SCHEME OF INSTRUCTION AND EXAMINATION
B. E. (ECE)

V – Semester

SNo	Code	Course Title	Scheme of Instruction			Contact Hrs/ Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
Theory										
1	PC501EC	Antenna and Wave Propagation	3	-	-	**3**	3	40	60	3
2	PC502EC	Digital System Design using Verilog HDL	3	-	-	**3**	3	40	60	3
3	PC503EC	Digital Communication	3	-	-	3	3	40	60	3
4	PC504EC	Linear Control Systems	3	-	-	**3**	3	40	60	3
5	PC505EC	Micro-controllers and Interfacing	3	-	-	**3**	3	40	60	3
6	PC506EC	Data Communications and Computer Networks	3	-	-	**3**	3	40	60	3
7	**Professional Elective-II**		3	-	-	**3**	3	40	60	3
	PE511EC	Artificial Intelligence & Machine Learning								
	PE512EC	Digital Image Processing								
	PE513EC	Object Oriented Programming using C++								
Practical's										
8	PC551EC	Analog and Digital Communication Lab	-	-	2	**2**	3	25	50	1
9	PC552EC	Micro-controllers Lab	-	-	2	**2**	3	25	50	1
10	PC553EC	Digital System Design Lab	-	-	2	**2**	3	25	50	1
		Total	**21**	**-**	**6**	**27**	**30**	**355**	**570**	**24**

SCHEME OF INSTRUCTION AND EXAMINATION
B. E (ECE)

VI – Semester

SNo	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
Theory										
1	ES601ME	Fundamentals of Robotics	3	-	-	**3**	3	40	60	3
2	HS901MC	Managerial Economics and Accountancy	3	-	-	3	3	40	60	3
3	PC601EC	IoT Applications	3	-	-	**3**	3	40	60	3
4	PC602EC	Embedded System Design	3	-	-	**3**	3	40	60	3
5	PC603EC	VLSI Design	3	-	-	3	3	40	60	3
6	**Professional Elective-III**		3	-	-	**3**	3	40	60	3
	PC604CS	Deep Learning								
	PE611EC	Satellite Communication and Applications								
	PE612EC	Radar Systems								
	PE613EC	Optical Communications								
7	OE#####	Open Elective-I	3	-	-	**3**	3	40	60	3
Practicals										
8	PC651EC	IoT & Embedded Systems lab	-	-	2	**2**	3	25	50	1
9	PC652EC	Electronic Design Automation Lab	-	-	2	**2**	3	25	50	1
10	PC653EC	Mini-Project	-	-	6	**6**	-	50	-	3
		Total	**21**	**-**	**10**	**31**	**27**	**380**	**520**	**26**

*Students have to undergo summer internship of 6 Weeks duration at the end of semester VI and Evaluation will be done in VII - Semester

List of subjects under Open Elective –I

1	OE 601BM	Engineering applications in Medicine
2	OE602BM	Human Assistive Technologies
3	OE601CE	Disaster Management
4	OE602CE	Road Safety Engineering
5	OE601CS	Python Programming
6	OE602CS	Cyber Security
7	OE601EC	Verilog HDL
8	OE602EC	Principles of Electronic Communication Systems
9	OE601EE	Applications of Electrical Energy
10	OE602EE	Electrical Safety Management
11	OE601ME	3D Printing Technology
12	OE602ME	Finite Element Methods

Course Code	Course Title						Core//PE/OE
PC501EC	ANTENNAS AND WAVE PROPAGATION						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives

1. To understand the various antenna parameters to give insight of the radiation phenomena
2. To have thorough understanding of radiation characteristics of different types of antennas.
3. To study the characteristics of array antennas having directional radiation characteristics
4. To get insight on aperture antennas and modern antennas
5. To understand the concepts of wave propagation and create awareness about the different types of propagation of radio waves at different frequencies

Course Outcomes

1. Acquires knowledge about the basic antenna parameters and radiation concepts
2. Analyze wire antennas in detail
3. Attain engineering fundamentals to analyze and design antenna arrays
4. Classify, analyze and design aperture and modern antennas
5. Identify and explain modes of propagation in different regions of atmosphere

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Fundamentals of Antenna theory: Principle of radiation, Basic Antenna Parameters – Patterns, Beam Area, Radiation Intensity, Beam Efficiency, Directivity, Gain, Antenna Apertures, Effective Height, Illustrative Problems. Retarded Potentials – Helmholtz Theorem. Thin Linear Wire Antennas – Radiation from Small Electric Dipole, Quarter Wave Monopole and Half Wave Dipole – Current Distributions, Near field and Far field Components, Radiated Power, Radiation Resistance, Beam Width, Directivity, Effective Area and Effective Height. Loop Antennas – Introduction, Small Loop, Comparison of Far Fields of Small Loop and Short Dipole.

UNIT–II

Antenna Arrays: Basic two element array, N element uniform linear array, Pattern multiplication, Broadside and End fire array, Planar array, Concept of Phased arrays, Basic principle of antenna Synthesis-Binomial array, Tschebysev array.

UNIT–III

Practical Antennas: Yagi-Uda antenna, V-Antenna, Rhombic antenna, Travelling wave antennas, Microstrip antennas– Introduction, Features, Advantages and Limitations, Rectangular Patch Antennas – Geometry, Design equations and Characteristics.

UNIT-IV

Aperture and Modern Antennas: - Reflector Antennas – Introduction, Flat Sheet and Corner Reflectors, Paraboloid Reflectors – Geometry, Pattern Characteristics, Feed Methods, Reflector – Types, Related Features, Illustrative Problems. Horn Antennas – Types, Fermat's Principle, Radiation from sectoral and pyramidal horns, Design Considerations of Pyramidal Horns, Reconfigurable antenna, Active antenna, Dielectric Antennas, Electronic band gap structure and applications.

UNIT – V

Wave propagation: Ground wave propagation. Space and surface waves, Tropospheric refraction and reflection. Sky wave propagation – Virtual height, critical frequency, Maximum usable frequency – Skip distance, Fading, Multi-hop propagation.

SUGGESTED READING:

1 Constantine A. Balanis, Modern Antenna Handbook, A John Wiley & Sons, Inc., Publication, 2008.
2 John D.Kraus, Ronald J.Marhefka and Ahmed S.Khan, Antennas for All Applications, 3rd Edition, Tata McGraw- Hill publishing company Limited, New Delhi, 2006.
3 K.D.Prasad, "Antennas and Wave Propagation", Khanna or Satya Publications.
4 Warren L. Stutzman, Gary A. Thiele, Antenna Theory and Design, 3rd Edition. May 2012

Course Code	Course Title						Core//PE/OE
PC502EC	DIGITAL SYSTEM DESIGN USING VERILOG HDL						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
STLD	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives: The course is taught with the objectives of enabling the student to:

1. Familiarize with structural modeling with different design approaches and writing test
2. Familiarize with behavioral modeling of digital systems using Verilog HDL
3. Understand synthesis of various sub systems
4. Familiarize with various ICs available (combinational units) and their usage and to design
5. Understand FSM coding

Course Outcomes : On completion of this course, the student will be able to :

1. Develop structural designs in top-down and bottom-up approach and develop test benches for the same
2. Develop combinational and sequential circuits in data flow and behavioral modeling styles
3. Understand the various language constructs and the corresponding hardware implementation (Synthesis).
4. Familiarize with commercially available ICs of various combinational and sequential building blocks
5. Develop verilog code for FSMs and FSMDs and verify

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

INTRODUCTION TO LOGIC DESIGN WITH VERILOG: Structural models of combinational logic: Verilog primitives, design encapsulation, structural models, module ports and structural connectivity, Top-down and nested modules, design hierarchy, vectors in Verilog. Four valued logic and signal resolution in Verilog, test methodology, Signal generators for test benches, test bench templates, propagation delay and truth table models of Combinational and sequential logic with Verilog.

UNIT–II

LOGIC DESIGN WITH BEHAVIORAL MODELS OF COMBINATIONAL AND SEQUENTIAL LOGIC: Data types, continuous assignment, Boolean equation based

behavioral models of combinational logic-multiplexers, encoders, decoders, modeling flip-flops and latches, edge detection, LFSRs, Modeling with repetitive algorithms(loops), clock generators, behavioral models of counters, registers, register files and Array of registers(Memories)

UNIT–III

SYNTHESIS OF COMBINATIONAL AND SEQUENTIAL LOGIC - Introduction to synthesis - Logic synthesis, RTL synthesis, High-level synthesis, Synthesis of combinational logic, synthesis of sequential logic with latches and flip flops, synthesis of loops.
Introduction to VLSI RTL designs: RTL designs- Goals and Constraints, RTL based chip design flow and design challenges

UNIT-IV

COMBINATIONAL LOGIC ICS – Specifications and Applications of TTL-74XX MSI ICs - Decoders, BCD- seven segment display Decoders with Drivers, Encoders, Priority Encoders, Multiplexers, Parity Generators/Checkers, Parallel Binary Adder/Subtractor and Magnitude Comparators
SEQUENTIAL LOGIC IC'S: Familiarity with commonly available TTL 74XX, CMOS 40XX Series ICs – Asynchronous and synchronous Counters, Decade Counters, Shift Registers.

UNIT – V

FINITE STATE MACHINES: Introduction, Mealy and Moore Outputs, FSM representation-state diagram and ASM chart, FSM code development and design examples.
FSM WITH DATA PATH (FSMD): Introduction, single RT operation, ASMD chart , Decision box realization with register, code development for FSMD with design examples.

SUGGESTED READING:

1. Michael D. Ciletti , "Advanced digital design with Verilog HDL", PHI learning Pvt Ltd, 2012
2. Samir Palnitkar, *"Verilog HDL A Guide to Digital Design and Synthesis,"* 2nd Edition, Pearson Education, 2006.
3. Sanjay Churiwala · Sapan Garg "Principles of VLSI RTL design- A practical guide", , Springer, 2010
4. R.P.Jain, *"Modern Digital Electronics",* Tata McGraw Hill, 4th Edition, 2009.
5. Pong P Chu, "FPGA Proto Typing by Verilog Examples" WILEY Publications

Course Code	Course Title						Core//PE/OE
PC503EC	DIGITAL COMMUNICATION						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Analog Communication, Probability Theory and Stochastic Process	3	-	-	-	40	60	3

Course Objectives: The course is taught with the objective of enabling the student to

1. Understand the building blocks of digital communication systems and waveform coding techniques
2. Get familiarized with various source coding techniques and Block codes
3. Get familiarized with convolution and cyclic codes
4. Analyze various digital carrier modulation techniques
5. Understand the concept of spread spectrum modulation

Course Outcomes : On completion of this course, the student will be able to :

1. Understand the basic components of digital communication systems
2. Understand how to design block codes, convolution, and cyclic codes
3. Apply suitable digital carrier modulation techniques and coding techniques for various applications for improved spectral efficiency
4. Learn to design an optimum receiver and analyze the error performance of baseband and band pass data transmission
5. Analyze the performance of the spread spectrum communication system

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	3	1	-	-	-	-	-	1	2
CO2	2	2	1	3	2	-	-	-	-	-	1	1
CO3	2	2	1	3	3	-	-	-	-	-	1	1
CO4	2	2	1	3	3	-	-	-	-	-	2	1
CO5	3	2	1	3	3	-	-	-	-	-	2	1

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Digital Transmission of Analog Signals: Elements of digital communication system, Sampling theory, Quantizing of Analog Signals, Coded Transmission of Analog Signals: PCM, Differential PCM, Delta Modulation, Noise in PCM, DM system. Performance comparison of the above systems.

UNIT–II

Source Coding: Introduction, Shannon-Fano Coding, Huffman Coding.

Linear Block Codes: Introduction, Matrix description of Linear Block codes, Error Detection and Error Correction capabilities of linear block codes, Single Error Correcting Hamming codes.

UNIT–III

Binary Cyclic Codes: Algebraic Structure of Cyclic Codes, Encoding, Syndrome Calculation, , Error Detection and Error Correction, BCH Codes

Convolution Codes: Introduction, Encoding of convolution codes, Graphical approach: State, Tree and Trellis diagram, The Viterbi algorithm. Comparison of the above codes.

UNIT-IV

Digital Band-Pass Modulation Techniques: Binary Amplitude-Shift Keying, Phase-Shift Keying, Frequency-Shift Keying, Summary of Three Binary Signaling Schemes, Noncoherent Digital Modulation Schemes, M-ary Digital Modulation Schemes, Mapping of Digitally Modulated Waveforms onto Constellations of Signal Points.

Bit Error Rate, Detection of a Single Pulse in Noise, Optimum Detection of Binary PAM in Noise, Optimum Detection of BPSK, Detection of QPSK and QAM in Noise, Optimum Detection of Binary FSK.

UNIT – V

Spread Spectrum Modulation: Introduction, Generation and Characteristics of PN- sequences. Direct Sequence Spread Spectrum system; Frequency Hopping spread spectrum system and their application, acquisition scheme for spread spectrum receivers, tracking of FH and DS signals.

SUGGESTED READING:

1. K Sam Shanmugam, *"Digital and Analog Communication Systems*", John Wiley &sons, 1979.
2. John G. Proakis, *"Digital Communications*", 4thEdition, Tata McGraw- Hill Publishing Company Limited, New Delhi, 2003.
3. Rodger E.Ziemer, William H.Tranter, "Principles of Communications-Systems, Modulation and Noise", 7th Edition,Wiley,2014.

Course Code	Course Title						Core//PE/OE
PC504EC	LINEAR CONTROL SYSTEM						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. To develop mathematical modeling for different control systems
2. To construct state space model for continuous and discrete data systems and analyze them
3. To analyze control system in time domain and determine stability using Routh-Hurwitz criterion and Root-Locus technique
4. To analyze control system in frequency domain and determine stability using Nyquist criterion and bode plots
5. To design compensators for control systems

Course Outcomes : On completion of this course, the student will be able to :

1. Able to develop mathematical models and derive transfer functions for various systems
2. Able to expose to an appropriate state space modeling of system and its analysis and the concept and testing of controllability and observability
3. Able to analyze the systems in time domain and determine its stability
4. Able to analyze the systems in frequency domain and determine relative stability
5. Able to design compensators for a given specifications

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	-	1	1	-	-	-	-	1	2	3	-
CO2	1	1	3	0	-	-	-	-	-	-	-	2	3	3
CO3	3	3	3	1	1	1	-	-	-	-	-	1	3	3
CO4	2	2	3	1	-	-	-	-	-	-	2	1	3	-
CO5	1	1	2	-	-	-	-	-	-	-	2	2	3	3

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Introduction to control systems: Basic components, classification of control systems, effects of feedback, mathematical modeling of physical systems, - Mathematical modelling of control systems - Electrical Systems and mechanical translational systems - transfer function – Electrical analogous of mechanical translational and Rotational systems -Block diagrams representation and reduction methods - signal flow graph - mason's gain formula

UNIT–II

State-variable analysis of continuous data systems: state, state variables, state equations, solution of state equations, state transition matrix and its properties, state diagram, relationship between state equations and transfer functions, concept and testing of controllability and observability.

UNIT–III

Analysis of continuous time systems - time domain solution of first order systems – time constant, time domain specifications - time domain solution of second order systems – damping ratio - response of second order systems for step input - steady state error and static error coefficients for standard inputs - concept of stability –location of roots on the s plane - Routh-Hurwitz techniques - construction of root locus

UNIT-IV

Frequency-domain analysis: Introduction to Frequency domain specifications, Relationship between time and frequency response, Nyquist stability criterion, Bode plots, relative stability – gain margin and phase margin.

UNIT – V

Design of control systems: Phase lag, phase lead and phase Lag-Lead compensators and their design. Controllers: Introduction to PI, PD and PID controllers.

SUGGESTED READING:

1. I.J.Nagrath and M Gopal, “Control System Engineering”, New Age International Private Limited, New Delhi, 2008, 5th Edition
2. Katsuhiko Ogata, “Modern Control Engineering”, Prentice-Hall of India Private Limited, New Delhi, 2003, 4th Edition.
3. Benjamin C. Kuo, “Automatic Control Systems”, Prentice Hall of India, 2009, 7th Edition
4. Control Systems Engineering by A. Nagoor Kani, RBA Publications

Course Code	Course Title						Core//PE/OE
PC505EC	MICRO-CONTROLLERS AND INTERFACING						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Computer Organization, Micro Processors	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. Discuss 8051 Basic architecture and programming
2. Discuss Timers, serial communication and interrupts of 8051
3. Discuss ARM architecture and Programming
4. Discuss Real time Interfacing and Programming

Course Outcomes : On completion of this course, the student will be able to :

1. To gain a comprehensive understanding of the 8051 microcontroller architecture and develop practical skills in programming
2. Understand timers, serial communication, and interrupts in embedded systems, along with practical skills in programming these features on the 8051 microcontroller
3. Understand RISC based ARM architecture
4. Develop programs for basic problem solving
5. Develop real time interfacing using 8051 and ARM

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	-	-	-	-	-	-	-	1
CO2	2	2	1	1	-	-	-	-	-	-	-	1
CO3	2	2	1	1	-	-	-	-	-	-	-	1
CO4	2	3	3	3	-	1	-	-	-	-	-	1
CO5	2	3	3	3	-	2	-	-	-	-	-	1

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

8051 Architecture and Programming:

Evolution of Microprocessors and Microcontrollers, Programming model of 8051, Register Organization, Flag Register, Pin configuration, Memory Organization: ROM and RAM, Register Bank, Addressing modes and Instruction Set. Assembly Language Programming and C programming. Internal structure of Ports and alternate functions of Ports, 8051 I/O programming, bit manipulation programs using I/O ports

UNIT–II

Timer, Serial communication and Interrupt programming:

Concept of Timer, Programming model of Timers of 8051, Programming timers, Basics of Serial Communication, Serial communication standards, Programming model of UART of 8051, Concept of Interrupts, 8051 Interrupts, Programming Interrupts.

UNIT–III

ARM-CORTEX-M: General Description, Features, Cortex M Architecture, Block Diagram, Registers, Reset, Memory, Operating Modes. Introduction to Input /Output

UNIT-IV

ARM Cortex-M Instruction Sets and Programming: The Software Development Process, ARM Cortex-M Assembly Language Syntax, Addressing Modes, Operands, Memory Access Instructions, Logical, Shift, Arithmetic Operations, Stack, Functions and Control Flow, Assembler Directives.

UNIT – V

Interfacing with 8051: D/A converter, A/D converter, multiplexed key board, multiplexed seven segment display, LCD interfacing, stepper Motor interfacing,
Interfacing with ARM Controller
I/O Port Programming and Direction Register, Switch inputs and LED outputs, PLL, Sys Tick Timer, PWM, Communication Interfaces.

SUGGESTED READING:

1. Mohammad Ali Mazidi, Rolin D McKinley, Janice G Mazidi, The 8051 Microcontroller and Embedded Systems, Second Edition, Prentice Hall
2. Raj Kamal, Embedded Systems – Architecture, Programming and Design, 2nd Edition, TMH, 2008
3. Jonathan W Valvano, INTRODUCTION TO ARM®CORTEX-M MICROCONTROLLERS Volume 1, Fifth Edition June 2014
4. Dr. Yifeng Zhu , Embedded Systems with ARM Cortex-M Microcontrollers in Assembly Language and C
5. Kenneth J Ayala, The 8051 Micro Controller: Architecture, Programming and Applications

Course Code	Course Title						Core//PE/OE
PC506EC	DATA COMMUNICATIONS AND COMPUTER NETWORKS						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
Computer Organization	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. To provide a conceptual foundation for the study of data communications using the Open Systems Interconnect (OSI) model for layer architecture
2. To study the principles of network protocols and Internet working
3. To understand the Network security and Internet applications
4. To understand the concepts of switched communication networks
5. To understand the performance of data link layer protocols for error and flow control and network security

Course Outcomes : On completion of this course, the student will be able to :

1. Understand the working of various network topologies, circuit and packet switching
2. Comprehend the role of data link layers and significance of MAC protocols
3. Understand the networking protocols and Internet protocols
4. Understand the transport layer working with TCP, UDP and ATM protocols
5. Comprehend the functionality of application layer and importance of network security

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1	3	1	-	-	-	-	-	1	2
CO2	2	2	1	3	2	-	-	-	-	-	1	1
CO3	2	2	1	3	3	-	-	-	-	-	1	1
CO4	2	2	1	3	3	-	-	-	-	-	2	1
CO5	3	2	1	3	3	-	-	-	-	-	2	1

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Data communication: A Communication Model, The Need for Protocol Architecture and Standardization, Network Types: LAN, WAN, MAN. Network Topologies: Bus, Star, Ring, Hybrid. Line configurations. Reference Models: OSI, TCP/IP.

Circuit switching: Circuit Switching Principles and concepts.

Packet switching: Virtual circuit and Datagram subnets, X.25.

UNIT–II

Data Link Layer: Need for Data Link Control, Design issues, Framing, Error Detection and Correction, Flow control Protocols: Stop and Wait, Sliding Window, ARQ Protocols, HDLC.
MAC Sub Layer: Multiple Access Protocols: ALOHA, CSMA, Wireless LAN. IEEE 802.2, 802.3, 802.4, 802.11, 802.15, 802.16 standards. Bridges and Routers.

UNIT–III

Network Layer: Network layer Services, Routing algorithms: Shortest Path Routing, Flooding, Hierarchical routing, Broadcast, Multicast, Distance Vector Routing, and Congestion Control Algorithms
Internet Working: The Network Layer in Internet: IPV4, IPV6, Comparison of IPV4 and IPV6, IP Addressing, ATM Networks

UNIT-IV

Transport Layer: Transport Services, Elements of Transport Layer, Connection management, TCP and UDP protocols, ATM AAL Layer Protocol.

UNIT – V

Application Layer: Domain Name System, SNMP, Electronic Mail, World Wide Web.
Network Security: Cryptography Symmetric Key and Public Key algorithms, Digital Signatures, Authentication Protocols.

SUGGESTED READING:

1. Andrew S Tanenbaum, “Computer Networks,” 5/e, Pearson Education, 2011.
2. Behrouz A. Forouzan, “Data Communication and Networking,”3/e, TMH, 2008.
3. William Stallings, “Data and Computer Communications,” 8/e, PHI, 2004.
4. Douglas E Comer, “Computer Networks and Internet”, Pearson Education Asia, 2000.
5. Prakash C. Gupta, “Data Communications and Computer Networks”, PHI learning,2013

Course Code	Course Title						Core//PE/OE
PE511EC	ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING						PE-II
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. Understand different types of Intelligent agents and Various search algorithms
2. Learn game-playing and CSP techniques
3. Learn Knowledge Representation, Reasoning, and Planning
4. Acquire knowledge of Probabilistic Reasoning
5. Understand the concepts of learning and its application

Course Outcomes : On completion of this course, the student will be able to :

1. Apply various search algorithms in real time
2. Apply game-playing and CSP techniques
3. Perform Knowledge Representation, Logical Reasoning and Planning
4. Perform Probabilistic Reasoning
5. Apply different types of learning in applications like NLP, robotics

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	1	-	-	-	-	-	2	2
CO2	3	2	2	3	2	-	-	-	-	-	1	1
CO3	2	1	1	3	3	-	-	-	-	-	2	1
CO4	3	1	2	3	3	-	-	-	-	-	2	1
CO5	3	2	1	3	3	-	-	-	-	-	3	1

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Introduction to AI: Introduction, history, intelligent systems, foundations of AI, applications, development of AI languages, current trends.

UNIT–II

Artificial Neural Networks: Biological neurons and artificial neurons. Model of an ANN. Activation functions used in ANNs. Typical classes of network architectures. Mathematical Foundations and Learning mechanisms, Feed forward ANN: Structures of Multi-layer feed forward networks. Back propagation algorithm. Back propagation – training and convergence. Functional approximation with back propagation.

UNIT–III

Supervised Machine Learning: Basics of linear regression, its assumptions, limitations and industry applications. Least square based and Gradient Descent Based Regression, Multiple linear regression, Polynomial regression, Logistic regression.

UNIT-IV

Unsupervised Machine Learning: Different clustering methods (Distance, Density, Hierarchical) , Iterative distance-based clustering; K-Means Clustering Algorithm and Image Quantization, basics of Principal Component Analysis

UNIT – V

Introduction to Deep learning: Analyze the key computations underlying deep learning, Convolutional Neural Network, Building blocks of CNN- Convolutional layers, Pooling layers Dense layers.

SUGGESTED READING:

1 Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", Third Edition, Pearson 2016.
2 Elaine Rich, Kevin Knight, Shivashankar B. Nair, Artificial Intelligence", McGraw-Hill, Third Edition, 2009.
3 Dan W. Patterson, "Introduction to Al and ES", Pearson, 2007.
4 Patrick H. Winston, "Artificial Intelligence", Third Edition, Pearson Education, 2006

Course Code	Course Title						Core//PE/OE
PE512EC	DIGITAL IMAGE PROCESSING						PE-II
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Digital Signal Processing	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. Understand the image formation and its digital representation
2. Learn digital image fundamentals. Be exposed to simple image processing techniques
3. Learn representation of images in frequency domain and enhancement techniques
4. Be familiar with image compression and segmentation techniques. Learn to represent image in form of features
5. Solve the problems related to image compression and learn the basics of video

Course Outcomes : On completion of this course, the student will be able to :

1. Understand how images are formed, sampled and quantized
2. Apply various transforms like Fourier, DCT, Haar, DWT and Hadamard Transform to different applications
3. Apply image enhancement techniques for practical applications
4. Implement the image restoration techniques
5. Implement image compression techniques by removing the redundancy

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	2	3	-	1	-	-	-	2	2
CO2	3	2	2	2	2	-	-	-	-	-	2	2
CO3	3	2	2	2	3	-	-	-	-	-	1	1
CO4	3	1	2	2	3	-	-	-	-	-	1	1
CO5	3	1	2	2	3	-	-	-	-	-	1	1

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Digital Image Fundamentals: Image sensing, acquisition, Image formation model, sampling and Quantization, Basic relationships between pixels; neighbors of a pixel, adjacency, connectivity, regions and boundaries. Image formation in the eye, its capabilities for brightness adaptation and discrimination. Categorization of images according to their source. Gamma ray imaging, x-ray imaging, imaging in the Ultra Violet band, visible and infrared bands, Microwave band and Radio band.

UNIT–II

Image Transforms: 2D Fourier transform, Properties of 2D Fourier transform, Walsh, Hadamard, Slant, Haar, Discrete cosine transform and Hotelling transform. Color Image Processing: Color Fundamentals, Color Models, Pseudo color Image Processing.

UNIT–III

Image Enhancement: Spatial domain techniques: Contrast stretching, histogram equalization and histogram specification method, Neighborhood averaging and adaptive Median filter. Frequency domain methods: Ideal Low pass, Butterworth and Gaussian Low pass filters. Ideal High pass, Butterworth and Gaussian High pass filters. Homomorphic filtering.

UNIT-IV

Image Restoration: Mathematical expression for degraded image, estimation of degradation functions: Image observation, experimentation and modeling. Inverse filter Wiener filter, Geometric transformation, periodic noise reduction method.

Image Segmentation and Compression: Detection of discontinuities, point detection methods, line detection. Edge detection methods: Gradient operation, Laplacian, Prewitt, Sobel, Laplacian of a Gaussian and Canny edge detectors.

UNIT – V

Image compression: Functional block diagram of a general image compression system and description of each unit, various types of redundancies, coding redundancy, psycho visual redundancy spatial and temporal redundancy, Huffman coding.

Video Sampling: Analog video, Digital Video, Time-varying Image formation models, 3D motion models, Geometric image formation, Photometric image formation, Sampling of video signals

SUGGESTED READING:

1. Rafael C. Gonzales, Richard E. Woods, "*Digital Image Processing*", Third Edition, Pearson Education, 2010.
2. Anil K Jain, "*Fundamentals of Digital Image Processing"*, Prentice-Hall of India Private Limited, New Delhi, 1995
3. . Milan Sonka, Vaclav Havel and Roger Boyle, "*Digital Image Processing and Computer vision"*, Cengage Learning India Pvt. Limited, 2008.
4. M. Tekalp, "Digital Video Processing", Prentice-Hall International, Second Edition,2015
5. ALAN C BOVIK, ―Hand Book of Image and Video Processing, 2nd Edition, Elsevier Academic Press, 2005

Course Code	Course Title						Core//PE/OE
PE513EC	OBJECT ORIENTED PROGRAMMING USING C++						PE-II
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives that the student is:

1. Introduced to Object Oriented Programming concepts using the C++ language
2. Introduced to the principles of data abstraction, inheritance and polymorphism
3. Introduced to the principles of virtual functions and polymorphism
4. Introduced with handling formatted I/O and unformatted I/O
5. Introduced to handle exceptions

Course Outcomes : On completion of this course, the student will be able to :

1. Able to develop programs with reusability
2. Understand different types of constructors and initialization of objects
3. Handle exceptions in programming
4. Handle formatted and unformatted I/O
5. Develop applications for a range of problems using object-oriented programming techniques

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Basic Concepts of OOP, Benefits of OOP, Object Oriented Languages, Features of OOP. How OOP Differ from POP. Applications of OOP, A Simple C++ Program, Structure of C++ Program. Keywords, Identifiers and Constants, Basic Data Types, User Defined Data Types, Derived Data Types, Dynamic Initialization of Variables, Reference Variables, Operators in C++, Scope Resolution Operator, Member Dereferencing Operators, Memory Management Operators

UNIT–II

Functions, Classes and Objects: Introduction of Classes, Specifying a Class, Defining a Member Functions, A C++ Program with Class Access Specifies, Inline functions, Nesting of Member Functions, Memory Allocation for Objects, Static Data Members, Static Member Functions, Arrays of Objects, Objects as Function Arguments, Default Arguments, Const

Arguments, Function Overloading, Friend Functions

UNIT–III

Constructors, Destructors, Inheritance: Introduction, Constructors, Parameterized Constructors, Multiple Constructors in a Class, Constructors with Default Arguments, Dynamic initialization of Objects, Copy Constructors, Dynamic Constructors, Destructors. Introduction to inheritance, Defining Derived Classes, Single Inheritance, Multiple Inheritance, Multi-Level Inheritance, Hierarchical Inheritance, Hybrid Inheritance, Abstract Classes, Constructors in Derived Classes, Containership, Operator overloading, Rules for Operator overloading, overloading of binary and unary operators

UNIT-IV

Pointers, Virtual Functions and Polymorphism: Introduction, Memory Management, new Operator and delete Operator, Pointers to Objects, this Pointer, Pointers to Derived Classes, Polymorphism, compile time polymorphism, Run time polymorphism, Virtual Functions, Pure Virtual Functions, Virtual Base Classes, Virtual Destructors

UNIT – V

Templates and Exception handling: Introduction, Class Templates, Class Templates with Multiple Parameters, Function Templates, Function Templates with Multiple Parameters, Member Function Templates. Basics of Exception Handling, Types of exceptions, Exception Handing Mechanism, Throwing and Catching Mechanism, Re-throwing an Exception, Specifying Exceptions

SUGGESTED READING:

1. Walter Savitch, *"Problem Solving with C++",* 6th Edition, Pearson Education Publishing.
2. SB Lippman, J Lajoie, *"C++ Primer"*, 3rd Edition, AW Publishing Company, 2007.
3. Paul Dietel, Harvey Dietel, *"C How to Program"*, 6th Edition, PHI, 2010.
4. BjarneStroustrup, *"The C++ Programming Language",* 3rd Edition, Pearson Education.
5. Ashok N.Kamthane, *"Programming in C++"* 2nd Edition, Pearson Education Publishing.

Course Code	Course Title						Core//PE/OE
PC551EC	ANALOG AND DIGITAL COMMUNICATION LAB						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Analog and Digital Communications	-	-	-	2	25	50	1

Course Objectives : The course is taught with the objectives of enabling the student to:

1. Perform Analog modulation and demodulation techniques and measure modulation
2. Perform experiments on Radio Receivers to measure their performance parameters
3. Perform Pulse analog modulation and demodulation techniques and understand.
4. Perform Pulse digital modulation and demodulation techniques and understand.
5. Perform carrier modulation techniques

Course Outcomes : On completion of this course, the student will be able to :

1. Acquire knowledge of performing modulation and demodulation and analyze the effects of various parameters on the process
2. Acquire knowledge of operation of various radio receiver sub systems
3. Acquire in-depth understanding of pulse analog modulation techniques
4. Acquire in-depth understanding of pulse digital modulation Techniques
5. Acquire skill to perform carrier modulation

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO	2	1	-	1	-	-	-	-	-	-	-	-
CO	1	1	-	1	-	-	-	-	-	-	-	-
CO	2	1	-	1	-	-	-	-	-	-	-	-
CO	1	1	-	1	-	-	-	-	-	-	-	-
CO	2	-	-	-	-	-	-	-	-	-	-	-

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

Experiment–I

To study the function of Amplitude Modulation & Demodulation (under modulation, perfect modulation & over modulation) and calculate the modulation index

Experiment–II

To study the functioning of frequency modulation & demodulation

Experiment–III

To observe the characteristics of a Frequency Mixer and to measure its conversion gain

Experiment–IV

To Study the AGC characteristics of a Radio Receiver

Experiment–V
To Study Pulse Amplitude Modulation and Demodulation

Experiment–VI
To Study Pulse Width Modulation and Demodulation using different sampling frequency

Experiment–VII
To study and observe the operation of Phase Lock Loop and its Capture range, lock range free running VCO Frequency

Experiment–VIII
To analyze a PCM system and interpret the modulated and demodulated waveforms.

Experiment–IX
To Study the Delta Modulation process by comparing the present signal with the previous signal of the given modulation signal and Demodulate the same

Experiment–X
To Study the ASK, FSK, PSK, QPSK Modulator and Demodulator and interpret the modulated and demodulated waveforms, and plot BER using MATLAB

SUGGESTED READING:

1 Simon Haykin, *"Communication Systems",* 4th Edition, John Wiley &sons.inc, 2000.

2 George Kennedy, Bernard Davis, *"Electronic Communication Systems"*, 4th Edition, Tata McGraw-Hill publishing company Limited, New Delhi, 1993.

Course Code	Course Title						Core//PE/OE
PC552EC	MICRO-CONTROLLERS LAB						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Micro-Controllers and Interfacing	-	-	-	2	25	50	1

Course Objectives : The course is taught with the objectives of enabling the student to:

1. Discuss Basic 8051 Assembly Language Programming
2. Discuss Basic ARM Programming
3. Discuss Timer & Interrupt Programming
4. Discuss Real time Interfacing using 8051 and ARM

Course Outcomes : On completion of this course, the student will be able to :

1. To understand Keil IDE for simulating 8051 and ARM7
2. To write basic assembly language programs for arithmetic and logical operations using 8051
3. To program Timers, serial communication and Interrupts using 8051
4. To interface ADC,DAC, LED, Seven Segment display, Stepper motor using 8051 and ARM LPC2148
5. To Write programs for PWM, sensor interfacing using LPC 2148

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	2	3	-	-	-	1	-	1	1
CO2	1	2	2	2	3	-	-	-	1	-	1	1
CO3	1	2	3	3	3	-	-	-	1	-	1	1
CO4	1	2	3	3	3	-	-	-	1	-	2	2
CO5	1	2	3	3	3	-	-	-	1	-	2	2

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

Experiment–I

Programs for Basic Arithmetic and Logical Operations using 8051

Experiment–II

Program for Sorting, Searching an array using 8051

Experiment–III

Generating Square wave form using Timers in 8051

Experiment–IV

Program for serial communication using on-chip UART 8051

Experiment–V

Design of a Digital Clock using Timers/ Counters in 8051

Experiment–VI
Design an interface to connect LEDs to 8051 and write a program for blinking LEDs

Experiment–VII
Design a Seven Segment Display interface using 8051and write a program to display varuios numbers

Experiment–VIII
Interface ADC to 8051 and interface DAC to 8051, and write programs to generate Triangle and square waves

Experiment–IX
Interface Stepper Motor using 8051, program it to rotate in clockwise and anti clockwise directions

Experiment–X
Interface DIP Switches and LEDs to ARM, program to blink LEDs on switch press

Experiment–XI
Design an interface to connect 16x2 LCD using ARM

Experiment–XII
Interface and rotate DC Motor using ARM

Experiment–XIII
Interfacing RTC Using I2C in ARM

Experiment–XIV
Using on chip Timers/Counters for PWM Generation using ARM

SUGGESTED READING:

1. Mohammad Ali Mazidi, Rolin D McKinley, Janice G Mazidi, The 8051 Microcontroller and Embedded Systems, Second Edition, Prentice Hall
2. Kenneth J Ayala, The 8051 Micro Controller: Architecture, Programming and Applications
3. Jonathan W. Valvano, " Introduction to ARM CORTEX-M Microcontrollers", Volume 1, fifth Edition, June 2024
4. Dr. Yifeng Zhu, "Embedded Systems with ARM Cortex-M micro controllers in Assembly Language ad C".

Course Code	Course Title						Core//PE/OE
PC553EC	DIGITAL SYSTEM DESIGN LAB						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Switching theory and logic design	-	-	-	2	25	50	1

Course Objectives : The course is taught with the objectives of enabling the student to:

1. To understand the operation of basic combinational building blocks
2. Understand the operation of display devices and perform code conversions
3. Understand the operation of all Flip flops
4. Design combinational and sequential circuits for given applications
5. Understand and design counters and registers using basic building blocks

Course Outcomes : On completion of this course, the student will be able to :

1. Use all basic building blocks to design any combinational functions
2. Configure and use display devices
3. Use all flip flops in sequential design and convert flip flops from one form to another
4. Use and configure IC counters as per the given specification
5. Design resisters and use them as per the application

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

Experiment -I

Verification of all basic gates using universal gates

Experiment –II

TTL combinational gate applications: Design and verify

1. 4-bit Binary to Grey code converter
2. AOI gate using 7400IC
3. Full adder and Full Subtractor
4. Full adder using 4:1 Mux

Experiment –III

Verify the operation of BCD- &-segment Decoder (7447) using 7-segment LED display

Experiment –IV
Verify the function of all flip flops realized using basic gates (SR, JK, T and D)

Experiment –V
Convert JK flip flop into T and D Flip flops and verify the design (use basic gates)

Experiment –VI
Design and verify a 3-bit up/down counter

Experiment –VII
Configure IC 7483 as BCD adder and verify the design

Experiment –VIII
Verify the operation of decade counter using IC 7490, configure it as Mod-N (N<9) counter and verify the operation

Experiment –IX
Configure IC 7492 as divide by 3 and 6 counter and verify

Experiment –X
Construct a 4-bit shift register (SISO) using IC 7476 and other logic gates and verify the operation

Experiment –XI
Design and verify the following using Verilog HDL

1. 8:1 encoder using structural modeling
2. BCD – 7-segment decoder using conditional constructs
3. 8:1 Encoder using behavioral constructs
4. ALU using Case Construct
5. 3-bit Binary counter using Loop statements

SUGGESTED READING:

1. R.P.Jain, “Modern Digital Electronics”, Tata McGraw Hill, 4th Edition, 2009
2. M.Morris Mano, Michael D. Ciletti, “Digital Design”, Pearson, 4th Edition, 2012
3. Ming-Bo Lin, “Digital System Design and Practices Using Verilog HDL and FPGAs”, Wiley India Pvt. Ltd., 2012

SCHEME OF INSTRUCTION AND EXAMINATION
B. E (ECE)

VI – Semester

SNo	Code	Course Title	Scheme of Instruction			Contact Hrs/Wk	Scheme of Evaluation			Credits
			L	T	P		Hrs	CIE	SEE	
Theory										
1	ES601ME	Fundamentals of Robotics	3	-	-	**3**	3	40	60	3
2	HS901MC	Managerial Economics and Accountancy	3	-	-	3	3	40	60	3
3	PC601EC	IoT Applications	3	-	-	**3**	3	40	60	3
4	PC602EC	Embedded System Design	3	-	-	**3**	3	40	60	3
5	PC603EC	VLSI Design	3	-	-	3	3	40	60	3
6	**Professional Elective-III**		3	-	-	**3**	3	40	60	3
	PC604CS	Deep Learning								
	PE611EC	Satellite Communication and Applications								
	PE612EC	Radar Systems								
	PE613EC	Optical Communications								
7	OE#####	Open Elective-I	3	-	-	**3**	3	40	60	3
Practicals										
8	PC651EC	IoT & Embedded Systems lab	-	-	2	**2**	3	25	50	1
9	PC652EC	Electronic Design Automation Lab	-	-	2	**2**	3	25	50	1
10	PC653EC	Mini-Project	-	-	6	**6**	-	50	-	3
		Total	**21**	**-**	**10**	**31**	**27**	**380**	**520**	**26**

*Students have to undergo summer internship of 6 Weeks duration at the end of semester VI and Evaluation will be done in VII - Semester

Open Elective-I

1	OE 601BM	Engineering applications in Medicine
2	OE602BM	Human Assistive Technologies
3	OE601CE	Disaster Management
4	OE602CE	Road Safety Engineering
5	OE601CS	Python Programming
6	OE602CS	Cyber Security
7	OE601EC	Verilog HDL
8	OE602EC	Principles of Electronic Communication Systems
9	OE601EE	Applications of Electrical Energy
10	OE602EE	Electrical Safety Management
11	OE601ME	3D Printing Technology
12	OE602ME	Finite Element Methods

SCHEME OF INSTRUCTION AND EXAMINATION
B. E (ECE)
VI – Semester

Course Code	Course Title						Core//PE/OE
ES601ME	FUNDAMENTALS OF ROBOTICS						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
-	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. Familiarize students with various robot configurations
2. Learn to perform forward and inverse kinematics for general robot configurations
3. Familiarize with various trajectory planning and control techniques
4. Will learn to integrate various components in to a robotic system

Course Outcomes : On completion of this course, the student will be able to :

1. Identify and classify various robot configurations with their workspaces & their usage in industry
2. Perform forward and inverse kinematics operations & determine singularity conditions for various robot configurations
3. Implement various path planning techniques & control algorithms for computing end effectors' motions for generalized robotic tasks
4. Understand and Use appropriate sensors for specified applications
5. Interface various hardware and software components to develop robotic systems for industry including the effects of multiple finger kinematics

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Brief History, Types of robots, Overview of robot subsystems, resolution, repeatability and accuracy, Degrees of freedom of robots, Robot configurations and concept of workspace, Mechanisms and transmission, End effectors and Different types of grippers, vacuum and other methods of gripping. Pneumatic, hydraulic and electrical actuators, applications of robots, specifications of different industrial robots.

UNIT–II

Rotation matrices, Euler angle and RPY representation, Homogeneous transformation matrices, Denavit-Hartenberg notation, Direct kinematics, Derivation of DH parameters for various robot configurations, Representation of absolute position and orientation in terms of joint parameters.

UNIT–III

Inverse Kinematics, direct v/s inverse kinematics, inverse orientation, inverse locations, Singularities, Determination of Singular conditions for various common robot configurations, Jacobean

UNIT-IV

Trajectory Planning: joint interpolation, task space interpolation, execution of user specified tasks. Independent joint control, PD and PID feedback, Computed torque control

UNIT – V

Sensors: types of sensors, tactile & non tactile sensors, sensors to measure Position, velocity & acceleration measurement, Optical encoders. Range and Proximity sensing, acoustic, pneumatic, hall effect sensor, Eddy current sensors, Force and Torque sensors. Vision: Image acquisition, types & components of vision system, Image representation, digitization, binary, gray scale, RGB representation, Image processing, Image segmentation, image smoothening, object descriptors, object recognition. Robots used in general applications like material handling, process applications, assembly operations, inspection applications, healthcare, entertainment

SUGGESTED READING:

1. Nagrath and Mittal, “Robotics and Control”, Tata McGraw-Hill, 2003.
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and sons, 2008.
3. S K Saha, “Introduction to Robotics “, 2nd edition, TMH, 2013
4. Harry Asada & Slottine “Robot Analysis& Control” , Wiley Publications, 2014
5. Fu. K.S, Gonzalez, R.C., Lee, C.S.G, Robotics, control, sensing, Vision and Intelligence, McGraw Hill International, 1987
6. A Mathematical Introduction to Robotic Manipulations- Richard M. Murray, Zexiang Li, S.Shankar Sastry CRC Press.Inc. 1st edition, 1994

Course Code	Course Title						Core//PE/OE
HS901MC	MANAGERIAL ECONOMICS AND ACCOUNTANCY						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. To learn important concepts of Managerial Economics and apply them to evaluate business decisions
2. To understand various parameters that determine the consumer's behavior
3. To evaluate all the factors that affect production
4. To understand the concepts of capital budgeting and payback period
5. To study the concepts of various book-keeping methods

Course Outcomes : On completion of this course, the student will be able to :

1. Apply the fundamental concepts of managerial economics to evaluate business decisions
2. Understand types of demand and factors related to it
3. Identify different types of markets and determine price-output under perfect competition
4. Determine working capital requirement and payback period
5. Analyze and interpret financial statements through ratios

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Meaning and Nature of Managerial Economics: Managerial Economics and its usefulness to Engineers, Fundamental Concepts of Managerial Economics-Scarcity, Marginalism, Equi-marginalism, Opportunity costs, Discounting, Time perspective, Risk and Uncertainty, Profits, Case study method.

UNIT–II

Consumer Behavior: Law of Demand, Determinants, Types of Demand; Elasticity of Demand (Price, Income and Cross-Elasticity); Demand Forecasting, Law of Supply and Concept of Equilibrium. (Theory questions and small numerical problem can be asked).

UNIT–III

Theory of Production and Markets: Production Function, Law of Variable Protection, ISO

quants, Economics of Scale, Cost of Production (Types and their measurements), Concept of Opportunity cost, Concept of Revenue, Cost-Output relationship, Break-Even Analysis, Price-Output determination under perfect Competition and Monopoly (Theory and problems can be asked).

UNIT-IV

Capital Management: Significance, determination and estimation of fixed and working capital requirements, sources of capital, Introduction to capital budgeting, methods of payback and discounted cash flow methods with problems. (Theory questions and numerical problems on estimating working capital requirements and evaluation of capital budgeting opportunities can be asked)

UNIT – V

Book-keeping: Principles and significance of double entry book keeping, Journal, Subsidiary books, Ledger accounts, Trial Balance, concept and preparation of Final Accounts with sample adjustments, Analysis and interpretation of Financial statements through Ratios.
(Theory questions and numerical problems on preparation of final accounts, cash book, pretty cash book, bank reconciliations statement, calculation of some ratios).

SUGGESTED READING:

1. Mehta P.L., *Managerial Economics-Analysis, Problems and Cases,* Sulthan Chand & Sons Educational Publishers, 2011
2. Maheswari S.N., *Introduction to Accountancy,* Vikas Publishing House, 2005
3. Pandey I.M., *Financial Management,* Vikas Publishing House, 2009

Course Code	Course Title						Core//PE/OE
PC601EC	IOT APPLICATIONS						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
-	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. Discuss fundamentals of IoT and its applications and requisite infrastructure
2. Describe Internet principles and communication technologies relevant to IoT
3. Discuss hardware and software aspects of designing an IoT system
4. Describe concepts of cloud computing and Data Analytics
5. Discuss business models and manufacturing strategies of IoT products

Course Outcomes : On completion of this course, the student will be able to :

1. Understand the various applications of IoT and other enabling technologies.
2. Comprehend various protocols and communication technologies used in IoT
3. Design simple IoT systems with requisite hardware and C programming software
4. Understand the relevance of cloud computing and data analytics to IoT
5. Comprehend the business model of IoT from developing a prototype to launching a product

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	-	-	-	-	-	-	-	-	1
CO2	1	2	1	2	-	-	-	-	-	-	-	2
CO3	3	1	2	-	-	-	-	-	-	-	-	-
CO4	1	2	-	-	-	-	-	-	-	-	3	-
CO5	3	1	2	-	3	-	-	-	-	2	-	-

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Introduction to Internet of Things IOT vision, Strategic research and innovation directions, Iot Applications, Related future technologies, Infrastructure, Networks and communications, Processes, Data Management, Security, Device level energy issues

UNIT–II

Internet Principles and communication technology Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open-Source Vs Closed Source

UNIT–III

Prototyping and programming for IoT Prototyping Embedded Devices – Sensors, Actuators,

Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling. Techniques for writing embedded C code: Integer data types in C, Manipulating bits - AND, OR, XOR, NOT, Reading and writing from I/ O ports. Simple Embedded C programs for LED Blinking, Control of motor using switch and temperature sensor for arduino board

UNIT-IV

Cloud computing and Data analytics Introduction to Cloud storage models -SAAS, PAAS, and IAAS. Communication APIs, Amazon webservices for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT - Apache hadoop- Map reduce job execution workflow

UNIT – V

IoT Product Manufacturing - From prototype to reality Business model for IoT product manufacturing, Business models canvas, Funding an IoT Startup, Mass manufacturing - designing kits, designing PCB,3D printing, certification, Scaling up software, Ethical issues in IoT- Privacy, Control, Environment, solutions to ethical issues

SUGGESTED READING:

1 Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, Wiley India Publishers, 2015
2 Daneil W lewies,”Fundamentals of embedded software: where C meets assembl”, Pearson, 200.
3 Arshdeep Bahga and Vijay Madisetti ,“Internet of Things: A Hands-on Approach”, Orient Blackswan Private publishers, First edition, 2015

Course Code	Course Title						Core//PE/OE
PC602EC	EMBEDDED SYSTEM DESIGN						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
-	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. To understand the processor selection criteria for Embedded System Design.
2. To provide a clear understanding of role of firmware, operating systems in correlation with hardware systems.
3. To gain the knowledge of tool chain for embedded systems.
4. To understand the importance of RTOS in building real time systems

Course Outcomes : On completion of this course, the student will be able to :

1. Design an embedded system.
2. Distinguish between RISC and CISC
3. Design procedure of embedded firm ware
4. Use Embedded Software Development Tools for Designing Embedded System applications
5. Apply their understanding in building real time systems

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Introduction to Embedded Systems: Embedded systems Vs General computing systems, History of Embedded systems, classification, Characteristics and quality attributes of Embedded Systems Challenges in Embedded System Design, Application and Domain specific Embedded Systems.

UNIT–II

Embedded firmware and Design and Development: Embedded Firmware Design Approaches and Development languages and Programming in Embedded C

UNIT–III

Embedded Software Development Tools: Host and Target Machines, Cross Compilers, Cross Assemblers, Tool Chains, Linkers/Locators for Embedded Software, Address Resolution,

Locator Maps. Getting Embedded Software Into Target System: PROM programmer, ROM emulator, In Circuit- Emulators, Monitors, Testing on Your Host Machine - Instruction Set Simulators, Logic Analysers.

UNIT-IV

Introduction to Real Time Operating Systems: Tasks and task states, tasks and Data, Semaphores and shared data. Operating system services: Message queues, mailboxes and pipes, timer functions, events, memory management, Interrupt routines in an RTOS environment..

UNIT – V

TASK COMMUNICATION: Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.

SUGGESTED READING:

1. Shibu KV, Introduction to Embedded System, Mc-Graw Hill, 2010.
2. Raj Kamal, Embedded Systems Architecture, Programming and Design, 2nd Ed., McGraw Hill, 2010
3. An Embedded Software Primer - David E. Simon, Pearson Education.
4. Jean.J.Labrosse, *MicroC/OS-II*, Taylor & Francis, 2002

Course Code	Course Title						Core//PE/OE
PC603EC	VLSI DESIGN						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
ED, STLD and DSDHDL	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. To provide a perspective on Digital Design in the Deep Sub-micron Technology
2. To focus on CMOS and Bi CMOS Short-channel Transistor Models
3. To Study CMOS Inverter elaborately
4. To explore static and dynamic implementations of combinational and sequential circuit designs
5. Introduce Testability of VLSI circuits

Course Outcomes : On completion of this course, the student will be able to :

1. Have an understanding of the Fabrication processes and the comparison between different state-of-the-art CMOS technologies
2. Acquire the knowledge in understanding CMOS Inverter characteristics. Illustrate circuit diagrams, stick diagrams and layouts
3. Design and analyze various Combinational Logic circuits in different models
4. Design and analyze various Arithmetic Blocks and Memory structures
5. Understand various fault models and testing methods

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Design Abstraction in Digital circuits, Fabrication process flow of NMOS and PMOS transistors, Overview of CMOS and BiCMOS technologies, MOSFET Transistor under static conditions, channel Length Modulation, Velocity Saturation, Sub-threshold Condition, Threshold variations, MOS structure Capacitance, CMOS Latch up, Technology scaling

UNIT–II

Digital CMOS Design: Static CMOS inverter-switching threshold, Noise margins, Voltage Transfer Characteristics, CMOS inverter Dynamic behavior- computing capacitance and propagation delay, Static and Dynamic Power Consumption.

Complementary CMOS, Ratioed Logic, Pass Transistor Logic, Full Adder and carry save multiplier design Considerations, Dynamic CMOS design -basic principle, Signal integrity issues in Dynamic Design, cascading dynamic gates. Designing sequential logic circuit- Bi-

stability Principle, Multiplexer based latch, Dynamic latches and registers

UNIT–III

Analog CMOS design: Significance of analog integrated circuits, Suitability of CMOS for analog IC design, , biasing styles, single stage amplifier with resistive load, single stage amplifier with diode connected load, CS, CD, CG amplifiers, current sources and sinks, limitations of single stage amplifier, gain boosting techniques, current mirror principles, introduction to differential amplifier

UNIT-IV

Designing Memory and Array architectures: Memory classification, Architecture and building blocks, Memory Core-Rom, Non volatile RWM, RAM-Static RAM, Dynamic RAM, Memory Peripheral Circuitry-Address decoders-Row decoders-static and dynamic, column and block decoders, sense amplifiers-differential and single ended sensing, voltage references, Timing and control.

UNIT – V

Implementation of strategies for Digital ICs, Testing of VLSI circuits**:** VLSI Chip Yield, Test procedures; Design for Testability- Ad Hoc Testing, Scan Based testing, Boundary Scan Design, Built in Self-Test, Built-in logic block observer, Test Pattern Generator, Automatic Test Pattern Generation (ATPG)

SUGGESTED READING:

1. JAN.M. Rabaey, A. Chandrakasan and B. Nikholic*, "Digital Integrated Circuits – A Design Perspective"*, 2nd Edition, PHI, 2007.
2. David A Hodges, H. Jackson and R. A. Saleh, "*Analysis and Design of Digital Integrated Circuits in Deep Submicron Technology"*, 3rd Edition, Tata McGraw Hill, 2007.
3. John. P. Uymera, "*Introduction to VLSI Circuits and system",* student edition, John Wiley and Sons, 2003
4. Douglas A. Pucknell, Kamran Eshraghian, " Basic VLSI design", 3rd Edition, PHI, 2003

Course Code	Course Title						Core//PE/OE
PC604CS	DEEP LEARNING						PE-III
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
-	L	T	D	P			
	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1 To understand complexity of Deep Learning algorithms and their limitations
2. To understand modern notions in data analysis oriented computing;
3. To apply Deep Learning algorithms in practical applications
4. To perform experiments in Deep Learning using real-world data.

Course Outcomes : The student will be able to

1. Understand the concepts of Neural Networks, its main functions, operations and the execution pipeline
2. Implement.
3. Learn topics such as deep learning algorithms, understand neural networks and traverse the layers of data abstraction Convolutional neural networks, recurrent neural networks, training deep networks and modifications
4. Build deep learning models in PyTorch and interpret the results

UNIT-I

Artificial Neural Networks: Introduction, Perceptron, XOR Gate ,Perceptron Training Rule, Activation Functions.

Linear Neural Networks: Linear Regression, Implementation of Linear Regression, Softmax Regression, The Image Classification Dataset , Implementation of Softmax Regression

UNIT-II

Multilayer Perceptrons:

Multilayer Perceptrons, Implementation of Multilayer Perceptrons, Model Selection, Underfitting and Overfitting, Weight Decay, Dropout, Forward Propagation, Backward Propagation, and Computational Graphs, Numerical Stability and Initialization, Considering the Environment, Predicting House Prices on Kaggle.

Optimization Algorithms: Optimization and Deep Learning, Convexity, Gradient Descent, Stochastic Gradient Descent, Mini batch Stochastic Gradient Descent, Momentum, Adagrad, RMS Prop, Ada delta, Adam, Learning Rate Scheduling.

UNIT-III

Introduction to Convolutional Neural Networks

Introduction to CNNs, Kernel filter, Principles behind CNNs, Multiple fillters,

Modern Convolutional Neural Networks

Deep Convolutional Neural Networks (AlexNet), Networks Using Blocks (VGG), Network in Network (NiN), Networks with Parallel Concatenations (GoogLeNet), Batch Normalization, Residual Networks (ResNet), Densely Connected Networks (DenseNet).

UNIT-IV

Recurrent Neural Networks: Sequence Models, Text Preprocessing, Language Models and the Dataset, Recurrent Neural Networks, Implementation of Recurrent Neural Networks from Scratch, Concise Implementation of Recurrent Neural Networks, Back propagation Through Time**.**

Modern Recurrent Neural Networks: Gated Recurrent Units (GRU), Long Short Term Memory (LST), Deep Recurrent Neural Networks, Bidirectional Recurrent Neural Networks, Machine Translation and the Dataset, Encoder-Decoder Architecture, Sequence to Sequence, Beam Search.

UNIT-V

Auto Encoders: Types of Auto Encoders and its applications

Generative Adversarial Networks: Generative Adversarial Network, Deep Convolutional Generative Adversarial Networks

Suggested Readings:

1. Good fellow, I., Bengio,Y., and Courville, A., "*Deep Learning"*, MIT Press, 2016.

2. Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola, "*Dive into Deep Learning",* 2020.

Course Code	Course Title						Core//PE/OE
PE611EC	SATELLITE COMMUNICATION AND APPLICATIONS						PE-III
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. To familiarize with basic concepts related to satellite Communication
2. To understand Sub-Systems of Satellites and Launches
3. To study about the Satellite signal propagation.
4. To know about the Satellite Navigation.
5. To understand about the Deep Space missions and applications of satellites

Course Outcomes : On completion of this course, the student will be able to :

1. Have knowledge about the Satellite communications Principles and Properties
2. Know about the Space craft subsystems, Launch vehicles and Satellite link.
3. Able to design the satellite signal propagation effects
4. Able to analyze the significance and operation of satellite navigation systems.
5. Able to understand the space missions and applications of Satellite Communication

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Origin of Satellite communications, A Brief History of Satellite Communication, Basic principles and properties of satellite communication. Earth segment, Space segment, Interpretation of Kepler's Laws, Space craft sub systems, Orbital Mechanics: The Equation of the Orbit, Describing the Orbit, Locating the Satellite in the Orbit, Orbital effects in communication system Performance: Doppler shift, Range variation, Eclipse and Sun-Transit Outage

UNIT–II

Equipment Reliability and Space Qualification: Space Qualification, Reliability, and Redundancy, Satellite launch and launch vehicles and Mechanics of Launching a Synchronous Satellite. Earth Stations – Types of Earth stations- large, medium and small. Satellite Link Design: Basic Transmission Theory, System Noise Temperature and G/T ratio, Noise Temperature, calculation of System Noise Temperature and Noise Figure

UNIT–III

Propagation on Satellite-Earth paths: Attenuation, depolarization, atmospheric absorption, Tropospheric Multipath effects and Land and Sea Multipath, Multipath Effects in System Design, Faraday rotation in the Ionosphere, Ionospheric scintillations, Rain and ice effects. Concept of TDMA

UNIT-IV

Satellite Navigation Applications: Significance, Transit system, Global and Regional Satellite Navigation Systems-Operating Principle, Advantages, Limitations, Current Status and Applications, Remote Sensing Satellites

UNIT – V

Space debris-History,Sources of debris, Hazards, Tracking and measurements, Debris removal Methods. Mars Orbiter mission, Chandrayaan1, 2 and 3 missions, Aditya L1, Gaganyaan, NISAR, Satellites, Indian Satellite Launchers under development, Indian Geo platform of ISRO -Bhuvan, Space applications

SUGGESTED READING:

1. Wilbur L. Pitchand and Henri G. Suyderhoud, Robert A. Nelson, ―Satellite Communication Systems Engineering‖, 2ndedn. 3rd Impression, Pearson Education.2008.
2. Timothy Pratt and Charles Nestian. W, ―Satellite Communication‖, John Wiley and Sons, 1988.
3. Tri T. Ha, ―Digital Satellite Communication‖, Tata McGraw- Hill, Special Indian Edition 2009
4. https://www.isro.gov.in

Course Code	Course Title						Core//PE/OE
PE612EC	RADAR SYSTEMS						PE-III
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
-	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. Familiarize with basic concepts of radar systems
2. Understand different Radar Systems
3. Know about Radar antennas
4. Know the propagation effects on a radar signal
5. Understand tracking radar principles

Course Outcomes : On completion of this course, the student will be able to :

1. Understand the components of a radar system
2. Understand the components of a radar system
3. Analyze the concept of MTI radar systems
4. Incorporate the effects of environment condition in a radar system
5. Apply appropriate mathematical and computer models relevant to radar systems to calculate system performance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-
CO3	3	-	3	-	1	1	1	1	-	-	-	-
CO4	2	2	-	-	-	1	-	-	1	-	-	1
CO5	2	2	-	-	-	-	1	1	-	-	-	-

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT–I

Radar Systems: Radar Block diagram and operation, Applications of Radar. Radar frequencies, Radar Range Equation, Radar Cross Section of target, Prediction of range performance, Minimum detectable signal, Receiver noise figure, Effective noise temperature, Signal to noise ratio, System losses, False alarm time and probability of false alarm, Integration of radar pulses, Pulse-repetition frequency and range ambiguities. Swerling‘s Models.

UNIT–II

CW and FMCW Radars: Doppler effects, CW Radar, FMCW Radar, Multiple frequency CW radar, Low noise front-ends, A-scope, B-scope, PPI Displays, and Duplexers

UNIT–III

MTI and Pulse Doppler Radar: MTI radar, Delay line canceller, Multiple and staggered prf, Blind speeds, Limitations to MTI performance, MTI using range gated Doppler filters, Pulse Doppler radar, Non coherent radar. CFAR techniques in Radar Detection

UNIT-IV

Tracking Radar: Sequential Lobing, Conical scan, Monopulse - Amplitude comparison and Phase comparison methods, tracking in range and in Doppler, Acquisition, and Comparison of Trackers

UNIT – V

Search Radar: Track while scan radars, Search radar range equation, Search scans, Effect of surface reflection, Line of Sight (LOS), Propagation effects: Propagation over a plane earth, the round earth, Refraction, Anomalous propagation, Diffraction, Attenuation by atmospheric gases, Environmental noise

SUGGESTED READING:

1. Skolnik, Merrill I, ―*Introduction to Radar Systems*‖, MGH, third edn. 2001.
2. Barton. David K, ―*Modern Radar System Analysis*‖, Artech House, 1988.
3. Peebles PZ, ―*Radar Principles*‖, John – Willey, 2004

Course Code	Course Title						Core//PE/OE
PE613EC	OPTICAL COMMUNICATIONS						PE-III
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
Analog and Digital Communications	3	-	-	-	40	60	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. To become familiar with the fundamental concepts of Light, Basic laws of light, various types of Optical fibers, modes and configurations
2. To acquaint with theoretical analysis of the Signal propagation and distortion during propagation of light in Optical Fibers
3. To become familiar with Optical sources, Optical detectors and Optical amplifiers
4. To understand the design principles of Digital and Analog links
5. To know the operating principles of WDM and components for its realization

Course Outcomes : On completion of this course, the student will be able to :

1. Able to apply Optical Laws to provide solutions to the problems of Optical Waveguides
2. Able to deal with the Optical Communication System designs
3. Able to carry out the calculations of various noise powers at Optical Receivers
4. Able to design the Optical Link Power Budget and Rise Time Budget for the given applications
5. Able to design the WDM systems with various system considerations

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

UNIT – I

Overview of Optical Fiber Communications: The evolution of optical fiber systems, Elements of an Optical fiber transmission link, Optical fibers, Nature of light – basic optical laws and definitions – Modes and configurations, Mode of theory of circular waveguides, Single and multi- mode step index and graded index fibers.

UNIT – II

Signal degradation in Optical fibers: Attenuation, Signal distortion in optical waveguides, Mode coupling, and Design optimization of single mode fibers.

Optical sources: Semiconductors as optical sources and their fabrication, LED's and Laser diodes, Linearity of sources.

UNIT – III

Photo detectors: Physical principles of PIN and APD, Photo detector noise, Detector response time, Avalanche multiplication noise, Comparisons of Photo detectors.

Optical receiver operation: Fundamental receiver operation, Digital receiver performance calculation. Preamplifiers types, Analog receivers.

UNIT – IV

Point-to-Point Optical links: System considerations, Link power budget, Rise time budget, Noise effects on system performance. Overview of analog links, Carrier noise ratio in analog systems.

UNIT –V

Optical Amplifiers & WDM: Introduction to optical amplifiers, Basic applications and types of Optical amplifier, WDM concepts and Components, operational principles, passive components, Tunable sources and Tunable filters.

Suggested Reading:

1. Gerd Keiser, "Optical Fiber Communications", 3rd Edition, Tata McGraw- Hill publishing company Limited, New Delhi, 2000.
2. D.C.Agarwal, "Fiber Optic Communication", 2nd Edition, Wheeler publishing, New Delhi, 1993.
3. D. k. Mynbaev, L.L. Scheiner, "Fiber-Optic Communications Technology", Pearson education, New Delhi, 2006.

Course Code	Course Title						Core//PE/OE
P651EC	IOT AND EMBEDDED SYSTEMS LAB						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	2	25	50	1

Course Objectives : The course is taught with the objectives of enabling the student to:

1. To understand functionalities of various single board embedded platforms fundamentals
2. To develop comprehensive approach towards building small low cost embedded IoT system
3. To implement the assignments based on sensory inputs
4. Able to Develop IoT prototyping for smart applications
5. To get familiarity with various IoT cloud services

Course Outcomes : On completion of this course, the student will be able to :

1. Design the minimum system for sensor based application
2. Implement communication protocol
3. Configure Raspberry Pi and deploy local web server for client application
4. Solve the problems related to the primitive needs using IoT
5. Develop full fledged IoT application for distributed environment with and without using RTOS

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1	-	-	-	-	-	-	-	-
CO2	1	2	3	2	-	-	-	-	-	-	-	2
CO3	1	2	2	-	3	-	-	-	-	-	-	2
CO4	1	2	3	3	3	-	-	-	-	-	-	2
CO5	1	1	3	-	-	-	-	-	-	3	-	2

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

Experiment-I

Programming the GPIO pins of Arduino Uno/Node-MCU to interface LEDS and switches and using the Light sensor, monitor the surrounding light intensity & automatically turn ON/OFF the high intensity LED's by taking some predefined threshold light intensity value.

Experiment-II

Building Intrusion Detection System with Arduino and Ultrasonic Sensor

Experiment-III

Design an IOT based system to sense the humidity and temperature using DHT11 sensor and

send it to cloud.

Experiment-IV
Design an IOT based system using microcontroller(Node-MCU) for controlling of home appliances

Experiment-V
Create a small dashboard application to be deployed on cloud. Different publisher devices can publish their information and interested application can subscribe.

Experiment-VI
Linking the Twitter account with Thing speak cloud server to give alerts using various sensors

Experiment-VII
Flashing the OS on to the device into a stable functional state by porting desktop environment with necessary packages.

Experiment-VIII
Programming available GPIO pins of Raspberry-Pi to interface LEDs and Switches

Experiment-IX
Write a server application to be deployed on Raspberry-Pi /Beagle board. Write client applications to get services from the server application

Experiment-X
Interfacing the regular USB webcam with the device and turn it into fully functional IP Webcam & test the functionality.

Experiment-X
Task Creation and Scheduling: Create an application with two tasks that wait on a timer while the main task loops. Illustrate the use of an event set between an ISR and a task.

Experiment-XI
Interrupt Handling: Demonstrate interruptible ISRs (requires the timer to have higher priority than external interrupt buttons).

Experiment-XII
Message Queues and Memory Blocks: Test message queues and memory blocks. Test byte queues

Experiment-XII

Time Slicing: Create two tasks of the same priority and set the time, slice period to illustrate time slicing

Experiment-XII

Interfacing Programs: Blink two different LEDs at different timings using two tasks. Display different messages on an LCD display using two tasks

Experiment-XII

Sending Messages to Mailbox: Create one task that sends messages to a mailbox and another task that reads the messages from the mailbox

Experiment-XII

Serial Communication: Implement three different tasks that send messages to a PC through a serial port based on priority

SUGGESTED READING:

1. Cuno Pfister, "Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud (Make: Projects) ", 1st Edition, Kindle Edition,2011
2. Peter Waher , Learning Internet of Things, PACKT publishing,2015

Course Code	Course Title						Core//PE/OE
PC652EC	ELECTRONIC DESIGN AUTOMATION LAB						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
DSD with Verilog HDL & VSLI design	-	-	-	2	25	50	1

Course Objectives : The course is taught with the objectives of enabling the student to:

1. To design and analyze building blocks for a Digital System using HDL platform
2. To understand a Digital System using HDL platform
3. To design and analyze CMOS circuits using back-end platform
4. To draw layout of basic CMOS circuits
5. To Design sequential and combinations circuits using building blocks

Course Outcomes : On completion of this course, the student will be able to :

1. Demonstrate basic building blocks of a Digital System using HDL platform
2. Realize a basic Digital Systems in HDL platform
3. Demonstrate basic building blocks of a Digital System using schematic modeling
4. Demonstrate Layout design and parasitic extraction of CMOS Inverter
5. Evaluate the performance parameters of CMOS inverter at different levels of design abstractions

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

Correlation rating: Low / Medium / High: 1 / 2 / 3 respectively.

Experiment-I

Design and Write a Verilog HDL code for BCD to 7-segment decoder for LED and LCD displays and verify

Experiment-II

Design a 4-bit shift right barrel shifter using 2:1 Mux
Design a 4-bit shift left barrel shifter using 2:1 Mux
Verify both the designs with a test bench.

Experiment-III

Design a sequence detector for a given sequence in Verilog HDL and verify its function through a test bench and write the output to a file.

Experiment-IV

Design a 4-bit CLA and develop HDL code using Generate Loop statements
Design a 4X4 unsigned array Multiplier and develop a HDL code using Generate Loop statements.
Verify both the designs with attest bench.

Experiment-V

Develop a Verilog HDL code for SR and T flip flops with synchronous reset
Develop a Verilog HDL code for JK and D flip flops with asynchronous reset
Verify them with a suitable test bench

Experiment-V

Design an N-bit shift register with asynchronous reset and synchronous load/shift controls to operate in the following modes, namely PIPO, SIPO, SISO, PISO. Develop a Verilog HDL code and verify the operation with a test bench

Experiment-VI

Draw schematic of all CMOS basic gates and simulate using Cadence Schematics tool

Experiment-VII

Develop basic Building blocks as MUX, Half adder, Full adder, Encoder using CMOS gates in Cadence and verify

Experiment-VIII

Develop a 4-bit Carry look ahead adder and a Carry Bypass adder using Cadence Schematics and verify.

Experiment-IX

Develop a 4-bit Array multiplier with CLA as end accumulator and verify .

Experiment-X

Develop a 4-bit Carry save multiplier and verify its function using cadence tool.

Experiment-X

Design and analyze the following CMOS circuits: Inverter using static, ratioed, dynamic and domino logic styles

Experiment-XI

Design a CMOS inverter and obtain VTC using Cadence Tools

Experiment-XII

Draw the layout and evaluate the performance of CMOS Inverter and two-input CMOS

NAND gate

SUGGESTED READING:

1. Samir Palnitkar, *"Verilog HDL A Guide to Digital Design and Synthesis,"* 2nd Edition, Pearson Education, 2006
2. Ming-Bo Lin, *"Digital System Designs and Practices: Using Verilog HDL and FPGA*," Wiley India Edition, 2008
3. David A Hodges, H. Jackson and R. A. Saleh, "*Analysis and Design of Digital Integrated Circuits in Deep Submicron Technology"*, 3rd Edition, Tata McGraw Hill, 2007.

Course Code	Course Title						Core//PE/OE
PC653EC	MINI - PROJECT						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	6	50	-	3

Course Objectives : The course is taught with the objectives of enabling the student to:

1. To enhance practical and Professional skills
2. To expose the students to industry practices and team work.
3. To encourage students to work with innovative and entrepreneurial ideas.

Course Outcomes : On completion of this course, the student will be able to :

1. Conceive a problem statement either from rigorous literature survey or from the requirements raisedfrom need analysis.
2. Design, implement and test the prototype/algorithm in order to solve the conceived problem.
3. Write comprehensive report on mini project work

Guidelines:

1. The mini-project is a team activity having 3-4 students in a team. This is mechanical product design work/ manufacturing process with a focus on mechanical system design/manufacturing process.
2. The mini project may be a complete hardware or a combination of hardware and software. The software part in mini project should be less than 50% of the total work.
3. Mini Project should cater to a small system required in laboratory or real life.
4. It should encompass components, devices, with which functional familiarity is introduced.
5. After interactions with course coordinator and based on comprehensive literature survey/ need analysis, the student shall identify the title and define the aim and objectives of mini-project.
6. Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and submit the proposal within first week of the semester.
7. The student is expected to exert on design, development and testing of the proposed work as per the schedule.
8. Art work and Layout should be made using CAD based software.
9. Completed mini project and documentation in the form of mini project report is to be submitted at the end of semester.

Course Code	Course Title						Core//PE/OE
PW762EC	SUMMER INTERNSHIP						Core
Pre-requisites	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
		-	6 Weeks	-	50	-	2

Course Objectives : The course is taught with the objectives of enabling the student to:

1. Will expose Technical students to the industrial environment, which cannot be simulated in theclassroom and hence creating competent professionals for the industry.
2. Provide possible opportunities to learn understand and sharpen the real time technical / managerialskills required at the job.
3. Exposure to the current technological developments relevant to the subject area of training.
4. Gain experience in writing Technical reports/projects.
5. Expose students to the engineer's responsibilities and ethics.
6. Familiarize with various materials, processes, products and their applications along with relevantaspects of quality control.
7. Promote academic, professional and/or personal development.
8. Expose the students to future employers.
9. Understand the social, economic and administrative considerations that influence the workingenvironment of industrial organizations
10. Understand the psychology of the workers and their habits, attitudes and approach to problem solving

Course Outcomes : On completion of this course, the student will be able to :

1. Understand the actual industrial environment and tuned to readily accept the works for execution
2. Generate detail project reports and understand industry administration and finance.machines
3. Troubleshoot problems with more confidence
4. Design systems/products following standard procedures and norms
5. Interact with fellow workers and manage the activities efficiently

INTERNSHIP ACTIVITIES

During summer vacation after 4th/ 6th sem.

Internship with Industry/ Govt. / NGO/ PSU/ Any Micro/ Small/ Medium enterprise/ Online Internship.

INTERNSHIP REPORT

(a) **Student's diary/ daily log**

The main purpose of writing daily diary is to cultivate the habit of documenting and to encourage the students to search for details. It develops the students‟ thought process and reasoning abilities. The students should record in the daily training diary the day to day account of the observations, impressions, information gathered and suggestions given, if any. It should contain the sketches & drawings related to the observations made by the students. The daily training diary should be signed after

every day by the supervisor/ in charge of the section where the student has been working. The diary should also be shown to the Faculty Mentor visiting the industry from time to time and got ratified on the day of his visit.
Student"s Diary and Internship Report should be submitted by the students along with attendance record and an evaluation sheet duly signed and stamped by the industry to the Institute immediately after the completion of the training. It will be evaluated on the basis of the following criteria:

- Regularity in maintenance of the diary.
- Adequacy & quality of information recorded.
- Drawings, sketches and data recorded.
- Thought process and recording techniques used.
- Organization of the information.

(b) **Internship report**

After completion of Internship, the student should prepare a comprehensive report to indicate what he has observed and learnt in the training period. The student may contact Industrial Supervisor/ Faculty Mentor/TPO for assigning special topics and problems and should prepare the final report on the assigned topics. Daily diary will also help to a great extent in writing the industrial report since much of the information has already been incorporated by the student into the daily diary. The training report should be signed by the Internship Supervisor and Faculty Mentor. The Internship report will be evaluated on the basis of following criteria:

i. Originality.
ii. Adequacy and purposeful write-up.
iii. Organization, format, drawings, sketches, style, language etc.
iv. Variety and relevance of learning experience.
v. Practical applications, relationships with basic theory and concepts taught in the course.

EVALUATION THROUGH SEMINAR PRESENTATION/VIVA-VOCE

The student will give a seminar based on his training report, before an expert committee constituted bythe Department as per norms of the institute. The evaluation will be based on the following criteria:

- Quality of content presented.
- Proper planning for presentation.
- Effectiveness of presentation.
- Depth of knowledge and skills.
- Attendance record, daily diary, departmental reports shall also be analyzed along with theinternship report.

Seminar presentation will enable sharing knowledge & experience amongst students & teachers andbuild Communication skills and confidence in students.

***Students have to undergo summer internship of 6 Weeks duration at the end of semester VI and the credits will be awarded after evaluation in VII semester.**

OPEN ELECTIVE - I

Course Code	Course Title						Course Type
OE 601 BM	ENGINEERING APPLICATIONS IN MEDICINE						OE
Prerequisite	Contact hours per week			Duration of SEE (Hours)	Scheme of Evaluation		Credits
	L	T	P		CIE	SEE	
	3	-	-	3	40	60	3

Course Objectives:

- To make the students gain basic knowledge of Human Physiology.
- To make the students learn the applications of various branches of engineering in Medicine.

Course Outcomes:

1. Describe the major organ systems of the human body
2. Understand the concepts of bioelectricity and medical instruments
3. Apply solid and fluid mechanics principles to joints and blood flow respectively
4. Learn the need and applications of BCI
5. Analyze and choose proper biomaterial for various applications

UNIT- I

Evolution of Modern healthcare, Major organ systems- Cardiovascular, Respiratory, Nervous, Skeletal, Muscular. Homeostasis. Physiological signals and their diagnostic importance.

UNIT-II

Bioelectricity-Excitable cells, Resting potential, Action potential, Accommodation, Strength-Duration Curve, Propagation of impulses in myelinated and unmyelinated nerves.

Medical Instrumentation System-Functions, Characteristics, Design Challenges.

Signal Processing-QRS detection.

UNIT- III

Solid mechanics-Analysis of muscle force and joint reaction force for the limb joints.

Fluid mechanics-Factors governing and opposing blood flow, Wind-Kessel model, Application of Hagen-Poiseuille flow to blood flow.

UNIT-IV

Brain-Computer Interface: Brain signals for BCIs, Generic setup for a BCI, Feature extraction and Feature translation involved in BCIs. Typical applications-Word forming, Device control.

UNIT-V

Materials and Tissue Replacements-Types of Biomaterials- Metals, Polymers, Ceramics and Composites and their applications in Soft and Hard tissue replacements. Implants-Manufacturing process, Design, fixation.

Suggested Reading:

1. John Enderle, Susan M. Blanchard and Joseph Bronzino, *Introduction to Biomedical Engineering*, Second Edition, Elsevier, 2005.
2. Ozkaya, Nordin. M, *Fundamentals of Biomechanics*, Springer International Publishing, 4th Edition, 2017.
3. Khandpur R.S., *Handbook of Biomedical Instrumentation*, Tata McGraw Hill, 2016.
4. John G.Webster, *Medical Instrumentation: Application and Design*, John Wiley and Sons Inc., 3rd Ed., 2003.

Course Code	Course Title						Course Type
OE 602 BM	**HUMAN ASSISTIVE TECHNOLOGIES**						OE
Prerequisite	**Contact hours per week**			**Duration of SEE**	**Scheme of Evaluation**		**Credits**
	L	**T**	**P**	**(Hours)**	**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To extend knowledge of the amputee, of lost and remaining functions affecting locomotion, and to collect information on the best possible medical treatment.
- To improve fitting techniques and practices, including training, so that existing devices might be used with greater comfort and function.
- To develop improved lower-extremity devices.

Course Outcomes:

1. Apply fundamental knowledge of engineering in rehabilitation
2. Apply analytical skills to assess and evaluate the need of the end-user
3. Develop self-learning initiatives and integrate learned knowledge for problem solving
4. Understand the basics of robotics and apply their principles in developing prosthetics
5. Apply the knowledge of computers in solving rehabilitation problems

UNIT- I

Introduction to Rehabilitation Engineering, Definition of Rehabilitation Engineering, Scope and importance of the field, Historical perspective. Interdisciplinary nature and collaboration with healthcare professionals. Physical disabilities: mobility impairments, spinal cord injuries. Cognitive disabilities: learning disabilities, traumatic brain injuries. Psychosocial aspects of disability.

UNIT-II

Assistive Technology, Human Factors and Ergonomics in Assistive Technology Design. Mobility Aids, Types of Wheelchairs and design aspects: Manual wheelchairs, Powered wheelchairs, Customizable features and design considerations, Auxiliary devices and systems. Human-Centered Designing.

UNIT- III

Sensory disabilities: visual and hearing impairments. Sensory augmentation and substitution: Visual system: Visual augmentation. Tactual vision substitution, Auditory vision substitution;

Auditory system: Auditory augmentation. Cochlear implantation, Visual auditory substitution, Tactual auditory substitution, Tactual system: Tactual augmentation. Tactual substitution. Assessment and Outcome Measurement

UNIT-IV

Rehabilitation Robotics, Exoskeletons, Major Limb Prosthetic Devices, Orthotic Devices, Types of orthotics and prosthetics, Intelligent prosthetic Knee, Prosthetic Hand, Controlled orthotics and prosthetics Materials and fabrication techniques, Functional and cosmetic considerations. FES system, Restoration of Hand function, Restoration of standing and walking, Myo-electric Hand.

UNIT-V

Case Studies and Real-World Applications. Augmentative and Alternative communications, Software tools for simulation and testing. Virtual reality applications in rehabilitation. Machine learning applications in assistive technology. Predictive analytics for personalized rehabilitation

Suggested Reading:

1. Robinson C.J., *Rehabilitation Engineering*, CRC Press, 1995.
2. Ballabio E., et al., *Rehabilitation Technology*, IOS Press, 1993.
3. Rory A Cooper, Hisaichi Ohnabe, Douglas A. Hobson, *Series in medical physis and biomedical engineering: An introduction to rehabilitation engineering*, Taylor and Francis Group, London, 2007.
4. Joseph D. Bronzino *The biomedical engineering handbook -biomedical engineering fundamentals*, 3rdEd., CRC Press, Taylor & Francis Group, London, 2006.

Course Code	Course Title						Course Type
OE 601 CE	**DISASTER MANAGEMENT**						OE
Prerequisite	**Contact hours per week**			**Duration of SEE**	**Scheme of Evaluation**		**Credits**
	L	**T**	**P**	**(Hours)**	**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**3**

UNIT- I

Introduction to Disaster: Understanding the Concepts, Definitions and Terminologies used in the field of Disaster Management (i.e. Hazard, Risk, Vulnerability, Resilience, and Capacity Building); Differential impacts of Disasters in terms of Gender, Age, Social Status, Location, Prosperity, Disabilities; Disaster- Development Nexus.

UNIT-II

Types of Hazards and Emerging Trends: Classification, Causes, Consequences and Controls of: Geophysical hazards-Earthquakes, Landslides, Tsunami; Weather related hazards-Meteorological (Cyclones, and Storm- surge), Hydrological (Floods, Droughts, Avalanches), Climatological (Wildfire, Cold & Heat Waves); Biological hazards-Epidemic & Pandemics; Technological hazards- Chemical, Industrial, Nuclear; Man-made hazards-Structural Failure, Fire, Transportation accidents, Terrorism and Wars; Emerging Disasters- Urban Areas, Climate Change; Regional and Global Trends-loss of life & Property in various hazards

UNIT- III

Disaster Management Cycle And International Framework: Disaster Management Cycle: Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Micro-zonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Building; Awareness; During Disaster –Evacuation – Disaster Communication – Search and Rescue– Emergency Operation Centre – Incident Command System – Relief and Rehabilitation; Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery– Reconstruction and Redevelopment; Paradigm Shift in Disaster Management: International Decade for Natural Disaster Reduction; Yokohama Strategy; Hyogo Framework of Action

UNIT-IV

Disaster Risk Management in India: Disaster Profile of India – Mega Disasters of India and Lessons Learnt; Disaster Management Act 2005 – Institutional and Financial Mechanism; National Policy on Disaster Management; National Guidelines and Plans on

Disaster Management; Role of Government (local, state and national), Non-Government and Inter-governmental Agencies

UNIT-V

Technological Approaches to Disaster Risk Reduction: Geo-informatics in Disaster Management (RS, GIS, GPS and RS); Technological in Disaster Communication System (Early Warning and Its Dissemination), rescue and restoration of services; Disaster Safe Designs and Constructions; Application of technology and innovations for Structural and non structural Mitigation; Science & Technology Institutions for Disaster Management in India

Suggested Reading:

1. Coppola D P, 2007. Introduction to International Disaster Management, Elsevier Science (B/H), London.
2. Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi
3. An overview on natural & man-made disasters and their reduction, R K Bhandani, CSIR, New Delhi
4. World Disasters Report, 2009. International Federation of Red Cross and RedCrescent, Switzerland
5. Disasters in India Studies of grim reality, Anu Kapur & others, 2005, 283 pages, Rawat Publishers, Jaipur
6. National Disaster Management Policy, 2009, GoI.
7. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management

Course Code	Course Title						Course Type
OE 602 CE	**ROAD SAFETY ENGINEERING**						OE
Prerequisite	**Contact hours per week**			**Duration of SEE**	**Scheme of Evaluation**		**Credits**
	L	**T**	**P**	**(Hours)**	**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To introduce the fundamentals of road safety and road safety audit.
- To get familiarized with various road safety techniques, measures and their applications.
- To be able to understand and evaluate various traffic control devices.
- Familiarize with traffic management techniques.
- To examine and analyze the incident management process.

Course Outcomes:

1. Analyze Accident data.
2. Plan and design of road safety improvement programs
3. Apply the principles of road safety in urban transport
4. Apply traffic management techniques
5. Able to plan effective incident management program

Articulation matrix of Course Outcomes with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	2	3	1	2	2	2	-	-	2	-	-	-	2	2
CO 2	2	2	2	2	2	2	-	2	-	1	1	-	1	1
CO 3	2	2	1	1	1	1	-	-	-	-	-	1	2	-
CO 4	3	2	2	2	2	2	-	1	2	-	-	2	3	2
CO 5	1	3	3	3	2	3	2	1	2	1	2	1	1	2

UNIT- I

Road accidents: Causes, scientific investigations and data collection, analysis of individual accidents to arrive at real causes, statistical methods of analysis of accident data, Basic concepts of road accident statistics, safety performance function: The empirical Bayes method identification of hazards road location. Application of computer analysis of accident data.

UNIT-II

Safety in Road Design: Operating the road network for safety, highway operation and counter measures, road safety audit, principles-procedures and practice, code of good practice and checklists, vehicle design factors & driver characteristics influencing road safety

UNIT- III

Road Signs and Traffic Signals: Classification, Location of signs, measures of sign effectiveness, Types of visual perception, sign regulations, sign visibility, sign variables, Text versus symbols, Road marking: Role of road marking, classification, visibility. Traffic signals: Need, Signal face illumination and location of signals, factors affecting signal design, pedestrian's safety, fixed and vehicle actuated signals. Design of signals, area traffic control, Delineators, traffic impact attenuators, road side rest areas, safety barriers, traffic aid posts

UNIT-IV

Traffic Management Techniques: Integrated safety improvement and traffic calming schemes, speed and load limit, traffic lights, safety cameras, tests on driver and vehicles, pedestrian safety issues, parking, parking enforcement and its influence on accidents, travel demand management, methods of traffic management measures: restriction of turning movements, One way streets, tidal flow operation methods, exclusive bus lanes and closing side-streets; latest tools and techniques used for road safety; legislation, enforcement, education and propaganda.

UNIT-V

Incident Management: Introduction, characteristics of traffic incidents types of incidents, impacts, incident management process, incident traffic management; application of ITS: Motorist information, equipment used; planning effective incident management program, best practice in incident management programs. National importance of survival of transpiration systems during and after all natural disasters especially cyclones, earthquakes, floods etc and manmade disasters like sabotage, terrorism etc.

Suggested Reading:

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017.
2. KadiyaliL.R,.Traffic Engineering and Transport planning, 9th Edition, Khanna Tech Publishers, 2013.
3. Donald Drew, Traffic Flow Theory Chapter 14 in Differential Equation Models, Springer, 1983
4. C. Jotinkhisty and B. Kent Lall, Transportation Engineering – An Introduction, 3rd Edition, Pearson publications, 2017
5. Rune Elvik, Alena Hoye, TrulsVaa, Michael Sorenson, Handbook of Road Safety measures, second Edition, Emerald Publishing, 2009

Course Code	Course Title						Course Type
OE 601 CS	**PYTHON PROGRAMMING**						OE
Prerequisite	**Contact hours per week**			**Duration of SEE**	**Scheme of Evaluation**		**Credits**
	L	**T**	**P**	**(Hours)**	**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To know the basics of Programming
- To convert an algorithm into a Python program
- To construct Python programs with control structures.
- To structure a Python Program as a set of functions
- To use Python data structures-lists, tuples, dictionaries.
- To do input/output with files in Python.
- To construct Python programs as a set of objects.

Course Outcomes:

1. Develop algorithmic solutions to simple computational problems.
2. Develop and execute simple Python programs.
3. Develop simple Python programs for solving problems.
4. Structure a Python program into functions.
5. Represent compound data using Python lists, tuples, dictionaries.
6. Read and write data from/to files in Python Programs

UNIT-I

Introduction to Computing and Problem Solving: Fundamentals of Computing – Computing Devices – Identification of Computational Problems – Pseudo Code and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms.

Introduction to Python Programming: Python Interpreter and Interactive Mode– Variables and Identifiers – Arithmetic Operators – Values and Types – Statements, Reading Input, Print Output, Type Conversions, The type() Function and Is Operator, Dynamic and Strongly Typed Language.

Control Flow Statements: The if, The if…else,The if…elif…else Decision Control Statements, Nested if Statement, The while Loop, The for Loop, The continue and break Statements.

UNIT-II

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, Command Line Arguments.

Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings.

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list

parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods;

advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, merge sort, histogram.

UNIT-III

Files and Exception: Text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

Strings: Basic String Operations, String Slicing, Testing, Searching, and Manipulating Strings

Dictionaries and Sets: Dictionaries, Sets, Serializing Objects.

UNIT-IV

Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance The Polymorphism.

Functional Programming: Lambda. Iterators, Generators, List Comprehensions.

UNIT-V

GUI Programming: Graphical User Interfaces, Using the tkinter Module, Display text with Label Widgets, Organizing Widgets with Frames, Button Widgets and Info Dialog Boxes, Getting Input with Entry Widget, Using Labels as Output Fields, Radio Buttons, Check Buttons.

Suggested Readings:

1. Richard L. Halterman, "*Learning To Program With Python*", Copyright © 2011.
2. Dr. Charles R, "*Python for Everybody, Exploring Data Using Python 3*", Severance. 2016.
3. Gowrishankar S., Veena A, "*Introduction to Python Programming*", CRC Press, Taylor & Francis Group, 2019.
4. Allen B. Downey, "*Think Python: How to Think Like a Computer Scientist*", 2nd Edition, Shroff O"Reilly Publishers, 2016

Course Code	Course Title						Course Type
OE 602 CS	**CYBER SECURITY**						OE
Prerequisite	**Contact hours per week**			**Duration of SEE (Hours)**	**Scheme of Evaluation**		**Credits**
	L	**T**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- Learn the various threats in networks and security concepts.
- Apply authentication applications in different networks.
- Understand security services for email.
- Awareness of firewall and IT laws and policies.

Course Outcomes:

1. Understand the various network threats
2. Analyze the forensic tools for evidence collection
3. Apply the firewalls for threat analysis

UNIT-I

Ethical hacking, Attack Vectors, Cyberspace and Criminal Behaviour, Clarification of Terms, Traditional Problems associated with Computer Crimes, Realms of Cyber world, brief history of the internet, contaminants and destruction of data, unauthorized access, computer intrusions, white-collar crimes, viruses and malicious code, virus attacks, pornography, software piracy, mail bombs, exploitation, stalking and obscenity in internet, Cyber psychology, Social Engineering.

UNIT-II

Introduction to Digital forensics, Forensic software and handling, forensic hardware and handling, analysis and advanced tools, forensic technology and practices, Biometrics: face, iris and fingerprint recognition, Audio-video evidence collection, Preservation and Forensic Analysis.

UNIT-III

Investigation Tools, e-discovery, EDRM Models, digital evidence collection and preservation, email investigation, email tracking, IP tracking, email recovery, search and seizure of computer systems, password cracking.

UNIT-IV

Forensic Analysis of OS artifact, Internet Artifacts, File System Artifacts, Registry Artifacts, Application Artifacts, Report Writing, Mobile Forensic- identification, collection and preservation of mobile evidences, social media analysis, data retrieval, Email analysis from mobile phones.

UNIT-V

Ethics, Policies and IT Act

Basics of Law and Technology, Introduction to Indian Laws, Scope and Jurisprudence, Digital Signatures, E Commerce-an Introduction, possible crime scenarios, law coverage, data interchange, mobile communication development, smart card and expert systems Indian Laws, Information Technology Act 2000, Indian Evidence Act, India Technology Amendment Act 2008, Indian Penal Code , Computer Security Act 1987, National Information Infrastructure Protection Act 1996, Fraud Act 1997, Children Online Protection Act 1998, Computer Fraud and Abuse Act 2001, Intellectual Property, IP Theft, Copyright, Trademark, Privacy and Censorship, Introduction to Cyber Ethics, rights over intellectual property, Corporate IT Policy Formulations, Compliance Auditing.

Suggested Readings:

1. Charles P. Fleeger, "*Security in Computing*", Prentice Hall, New Delhi, 2009.
2. BehrouzA.Forouzan, "*Cryptography & Network Security*", Tata McGraw Hill, India, New Delhi, 2009.
3. William Stallings, "*Cryptography and Network Security*", Prentice Hall, New Delhi, 2006.
4. Chalie Kaufman, Radia Perlman, Mike Speciner, "*Network Security: Private Communication in a Public Network*", Pearson Education, New Delhi, 2004.
5. Neal Krawetz, "*Introduction to Network Security*", Thomson Learning, Boston, 2007.
6. Bruce Schneier, "*Applied Cryptography*", John Wiley & Sons, New York, 2004.

Course Code	Course Title					Course Type
OE 601EC	**VERILOG HDL**					OE
Prerequisite	**Contact hours per week**			**Duration of SEE (Hours)**	**Scheme of Evaluation**	**Credits**
	L	**T**	**P**		**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- Tofamiliarizewithvariousmodelingstyles:structural,dataflowandbehavioralofVerilog HDL
- Todevelopcombinationalandsequentialcircuitsusingvariousmodelingstylesof Verilog HDL
- TodesignanddevelopVerilogHDLmodelsofcombinationalandsequentialcircuits
- To learn Synthesis and FPGA design flow
- Todesignanddevelopreal timeapplications:Booth‘smultiplier,Divider,hardwired control for basic CPU, FIR filter

Course Outcomes:

1. Implement and distinguish different Verilog HDL modeling styles.
2. Construct and analyze Verilog HDL models of combinational and sequential circuits.
3. Design and develop Verilog HDL modeling and test bench for digital systems for the given specifications.
4. Outline FPGA design flow and timing analysis.
5. Understand implementation of real time applications.

Articulation matrix of Course Outcomes with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	1	2	2	-	-	-	-	-	2	-	-	-	2	-
CO 2	2	2	2	2	2	-	-	-	2	2	-	-	2	-
CO 3	2	3	3	2	2	-	-	-	2	2	-	-	2	-
CO 4	2	3	3	2	2	1	-	-	2	2	-	2	2	-
CO 5	2	2	2	-	-	1	-	-	2	1	-	2	2	-

UNIT-I

Introduction to HDL: Overview and Importance of HDLs, Differences between HLL, HDL and ALP. Design methodologies, Modules, Lexical Conventions, Number Specifications, Strings, Identifiers and Keywords Data types, System task and compiler Directives, Port declaration and port connection rules

UNIT-II

Structural and Dataflow Modeling: gate-level modeling, delays, hazards, dataflow modeling: Continuous Assignments, Delays, Expressions, Operators and Operands, Operator Types and Design Examples.

UNIT-III

Behavioral Modeling: Structured Procedures, Procedural Assignments, Timing Controls, Conditional Statements, multi-way branching, Loops, Sequential and Parallel blocks, Generate blocks. Combinational, sequential logic modules Simulation: Types of Simulation, Event driven Simulation and Cycle Based Simulation; design examples.

UNIT-IV

Synthesis and Verification: Tasks and Functions: Differences between Tasks and Functions, Tasks and Functions. Verilog HDL synthesis, synthesis, Application Specific IC (ASIC) and Field Programmable Gate Array (FPGA) design flow. Verification: Timing analysis and Test bench design. Design examples.

UNIT-V

Real time implementations: Fixed-Point Arithmetic modules: Addition, Multiplication, Division, Arithmetic and Logic Unit (ALU), Timer, Universal Asynchronous Receiver and Transmitter (UART), DSP modules: FIR and IIR filters, CPU design: Data path and control units.

Suggested Reading:

1. Samir Palnitkar, ―*Verilog HDL A Guide to Digital Design and Synthesis,*‖ 2nd Edition, Pearson Education, 2006..
2. Ming-BoLin,―*DigitalSystemDesignsandPractices:UsingVerilogHDLandFPGA,*‖ Wiley India Edition, 2008
3. J.Bhasker,―*AVerilogHDLPrimer*,‖2ndEdition,BSPublications, 2001

Course Code	Course Title						Course Type
OE 602 EC	**PRINCIPLES OF ELECTRONIC COMMUNICATION SYSTEMS**						OE
Prerequisite	**Contact hours per week**			**Duration of SEE**	**Scheme of Evaluation**		**Credits**
	L	**T**	**P**	**(Hours)**	**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- Provide an introduction to fundamental concepts in the understanding of Electronic communications systems
- Provide an introduction to network model and some of the network layers including physical layer, data link layer, network layer and transport layer
- Provide an introduction to the evolution of wireless systems and current wireless technologies
- Provide an introduction to fundamental concepts in the understanding of Telecommunication and optical communications systems
- Provide an introduction to fundamental concepts in Analog and Digital Communications

Course Outcomes:

1. Understand the working of analog and digital communication systems.
2. Understand the Data Communication and Networking
3. Understand the concepts of modulation and demodulations
4. Understand the evolution of communication technologies from traditional telephony systems to modern wireless communication systems
5. Understand the principles of optical communications systems

Articulation matrix of Course Outcomes with POs:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	1	1	-	-	-	1	1	1	1
CO2	2	1	2	1	-	-	-	-	1	1	1	1
CO3	2	1	1	1	-	-	-	-	1	1	1	1
CO4	3	2	2	2	-	1	1	1	1	1	1	1
CO5	1	1	2	2	1	-	1	-	1	1	1	1

UNIT- I

Introduction to communication systems: Electromagnetic Frequency Spectrum, Signal and its representation, Elements of Electronic Communications System, Types of Communication Channels, Signal Transmission Concepts-Baseband transmission and Broadband transmission, Communication parameters-Transmitted power, Channel bandwidth and Noise, Need for modulation Signal Radiation and Propagation-Principle of electromagnetic radiation, Types of Antennas, Antenna Parameters and Mechanisms of Propagation

UNIT-II

Analog and Digital Communications: Amplitude modulation and demodulation, FM modulation and demodulation, Digital converters, Digital modulation schemes – ASK, FSK, PSK, QPSK, Digital demodulation

UNIT- III

Data Communication and Networking: Network Models, OSI Model, Data Link Layer – Media Access control, Ethernet, Network Layer – Internet Protocol (IPv4/IPv6), Transport Layer – TCP, UDP

UNIT-IV

Telecommunication Systems: Telephones, Telephone system, Paging systems, Internet Telephony. Optical Communications: Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing

UNIT-V

Wireless Communications: Evolution of Wireless Systems: AMPS, GSM, CDMA, WCDMA, And OFDM. Current Wireless Technologies: Wireless LAN, Bluetooth, PAN and ZigBee, Infrared wireless, RFID communication, UWB, Wireless mesh networks, Vehicular adhoc networks

Suggested Reading:

1. Louis E. Frenzel, "Principles of Electronic Communication Systems", 3e, McGraw Hill publications, 2008.
2. Behrouz A. Forouzan,"Data Communications and Networking", 5e TMH, 2012.
3. Kennady, Davis, "Electronic Communications systems", 4e, TMH, 1999.
4. Keiser Gerd "Optical Fiber Communication (SIE)",5th Edition, McGraw Hill Education India,2017.
5. Simon Haykin, "Communication Systems", 5th Edition, Wiley publications, 2006

Course Code	Course Title						Course Type
OE 601 EE	**APPLICATIONS OF ELECTRICAL ENERGY**						OE
Prerequisite	**Contact hours per week**			**Duration of SEE**	**Scheme of Evaluation**		**Credits**
	L	**T**	**P**	**(Hours)**	**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating.
- To understand various techniques of electric welding and types of batteries.
- To understand the concept of illumination and study about the laws of illumination.
- To know the applications of various lamps to factory lighting, street lighting etc.
- To understand the concept of electric traction including speed – time curves of different traction services.

Course Outcomes:

1. Identify a suitable heating scheme for a given application.
2. Identify proper welding technique and various characteristics of batteries.
3. Study the nature and production of light and laws related to illumination.
4. Classify types of electric light sources based on nature and operation and their objectives, performance and reliability.
5. Determine the speed-time characteristics of various traction services and also estimate the energy consumption levels at various modes of operation.

Articulation matrix of Course Outcomes with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	1	2	-	-	2	-	-	1	-	-	1	2	1
CO 2	3	1	2	-	-	2	-	-	1	-	-	1	2	1
CO 3	3	2	2	-	-	2	-	-	1	-	-	1	2	1
CO 4	3	1	2	-	-	2	-	-	1	-	-	1	2	1
CO 5	3	1	2	-	-	2	-	-	1	-	-	1	2	1

UNIT- I

Industrial Heating: Advantages and methods of electric heating. Description, operation and performance of resistance ovens, Design of heating element. High frequency heating, Induction Heating, Induction furnaces, Core type, Coreless furnaces, Dielectric heating. Electric Arc furnaces, Direct Arc furnace, Indirect Arc furnaces.

UNIT-II

Electric welding: Classification of electric welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

Batteries: Lead acid batteries, SMF batteries, Construction and maintenance, Charging and rating of batteries.

UNIT- III

Illumination: Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, Lighting calculations, Determination of M.S.C.P, Rousseau‟s construction.

UNIT-IV

Types of lamps - Discharge lamps, Sodium vapour lamps, Mercury vapour lamps, Fluorescent lamp and LED lamps. Starting and power factor corrections, stroboscopic effects, Application to factory lighting, Street lighting and Flood lighting.

UNIT-V

Electric Traction: System of Electric Traction, Transmission of drive, Systems of track electrification, Traction mechanics, Speed time curves, Tractive effort, Power of Traction motor, Specific energy consumption, Mechanics of train movement, Coefficient of adhesion..

Suggested Reading:

1. Partab H, Art and Science of Utilization of Electric Power, Dhanpat Rai & Sons, 1997.
2. K.B. Raina & S.K. Bhattacharya, Electrical Design, Estimating 1. and Costing, Wiley Eastern Ltd., 1991.
3. Partab H, Modern Electric Traction, Dhanpat Rai & Sons, 2000.
4. B.L.Theraja, A Text Book of Electrical Technology, S.Chand & Company Ltd, Vol-I.

Course Code	Course Title						Course Type
OE 602 EE	**ELECTRICAL SAFETY MANAGEMENT**						OE
Prerequisite	**Contact hours per week**			**Duration of SEE**	**Scheme of Evaluation**		**Credits**
	L	**T**	**P**	**(Hours)**	**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- Understand electrical safety measures, the hazards associated with electric current, and voltage identify different types of electrical shocks.
- Understand installation work of electrical plant and equipment. Safety during installation of outdoor switchyard equipment, safety during installation of electrical rotating machines.
- Understand procedure of domestic wirings to handle different domestic electrical appliances, Procedure of Agricultural pump installation.
- Identifies different hazardous zones, classification of equipment enclosure for various hazardous gases, importance of earthing system. Understand Management Safety Policy.
- Understand standards on electrical safety, different IE Rules and Acts.

Course Outcomes:

1. Explain the objectives and precautions of Electrical safety, effects of shocks and their prevention.
2. Summarize the safety aspects during installation of plant and equipment.
3. Describe the electrical safety in residential, commercial and agricultural installations.
4. Describe the various Electrical safety in hazardous areas, Equipment earthing and system neutral earthing.
5. State the electrical systems safety management and IE rules.

Articulation matrix of Course Outcomes with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO 1	3	3	3	1	2	2	2	-	2	2	-	2	2	2
CO 2	3	3	3	1	2	2	2	-	2	2	-	2	2	2
CO 3	3	3	3	1	2	2	2	-	2	2	-	2	2	2
CO 4	3	3	3	2	2	2	2	-	2	2	-	2	2	2
CO 5	3	3	3	1	2	2	2	-	2	2	-	2	2	2

UNIT- I

Introduction to electrical safety, shocks and their prevention: Terms and definitions, objectives of safety and security measures, Hazards associated with electric current, and voltage, who is exposed, principles of electrical safety, Approaches to prevent Accidents, scope of subject electrical safety.

Primary and secondary electrical shocks, possibilities of getting electrical shock and its severity, medical analysis of electric shocks and its effects, shocks due to flash/ Spark over's, prevention of shocks, safety precautions against contact shocks, flash shocks, burns, residential buildings and shops.

UNIT-II

Safety during installation of plant and equipment: Introduction, preliminary preparations, preconditions for start of installation work, during, risks during installation of electrical plant and equipment, safety aspects during installation, field quality and safety during erection, personal protective equipment for erection personnel, installation of a large oil immersed power transformer, installation of outdoor switchyard equipment, safety during installation of electrical rotating machines, drying out and insulation resistance measurement of rotating machines.

UNIT- III

Electrical safety in residential, commercial and agricultural installations: Wiring and fitting – Domestic appliances – water tap giving shock – shock from wet wall – fan firing shock – multi-storied building – Temporary installations – Agricultural pump installation – Do's and Don'ts for safety in the use of domestic electrical appliances.

UNIT-IV

Electrical safety in hazardous areas: Hazardous zones – class 0,1 and 2 – spark, flashovers and corona discharge and functional requirements – Specifications of electrical plants, equipment for hazardous locations – Classification of equipment enclosure for various hazardous gases and vapours – classification of equipment/enclosure for hazardous locations.

Equipment earthing and system neutral earthing: Introduction, Distinction between system grounding and Equipment Grounding, Equipment Earthing, Functional Requirement of earthing system, description of a earthing system, neutral grounding (System Grounding), Types of Grounding, Methods of Earthing Generators Neutrals.

UNIT-V

Safety management of electrical systems: Principles of Safety Management, Management Safety Policy, Safety organization, safety auditing, Motivation to managers, supervisors, employees.

Review of ie rules and acts and their significance: Objective and scope – ground clearances and section clearances – standards on electrical safety - safe limits of current, voltage –Rules regarding first aid and fire fighting facility. The Electricity Act, 2003, (Part1, 2, 3, 4 & 5).

Suggested Reading:

1. S.Rao, Prof. H.L.Saluja, "Electrical safety, fire safety Engineering and safety management", 1st edition Khanna Publishers. New Delhi, 2016 Reprint.
2. Pradeep Chaturvedi, "Energy management policy, planning and utilization", Concept Publishing company, New Delhi, 1997.

Course Code	Course Title						Course Type
OE 601 ME	**3D PRINTING TECHNOLOGY**						OE
Prerequisite	**Contact hours per week**			**Duration of SEE**	**Scheme of Evaluation**		**Credits**
	L	**T**	**P**	**(Hours)**	**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To understand the fundamental concepts of 3D Printing, its advantages and limitations.
- To know the working principle, advantages, disadvantages and applications of liquid, solid and Powder based 3D Printing Technologies.
- To know the various types of STL file errors and other data formats used in 3D Printing Technology.
- To know the features of various 3D Printing software's.
- To know diversified applications of 3D Printing Technologies.

Course Outcomes:

1. Interpret the features of 3D Printing and compare it with conventional methods.
2. Illustrate the working principle of liquid, solid and powder based 3D Printing Technologies.
3. Identify various types of errors in STL file and other data formats used in 3D Printing Technology.
4. Select suitable software used in 3D Printing Technology.
5. Apply the knowledge of various 3D Printing technologies for developing innovative applications.

UNIT- I

Introduction: Prototyping fundamentals: Need for time compression in product development, Historical development, Fundamentals of 3D Printing, 3D Printing Process Chain, Advantages and Limitations of 3D Printing, 3D Printing wheel, Commonly used Terms, Classification of 3D printing processes, Fundamental Automated Processes: Distinction between 3D Printing and Conventional Machining Processes.

UNIT-II

Liquid-based 3D Printing Systems: Stereo Lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Polyjet: Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies Solid-based 3D Printing System: Laminated Object Manufacturing

(LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

UNIT- III

Powder Based 3D Printing Systems: Working principle, Specifications, Materials used, Process, Applications, Advantages and Disadvantages, Case studies of the following 3D Printing Technologies like Selective laser sintering (SLS), Selective Laser Melting (SLM) and Direct Metal Laser Sintering (DMLS), Laser Engineered Net Shaping (LENS), Electron Beam Melting (EBM),

UNIT-IV

3D Printing Data Formats & Software: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. 3D Printing Software's Features: Magics, Mimics, Solid View, View Expert, 3 D Rhino, 3 D doctor, Flash Print, Object Studio, Cura, ITK Snap, 3-matic, Simplant, 3-matic, Simplant, MeshLab, Ansys for Additive Manufacturing.

UNIT-V

Applications of 3D Printing : Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Electronic Industry, Jewellery Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules. Biopolymers, Packaging, Disaster Management, Entertainment and Sports industry.

Suggested Reading:

1. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World scientific
2. Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing- Ian Gibson, David W Rosen, Brent Stucker, Springer, Second Edition, 2010.
3. Rapid Prototyping & Engineering Applications – Frank W.Liou, CRC Press, Taylor & Francis Group, 2011.
4. Rafiq Noorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.
5. NPTEL Course on Rapid Manufacturing. https://nptel.ac.in/courses/112/104/112104265

Course Code	Course Title						Course Type
OE 602 ME	**FINITE ELEMENT METHOD**						OE
Prerequisite	**Contact hours per week**			**Duration of SEE**	**Scheme of Evaluation**		**Credits**
	L	**T**	**P**	**(Hours)**	**CIE**	**SEE**	
	3	**-**	**-**	**3**	**40**	**60**	**3**

Course Objectives:

- To understand the theory and application of the finite element method for analyzing structural systems.
- To learn Approximation theory for structural problems as the basis for finite element methods.
- To learn formulations for a variety of elements in one, two, and three dimensions. Implementations of element formulations will be examined using Matlab.
- To understand modeling and analysis of structures using planar, solid, and plate elements

Course Outcomes:

1. Demonstrate a basic understanding of the concepts, mathematical formulation and numerical implementation.
2. Demonstrate the ability to invoke appropriate assumptions, select proper elements and develop FEA models that adequately and efficiently represent physical systems.
3. Underlying the FEA as applied to solid mechanics.
4. Solve 2D vector variable problems and analyze higher order elements and its applications.
5. Create his/her own FEA computer programs using Matlab to solve simple engineering problems.

UNIT- I

Introduction: Historical Background – Mathematical Modeling of field problems in Engineering – Governing Equations – Discrete and continuous models – Boundary, Initial and Eigen Value problems– Weighted Residual Methods – Variational Formulation of Boundary Value Problems – Ritz Technique – Basic concepts of the Finite Element Method.

UNIT-II

One-Dimensional Problems: One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Derivation of Shape functions and Stiffness

matrices and force vectors- Assembly of Matrices – Solution of problems from solid mechanics and heat transfer. Longitudinal vibration frequencies and mode shapes.

UNIT- III

Two Dimensional Scalar Variable Problems: Second Order 2D Equations involving Scalar Variable Functions – Variational formulation –Finite Element formulation – Triangular elements – Shape functions and element matrices and vectors. Application to Field Problems – Thermal problems – Torsion of Non circular shafts –Quadrilateral elements – Higher Order Elements.

UNIT-IV

Two Dimensional Vector Variable Problems: Equations of elasticity – Plane stress, plane strain and axisymmetric problems – Body forces and temperature effects – Stress calculations – Plate and shell elements.

UNIT-V

Isoparametric Formulation: Natural co-ordinate systems – Isoparametric elements – Shape functions for iso parametric elements – One and two dimensions – Serendipity elements – Numerical integration and application to plane stress problems – Matrix solution techniques – Solutions Techniques to Dynamic problems – Introduction to Analysis Software.

Suggested Reading:

1. Tirupathi R. Chandraputla and Ashok, D. Belgundu" Introduction to Finite Elements in Engineering", Pearson Education, 2002, 3rd Edition.
2. Rao S.S., "The Finite Element Methods in Engineering", pergamon Press, 1989.
3. Segerlind, L.J. "Applied Finite Element Analysis", Wiley Publication, 1984.
4. Reddy J.N., "An Introduction to Finite Element Method", McGraw-Hill Company, 1984.