B.E VI - SEM ECE

S. No.	Course Category	Course Title	Scheme of Instruction				Scheme of Examination		Credits
			L	T	P	Total Hours	CIE	SEE	
Theory									
1	5PC613EC	Digital Communication	3	0	0	3	40	60	3
2	5PC614EC	VLSI Design	3	0	0	3	40	60	3
3	5PC615EC	Antenna and Wave Propagation	3	0	0	3	40	60	3
4	5PE62XEC	Professional Elective – II	3	0	0	3	40	60	3
5	5PE63XEC	Professional Elective – III	3	0	0	3	40	60	3
6	XOE6XXXX	Open Elective - II	3	0	0	3	40	60	3
Laboratories									
7	5PC651EC	Analog & Digital Communication Laboratory	0	0	2	2	40	60	1
8	5PC652EC	VLSI Design Lab	0	0	2	2	40	60	1
9	5HS653HS	Soft Skills Laboratory	0	0	2	2	40	60	1
10	5PW672EC	Technical seminar	0	0	2	2	50	-	1
11	5PW774EC	Summer Internship (during summer break)	-	-	-	-	-	-	*
Total Credits									**22**

***Note: Summer Internship** to be conducted during summer break and evaluation will be in VII Sem.

5PE62XEC	Professional Elective - II
1	Embedded System Design
2	Data analytics using R-Programming
3	Digital Image processing
4	CPLD/FPGA Architectures

5PE63XEC	Professional Elective-III
1	Internet of Things
2	Cyber Security
3	Multirate Signal Processing
4	Fundamentals of Electronics Packaging

XOE6XXXX	Open Elective - II	Offered by
1	Green Building Technologies	CIVIL
2	Software Engineering	CSE
3	Deep Learning	AI&DS
4	Electric Vehicle Technology	EEE
5	Fundamentals of IOT	ECE
6	3D Printing Technologies	MECH

VI - Semester Detailed Syllabus

Course Code	Course Title						Core/Elective
5PC613EC	Digital Communication						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
PTSP, AC	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. Familiarize the students with elements of digital communication system and waveform coding techniques like PCM, DPCM, DM and ADM.
2. Introduce the concepts of information theory and source coding.
3. Familiarize the students with channel coding techniques such as LBC, BCC and convolution codes.
4. Introduce the concepts of baseband digital data transmission and analyze the error performance of different digital carrier modulation schemes like ASK, FSK, PSK etc.
5. Familiarize the students with the concepts of spread spectrum communication with emphasis on DSSS and FHSS.

COURSE OUTCOMES :

1. Classify the different types of digital modulation techniques PCM, DPCM, DM and ADM and compare their performance by SNR.
2. Illustrate the classification of channels and Source coding methods.
3. Distinguish different types of Error control codes along with their encoding/ decoding algorithms.
4. Examine the Performance of different Digital Carrier Modulation schemes of Coherent and Non-coherent type based on Probability of error.
5. Generation of PN sequence using Spread Spectrum and characterize the Acquisition Schemes for Receivers to track the signals.

UNIT - I

Elements of Digital Communication System: Comparison of Digital and Analog Communication Systems,

Pulse Digital Modulation Schemes: Quantization and Encoding techniques, PCM. Companding in PCM systems - u law and a law, Applications of PCM. Modulation and demodulation of DPCM, DM and ADM. Comparison of PCM, DPCM, DM and ADM. SNRQ of PCM and DM.

UNIT - II

Information Theory and Source Coding: Uncertainty, Information and entropy. Source-coding, Shannon – Fano and Huffman coding Discrete memory less channel – Probability relations in a channel, mutual information, Channel capacity - Binary Symmetric Channel, Binary Erasure Channel, , cascaded channels, information rate. Shannon-Hartley Theorem.

UNIT - III

Channel Coding: Types of transmission errors, need for error control coding, Linear Block Codes (LBC): description of LBC, generation, Syndrome and error detection, Minimum distance of Linear block code, error correction and error detection capabilities, Standard array and syndrome decoding, Hamming codes.

Binary cyclic codes (BCC): Description of cyclic codes, encoding, decoding and error correction using shift registers.

Convolution codes: description, encoding – code tree, state diagram.

UNIT - IV

Base band digital data transmission – Block diagram, Inter Symbol Interference, Nyquist criterion for Zero ISI, Eye pattern

Digital Carrier Modulation Schemes - Description and generation of ASK, FSK, PSK optimum receiver – matched filter, correlation receiver. Gaussian error probability -Coherent detection of Binary ASK, FSK, PSK DPSK Comparison of digital carrier modulation schemes M-ary signaling schemes – Introduction, QPSK.

UNIT - V

Spread Spectrum Communication: Advantages of Spread Spectrum, generation and characteristics of PN sequences. Direct sequence spread spectrum and Frequency hopping spread spectrum systems and their applications. Acquisition and Tracking of DSSS and FHSS signals.

TEXT BOOKS :

1. Simon Haykin, “Communication systems” 4/e, Wiley India 2011
2. Sam Shanmugam K, “Digital and Analog Communication systems”, Wiley 1979.
3. B. P. Lathi, “Modern digital and analog communication systems” 3/e, Oxford University Press. 1998

REFERENCE BOOKS:

1. Leon W. Couch II., "Digital and Analog Communication Systems", 6th Edition, Pearson Education inc., New Delhi,2001.
2. R.E. Zimer & R. L. Peterson: "Introduction to Digital Communication", PHI, 2001.

Course Code	Course Title						Core/Elective
5PC614EC	VLSI Design						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
L	T	D	P				
STLD, ED	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To describe verilog hdl and develop digital circuits using various modeling styles.
2. To explain electrical properties of MOS devices to analyze the behaviour of inverters designed with various loads.
3. To give exposure to the design rules to be followed to draw the layout of any logic circuit and provide concept to design different types of combinational and sequential circuits.

COURSE OUTCOMES :

On successful completion of the course, the students will be able to

1. Familiarize with the constructs and conventions of the verilog HDL programming in gate level and data flow modeling.
2. Generalize combinational and sequential logic circuits in behavioural modeling and concepts of switch level modelling.
3. Analyze modes of operation of MOS transistor and its basic electrical properties.
4. Draw stick diagrams and layouts for any MOS transistors.
5. Analyse the operation of various arithmetic and sequential logic circuits using CMOS transistors.

UNIT - 1

Introduction to HDLs: Basic Concepts of Verilog, Data types, system tasks and compiler directives. Gate Level Modeling: Gate types and Gate Delays, Dataflow Modeling: Continuous assignments and Delays. Design of stimulus blocks. Design of Arithmetic Circuits using Gate level, Data flow modeling for Adders, Subtractors, 4- bit Binary Adder and 1-digit BCD adder.

UNIT - II

Modeling of Sequential Logic Modules: Latches, Flip Flops, Counters and Shift registers applications Tasks, Functions, Procedural Continuous Assignments, Design of Mealy and Moore FSM models for sequence detector using Verilog. Switch Level Modelling of basic gates.

UNIT - III

Introduction: Introduction to IC Technology – MOS, PMOS, NMOS, CMOS Fabrication Process. Basic Electrical Properties: Basic Electrical Properties of MOS: Ids- Vds relationships, MOS transistor threshold Voltage, gm, gds, figure of merit; Pass transistor, NMOS Inverter, Various pull ups, CMOS Inverter analysis and design.

UNIT - IV

VLSI Circuit Design Processes: VLSI Design Flow, MOS Layers, Stick Diagrams, Design Rules and Layout, and Transistors Layout Diagrams for NMOS and CMOS Inverters and Gates. Basic circuit concepts. Design basic gates using Pass Transistor Logic, Transmission Gates and Multiplexers.

UNIT - V

Sub-system Design : Shifters, carry skip adder, carry select adder, Memory Elements: 6T SRAM cell, 1T DRAM cell. Sequential Logic Design: Behaviour of Bi-stable elements, CMOS D latch and Edge triggered Flip flops.

TEXT BOOKS :

1. Samir Palnitkar, "Verilog HDL A Guide to Digital Design and Synthesis," 2nd Edition, Pearson Education, 2006.
2. Kamran Eshraghian Dougles and A. Pucknell, Essentials of VLSI circuits and systems", PHI, 2005 Edition
3. Weste and Eshraghian Principles of CMOS VLSI Design ', Pearson Education, 2ndedition,1999.

REFERENCE BOOKS:

1. John. P. Uyemura, "Introduction to VLSI Circuits and Systems", John Wiley, 2003
2. John M. Rabaey, "Digital Integrated Circuits", PHI, EEE, 1997.

Course Code	Course Title						Core/Elective
5PC615EC	Antenna and Wave Propagation						Core
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
EMTL	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To familiarize the students with the basic principles of antennas and introduce the antenna terminology.
2. To introduce different types of wire antennas and make proficient in analytical skills for understanding practical antennas.
3. To familiarize with the design of different types of antennas for various frequency ranges and latest developments in the practical antennas.
4. To introduce need for antenna arrays and the concepts of measurements of antennas.
5. To introduce the various modes of Radio Wave propagation used.

COURSE OUTCOMES :

1. To illustrate the basic principles of antennas and learn the antenna terminology.
2. To design different types of wire antennas and make proficient in analytical skills for understanding practical antennas.
3. To design different types of antennas for various frequency ranges and get updated with latest developments in the practical antennas.
4. To apply the principles of antennas, to design antenna arrays and measure various parameters of antennas.
5. To Identify and understand the suitable modes of Radio Wave propagation used in current practice.

UNIT - I

Antenna Fundamentals: Introduction, Radiation Mechanism, Retarded potential, Isotropic Radiator, Radiation pattern, Radian and Steradian, Radiation Intensity, Gain, Directivity, Antenna Efficiency, Effective Aperture, Effective Length, Reciprocity Theorem, Friis transmission equation, Front–to-back ratio, Antenna Beamwidth, Beam Efficiency, Beam Area, Antenna Impedance, Polarization, Antenna temperature, Antenna Field Regions.

UNIT – II

Thin Linear wire Antennas: Radiation from Infinitesimal Dipole, Radiation Resistance of Short Dipole, Halfwave Dipole and Monopole, Loop Antennas, Helical Antennas.

UNIT – III

Antenna Arrays: Array of point sources, two element arrays with equal and unequal amplitudes, different phases, linear n- element array with uniform distribution, Principle of Pattern Multiplication, Binomial array, V- Antenna, Rhombic Antenna, Yagi - Uda Antenna, Log- periodic Antenna.

UNIT – IV

VHF and UHF Antennas: Babinets principle, Slot Antennas, Horn antenna, Parabolic Reflector and Cassegrain Antennas, Lens Antennas, Microstrip Antennas, Smart Antennas

Antennas for Special Applications: Vehicle mounted antennas, VSAT and DBS TV antennas, RFID antenna, Plasma antenna, Terahertz antenna.

UNIT – V

Radio Wave Propagation: Modes of propagation - Ground wave propagation, Sky Wave Propagation and Space Wave Propagation, Structure of Atmosphere, Characteristics of Different Ionized Regions, Sky wave propagation, Ray Path, Virtual Height, MUF, Skip Distance, LOS.

TEXT BOOKS :

1. K. D. Prasad, Antennas and wave Propagation, Tech India Publication, New Delhi, 4e, 2019-20
2. Edward C. Jordan and Kenneth G. Balmain, "Electromagnetic Waves and Radiating Systems," 2/e, PHI, 2001.

REFERENCE BOOKS :

1. J. D. Kraus, R. J. Marhefka; Ahmad S. Khan, Antennas and wave Propagation, McGraw-Hill, 4th Edition, 2010.
2. Constantine A. Balanis, Antenna Theory: Analysis and Design, Wiley, 3rd edition, 2005.
3. R. E. Collins, Antennas and Radio Propagation, Singapore: McGraw Hill, 1985.
4. R Harish and M. Sachidananda, Antennas and Wave Propagation, Oxford University Press, 2011.

PROFESSIONAL ELECTIVE-II
(5PE62XEC)

Course Code	Course Title						Core/Elective
5PE621EC	Embedded System Design						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Microcontrollers	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. Detailed overview of important concepts of Embedded system.
2. Analyze PIC microcontroller, its features and programming.
3. Describe ARM Microcontroller architectural details and instruction set.
4. Understand ARM Memory management.
5. Learn the techniques to develop an embedded system and case studies.

COURSE OUTCOMES :

1. After completing this course, the student will be able to:
2. Understand the fundamentals of the embedded system design.
3. Enumerate the instruction set of ARM Processor by studying the architecture of ARM core.
4. Acquire knowledge on the serial, parallel and network communication protocols.
5. Learn the embedded system design life cycle and co-design issues.
6. List the various embedded software development tools used in the design of embedded system for various applications.

UNIT - I

Introduction to Embedded Systems: Overview of Embedded System Architecture, Challenges & Trends of Embedded Systems, Hardware Architecture, Software Architecture. Application areas of Embedded Systems and Categories of Embedded Systems. Embedded System Design and Co-Design issues and Design Cycle Process.

UNIT - II

PIC 18: Family Overview, Architecture, Instruction Set, Addressing modes. Timers, interrupts of PIC 18, Capture/Compare and PWM modules of PIC 18.

UNIT - III

ARM Architecture: ARM Processor Families. Instruction Set: Data Processing

Instructions, Addressing Modes, Branch, Load, Store Instructions, PSR Instructions, Conditional Instructions.

UNIT - IV

ARM Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing Instruction Single-Register and Multi Register Load-Store Instructions, Stack, Software Interrupt Instructions. Exception and interrupt handling.

ARM Memory Management: Cache Architecture, Polices, Flushing and Caches, MMU, Page Tables, Translation Access Permissions, Context Switch.

UNIT - V

Embedded Software Development Tools, Host and Target Machines, Linkers/ Locators for Embedded Software, Getting Embedded Software into the Target System. Debugging Techniques.

Case Studies: Design of Embedded Systems using Microcontrollers – for applications in the area of communications and automotives. (GSM/GPRS, CAN, Zigbee).

TEXT BOOKS :

1. Raj Kamal, "Embedded Systems - Architecture, Programming and Design", 2nd Edition, TMH, 2008.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, "ARM Systems Developer's Guides – Designing & Optimizing System Software," Elsevier, 2008.

REFERENCE BOOKS :

1. Mazidi, MCKinlay and Danny Causey, "PIC Microcontrollers and Embedded Systems", Pearson Education, 2007.
2. David.E. Simon, "An Embedded Software Primer", 1st Edition, Pearson Education, 1999.
3. Jonathan W. Valvano, "Embedded Microcomputer Systems", Real Time Interfacing, Thomas Learning, 1999.

Course Code	Course Title						Core/Elective
5PE622EC	Data analytics using R-Programming						Elective
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Engineering. Mathematics	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To learn basics of R Programming environment: R language, R- studio and R packages.
2. To learn various statistical concepts like linear and logistic regression, cluster analysis, time series forecasting.
3. To learn Decision tree induction, association rule mining and text mining.

COURSE OUTCOMES :

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

1. Use various data structures and packages in R for data visualization and summarization.
2. Use linear, non-linear regression models, and classification techniques for data analysis.
3. Use clustering methods including K-means and CURE algorithm.

UNIT - I

Data Science: Introduction to data science, Linear Algebra for data science, Linear equations, Distance, Hyper planes, Half spaces, Eigen values, Eigenvectors.

UNIT - II

Statistical Modelling, Random variables, Probability mass/density functions, sample statistics, hypothesis testing.

UNIT - III

Predictive Modelling: Linear Regression, Simple Linear Regression model building, Multiple Linear Regression, Logistic regression.

UNIT - IV

Introduction to R Programming, getting started with R: Installation of R software and using the interface, Variables and data types, R Objects, Vectors and lists,

Operations: Arithmetic, Logical and Matrix operations, Data frames, functions, Control structures, Debugging and Simulation in R.

UNIT - V

Classification : performance measures, Logistic regression implementation in R, K-Nearest neighbours (KNN), K-Nearest neighbour's implementation in R, Clustering: K-Means Algorithm, K-Means implementation in R.

TEXT BOOKS :

1. Nina Zumel, Practical Data Science with R, Manning Publications, 2014.
2. Peter Bruce and Andrew Bruce, Practical Statistics for Data Scientists, O'Reilly, 2017.
3. Hadley Wickham and Garrett Grolemund, R for Data Science, O'Reilly, 2017.

REFERENCE BOOKS :

1. Roger D Peng, R Programming for Data science, Lean Publishing, 2016.
2. Rafael A Irizarry, Introduction to Data Science, Lean Publishing, 2016.

Course Code	Course Title						Core/Elective
5PE623EC	Digital Image Processing						Elective
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
S&S, DSP	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To provide an introduction to the basic concepts and methodologies for Digital Image processing.
2. To familiar with spatial and transform domain techniques used in Image Enhancement, Restoration and Segmentation of Images.
3. To gain knowledge about various Image transforms used in Image processing and Image compression problems.
4. To understand various methods employed for edge, line and isolated points detection in an image.

COURSE OUTCOMES :

After completing this course, the student twill be able to

1. Develop a foundation that can be used as the basis for higher study and research in the Image processing area.
2. Design various filters for processing and deblurring of images without destroying fine details like edges and lines.
3. Apply image processing techniques for processing and analysis of remotely sensed, Microscope, Radar and Medical images.
4. Understand the need for Digital Image processing techniques for Machine vision.
5. Applications and concept of image compression.

UNIT – I

Digital Image Fundamentals: Image sensing, acquisition, Image formation model, sampling and Quantization, Basic relationships between pixels; neighbours of a pixel, adjacency, connectivity, regions and boundaries. Image formation, brightness, adaptation and discrimination. Categorization of images according to their source of EM radiation.

UNIT – II

Image Transforms : 2D Fourier transform, Properties of 2D Fourier transform, Walsh, Hadamard, Slant, Haar, Discrete cosine transform and Hotelling transform.

UNIT – III

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

UNIT – IV

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

UNIT – V

Image segmentation and Compression: Detection of discontinuities, point line And Edge detection methods: Gradient operation, Laplacian, Prewitt, Sobel, Laplacian of a Gaussian and Canny edge detectors. Image compression: Functional block diagram of a general image compression system various types of redundancies, Huffman coding, Arithmetic coding.

TEXT BOOKS :

1. Rafeal C. Gonzalez, Richars E. Woods, Digital Image Processing ?, Pearsons Education, 2009, 3rd Edition.
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.

REFERENCE BOOKS:

1. S.Jayaraman, S. Esakkirajan,T. Veerakumar,-Digital Image Processing-TataMcGrawHill2014.
2. A K. Jain, -Fundamentals of Digital Image Processing- Pearson 2004.
3. Vipul Singh, -'Digital Image Processing with MATLAB and Lab view', Elsevier 2013.

Course Code	Course Title						Core/Elective
5PE624EC	CPLD/FPGA Architectures						Elective
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
STLD, VLSI	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. Understand the ASIC design flow and Programming Technologies.
2. Study different Architecture of FPGAS.
3. Understand the FPGA physical Design Flow of FPGA.
4. Learn the placement and routing algorithms.
5. Enlist the verification and testing methods of digital circuits.

COURSE OUTCOMES :

1. After completing this course, the student will be able to.
2. Design of ASICs using implementation tools for simulation and synthesis.
3. Describe the architecture of FPGAs.
4. Discuss physical design using FPGAs and CAD tools.
5. Describe placement & routing algorithms.
6. Analyze verification and testing of Digital circuits.

UNIT - I

Introduction to ASICs : Types of ASIC's, ASIC design flow, Economies of ASICs, Programmable ASICs: CPLD and FPGA. Commercially available CPLDs and FPGAs: XILINX, ALTERA, ACTEL. FPGA Design cycle, Implementation tools: Simulation and synthesis, Programming technologies. Applications of FPGAs.

UNIT - II

FPGA logic cell for XILINX, ALTERA and ACTEL ACT, Technology trends, Programmable I/O blocks, FPGA interconnect: Routing resources, Elmore's constant, RC delay and parasitic capacitance, FPGA design flow, Dedicated Specialized components of FPGAs.

UNIT-III

FPGA physical design, CAD tools, Power dissipation, FPGA Partitioning, Partitioning methods.

Floor planning: Goals and objectives, I/O, Power and clock planning, Low-level design entry.

UNIT - IV

Placement: Goals and objectives, Placement algorithms: Min-cut based placement, Iterative Improvement and simulated annealing.

Routing, introduction, Global routing: Goals and objectives, Global routing methods, Back-annotation. **Detailed Routing:** Goals and objectives, Channel density, Segmented channel routing, Maze routing, Clock and power routing, Circuit extraction and DRC.

UNIT - V

Verification and Testing: Verification: Logic simulation, Design validation, Timing verification. Testing concepts: Failures, Mechanism and faults, Fault coverage.

Testing concepts: failures, mechanisms and faults, fault coverage, ATPG methods, and programmability failures.

TEXT BOOKS :

1. Pak and Chan, Samiha Mourad, "Digital Design using Field Programmable Gate Arrays", Pearson Education, 1/e, 2009.
2. Michael John Sebastian Smith, "Application Specific Integrated Circuits", Pearson Education Asia, 3/e, 2001.

REFERENCE BOOKS :

1. S. Trimberger, Edr, "Field Programmable Gate Array Technology", Kluwer Academic Publications, 1994.
2. John V. Oldfield, Richard C Dore, "Field Programmable Gate Arrays", Wiley Publications.
3. Clive Maxfield, "The Design Warrior's Guide to FPGAs?, Elsevier, 2004.

PROFESSIONAL ELECTIVE-III
(5PE63XEC)

Course Code	Course Title						Core/Elective
5PE631EC	Internet of Things						Elective
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
Controllers, Communication protocols, web services	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To discuss about the fundamentals of IoT and its applications and requisite infrastructure.
2. To describe Internet principles and communication technologies relevant to IoT.
3. To illustrate hardware and software aspects of designing an IoT system.
4. To describe concepts of cloud computing and data analytics.
5. To demonstrate business models and manufacturing strategies of IoT products.

COURSE OUTCOMES :

On successful completion of the course, the students 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 Python 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.

UNIT-I

Introduction to Internet of Things: Physical Design of IoT: Things in IoT, IoT protocols, Logical Design of IoT: IoT functional Blocks, Communication Models, APIs, IoT enabling technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics, IoT Applications: Smart Home, Smart Cities, Smart Environment, Smart Energy, Smart Retail and logistics, Smart Agriculture and Industry, Smart Industry and smart Health.

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.

UNIT - III

Prototyping and Programming: Cost Vs Ease of Production, Prototypes and Production, Open-Source Vs Closed Source. 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.

Introduction to Python: Python packages for IoT, IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi with Python - Controlling LED and LDR using Pi with python programming.

UNIT - IV

Cloud Computing and Data analytics: Introduction to Cloud storage models -SAAS, PAAS, IAAS. Communication APIs, Amazon web services for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT - Apache Hadoop- Map reduce job execution workflow.

UNIT - V

IoT Case Studies: Case studies illustrating IoT Design – Smart Lighting, Weather Monitoring, Smart Irrigation, Business model for IoT product manufacturing, IoT Startups, Mass manufacturing, Ethical issues in IoT.

TEXT BOOKS :

1. Internet of Things - Converging Technologies for smart environments and integrated ecosystems, River Publishers.
2. Adrian McEwen (Author), Hakim Cassimally, “Designing the Internet of Things”, Wiley India Publishers.

REFERENCE BOOKS :

1. Kenneth A Lambert and B.L. Juneja, “Fundamentals of Python”, Cengage Learning.
2. Vijay Madisetti, Arshdeep Bahga, “Internet of Things (A Hands-on-Approach),” VPT Publisher, 1st Ed., 2014.

Course Code	Course Title						Core/Elective
5PE632EC	Cyber Security						Elective
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
Programming skills, web services	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To understand various types of cyber-attacks and cyber-crimes.
2. To learn threats and risks within context of the cyber security.
3. To have an overview of the cyber laws & concepts of cyber forensics.
4. To study the defensive techniques against these attacks.

COURSE OUTCOMES :

On successful completion of the course, the students will be able to

1. Analyze and evaluate the cyber security needs of an organization.
2. Understand Cyber Security Regulations and Roles of International Law.
3. Design and develop security architecture for an organization.
4. Understand fundamental concepts of data privacy attacks.

UNIT - I

Introduction to Cyber Security: Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Cyber Espionage, etc., Comprehensive Cyber Security Policy.

UNIT-II

Cyberspace and the Law & Cyber Forensics: Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace, National Cyber Security Policy.

Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics.

UNIT - III

Cybercrime : Mobile and Wireless Devices: Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on Mobile/Cell Phones, Organizational security Policies and Measures in Mobile Computing Era, Laptops.

UNIT - IV

Cyber Security: Organizational Implications: Introduction, cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing: security risks and perils for organizations, social computing and the associated challenges for organizations.

UNIT - V

Privacy Issues: Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc.

Cybercrime : Examples and Mini - Cases

Examples: Official Website of Maharashtra Government Hacked, Indian Banks Lose Millions of Rupees, Parliament Attack, Pune City Police Bust Nigerian Racket, e-mail spoofing instances.

Mini-Cases: The Indian Case of online Gambling, An Indian Case of Intellectual Property Crime, Financial Frauds in Cyber Domain.

TEXT BOOKS :

1. Nina Godbole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, Computer Forensics and Legal Perspectives, Wiley
2. B.B. Gupta, D.P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles,
3. Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.

REFERENCE BOOKS :

1. James Graham, Richard Howard and Ryan Otson, -Cyber Security Essentials, CRC Press.
2. Chwan-Hwa(john) Wu,J. David Irwin, -Introduction to Cyber Security, CRC Press T&F Group.

Course Code	Course Title						Core/Elective
5PE633EC	Multirate Signal Processing						Elective
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
S&S, DSP	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To review the fundamentals of multirate systems.
2. To describe the techniques for multirate filter banks.
3. To explain the quadrature-mirror filter banks.
4. To demonstrate the concept of adaptive digital filters.
5. To illustrate the concept and application of wavelets.

COURSE OUTCOMES :

On successful completion of the course, the students will be able to

1. Solve problems in sampling rate conversion and filter banks.
2. Build digital filter bank systems.
3. Implement quadrature-mirror filter banks for multirate signal processing.
4. Analyze the various adaptive processing algorithms.
5. Implement wavelets in signal processing applications.

UNIT - I

Review of fundamentals of Multirate systems: Decimation by an integer factor D, Interpolation by an integer factor L, Time- and frequency-domain representation and analysis of decimated and interpolated signals, Efficient structures for decimation and interpolation filters, Sampling rate conversion by a rational factor I/D, Inter connection of building blocks, polyphase representation, Multi stage implementation of sampling-rate conversion, Applications of Multirate systems.

UNIT - II

Multirate Filter banks: Digital filter banks, Uniform DFT filter banks, Polyphase implementation of Uniform filter banks.

Nyquist filters : Lth -band filters, half band filters, Half-band High pass filter, Window Design of Half-Band Filter, Interpolation and decimation with Low Pass Half-Band

Filters, Design of Linear phase Lth- band FIR filters, Relation between Lth-Band filters and power complementary filters.

UNIT - III

Quadrature- Mirror Filter banks: The filter bank structure, Analysis of Two channel QMF bank, Errors in the QMF bank, Alias free filter banks, Alias-free realization, Alias-free FIR QMF bank, Alias-free IIR QMF bank, perfect reconstruction(PR) two-channel FIR filter bank, Alias-free L-channel filter bank and Multilevel filter banks-filter with equal and unequal pass band widths.

UNIT - IV

Adaptive Algorithms to adjust coefficients of digital filters: Least Mean Square (LMS), Recursive Least Square (RLS) and Kalman Filter Algorithms.

UNIT - V

Wavelets and its applications: Introduction to wavelet Theory, wavelet transform, Definition and properties, Continuous Wavelet Transform and Discrete Wavelet Transform, Application of Wavelets in signal processing.

TEXT BOOKS:

1. J.G. Proakis. D.G. Manolakis. "Digital Signal Processing: Principles. Algorithms and Applications",3rd Edn. Prentice Hall India,1999.
2. P.P. Vidyanathan, "Multi-rate Systems and Filter Banks," Pearson Education, 2008.
3. Bruce W Suter, "Multi-rate and Wavelet Signal Processing." Volume 8, Academic Press, 1998.

REFERENCE BOOKS :

1. B. Widrow & S Stearns, "Adaptive Signal Processing", PHI, 1985.
2. K. P. Soman, K. I. Ramachandran, N. G. Resmi, "Insight into wavelets from theory to practice", PHI.

Course Code	Course Title						Core/Elective
5PE634EC	Fundamentals of Electronics Packaging						Elective
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
Electrical and Electronics; Mechanical, Chemical, Instrumentation, Chemistry, Physics, Materials Engineering	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. The course will sensitize the participants to the fundamentals of electronics systems packaging.
2. The course is multidisciplinary in nature.
3. Today products in electronics industry need to be packaged to current state-of-art if it has to be in the leading edge market. Hence systems packaging is essential.

COURSE OUTCOMES :

1. Discuss the various packaging types.
2. Design of packages which can withstand higher temperature, vibrations and shock.
3. Design of PCBs which minimize the EMI and operate at higher frequency.
4. Analyze the concepts of testing methods.
5. Discuss the various packaging types.

UNIT - I

Overview of Electronic Systems Packaging: Functions of Electronic Packaging, Packaging Hierarchy, IC packaging: MEMS packaging, consumer electronics packaging, medical electronics packaging, Trends and Challenges, Driving Forces on Packaging Technology, Materials for Microelectronic packaging, Packaging Material Properties, Ceramics, Polymers, and Metals in Packaging, Material for high density interconnect substrates.

UNIT - II

Electrical Issues in Packaging: Electrical Issues of Systems Packaging, Signal Distribution, Power Distribution, Electromagnetic Interference, Transmission Lines,

Clock Distribution, Noise Sources, Digital and RF Issues. Design Process Electrical Design: Interconnect Capacitance, Resistance and Inductance fundamentals; Packaging roadmaps - Hybrid circuits - Resistive, Capacitive and Inductive parasitics.

UNIT - III

Chip Level Packaging : IC Assembly - Purpose, Requirements, Technologies, Wire bonding, Tape Automated Bonding, Flip Chip, Wafer Level Packaging, reliability, wafer level burn – in and test.

Single chip packaging: functions, types, materials processes, properties, characteristics, trends.

Multi chip packaging: types, design, comparison, trends. System – in – package (SIP); Passives: discrete, integrated, and embedded.

UNIT - IV

PCB, Surface Mount Technology and Thermal Considerations: Printed Circuit Board: Anatomy, CAD tools for PCB design, Standard fabrication, Micro via Boards. Board Assembly: Surface Mount Technology, Through Hole Technology, Process Control and Design challenges. Structural analysis, Thermal Management, Heat transfer fundamentals, Thermal conductivity and resistance, Conduction, convection and radiation – Cooling requirements.

UNIT - V

Testing: Reliability, Basic concepts, Environmental interactions. Thermal mismatch and fatigue –failures – thermo mechanically induced –electrically induced – chemically induced.

Electrical Testing: System level electrical testing, Interconnection tests, Active Circuit Testing, Design for Testability.

TEXT BOOK :

1. Tummala, Rao R., Fundamentals of Microsystems Packaging, McGraw Hill, 2001.
2. Blackwell (Ed), The electronic packaging handbook, CRC Press, 2000.

REFERENCE BOOK:

1. Tummala, Rao R, Microelectronics packaging handbook, McGraw Hill, 2008.
2. Bosshart, Printed Circuit Boards Design and Technology, TataMcGraw Hill, 1988.
3. R.G. Kaduskar and V.B.Baru, Electronic Product design, Wiley India, 2011.
4. R.S.Khandpur, Printed Circuit Board, Tata McGraw Hill, 2005.
5. Recent literature in Electronic Packaging.
6. Michael L. Bushnell & Vishwani D. Agrawal," Essentials of Electronic Testing for Digital, memory & Mixed signal VLSI Circuits", Kluwer Academic Publishers.2000.
7. M. Abramovici, M. A. Breuer, and A.D. Friedman, "Digital System Testing and Testable Design", Computer Science Press, 1990.

OPEN ELECTIVE-II
(XOE6XXXX)

Course Code	Course Title						Core/Elective
2OE602CE	Green Building Technologies						Elective
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

COURSE OBJECTIVES :

The objective of this course is to impart knowledge of

1. To impart knowledge of the principles behind the green building technologies
2. To know the importance of sustainable use of natural resources and energy.
3. To understand the principles of effective energy and resources management in buildings
4. To bring awareness of the basic criteria in the green building rating systems
5. To understand the methodologies to reduce, recycle and reuse towards sustainability.

COURSE OUTCOMES :

After completion of the course, the student will be able to

CO 1. Define a green building, along with its features, benefits and rating systems.

CO 2. Describe the criteria used for site selection and water efficiency methods.

CO 3. Explain the energy efficiency terms and methods used in green building practices.

CO 4. Select materials for sustainable built environment & adopt waste management methods.

CO 5. Describe the methods used to maintain indoor environmental quality.

UNIT - I

Introduction to Green Buildings : Definition of green buildings and sustainable development, typical features of green buildings, benefits of green buildings towards sustainable development. Green building rating systems - GRIHA, IGBC and LEED, overview of the criteria as per these rating systems.

UNIT - II

Site selection and planning: Criteria for site selection, preservation of landscape, soil erosion control, minimizing urban heat island effect, maximize comfort by proper orientation of building facades, day lighting, ventilation, etc.

Water conservation and efficiency: Rainwater harvesting methods for roof & non-roof, reducing landscape water demand by proper irrigation systems, water efficient plumbing systems, water metering, waste water treatment, recycle and reuse systems.

UNIT - III

Energy Efficiency: Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy.

Methods to reduce operational energy: Energy efficient building envelopes, efficient lighting technologies, energy efficient appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings.

UNIT - IV

Building materials: Methods to reduce embodied energy in building materials: (a) Use of local building materials (b) Use of natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks,(c) use of materials with recycled content such as blended cements, pozzolona cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) reuse of waste and salvaged materials

Waste Management: Handling of construction waste materials, separation of household waste, on-site and off- site organic waste management

UNIT - V

Indoor Environmental Quality for Occupant Comfort and Wellbeing: Day lighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics.

Codes related to green buildings : NBC, ECBC, ASHRAE, UPC etc.

TEXT BOOKS :

1. Michael Bauer, Peter Mösle and Michael Schwarz "Green Building – Guidebook for Sustainable Architecture" Springer, 2010.
2. GRIHA version 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment.

REFERENCE BOOKS :

1. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, 2013, Indian Green Building Council Publishers.
2. K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao 'Alternative building materials and technologies'.

Course Code	Course Title						Core/Elective
3OE602CS	Software Engineering						Elective
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

COURSE OBJECTIVES :

The objective of this course is to impart knowledge of

1. Describe and compare various software development methods and understand the context in which each approach might be applicable
2. To impart knowledge on various phases, methodologies and practices of software development
3. To apply the project management and analysis principles to software project development.
4. To understand the importance of testing in software development, study various testing strategies along with its relationship with software quality and metric
5. To apply the design & testing principles to software project development.

COURSE OUTCOMES :

After completion of the course, the student will be able to

1. Acquired working knowledge of alternative approaches and techniques for each phase of SDLC.
2. Judge an appropriate process model(s) for software project attributes and analyze requirements for project development.
3. Acquire skills necessary as an independent or as part of a team for architecting a complete software project by identifying solutions for recurring problems exerting
4. Concede product quality through testing techniques employing appropriate metrics by understanding the practical challenges associated with the development of a significant software system
5. Apply the software engineering principles in real time project development.

UNIT - I

Introduction to Software : What is software? Types of software, Characteristics of software Attributes of good software.

Software Engineering: What is software engineering, Software engineering costs? What are the key challenges facing software engineering, Systems engineering & software Engineering, SDLC.

Software Development Process Models: prescriptive Models, Waterfall Model, Incremental Process Models, Evolutionary Process Models, Specialized Process Models, The Unified Models, Personal and Team Process Models, Process Technology, Product and Process.

UNIT - II

Software Engineering Principles : SE Principles, Communication Principles, Planning Principles, Modelling Principles, Construction Principles, Deployment.

Software Requirement Analysis and Specification: System and software requirements, Types of software requirements, Elicitation and analysis of requirements, Requirement validation, Requirements specification, Feasibility.

UNIT - III

Building the Analysis Model : Data Modeling Concepts, Object-Oriented Analysis, Scenario-based Modeling, Flow-oriented Modeling, Class-based Modeling.

Design Engineering: Design Process and Quality, Design Concepts, the Design Model.

Performing User Interface Design : The Golden Rules, User Interface Analysis and Design, Interface Analysis, Interface Design Steps, Design Evaluation.

UNIT - IV

Creating an Architectural Design: Software Architecture, Data Design, Architectural Styles and Patterns, Architectural Design.

Coding: Programming languages and development tools, Selecting languages and tools Good programming practices, Coding Standards

UNIT - V

Software Testing and Quality Assurance: Verification and validation Techniques of testing Black-box and White-box testing Inspections Levels of testing Unit testing, Integration Testing, Interface testing, System testing, Alpha and beta testing, Regression testing Design of test cases, Quality management activities: Product and process quality Standards, ISO900, Capability Maturity Model (CMM), Risk management.

Debugging: Debugging Techniques, The Art of Debugging.

Current trends in Software Engineering Software Engineering for projects and products.

TEXTBOOKS :

1. Roger S. Pressman, Software Engineering: A Practitioner's Approach, VII Edition, McGraw Hill, 2009.
2. Ian Sommerville, Software Engineering, VII edition, Addison-Wesley.
3. RajibMall, -Fundamentals of Software Engineering.

REFERENCE BOOKS :

1. Ali Behforooz and Frederick J. Hudson, Software Engineering Fundamentals, Oxford University Press, 1996
2. Pankaj Jalote, An Integrated Approach to Software Engineering, III Edition, Narosa Publishing House, 2000.

Course Code	Course Title						Core/Elective
1OE602AD	Deep Learning						Elective
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

COURSE OBJECTIVES :

The objective of this course is to impart knowledge of

1. Develop and Train Deep Neural Networks.
2. Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition.
3. Build and train RNNs, work with NLP and Word Embeddings.
4. The internal structure of LSTM and GRU and the differences between them.

COURSE OUTCOMES :

After completion of the course, the student will be able to

1. Feature Extraction from Image and Video Data.
2. Implement Image Segmentation and Instance Segmentation in Images.
3. Implement image recognition and image classification using a pretrained network (Transfer Learning).
4. Traffic Information analysis using Twitter Data.
5. Autoencoder for Classification & Feature Extraction.

UNIT - I

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data.

UNIT - II

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT - III

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Back propagation Through the Convolutional Layer. Filters and Feature Maps. Back propagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, Alex Net, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. RCNN, Fast R-CNN, Faster R- CNN, Mask-RCNN, YOLO

UNIT - IV

About NLP & its Toolkits. Language Modeling. Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Cooccurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Back propagation Through Time. Bidirectional RNNs (BRNN) . Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to- Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT - V

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Autoencoding. Convolutional Auto Encoding. Variational.

TEXT BOOKS

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc. 2017.
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress, 2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020.

REFERENCE BOOKS

1. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND, 2017.
2. Pro Deep Learning with Tensor Flow, Santanu Pattanayak, Apress, 2017.

Course Code	Course Title						Core/Elective
4OE602EE	Electric Vehicle Technology						Elective
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
	3	-	-	-	40	60	3

COURSE OBJECTIVES :

The objective of this course is to impart knowledge of

1. Know the history of electric hybrid electric vehicles (EV & HEV) and emphasize the need and importance of EV-HEV for sustainable future.
2. Introduce the fundamental concepts and principles of electric and hybrid electric vehicles drive train topologies.
3. Develop a thorough understanding of the key elements of EV/HEV: Electric Machines for Propulsion Applications and Energy Sources.

COURSE OUTCOMES :

After completion of the course, the student will be able to

1. To identify and describe the history and evolvement of electric & hybrid electric vehicles to emphasize on the need and importance of EV/HEV for sustainable future.
2. To identify and describe the principles of various EV/HEVs drive train topologies along with their power flow control and fuel efficiency estimation.
3. To design and select electric propulsion system components for EV/HEV drives suitability for the desirable performance and control.
4. To compare and evaluate various energy sources and energy storage components for EV and HEV applications.

UNIT - I

Introduction : History of electric vehicles (EV) and hybrid electric vehicles (HEV), need and importance of EV and HEV, Power/Energy supplies requirements for EV/ HEV applications, vehicle power source characterization, and transmission characteristics. Vehicle mechanics – Roadway fundamentals, vehicle kinetics, Dynamics of vehicle motion.

UNIT - II

Drive-Train Topologies: Series, Parallel, Series -Parallel and Complex configurations of HEV, basics of hybrid traction system, various hybrid drive-train topologies, power flow control in drive-train topologies, fuel efficiency analysis.

UNIT - III

Electrical Machines and Power Converters for Hybrid and Electric Vehicles: Electric system components for EV/HEV, suitability of DC and AC machines for EV/HEV applications, AC and DC Motor drives. Permanent magnet and switch reluctance machines, configuration and control of drives. Power Converters- Converters for EV and HEV applications.

UNIT - IV

Energy Sources for EV/HEV : Requirements of energy supplies and storage in EV/HEV, Review of batteries, fuel cells, flywheels and ultra-capacitors as energy sources for EV/HEV, characteristics and comparison of energy sources for EV/HEV, hybridization of different energy sources.

UNIT - V

Electric Vehicles Charging Station : Type of Charging station, Selection and Sizing of charging station, Components of charging Station and Single line diagram of charging station. Contactless inductive charging- Stationary Inductive charging, resonant and compensation circuit topologies.

TEXT BOOKS :

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiely, USA, 2012.
2. Iqbal Hussain, Electric & Hybrid Vehicles – Design Fundamentals, 2nd Edition, CRC Press, 2011.

REFERENCES BOOKS :

1. Chris Mi, M. Abdul Masrur, David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspective, Wiely, 2011
2. Simora Onori, Hybrid Electric Vehicles Energy Management Strategies, Springer.

Course Code	Course Title						Core/Elective
5OE602EC	Fundamentals of IOT						Open Elective -II
Prerequisite	Contact Hours per Week						
Controllers, Communication protocols, web services	L	T	D	P	CIE	SIE	Credits
	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To introducee the fundamentals, applications and requisite infrastructure of IoT.
2. To describe Internet principles and communication technologies relevant to IoT.
3. To discuss hardware and software aspects of designing an IoT system.
4. To explain the concepts of cloud computing and data analytics.
5. To illustrate the business models and manufacturing strategies of IoT products.

COURSE OUTCOMES :

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

UNIT - I

Introduction to Internet of Things: Introduction to Internet of Things: Physical Design of IoT : Things in IoT, IoT protocols, Logical Design of IoT : IoT functional Blocks, Communication Models, APIs, IoT enabling technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics, IoT Applications: Smart Home, Smart Cities, Smart Environment, Smart Energy, Smart Retail and logistics, Smart Agriculture and Industry, Smart Industry and smart Health.

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.

UNIT - III

Prototyping and Programming : Cost Vs Ease of Production, Prototypes and Production, Open-Source Vs Closed Source. 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.

Introduction to Python, Data Types and Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/Time Operations., Classes, Python packages for IoT, IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi with Python - Controlling LED and LDR using Pi with python programming.

UNIT - IV

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

UNIT - V

IoT Case Studies: Case studies illustrating IoT Design – Smart Lighting, Weather Monitoring, Smart Irrigation, Business model for IoT product manufacturing, IoT Startups, Mass manufacturing, Ethical issues in IoT.

TEXT BOOKS:

1. Internet of Things - Converging Technologies for smart environments and integrated ecosystems, River Publishers.
2. Adrian McEwen (Author), Hakim Cassimally, “Designing the Internet of Things”, Wiley India Publishers.

REFERENCE BOOKS :

1. Fundamentals of Python, Kenneth A Lambert and B.L. Juneja, Cenage Learning.
2. Internet of Things (A Hands-on-Approach), Vijay Madisetti , Arshdeep Bahga, VPT Publisher, 1st Ed., 2014.

Course Code	Course Title						Core/Elective
6OE602ME	3D Printing Technologies						Open Elective-II
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
NIL	3	-	-	-	40	60	3

COURSE OBJECTIVES :

1. To understand the fundamental concepts of 3D Printing, its advantages & limitations.
2. To know the various types of STL file errors and other data formats used in additive manufacturing Technology.
3. To know the working principle, advantages, disadvantages & applications of liquid, solid and powder based 3D Printing technologies.
4. To know the diversified applications of 3D Printing technologies and explore them in different industrial sectors.

COURSE OUTCOMES :

After the completion of course the students will be able to:

1. Describe the fundamentals of 3D printing, classify and explain advantages and disadvantages of 3D Printing technologies.
2. Select thesuitable CAD data formats and software used in 3D Printing technology.
3. Describe the operating principles, capabilities and limitations of liquid, solid & powder based 3D Printing Technologies.
4. Compare different 3D printing technologies based on their process capabilities and applications.
5. Apply the capabilities and knowledge of 3D printing in different industrial sectors.

UNIT-I

Prototyping Fundamentals: Historical Development, Fundamentals of 3D Printing, Advantages and Limitations of 3D Printing, commonly used terms, 3D Printing Process Chain, 3D Modelling, Data conversion and transmission, Checking & Preparing, Building, Post processing, Classification of 3D Printing processes,

Fundamental Automated Processes, Distinction between 3D Printing and Conventional Machining Processes.

Data Formats & Software : Data formats; conversion and transmission, STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs, Newly Proposed Formats. Software's Features: Magics, Mimics, Solid View, Cura, ITK Snap.

UNIT-II

Liquid based Systems : Stereo Lithography Apparatus (SLA): Models and Specifications, Process, working principle, photopolymers, photo polymerization, Layering Technology, laser and laser scanning, Applications, Advantages and Disadvantages. Poly jet: Models and

Specifications, Process, working principle, Applications, Advantages and Disadvantages. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages.

UNIT-III

Solid-based Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. Fused Deposition Modelling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. Multi Jet Modelling (MJM): Models and specifications, Process, Working principle, Applications, Advantages and Disadvantages.

UNIT-IV

Powder Based Systems: Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages. Three **Dimensional Printing (3DP):** Models and Specifications, Process, working principle, Applications, Advantages and Disadvantages. **Laser Engineered Net Shaping (LENS):** Models and specifications, Process, working principle, Applications, Advantages and Disadvantages.

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, Construction field, Arts and Architecture, Pattern for investment and vacuum casting, Medical Models

and **Bioengineering Applications:** Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production Medical Devices, Forensic Science and Anthropology and Web Based Rapid Prototyping Systems.

TEXT BOOKS :

1. Chee Kai Chua and Kah Fai Leong, "3D Printing and Additive Manufacturing Principles and Applications" Fifth Edition, World scientific
2. 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing" Springer, Second Edition.

REFERENCE BOOKS :

1. Ian Gibson, David W Rosen, Brent Stucker, "Additive Manufacturing Technologies:
2. Frank W. Liou, "Rapid Prototyping & Engineering Applications"- CRC Press, Taylor & Francis Group.
3. Rafiq Noorani, "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley & Sons.

Course Code	Course Title						Core/Elective
5PC651EC	Analog /Digital Communication Lab						Core
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
AC, DC	-	-	-	2	40	60	1

COURSE OBJECTIVES :

1. Demonstrate AM, FM, Mixer, PAM, PWM and PPM techniques.
2. Understand multiplexing techniques.
3. Understand and simulate digital modulation (i.e., ASK, FSK, BPSK, QPSK) generation and detection.
4. Model analog, pulse modulation, PCM, Delta and Digital modulation techniques using CAD tools
5. Obtain data formats.

COURSE OUTCOMES :

1. Understand and simulate modulation and demodulation of AM and FM.
2. Construct pre-emphasis and de-emphasis at the transmitter and receiver respectively.
3. Understand and simulate the PAM, PWM & PPM circuits
4. Understand baseband transmission (i.e., PCM, DPCM, DM, and ADM) generation and detection.
5. Understand error detection and correction.

PART-A

Analog Communication Experiments list:

1. AM generation and detection
2. FM generation and detection
3. Pre emphasis and De-emphasis circuits
4. Multiplexing Techniques (FDM and TDM)
5. Mixer Characteristics
6. Sampling , PAM, PWM, and PPM generation and detection
7. Generation and Detection of Analog and Pulse modulation techniques by using MATLAB/Simulink/Labview

PART-B

Digital Communication Experiments list:

1. PCM generation and detection
2. Data formats / channel encoding and decoding.
3. Linear and Adaptive Delta Modulation and Demodulation
4. Modem characteristics.
5. ASK generation and Detection.
6. FSK and Minimum Shift Keying generation and Detection.
7. Phase shift keying methods (BPSK, QPSK) generation and Detection.
8. Generation and Detection of PCM, Delta modulation and Digital modulation Schemes (ASK. FSK, BPSK, QPSK) by using MATLAB/Simulink/Lab-view.

Note: At least ten experiments should be conducted in the semester, of which five should be from PART - B.

Course Code	Course Title						Core/Elective
5PC652EC	VLSI Digital Lab						Core
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
STLD, VLSI	-	-	-	2	40	60	1

COURSE OBJECTIVES :

1. To develop Verilog HDL code for digital circuits using gate level, data flow and behavioural, Modelling and Verify the design block using stimulus.
2. To study the VLSI CAD tools.
3. To implement transistor level circuits.

COURSE OUTCOMES :

On successful completion of the course, the students will be able to:

1. Write the Verilog HDL programs in Gate level and Data flow Modelling.
2. Implement combinational and sequential circuits using Verilog.
3. Analyse digital circuits using VLSI CAD tools like DSCH, Microwind.
4. Design CMOS circuits like basic gates, adders at the transistor level.
5. Implement the layout of simple CMOS circuits like inverter and basic gates.

List of Experiments

PART-A

1. Write structural Verilog HDL model for
   a. 4-bit ripple carry adder.
   b. 4-bit binary Adder cum Subtractor
   c. 1-digit BCD adder
2. Write a Verilog HDL program in behavioural model for
   a. 8:1 multiplexer b. 8:3 encoder c. 3:8 decoder
3. Write a Verilog HDL program in Hierarchical structural model for
   a. 16:1 multiplexer realization using 4:1 multiplexer
   b. 3:8 decoder realization through 2:4 decoder

4. Write a Verilog HDL program in behavioural model for
   a. SR-FF, b. D-FF, c. JK-FF and d. T-FF
5. Write a Verilog HDL program in behavioural model for
   a. 8 bit asynchronous up-down counter
   b. 8 bit synchronous up-down counter
6. Write a Verilog HDL program for 4-bit sequence detector through Mealy state machines
7. Write a Verilog HDL program for 3-bit sequence detector through Moore state machines

PART-B

Transistor Level implementation of CMOS circuits using VLSI CAD tool

1. Basic Logic Gates:
   a. Inverter,
   b. NAND and
   c. NOR
2. Half Adder and Full Adder
3. Half Subtractor and Full Subtractor
4. Implement the Layout of CMOS Inverter.
5. Implement the Layout of CMOS NAND.
6. Implement the Layout of CMOS NOR
7. Implement the Layout of CMOS Half Adder and Full Adder.
8. Implement the Layout of CMOS Half Subtractor and Full Subtractor

Note:

1. A total of 10 experiments must be completed in the semester.
2. Minimum of 5 experiments from Part-A and 5 from Part-B is compulsory.

Course Code	Course Title						Core/Elective
HS 553HS & HS653HS	Soft Skills Lab (Common to CSE & AI & DS – V SEM & ECE, ME, CE & EEE – VI SEM)						Core
Prerequisite	Contact Hours Per Week				CIE	SEE	Credits
	L	T	D	P			
	-	-	-	2	40	60	1

COURSE OBJECTIVES :

The following are the Objectives of the Course :

1. To enable the students to listen to different speakers in different contexts for various purposes and learn target language expressions.
2. To enable the students to develop confidence and interactive skills to speak professionally in different situations.
3. To enable students to learn and develop various reading skills and strategies.
4. To enable the students to develop written expression of thought and provide opportunities to explore ideas by utilizing various techniques.
5. To equip the students to develop needed confidence and interactive skills to speak professionally and acquire skills to face any Interview.

COURSE OUTCOMES :

After completion of the course, the student will be able to

CO 1. Listen to a variety of speakers and texts and will be able to comprehend and perform the required tasks.

CO 2. Interact in a group professionally and communicate confidently in terms of both the spoken and written communication.

CO 3. Develop the skills and strategies of reading and writing.

CO 4. Face any Interview confidently by managing time, making decisions by speaking appropriately according to the context.

CO 5. Demonstrate right attitude and right skills to cope with team and communicate professionally.

LIST OF EXPERIMENTS

I. Listening Skills

- Listening to different situations by Native Speakers.
- Listening to Conversations.
- Listening to Motivational Speeches.

II. Speaking Skills

- Describing a person or a place or a thing using relevant adjectives.
- Picture Perception
- Oral Presentations.
- Etiquette in different situations.

III. Reading Skills

- Reading different Texts
- Reading Comprehension Passages.
- Skimming and Scanning
- Paraphrasing.

IV. Writing Skills

- Writing Slogans related to the image.
- Communicating on Social Media.

V. Interview Skills

- Skills required to attend an Interview
- Soft Skills to be demonstrated in a Job Interview.
- Debates and Group discussions.

SUGGESTED READINGS :

1. Andrea J. Rutherford. Basic Communication Skills for Technology. Pearson Education. Inc. New Delhi.
2. Antony Jay and Ros Jay. Effective Presentation. How to be a Top Class Presenter. Universities Press.(India) Limited.1999.
3. Robert M Sherfield and etal. "Developing Soft Skills" 4th edition, New Delhi: Pearson Education,2009.
4. M.Ashraf Rizvi Effective Technical Communication, Tata McGraw-Hill Publishing Company Limited. New Delhi.

Course Code	Course Title						Core/Elective
5PW672EC	Technical Seminar						Core
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
Professional skills, communication skills	-	-	-	2	50	-	1

Seminar based on core contents related to parent discipline/department/branch of Engineering.

Course Code	Course Title						Core/Elective
5PW774EC	Summer Internship						Core
Prerequisite	Contact Hours per Week				CIE	SIE	Credits
	L	T	D	P			
professional skills, soft skills, communication skills	-	-	-	-	40	60	1

COURSE OBJECTIVES :

1. To enhance practical and professional skills.
2. To provide training in soft skills and also train them in presenting seminars and technical report writing.
3. To expose the students to industry practices and team work.

COURSE OUTCOMES :

On successful completion of the course, the students will be able to:

1. Acquire practical experience of software design and development, and coding practices within Industrial / R&D Environments.
2. understand working practices within Industrial/R&D Environments
3. Prepare reports and deliver effective presentation.
4. demonstrate effective written and oral communication skills
5. Innovate in various engineering disciplines and nurture their entrepreneurial ideas.

Summer Internship is introduced as part of the curriculum for encouraging students to work on problems of interest to industries. A batch of three students will be attached to a person from the Government or Private Organizations/Computer Industry/Software Companies/R&D Organization for a period of 4 to 6 weeks. This will be during the summer vacation following the completion of the III-year Course. One faculty coordinator will also be attached to the group of 3 students to monitor the progress and to interact with the industry co-ordinate (person from industry).

The course schedule will depend on the specific internship/training experience. The typical time per topic will vary depending on the internship.

- Overview of company/project
- Safety training
- Discussions with project teams
- Background research, review of documents, white papers, and scientific papers
- Planning, designing, and reviewing the planned work
- Executing the plans
- Documenting progress, experiments, and other technical documentation
- Further team discussions to discuss results
- Final report writing and presentation

After the completion of the project, each student will be required to:

1. Submit a brief technical report on the project executed and
2. Present the work through a seminar talk (to be organized by the Department)

Award of internal marks are to be based on the performance of the students at the workplace and awarded by industry guide and internal guide (xx Marks) followed by presentation before the committee constituted by the department (25 Marks). One faculty member will coordinate the overall activity of Industry Attachment Program.

Note : Students have to undergo summer internship of 4 to 6 weeks at the end of semester VI and credits will be awarded after evaluation in VII semester.