flanagan	Speech Analysis Synthesis and Perception	Sprenger Vertag Second edition	1972

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	I.H.Witten	Principles of Computer Speech	Academic press	1983
2	Thomas F. Quatieri	Discrete-time Speech Signal Processing: Principles and Practice	Prentice Hall, Signal Processing Series	2002
3	Tokunbo Ogunfunmi, Roberto Togneri, Madihally Narasimha	Speech and Audio Processing for Coding, Enhancement and Recognition	Springer	2015

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23ECE34	MULTIMEDIA SIGNAL PROCESSING	L	T	P	C
		3		0	3

Course Objective:

- To Understand encoding and decoding of digital data streams
- To Be familiar with the generation of codes and their decoding techniques
- To Be aware of compression and decompression techniques
- To Learn the concepts of multimedia communication
  To Learn applications of video compression

Course Outcomes:

23ECE34.CO1 Explain encoding and decoding of digital data streams

23ECE34.CO2 Explain the different coding techniques

23ECE34.CO3 Describe Contour based compression and Motion estimation techniques.

23ECE34.CO4 Explain the concepts of multimedia communication

23ECE34.CO5 Able to learn applications of video compression

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE34.CO1	x	x	x	x									x		
23ECE34.CO2	x	x	x	x								x	x		
23ECE34.CO3	x	x	x	x	x						x	x		x	x
23ECE34.CO4	x	x	x	x	x						x	x		x	x
23ECE34.CO5	x	x	x	x	x						x	x		x	x

Unit-I INTRODUCTION **9**

Special features of Multimedia – Graphics and Image Data Representations ¬Fundamental Concepts in Video and Digital Audio – Storage requirements for multimedia applications ¬Need for Compression - Taxonomy of compression techniques – Overview of source coding, source models, scalar and vector quantization theory – Evaluation techniques – Error analysis and methodologies

Unit-II TEXT COMPRESSION **9**

Compaction techniques – Huffmann coding – Adaptive Huffmann Coding – Arithmetic coding – Shannon - Fano coding – Dictionary techniques – LZW family algorithms

Unit-III AUDIO COMPRESSION **9**

Audio compression techniques - μ- Law and A-Law companding. Speech compression- waveform codes source codes hybrid codes- Shorten compressor, Frequency domain and filtering – Basic sub band coding – Application to speech coding – G.722 –Application to audio coding – MPEG audio, progressive encoding for audio – Silence compression, speech compression techniques – Formant and CELP Vocoders

Unit-IV IMAGE COMPRESSION 9

Predictive techniques – DM, PCM, DPCM: Optimal Predictors and Optimal Quantization– Contour based compression – Transform Coding – JPEG Standard – Sub band coding algorithms: Design of Filter banks – Wavelet based compression: Implementation using filters – EZW, SPIHT coders – JPEG 2000 standards – JBIG, JBIG2 Standards

Unit-V VIDEO COMPRESSION 9

Video compression techniques and standards – MPEG Video Coding I: MPEG – 1 and 2 MPEG Video Coding II: MPEG – 4 and 7 – Motion estimation and compensation techniques – H.261 Standard – DVI technology – PLV performance – DVI real time compression – Packet Video

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Khalid Sayood	Introduction to Data Compression	Morgan Kauffman Harcourt India	2000
2	David Salomon	Data Compression	Springer Verlag New York Inc	2001
3	Yun Q.Shi, Huifang Sun	Image and Video Compression for Multimedia Engineering Fundamentals, Algorithms & Standards	CRC press	2003

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Peter Symes	Digital Video Compression	McGraw Hill Pub	2004
2	Mark S.Drew, ZeNian Li	Fundamentals of Multimedia	PHI, 1st Edition	2003

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		L	T	P	C
23ECE35	**COMPUTER VISION**	**3**	**0**	**0**	**3**

Course Objective:

- To Learn digital image formation and low level processing
- To Understand the concept of depth estimation and multi camera view
- To Be familiar with feature extraction
- To Learn to image segmentation
- To Understand the pattern analysis

Course Outcomes:

23ECE35.CO1 Explain the concepts of digital image formation and low level processing.

23ECE35.CO2 Explain the concept of depth estimation and multi camera view

23ECE35.CO3 Apply feature extraction in digital images.

23ECE35.CO4 Develop algorithms for image segmentation.

23ECE35.CO5 Explain the pattern analysis

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE34.CO1	x	x	x	x									x		
23ECE34.CO2	x	x	x	x								x	x		
23ECE34.CO3	x	x	x	x	x						x	x		x	x
23ECE34.CO4	x	x	x	x	x						x	x		x	x
23ECE34.CO5	x	x	x	x	x						x	x		x	x

Unit-I DIGITAL IMAGE FORMATION AND LOW LEVEL PROCESSING **9**

Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.

Unit-II DEPTH ESTIMATION AND MULTI CAMERA VIEWS **9**

Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3- D reconstruction framework; Auto-calibration

Unit-III FEATURE EXTRACTION **9**

Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT

Unit-IV IMAGE SEGMENTATION **9**

Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentat Object detection

Unit-V PATTERN ANALYSIS **9**

Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rafael C. Gonzales, Richard E. Woods	Digital Image Processing.	Pearson education	2010.
2	A.K. Jain	Fundamentals of Digital Image Processing.	Prentice Hall India	1988

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Madhuri.A. Joshi,	Digital Image Processing – an algorithmic approach	PHI Publisher	2006
2	S.Sridher	Digital Image Processing	Oxford University Press	2011
3	Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins,	Digital Image Processing using MATLAB	Tata McGraw Hill Pvt. Ltd.,	2011
4	Willliam K Pratt,	Digital Image Processing	John Willey	2002
5	Malay K. Pakhira,	Digital Image Processing and Pattern Recognition	PHI Learning Pvt. Ltd.	2011

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23ECE36	SYSTEM DESIGN FOR SUSTAINABILITY	L	T	P	C
		3	0	0	3

Course Objective:

- To learn about sustainable product design
- To understand the product life cycle design
- To get the knowledge on Product Service System Design
- To explain the methods and tools for sustainable product design
- To define engineering design criteria for Sustainable

Course Outcomes:

23ECE36.CO1 Understand the importance of Sustainable Product Design

23ECE36.CO2 Know about the product life cycle design for sustainability

23ECE36.CO3 Extract the Product Service System Design Types

23ECE36.CO4 Practice with Methodologies and Tools for Sustainable Product Design

23ECE36.CO5 Interpret the Engineering Design Criteria and Guidelines for Sustainable

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE36.CO1	x	x	x	x									x		
23ECE36.CO2	x	x	x	x								x	x		
23ECE36.CO3	x	x	x	x					x		x	x		x	x
23ECE36.CO4	x	x	x	x					x		x	x		x	x
23ECE36.CO5	x	x	x	x					x		x	x		x	x

Unit-I PRODUCT SERVICE SYSTEM DESIGN FOR SUSTAINABILITY **9**

Sustainable Development – Sustainability: Dimensions, Radical Changes - Evolution of sustainability within Design – Sustainability within a context in strong evolution – The diverse paths towards sustainability.

Unit-II PRODUCT LIFE CYCLE DESIGN **9**

Product Service System Design (PSS): Approaches and Skills – Design Criteria for eco-efficiency - Design Criteria for Social Equity and Cohesion – PSS for Sustainability in Asia – Product Life Cycle: Methods & Strategies, Software Tools.

Unit-III SUSTAINABLE COMPONENTS AND PSS **9**

Environmentally Friendly Workspaces - The Stakeholder Model - Sustainable Mission Statements - Lean/Agile Workflows - Software Frameworks - Open Source and Sustainability - Potential Barriers and Workarounds – A Tale of Green Hosting Woe – PSS: Definition, Types & Examples, Transition Path and Challenges

Unit-IV SUSTAINABLE DESIGN **9**

Challenges in Design for Sustainability - From green design to design for sustainability transitions – Product Eco- Design – Design Practice – Emotionally Durable Design - Designing for Sustainable: Methods and Tools.

Unit-V DESIGN PRACTICES **9**

Supporting communities in place-based innovations: Design Practices, Methods and Tools, Limitations - Design for Sustainability – Engineering Design Criteria and Guidelines - Other Design for Sustainability Tools and approaches

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Carlo Vezzoli et al	Product-Service System Design for Sustainability	Routledge	2014
2	Fabrizio Ceschin and İdil Gaziulusoy	Design for Sustainability: A Multi-level Framework from Products to Socio-technical Systems	Routledge	2020

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Tim Frick	Designing for Sustainability	O'Reilly	2016
2	Joseph Fiksel	Design for Environment: A Guide to Sustainable Product Development	The McGraw-Hill Companis, Inc	2009
3	Daniel A. Vallero, Chris Brasier	Sustainable Design: The Science of Sustainability and Green Engineering	Wiley	2008
4	Tracy Bhamra and Ricardo J. Hernandez	Thirty years of design for sustainability: an evolution of research, policy and Practice	Cambridge University Press	2021

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23ECE37	INNOVATION, BUSINESS MODELS AND ENTREPRENEURSHIP	L	T	P	C
		3	0	0	3

Course Objective:

- To learn about creative thinking
- To understand the importance of Innovation
- To know about patent and IPR
- To learn how to become an entrepreneur
- To understand Innovation Sustainable Conditions

Course Outcomes:

23ECE37.CO1 Identify the Key Components of Creative Thinking and Innovation Management

23ECE37.CO2 Define the Technology Innovation and Innovation Management

23ECE37.CO3 Describe the Business Models for Entrepreneurs in his/her own Perspectives

23ECE37.CO4 Recite Patent and Copyright Details

23ECE37.CO5 Recognize the sustainability of Innovation and Entrepreneurship

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE37.CO1	X	x	x	x									x		
23ECE37.CO2	X	x	x	x								x	x		
23ECE37.CO3	X	x	x	x					x		x	x		x	x
23ECE37.CO4	X	x	x	x					x		x	x		x	x
23ECE37.CO5	X	x	x	x					x		x	x		x	x

Unit-I CREATIVITY **9**

Innovation and Creativity: An Introduction, Innovation in Current Environment, Types of Innovation - Challenges of Innovation - Steps of Innovation Management - Idea Management System – Divergent V/s Convergent Thinking – Design Thinking and Entrepreneurship

Unit-II TECHNOLOGICAL INNOVATION AND MANAGEMENT **9**

Experimentation in Innovation Management - Idea Championship – Participation for Innovation – Co-creation for Innovation – Prototyping to Incubation – Marketing of Innovation – Technology Innovation: Process, Management Planning, Management Strategies – Technology Forecasting

Unit-III BUSINESS MODEL **9**

Analyzing the Current Business Scenario - Business Models and value proposition – Business Model Failure: Reasons and Remedies – Incubators: Business Vs Technology, Managing Investor for Innovation – Future markets and Innovation needs for India.

Unit-IV IPR **9**

Management of Innovation - Creation of IPR - Management of Innovation - Creation of IPR - Types of IPR - Patents and Copyrights - Patents in India

Unit-V ENTREPRENEURSHIP **9**

Sustainability Innovation and Entrepreneurship - Innovation Sustainable Conditions - Innovation: Context and Pattern - SME'S strategic involvement in sustainable development - Exploration of business models for material efficiency services

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rishikesha T.Krishnan, Vinay Dabholkar	8 Steps To Innovation : Going From Jugaad To Excellence	HarperCollins Publishers India	2013
2	Peter Drucker, Joseph Maciariello	Innovation and Entrepreneurship	Routledge	2014

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Tim Mazzarol , Sophie Reboud	Entrepreneurship and Innovation: Theory, Practice and Context	Springer	2020
2	Mike Kennard	Innovation and Entrepreneurship	Routledge	2021
3	Khanka SS	Creativity and Innovation in Entrepreneurship	Sultan Chand & Sons	2023
4	Robert D. Hisrich & Claudine Kearney	Managing Innovation and Entrepreneurship	SAGE Publications Ltd	2017

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		L	T	P	C
23ECE38	**INDUSTY 4.0 AND INDUSTRIAL IoT**	**3**	**0**		**3**

Course Objective:

- To get awareness on next generation industry technology
- To know more on IoT for Industrial Applications and key technologies
- To learn about data transmission techniques for IoT
- To learn how to apply ML techniques in IoT architectures
- To gain knowledge on inventory management

Course Outcomes:

23ECE38.CO1 Describe the Architectures, Protocols and Applications of IoT and IIoT

23ECE38.CO2 Define the Design Requirements and Security Issues of Industry 4.0

23ECE38.CO3 Recite the Key Technologies for IIoT

23ECE38.CO4 Discuss about Data Transmission Techniques and DAQ Systems for Industry 4.0

23ECE38.CO5 Discuss the Applications of AI and ML for Industry 4.0 and Safety Measures in Plant

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE38.CO1	x	x	x	x									x		
23ECE38.CO2	x	x	x	x								x	x		
23ECE38.CO3	x	x	x	x					x		x	x		x	x
23ECE38.CO4	x	x	x	x					x		x	x		x	x
23ECE38.CO5	x	x	x	x					x		x	x		x	x

Unit-I IoT & IIoT **9**

IoT: Architectures, Application Based Protocols, Big Data – Industrial IoT: IIoT and Industry 4.0 – IIC – Industrial Internet Systems – Industrial Sensing – Industrial Processes – Business Models of IIoT – Reference Architecture of IIoT – IIRA

Unit-II INDUSTRY 4.0 **9**

Industry Revolutions – Design Requirements of Industry 4.0 – Drivers of Industry 4.0 – Sustainability Assessment of Industries – Smart Business – Cyber Security – Impact of Industry 4.0.

Unit-III KEY TECHNOLOGIES **9**

Off-Site Technologies: Cloud Computing and Fog Computing – Onsite Technologies: Augmented Reality, Virtual Reality, Big Data and Advanced Analytics – Smart Factories – Sensors and Actuators: Categories and Characteristics

Unit-IV DATA TRANSMISSION & DAQ **9**

Industrial Data Transmission: Foundation Field Bus, Profibus, CAN, LoRa and LoRaWAN, NB-IoT, IEEE 802.11AH – Industrial DAQ Systems: DCS, PLC and SCADA – IIoT Analytics: Necessity and Usages.

Unit-V AI, ML AND APPLICATIONS 9

Machine Learning and Deep Learning: Categories and Applications – Inventory Management and IIoT – Quality Control – IIoT Applications for undertaking safety measures in plant.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Sudip Misra, Chandana Roy, Anandarup Mukherjee	Introduction to Industrial Internet of Things and Industry 4.0	CRC Press	2021
2	Alasdair Gilchrist	Industry 4.0: The Industrial Internet of Things	Springer	2016

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Jyotir Moy Chatterjee, Harish Garg, R. N. Thakur	A Roadmap for Enabling Industry 4.0 by Artificial Intelligence	Scrivener Publishing LLC	2022
2	Aboul Ella Hassanien, Jyotir Moy Chatterjee, Vishal Jain	Artificial Intelligence and Industry 4.0	Elsevier	2022
3	Yilmaz Uygun	Industry 4.0: Principles, Effects and Challenges	Nova Press	2020
4	Bruno S. Sergi et al	Understanding Industry 4.0: AI, the Internet of Things, and the Future of Work	Emerald Publisher	2019

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23ECE39	KNOWLEDGE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objective:

- To know the importance of Knowledge Management
- To learn about KM systems and applications
- To identify the tools for Knowledge Management, Ethical and Legal Issues
- To understand data mining process
- To gain knowledge on ethical issues

Course Outcomes:

23ECE39.CO1 Understand the importance of Knowledge Management in Real Life

23ECE39.CO2 Discuss about Knowledge Codification and System Implementation

23ECE39.CO3 Recite the KM Systems and Analysis

23ECE39.CO4 Relate the Suitable Tools and Portals for KM Systems

23ECE39.CO5 Describe the Ethical and Legal Issues for KM

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE39.CO1	x	x	x	x									x		
23ECE39.CO2	x	x	x	x								x	x		
23ECE39.CO3	x	x	x	x					x		x	x			
23ECE39.CO4	x	x	x	x					x		x	x		x	x
23ECE39.CO5	x	x	x	x					x		x	x		x	x

Unit-I KNOWLEDGE CREATION AND CAPTURE **9**

Introducing the concept of KM: Why KM, KM system life cycle, and aligning KM and business strategy – KM Cycle: Knowledge creation, capturing tacit knowledge, Types of knowledge and its implications for KM.

Unit-II KNOWLEDGE CODIFICATION AND SYSTEM IMPLEMENTATION **9**

Knowledge Codification – System Testing and Deployment – Knowledge Transfer and Knowledge Sharing – Knowledge Transfer in the E-World.

Unit-III KM ANALYSIS **9**

Analysis design and development – Knowledge Infrastructure – Knowledge audit – Knowledge Team – Knowledge Management System: Analysis, Design and Development

Unit-IV KM SYSTEM TOOLS AND PORTALS 9

Learning From Data - Data Mining: Knowing the Unknown – KM Tools and Knowledge Portals

Unit-V ETHICAL, LEGAL, AND MANAGERIAL ISSUES 9

Who Owns Knowledge? – Managing Knowledge Workers – Where Do We Go from Here?

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Awad, E.M	Knowledge Management	Pearson India	2007
2	Fernandez I. B. and Sabherwal, R	Knowledge Management: System and Resources	PHI Delhi	2010

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Kimiz Dalkir	Knowledge Management in Theory and Practice	Elsevier	2005
2	Tiwana Amrit	The Knowledge Management Toolkit	Prentice Hall PTR	1999
3	Klaus North , Gita Kumta	Knowledge Management: Value Creation Through Organizational Learning	Springer	2018
4	Peter Massingham	Knowledge Management: Theory in Practice	SAGE Publications	2019

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23ECE40	PROJECT MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objective:

- To get the knowledge on Effective Project Management
- To know the importance of Organizational Culture and Time Management
- To understand the Risk Management and Resource Scheduling
- To practice the different stages of Project works through various methods
- To gain knowledge on project management

Course Outcomes:

23ECE40.C01 Identify the suitable portfolio management systems for effective project management

23ECE40.CO2 Describe the management structures and organizational culture for projects

23ECE40.CO3 Explain the Importance of Cost and Time Management for Projects

23ECE40.CO4 Outline risk management and resource scheduling

23ECE40.CO5 Recite the stages of project process and project evaluation methods

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECE40.CO1	x	x	x										x		
23ECE40.CO2	x	x	x	x								x	x		
23ECE40.CO3	x	x	x	x					x		x	x			
23ECE40.CO4	x	x	x	x					x		x	x		x	x
23ECE40.CO5	x	x	x	x					x		x	x		x	x

Unit-I PROJECT MANAGEMENT AND PORTFOLIO SYSTEM **9**

The Importance of Project Management - The Strategic Management Process - Scenario Planning - The Need for an Effective Project Portfolio Management System - A Portfolio Management System - Applying a Selection Model - Managing the Portfolio System

Unit-II ORGANIZATIONAL CULTURE **9**

Project Management Structures - Right Project Management Structure - Organizational Culture - Implications of Organizational Culture for Organizing Projects - Project Definition, Activities and Work Breakdown structure

Unit-III PLANNING AND ESTIMATION **9**

Project time and cost estimation - Time Management - Developing Project Plan - Network Analysis using PERT/ CPM technique - Risk Management Process - Contingency Planning - Opportunity Management

Unit-IV RESOURCE MANAGEMENT **9**

Resource Scheduling Problem - Resource Constraints - Scheduling Problem - Resource Allocation Methods - Splitting Activities - Benefits of Scheduling Resources - Reducing Project duration - Crashing project Activities - Project Risk Management - Identification, quantification, and mitigation of risks

Unit-V PROCESS OF PROJECT MANAGEMENT **9**

Project Outsourcing, Negotiation - Managing inter-organizational Relations - Project Procurement and Contract Management - Project Evaluation - Project progress and Performance Management - Project Closure, and Project Oversight - Familiarization with Project Management software.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Gray, C.F., Larson, E.W., and Joshi, R	Project Management – The Managerial Process	McGraw Hill Education, 8th edition	2020
2	Jeffrey K. Pinto	Project Management – Achieving Competitive advantage	Pearson Publishing Ltd., 5 th edition	2019

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Meredith, J.R. and Mantel, S.J	Project Management: A Managerial Approach	Wiley	2011
2	Gido, J. and Clements, J.P	Successful Project Management	Cengage Learning, 6th edition	2003
3	John M. Nicholas	Project Management for Business and Technology – Principles and Practice	Prentice-Hall of India Ltd	2008
4	Prasanna Chandra	Projects Planning, Analysis, Selection, Implementation & Review	Tata-McGraw Hill Publishing	2011

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23ECC01	SOLID STATE DEVICES	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the basics of Semiconductor Diodes.
- To impart knowledge on the working principle and characteristics of BJT.
- To learn the operation and characteristics of FET.
- To familiarize the biasing techniques of BJT and FET.
- To understand the working principle of special diodes and opto electronic devices.

Course Outcomes:

23ECC01.C01 Explain the construction and operation of semiconductor diodes
23ECC01.C02 Demonstrate the characteristics of BJT
23ECC01.C03 Demonstrate the characteristics of BJT
23ECC01.C04 Explain the biasing techniques of BJT and FET
23ECC01.C05 To understand the working principle of special diodes and opto electronic devices.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC01.C01	x	x	x	x	x				x		x		x	x	x
23ECC01.C02	x	x	x	x	x				x		x		x	x	x
23ECC01.C03	x	x	x	x	x				x		x	x	x	x	x
23ECC01.C04	x	x	x	x	x				x		x	x	x	x	x
23ECC01.C05	x	x	x	x	x				x		x	x	x	x	x

Unit-I SEMICONDUCTOR DIODES **9**

Review of Semiconductor Physics-Drift and diffusion currents-Continuity Equation-Theory of PN Junction Diode-Diode Current Equation-Current Voltage Characteristics-Effect of Temperature on PN Junction diodes-Diffusion Capacitance-Applications: Rectifiers, Clippers, Clampers-Avalanche Breakdown Mechanism-Zener Diode as a Voltage Regulator.

Unit-II BIPOLAR JUNCTION TRANSISTORS **9**

Bipolar Junction Transistor Operations-Configurations: CC, CB, CE-Transistor Current Components-Ebermoll's Model of Transistor-Small Signal Low Frequency Hybrid-High Frequency Effects-Transistor as an Amplifier and Switch.

Unit-III FIELD EFFECT TRANSISTOR **9**

Operation and Characteristics of JFET-Configurations of JFET-JFET as Amplifier, Switch, Voltage Variable Resistor-Metal Oxide Semiconductor Field Effect Transistor (MOSFET)-Enhancement and Depletion Mode MOSFET-Characteristics of n-MOS and p-MOS-Introduction to CMOS.

Unit-IV BIASING OF BJT AND FET 9

DC operating point and Load line-Q point-Bias Stability-Transistor Biasing Methods: Fixed Bias-Collector to Base Bias-Self biasing, Thermal Runaway, Thermal Stability-FET biasing methods: Self bias-Source bias-Voltage divider bias-Biasing MOSFETs.

Unit-V SPECIAL DIODES AND OPTO ELECTRONIC DEVICES 9

Theory and Characteristics of Tunnel Diode-Varactor Diode-SCR-TRIAC-LDR-UJT-Photoemissivity and Photoconductivity-Photoconductive Cell-Photo Voltaic Cell-Photodiode-Phototransistors-Construction and Characteristics of LED - Opto Couplers, FINFET.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Jacob Millman, Christos Halkias & Satyabrata Jit, Millman's	Electronic Devices and Circuits	McGraw Hill	2008
2.	Robert L. Boylestad, Louis Nashelsky	Electronic Devices and Circuit Theory	Pearson education	2012

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Allen Mottershead	Electronic Devices and Circuits	Prentice Hall of India	2008
2.	Douglas. A.Pucknell, Kamran Eshraghian	Basic VLSI Design, Principles and Application	Prentice Hall of India	2009
3.	S.Salivahanan, N.Sureshkumar and A.Vallavaraj	Electronic Devices and Circuits	Tata McGraw Hill	2008
4.	Donald A. Neamen	Semiconductor Physics and Devices	Tata McGraw Hill	2017
5.	S. M. Sze	Semiconductor Devices: Physics and Technology	Wiley	2016

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		L	T	P	C
23ECC02	**CIRCUIT THEORY AND ANALYSIS**	**3**	**0**	**0**	**3**

Course Objective:

- To impart knowledge on Laws and Theorems of electrical networks
- To understand the concepts of A.C. circuits
- To know the parameters of two port network
- To gain knowledge of Laplace Transform for circuit analysis
- To understand the concept of three phase circuit

Course Outcomes:

23ECC02.C01	Apply networks theorems to circuit theory problems
23ECC02.C02	Analyze the phasor relation between the components in the given circuit
23ECC02.C03	Summarize the various parameters of a two port network
23ECC02.C04	Apply Laplace Transform to circuit theory problems
23ECC02.C05	Explain the power and power factor measurements in three phase circuit.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC02.C01	x	x	x								x	x	x		
23ECC02.C02	x	x	x								x	x	x		
23ECC02.C03	x	x	x	x	x				x		x	x		x	x
23ECC02.C04	x	x	x	x	x				x						x
23ECC02.C05	x	x	x	x					x						

Unit-I DC CIRCUITS AND NETWORK THEOREMS 9

Basic circuit elements - Ohm's law - Resistors in series and parallel circuits - Voltage division and current division- Kirchhoff's laws - Source transformation - Star-Delta conversion - Mesh and Nodal analysis- Thevenin's theorem-Norton's theorem - Superposition theorem - Maximum power transfer theorem.

Unit-II AC CIRCUITS 9

Introduction to AC circuits- Form Factor - Phase and phase difference - Sinusoidal Voltage and Current - Single phase AC circuits - Series RL, RC and RLC circuits - Power - Power factor.

Unit-III TWO PORT NETWORK AND RESONANCE CIRCUITS 9

Two port Network: One port network, Impedance Parameter, Admittance Parameter, Transmission line, Hybrid Parameter and their inter- relationship, Frequency Response: Resonant Frequency of circuits with L and C, Quality Factor and Bandwidth, Frequency and Magnitude scaling.

Unit-IV APPLICATION OF LAPLACE TRANSFORM TO CIRCUIT ANALYSIS 9

Complex frequency and LT**:** complex frequency, Damped Sinusoidal forcing function, Introduction to Laplace Transform and Inverse Transform techniques - Transient response of RL, RC and RLC Circuits using Laplace

transform for DC input

Unit-V THREE PHASE CIRCUITS **9**

Three phase balanced / unbalanced voltage sources - Analysis of three phase 3-wire and 4-wire circuits with star and delta connected loads, balanced & un balanced loads - Phasor diagram of voltages and currents - Power and Power factor measurements in three phase circuits.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	W.H.Hayt, J.E.Kimmerly and S.M.Durbin	Engineering circuit analysis	McGraw Hill Education private limited,	2013
2.	Charles K Alexander, Mathew N.O Sadiku	Fundamentals of Electric circuits	McGraw Hill	2004

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Sudhakar A and Shyam Mohan SP	Circuits and Network Analysis and Synthe- sis	Tata McGraw Hill	2007.
2.	Mahmood Nahvi and Joselph Edminister	Electric Circuits	Schaum's Outline series,	2004.
3.	Charles K.	Fundamentals of Electric Circuits	McGraw Hill	2003.
4.	S. K. Bhattacharya	Basic Electrical and Electronics Engineering	Pearson Education; First edition	2011
5.	D P Kothari and I J Nagrath	Basic Electrical and Electronics Engineering	McGraw Hill Education (India) Private Limited	2014

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23ECC03	ANALOG ELECTRONICS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the concept of BJT and FET Amplifiers
- To impart knowledge on the working of Power and Feedback amplifiers
- To know the construction of oscillators
- To understand mathematical analysis of Tuned Amplifiers.
- To know principles of blocking oscillator and time base generators

Course Outcomes:

23ECC03.C01 Explain the working of BJT and FET amplifiers

23ECC03.C02 Outline the working of Power and Feedback amplifiers

23ECC03.C03 Distinguish different types oscillators and Multivibrators

23ECC03.C04 Explain the concept of tuned amplifiers

23ECC03.C05 Summarize the types of blocking oscillator and time base generator

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC03.C01	x	x	x	x	x						x		x		x
23ECC03.C02	x	x	x	x	x	x	x				x		x		x
23ECC03.C03	x	x	x	x	x	x	x				x		x		x
23ECC03.C04	x	x	x	x	x	x	x				x		x		x
23ECC03.C05	x	x	x	x	x						x		x		x

Unit-I BJT AND FET AMPLIFIERS **9**

BJT and FET Amplifiers -Method of drawing small-signal equivalent circuit- Analysis of transistor amplifier Configurations-current and voltage gain, input and output impedance -Differential amplifiers- CMRR-Darlington Am- plifier- Bootstrap technique.

Unit-II POWER AMPLIFIERS AND FEEDBACK AMPLIFIERS **9**

Large signal Amplifiers – Class A, Class B , Class C Power Amplifiers, Class AB and Class D Power Amplifiers-output power and conversion efficiencies. Feedback Concept – Feedback topologies - Properties - Feedback Ampli- fiers - Stability Analysis

Unit-III OSCILLATORS AND MULTIVIBRATORS **9**

Condition for Oscillation - Sinusoidal Oscillators: RC Oscillators(Phase shift, Wien Bridge) and LC Oscillators(Hartley, Colpitts, Clapp)–Non-sinusoidal oscillators: Astable, monostable, bistable Multivibrators and Schmitt Trigger.

Unit-IV TUNED AMPLIFIERS **9**

Principle of Tuned Amplifiers - loaded and unloaded Q of tank circuits, small signal tuned amplifiers - Analysis of capacitor coupled single tuned amplifier – double tuned amplifier - effect of cascading single tuned and double tuned amplifiers on bandwidth- Class C tuned amplifiers and their applications-Stagger tuned amplifier

Unit-V BLOCKING OSCILLATORS AND TIME BASE GENERATORS **9**

UJT saw tooth waveform generator, Pulse transformers – equivalent circuit – applications, Blocking Oscillator – Free running blocking oscillator - Astable Blocking Oscillators with base timing – Push-pull Astable blocking oscil- lator with emitter timing, Triggered blocking oscillator – Monostable blocking oscillator with base timing – Mono- stable blocking oscillator with emitter timing, Time base circuits - Voltage-Time base circuit, Current-Time base circuit

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Adel .S. Sedra, Kenneth C. Smith	Micro Electronic Circuits	Oxford Uni- versity Press	2013
2.	David A. Bell	Electronic Devices and Circuits	Oxford Higher Education Press	2010

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Donald .A. Neamen	Electronic Circuit Analysis and Design	Tata McGraw Hill	2009
2.	Floyd	Electronic Devices	Pearson Education	2002
3.	Millman J. and Taub H	Pulse Digital and Switching Waveforms	TMH	2000
4.	Robert L. Boylestad and Louis Nasheresky	Electronic Devices and Circuit Theory	Pearson Edu- cation / PHI	2008
5.	S. Salivahanan, N. Suresh Kumar and A. Vallavaraj	Electronic Devices and Circuits	TMH	2007

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23ECC04	DIGITAL SYSTEM DESIGN	L	T	P	C
		3	0	0	3

Course Objective:

- To introduce Boolean Algebra to simplify the logical expressions
- To introduce the design of combinational circuits
- To impart knowledge on sequential circuits
- To gain knowledge on state table and execution table
- To provide the basic knowledge of Verilog HDL and its uses

Course Outcomes:

23ECC04.C01 Explain the construction and operation of semiconductor diodes

23ECC04.C02 Demonstrate the characteristics of BJT

23ECC04.C03 Demonstrate the characteristics of BJT

23ECC04.C04 Explain the biasing techniques of BJT and FET

23ECC04.C05 To understand the working principle of special diodes and opto electronic devices.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC04.C01	x	x	x	x							x		x		
23ECC04.C02	x	x	x	x							x	x	x		
23ECC04.C03	x	x	x	x	x				x		x	x	x	x	x
23ECC04.C04	x	x	x	x	x				x		x	x	x	x	x
23ECC04.C05	x	x	x	x	x				x		x	x	x	x	x

Unit-I BASIC CONCEPTS OF DIGITAL SYSTEMS AND LOGIC FAMILIES **9**

Review of Number Systems, Number Representation, Logic Gates and Binary Operations-Exclusive–OR and Exclusive– NOR Implementations of Logic Functions using gates, NAND–NOR implementations – Multi level gate implementations- Multi output gate implementations-Boolean postulates and laws – De-Morgan's Theorem - Principle of Duality, Boolean function, Canonical and standard forms, Minimization of Boolean functions, Minterm, Maxterm, Sum of Products (SOP), Product of Sums (POS),Karnaugh map Minimization, Don't care conditions.

Unit-II COMBINATIONAL CIRCUITS **9**

Combinational logic circuits : Half adder – Full Adder – Half subtractor - Full subtractor– Parallel binary adder, parallel binary Subtractor – Fast Adder - Carry Look Ahead adder– Serial. Adder/Subtractor - BCD adder – Binary Multiplier – Binary Divider - Multiplexer/De-multiplexer – decoder - encoder – parity checker – parity generators – code converters Magnitude Comparator.

Unit-III SEQUENTIAL CIRCUITS **9**

Flip Flops – SR,JK, D and T -Master Slave – Triggering- characteristic table and equation – Application table- Asynchronous and Synchronous counters -Shift Registers- Types -Universal Shift Registers- Ring Counter-

Johnson Counter- Johnson Counters-Serial Adder / Subtractor

Unit-IV SYNCHRONOUS AND ASYNCHRONOUS SEQUENTIAL CIRCUITS **9**

Mealy and Moore models-state diagram – State table – State Minimization-State assignment – Excitation table – Design of Synchronous Sequential Circuits ; Counters and sequence generators – Circuit Implementation-Asynchronous sequential circuits – Hazards and Races, Hazard free combinational circuits

Unit-V VERILOG HDL PROGRAMMING **9**

A brief history of HDL, Structure of HDL Module, Operators, Data types, Types of Descriptions, Verilog HDL Programming : Dataflow modeling, Behavioral modeling, Structural Modeling – Test Benches, Simulation and implementation of Combinational and Sequential Circuits

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Morris Mano M. and Michael D. Ciletti	Digital Design	Pearson education	2013
2	Donald D.Givone,	Digital Principles and Design	Tata Mc-Graw Hill Publishing company limited, New Delhi	2002

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Thomas L. Floyd	Digital Fundamentals	Pearson Education Inc	2011
2	Charles H. Roth Jr,	Fundamentals of Logic Design	Jaico Publishing House	2003
3	Leach D, Malvino A P &Saha	Digital Principles and Applications	Tata McGraw-Hill Publishing Company	2014
4	John F. Wakerly,	Digital Design Principles and Practices	Pearson Education	2007
5	John.M Yarbrough	Digital Logic Applications and Design	Thomson – Vikas Publishing House	2002

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23ECC05	SIGNALS AND SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

- To Understand the Basic Properties of Signal & Systems and the Different methods of Classification.
- To Learn Laplace Transform &Fourier Transform and Their Properties.
- To Learn Continuous Time LTI System.
- To know Z transform & DTFT and their properties.
- To characterize of discrete LTI systems in the Time domain and various Transform domains.

Course Outcomes:

23ECC05.C01 Classify the given system is linear/causal/statics

23ECC05.C02 Interpret to represent the CT signal in Fourier series and transformers

23ECC05.C03 Analyze the capability of LTI system in time domain and frequency domain

23ECC05.C04 Estimate frequency components present in a deterministic DT signal

23ECC05.C05 Illustrate the concept of transfer function and determine the magnitude and phase response of LTI system

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC05.C01	x	x	x	x	x						x			x	
23ECC05.C02	x	x	x	x	x						x	x		x	
23ECC05.C03	x	x	x	x	x						x			x	x
23ECC05.C04	x	x	x	x	x						x	x		x	x
23ECC05.C05	x	x	x	x	x						x			x	x

Unit-I SIGNALS AND SYSTEMS **9**

Signals-Classification of signals- Continuous –time and Discrete time signals, Deterministic and random signal, even and odd signals, periodic and aperiodic signals, energy and power signals, Basic Continuous –time and Discrete time signals- step, impulse, Ramp, Exponential, sinusoidal ,Exponentially damped sinusoidal signals, rectangular pulse- Properties of Impulse Signal, Basic operations on signals-amplitude scaling ,addition, multiplication, differentiation and integration, Systems- Classification of systems - Static & Dynamic, Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non causal, Stable & Unstable.

Unit-II ANALYSIS OF CONTINUOUS TIME SIGNALS **9**

Fourier Series Analysis- Trigonometric Fourier Series- Exponential Form of Fourier Series, Properties of Fourier Series, Fourier Transform in CT Signal Analysis- Conditions for the Existence of Fourier Transform- Properties of Fourier Transform, Laplace Transform in CT Signal Analysis-Region of Convergence- Properties of Laplace Transform

Unit-III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS **9**

Differential Equation- Block Diagram Representation- Impulse Response- Step response- Stability, Convolution Integrals- Properties of Convolution Integrals- Graphical Method Procedure to Perform Convolution, Laplace Transform in Analyzing of RL,RC network with step and Impulse function,

Unit-IV ANALYSIS OF DISCRETE TIME SIGNALS **9**

DTFT– Properties of DTFT, Sampling theorem, Z Transform- The region of convergence for Z transform, Properties of Z Transform, The relationship between Z transform and DTFT.

Unit-V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS **9**

Difference Equation- Block Diagram Representation- Impulse Response- Convolution Sum- Properties of convolutions Analysis of Recursive and Non-recursive System.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Alan V. Oppenheim, Alan S. Willsky	Signals and Systems	Pearson Education	2015
2	P. Ramakrishna Rao	Signals and Systems	McGraw Hill	2013

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	B P Lathi	Signals and Systems	B S Publisher	2001
2	Nagrath ,Sharan	Signals and Systems	McGraw Hill	2009
3	S.Salivahanan, N.Sureshkumar and A.Vallavaraj	Signals and Systems	Tata McGraw Hill	2011
4	D.GaneshRao,SathishTunga	Signals and Systems	Pearson	2011
5	S.Haykin, B.VanVeen	Signals and Systems	John Willey &Sons,New York	1999

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23ECC06	ELECTROMAGNETIC FILELDS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the fundamentals of coordinate systems
- To impart knowledge on fields and potentials due to static charges
- To gain knowledge on static magnetic field
- To impart knowledge on Maxwell's equation
- To understand the principles of electromagnetic wave propagation

Course Outcomes:

23ECC06.C01 Translate one coordinate system in to another coordinate system

23ECC06.C02 Calculate static electric field intensity at any point

23ECC06.C03 Explain the concepts of Magnetostatics

23ECC06.C04 Apply Maxwell's equations for time varying conditions

23ECC06.C05 Develop the wave equation for various propagation mediums

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC06.C01	x	x	x	x									x		
23ECC06.C02	x	x	x	x									x		x
23ECC06.C03	x	x	x	x	x							x		x	x
23ECC06.C04	x	x	x	x	x		x				x	x		x	x
23ECC06.C05	x	x	x	x	x		x				x	x		x	x

Unit-I VECTOR ANALYSIS **9**

Introduction to Co-ordinate System – Rectangular – Cylindrical and Spherical Coordinate System –Relation between Cartesian and cylindrical coordinate system, Cartesian and spherical coordinate system- Transformation of vectors from Cartesian to cylinder, Cartesian to sphere, sphere to cylinder and vice versa and problems– Definition of Curl, Divergence and Gradient – Definition of Divergence theorem and Stokes theorem

Unit-II STATIC ELECTRIC FIELDS **9**

Coulomb's Law – Definition of Electric Field Intensity – Electric Field due to discrete charges – Electric field due to continuous charge distribution - Electric Field due to charges distributed uniformly on an infinite and finite line – Relationship between potential and electric field –Electric Flux Density – Gauss Law – Proof of Gauss Law, Poisson's and Laplace's equation – Capacitance: Capacitance of parallel plate capacitor, Boundary conditions for electric fields.

Unit-III TIME-VARYING FIELDS AND MAXWELL's EQUATIONS **9**

Biot-Savart Law– Magnetic Field intensity due to infinite and finite wire carrying current– Ampere's circuital law. Magnetic flux density –Lorentz force equation – Force on a wire carrying a current placed in a magnetic field – Torque on a loop carrying a current – Magnetic moment – Magnetic Vector Potential- Inductance of loops

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Unit-IV TIME VARYING ELECTRIC AND MAGNETIC FIELDS **9**

Faraday's law – Transformer and Motional electromotive forces - Displacement current – Maxwell's

equations in integral form and differential form –Maxwell's equation in phasor form - Poynting Vector and the flow of power – Poynting theorem.

Unit-V ELECTROMAGNETIC WAVES **9**

Uniform Plane Waves - Wave equations for conducting and non-conducting media - Wave equations in phasor form-Plane waves in good conductors, Plane waves in lossy dielectrics- Skin effect-Reflection of plane waves by a perfect conductor-Normal and oblique incidence-Reflection of plane waves by a perfect dielectric-normal incidence.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	William H.Hayt, J A Buck	Engineering Electromagnetics	Tata McGraw-Hill	2016
2	E.C. Jordan & K.G. Balmain	Electromagnetic Waves and Radiating Systems	Prentice Hall of India	2011

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	D. Ganesh Rao, C. K. Narayanappa	Engineering Electromagnetics	Cengage India Private Limited	2016
2	M.N.O.Sadiku	Elements of Engineering Electromagnetics	Oxford University Press	2007
3	Clayton.R.Paul, Keith W.Whites, Syed.A.Nasar	Introduction to Electro Magnetic Fields||	WCB/McGraw-Hill	2012
4	Carlo G. Someda	Electromagnetic Waves	CRC Press	2010
5	Gottapu Sasibhushana Rao	Electromagnetic Field Theory and Transmission Lines	Wiley Publishers	2012

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23ECC07	CONTROL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the different ways of system representations
- To know the system performance using time domain analysis and methods for improving it
- To assess the system performance using frequency domain analysis and techniques
- To understand the various controllers and compensators to improve system
- performance To introduce the state variable representation of physical systems

Course Outcomes:

23ECC07.C01 Explain different types of systems and their algebraic equations

23ECC07.C02 Predict the transient performance parameters of the system for standard input signals

23ECC07.C03 Analyze the nature of stability of the system in frequency domain

23ECC07.C04 Analyze stability and control design techniques.

23ECC07.C05 Explain the state space and variable models.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC07.C01	x	x													
23ECC07.C02	x	x	x	x										x	x
23ECC07.C03	x	x	x	x							x	x		x	x
23ECC07.C04	x	x	x	x	x						x	x		x	x
23ECC07.C05	x	x	x	x	x						x	x		x	x

Unit-I SYSTEMS AND THEIR REPRESENTATION **9**

Concepts of control systems – Open and closed loop systems – Electrical analogy of mechanical and thermal systems – Transfer function – Synchro's – AC and DC servomotors – Block diagram reduction techniques – Signal flow graphs - Transfer function of DC generator and motor.

Unit-II TIME RESPONSE ANALYSIS **9**

Standard test signals -Time response analysis – Time domain specifications – Types of test input – Impulse and step response analysis of I and II order system – Error coefficients – Generalized error series – Steady state error - Effects of P, PI, PID modes of feedback control –Time response analysis using MATLAB (only simulation).

Unit-III FREQUENCY RESPONSE ANALYSIS **9**

Frequency response – Bode plot – Polar plot -Nyquist plot – Determination of closed loop response from open loop response - Constant M and N Circles - Nichol‟s Chart - Use of Nichol‟s Chart in Control System Analysis. - Correlation between frequency domain and time domain specifications- Analysis using MATLAB (only simulation).

Unit-IV STABILITY ANALYSIS & CLASSICAL CONTROL DESIGN TECHNIQUES **9**

Characteristics equation – Routh Hurwitz criterion – Root locus construction-Nyquist stability criterion- - Stability analysis using Polar plot, Nyquist plot, Bode plot, Determination of phase margin and gain margin using Bode plot.

Unit-V STATE SPACE &VARIABLE ANALYSIS OF CONTINUOUS SYSTEMS **9**

Concept of state variables – State models for linear and time invariant Systems – Solution of state and output equation in controllable canonical form – Concepts of controllability and observability – Effect of state feedback. State Transition Matrix and its Properties.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	M. Gopal	Control Systems, Principles and Design	Tata McGraw Hill	2012
2	S.K.Bhattacharya	Control System Engineering	Pearson education	2013

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Nise	Control Systems Engineering	John wiley, 6th Edition,	2011
2	K. Ogeta Pearson	Moderncontrol Engineering	Ogeta Pearson 5th Edition	2010
3	Benjamin C. Kuo	Automatic Control systems	PHI press	2010
4	K. Ogata	Modern Control Engineering	PHI press	2012
5	S.N.Sivanandam, S.N.Deepa	Control System Engineering using Mat Lab	Vikas Publishing	2012

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23ECC08	DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

Course Objective:

- To study DFT and its applications,
- To design techniques for IIR filters
- To design techniques for FIR filters
- To study finite word length effects applications
- To study the fundamentals of multi rate filters DSP and spectrum estimations.

Course Outcomes:

23ECC08.C01	Explain the concept of Discrete Fourier Transform for computation of linear filtering and correlation
23ECC08.C02	Design IIR filters using Impulse Invariant Techniques and Bilinear Transformation Method
23ECC08.C03	Design linear phase FIR filters using Windowing Techniques and sampling method
23ECC08.C04	Analyze the effects of Finite word length on digital filters
23ECC08.C05	Explain the concept of sampling rate conversation of digital signals and Spectrum applications.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC08.C01	x	x	x	x	x						x			x	x
23ECC08.C02	x	x	x	x	x						x			x	x
23ECC08.C03	x	x	x	x	x						x			x	x
23ECC08.C04	x	x	x	x	x						x	x		x	x
23ECC08.C05	x	x	x	x	x						x	x		x	x

Unit-I FOURIER ANALYSIS OF DISCRETE TIME SIGNALS **9**

Introduction –Discrete Fourier Transform (DFT) – Properties of DFT, FFT algorithms – Radix 2 FFT algorithms: Decimation in Time and Decimation

Unit-II DESIGN OF IIR FILTER **9**

Design of IIR filters from Analog filters – Frequency Transformation in the analog domain – IIR filters Design: Butterworth filters, Chebyshev filters.-Approximation of derivatives, Impulse invariance method, Bilinear transformation. Structure of IIR filter - direct form I, direct form II, Cascade, parallel realizations

Unit-III DESIGN OF FIR FILTER **9**

Design of FIR filters – Symmetric and Anti symmetric FIR filters – Design of Linear Phase FIR filters: Windowing Techniques (Rectangular, Hamming, Henning and Blackman), Frequency sampling method, FIR filter structures - linear phase structure, direct form realizations and polyphase structure

Unit-IV FINITE WORDLENGTH EFFECTS **9**

Fixed point and floating point number representations – ADC –Quantization- Truncation and Rounding

errors - Quantization noise – coefficient quantization error – Product quantization error - Overflow error – Round off noise power - limit cycle oscillations due to product round off and overflow errors – Principle of scaling .**Dead band effects**

Unit-V MULTIRATE AND DIGITAL SIGNAL PROCESSORS **9**

Basic Multirate Operations – Decimation and Interpolation – Fractional sampling rate conversion – Interconnection of building blocks – The poly phase representation – Efficient structure of Decimation and Interpolation Spectrum Estimation: Non parametric spectrum estimation –Periodogram – Bartlett's method Minimum variance estimation Parametric methods

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	John G Proakis, Dimitris G Manolakis,	'Digital Signal Processing Principles, Algorithms and Application'	Pearson	2014
2	B.Venkataraman i&M.Bhaskar	Digital Signal Processor Architecture, Programming and Application	McGraw-Hill	2014

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	S.K.Mitra	Digital Signal Processing: A Computer based approach	McGraw-Hill	2011
2	Mark Owen	Practical Signal Processing	Cambridge University Press	2012
3	Alan V Oppenheim, Ronald W Schafer, John R Back	Discrete Time Signal Processing	Pearson	2013
4	P.RameshBabu	Digital Signal Processing	Scitech	2015
5	Sen M.Kuo, WoonSengGan Avtar Singh, S.Srinivasan	Digital Signal Processing Architectures, Implementations, and Applications	Pearson Education	2005

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23ECC09	MICROCONTROLLERS AND EMBEDDED SYSTEMS	L	T	P	C
		3	1	0	4

Course Objective:

- To understand the architecture of 8051 Microcontroller and its programming methods.
- To provide the information on PIC Microcontroller and its nature of Programming
- To impart the knowledge on ARM Cortex architecture and programming
- To introduce the embedded system and embedded
- firmware To understand the RTOS based embedded system

Course Outcomes:

23ECC09.C01 Describe the Microprocessor and Microcontroller Architecture and Programming Techniques.

23ECC09.C02 Discuss the PIC Microcontroller Architecture and its Programming.

23ECC09.C03 Summarize the ARM cortex M3 architecture and Programming Techniques.

23ECC09.C04 Illustrate the features of embedded systems and embedded firmware

23ECC09.C05 Demonstrate the RTOS based Embedded system design

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC09.C01	x	x	x	x										x	
23ECC09.C02	x	x	x	x							x			x	
23ECC09.C03	x	x	x	x	x				x		x	x		x	
23ECC09.C04	x	x	x	x	x				x		x	x		x	x
23ECC09.C05	x	x	x	x	x				x		x	x		x	x

Unit-I INTRODUCTION TO MICROPROCESSORS AND MICROCONTROLLERS **9**

Architecture of 8085 and 8086 – Addressing modes, instruction set and assembly language programming with 8086 – Architecture of 8051 microcontroller – I/O ports, Interrupts, Timers, memory organization - Addressing modes and Instruction set of 8051 - Assembly language programming, LCD, keyboard and stepper motor Interfacing.

Unit-II PIC MICROCONTROLLER **9**

Introduction to PIC Microcontrollers – PIC 16C6x architecture, PIC16Cxx pipelining, program memory considerations, addressing modes, Instruction set - simple operations - Interrupt programming - Timer programming, LCD, ADC, DAC and stepper motor Interfacing.

Unit-III ARM CORTEX M3 ARCHITECTURE AND PROGRAMMING **9**

Architecture of ARM Cortex M3, General Purpose Registers, Special Registers, exceptions, interrupts, stack operation, reset sequence - Useful instructions, Memory mapping, Bit-band operations and CMSIS, Assembly language Programming, LCD, LED, ADC, DAC and stepper motor Interfacing.

Unit-IV INTRODUCTION TO EMBEDDED SYSTEMS AND EMBEDDED FIRMARE **9**

Introduction to Embedded Systems, Classification, Characteristics and Quality Attributes of Embedded Systems- Core of the Embedded System - Memory – Communication interface - Sensors and Actuators - Reset Circuit, Brown-out Protection Circuit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.

Unit-V RTOS BASED EMBEDDED SYSTEM DESIGN **9**

RTOS – Definition, Characteristics – Task, Process and Threads, Task scheduling, Synchronization, Communication – Embedded system design with MicroC/OS-II and VxWorks – Case study of Digital camera.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Mohamed Ali Mazidi, Janice GillispieMazidi, RolinMcKinlay	The 8051 Microcontroller and Embedded Systems: Using Assembly and C	Pearson Education	2011
2	Shibu K.V.	Introduction to Embedded Systems	Tata McGraw Hill	2009

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Kenneth J. Ayala	The 8051 Microcontroller	Thomsan Learning	2004
2	Martin P. Bates	PIC Microcontrollers	Elsevier Science & Technology	2011
3	Dr. Yifeng Zhu	Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C	E-Man Press LLC	2015
4	Dr. K.V. K. K. Prasad	Embedded Real Time System: Concepts, Design and Programming	Dreamtech	2014
5	Rajkamal	Embedded Systems: Architecture, Programming and Design	Tata McGraw Hill	2015

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23ECC10	COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

- To understand the concept of amplitude modulation
- To describe the concepts of frequency modulation techniques.
- To discuss the working of communication systems and influence of noise over its performance.
- To gain knowledge on digital communication systems
- To understand the various digital binary modulation techniques.

Course Outcomes:

23ECC10.C01	Explain the concept of amplitude modulation and detection schemes
23ECC10.C02	Analyze the various features of frequency modulation and demodulation techniques
23ECC10.C03	Explain the working of radio transmitters and noise analysis of analog communication systems.
23ECC10.C04	Understand the basic components of digital communication systems
23ECC10.C05	Understand the concepts and working of various digital binary modulation techniques.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC10.C01	x	x	x	x	x	x	x					x			
23ECC10.C02	x	x	x	x	x	x	x					x	x		
23ECC10.C03	x	x	x	x	x	x	x					x	x	x	x
23ECC10.C04	x	x	x	x	x	x	x					x		x	x
23ECC10.C05	x	x	x	x	x	x	x					x		x	x

Unit-I AMPLITUDE MODULATION **9**

Introduction to communication system, Need for modulation, Amplitude Modulation, Definition, Time domain and frequency domain description of AM system, single tone modulation, power relations in AM waves, Time domain and frequency domain description of DSB-SC, SSB-SC and VSB-SC systems. Comparison of AM Techniques, Applications of different AM Systems

Unit-II FREQUENCY MODULATION TECHNIQUES **9**

Basic concepts, Frequency Modulation: Single tone frequency modulation, Spectrum Analysis of Sinusoidal FM Wave, Narrow band FM, Wide band FM, Constant Average Power, Transmission bandwidth of FM Wave - Generation of FM Waves with Direct and Indirect methods, Detection of FM Waves: Balanced Frequency discriminator, Phase locked loop, Comparison of FM and AM.

Unit-III RADIO TRANSMITTERS & RECEIVERS **9**

A: **Transmitters:** Block diagram of AM Transmitter and FM Transmitter. Types of Noise: Resistive (Thermal) Noise Source, Shot noise, Extraterrestrial Noise, Arbitrary Noise Sources, White Noise, Narrowband Noise- In phase and Quadrature phase components and its Properties, Average Noise Figures, Average Noise Figure of cascaded networks. Noise Analysis in AM and FM Systems.

B: **Radio Receivers**: Introduction, Receiver Types - Tuned radio frequency receiver, Super heterodyne receiver, RF section and Characteristics - Frequency changing and tracking, Intermediate frequency, AGC, AM & FM Receivers, Comparison with AM Receiver, Amplitude limiting. Frequency Division Multiplexing.

Unit-IV ELEMENTS OF DIGITAL COMMUNICATION SYSTEMS **9**

Model of Digital Communication System, Advantages of Digital Communication Systems. Pulse Analog Modulation: Introduction, PAM, PWM, PPM Modulation and Demodulation Techniques.

Pulse Digital Modulation: PCM Generation and Reconstruction, Quantization Noise, Non Uniform Quantization and Companding, DPCM, Adaptive DPCM, DM and Adaptive DM, Noise in PCM and DM.

Unit-V DIGITAL BINARY CARRIER MODULATION SCHEMES **9**

Introduction, ASK, ASK Modulator, Coherent ASK Detector, Non-Coherent ASK Detector, FSK, Bandwidth and Frequency Spectrum FSK, Non Coherent FSK Detector, Coherent FSK Detector, FSK Detection using PLL, BPSK, Coherent PSK Detection, Differential PSK.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Herbert Taub, Donald L Schilling and Goutamsoha	Principles of Communication Systems	Tata McGraw Hill	2014
2	Sam Shanmugam	Digital and Analog Communication Systems	John Wiley	2005

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Simon Haykin	Communication Systems	John Wiley & Sons	2001
2	R.P Singh and S.D.Sapre	Communication Systems - Analog and Digital	Tata McGraw Hill	2007
3	Bruce Carlson	Communication Systems	Tata McGraw Hill	2011
4	B.P.Lathi	Modern Digital and Analog Communication Systems	Oxford Press	2007
5	John G. Proakis, MasoudSalehi	Fundamentals of Communication Systems	Pearson Education	2006

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23ECC11	TRANSMISSION LINE AND WAVE GUIDES	L	T	P	C
		3	0	0	3

Course Objective:

- To introduce the concept of transmission lines
- To give knowledge on the transmission line at Radio frequencies
- To understand wave propagation in guided system
- To impart knowledge on the propagation of waves through wave
- guides To become familiar with circular waveguides and cavity resonators.

Course Outcomes:

23ECC11.C01	Calculate the parameters of a transmission lines
23ECC11.C02	Use Smith chart for impedance matching
23ECC11.C03	Explain the nature of Guided wave propagation
23ECC11.C04	Demonstrate the characteristics of TE and TM wave in a rectangular waveguide
23ECC11.C05	Explain the concept of circular waveguides

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC11.C01	x	x	x	x									x		
23ECC11.C02	x	x	x	x									x		x
23ECC11.C03	x	x	x	x	x							x		x	x
23ECC11.C04	x	x	x	x	x		x				x	x		x	x
23ECC11.C05	x	x	x	x	x		x				x	x		x	x

Unit-I TRANSMISSION LINE THEORY **9**

Transmission line parameters- General solutions of transmission line –Wavelength , velocity of propagation - Waveform distortion – The distortion less line ,Reflections on a line not terminated in Z0 - Reflection coefficient - Calculation of current, voltage, power delivered and efficiency of transmission - Open and short circuited lines - Reflection factor and reflection loss.

Unit-II TRANSMISSION LINES AT RADIO FREQUENCIES **9**

Line of zero dissipation - Constants for the line of zero dissipation - Voltages and currents on the dissipation less line- Standing Waves, Nodes, Standing wave Ratio - Input impedance of the dissipation less line - Input impedance of open and short circuited lines, Impedance transformation using Quarter wave line - Impedance matching by stubs: Single stub matching, double stub matching - Smith chart and its application – Single stub matching using Smith chart

Unit-III GUIDED WAVES **9**

Guided waves: Waves between parallel planes – Transverse Electric waves and Transverse Magnetic waves – Char- acteristics of Transverse Electric and Transverse Magnetic Waves – Transverse Electromagnetic waves – Velocities of propagation –Wave impedance.

Unit-IV RECTANGULAR WAVEGUIDES **9**

Transverse Magnetic Waves in Rectangular Wave guides – Transverse Electric Waves in Rectangular Waveguides – Characteristic of TE and TM Waves – Cutoff wavelength and phase velocity – Impossibility of TEM waves in waveguides – Dominant mode in rectangular waveguide, Wave impedances– Excitation of modes

Unit-V CIRCULAR WAVEGUIDES AND RESONATORS **9**

Transverse Electric and Transverse Magnetic waves in Circular guides - Dominant mode in Circular waveguide – Method of excitation of modes in circular waveguide – Resonators, Rectangular cavity resonators, Unloaded Q fac- tor of rectangular cavity resonator for TE_{101} mode.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	John D Ryder	Networks, Lines and Fields	Prentice Hall India	2010
2	E.C. Jordan & K.G. Balmain	Electromagnetic Waves and Radiating Systems	Prentice Hall of India	2011

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	G.S.N Raju	Electromagnetic Field Theory and Transmission Lines	Pearson Education	2005
2	Umesh Sinha	Transmission Lines and Networks	Satya Prakashan (Tech. India), New Delhi	2010
3	R. Shevgaonkar	Electromagnetic Waves	Mcgraw Hill Education	2005
4	B. Somanathan Nair	Transmission lines & Waveguides	Sanguine Technical Publishers	2006.
5	Simon Ramo, John R. Whinnery, Theodore Van Duzer	Fields and Waves in Communication Electronics	John Wiley	1994

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23ECC12	INTEGRATED CIRCUITS AND APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objective:

- To acquire knowledge of OP-AMP
- To understand the Applications of OP-AMP
- To introduce the concept of Waveform Generators
- To study the concept of Data Converters
- To impart knowledge on Filters and Voltage Regulators

Course Outcomes:

23ECC12.C01	Describe the characteristics of OP-AMP
23ECC12.C02	Develop OP-AMP Application Circuits
23ECC12.C03	Illustrate the Operation ,Applications of Waveform Generators and PLL
23ECC12.C04	Demonstrate the working of Data Converters using OP-AMP
23ECC12.C05	Outline the concept of Voltage Regulators and special function IC's

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC12.C01	x	x	x	x	x								x	x	x
23ECC12.C02	x	x	x	x	x		x		x		x		x	x	x
23ECC12.C03	x	x	x	x	x		x				x		x	x	x
23ECC12.C04	x	x	x	x	x				x		x		x		x
23ECC12.C05	x	x	x	x	x				x		x		x		x

Unit-I OPERATIONAL AMPLIFIERS **9**

Internal block diagram of OP-AMP-Constant current sources, Widlar and Wilson current sources, Current repeaters. DC Characteristics of OP-AMP: Input bias current-Input offset current-Input offset voltage – Thermal drift. AC characteristics of OP-AMP: Frequency response- Frequency compensation methods –slew rate

Unit-II APPLICATIONS OF OP-AMP **9**

Inverting and Non inverting Amplifiers-Voltage Follower-Adder-Subtractor -Instrumentation amplifier– Differentiator–Integrator–Comparators-Appplications-Logarithmic Amplifiers-Log/Antilog Modules, Precision Rectifier, Peak Detector, Sample and Hold Circuits, Schmitt Trigger. Low-pass, high-pass and band-pass, Butterworth filters

Unit-III WAVEFORM GENERATORS AND PLL **9**

Waveform Generators: Sine-wave Generators – Square / Triangle / Saw-tooth Wave generators. IC 555 Timer: Monostable operation and its applications – Astable operation and its applications. PLL: Operation of the Basic PLL-Voltage Controlled Oscillator-PLL applications

Unit-IV DATA CONVERTORS **9**

Digital to Analog Conversion: DAC Specifications – DAC circuits – Weighted Resistor DAC-R-2R Ladder, Voltage Mode and Current-Mode R - 2R Ladder types - switches for D/A converters , Analog to Digital conversion: ADC specifications-ADC circuits-Ramp Type ADC-Successive Approximation ADC-Single Slope-Dual Slope ADC-Flash Type ADC.

Unit-V REGULATORS AND SPECIAL FUNCTION ICS **9**

IC Voltage Regulators, Fixed Voltage Regulators (78/79, XX), adjustable voltage regulators-General Purpose regulator (IC 723)- Switching regulator- Switched capacitor filter IC MF10, Frequency to Voltage and Voltage to Frequency converters, Audio Power amplifier, Video Amplifier, Isolation Amplifier, Optocouplers and fibre optic IC

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	D.Roy Choudhry, Shail Jain	Linear Integrated Circuits	New Age International Pvt. Ltd	2018
2	Sedra and Smith	Microelectronic Circuits	Oxford University press	2005

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Ramakant A. Gayakwad	OP-AMP and Linear ICs	Prentice Hall / Pearson Education	2015
2	Millman and Halkias. C	Integrated Electronics,	TMH	2009
3	S.Salivahanan& V.S. Kanchana Bhaskaran	Linear Integrated Circuits||	TMH	2016
4	Ramakant A. Gayakwad	OP-AMP and Linear ICs	Prentice Hall / Pearson Education	2015
5	Millman and Halkias. C	Integrated Electronics,	TMH	2009

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23ECC13	IMAGE PROCESSING & MACHINE LEARNING	L	T	P	C
		3	0	0	3

Course Objective:

- Learn digital image fundamentals and image enhancement
- Understand the concept of Image Restoration and segmentation
- Be familiar with image compression and image representation
- Learn to machine learning algorithms Understand the Neural networks
- Understand the Neural networks

Course Outcomes:

23ECC13.C01 Explain the fundamentals of image processing and image enhancement

23ECC13.C02 Apply image processing restoration techniques and segmentation methods

23ECC13.C03 Apply image processing Compression and representations,

23ECC13.C04 Develop algorithms for machine leavening

23ECC13.C05 Explain the analysis of neural network techniques

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC13.C01	x	x	x		x				x					x	x
23ECC13.C02	x	x	x		x				x					x	x
23ECC13.C03	x	x	x		x				x					x	x
23ECC13.C04	x	x	x		x				x					x	x
23ECC13.C05	x	x	x	x	x				x					x	x

Unit-I DIGITAL IMAGE FUNDAMALENTS AND IMAGE ENHANCEMENT 9

Introduction – Origin – Steps in Digital Image Processing – Components – Elements of Visual Perception Image Sampling and Quantization – Relationships between pixels - color image processing – RGB color model – **HSV and LAB** Color model, Image Transform –DCT Image enhancement Spatial Domain: Gray level transformations Histogram processing – Basics of Spatial Filtering– Smoothing and Sharpening Spatial Filtering – Frequency Domain: Introduction to Fourier Transform – Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters

Unit-II IMAGE RESTORATION AND IMAGE SEGMENTATION 9

Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering Segmentation: Detection of Discontinuities–Edge Linking and Boundary detection – Region based segmentation--**Morphological based boundary detection**.

Unit-III IMAGE COMPRESSION AND IMAGE REPRESENTATION 9

Compression: Fundamentals – Image Compression models –Lossy Compression – Lossy Predictive Coding – Compression Standards - JPEG- MPEG, Boundary representation – Chain Code – Polygonal approximation

signature, boundary segments – Boundary description – Shape number – Fourier Descriptor, moments- Regional Descriptors – Topological feature, Texture

Unit-IV BASICS OF MACHINE LEARNING **9**

Machine learning Introduction – Supervised Unsupervised learning and Reinforcement Learning Classification and Regression: K-Nearest Neighbor, Linear Regression, Logistic Regression, Support Vector Machine (SVM) K- means clustering.

Unit-V NEURAL NETWORK **9**

Biological and Artificial Neural Network – Activation Function -McCulloch Pitts Neuron -thresholding logic Perceptron- Multilayer Perceptron Feedforward Neural Network – Backpropagation Neural Network-Adam optimizer

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Rafael C. Gonzales, Richard E. Woods	Digital Image Processing.	Pearson education	2010
2	A.K. Jain	Fundamentals of Digital Image Processing.	Prentice Hall India	1988

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Madhuri.A. Joshi	Digital Image Processing – an algorithmic approach	PHI Publisher	2006
2	S.Sridher	Digital Image Processing	Oxford University Press	2011
3	Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins,	Digital Image Processing using MATLAB	Tata McGraw Hill Pvt. Ltd.,	2011
4	Willliam K Pratt,	Digital Image Processing	John Willey	2002
5	Malay K. Pakhira,	Digital Image Processing and Pattern Recognition	PHILearning Pvt. Ltd.	2011

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23ECC14	ANTENNA AND RF ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

- To understand wave propagation in guided system
- To introduce antenna parameters and antenna arrays
- To impart knowledge on horn antenna and special antenna
- To understand the measurement of antenna parameter
- To deal with RF amplifier and matching networks

Course Outcomes:

23ECC14.C01 **Explain wave propagation in guided systems**

23ECC14.C02 Explain antenna parameters and the concept of antenna arrays

23ECC14.C03 Explain the radiation mechanism of horn antenna and special antenna

23ECC14.C04 Illustrate antenna parameter measurement techniques

23ECC14.C05 Construct RF matching networks

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC14.C01	x	x	x	x											
23ECC14.C02	x	x	x	x	x	x				x					
23ECC14.C03	x	x	x	x	x	x				x	x				x
23ECC14.C04	x	x	x	x	x		x			x	x	x		x	x
23ECC14.C05	x	x	x	x			x				x	x		x	x

Unit-I GUIDED WAVES AND WAVEGUIDES **9**

Waves between parallel planes – Transverse Electric waves and Transverse Magnetic waves – Characteristics of Transverse Electric and Transverse Magnetic Waves – Transverse Electric Waves in Rectangular Waveguides – Characteristic of TE Waves – Cutoff wavelength and phase velocity –Dominant mode in rectangular waveguide, Excitation of modes.

Unit-II ANTENNA FUNDAMENTALS AND ANTENNA ARRAYS **9**

Radiation from antenna, Basic antenna parameters: Radiation pattern, Radiation intensity, Beam area, Beam solid angle, Band width, Beam width , Directivity, Gain, Radiation Resistance, Input Impedance. Radiation from Half wave dipole, Antenna Arrays: Expression for electric field from N element Array, Broad-side array and End-Fire array - Pattern Multiplication- Binomial array.

Unit-III HORN ANTENNA AND SPECIAL ANTENNAS **9**

Mechanism of Horn antenna and its types, Parabolic reflector antennas and its feed systems, Aperture blockage, Principle of frequency independent antennas: Spiral antenna, Helical antenna, Log Periodic Dipole

Array – Micro strip antennas – Radiation mechanism – Application.

Unit-IV ANTENNA MEASUREMENTS AND PROPAGATION OF RADIO WAVES **9**

Antenna Measurements: Test Ranges, Measurement of Gain, Radiation pattern - Modes of propagation - Structure of atmosphere , Ground wave propagation , Tropospheric propagation , Virtual height, critical frequency , Maximum usable frequency, Skip distance

Unit-V RF AMPLIFIERS AND MATCHING NETWORKS **9**

RF behavior of Resistors, Capacitors and Inductors, Characteristics of Amplifiers, Amplifier power relations, Stability considerations, Stabilization Methods, Noise, Constant VSWR Circle, Matching using discrete components, Two component matching Networks, Microstrip Line Matching Networks.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	John D Kraus	Antennas for all Applications	McGraw Hill	2005
2	R.E.Collin	Antennas and Radio wave Propagation	McGraw Hill	1985

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Constantine.A.Balanis	Antenna Theory Analysis and Design	Wiley Student Edition,	2006
2	Robert S.Elliott	Antenna Theory and Design	Wiley Student Edition	2006
3	Rajeswari Chatterjee	Antenna Theory and Practice	New Age International Publishers	2006
4	S. Drabowitch	Modern Antennas	Modern Antennas	2007
5	Edward C.Jordan and Keith G.Balmain	Electromagnetic Waves and Radiating Systems	Prentice Hall of India	2006

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23ECC15	WIRELESS COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

Course Objective:

- Introduce the concepts of wireless / mobile communication using cellular environment
- Know about the various propagation models, coding.
- Understand multi access techniques used in the mobile communication.
- Know about the various propagation models, coding.
- Understand multi access techniques used in the mobile communication.

Course Outcomes:

23ECC15.C01 Test the wireless communication systems

23ECC15.C02 Apply the concepts of mobile radio propagation models

23ECC15.C03 Show the design parameters for base and mobile stations

23ECC15.C04 Identify Multiple access techniques.

23ECC15.C05 Use the latest wireless technologies and standards

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC15.C01	x	x				x									
23ECC15.C02	x	x												x	x
23ECC15.C03		x	x	x	x	x					x			x	x
23ECC15.C04		x	x	x	x	x					x	x	x	x	x
23ECC15.C05			x			x					x	x	x	x	x

Unit-I **INTRODUCTION TO WIRELESS COMMUNICATION** **9**

History and evolution of mobile radio communication-Mobile radio systems around the world-Examples of wireless communication- comparison of common wireless communication systems - Generations – Frequency reuse – Channel Assignment strategies – Handoff strategies – Interference- Trucking and Grade of service-Improving Coverage and capacity of cellular system

Unit-III **FADING AND DESIGN PARAMETERS OF BASE AND MOBILE STATION** **9**

Fading. Multipath propagation. Statistical characterization of multipath fading. Diversity Techniques. Design parameters at the base station: Antenna Location-Spacing-height configuration. Design parameters at the Mobile unit: Directional antennas -Antenna Connection and Location

Unit-IV **MULTIPLE ACCESS SCHEMES** **9**

Operation principle and working of FDMA-TDMA-CDMA-WCDMA-OFDM principle – Cyclic prefix, Windowing, PAPR -MC-CDMA –SDMA - SC-FDMA and its comparison

Unit-V **WIRELESS SYSTEMS AND STANDARDS** **9**

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – Role of Machine Learning – No SQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Andreas.F. Molisch	Wireless Communications	John Wiley, India	2010
2	T.S.Rappaport	Wireless Communications: Principles and Practice	Prentice Hall of India, Third Indian Reprint	2003

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	P. Muthu Chidambara Nathan	Wireless Communications	PHI, 1st edition	2008
2	Goldsmith	Wireless Communications	Cambridge University Press	2005
3	R. Blake	Wireless Communication Technology	Thomson Delmar,	2000
4	Stefania Sesia, Issam Toufik, and Matthew Baker	LTE – The UMTS Long Term Evolution ; From Theory to Practice	John Wiley&Sons, Ltd.	2009
5	Upena Dalal	Wireless Communication	Oxford University press	2009

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		L	T	P	C
23ECC16	**CMOS VLSI DESIGN**	**3**	**0**	**0**	**3**

Course Objective:

- To study the characteristics of MOS, CMOS transistors
- To learn CMOS process technology
- To learn techniques of chip design using programmable devices
- To learn the concepts of designing VLSI Subsystems
- To learn the concepts of modeling a digital design using HDL

Course Outcomes:

23ECC16.CO1	Explain the various IC fabrication methods
23ECC16.CO2	Design the layout of simple MOS circuit using lambda-based design rules
23ECC16.CO3	Apply the lambda-based design rules for subsystem design
23ECC16.CO4	Interpret various FPGA architectures
23ECC16.CO5	Design digital circuits using Verilog HDL

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC16.CO1	x	x	x		x										
23ECC16.CO2	x	x	x	x	x						x			x	x
23ECC16.CO3	x	x	x	x	x				x		x		x	x	x
23ECC16.CO4	x	x	x		x				x		x	x	x	x	x
23ECC16.CO5	x	x	x	x	x				x		x	x	x	x	x

Unit-I MOS TRANSISTOR THEORY 9

MOSFET– Enhancement mode & Depletion mode – Fabrication – NMOS, PMOS – CMOS fabrication – P-well, N-well, Twin-Tub, SOI – CMOS Process Enhancements – Interconnects, Circuit elements-CMOS Latch Up and Prevention

Unit-II MOS CIRCUITS AND DESIGN 9

Basic Electrical properties of MOS circuits – Ideal I-V Characteristics, C-V Characteristics DC Equations, Second Order Effects – MOSFET Scaling and Small-Geometry Effects, MOSFET Capacitances – Design Rules-Need for Design Rules- CMOS Lambda Based Design Rules-Stick Diagram and Layout for CMOS Inverter.

Unit-III SUBSYSTEM DESIGN & LAYOUT 9

Switch Logic – Pass transistors and transmission gates – Power: Dynamic Power, Static Power - Two input NMOS, CMOS gates: NOT– NAND– NOR gates – Other forms of CMOS logic – Static CMOS logic-Dynamic CMOS logic – Clocked CMOS logic - Precharged domino CMOS logic – Structured design of simple Combinational logic design– Multiplexers – Clocked sequential circuits – Two phase clocking - Charge storage - Dynamic register element – Dynamic shift register

Unit-IV PROGRAMMABLE LOGIC DEVICES 9

Programmable Logic Devices – PLA , PAL – Finite State Machine design using PLA – Introduction to FPGA – FPGA Design flow –Architecture – FPGA devices: Xilinx XC 4000 – Altera cyclone III - FPGA Interconnect Routing Procedures.

Unit-V VERILOG HDL DESIGN PROGRAMMING 9

Basic concepts: VLSI Design flow, Modeling – Structural Gate Level Modeling, Switch Level Modeling, Behavioral and RTL Modeling - Design Examples: Combinational Logic – Multiplexer, Binary Decoder, Comparator, Sequential logic- Flip Flops, Registers, and Counters, Memor

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	Douglas A.Pucknell, K. Eshragian	Basic VLSI Design	PHI	Third edition 2009
2.	Neil.H.E.Weste, KamaranEshraghian	Principles of CMOS VLSI Design	AddisoWesley Publications	Third Edition 2005

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1.	SamirPalnitkar	Verilog HDL–Guide to Digital designand synthesis	Pearson Edu-caion	2009
2.	WayneWolf	Modern VLSI Design	Pearson Edu-cation	2003
3.	EugeneD.Fabricius	Introduction to VLSI Design	Tata McGraw Hill	1990
4.	John P.Uyemura	Introduction to VLSI circuits and Systems	John Wiley and Sons	2005
5.	KeshabK.Parhi	VLSI Digital Signal Processing Systems, Design and Implementation	John Wiley, Indian Reprint	2007

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		L	T	P	C
23ECC17	**MICROWAVE AND OPTICAL ENGINEERING**	**3**	**0**	**0**	**3**

Course Objective:

- To understand the S parameter and its properties
- To impart knowledge on the generation of microwave
- To deal with the microwave measurement techniques
- To introduce the basics of optical fiber modes and signal degradation
- To understand the concept of optical fiber networks

Course Outcomes:

23ECC17.CO1	Explain the properties of S parameter
23ECC17.CO2	Explain the operation of microwave generators
23ECC17.CO3	Use microwave test bench and measuring instruments
23ECC17.CO4	Explain the concept of signal degradation in optical fiber
23ECC17.CO5	Explain the principle of optical networks

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC17.CO1	x	x	x	x										x	x
23ECC17.CO2	x	x	x	x	x						x			x	x
23ECC17.CO3	x	x	x	x	x	x			x		x	x			x
23ECC17.CO4	x	x	x	x		x			x		x	x			x
23ECC17.CO5	x	x	x	x	x	x			x		x				x

Unit-I TWO PORT NETWORK THEORY **9**

Review of Low frequency parameters: Impedance, Admittance, Hybrid and ABCD parameters, Different types of interconnection of Two port networks, High Frequency parameters, Formulation of S parameters, Properties of S parameters and its proof, Reciprocal and lossless Network.

Unit-II MICROWAVE DEVICES AND GENERATOR **9**

Attenuators, Directional couplers, E-plane , H-Plane and Magic Tee, Circulator, Isolator, Gunn diode oscillator,

High frequency effects in vacuum Tubes, Theory and application of Two cavity Klystron, Reflex Klystron oscillator, Traveling wave tube amplifier -Magnetron oscillator using Cylindrical Cavity

Unit-III MICROWAVE MEASUREMENTS 9

Measuring Instruments : Principle of operation and application of VSWR meter, Power meter, Spectrum analyzer, Network analyzer, Measurement of Impedance, Frequency, Power, VSWR, Dielectric constant, Attenuation, S- parameters

Unit-IV OVERVIEW OF OPTICAL FIBER AND SIGNAL DEGRADATION 9

Elements of Optical Fiber Systems – Basic Optical Laws and Definitions – Optical Fiber Modes and Configurations – Mode Theory for Circular Waveguides – Single Mode Fibers – Graded Index Fiber Structure – Fiber Materials – Attenuation : Absorption, Scattering Losses, Bending Losses, Core and Cladding Losses - Signal Distortion in Fibers - Characteristics of Single Mode Fibers.

Unit-V OPTICAL FIBER MEASUREMENTS AND NETWORKS 9

Fiber to Fiber Joints - Fiber splices - Optical amplifiers, Measurements: Attenuation, Dispersion, Cutoff wavelength, Power and Numerical aperture, OTDR, Basic Networks – SONET / SDH – Operational Principles of WDM - WDM Networks, Link Power budget

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Robert E Colin	Foundations for Microwave Engineering	John Wiley & Sons	2001
2	Gerd Keiser	Optical Fiber Communication	Mc Graw -Hill	2010

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	David M. Pozar	Microwave Engineering	Wiley India (P) Ltd	2011
2	Annapurna Das and Sisir K Das	Microwave Engineering	Tata McGraw Hill	2004
3	Liao, S.Y	Microwave Devices & Circuits	Prentice Hall of India	2006
4	Govind P.Agrawal	Fiber Optic Communication Systems	John Wiley & Sons	2004
5	John Gowar	Optic Communication Systems	Prentice Hall	1993

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		L	T	P	C
23ECC18	**MEMS AND NEMS**	**3**	**0**	**0**	**3**

Course Objective:

- To gain knowledge on the materials used in MEMS and NEMS Systems
- To know the fabrication process of Microsystems
- To understand the working of Micro Sensors
- To introduce the concepts of Micro actuators
- To understand the concept of Quantum Mechanics

Course Outcomes:

23ECC18.CO1 Explain various materials used in MEMS and NEMS Systems

23ECC18.CO2 Summarize the fabrication steps of MEMS

23ECC18.CO3 Demonstrate various Micro Sensors

23ECC18.CO4 Explain the designing techniques of Micro Actuators

23ECC18.CO5 Explain the Quantum Mechanics concepts

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC18.CO1	x	x	x										x		
23ECC18.CO2	x	x	x	x									x		
23ECC18.CO3	x	x	x	x								x	x		x
23ECC18.CO4	x	x	x	x							x	x	x		x
23ECC18.CO5	x	x	x	x							x	x	x		x

Unit-I INTRODUCTION TO MEMS AND NEMS **9**

Introduction to Design of MEMS and NEMS, Overview of Nano and Microelectro-mechanical Systems, Applications of Micro and Nanoelectro-mechanical systems, Materials for MEMS and NEMS: Silicon, silicon compounds, polymers, metals

Unit-II MEMS FABRICATION TECHNOLOGIES **9**

Photolithography, Ion Implantation, Diffusion, Oxidation, CVD, Sputtering Etching techniques,

Micromachining: Bulk Micromachining, Surface Micromachining, LIGA.

Unit-III MICRO SENSORS **9**

MEMS Sensors: Design of Acoustic wave sensors, Vibratory gyroscope, Capacitive Pressure sensors, Case study: Piezoelectric energy harvester.

Unit-IV MICRO ACTUATORS **9**

Design of Actuators: Actuation using thermal forces, Actuation using shape memory Alloys, Actuation using piezoelectric crystals, Actuation using Electrostatic forces, Case Study: RF Switch Design using EDA tools.

Unit-V NANO DEVICES **9**

Atomic Structures and Quantum Mechanics, Shrodinger Equation, ZnO nanorods based NEMS device: Gas sensor, Simulation of Nano-devices.

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Marc Madou	Fundamentals of Microfabrication	CRC press	1997
2	Stephen D. Senturia	Micro system Design	Kluwer Academic Publishers	2001

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Tai Ran Hsu	MEMSand Microsystems Design and Manufacture	Tata Mcraw Hill	2002
2	Chang Liu	Foundations of MEMS	Pearson Education India limited	2006
3	Sergey Edward Lyshevski	MEMS and NEMS: Systems, Devices, and Structures	CRC Press	2002
4	Cornelius T. Leondes	MEMS and NEMS Handbook Techniques and Applications	Sprinzer	2006
5	Mohamed Gad-el-Hak	The MEMS Handbook	CRC Press	2005

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23ECC19 **ENGINEERING ETHICS AND HUMAN VALUES**

L	T	P	C
3	0	0	3

Course Objective:

- To understand the human values
- To know the basic perception of professional ethics and moral issues
- To understand the role of Engineers as Experimenters
- To know the safety, responsibilities and rights
- To gain knowledge on different global issues

Course Outcomes:

23ECC19.CO1 Explain different types of systems and their algebraic equations

23ECC19.CO2 Predict the transient performance parameters of the system for standard input signals

23ECC19.CO3 Explain the role of Engineers as Experimenters

23ECC19.CO4 Describe safety, responsibilities and rights

23ECC19.CO5 Correlate different global issues

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC19.CO1								x							
23ECC19.CO2								x							
23ECC19.CO3			x			x	x	x			x	x	x		
23ECC19.CO4	x	x	x			x	x	x			x	x	x		
23ECC19.CO5	x	x	x			x	x	x			x	x	x		

Unit-I HUMAN VALUES **9**

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management

Unit-II ENGINEERING ETHICS **9**

Senses of Engineering Ethics – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg‟s theory – Gilligan‟s theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories

Unit-III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – Importance of Industrial Standards – A balanced outlook on law – Anticorruption- Occupational crime - The challenger case study.

Unit-IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

Unit-V GLOBAL ISSUES 9

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Mike W. Martin and Roland Schinzinger	Ethics in Engineering	Tata McGraw Hill	2003
2	Govindarajan M, Natarajan S, Senthil Kumar V. S S.K.Bhattacharya	Engineering Ethics – Concepts and Cases	Cengage Learning	2009

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Charles B. Fleddermann,	Engineering Ethics	Pearson Prentice Hall	2004
2	Charles E. Harris, Michael S. Pritchard and Michael J. Rabins	Engineering Ethics	Cengage Learning,	2009
3	John R Boatright	Ethics and the Conduct of Business	Pearson Education, New Delh	2003
4	Edmund G Seebauer and Robert L Barry	Fundamentals of Ethics for Scientists and Engineers	Oxford University Press	2001
5	R.Subramanian	Professional Ethics	Oxford University Press	2015

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		L	T	P	C
23ECC20	**INTERNET OF THINGS**	**3**	**0**	**0**	**3**

Course Objective:

- To understand Smart Objects and IoT Architectures.
- To learn about various IoT-related protocols
- To build simple IoT protocol and IOT technologies
- To understand network security and IoT applications
- To gain knowledge on service layer protocols

Course Outcomes:

23ECC20.CO1 Explain the concepts of IoT and its present developments.

23ECC20.CO2 Describe the architecture of IoT

23ECC20.CO3 Apply various wireless technology for IoT

23ECC20.CO4 Design a real time application using IoT

23ECC20.CO5 Design a system using various service layer protocols

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC20.CO1	x	x	x	x	x										
23ECC20CO2	x	x	x	x											
23ECC20.CO3	x	x		x	x	x					x	x		x	x
23ECC20CO4	x	x	x	x		x					x	x		x	x
23ECC20.CO5	x	x	x	x	x	x					x	x		x	x

Unit-I OVERVIEW OF IOT **9**

Introduction, Design Principles for connected Devices, Prototyping for embedded Devices, Prototyping for Physical design. IoT Enabling Technologies, IoT Levels & Deployment Templates.

Unit-II IOT ARCHITECTURE **9**

Node Structure, Sensing, Processing, Communication, Powering, Networking, Topologies, Layer/Stack architecture, IoT Standards, Cloud computing for IoT.

Unit-III WIRELESS TECHNOLOGY FOR IOT **9**

WiFi (IEEE 802.11) - Bluetooth - Bluetooth Low Energy, beacons - Bluetooth Smart - ZigBee/ZigBee Smart – RFID - UWB (IEEE 802.15.4) - 6LoWPAN – LoRaWAN - Proprietary systems

Unit-IV BUILDING IOT WITH RASPBERRY PI **9**

RASPBERRY PI: Introduction to RaspberryPi, About the RaspberryPi Board: Hardware Layout, Operating Systems on RaspberryPi, Installing Raspberry Pi, Connecting Raspberry Pi via SSH. Linux on Raspberry Pi, - Raspberry Pi Interfaces – Programming- APIs / Packages - Web services

Unit-V DATA ANALYTICS AND SUPPORTING SERVICES **9**

Structured Vs Unstructured Data and Data in Motion Vs Data in Rest – IoT Data Analytics overview - Role of Machine Learning – NoSQL Databases – Hadoop Ecosystem – Apache Kafka, Apache Spark – Edge Streaming Analytics and Network Analytics – Xively Cloud for IoT, Python Web Application Framework – Django – AWS for IoT – System Management with NETCONF-YANG

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Adrian McEwenand Hakim Cassimally	Designing the Internet of Things	Wiley	2014
2	Oliver Hersent, David Boswarthick and Omar Elloumi	The Internet of Things	Wiley	2016

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Jean - Philippe Vasseur, Adam Dunkels	Interconnecting Smart Objects with IP: The Next Internet	Morgan Kuffmann Publishers	2010
2	Arshdeep Bahga and Vijai Madisetti	A Hands - on Approach Internet of Things	Universities Press	2015
3	Dieter Uckelmann, Mark Harrison, Mi chahelles, Florian	Architecting the Internet of Things	Springer	2011
4	Michael Margolis	Arduino Cook book, Recipes Begin ,Expand, and Enhance Your Projects		2011
5	Olivier hersent, Omar elloumi	The Internet of Things	Wiley	2012

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23ECC21	ARTIFICIAL INTELLIGENCE AND DATA SCIENCE	L	T	P	C
		3	0	0	3

Course Objective:

- Study the concepts of Artificial Intelligence
- To Learn the methods of solving problems using Artificial Intelligence
- To Introduce the concepts of Expert Systems
- To Apply fundamental tidy data concepts
- To be familiar with Tools for Data Science

Course Outcomes:

23ECC21.CO1 Identify problems that are amenable to solution by AI methods

23ECC21.CO2 Identify appropriate AI methods to solve a given problem.

23ECC21.CO3 Explain the architecture of expert system

23ECC21.CO4 Apply the skills of data inspecting and cleansing

23ECC21.CO5 Demonstrate proficiency with statistical analysis of data

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC21.CO1	x	x													
23ECC21.CO2	x	x	x	x	x								x		
23ECC21.CO3	x	x	x	x	x	x						x	x	x	x
23ECC21.CO4	x	x	x	x	x	x						x		x	x
23ECC21.CO5	x	x	x	x	x	x						x		x	x

Unit-I INTRODUCTION TO Al AND PRODUCTION SYSTEMS **9**

Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics -Specialized production system- Problem solving methods - Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing-Depth first and Breath first, Constraints satisfaction - Related algorithms, Measure of performance and analysis of search algorithms.

Unit-II REPRESENTATION OF KNOWLEDGE **9**

Game playing - Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic- Structured representation of knowledge

Unit-III EXPERT SYSTEMS 9

Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells

Unit-IV INTRODUCTION TO DATA SCIENCE 9

Overview of Data Science: Challenges in Data Science, History of Data Science, Data Science Process, Discovery and Preparation, Model Planning and Building, Introduction to Python: Variables, Data types, Strings, Conditions and statements, Classes and objects, Type conversion, Functions and Pac

Unit-V DATA EXPLORATION AND PROCESSING 9

Pandas - Data Structures, Series, DataFrame, NumPy - ndarray, SciPy - SciPy subpackages, Data Structures, Matplotlib, Seaborn, Datashader. Data Processing: Processing CSV, JSON, XLS data, Data Wrangling, Data Aggregation

Total Periods: 45

Text Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Kevin Night and Elaine Rich, Nair B.	Artificial Intelligence (SIE)	McGraw Hill	2008
2	David Cielen, Arno D. B. Meysman, and Mohamed Ali	Introducing Data Science	Manning Publications	2016

Reference Books:

Sl.No.	Author(s)	Title of the Book	Publisher	Year of Publication
1	Peter Jackson	Introduction to Expert Systems	Pearson Education	2007
2	Deepak Khemani	Artificial Intelligence	Tata Mc Graw Hill Education	2013
3	Stuart Russel and Peter Norvig	AI – A Modern Approach	Pearson Education	2007
4	Chirag Shah	A Hands-On Introduction to Data Science	Cambridge University Press	2020
5	Sanjeev J. Wagh, Manisha S. Bhende, Anuradha D. Thakare	Fundamentals of Data Science	CRC Press	2022

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23ECC22	ELECTRONIC CIRCUITS LABORATORY	L	T	P	C
		0	0	2	1

Course Objective:

- To study about Transistor Amplifiers
- To understand the operation of Differential Amplifiers
- To gain knowledge on feedback circuits and oscillators
- To know the operation of multivibrators

Course Outcomes:

23ECC22.CO1 Design BJT and FET amplifiers

23ECC22.CO2 Interpret the performance of Feedback Amplifiers and Differential Amplifier.

23ECC22.CO3 Design Oscillators ,Power Amplifier circuits and Multivibrators

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC22.CO1	x	x		x	x	x	x		x	x	x		x		x
23ECC22.CO2	x				x	x	x		x	x	x		x		x
23ECC22.CO3	x	x	x	x	x	x	x		x	x	x		x		x

Sl.No. **List of Experiments**

1. Analysis of VI Characteristics of Semiconductor P-N junction Diodes
2. Design a circuit to perform half-wave and full wave rectification.
3. Design a voltage regulator using Zener Diode
4. Design a clipper and clamper circuits
5. Design of BJT amplifier in Common Emitter Configuration
6. Design of FET amplifier in Common Source Configuration
7. Frequency response of feedback amplifier circuit-current series & voltage shunt
8. CMRR measurement of Differential Amplifier
9. Design of single Tuned and double tuned Amplifier
10. Design of Class C power amplifier
11. Design of Astable and Monostable Multivibrator
12. Mini Project

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		L	T	P	C
23ECC23	**DIGITAL SYSTEM DESIGN LABORATORY**	**0**	**0**	**2**	**1**

Course Objective:

- To introduce the design procedure of Combinational circuits
- To introduce the design procedure of Sequential circuits
- To understand synchronous and asynchronous sequential circuits
- To impart knowledge on programmable logic devices and Verilog HDL.

Course Outcomes:

23ECC23.CO1 Construct Combinational circuits using logic gates

23ECC23.CO2 Construct Sequential circuits using logic gates

23ECC23.CO3 Apply Verilog HDL programming to implement combinational and sequential circuits

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC23.CO1	x	x			x				x	x	x				x
23ECC23.CO2	x	x			x				x	x	x			x	x
23ECC23.CO3	x	x		x	x				x	x	x	x	x	x	x

Sl.No. **List of Experiments**

1 a. Study of different digital ICs and its specifications.
b. Verification of truth table of logic gates using TTL ICs.

2 Implementation of the given boolean function using logic gates in both SoP and PoS forms

3 Implementation of Adder and Subtractor

4 Design and Implementation of Multiplexer and Demultiplexer

5 Design and Implementation of Encoders and Decoders

6 Design and Implementation of Synchronous and Asynchronous Counters.

7 Implementation of 4-bit parallel adder using IC7483

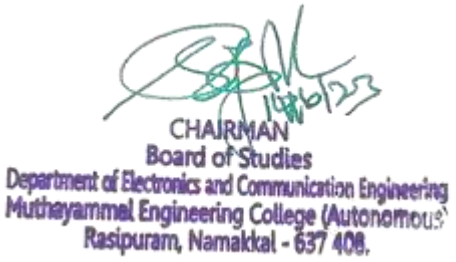
8 Design and implementation of half adder using Verilog HDL

9 Design and implementation of 8 to 1 multiplexer using Verilog HDL

10 Design and implementation of JK flip flop using Verilog HDL

11 Design and implementation of up counter using Verilog HDL

12 Mini Project



		L	T	P	C
23ECC24	**SIGNAL PROCESSING LABORATORY**	**0**	**0**	**2**	**1**

Course Objective:

- To perform basic signal processing operations such as Linear Convolution, Circular Convolution, and Frequency analysis in MATLAB
- To implement FIR and IIR filters in MATLAB
- To implement multirate DSP in MATLAB
- To implement periodogram power spectral density in MATLAB

Course Outcomes:

23ECC24.CO1 Demonstrate their abilities towards MATLAB based implementation of various DSP systems

23ECC24.CO2 Design and Implement the FIR and IIR Filters in MATLAB for performing filtering operation

23ECC24.CO3 Analyze the power spectral density in MATLAB

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC24.CO1	x	x		x	x				x	x		x			x
23ECC24.CO2	x	x		x	x				x	x		x		x	x
23ECC24.CO3	x	x		x	x				x	x		x		x	x

Sl.No.	List of Experiments
1	Generation of elementary Discrete-Time sequences in MATLAB
2	Linear and Circular convolutions in MATLAB
3	Auto correlation and Cross Correlation in MATLAB
4	Frequency Analysis of DFT in MATLAB
5	Sampling and effect of Aliasing in MATLAB
6	Implementation of sampling rate conversion by decimation, interpolation and a rational factor in MATLAB
7	Implementation of periodogram power spectral density in MATLAB
8	Implementations of Infinite Impulse Response (IIR) filter in MATLAB.
9	Implementations of finite Impulse Response (FIR) filter in MATLAB.
10	Any topic on recent areas of research in multirate Signal Processing

11 Solution of difference equations using z- Transform and Fourier tools,

12 Determination of RMS value Form factor and Zero crossing of signals

		L	T	P	C
23ECC25	**EMBEDDED SYSTEMS LABORATORY**	**0**	**0**	**2**	**1**

Course Objective:

- To understand an architecture of 8051 Microcontroller and its programming methods
- To provide the various I/O devices interfacing with 8051
- To understand the architecture of ARM Microcontrollers
- To gain knowledge of I/O devices interfacing withARM7 based LPC2148 Microcontroller

Course Outcomes:

23ECC25.CO1 Explain the 8051 Microcontroller Architecture, Programming and interfacing with I/O devices

23ECC25.CO2 Demonstrate I/O devices interfacing with ARM7 based LPC2148 Microcontroller

23ECC25.CO3 Design microcontroller based projects

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC25.CO1	x	x		x	x				x	x			x	x	x
23ECC25.CO2	x	x		x	x				x	x	x		x	x	x
23ECC25.CO3	x	x	x	x	x				x	x	x		x	x	x

Sl.No. **List of Experiments**

1 Study the Architecture of 8085 and 8086 Microprocessors
2 Study the Architecture of 8051 Microcontroller
3 ALP of 8-bit numbers using 8051(addition, subtraction, multiplication, division etc.)
4 Interfacing of LED with Microcontroller 8051 / PIC.
5 Interfacing of LCD with Microcontroller 8051 / PIC.
6 Interfacing of Stepper Motor with Microcontroller 8051 / PIC.
7 Interfacing of Seven Segment Display with Microcontroller 8051 / PIC.
8 Interfacing LCD with ARM7 based LPC2148 Microcontroller
9 Interfacing of Stepper Motor with ARM7 based LPC2148 Microcontroller
10 Interfacing of ADC and DAC with ARM7 based LPC2148 Microcontroller
11 Mini Project

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23ECC26	COMMUNICATION SYSTEMS LABORATORY	L	T	P	C
		0	0	2	1

Course Objective:

- To study the Amplitude and Frequency modulation and demodulation.
- To study the characteristics of AM and FM receivers
- To Understand different forms of pulse modulation schemes and implement using hardware kits
- To simulate digital modulation schemes using MATLAB

Course Outcomes:

23ECC26.CO1 Evaluate amplitude and frequency modulation parameters

23ECC26.CO2 Demonstrate the analog pulse modulation and demodulation circuits

23ECC26.CO3 Design digital modulation and demodulation system using simulation to

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC26.CO1	x	x		x	x	x	x		x	x	x				x
23ECC26.CO2	x	x		x	x	x	x		x	x	x	x		x	x
23ECC26.CO3	x	x		x	x	x	x		x	x	x	x		x	x

Sl.No. **List of Experiments**

PART A: Analog Communication Systems (AC)

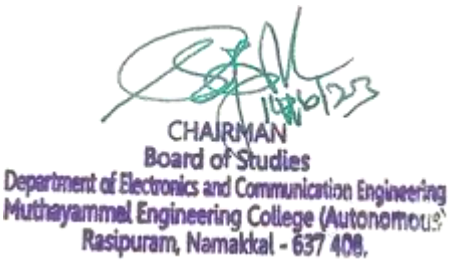
1 Amplitude Modulation and Demodulation
2 Frequency Modulation and Demodulation (using IC 565)
3 Pre-emphasis & de-emphasis.
4 Mixer Stage Using Discrete Components
5 Characteristics of AM receiver (Selectivity & Sensitivity).

PART B: Digital Communication Systems (DC)

6 Sampling and Reconstruction of signals
7 Hardware implementation of PAM, PPM and demodulation
8 Simulation of error control and line coding schemes
9 Simulation of ASK, FSK, PSK, QPSK and DPSK

10 Simulation of DM and ADM using MATLAB

11 Mini Project



		L	T	P	C
23ECC27	**MACHINE LEARNING LABORATORY**	**0**	**0**	**2**	**1**

Course Objective:

- To understand basic image processing operations such as sampling, quantization, DCT and histogram in MATLAB
- To gain knowledge on image enhancement and segmentation in MATLAB.
- To understand linear regression using python.
- To impart knowledge on classifiers using python

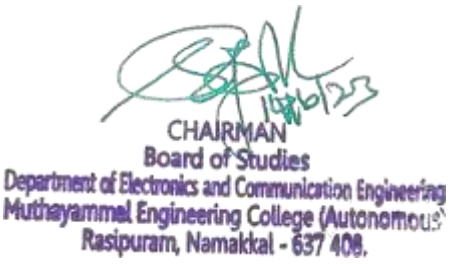
Course Outcomes:

23ECC27.CO1	Demonstrate their abilities towards MATLAB based implementation of various image processing operations such as sampling quantization and image transforms.
23ECC27.CO2	Design and Implement the image enhancement and segmentation in MATLAB
23ECC27.CO3	Analyze the linear regression and classifiers using python

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
23ECC27.CO1	x	x		x	x				x	x		x			x
23ECC27.CO2	x	x		x	x				x	x		x		x	x
23ECC27.CO3	x	x	x	x	x				x	x		x		x	x

Sl.No.	**List of Experiments**
1	To perform image sampling and quantization using MATLAB
2	To perform intensity transformation of images using MATLAB
3	To apply Discrete Cosine Transform on image using MATLAB
4	To study the histogram and histogram equalization
5	To perform image enhancement by spatial filtering
6	To obtain frequency domain filters from spatial domain
7	To perform region based segmentation of image using MATLAB
8	To Implement k-neighbours classification using python
9	To Implement linear regression using python
10	To Implement naïve baye's theorem to classify the English text using python

11	Extract the data from database using python
12	To Implement SVM classifier using python



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23ECC28	**INTEGRATED CIRCUITS LABORATORY**	**0**	**0**	**2**	**1**

Course Objective:

- To understand the basic concepts of OP Amps
- To provide different features of OP Amps
- To understand the operation of Timers
- To understand the concepts of Filters

Course Outcomes:

23ECC28.CO1	Explain the Concepts of OP Amps
23ECC28.CO2	Demonstrate the Applications of OP Amps
23ECC28.CO3	Design Filters and Wave Shaping Circuits

Course Outcomes	**Program Outcomes**												**Program Specific Outcomes**		
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
23ECC28.CO1	x	x							x	x	x				x
23ECC28.CO2	x	x		x	x				x	x	x	x	x	x	x
23ECC28.CO3	x	x	x	x	x				x	x	x	x	x	x	x

Sl.No. **List of Experiments**

1. Inverting, Non inverting and Differential amplifiers
2. Integrator and Differentiator
3. Precision Rectifiers
4. Instrumentation Amplifier
5. Comparators and Schmitt Trigger
6. Astable and Monostable Operation Using 555
7. IC Voltage Regulator
8. Voltage Controlled Oscillator and Phase Locked Loop
9. Realization of Second Order High Pass and Low Pass Active Filters
10. Implementation of Wave Shaping Circuits
11. Mini Project

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		L	T	P	C
23ECC29	**ANTENNA AND RF ENGINEERING LABORATORY**	**0**	**0**	**2**	**1**

Course Objective:

- To gain knowledge on propagation in wave guides
- To understand the characteristics of antenna arrays
- To know the concept of frequency independent antenna
- To know the basics concepts patch antenna

Course Outcomes:

23ECC29.CO1 Demonstrate the characteristics of antenna arrays

23ECC29.CO2 Explain the radiation pattern of Horn and Helical antenna

23ECC29.CO3 Explain the characteristics of frequency independent antenna

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
23ECC29.CO1	x				x				x	x	x				
23ECC29.CO2	x	x			x				x	x	x	x		x	x
23ECC29.CO3	x	x	x	x	x	x	x		x	x	x	x	x	x	x

Sl.No. **List of Experiments**

1. Study of wave propagation in Guided system
2. Radiation pattern of Broad Fire array
3. Radiation pattern of End Fire array
4. Radiation pattern of Half wave dipole
5. Radiation pattern of Parabolic reflector antenna
6. Radiation pattern of Horn antenna
7. Radiation pattern of Log periodic antenna
8. Radiation pattern of Helical antenna
9. Impedance matching using Smith chart
10. Design of two component matching networks
11. Design and simulation of microstrip antenna

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		L	T	P	C
23ECC30	**MICROWAVE AND OPTICAL ENGINEERING LABORATORY**	**0**	**0**	**2**	**1**

Course Objective:

- To gain knowledge on microwave generators
- To understand the characteristics of microwave device
- To know the radiation pattern of microwave antenna
- To know the basics concepts of Optical Fibers

Course Outcomes:

23ECC30.CO1 Demonstrate the characteristics of microwave generators

23ECC30.CO2 Explain the characteristics of microwave device

23ECC30.CO3 Explain the Numerical aperture and losses take place in an optical fiber.

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
23ECC30.CO1	x				x				x	x	x				
23ECC30.CO2	x	x			x				x	x	x	x		x	x
23ECC30.CO3	x	x		x	x	x	x		x	x	x	x	x	x	x

Sl.No.	List of Experiments
1	Measurement of Frequency and Wavelength
2	Gunn diode characteristics
3	Reflex klystron characteristics
4	Measurement of attenuation and VSWR
5	Characteristics of Directional Coupler
6	Characteristics of Magic Tee
7	Radiation pattern of Horn Antenna
8	Fiber optic analog and digital link
9	Characteristics of LED and Photo diode

10 Determination of Numerical Aperture

11 Measurement of attenuation, bending and propagation losses

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		L	T	P	C
23ECC31	**CMOS VLSI DESIGN LABORATORY**	**0**	**0**	**2**	**1**

Course Objective:

- To learn Hardware Description Language
- To learn the fundamental principles of VLSI circuit design in digital and analog domain
- To familiarize fusing of logical modules on FPGAs
- To provide hands on design experience with professional design (EDA) platforms

Course Outcomes:

23ECC31.CO1 Write HDL code for digital Integrated circuits

23ECC31.CO2 Demonstrate fusing of logic modules into FPGA Boards

23ECC31.CO3 Design a mini project using EDA tools

Course Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO 3
23ECC31.CO1	x				x				x	x	x				
23ECC31.CO2	x	x		x	x				x	x	x			x	
23ECC31.CO3	x	x		x	x				x	x	x	x		x	

Sl.No.	List of Experiments
1	Study of Xilinx Vivado simulation and synthesis tool.
2	Design and Simulation of Combinational logic circuits using Verilog HDL
3	Half Adder and Full Adder Multiplier
4	Multiplexer and Demultiplexer
5	Encoder and Decoder Design and Simulation of Combinational logic circuits using Verilog HDL
6	Flip-flops
7	Counters
8	Shift Registers Design and Implementation of CMOS inverter using Mentor Graphics
9	Design and Implementation of Universal Gates using Mentor Graphics.
10	Mini Project

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