COURSE STRUCTURE (R19)
AND
DETAILED SYLLABUS
(IV YEAR)

ELECTRONICS & COMMUNICATION ENGINEERING

For
B.Tech., Four Year Degree Course
(Applicable for the batches admitted from 2019-20)

LENDI INSTITUTE OF ENGINEERING AND TECHNOLOGY
An Autonomous Institution
Approved by AICTE & Permanently Affiliated to
JNTUK, Kakinada Accredited by NAAC with "A" Grade
and NBA (CSE, ECE, EEE & ME)Jonnada (Village),
Denkada (Mandal), Vizianagaram Dist – 535 005 Phone
No. 08922-241111, 241112
E-Mail: lendi_2008@yahoo.com Website: www.lendi.org

IV YEAR–I SEMESTER							
S.No	**Course Code**	**Course**	**Category**	**L**	**T**	**P**	**Credits**
1	**R19ECE-PC4101**	Optical communications	PC	3	0	0	3
2	**R19ECE-PC4102**	Data Communications & Computer Networks	PC	3	0	0	3
3	**R19ECE-PC4103**	Digital Image and Video Processing	PC	3	0	0	3
4	**R19ECE-PE4101**	**Professional Elective (PE3)** 1. Mobile and Cellular Communications 2. SOC Architecture 3. Cognitive Radio 4. Low Power VLSI	PCE	3	0	0	3
5	**R19ECE-PE4102**	**Professional Elective (PE4)** 1. Satellite communications 2. IOT applications 3. Speech Processing 4. Optimization Techniques	PCE	3	0	0	3
6	**R19ECE-OE4101**	**Open Elective (OE2)** 1. DBMS (CSE) 2. Introduction to MachineLearning (CSSE) 3. Mobile applications (CSIT) 4. Industrial Robotics(MECH)	OE	3	0	0	3
7	**R19ECE-PC4104**	Digital Image and Video signal Processing lab	PC	0	0	3	1.5
8	**R19ECE-SD4101**	Data Communications lab	SD	0	0	3	0
9	**R19ECE-PJ4101**	Mini project	PJ	0	0	8	4
	R19CSE-HN3203	.NET Framework		3	1	0	4
				Sub-Total			**27.5**

IV YEAR–II SEMESTER							
S. No.	**Course Code**	**Course**	**Category**	**L**	**T**	**P**	**Credits**
1	**R19ECE-PE4201**	**Professional Elective (PE5)** 1. Wireless Sensor Networks 2. VLSI Testing & Testability 3. Advanced Video Signal Processing 4. Radar Engineering	PE	3	0	0	3
2	**R19ECE-OE4201**	**Open Elective (OE-3)** 1. Operating Systems (CSE) 2. Electrical Power Distribution Systems (EEE) 3. Elements of Mechanical Engineering (MECH) 4. Software Engineering (CSIT)	OE	3	0	0	3
3	**R19ECE-PJ4201**	Project	PJ	0	0	16	8
				Sub-Total			**14**
				Total			**160**

**The Eligible students who opted the courses for B.Tech with Honors/Minor only*

Note :L- Lecture, T-Tutorial, P-Practical, C-Credits

Subject Code	Subject Name	L	T	P	C
R19ECE-PC4101	Optical Communications	3	0	0	3

Course Objectives: The main objectives of this course are given below:

- Learn the basic principles and significance of optical fiber communication with different modes of light propagation.
- To understand the transmission characteristics and losses in optical fibers.
- To study physical construction and principle of operation of different types of optical sources and detectors
- To understand the design of optical systems and WDM.

Course Outcomes:

At the end of this course the student will able to:

1. Understand the constructional parameters and operating principles of optical fibers.
2. Examine the losses and propagation characteristics of an optical signal through fibers.
3. Classify the Optical sources and detectors and to discuss their principle of operation.
4. Analyze the losses occur in different fiber to fiber and fiber to source jointing mechanisms.
5. Construct optical point-to-point links for digital data transmission with consideration of power budget and rise time budget.

UNIT- I

Overview of Optical Fiber Communication : Historical development and evolution of fiber optic system, spectral bands, Key elements of an Optical Fiber Transmission link, advantages and applications of optical fiber communications, Basics of Ray theory transmission-Total Internal Reflection, Acceptance Angle, Numerical Aperture, Skew Rays, Cylindrical fibers-Modes, V-number, Mode coupling, Step index and Graded Index fibers, Single mode fibers-Cut off wavelength, Mode Field Diameter, Effective Refractive Index,

Learning outcomes:

- Understand basic building blocks of an optical fiber transmission link. (L2)
- Classify fibers, and modes of propagation. (L2)
- Calculate number of possible modes that a fiber can support. (L3)

Applications: The application and uses of optical fiber can be seen in: Medical Industry, Communication, Defense, Industries, Broadcasting, Automotive Industry, Remote Sensing etc

UNIT –II

Fiber Materials &Transmission Characteristics of Optical Fibers: **Fiber Materials** – Desirable Properties, Glass, Halide, Active Glass, Chalgenide Glass, Plastic Optical Fibers.

Transmission Characteristics of Optical Fibers: Attenuation, Material Absorption losses, scattering losses, Bending losses, Core and Cladding losses, Information capacity determination, Group delay, Types of Dispersion- Material dispersion, Wave-guide dispersion, Polarization-Mode dispersion, Intermodal dispersion, Overall, Fiber Dispersion in Multi-Mode and Single Mode Fibers.

Learning outcomes:

- Classify the types of losses in a fiber.(L2)
- Analyze effects of dispersion in fibers.(L4)
- Classify the fiber materials. (L2)

Applications:

- The main applications for glass fiber are communication, sensor, and measurement system. Some types of glass optical fiber cables can also be used in harsh environments such as corrosive and wet environments.
- Plastic Optical fibers are commonly used for low-speed, short-distance (up to 100 meters) applications in digital home appliances, home networks, industrial networks (PROFIBUS, PROFINET, Sercos, Ether CAT), and car networks (MOST).

UNIT –III

Optical Sources: Light Emitting diodes: Direct and indirect Band gap materials, LED Structures, Light Source Materials, Laser Diodes: Modes, Laser Diode structures and Radiation Patterns.

Photo detectors: Physical principles of PIN, APD Photodiodes, Comparison of photo detectors.

Optical Receiver: Fundamental Receiver Operation and Digital signal Transmission, Digital Receiver Performance: Probability of Error, Receiver sensitivity, Quantum Limit.

Learning outcomes:

- Analyze characteristics of LEDs and lasers. (L4)
- Understand working of PIN and APD diodes. (L2)
- Understand the working of optical receiver. (L2)

Applications:

- The applications of optical sources include indicator lights, LCD panel back lighting, fiber optic data transmission, remote control, opto-isolators etc.
- Optical Detectors are used to measure optical powers e.g. in spectrometers, light barriers, optical data storage devices, auto correlators, beam profilers, fluorescence microscopes, interferometers and various types of optical sensors.

UNIT-IV

Optical Fiber Cable Jointing & Power Launching Techniques

Optical fiber Connectors-Connector types, Single mode fiber connectors, Connector return loss, Fiber Splicing-Splicing techniques, Splicing single mode fibers, Fiber alignment and joint loss- Multimode fiber joints, single mode fiber joints, Source to fiber power launching and power coupling methods.

Learning outcomes:

- Describe various power launching and power coupling methods. (L2)
- Explain how Connectors, Splices, Joints are used for power coupling in a fiber optic link. (L2)

Applications:

- The common application for splicing is jointing cables in long outside plant cable runs.
- Connectors are commonly used in Fiber to the Home (FTTH) connections, local networks, Telephone Exchanges, CATV, data center interconnections (DCIs), etc.

UNIT –V

Optical System Design: Point to point links, systems considerations, Link Power budget, Rise time budget with examples, Line coding in optical links, Measurement of attenuation and dispersion, Eye Pattern, WDM Features, Operational principles of WDM, Types of WDM, Optical Ethernet

Learning outcomes:

- Analyze design considerations of digital optical systems. (L4)
- Learn the operational principles of WDM. (L2)

Applications:

- The technique of WDM is used in SONET network that includes multiplexing and demultiplexing of various optical fiber cables.
- Application of WDM to the avionics environment to support analog RF signal transmission.

TEXT BOOKS:

1. Optical Fiber Communications – Gerd Keiser, Mc Graw-Hill International edition, 3rd Edition, 2000.
2. Optical Fiber Communications – John M. Senior, PHI, 2nd Edition, 2002.

RERFERENCE BOOKS:

1. Fiber Optic Communications – D.K. Mynbaev , S.C. Gupta and Lowell L. Scheiner, Pearson Education,2005.
2. Text Book on Optical Fiber Communication and its Applications – S.C.Gupta, PHI, 2005.

Subject Code	Subject Name	L	T	P	C
R19ECE-PC4102	Data Communication & Computer Networks	3	0	0	3

Course Objectives:

- To familiarize various network topologies and types of switching
- To Explain various medium access protocols and network hardware components
- To Explain various protocols used for network control, management and testing.
- To Understand application layer of internet (web technology)
- To familiarize the concepts of world wide web and HTTP protocol internet applications

Course Outcomes:

At the end of this course the student will able to:

1. Compare various types of network topologies and switching(L4)
2. Analyze various medium access protocols and network hardware components (L4)
3. Understand details of network layer protocols IPv4 and IPv6 (L2)
4. Interpret with various protocols used for network control, management and testing (L2).
5. Explain the concept of transportation layer protocols (L2)

UNIT-I

Introduction

Networks and services; network topologies; switching methods; network evolution; concept of layered architecture; the OSI model; the TCP/IP model, standardization and standards organizations. Study of telephone network;

Learning Outcomes:

- Explain network topologies and concept of OSI model(L2)
- Compare the computer networks and telephone networks(L4)

Applications:

- Used to perform number of functions with respect to the transfer of data.
- Used to interconnect network devices on the internet and in private computer networks.

UNIT-II

Switching and Signaling

PCM, TDM based IDN; circuit switching; space and time division switching; signaling methods; store-and-forward switching. ISDN fundamentals; SS#7; Frame relay and ATM networks; SONET and SDH

Learning Outcomes:

- Analyse the types of switching and signalling methods (L4)
- Understand the ISDN, SS7 ATM, SONET and SDH networks (L2)

Applications:

- Used for long distance communications, voice telephony and data communications.
- Used in transmitting large volume of data using fiber optic medium.

UNIT-III

LANs and MAC protocols

ALOHA, slotted ALOHA, CSMA and CSMA-CD protocols; IEEE 802.3 protocol and MAC frame format. Details of 802.3 hardware options; 100 Mbps and 1000 Mbps Ethernet LANs, switches, bridges and VPN; Wireless LANs; LAN applications; client-server architecture;

Learning Outcomes:

- Understand the functioning of ALOHA and slotted ALOHA networks (L2)

- Compare various types of MAC protocols with applications (L1)

Applications:

- Used for transmission of data via shared network channel and in wireless medium.
- LAN used in educational institutes, offices, etc., by sharing resources.
- High speed LANs used to connect many slower networks together.

UNIT-IV

Network Layer

Network Layer: services offered to the transport layer, internal organization as datagram or virtual circuit subnets; routing algorithms; congestion control; internetworking; Study of IPv4 and IP v6, DNS and Internet routing protocols.

Learning Outcomes:

- Explain various services offered by transport layer(L2)
- Analyse the process of congestions control in network (L1)
- Understand the functioning of internet routing protocols. (L2)

Applications:

- IPv4 and IPv6 support internet explorer, Microsoft SQL server.
- Used as hosting/accessory platforms.

UNIT-V

Transport Layer

Transport Layer: Design issues; study of TCP; connection setup and removal; flow control; reliable and efficient delivery, timer management. The TCP/IP protocol stack: ICMP, IGMP, UDP, BOOTP, DHCP etc.

Learning Outcomes:

- Define the design issues of Transport layer protocols (L2)
- Understand the function of TCP/IP protocol stack. (L1)

Applications:

- Used to get information from the server which simplifies configuration.
- Used for spitting of transport connection, data transfer, address mapping.

Text Books

1. Tanenbaum A. S.; “Computer Networks”, PHI, 4e,
2. B. Forouzan, “Data Communication and Networking”, TMH ,4e

Reference Books

1. Stallings William, “Data and Computer Communication”, PHI, 6e .
2. Leon-Garcia and Widjaja, “Communication Networks”, TMH 3e

Subject Code	Subject Name	L	T	P	C
R19ECE-PC4103	Digital Image and Video Processing	3	0	0	3

Course Objectives:

- To introduce fundamentals of Image Processing.
- To expose various intensity transformations in spatial and frequency domains.
- To impart concepts of wavelets and various coding techniques for image compression.
- To dissimilate various segmentation techniques for images.
- To teach various color models and to introduce the concepts of color image segmentation.

Course Outcomes: At the end of this course the student will able to:

1. Analyze various types of images mathematically
2. Compare image enhancement methods in spatial and frequency domains
3. Demonstrate various segmentation algorithms for given image and describe various colour models for color image processing
4. Justify DCT and wavelet transform techniques for image compression
5. Demonstrate the basics of video processing

Unit-I: Digital Image Fundamentals

Elements of visual perception, image sensing and acquisition, image sampling and quantization, basic relationships between pixels – neighborhood, adjacency, connectivity, distance measures.

Learning outcomes:

- Explain mathematical models of various types of images (L2)
- Define image processing parameters such as adjacency and distance measures (L1)

Unit-II: Image Enhancements and Filtering

Gray level transformations, histogram equalization and specifications, pixel-domain smoothing filters – linear and order-statistics, pixel-domain sharpening filters – first and second derivative, two-dimensional DFT and its inverse, frequency domain filters – low-pass and high-pass.

Learning outcomes:

- Compare image enhancement methods in spatial and frequency domains (L4)
- Apply frequency Domain filtering techniques for image enhancement (L3)

Unit-III: Image Segmentation

Detection of discontinuities, edge linking and boundary detection, thresholding – global and adaptive, region-based segmentation. Color Image Processing-Color models–RGB, YUV, HSI; Color transformations– formulation, color complements, color slicing, tone and color corrections ;Color Image smoothing and sharpening; Color Segmentation.

Learning outcomes:

- Describe various Image segmentation techniques (L2)
- Illustrate detection of discontinuities in an image (L2)
- Describe various color models for color image processing (L2)
- Apply various techniques for color image smoothing, sharpening and segmentation (L3)

Unit-IV: Wavelets and Multi-resolution image processing

Image Pyramids, Sub band Coding, The Haar Transform. Wavelet functions. Wavelet Transforms in Two Dimensions. Image Compression- Coding Redundancy, Spatial

Redundancy; compression Methods- Huffman Coding, Arithmetic Coding, Bit Plane Coding, Block Transform Coding, Predictive Coding. Still image compression standards JPEG and JPEG-2000.

Learning outcomes:

- Describe various transform techniques for lossy compression (L2)
- Apply various coding techniques for lossless compression (L3)

Unit-V

Basic Steps of Video Processing

Analog video, Digital Video, 2-D Motion Estimation: Optical flow, pixel based motion estimation, Block matching algorithm, Application of motion estimation in video coding, Video Segmentation.

Learning outcomes:

- Describe various steps of video processing and image formation models (L2)
- Apply various techniques for motion estimation and video segmentation (L3)

Text Books:

1. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Second Edition, Pearson Education, 2008.
2. Yao wang, Joem Ostarmann and Ya – quin Zhang," Video processing and communication ",1st edition, PHI

References:

1. Rafael C. Gonzalez, Richard E woods and Steven L. Eddins, "Digital Image processing using MATLAB", Tata McGraw Hill, 2010.
2. Anil Kumar Jain, Fundamentals of Digital Image Processing, Prentice Hall of India, 2nd edition 2004.

Subject Code	Subject Name	L	T	P	C
R19ECE-PE4101.1	Mobile and Cellular Communications	3	0	0	3

Course Objectives:

The main objectives of this course are given below:

- Familiarize the basic Elements of Cellular Mobile Radio System design and its performance criteria.
- Introduce the different antenna system design for reduction of interference and cell coverage in different terrains.
- Familiarize various cell site and mobile antennas for cellular mobile communication system.
- Illustrate the concepts of frequency management and channel assignments mechanism in mobile communications.
- Distinguish various handoff mechanisms, cell splitting techniques in mobile communication systems.

Course Outcomes:

At the end of this course the student will able to:

1 Explain the fundamentals of cellular radio system design and its basic elements.(L2)

2 Analyze the concepts of different co-channel, non-co-channel interference and cellular coverage on signal & traffic of a designed system.(L4)

3 Identify the various types of antenna system design suitable for mobile communications.(L3)

4 Explain the number of radio channels, channel assignment and frequency management used in mobile communications.(L2)

5 Analyze the different hand off & cell splitting techniques and dropped call rate at cell site area.(L3)

UNIT- I: Cellular Mobile Radio Systems:

Introduction to Cellular Mobile System, Performance criteria, uniqueness of mobile radio environment, operation of cellular systems, Hexagonal shaped cells, Analog and Digital Cellular systems.

Elements of Cellular Radio System Design: General description of the problem, concept of frequency channels, Co-channel Interference Reduction Factor, desired C/I from a normal case in a Omni directional Antenna system, Cell splitting, consideration of the components of Cellular system.

Learning outcomes:

Students can be able to:

- Identify the difference between Mobile and Cellular communication. (L2)
- Measure the performance of a cellular system. (L2)
- Understand why to use Hexagonal shaped cells. (L2)

Applications:

- Provides a wireless connection to the public telephone net- work for any user location within the radio range of the system.
- For planning and analysis of cellular networks in any area.

UNIT –II: Interference:

Introduction to Co-Channel Interference, real time Co Channel interference, Co-Channel measurement, design of Antenna system, Antenna parameters and their effects, diversity receiver, non-co channel interference-different types.

Cell Coverage for Signal and Traffic: Lee Point to point model, phase difference between direct and reflected paths, mobile propagation over water and flat open area,

Learning outcomes:
Students can be able to:

- Understand the concept of Co-Channel and Non-cochannel Interference. (L2)
- Understand the concept of Lee point to point model and phase difference between direct and reflected paths. (L2)

Applications:

- To get peer to peer communication applications, instant messaging services in communication networks.
- To get signal broadcasting over flat open areas as well as over water.

UNIT –III: Cell Site and Mobile Antennas:

Sum and difference patterns and their synthesis, omni directional antennas, directional antennas for interference reduction, space diversity antennas, umbrella pattern antennas, minimum separation of cell site antennas, high gain antennas.

Learning outcomes:
Students can be able to:

- Understand the concept of sum and difference patterns and their synthesis. (L2)
- Understand basics of different types cell site and mobile antennas. (L2)

Applications:

- Desired antenna configurations can be considered for any network
- To get more efficiency in any communication network, antenna can be pointed in different directions and with different spacing.

UNIT-IV: Frequency Management and Channel Assignment:

Numbering and grouping, setup access and paging channels channel assignments to cell sites and mobile units, channel sharing and borrowing, sectorization, overlaid cells, non-fixed channel assignment.

Learning outcomes:
Students can be able to:

- Understand the concept of numbering and grouping, setup access and paging channels.
- Understand the concepts of channel assignments to cell sites and mobile units.
- Differentiate between fixed and non-fixed channel assignment strategies

Applications:

- Effective usage of frequency allocated in any network
- Improving frequency spectrum reuse, spectrum efficiency time
- Invalid calls load reduced and improving the network efficiency

UNIT –V: Handoff Techniques:

Handoff, dropped calls and cell splitting, types of handoff, handoff invitation, delaying handoff, forced handoff, mobile assigned handoff. Intersystem handoff, cell splitting, micro cells, vehicle locating methods, dropped call rates and their evaluation. Introduction to 4G,5G,6G wireless Networks.

Learning outcomes:
Students can be able to:

- Understand what is Handoff and different types of handoff.
- Derive the formula for dropped call rate and evaluation.
- Understand the concepts of different handoff algorithms
- Understand the concepts of cell splitting, micro cells, vehicle locating methods for for better coverage

Applications:

- Wide area communication services
- Uninterrupted mobile conversations

Text Books:

1. Mobile Cellular Telecommunications – W.C.Y. Lee, Tata McGraw Hill, 2rd Edn., 2006.
2. Principles of Mobile Communications – Gordon L. Stuber, Springer International 2nd Edition, 2007.

Reference Books:

1. Wireless Communications – Theodore. S. Rapport, Pearson education, 2nd Edn., 2002.
2. Wireless and Mobile Communications – Lee McGraw Hills, 3rd Edition, 2006.

Subject Code	Subject Name	L	T	P	C
R19ECE-PE4101.2	SOC Architecture	3	0	0	3

Course Objectives:

- Understand the System Architecture and Processor Architecture, approach for a SOC Design.
- Learn the, Basic concepts in Processor Micro Architecture, and Learn Different Types of Processors like VLIW Processors, Superscalar Processors etc.
- Learn about SOC external memory, Scratchpads and Cache memory and Multilevel Caches.
- Learn the SOC Design approach, Design and evaluation, Applications Like Image compression etc.

Course Outcomes:

At the end of this course the student will able to:

1. Understand the SoC architecture and SoC design approach
2. Design of processor architectures like micro architecture, VLIW and super scalar architectures
3. Analyze performance of memory units like cache memory and memory requirements for SoC design
4. Design of Interconnect bus architectures in SoC design
5. Understand the design and analysis of reconfigurable interconnect devices for processor design in SoC

UNIT -I: Introduction to the System Approach

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

Learning Outcomes:

- Explain the concept of system on chip (SoC) through standard design methodology(L2)
- Demonstrate the architectures of processor and components of the system(L2)

UNIT-II: Processors

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

Learning Outcomes:

- Discuss the concepts in different processor architecture(L2)
- Explain different elements in instruction handling and its minimization(L2)

UNIT-III: Memory Design for SOC

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

Learning Outcomes:

- Classify different types of memories(L2)
- Outline the models of processor memory interaction(L2)

UNIT-IV: Interconnect Customization and Configuration

Inter Connect Architectures, Bus: Basic Architectures, SOC Standard Buses, Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SOC Customization: An overview, Customizing Instruction Processor.

Learning Outcomes:

- Illustrate different bus architectures(L2)
- Discuss bus transactions and contention time(L2)

UNIT-V: Interconnect Configuration

Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance-Specific design, Customizable Soft Processor, Reconfiguration – overhead analysis and trade-off analysis on reconfigurable Parallelism.

Application Studies / Case Studies: SOC Design approach, AES algorithms, Design and evaluation, Image compression – JPEG compression.

Learning Outcomes:

- Discuss different interconnect configurations(L2)
- Explain mapping design onto reconfigurable devices(L2)
- Make use of different SOC design approaches(L3)
- Analyze various design issues and techniques of SoC(L4)

Text Books

1. Computer System Design System-on-Chip – Michael J. Flynn and Wayne Luk, Wiely India Pvt. Ltd.
2. Design of System on a Chip: Devices and Components – Ricardo Reis, 1st Ed., 2004, Springer

Reference Books

1. ARM System on Chip Architecture – Steve Furber –2nd Ed., 2000, Addison Wesley Professional.
2. System on Chip Verification – Methodologies and Techniques – PrakashRashinkar, Peter Paterson and Leena Singh L, 2001, Kluwer Academic Publishers.

Subject Code	Subject Name	L	T	P	C
R19ECE-PE4101.3	Cognitive Radio	3	0	0	3

Course Objective:

The student should be made:

- To understand the evolving software defined radio and cognitive radio techniques and their essential functionalities.
- To study the basic architecture and standard for cognitive radio.
- To understand the physical, MAC and Network layer design of cognitive radio.
- To expose the student to evolving applications and advanced features of cognitive radio.

Course Outcomes:

At the end of the course, the student should be able to:

1. Gain knowledge on the design principles on software defined radio and cognitive radio.
2. Develop the ability to design and implement algorithms for cognitive radio spectrum sensing and dynamic spectrum access.
3. Build experiments and projects with real time wireless applications.
4. Apply the knowledge of advanced features of cognitive radio for real world applications.
5. Apply the public safety methods with cognitive radio

UNIT-I: Introduction to Software-Defined Radio and Cognitive Radio

Evolution of Software Defined Radio and Cognitive radio: goals, benefits, definitions, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations.

Learning outcomes:

Students can be able to:

- Understand the concept of concept of software defined radio(L2)
- Explore the frequency spectrum and regulation. (L4)

Unit-II: Cognitive Radio Architecture

Cognition cycle – orient, plan, decide and act phases, Organization, SDR as a platform for Cognitive Radio – Hardware and Software Architectures, Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

Learning outcomes:

Students can be able to:

- Understand the concept of components and structure of Cognitive Radio. (L2)
- Select the software and architecture of cognitive Radio. (L4)

Unit-III: Spectrum Sensing and Dynamic Spectrum Access

Introduction – Primary user detection techniques – energy detection, feature detection, matched filtering, cooperative detection and other approaches, Fundamental Tradeoffs in spectrum sensing, Spectrum Sharing Models of Dynamic Spectrum Access – Unlicensed and Licensed Spectrum Sharing, Fundamental Limits of Cognitive Radio.

Learning outcomes:

Students can be able to:

- Understand the concept ofprimary userdetection techniques. (L2)

- Understand the Fundamental Trade-offs in spectrum sensing, Spectrum Sharing Models of Dynamic Spectrum Access. (L2)

Unit-IV: Mac and Network Layer Design for Cognitive Radio

MAC for cognitive radios – Polling, ALOHA, slotted ALOHA, CSMA, CSMA / CA, Network layer design – routing in cognitive radios, flow control and error control techniques.

Learning outcomes:

Students can be able to:

- Understand the various types of MAC protocols are used in cognitive radio. (L2)
- Understand the routing in cognitive radios, flow control and error control techniques. (L2)

Unit-V: Advanced Topics in Cognitive Radio

Overview of security issues in cognitive radios, auction-based spectrum markets in cognitive radio networks, public safety and cognitive radio, cognitive radio for Internet of Things.

Learning outcomes:

Students can be able to:

- Understand the overview of security issues in cognitive radios. (L2)
- Analyze the public safety methods with cognitive radio. (L4)

Text Books:

1. Alexander M. Wyglinski, MaziarNekovee, Thomas Hou, Cognitive Radio Communications and Networks, Academic Press, Elsevier, 2010.
2. HuseyinArslan (Ed.), Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, Springer, 2007.

References:

1. Bruce Fette, Cognitive Radio Technology, Newnes, 2006.
2. Kwang-Cheng Chen, Ramjee Prasad, Cognitive Radio Networks, John Wiley and Sons, 2009.

Subject Code	Subject Name	L	T	P	C
R19ECE-PE4101.4	LOW POWER VLSI DESIGN	3	0	0	3

Course objectives:

- To know the sources of power consumption in CMOS circuits
- To understand the various types of power reduction techniques and power estimation methods.
- To study the design concepts of low power circuits.
- To familiarize the power estimation techniques
- To understand synthesis of low power and behavioral level process

Course Outcomes:

1. To know the sources of power consumption in CMOS circuits
2. To understand the various types of power reduction techniques and power estimation methods.
3. To study the design concepts of low power circuits.
4. To familiarize the power estimation techniques
5. To understand synthesis of low power and behavioral level process

UNIT-I: Power Dissipation

Hierarchy of limits of power – Sources of power consumption – Physics of power dissipation in CMOS FET devices – Basic principle of low power design.

UNIT-II: Power Optimization

Logic level power optimization – Circuit level low power design – circuit techniques for reducing power consumption in adders and multipliers.

UNIT-III: Design of Low Power Circuits

Computer arithmetic techniques for low power system – reducing power consumption in memories – low power clock, Inter connect and layout design – Advanced techniques – Special techniques.

UNIT-IV: Power Estimation

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

UNIT-V: Synthesis And Software Design

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

Text Books:

1. Kaushik Roy and S.C.Prasad, “Low power CMOS VLSI circuit design”, Wiley, 2000.
2. DimitriosSoudris, Christians Pignet, Costas Goutis, “Designing CMOS Circuits for Low Power”, Kluwer, 2002.

Reference Books

1. A.P.Chandrasekaran and R.W.Broadersen, “Low power digital CMOS design”, Kluwer,1995.
2. J.B.Kulo and J.H Lou, “Low voltage CMOS VLSI Circuits”, Wiley 1999.
3. AbdelatifBelaouar, Mohamed.I.Elmasry, “Low power digital VLSI design”, Kluwer, 1995.
4. James B.Kulo, Shih-Chia Lin, “Low voltage SOI CMOS VLSI devices and Circuits”, John Wiley and sons, inc. 2001.

Subject Code	Subject Name	L	T	P	C
R19ECE-PE4102.1	SATTELITE COMMUNICATIONS	3	0	0	3

Course Objectives:

- Explain the basic concept in the field of Satellite Communication.
- Familiarize the parameters of orbital mechanics and different types of launchers.
- Interpret the earth and space subsystems in satellite communication.
- Explain link power budget and different satellite access schemes.
- Illustrate earth station technology, low earth orbit and geostationary satellite systems.
- Explain principle of satellite navigation and Global Position System.

Course Outcomes:

The students will be able to

1. Understand the evolution of satellite communications and its fundamentals of orbital parameters, mechanism, effects (L2).
2. Understand the functionality of satellite subsystems and the earth station technology (L2).
3. Design a satellite link power budget with constituent parameters and summarize different multiple access methods (L3).
4. Contrast the constituent design considerations of LEO, NGSO satellite systems and to understand the Indian Satellite Programmes (L2).
5. Understand the satellite Navigation, Triangulation of GPS and differential GPS (L2).

UNIT-I

Introduction

Origin of Satellite Communications, Historical Back-ground, Basic Concepts of Satellite Communications, Frequency allocations for Satellite Services, Applications, Future Trends of Satellite Communications.

Orbital Mechanics And Launchers: Orbital Mechanics, Look Angle determination, Orbital perturbations, Orbit determination, launches and launch vehicles, Orbital effects in communication

Applications:

Kepler's laws and orbital mechanics can be applied to determine the satellite placement location in an orbit and tracking its trajectory.

Learning Outcomes: The students will be able to

1. Describe the fundamental principles of satellite communications
2. Discuss useful satellite orbits for various communication tasks

UNIT-II

Satellite Subsystems

Attitude and orbit control system, telemetry, tracking, Command and monitoring, power systems, communication subsystems, Satellite antenna Equipment reliability and Space qualification

Applications:

1. To provide a stable platform on which to mount the antennas.
2. For station keeping and to provide the required electrical power for the communication system.
3. To provide a controlled temperature environment for the communications electronics.
4. Earth stations can be used to transmit to and receive from the satellite or only to receive or only to transmit.

Learning Outcomes: The students will be able to

1. Understand how the satellite subsystems are effective for the survival of satellite in the hostile environment of outer space for that long.
2. Understand the functionality of various blocks in satellite earth stations.

UNIT-III

Satellite Link Design

Basic transmission theory, system noise temperature and G/T ratio, Design of down links, up link design, Design of satellite links for specified C/N, System design example.

Multiple Access: Frequency division multiple access (FDMA) Intermediation, Calculation of C/N. Time division Multiple Access (TDMA) Frame structure, Examples. Satellite Switched TDMA Onboard processing, DAMA, Code Division Multiple access (CDMA), Spread spectrum transmission and reception.

Applications:

1. To design a satellite system with required performance of the uplink and downlink, considering the propagation characteristics and rain attenuation for the frequency band being used at the earth station locations, and the parameters of the satellite and the earth stations.
2. To make the communication capacity of the satellite to be shared among a large number of earth stations.

Learning Outcomes: The students will be able to

1. Describe signal to noise ratios in satellite communications and basic procedures for the design of satellite communication links
2. Calculate complete link budgets.
3. Understand the functionality of various blocks in satellite earth stations.
4. To understand the ability of the satellite to carry many signals at the same time through multiple access techniques.

UNIT-IV

Earth Station Technology

Introduction, Transmitters, Receivers, Antennas, Tracking systems, Terrestrial interface, Primary power test methods.

Low Earth Orbit and Geo-Stationary Satellite Systems: Orbit consideration, coverage and frequency considerations, Delay & Throughput considerations, System considerations, Operational NGSO constellation Designs.

Applications:

Surveillance of the earth's surface, for both military data gathering and earth resources

applications
Requires satellites in low earth orbit that cover the entire surface of the earth.

Learning Outcomes: The students will be able to

1. Understand the LEO and NGSO satellite systems with various parametric considerations.
2. Summarize the evolution of Indian Satellite Systems through various Space Programmes.

UNIT-V

Satellite Navigation & The Global Positioning System

Radio and Satellite Navigation, GPS Position Location principles, GPS Receivers and codes, Satellite signal acquisition, GPS Navigation Message, GPS signal levels, GPS receiver operation, GPS C/A code accuracy, Differential GPS.

Applications:

Determining a position/location, navigation, tracking, mapping, timing and etc.

Learning Outcomes: The students will be able to

1. Understand the operating principle of satellite-based navigation systems through GPS.
2. Understand the GPS code generation and augmentation techniques through DGPS.

Text Books:

1. Satellite Communications – Timothy Pratt, Charles Bostian and Jeremy Allnutt, WSE, Wiley Publications, 2nd Edition, 2003
2. Satellite Communications Engineering – Wilbur L. Pritchard, Robert A Nelson and Henri G.Suyderhoud, 2nd Edition, Pearson Publications, 2003.

Reference Books

1. Satellite Communication - D.C Agarwal, Khanna Publications, 5th Ed
2. Satellite Communications – Dennis Roddy, McGraw Hill, 2nd Edition, 1996

Subject Code	Subject Name	L	T	P	C
R19ECE-PE4102.2	IOT Applications	3	0	0	3

Course Objectives

- Introducing the application areas of IoT technologies by conducting Industrial case studies
- Processing the knowledge on IoT Standards and IoT legal perspectives at design phase

Course Outcomes

1. Explore Smart Water & Environment applications and IoT Use Cases and IoT Use Cases
2. Investigate Smart Metering & Smart Cities applications and IoT Use Cases
3. Investigate Smart Health ,Home Automation , Smart Retail & Logistics applications and IoT Use Cases
4. Comprehend the Smart Industrial control & Agricultural applications and IoT Use Cases
5. Understand the standardization of IoT and IoT Legal perspectives

Unit I Smart Water and Environment

Smart Environment: Forest Fire Detection, Air Pollution, Snow Level Monitoring, Landslide and Avalanche Prevention, Earthquake Early Detection. Smart Water: Potable water monitoring, Chemical leakage detection in rivers, Swimming pool remote measurement, Pollution levels in the sea, Water Leakages, River Floods

Unit II Smart Metering and Smart Cities

Smart Cities: Parking, Structural Health, Noise Urban maps, Smart Phone Detection, Electromagnetic Field Levels, Traffic Congestion, Smart Lighting, Waste Management, Smart Roads. Smart Metering : Smart Grid, Tank level, Photovoltaic Installations, Silos Stock Calculation

Unit III: Smart Health, Home Automation, Retail and Logistics

Home Automation: Energy and Water Use, Intrusion Detection Systems. Health: Fall Detection, Medical Fridges, Sportsmen Care, Patients Surveillance, Ultraviolet Radiation Smart Retail: Supply Chain Control, NFC Payment, Intelligent Shopping Applications, Smart Product Management. Logistics: Quality of Shipment Conditions, Item Location, Storage Incompatibility Detection, Fleet Tracking

Unit IV Smart Industrial control and Agricultural

Industrial Control: M2M Applications, Indoor Air Quality, Temperature Monitoring, Ozone Presence, Indoor Location, Vehicle Auto-diagnosis, Perimeter Access Control, Liquid Presence, Radiation Levels, Explosive and Hazardous Gases. Agricultural: Green Houses, Golf Courses, Meteorological Station Network, Compost, Hydroponics, Offspring Care, Animal Tracking, Toxic Gas Levels

Unit V IoT Legal Perspectives and Standardization

Self-Regulation, International Legal Framework, Security and Privacy: Privacy Enhancing Technologies, Legal Challenges for a Privacy Framework, , Responsibility for Violations of Privacy, Tackling Environmental Concerns Standardization: ISO, IEC, ETSI, IEEE, IETF, ITU-T, OASIS, OGC and one M2M

Text Books

1. Ovidiu Vermesan, Peter Friess, Internet of Things From research and innovation to market deployment, 2014, River Publishers Series in Communication, USA.
2. Internet of Things and its Applications: Made simple (English Edition)

Reference Books

1. Ovidiu Vermesan, Peter Friess, Internet of Things Converging Technologies for Smart Environments and Integrated Eco Systems, 2013, River Publishers Series in Communication, USA.
2. Libelium Inc, Internet of Things: Case Studies, http://www.libelium.com/resources/casestudies, White papers, Spain.

Subject Code	Subject Name	L	T	P	C
R19ECE-PE4102.3	Speech Processing	3	0	0	3

Course Objectives:

- To impart knowledge on anatomy and physiology of Speech Production system and perception model.
- To instruct speech in time domain and extract various time domain parameters.
- To describe speech parameters in frequency domain for various applications like formant extraction, pitch extraction, etc.
- To explain speech features using LPC analysis and implement the techniques like Pitch Detection and formant analysis using LPC parameters.
- To introduce concept of homomorphism system and its use in extracting the vocal tract information from speech using cestrum and study various Speech Processing applications.

Course Outcomes:

1. Formulate vocal tract model based on the speech production mechanism
2. Solve features of speech in Time Domain
3. Use LPC coefficients for Pitch and Formant detection
4. Analyze the given speech using homomorphism speech system
5. Describe different speaker recognition systems

UNIT –I: **Fundamentals of Digital Speech Processing**

Anatomy & Physiology of Speech Organs, The process of Speech Production, Acoustic Phonetics, Articulator Phonetics, The Acoustic Theory of Speech Production- Uniform lossless tube model, effect of losses in vocal tract, effect of radiation at lips, Digital models for speech signals.

Learning Outcomes:

- Describe Speech Production Mechanism (L2)
- Compare speech production process using different acoustic models (L5)

UNIT-II: **Time Domain Models for Speech Processing**

Introduction- Window considerations, Short time energy and average magnitude Short time average zero crossing rate, Speech Vs Silence discrimination using energy and zero crossing, Pitch period estimation using a parallel processing approach, The short time autocorrelation function, The short time average magnitude difference function, Pitch period estimation using the autocorrelation function.

Learning Outcomes:

- Classify time domain parameters of speech signal (L2)
- Analyze feature extraction parameters in time domain (L4)

UNIT-III: **Linear Predictive Coding (LPC) Analysis**

Basic principles of Linear Predictive Analysis: The Autocorrelation Method, The Covariance Method, Solution of LPC Equations: Cholesky Decomposition Solution for Covariance Method, Durbin's Recursive Solution for the Autocorrelation Equations, Comparison between the Methods of Solution of the LPC Analysis Equations, Applications of LPC Parameters: Pitch Detection using LPC Parameters, Formant Analysis using LPC Parameters.

Learning Outcomes:

- Solve normal equations using linear prediction coding (L3)
- Choose LPC Feature Extraction Coefficients in speech recognition (L3)

- Determine Pitch and Formant of the given speech using Linear Predictive Coding (L4)

UNIT-IV: **Homomorphic Speech Processing**

Introduction, Homomorphic Systems for Convolution: Properties of the Complex Cepstrum, Computational Considerations, the Complex Cepstrum of Speech, Pitch Detection, Formant Estimation, the Homomorphic Vocoder. Speech Enhancement: Nature of interfering sounds, Speech enhancement techniques: Single Microphone Approach: spectral subtraction, Enhancement by re-synthesis, Comb filter, Wiener filter, Multi microphone Approach.

Learning Outcomes:

- Illustrate properties of convolution in Cepstrum analysis of speech (L2)
- Apply Cepstrum analysis methods in pitch detection and formant estimation of speech (L3)

UNIT-V: **Automatic Speech & Speaker Recognition**

Basic pattern recognition approaches, Parametric representation of speech, Evaluating the similarity of speech patterns, Isolated digit Recognition System, Continuous digit Recognition System Hidden Markov Model (HMM) for Speech: Hidden Markov Model (HMM) for speech recognition, Viterbi algorithm, Training and testing using HMMS.

Learning Outcomes:

- Classify speech pattern recognition approaches (L2).
- Differentiate various speech recognition systems and testing (L5)

Text Books:

1. Digital Processing of Speech Signals - L.R. Rabiner and S. W. Schafer. Pearson Education.
2. Speech Communications: Human & Machine - Douglas O'Shaughnessy, 2nd Ed., Wiley India, 2000.

Reference Books:

1. Discrete Time Speech Signal Processing: Principles and Practice - Thomas F. Quateri, 1st Ed., PE.
2. Speech & Audio Signal Processing- Ben Gold & Nelson Morgan , 1st Ed., Wiley.

Subject Code	Subject Name	L	T	P	C
R19ECE-PE4102.4	Optimization Techniques	3	0	0	3

Course Objectives:

- To introduce various optimization techniques i.e classical, linear programming, transportation problem, simplex algorithm, dynamic programming
- Constrained and unconstrained optimization techniques for solving and optimizing an electrical and electronic engineering circuits design problems in real world situations.
- To explain the concept of Dynamic programming and its applications to project implementation.

Course Outcomes:

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

1. Explain the need of optimization of engineering systems
2. Understand optimization of electrical and electronics engineering problems
3. Apply classical optimization techniques, linear programming, simplex algorithm, transportation problem
4. Apply unconstrained optimization and constrained non-linear programming and dynamic programming
5. Formulate optimization problems.

UNIT-I: Introduction and Classical Optimization Techniques

Statement of an Optimization problem – design vector – design constraints – constraint surface – objective function – objective function surfaces – classification of Optimization problems.

Classical Optimization Techniques: Single variable Optimization – multi variable Optimization without constraints – necessary and sufficient conditions for minimum/maximum – multivariable Optimization with equality constraints.

Solution by method of Lagrange multipliers – Multivariable Optimization with inequality constraints – Kuhn – Tucker conditions.

UNIT-II: Linear Programming

Standard form of a linear programming problem–geometry of linear programming problems – definitions and theorems – solution of a system of linear simultaneous equations – pivotal reduction of a general system of equations – motivation to the simplex method–simplex algorithm.

Transportation Problem: Finding initial basic feasible solution by north – west corner rule, least cost method and Vogel's approximation method – testing for optimality of balanced transportation problems.

UNIT-III

Unconstrained Nonlinear Programming: One dimensional minimization methods, Classification, Fibonacci method and Quadratic interpolation method

Unconstrained Optimization Techniques: Univariant method, Powell's method and steepest descent method.

UNIT-IV: Constrained Nonlinear Programming

Characteristics of a constrained problem - classification - Basic approach of Penalty

Function method - Basic approach of Penalty Function method - Basic approaches of Interior and Exterior penalty function methods - Introduction to convex programming problem.

UNIT-V: Dynamic Programming

Dynamic programming multistage decision processes – types – concept of sub optimization and the principle of optimality – computational procedure in dynamic programming – examples illustrating the calculus method of solution - examples illustrating the tabular method of solution.

Text Books:

1. SingiresuS.Rao,EngineeringOptimization:TheoryandPracticebyJohnWileyand Sons, 4th edition,2009.
2. H.S.Kasene&K.D.Kumar,IntroductoryOperationsResearch,Springer(India), Pvt. Ltd.,2004

Reference Books:

1. George Bernard Dantzig, Mukund Narain Thapa, "Linear programming", Springer series in operations research 3rd edition,2003.
2. H.A.Taha, "Operations Research: An Introduction", 8th Edition, Pearson/Prentice Hall,2007.

Subject Code	Subject Name	L	T	P	C
R19ECE-OE4101.1	Data base Management Systems	3	0	0	3

Course objectives:

- Train in the fundamental concepts of database management systems, database modeling and design, SQL, PL/SQL, and System implementation techniques.
- Enable students to model ER diagram for any customized applications
- Provide knowledge on concurrency techniques
- Understand normalization theory and apply such knowledge to the normalization of a database.

Course Outcomes:

1. Understand File System Vs Databases.
2. Understand the usage of Key Constraints on Database.
3. Construct simple and Complex queries using SQL.
4. Understand the conceptual Design of Databases.
5. Analyze various normal forms.
6. Understand efficient data storage and retrieval mechanism, recovery techniques.

UNIT-I

INTRODUCTION-Database system, Characteristics (Database Vs File System),Database Users(Actors on Scene, Workers behind the scene), Advantages of Data base systems, Database applications. Brief introduction of different Data Models; Concepts of Schema, Instance and data independence; Three tier schema architecture for data independence; Database system structure, environment, Centralized and Client Server architecture for the database.

Learning outcomes: Student will be able to

1. Distinguish between Database and File System (L2)
2. Categorize different kinds of data models (L2)
3. Define functional components of a DBMS. (L1)

UNIT-II

RELATIONAL MODEL: Introduction to relational model, concepts of domain, attribute, tuple, relation, importance of null values, constraints (Domain, Key constraints, integrity constraints) and their importance , Relational algebra, Relational Calculus.

ENTITY RELATIONSHIP MODEL: Introduction, Representation of entities, attributes, entity set, relationship, relationship set, constraints, sub classes, super class, inheritance, specialization, generalization using ER Diagrams.

Learning Outcomes: Student will be able to

1. Develop E-R model for the given problem (L6)
2. Derive tables from E-R diagrams (L6)
3. Outline the elements of the relational model such as domain, attribute , tuple, relation and entity (L2)

4. Distinguish between various kinds of constraints like domain, key and integrity (L4)

UNIT-III

BASIC SQL: Simple Database schema, data types, table definitions (create, alter), different DML operations (insert, delete, update), basic SQL querying (select and project) using where clause, arithmetic & logical operations, SQL functions(Date and Time, Numeric, String conversion).

SQL: Creating tables with relationship, implementation of key and integrity constraints, nested queries, sub queries, grouping, aggregation, ordering, implementation of different

types of joins, view(updatable and non-updatable).

Learning Outcomes: Student will be able to

1. Develop simple and complex queries using Relational Algebra and SQL (L3)
2. Apply SQL operations on databases (L3)
3. Formulate SQL queries using join operations on tables (L6)

UNIT-IV

SCHEMA REFINEMENT (NORMALIZATION): Purpose of Normalization orschema refinement, concept of functional dependency, normal forms based on functional dependency(1NF, 2NF and 3NF), concept of surrogate key, Boyce-codd normal form(BCNF), Lossless join and dependency preserving decomposition, Fourth normal form(4NF).

Learning Outcomes: Student will be able to

1. Differentiate between various normal forms based on functional dependency (L2)
2. Apply Normalization techniques to eliminate redundancy (L3)

UNIT-V

TRANSACTION AND INDEXING CONCEPTS: Transaction State, Implementation of Atomicity and Durability, Concurrent Executions, Serializability, Deadlocks in transactions, Recoverability, Implementation of Isolation, Testing for Serializability, Failure Classification, Storage, Recovery and Atomicity, Recovery algorithm.

Learning Outcomes: Student will be able to

1. Summarize transaction properties and recoverability (L2)

Text Books:

1. Database Management Systems, 3/e, Raghurama Krishnan, Johannes Gehrke,TMH
2. Database System Concepts,5/e, Silberschatz, Korth, TMH

Reference Books:

1. Database Management System, 6/e Ramez Elmasri, Shamkant B. Navathe, PEA
2. Database Principles Fundamentals of Design Implementation and Management, Carlos Coronel, Steven Morris, Peter Robb, Cengage Learning.

Subject Code	Subject Name	L	T	P	C
R19ECE-OE4101.2	Introduction to Machine Learning	3	0	0	3

Course Objectives:

- To familiarize with a set of well-known supervised unsupervised and semi-supervised learning algorithms.
- To implement some basic machine learning algorithms
- To Understanding of how machine learning algorithms are evaluated
- To be able to formulate machine learning problems corresponding to different applications.
- To understand a range of machine learning algorithms along with their strengths and weaknesses.
- To be able to apply machine learning algorithms to solve problems of moderate complexity.

Course Outcomes:

1. Understand the characteristics of machine learning that make it useful to real-world Problems. (L2)
2. Apply regression algorithms for finding relationships between data variables and decision trees to identify the best split and label data points. (L3)
3. Apply theoretical foundations of Bayesian classifier to label data points (L3)
4. Apply SVM supervised machine learning techniques for data classification. (L3)
5. Understand the context of neural networks and deep learning (L2)

UNIT - I: Introduction

Basic definitions, Examples of Machine Learning Applications, Supervised Learning and Un Supervised Learning, Categorical and Continuous features, Regression and Classification, Bias and Variance, hypothesis space and inductive bias, evaluation, cross-validation.

Applications:

Below are some most trending real-world applications of Machine Learning:

Image Recognition, Speech Recognition, Traffic prediction, Product recommendations, Self-driving cars, Email Spam and Malware Filtering, Virtual Personal Assistant, Online Fraud Detection:

Learning outcomes:

- Understand basic building blocks of an machine learning process(L2)
- Classify supervised and unsupervised learning(L4)
- Classify Regression and Classifications.(L4)

UNIT - II: Regression and Decision Tree

Regression basics: Relationship between attributes using Covariance and Correlation, Linear regression, Multiple Linear Regression, Polynomial Linear Regression, logistic regression. Decision trees, over fitting

Applications:

Linear regressions can be used in business to **evaluate trends and make estimates or forecasts**. Decision trees are used for **handling non-linear data sets effectively**. The decision tree tool is used in real life in many areas, such as engineering, civil planning, law, and business.

Learning outcomes:

- Understand the relation ship between attributes using covariance and correlations (L2)
- Analyze the evolutions over various Regression Techniques.(L4)
- Classify the regression and Decision tree (L4)

UNIT - III: Instance Based Learning and Bayesian Learning

k-Nearest Neighbour, Feature Selection, Feature Extraction, Bayes theorem, Bayesian Learning, Naive Bayes, Bayesian Network.

Applications:

Bayesian Networks are used **to create turbo codes that are high-performance forward error correction codes**. These are used in 3G and 4G mobile networks

Learning outcomes:

- Understand the concept of K-Nearest Neighbor algorithm(L2)
- Understand the concept of Bayes theorem,(L2)
- Apply the Bayes theorem on network(L3)

UNIT - IV: SVM and Clustering

Introduction Support Vector Machine, Kernel function and Kernel SVM, Introduction to Clustering, K means Clustering.

Applications:

SVM Applications are Inverse Geosounding Problem. Seismic Liquefaction Potentials, Protein Fold and Remote Homology Detection. Data Classification using SSVM. Facial Expression Classification. Texture Classification using SVM. Text Classification. Speech Recognition. **Clustering analysis** is broadly used in many applications such as market research, pattern recognition, data analysis, and image processing.

Learning outcome:

- Understand the concept of SVM algorithm (L2).
- Interpret the clustering methods for data analysis (L2)

UNIT - V: Neural networks

Neural network: Perception, multilayer network, back propagation, introduction to deep neural network.

Applications:

Artificial neural networks are used for a range of applications, including **image recognition, speech recognition, machine translation, and medical diagnosis**

Learning Outcomes:

- Explain various applications offered by an neural networks(L2)
- Analyze the process of various types of neural networks (L4)
- Understand the process of deep neural network(L2).

Text Books:

1.Tom M. Mitchell, Machine Learning, MGH.

2. Ethem Alpaydin, Introduction to machine learning, 2nd edition, PHI.

Reference Books:

1. Kevin P. Murphy, "Machine Learning," A Probabilistic Perspective, MIT Press, 2012.

2. Drew Conway, John Myles White ”Introduction to machine learning with python a guide for data scientists” o′reilly publications

Subject Code	Subject Name	L	T	P	C
R19ECE-OE4101.3	Mobile Applications	3	0	0	3

Course Objectives:

- To Understand different mobile operating systems and their advantages
- To implement different Android APIs in Android Virtual Devices.
- To Create Apps using iOS APIs.
- To Understand Web Designing using Bootstrap and node.js
- To create cross platform mobile applications.
- To Develop Apps related to society.

Course Outcomes:

1. Understand the working environments of mobile operating systems.
2. Implement android core APIs using ADT and AVD.
3. Implement iOS annotations and APIs to build different interfaces.
4. Understand request/response functionalities in web server using node.js
5. Create cross platform mobile applications using jquery and cordova.

Unit 1: Mobile Operating Systems and Environment

Android: History of Android, Android Architecture, Dalvik Virtual Machine, Android Virtual Device.

IOS: IOS Architecture, Different Layers, Environment of iOS, iOS App Structure, MVC Framework in iOS.

Learning Outcomes: Student should be able to

- Understand architecture of Mobile Operating Systems. (L2)
- Understand the structure of Android and iOS programs. (L2)

Unit 2: Android in Action

Android ADT and AVD, Activity, Layouts, Android Widgets, Intents, Fragments, Embedding Audio and Video, Event Handling.

Learning Outcomes: Student should be able to

- Implement Android Core API's. (L3)
- Implement relationship between objects. (L3)

Unit 3: iOS APIs

Introduction to XCode, Creating Interfaces, Buttons, UIKit and Interface Builder, Modifying View, Basic Annotations, Table Views and Delegate Pattern, Action Sheet, Image Picker and Activity Controller, Introduction to Camera and Emailing.

Learning Outcomes: Student should be able to

- Understand UI and MVC Framework. (L2)
- Create iOS Apps using iOS APIs. (L6)

Unit 4: Web UI for Mobile Apps

HTML5, CSS3, Layouts using DIV and Table, Using Bootstrap for better UI, Introduction to JQuery and its functions, Introduction to node.js, Functions and Modules in node, Debugging node.js Application, Handling HTTP Requests and Sending Requests.

Learning Outcomes: Student should be able to

- Understand Web User Interface using different frameworks. (L2)
- Implement Server based applications using node.js. (L3)

Unit 5: Cross Platform Mobile Apps

Introduction to Cordova, Setting Environment with Cordova, Create and Build App, Running Cordova with AVD Emulator, Accessing Device Information, Open dynamic links using InAppBrowser plugins, Android and iOS Web views with Cordova.

Learning Outcomes: Student should be able to

- Understand Cordova Environment and its Setup. (L2)
- Create Cordova Apps using different plugins. (L3)

TEXT BOOKS:

1) Android in Practice - Charlie Collins, Michale Galpin, Matthias Kaeppler Manning Publications 2012
2) Steele J.: The Android Developer's Cookbook: Building Applications with the Android SDK., Addison-Wesley Professional, 2010

REFERENCE BOOKS:

1. E. Łukasik, M. Skublewska-Paszkowska. IOS Application DevelopmentLublin: PIPS Polish Information Processing Society, 2016.
2. Wargo J. M., Apache Cordova 3 Programming, Addison-Wesley, 2013.

Subject Code	Subject Name	L	T	P	C
R19ECE-OE4101.4	Industrial Robotics (Common to ECE & CSE)	3	0	0	3

Course Objectives:

The objectives of the course are to

- Learn the types of robots used for Industrial Applications.
- Understand the use of vision systems in automation.
- Gain knowledge on the different methods of material handling.
- Identify robots and its peripherals for industrial applications.
- Analyze the factors for selection for Robotic systems.

Course Outcomes:

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

1. Illustrate the types of Industrial Robots and their architecture.(L2)
2. Explain the applications of robots in various industrial applications.(L2)
3. Analyze simple grippers for pick and place application.(L4)
4. Analyze the factors for selection of Robot for a given industrial application.(L4)
5. Summarize the features of material handling system in automation.(L2)

Unit I

INTRODUCTION: Types of industrial robots, Load handling capacity, general considerations in Robotic material handling

ROBOTS FOR INSPECTION: Robotic vision systems, image representation, object recognition and categorization.

Applications: manufacturing, space exploration, military, customer service, underwater exploration, identify errors or defects, better quality and consistency.

Learning outcomes:

1. ***Classify*** the types of Robots(L2)
2. ***understand*** the general considerations for material handling(L2)
3. ***explain*** the significance of Vision systems(L2)

Unit II

APPLICATIONS: Application of Robots in continuous arc welding, Spot welding, Spray painting, assembly operation, cleaning, biomedical applications, robots for underwater applications.

Learning outcomes:

1. classify the types of Robots(L2)
2. understand the applications of Robots(L2)

Unit III

END EFFECTORS: Gripper force analysis and gripper design for typical applications, design of multiple degrees of freedom, active and passive grippers.

Learning outcomes:

1. analyze the forces involved in gripper analysis(L4)
2. choose the gripper design for typical applications(L3)

3. distinguish the active and passive grippers(L4)

Unit IV

SELECTION OF ROBOT : Factors influencing the choice of a robot, robot performance testing, economics of robotisation, Impact of robot on industry and society.

Learning outcomes:

1. identify the factors influencing the choice of robots(L3)
2. understand the Robot performance testing(L2)
3. explain the impact of Robot on Industry and society(L2)

Unit V

Robots in Flexible Manufacturing Systems: Requirement of robots in FMS, advanced material handling systems with robots, Automated Guided Vehicles, automated storage and retrieval systems(ASRS), barcode technology.

Learning outcomes:

1. classify the material handling systems(L2)
2. understand the principles of material handling systems(L2)
3. apply the knowledge gained, in the usage of various types of technologies(L3)
4. explain the features of ASRS(L2)

TEXTBOOKS:

1. Richard DK lafter, Thomas Achmielewski and Mickael Negin,―Robotic Engineering–An integrated Approach ‖Prentice Hall India, NewDelhi,2001.
2. MikellP Groover, "Automation, Production Systems,and Computer-Integrated Manufacturing", Pearson Education,2015.

REFERENCES:

1. James ARehg,―Introduction to Robotics in CIMSystems‖ ,PrenticeHallofIndia,
2. DebSR,"Robotics Technology and Flexible Automation", TataMcGrawHill,NewDelhi,.

Subject Code	Subject Name	L	T	P	C
R19CSE-HN3203	.NET Framework	3	1	0	4

Course Objectives:

- To understand the working environment of Microsoft Visual Studio.
- Understand the OOPS concepts, Threads and File handling
- Understand and gain practical knowledge of Collections and Reflection framework
- To make the student to create websites using ASP.NET
- Understand the concept of session tracking mechanism in real time applications.

Course Outcomes:

1. Understand structure of C# program constructs.
2. Implement object oriented concepts with files and threads.
3. Implement generics and reflections for data collection.
4. Create user interactive web pages using ASP.NET
5. Develop secure web applications with persistence and state.

Unit I:

Introduction to C#-Overview of Environment-Microsoft Visual Studio 2019 and Visual C#, features, Program Structure, Data Types, Working with Variables and Constants, Type Conversion, Operators, Decision Making statements, Loops, Methods, Boxing and Un boxing, Arrays, Strings.

Learning Outcomes: Student will be able to

- Understand Microsoft Visual Studio environment and its program structure. (L2)
- Understand decision making and iterations in C#. (L2)
- Implement typecasting and conversion constructs. (L4)

Unit II:

File Handling and Threads-Structure, Enums, Classes, Inheritance, Abstract class, Polymorphism, Operator Overloading, Interfaces, Namespaces, Pre-processor Directives, Exception Handling, Garbage collection, Threads-Life cycle, creation and managing threads, File Handling.

Learning Outcomes: Student will be able to
Understand object oriented concepts with real time applications. (L2)

Implement Threads and file handling for synchronous data processing. (L4)

Understand error and exception handling strategies. (L2)

Unit III:

Collections and Reflections -Attributes, Reflections, Properties, Indexers, Delegates,Events, Collections, Generics, Anonymous Methods, Unsafe Codes.

Learning Outcomes: Student will be able to

Understand hierarchy of Collections and Reflections. (L2)

Implement delegates and events in collections. (L4)

Unit IV:

ASP.NET – Controls- An introduction to Web Forms, MVC Architecture, Server-side controls, The ASP.NET execution model. ASP.Net Page Life Cycle, Controls-User, Navigation, Validation and Login Controls, Master Page and Content Page, Themes.

Learning Outcomes: Student will be able to

- Implement the Model-View-Controller architecture for creating web applications. (L4)
- Implement ASP life cycle through user controls and navigation. (L4)
- Understand login and validation controls in the web application. (L2)

Unit V:

ADO.NET and Session Management : Data access and data binding using ADO.NET, ASP.Net State Management-View, Session, Application, cookies and URL encoding, Web Application Security, Authentication and Authorization, Impersonation, ASP.Net provider model, Caching, Networking concepts-Web client, Web request and response, TcpListener, Tcpclient

Learning Outcomes: Student will be able to

- Implement ADO.NET for database accessing.(L4)
- Develop web applications with persistency and state management. (L4)
- Develop secure applications for request-response handling. (L4)

TEXT BOOKS:

1. A Text book on C#- Pearson Education,S.Tamarai Selvi,R.Murugesan.
2. Programming C# 8.0: Build Cloud, Web, and Desktop Applications,Orielly Publications
3. The Complete Reference ASP.NET, Mathew Mc Donald,Mc Graw Hill

REFERENCE BOOKS:

1. C# in depth, manning publications, John Skeet
2. ASP.NET Core in Action, Andrew Lock,Manning publication.

Subject Code	Subject Name	L	T	P	C
R19ECE-PC4104	Digital Image and Video signal Processing lab	0	0	3	1.5

Course Objectives:

- To learn basic concepts of image processing, fundamentals and mathematical models in digital image processing.
- To develop time and frequency domain techniques for image enhancement
- To understand Image segmentation, restoration, and morphological signal Processing with applications.
- To understand basic concepts of Image Compression and Image Watermarking algorithms with applications.
- To give an overview of applications and to practical aspects of video processing.

Image Processing & Video Signal Processing Experiments
Minimum of Twelve Experiments has to implemented in software using MATLAB.

1. Perform various operations on Digital Images
2. Basic Color Transformations of an Image i.e. RGB layer-wise, Grayscale conversion & Binary conversion.
3. Represent an image in the form of Bit-Planes.
4. Perform the histogram equalization/mapping on an image.
5. Implementation of Image Smoothening Filters (Mean and Median filtering of an Image) in the spatial domain with and without Noise.
6. Implementation of image sharpening filters and Edge Detection using Gradient Filters in the spatial domain.
7. Implementation of image smoothening/sharpening filters in the frequency domain
8. Perform Conversion of images using different color spaces.
9. Implementation of some morphological operations on Binary images.
10. Implementation of a compression algorithm on an Image.
11. Implementation of a simple Image watermarking algorithm.
12. Live video acquisition.
13. Represent the video in to frames.
14. Motion detection in a video

Course Outcomes

1. Apply image enhancement techniques on degraded images in both spatial and frequency domains.
2. Apply Image segmentation, restoration, and morphological signal processing techniques to various types of images.
3. Interpret and analyze 2D signals through Histogram Mapping and Equalization.
4. Apply Image Compression and Image Watermarking algorithms on various types of images.
5. Apply the basic video processing techniques for motion detection and live video acquisition.

Subject Code	Subject Name	L	T	P	C
R19ECE-SD4101	Data Communication& Computer Networks Lab	0	0	3	0

Course Objectives:

- To study the network devices involved in the interaction between computers.
- To understand the IP addressing schemes and diagnostic procedure through Ping.
- To implement and verify various network topologies in computer networks.
- To configure WAN, VLANs through routing protocols.
- To understand the significance of NAT & PAT address translations for conserving the IP addresses.
- To interpret the interior gateway protocols like RIP, OSPF, EIGRP.

Course Outcomes:

The student will be able to

1. Understand the basic concepts of networking hardware and addressing schemesused in computer communication (L2).
2. Build an arrangement of network devices and verification of network topologies (L3).
3. Configure the WAN, Virtual LAN through GUI (L3).
4. Configure the Address Translations, IP addressing protocols and address resolving mechanisms (L3).
5. Implement and verify the Interior Gateway Protocols (L3).

List of Experiments:

1. Study of Network devices in detail.
2. Implementation of IP Addressing scheme and interpreting Ping.
3. Design and implementation of Network Topologies.
4. Design and implementation of Hybrid Topology using Router.
5. Implementation of Signal Regeneration using Repeater.
6. Configuration of WAN through Static Routing Protocols
7. Configuration of WAN through Dynamic Routing Protocols.
8. Configuration of Virtual LAN Communication
9. Configuration of Inter VLAN Communication.
10. Configuration of NAT-PAT in router.
11. Configuration of DHCP, DNS and Webserver.
12. Implementation of RIP.
13. Implementation of OSPF.
14. Implementation of EIGRP.

Text Books

1. Tanenbaum A. S.; “Computer Networks”, PHI, 4e,
2. B. Forouzan, “Data Comuncation and Networking”, TMH ,4e

Reference Books

1. Stallings William, “Data and Computer Communication”, PHI, 6e
2. Leon-Garcia and Widjaja, “Communication Networks”, TMH 3e

Subject Code	Subject Name	L	T	P	C
R19ECE-PE4201.1	Wireless Sensor Networks	3	0	0	3

Course Objectives:

- Emphasize the basic WSN technology with its unique constraints and challenges in design of WSN for different Applications.
- Relate architecture of sensor networks for various network technologies and discuss design considerations of a sensor node and transceiver design
- Explain various key MAC protocols for sensor networks with their merits and demerits
- Explain the principle of various transport layer protocols defined for wireless sensor network.
- Create awareness on security considerations, sensor network platforms and tools with a brief study of different WSN applications.

Course Outcomes:

1. Illustrate the wireless sensor network definitions, advantages, constraints and challenges with applications and technologies that drive its growth.
2. Outline the single node architecture, its components, transceiver design, associated network topologies and different optimization goals.
3. Inspect the issues and goals of MAC protocols for wireless sensor network, Also examine the MAC protocols applied to wireless sensor networks.
4. Interpret the issues and goals of network layer routing protocols for wireless sensor network, Also examine the routing protocols applied to wireless sensor networks.
5. Inspect the issues and goals of transport layer protocols for wireless sensor network, Also Summarize the network security requirements, attacks, issues and challenges of wireless sensor network. Summarize applications of wireless sensor network and different platforms and tools used in their development.

UNIT-1: Overview of Wireless Sensor Networks:

Key definitions of sensor networks, Advantages of sensor Networks, Unique constraints a challenges, Driving Applications,

Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Network Architecture -Sensor Network Scenarios, Gateway Concepts.

Physical Layer and Transceiver Design Considerations, Personal area networks (PANs), hidden node and exposed node problem, Topologies of PANs, MANETs, and WANETs.

Learning Outcomes:

- Define wireless sensor network (L1).
- Analyze the challenges of sensor networks (L4)
- Examine the problems associated with nodes in WSN (L4). •
- Describe the network topologies of WSN (L2).

UNIT-2:MAC Protocols for Wireless Sensor Networks

Issues in Designing a MAC protocol for Ad Hoc Wireless Networks, Design goals of a MAC Protocol for Ad Hoc Wireless Networks, Classifications of MAC Protocols, Contention – Based Protocols, Contention - Based Protocols with reservation Mechanisms, Contention – Based MAC Protocols with Scheduling Mechanisms, MAC Protocols that use Directional Antennas, Other MAC Protocols.

Learning Outcomes:

- Understand the issues in designing MAC protocols for wireless sensor networks (L1).
- Compare the MAC layer protocols used in WSN (L4).

UNIT-3: Routing Protocols

Introduction, Issues in Designing a Routing Protocol for Ad Hoc Wireless Networks, Classification of Routing Protocols, Table –Driven Routing Protocols, On – Demand Routing Protocols, Hybrid Routing Protocols, Routing Protocols with Efficient Flooding Mechanisms, Hierarchical Routing Protocols, Power – Aware Routing Protocols, Proactive Routing

Learning Outcomes:

- Describe the issues in designing routing protocols for wireless sensor networks (L2).
- Compare the network layer protocols used in WSN (L4).

UNIT-4: Transport Layer and Security Protocols

Introduction, Issues in Designing a Transport Layer Protocol for Ad Hoc Wireless Networks, Design Goals of a Transport Layer Protocol for Ad Hoc Wireless Networks, Classification of Transport Layer Solutions, TCP Over Ad Hoc Wireless Networks, Other Transport Layer Protocol for Ad Hoc Wireless Networks.

Learning Outcomes:

- Describe the issues in designing Transport protocols for wireless sensor networks (L2).
- Compare the transport layer protocols used in WSN (L4).

UNIT-5: Security and WSN Tools:

Security in Ad Hoc Wireless Networks, Network Security Requirements, Issues and Challenges in Security Provisioning, Network Security Attacks, Key Management, Secure Routing in Ad Hoc Wireless networks.

Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

Learning Outcomes:

- Understand the issues in designing security for wireless sensor networks (L2).
- Compare the various types of sensor node hardware are used in WSN (L4).

Text Books:

1. Ad Hoc Wireless Networks: Architectures and Protocols - C. Siva Ram Murthy and B.S.Manoj, 2004, PHI
2. Wireless Ad- hoc and Sensor Networks: Protocols, Performance and Control – Jagannathan Sarangani, CRC Press

Reference Books

1. Holger Karl & Andreas Willig, “Protocols And Architectures for Wireless Sensor Networks", John Wiley, 2005
2. KazemSohraby, Daniel Minoli, &TaiebZnati, “Wireless Sensor Networks-Technology, Protocols, and Applications”, John Wiley, 2007

Subject Code	Subject Name	L	T	P	C
R19ECE-PE4201.2	VLSI Testing &Testability	3	0	0	3

Course Objectives:

- Impart knowledge on the basic faults that occur in digital systems
- Describe fault detection techniques in combinational circuits.
- Outline procedures to generate test patterns for detecting single stuck faults in combinational and sequential circuits.
- Explain design for testability techniques with improved fault coverage.
- Introduce BIST concepts and specific architectures and approaches for introducing BIST into logic circuits, memories.

Course Outcomes:

1. To know the fundamentals of basic faults and different modeling levels.
2. To understand occurrences of the fault models, fault detection and fault equivalence in digital circuits.
3. To impart knowledge on procedures to generate test patterns for detecting single stuck faults in combinational and sequential circuits.
4. To understand the design for testability techniques with improved fault coverage.
5. To understand the BIST concepts and their architectures.

UNIT-I

Introduction to Test and Design for Testability (DFT) Fundamentals, Modelling: Modelling digital circuits at logic level, register level and structural models. Levels of Modelling. Logic Simulation: Types of simulation, Delay models, Element evaluation, Hazard detection, Gate level event driven simulation.

Learning Outcomes:

- Explain importance and challenges of VLSI Testing at different abstraction levels.(L2)
- Apply the concepts in testing which can help them design a better yield in IC design(L3)

UNIT-II

Fault Modelling – Logic fault models, Fault detection and redundancy, Fault equivalence and fault location. Single stuck and multiple stuck – Fault models. Fault simulation applications, General techniques for Combinational circuits.

Learning Outcomes:

- Apply concepts of logic simulation and fault simulation in designing and testing of VLSI circuits.(L3)
- solve the problems associated with testing of semiconductor circuits at earlier design(L3)

UNIT-III

Testing for single stuck faults (SSF), Automated test pattern generation (ATPG/ATG) for SSFs in combinational and sequential circuits, Functional testing with specific fault models, Vector simulation – ATPG vectors, formats, Compaction and compression, Selecting ATPG Tool.

Learning Outcomes:

- Apply various fault models for generation of test vectors.(L3)
- Identify the design for testability methods for combinational & sequential circuits(L4)

UNIT-IV

Design for testability – testability trade-offs, techniques. Scan architectures and testing – controllability and Observability, generic boundary scan, full integrated scan, storage cells for scan design. Board level and system level DFT approaches. Boundary scans standards. Compression techniques – different techniques, syndrome test and signature analysis.

Testability Measures: SCOAP Controllability and Observability, High Level Testability Measures, Digital DFT and Scan Design: Ad-Hoc DFT Methods, Scan Design, Partial-Scan Design, Variations of Scan

Learning Outcomes:

- show a given circuit into a scan design.(L2)
- Analyze effect of logic built in self-test (a DFT technique) in VLSI circuits designing.(L4)
- Test for observability and controllability parameters of given circuit.(L4)
- List the techniques to improve testability of a given circuit.(L4)

UNIT-V

Built-in self-test (BIST): BIST Concepts and test pattern generation. Specific BIST Architectures –CSBL, BEST, RTS, LOCST, STUMPS, CBIST, CEBS, RTD, SST, CATS, CSTP, BILBO. Brief ideas on some advanced BIST concepts and design for self-test at board level. Memory BIST (MBIST): Memory test architectures and techniques – Introduction to memory test, Types of memories and integration, embedded memory testing model. Memory test requirements for MBIST. Brief ideas on embedded core testing.

Learning Outcomes:

- Apply various algorithms for test pattern generation.(L4)
- Identify the BIST techniques for improving testability.(L3)

Text Books:

1. MironAbramovici, Melvin A. Breur, Arthur D. Friedman, Digital Systems Testing and Testable Design, Jaico Publishing House, 2001.
2. Alfred Crouch., Design for Test for Digital ICs & Embedded Core Systems, Prentice Hall.

References:

1. Robert J. Feugate, Jr., Steven M. Mentyn, Introduction to VLSI Testing, Prentice Hall, Englehood Cliffs, 1998.
2. Bushnell, M., and Agrawal, Vishwani D, Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, Kluwer Academic Publishers,2002

Subject Code	Subject Name	L	T	P	C
R19ECE-PE4201.3	Advanced Video Signal Processing	3	0	0	3

Course Objectives:

- Knowledge about the processing of digital video signal in its time and frequency domain analysis.
- Understand the basic compression and coding techniques required for the transmission of video signal.

Course Outcomes:

1. Identify the importance of digital video applications in today's world
2. Analyze how motion estimation algorithms work in video processing.
3. Compare various types of Video coding Techniques
4. Distinguish the various and recent compression standards that exist.
5. Analysis of video communication and types of errors.

UNIT-I: Video acquisition Techniques

Video Capture and Display, Analog Video Raster, Progressive vs Interlaced scans, Digital Video – notation and formats Fourier Analysis of Video Signals, Spatial and Temporal Frequencies. Sampling Video in Two Dimensions: Progressive versus Interlaced Scans

Learning Outcomes:

After completion of this unit, the student will be able to

• analyze the Analog to digital video acquisition (L4).

• Compare a Sampling Video in Two Dimensions: Progressive versus Interlaced Scans(L5)

UNIT-II: Motion Estimation

Optical Flow, Optical Flow Equation and Ambiguity in Motion Estimation, Motion Estimation Criteria. Block-Matching Algorithm, Exhaustive and fast algorithms, Multi resolution Motion Estimation, Application of Motion Estimation in Video Coding

Learning Outcomes:

After completion of this unit, the student will be able to

• explain the properties of motion estimation (L2).

• apply block-matching algorithm for motion estimation (L3.)

• Understand the multi resolution motion estimation (L2)

UNIT-III: Video Coding

Block-Based Transform Coding, The Discrete Cosine Transform, DCT-Based Image Coders and the JPEG Standard. Predictive Coding, Spatial-Domain linear Prediction, Motion-Compensated Temporal Prediction.

Learning Outcomes: After completion of this unit, the student will be able to

• understand the development of video coding algorithms (L1).

• apply DCT based algorithms to JPEG standard compression(L3).

• Analyze motion compensated temporal prediction (L4)

UNIT-IV: Video compression

Basic compression techniques, Video compression standards (H.261 and H.263-Overview,highlights). MPEG1, MPEG2, MPEG4 profiles and features.

Learning Outcomes: After completion of this unit, the student will be able to

• understand the development video compression standards(L1).

• apply MPEG algorithms to finite duration video signal (L3).

UNIT-V: Error Control in Video Communications

Motivation and Overview of Approaches , Typical Video Applications and Communication Networks , Transport-Level Error Control , Error-Resilient Encoding , Decoder Error Concealment , Encoder–Decoder Interactive Error Control , Error-Resilience Tools in H.263 and MPEG

Learning Outcomes: After completion of this unit, the student will be able to

• understand the error control coding approaches for vedio applications(L1).

• Compare the transport level error control methods(L4)

Text Books:

1. “Digital Video Processing,” by NuratTekalp, Prentice Hall Signal Processing Series, 1995.
2. "Video Processing and Communications" by Yao Wang, JoernOstermann, and Ya-Qin Zhang, Pr

References:

1. “Fundamentals of Multimedia”, by Ze-Nian Li, and Mark S. Drew, Pearson Prentice Hall, October 2003

Subject Code	Subject Name	L	T	P	C
R19ECE-PE4201.4	Radar Engineering	3	0	0	3

Course Objectives:

- Define the basic function of radar system and determine its range
- Explain the working principle of CW and FM-CW radar and their characteristics
- Introduce the functioning of MTI radar to acquire the target location with aid of various tracking techniques
- List various types of radar antennas and their parameters.
- Explain detection criteria of the radar signal and concepts of matched filter receiver

Course Outcomes:

1. Illustrate basic radar block diagram and discuss the parameter variations of radar range equation.
2. Compare the Doppler concept in CW and FMCW radars.
3. Explain the operating principle of MTI radar and tracking techniques.
4. Classify various types radar antennas and their arrays used in radar communication.
5. Summarize detection characteristics of radar antennas in presence of noise and examine the functionalities of various radar receivers, scopes and duplexers in the radar system.

UNIT-I: Introduction

Nature of Radar. Maximum Unambiguous Range. Radar Waveforms, Simple form of Radar Equation, Radar Block Diagram and Operation, Radar Frequencies and Applications. Related Problems. Radar Equation:

CW Radar – Block Diagram, Isolation between Transmitter and Receiver, Non-zero IF Receiver, Receiver Bandwidth Requirement, Applications of CW radar. FMCW Radar, Range and Doppler Measurement, Block Diagram and Characteristics

Learning Outcomes:

- Identify different segments of a pulse radar and explain the function of each block (L1).
- Relate the frequency bands in which radars are operating based on the application (L1)

UNIT-II: MTI and Pulse Doppler Radar

Introduction, Principle, MTIR Radar with- Power Amplifier Transmitter and Power Oscillator Transmitter, Delay Line Cancellers – Filter Characteristics, Blind Speeds, and Double Cancellation staggered PRFs. Range Gated Doppler Filters. MTI Radar Parameters, Limitations to MTI Performance. Non-coherent MTI, MTI versus Pulse Doppler Radar. Tracking Rader: Tracking with Rader, Sequential Lobing, Conical Scan, Mono-pulse Tracking

Learning Outcomes:

- Explain how the moving targets can be distinguished from stationery targets using A-scope (L2).
- Distinguish MTI and Pulse Doppler radars (L4).

UNIT-III: Radar Amplitude Comparison

Mono-pulse (one – and two –coordinates), Phase Comparison Mono-pulse. Target Reflection Characteristics and Angular Accuracy. Tracking in Range Acquisition and Scanning Patterns.

Comparison of Trackers. Radar Antennas – Antenna Parameters, Reflector Antennas, Lens Antennas, Lens Antennas Cosecant- Squared Antenna Pattern, Radomes.

Learning Outcomes:

- Discuss various tracking systems (L2).
- Analyze the tracking of targets using range gates (L5).

UNIT-IV: Detection of Radar Signals in Noise

Introduction, Matched Filter Receiver –Response Characteristics and Derivation, Correlation detection, Detection criteria, Detector Characteristics, Automatic Detection, Constant False Alarm Rate Receiver.

Learning Outcomes:

- Determine signal-to-noise ratio, receiver noise, probability of detection and false alarms (l3).
- propose various counter and counter-counter measures (l5).

UNIT-V: Radar Receivers

Noise Figure and Noise Temperature. Displays – types. Duplexer – Branch type and Balanced type, Circulators as Duplexers. Introduction to Phased Array Antennas- Basic Concepts, Radiation Pattern. Beam Steering and Beam Width changes, Series versus Parallel Feeds. Applications, Advantages and Limitations

Learning Outcomes:

- Apply different types of radar displays and analyze the parameters displayed (L3).
- Explain about radar receiver (L2).

Text Books

1. Introduction to Radar Systems – Merrill I. Skolnik, SECOND EDITION, McGraw – Hill, 1981
2. Radar Engineering and fundamentals of Navigational Aids-G.S.N.Raju, I.K International, 2008

Reference Books:

1. Introduction to Radar Systems – Merrill I. Skolnik, THIRD EDITION, Tata McGraw – Hill, 2001
2. Radar: Principles, Technologies, Applications- Byron Edde, Pearson Education

SubjectCode	Subject Name	L	T	P	C
R19CS-OE4201.1	Operating Systems	3	0	0	3

Course objectives:

- Provide knowledge about the services rendered by operating systems.
- Present detail discussion on processes, threads and scheduling algorithms.
- Expose the student with different techniques of handling deadlocks.
- Discuss various file-system implementation issues and memory management techniques..
- Learn the basics of Linux system and Android Software Platform**.**

Course Outcomes:

1. Understand the importance of operating systems and different types of system calls(L2).
2. Analyze process scheduling algorithms and various IPC mechanisms.(L4).
3. Understand the process synchronization, different ways for deadlocks handling.(L2).
4. Analyze different page replacement methods, various File management techniques.(L4).
5. Analyze various disk scheduling policies (L2).

Unit-I:

Operating Systems Overview: Introduction: what is an operating system, Types of operating systems, operating systems concepts, operating systems services, Introduction to System call, System call types. Operating System Generation

Learning outcomes: Student should be able to

- Understand operating system structure and functions.(L2).
- Understand operating system services and system calls(L2).

Unit–II:

Process Management:

Process concept: Process Concept, Process Scheduling, Operations on Processes, Inter process Communication.

Multi threaded Programming: Overview, Multi threading models, Threading Issues.

Process scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms.

Learning outcomes: Student should be able to

1. Identify various message sharing mechanisms used in IPC.(L2).
2. Understand how to handling multiple threads.(L2).
3. Differentiate between preemptive, non-preemptive and real time CPU scheduling(L2).

Unit-III:

Synchronization: Process Synchronization, TheCritical-SectionProblem,Synchronization Hardware, Semaphores ,Classic Problems of Synchronization, Monitors, Synchronization examples

Principles of deadlock – System Model, Deadlock Characterization, Deadlock Prevention ,Detection and Avoidance ,Recovery form Deadlock

Learning outcomes: Student should be able to

1. Analyze various solutions for process synchronization.(L4).
2. Analyze the reasons for deadlocks and proposed solutions to detect, avoid ,recovery from deadlocks.(L4).

Unit-IV:

Memory Management:
Memory Management strategies: Swapping, Contiguous Memory Allocation, Segmentation, Paging, Structure of the Page Table.
Virtual Memory Management: Virtual Memory, Demand Paging, Page-Replacement Algorithms, Thrashing..
Learning outcomes: Student should be able to

- Demonstratetheabilitytoimplementvariousmemorymanagementtechniques(L2)
- Illustrate various demand paging techniques.(L2).

Unit-V:

File system Interface-the concept of a file, Access Methods, Directory and Disk structure ,File system mounting.
File System implementation: File system structure, allocation methods, free-space management
Mass-storage structure: overview of Mass-storage structure, Disk scheduling.
Process management.
Learning outcomes: Student should be able to

1. Identify various file management and optimization techniques.(L2).
2. Understand how data streams are exchanged between I\O subsystems.(L2).
3. Analyzevariousstoragestructurestostorethedatainsecondarymemory.(L4).
4. Analyze different disk scheduling algorithms.(L4).

TextBooks:

1. Silberschatz A,GalvinPB,andGagne G,OperatingSystemConcepts,9thedition,Wiley,2013.
2. TanenbaumAS,ModernOperatingSystems,3rdedition,PearsonEducation,2008.(for InterprocessCommunicationandFile systems).

References:

1. TanenbaumAS,WoodhullAS,OperatingSystemsDesignandImplementation,3rdedition,PHI,2006.
2. DhamdhereDM,OperatingSystemsAConceptBasedApproach,3rdedition,TataMc Graw-Hill,2012.

Course Code	Course Title	L: T: P	Credits
R19EE-OE4201.2	Electrical Power Distribution systems	3:0:0	3

Course Objectives:

- To understand the need of distribution system and factors effecting the Distribution system
- To learn about the substations and distribution feeders
- To solve the voltage drop, power loss for different load areas and know the voltage control methods.
- To familiarize the distribution system protection and its coordination.
- To know the effect of compensation on power factor improvement.

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

1. Understand the various factors effecting the distribution system (L2)
2. Explain about the substations and distribution feeders (L2)
3. Determine the voltage drop, power loss for different load areas (L3)
4. Analyze the various protection schemes and its coordination Procedure. (L4)
5. Analyze the effect of compensation on P.F improvement (L4)

UNIT – I General Concepts

Introduction to distribution systems, Load modeling and characteristics –Coincidence factor – Contribution factor, loss factor – Relationship between load factor and loss factor – Classification of loads (Residential, commercial, Agricultural and Industrial) and their characteristics.

Learning Outcome: The students are able to

- Understand the different types of factors and characteristics (L2)
- Classify the different loads and their characteristics(L2)

UNIT – II: Substations

Location of substations**:** Rating of distribution substation – Service area within primary feeders – Benefits derived through optimal location of substations.

Distribution Feeders

Design Considerations of distribution feeders**:** Radial and loop types of primary feeders – Voltage levels – Feeder loading – Basic design practice of the secondary distribution system.

Learning Outcome: The students are able to

- Understand the location of substations and benefits of optimal location of substations (L2)
- Understand the distribution feeders (L2)

UNIT – III: System Analysis

Voltage drop and power–loss calculations: Derivation for voltage drop and power loss in lines – Manual methods of solution for radial networks – Three phase balanced primary lines.

Voltage Control: Equipment for voltage control – Effect of series capacitors – Effect of AVB/AVR –Line drop compensation.

Learning Outcome: The students are able to

- Determine the voltage drop and power loss calculations(L3)
- Understand the effect of different voltage controllers (L2)

UNIT – IV: Protection

Objectives of distribution system protection – Types of common faults and procedure for fault calculations – Protective devices**:** Principle of operation of fuses – Circuit reclosures –

Line sectionalizers and circuit breakers.
Coordination: Coordination of protective devices**:** General coordination procedure – Residual current circuit breaker RCCB.
Learning Outcome: The students are able to

- Classify the different types of faults (L4)
- Analyze the operation of different types of protective devices (L4)

UNIT – V: Compensation for Power Factor Improvement

Capacitive compensation for power–factor control – Different types of power capacitors – shunt and series capacitors – Effect of shunt capacitors (Fixed and switched) – Power factor correction – Capacitor allocation – Economic justification – Procedure to determine the best capacitor location.
Learning Outcome: The students are able to

- Classify the different types of power capacitors (L4)
- Analyze the effect of compensation on P.F improvement (L4)

Text Book:

1. Electric Power Distribution system, Engineering – by TuranGonen, McGraw–hill Book Company.

Reference Books:

2. Electrical Distribution Systems by Dale R.Patrick and Stephen W.Fardo, CRC press
3. Electric Power Distribution – by A.S. Pablo, Tata McGraw–hill Publishing Company, 4thEdition, 1997.
4. Electrical Power Distribution Systems by V.Kamaraju, Right Publishers

Subject Code	Subject Name	L	T	P	C
R19MECH-OE4201.3	ELEMENTS OF MECHANICAL ENGINEERING (Common to ECE & CSE)	3	0	0	3

Course Objectives:

This course will enable students to

- Learn the fundamental concepts of energy, its sources and conversion.
- Comprehend the basic concepts of thermodynamics
- Understand the concepts of boilers, turbines, pumps, internal combustion engines and refrigeration
- Distinguish different metal joining techniques
- Enumerate the knowledge of working with conventional machine tools, their specifications.

Course Outcomes:

Upon completion of this course, students will be able to

1. Illustrate the applications of themodynamic laws to mechanical systems(L2)
2. Explain the working principle of hydraulic turbines and pumps.(L2)
3. Calculate the performance parameters of IC engines.(L3)
4. Understand the properties of common engineering materials and their applications in engineering industry. .(L2)
5. Illustrate the working principles of conventional machine tools, CNC machines and robots.(L2)

UNIT-I

Basic concepts of Thermodynamics: Introduction, states, concept of work, heat, temperature; Zeroth, 1st, 2nd and 3rd laws of thermodynamics. Concept of internal energy, enthalpy and entropy. Applications of thermodynamics laws to mechanical systems.

Learning outcomes:

- Understand the concept of internal energy, enthalpy and entropy.(l2)
- Explain the laws of thermodynamics.(l2)

UNIT-II

Turbines: Hydraulic Turbines – Classification and specification, Principles and operation of Pelton wheel turbine, Francis turbine and Kaplan turbine (elementary treatment only).

Hydraulic Pumps: Introduction, classification and specification of pumps, reciprocating pump and centrifugal pump, concept of cavitation and priming.

Learning outcomes:

- **classify** the turbines and pumps.(L2)
- **Explain** the working principles of turbines, pumps.(L2)

UNIT-III

Internal Combustion Engines

Classification, I.C. Engines parts, 2 and 4 stroke petrol and 4-stroke diesel engines. P-V diagrams of Otto and Diesel cycles. Simple problems on indicated power, brake power, indicated thermal efficiency, brake thermal efficiency, mechanical efficiency and specific fuel consumption.

Refrigeration and Air conditioning

Refrigeration - Refrigerating effect, Ton of Refrigeration, COP, Unit of Refrigeration. Refrigerants, Properties of refrigerants, List of commonly used refrigerants. Principle and working of vapor compression refrigeration, Domestic refrigerator. Principles and applications of air conditioners, window and split air conditioners.

Learning outcomes:

- **compare** 4 stroke petrol and 4-stroke diesel engines (L2)
- **Explain** the Properties of refrigerants.(L2)
- **Illustrate** the principle and working of vapor compression refrigeration system.(L2)

UNIT-IV

Properties, Composition and Industrial Applications of engineering materials

Metals – Ferrous: cast iron, tool steels and stainless steels and nonferrous: aluminum, brass, bronze. Polymers - Thermoplastics and thermosetting polymers. Ceramics - Glass, optical fiber glass, cermets. Composites - Fiber reinforced composites, Metal Matrix Composites Smart materials – Piezoelectric materials, shape memory alloys, semiconductors and insulators.

Joining Processes: Soldering, Brazing and Welding

Soldering, brazing and welding ,arc welding,

oxy-acetylene welding, TIG welding, and MIG welding.

Learning outcomes:

- **understand** the Properties ofMetals, Polymers, Ceramics, Composites , Smart materials (L2)
- **Explain** the joining processes.(L2)

UNIT-V

Lathe - Specification of Lathe. Principle of working of a center lathe. Parts of a lathe. Operations on lathe - Turning, Facing, Knurling, Thread Cutting, Drilling, Taper turning

Milling Machine - Principle of milling, types of milling machines. Working of horizontal and vertical milling machines. Milling operations.

Introduction to Advanced Manufacturing Systems

Computer Numerical Control (CNC): Introduction, components of CNC, advantages of CNC, CNC Machining centers and Turning centers.

Robots: common robot configurations. Applications of Robots in material handling, processing and assembly and inspection.

Learning outcomes:

- **illustrate** the working of machine tools(L2)
- **explain** the components of CNC systems, robot configurations (L2)

TEXT BOOKS

1. Elements of Mechanical Engineering, K. R. Gopalakrishna, Subhas Publications, Bangalore

2. Elements of Mechanical Engineering, Vol.-1 & 2, Hajra Choudhury, Media Promoters, New Delhi.

. **REFERENCE BOOKS**

1. Elements of Mechanical Engineering, R.K. Rajput, Firewall Media.
2. Elements of Mechanical Engineering, Dr. A. S. Ravindra, Best Publications, 7th edition,

Subject Code	Subject Name	L	T	P	C
R19CS-OE4201.4	Software Engineering	3	0	0	3

Course Objectives:

- To understand the software life cycle models.
- To understand the software requirements and SRS document.
- To understand the importance of modeling and Software Design techniques
- To understand the coding standards and Testing process techniques.
- To understand how to ensure good quality software.

Course Outcomes:

1. Understand the software development process models.
2. Demonstrate the Requirements and Design SRS document of the Software Systems process.
3. Implement different modules and objects to organise data.
4. Apply coding standards and software testing approaches.
5. Analyze various testing techniques, Risk management and Software quality of the Software products.

UNIT-1

Introduction: Introduction to Software Engineering, Evolving role of Software, Software Crisis, Changing Nature of Software, Software myths, Process Models for Software Development, Waterfall, prototyping Evolutionary models: Incremental model, Spiral model, Agile developmental process.

Applications: Various models for different projects

Learning Outcomes:

At the end of the module, students will be able to:

- List the steps involved in software development. (L1)
- Explain myths of software. (L2)
- Apply various software process models (L3)

UNIT-2

Software Requirements Engineering: Requirements Gathering and Requirements Analysis, Requirements Elicitation, requirements verification and validation, Functional& Non functional requirements, , Software Requirement Specification (SRS).

Applications: Finding Functional &Non-functional requirements and preparing Software Requirement Specification (SRS) for banking system

Learning Outcomes:

At the end of the module, students will be able to:

- Gathering and Requirements Analysis for software (L2)
- Define functional and non-functional requirements for software development (L1)
- Analyze Software Requirement Specification (SRS).(L4)

UNIT-3

Design Engineering: Design concepts, software architecture, Architectural styles, Developing the DFD Model of a System, Structured Design, Detailed Design User Interface

Design: Characteristics of Good User Interface, Basic Concepts, Types of User Interfaces, Fundamentals of Component-based GUI Development. Applications: Data designing for banking system

Learning Outcomes:

At the end of the module, students will be able to:

- List the software architecture style for the given problem. (L1)
- Develop the DFD Model of a System based on requirements. (L3)
- User Interface Analysis and Design (L5)

UNIT-4

Coding &Testing: Coding standards, code review and verification, Testing levels: Unit testing, integration testing, system testing . alpha and beta testing, black box and white box testing, debugging. Software Documentation

Applications: Applying testing techniques on any software project

Learning Outcomes:

At the end of the module, students will be able to:

1. Implementation of coding standards(L6)
2. Apply different Testing concepts (L3)

UNIT-5

Software Quality Management: Software Reliability, Software Quality, Software Quality Management System, ISO 9000, SEI Capability Maturity Model Software Maintenance: Software maintenance, Maintenance Process Models, Software Configuration Management

Applications: analyze the Software Quality and maintenance in any software project

Learning Outcomes:

At the end of the module, students will be able to:

3. Evaluate different Risk management techniques. (L5)
4. Apply different Software Quality standards concepts(L3)

Text books:

1. Roger S. Pressman, Software Engineering, A practitioner.s Approach, 7thEdition, McGraw- Hill International Edition, 2009

2. Rajib Mal, Fundamentals of software Engineering, 3rdEdition, Eastern Economy Edition, 2009

Reference books:

1. Sommerville, Software Engineering, 7thEdition, Pearson education, 2004

2. K KAggarwal and Yogeshsingh, Software engineering,3rd Edition, New age international publication,2008