COURSE STRUCTURE (R20)
AND
DETAILED SYLLABUS
(IV YEAR)

ELECTRONICS AND COMMUNICATION ENGINEERING

For
B. Tech., Four Year Degree Course
(Applicable for the batches admitted from 2020-21)

LENDI INSTITUTE OF ENGINEERING AND TECHNOLOGY
An Autonomous Institution
Approved by AICTE & Permanently Affiliated to JNTUK, Kakinada
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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING(ECE)

B. Tech IV-Year Course Structure and Syllabus–R20

IV Year-I Semester							
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**Credits**
1	R20ECE-PE4101.1 R20ECE-PE4101.2 R20ECE-PE4101.3 R20ECE-PE4101.4 R20ECE-PE4101.5	**Professional Elective-3** 1. Optical Communications 2. Mixed signal IC Design 3. Embedded and IoT System Design and Applications 4. Micro Electronic Mechanical Systems (MEMS) 5. Digital signal processors &architecture	PE	3	0	0	3
2	R20ECE-PE4102.1 R20ECE-PE4102.2 R20ECE-PE4102.3 R20ECE-PE4102.4 R20ECE-PE4102.5	**Professional Elective-4** 1. Mobile and Cellular Communications 2. VLSI Testing & Testability 3. Industrial IoT 4. RF Circuit Design 5. Speech Signal Processing	PE	3	0	0	3
3	R20ECE-PE4103.1 R20ECE-PE4103.2 R20ECE-PE4103.3 R20ECE-PE4103.4 R20ECE-PE4103.5	**Professional Elective-5** 1. Satellite Communications 2. SOC Architecture 3. Operating System for embedded and IoT **4.** Electromagnetic Interference & Electromagnetic Compatibility **5.** Digital Image & Video Processing	PE	3	0	0	3
4	R20CSE-OE4103 R20CIT-OE4101 R20CSS-OE4101 R20EEE-OE4101 R20MEC-OE4102	**Open Elective-3** 1. Operating Systems Concepts 2. Introduction to Machine Learning 3. Mobile APP Development 4. Basic Electrical Distribution systems 5. Mechatronics	OE	3	0	0	3
5	R20CSE-OE4104 R20CIT-OE4102 R20CSS-OE4102 R20EEE-OE4102 R20MEC-OE4103	**Open Elective-4** 1. Data Base Management System 2. Object Oriented Analysis and Design 3. Software Engineering 4. Energy Conservation and Auditing 5. Nano Materials	OE	3	0	0	3
6	R20BSH-HM4101	Universal Human values Understanding Harmony	HM	3	0	0	3
7	R20ECE-SC4101	Programming Embedded and IoT Systems **(Skill Oriented Course-5)**	SC	0	0	3	2
8	R20ECE-SI4101	**Summer Internship-2 (Evaluation)**	**SI**	0	0	0	3
			Total	**18**	**0**	**3**	**23**
Honors Course-4/Minor Course-4							

IV Year -II Semester							
S. No	**Course Code**	**Course Title**	**Category**	**L**	**T**	**P**	**Credits**
1	R20ECE-PJ4201	Project work	PJ	0	0	0	12
			Total	**0**	**0**	**0**	**12**

IV Year-I Semester

Subject Code	Subject Name	L	T	P	C
R20ECE-PE4101.1	Optical Communications **(Professional Elective Course-3)**	3	0	0	3

Course Objectives:

- 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 the 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:

- Illustrate the principles of ray theory transmission, including total internal reflection, acceptance angle, and numerical aperture, to characterize step-index and graded-index optical fibers (L2).
- Apply the fundamentals of optical communication to estimate channel impairments like attenuation and dispersion, and select suitable materials for constructing optical fibers (L3).
- Design an optical Communication system by selecting appropriate optical sources and detectors, and evaluate the performance of the optical receivers. (L3).
- Apply the various fiber to fiber and fiber to source jointing mechanisms to ensure efficient signal transmission with minimal joint loss (L3).
- Construct optical point-to-point links for digital data transmission, incorporating power and rise time budgeting, and measure attenuation and dispersion in optical Communication systems (L3).

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 outcome:

- 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, Types of Dispersion-Material dispersion, Wave-guide dispersion, Polarization-Mode dispersion, Intermodal dispersion.

Learning outcome:

- 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 cable scan a lobe 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 carnet works (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 Photo diodes, Comparison of photo detectors.

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

Learning outcome:

- 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 correlates, 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- multi-mode fiber joints, single mode fiber joints, Source to fiber power launching and power coupling methods.

Learning outcome:

- 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 inter connections (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 outcome:

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

Applications:

- The technique of WDM is used in SONET networks that include 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.

Reference 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
R20 ECE-PE4101.2	Mixed Signal IC Design **(Professional Elective Course-3)**	3	0	0	3

Course Objectives:

- To give exposure to mixed signal systems and understand the necessity of mixed signals system design.
- To explain mixed signal system design process flow.
- To introduce sampling circuits and architectures.
- To study behavior of A/D and D/A architectures.
- To provide concepts required to design A/D and D/A converters

Course Outcomes:

1. Describe design process of mixed signal processing (L2)
2. Estimate performance metrics of sampling circuits and architectures(L5)
3. Design Analog to Digital converters(L6)
4. Design Digital to Analog converters(L6)
5. Outline layout generation problems in mixed signal design for given specifications and constraints (L2)

UNIT-I

Introduction to Mixed Signal Processing: Introduction, Methods and Technologies Available for Processing Real-World Signals-Analog Versus Digital Signal Processing, block diagram of a typical sampled data DSP system, mixed signal system design flow.

Learning Outcomes:

- Understand the necessity of mixed signal systems in real time world. (L2)
- Outline the block diagram of DSP systems(L2)
- Draw the mixed signal system design flow(L3)

UNIT-II

Sampling Circuits: Basicsampling circuits for analog signal sampling, performance metrics of sampling circuits, different types of sampling switches. Sample- and -Hold Architectures-Open-loop & closed-loop architectures, open-loop architecture with miller capacitance, multiplexed-input architectures, recycling architecture, switched capacitor architecture, current-mode architecture.

Learning Outcomes:

- Understand sampling circuits(L2)
- Estimate performance metrics of sampling circuits (L5)
- Distinguish open-loop and closed-loop architectures (L4).
- Design of architecture for sampling signal s (L5).

UNIT-III

A/D Converter Architectures: Input/output characteristics and quantization error of an A/D converter, performance metrics of pipelined architectures, Successive approximation architectures, interleaved architectures.

Unit Outcomes:

- Draw input and output characteristics of A/D converters (L3).
- Evaluate performance metrics and quantization error of A/D converters (L5).
- Compare successive and interleaved architectures of A/D converters (L3).

UNIT-IV

D/A Converter Architectures: Input/output characteristics of an ideal D/A converter, performance metrics of D/A converter, D/A converter in terms of voltage, current, and charge division or multiplication, switching functions to generate an analog output corresponding to

A digital input. Resistor-Ladder architectures, Current steering architectures.

Learning Outcomes:

- Plot input and output characteristics of D/A converters (L3).
- Analyze D/A converters in terms of voltage, current, and charge division (L4).
- Estimate the analog output for digital input using switching functions in D/A converters (L4).
- Compare resistor-based and current-steering architectures of D/A converters (L4).

UNIT-V

Mixed signal layout generation concepts: VLSI Design Cycle, Mixed-Signal Layout Styles, From Circuit to Layout, Layout System Requirements, The Mapping Problem-High- Level Specifications, Layout System Specifications, Constraint Mapping Problem, Placement and Routing Constraints

Learning Outcomes:

- List mixed signal layout styles(L2)
- Understand the requirements and constraints in layout generation(L2)
- Develop algorithm for constraint mapping problem (L5)

Text Books:

1. David A. Johns, Ken Martin, "Analog Integrated Circuit Design" John Wiley & Sons, 2002.
2. Chieh Lin, Arthur H.M. van Roermund and Domine M.W. Leenaerts, "Mixed-Signal Layout Generation Concepts", Kluwer Academic Publishers, 2003.

References:

1. Benhard Razavi, "Data Converters", Kluwer Publishers, 1999.
2. Tsivid is Y P, "Mixed Analog and Digital VLSI Devices and Technology", Mc-Graw Hill, 1996.
3. "Mixed-Signal and DSP Design Techniques", Analog Devices, Inc.
4. Rudy van de Plassche "Integrated Analog-to-Digital and Digital-to-Analog Converters ", Kluwer 1999.

Subject Code	Subject Name	L	T	P	C
R20 ECE-PE4101.3	Embedded and IoT System Design and Applications **(Professional Elective Course-3)**	3	0	0	3

Course Objectives:

- To introduce the basics, classification and purpose, quality attributes, core components and communication interface of embedded systems.
- To educate the students on embedded firmware development languages, an overview of embedded system development environment and fundamental issues in embedded hardware and firmware.
- To teach the students the characteristics, physical/logical design, and functional blocks of IoT.
- To impart knowledge on building IoT with Raspberry Pi, Arduino IDE and various real time applications of IoT.
- To explain the overview of IoE, software, management tools and communication for IoT cloud storage.

Course Outcomes:

1. Identify the core components of a typical embedded system and their functions. (L2)
2. Apply development approaches and tools to select suitable embedded firmware development languages. (L3)
3. Understand principles of IoT system management for effective maintenance. (L2)
4. Outline IoT solutions frameworks focusing on device integration, data storage, and device authentication and security aspects. (L2)
5. Deploy IoT in different domain applications using various cloud services for real-time data processing. (L3)

UNIT-I

Embedded System Vs General Computing System: Classification of Embedded System, Purpose of Embedded system, Quality Attributes of Embedded System -Typical Embedded System- Core of Embedded System, Memory, Sensors and Actuators, Communication Interface- Onboard communication interface, External communication interface.

Learning Outcomes:

- Differentiate embedded system and general computing system(L2)
- Classify embedded systems based on performance, complexity and era in which they are evolved (L2)
- Discuss basic hardware and software units used in embedded systems(L2)

UNIT-II

Embedded Firmware Design Approaches : Embedded Firmware Development Languages-Embedded System Development Environment - IDE, Compiler, Linker - Types of File Generated on Cross Compilation-Simulator, Emulator and Debugging-Fundamental issues in Hardware Software Co-design- Integration and Testing of Embedded Hardware and Firmware.

Learning Outcomes:

- Understanding and use tools for Embedded Software development(L2)
- Burning embedded software into the target system(L3)
- Apply debugging techniques(L3)

UNIT-III

Introduction Characteristics: Physical design protocols, Logical design enabling technologies, IoT Levels Domain Specific IoTs, IoT vs M2M, IoT systems management, IoT Design Methodology, Specifications Integration and Application Development.

Learning Outcomes:

- Differentiate Microprocessor, Microcontroller, Embedded System. (L2)
- Explain the Characteristics of IoT(L2)
- Explain the physical design and logical design of IoT(L2)

UNIT-IV

Physical device: Raspberry Pi Interfaces, Programming APIs / Packages, Web services. Intel GalileoGen2with Arduino, Interfaces, Arduino IDE Programming, APIs and Hacks, Various Real time applications of IoT, Connecting IoT to cloud, Cloud Storage for IoT, Data Analytics for IoT, Software & Management Tools for IoT.

Learning Outcomes:

- Show Arduino IDE installation. (L3)
- Understand the Raspberry Pi hardware and Installation software. (L2)

UNIT-V

IoE Overview: Architecture, Smart objects and LLNs, Secure mobility, Home automation, Cities: Smart parking, Environment: Weather monitoring, Agriculture: Smart irrigation, Data analytics for IoT, Software & management tools for IoT, Cloud storage models & Communication APIs, Cloud for IoT, Amazon Web Services for IoT.

Learning Outcomes:

- Describe various applications of IoT(L2)
- Demonstrate the prototypes using Arduino with external devices (L2).
- Design a basic prototype IoT system for various applications (L6).

Text Books

1. Shibu K.V, "Introduction to Embedded System", Tata Mc Graw- Hill, 2014.2.
2. Wesley, 2001 4. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A h and s-on approach", Universities Press, 2015

References:

1. Marilyn Wolf, Computers as Components, Principles of Embedded Computing System Design", Morgan Kaufmann Publishers, Third edition, 2012.
2. Marco Schwartz, "Internet of Things with the Arduino Yun", Packt Publishing, 2014.

Subject Code	Subject Name	L	T	P	C
R20 ECE-PE4101.4	Micro Electronic Mechanical Systems (MEMS) **(Professional Elective Course-3)**	3	0	0	3

Course Objectives

- To introduce the basic concepts of microsystems and the advantages of miniaturization.
- To study the various materials and their properties used for micromachining techniques.
- To Analyze the fundamentals of micromachining and micro fabrication techniques.
- To impart knowledge of the basic concepts of electromechanical effects, thermal effects, microfluidics, and integrated fluidic systems.
- To study the fundamentals of pressure sensors and accelerometer sensors through design and modelling.

Course Outcomes

1. Outline the basic overview of MEMS and Microsystems with broad category of MEMS & Micro system applications.
2. Understanding the working principles of Microsystems.
3. Explain the Scaling Laws in Miniaturization and Materials for MEMS and Microsystems
4. Understand the Micro system Fabrication Process and analyze the different Micro manufacturing process and Applications.
5. Analyze the different types of RF switches, Various Switching Mechanism and their applications.

UNIT-I

Overview of MEMS and Microsystems: MEMS and Microsystems, Typical MEMS and Microsystems products, Evolution of Micro fabrication, Microsystems and Microelectronics, The Multidisciplinary nature of microsystem design and manufacture, Microsystems and Miniaturization, Application of Microsystems in the automotive industry, Application of Microsystems in other industries, Health care industry, Aerospace industry, Industrial products, Consumer products, Telecommunications. Markets for Microsystems.

Learning outcome:

- Understand basic building blocks of a microsystems. (L2)
- Evaluate the Microfabrication, Microsystem and Microelectronics. (L3)
- Explain the applications of MEMS in the industry. (L2)

UNIT-II

Working Principles of Microsystems: Introduction, Microsensors, Acoustic Wave Sensors, Biomedical sensors and Biosensors, Chemical sensors, Pressure sensors, Thermal sensors. Micro actuation: Actuation using thermal forces, shaped memory alloys, piezoelectric crystals, Electrostatic forces. MEMS with Micro actuators: Microgrippers, Micromotors, Microvalves, Micropumps, Micro accelerators, Micro fluidics.

Learning outcome:

- Understand basic principles of the microsensors. (L2)
- Discuss the working principles of micro actuators. (L2)

UNIT-III

Scaling Laws in Miniaturization: Introduction to scaling, Scaling in Geometry, Scaling in Rigid, Body Dynamics, Scaling in Electrostatic Forces, Scaling in Electromagnetic Forces, Scaling in Electricity, Scaling in Fluid Mechanics, Scaling in Heat Transfer. **Materials for MEMS and Microsystems**: Introduction, Substrates and wafers, Active substrate martial 's, Silicon as a substrate material. Silicon compounds, Silicon piezo resistors, Gallium Arsenide, Quartz, Piezoelectric crystals, Polymers, Packing materials.

Learning outcome:

- Explain the scaling in geometry for microsystems. (L2)
- Classify the different types of materials are used for microsystems. (L2)

UNIT-IV

Micro System Fabrication Process: Photolithography, Ion Implantation, Diffusion, Oxidation, Chemical Vapour Deposition, Physical Vapour Deposition, Deposition by Epitaxial, Etching. Overview of Micro manufacturing and Applications: Bulk Micro manufacturing any one example of application, Surface Micromachining-any one example of application. LIGA Process any one example of application.

Learning outcome:

- Understand the steps to fabricate the microsystems(L2)
- Outline the overview of Micro manufacturing and Applications. (L2)

UNIT-V

Applications of Mems Switching: Introduction, Switch parameters, Basics of switching, Mechanical switches, electronic switches for RF and microwave applications, Mechanical RF switches, PIN diode RF switches.

Learning outcome:

- Understand Basics in micro switches for micro wave applications(L2)
- Classify MEMS switches and modes of operation. (L2)

Text Books

1. Tai-Ran Hsu, "MEMS and Microsystems: Design and Manufacture", Tata McGraw Hill, (2002).
2. Gabriel M. Rebeiz, "RFMEMS Theory, Design and Technology", Wiley India Pvt Ltd.

Reference Books

1. Stephen D. Senturia, "Microsystem Design", Springer International Edition, (2010).
2. Mohamed Gad-El-Hak, " The MEMS H and book ", CRC Press, (2002).

Subject Code	Subject Name	L	T	P	C
R20ECE-PE4101.5	Digital Signal Processors &Architecture **(Professional Elective Course-3)**	3	0	0	3

Course Objectives:

- To describe unique features of Digital Signal Processing.
- To demonstrate various computational parameters of DSP devices.
- To introduce architectural improvements in programmable DSP devices.
- To expose to basic DSP algorithms.
- To outline DSP processors for developing various applications.

Course Outcomes:

1. Summarize features of Digital Signal Processing.
2. Evaluate dynamic range and precision for the given DSP system.
3. Explain architectural features of DSP processors.
4. Analyze the performance of DSP algorithms on a programmable DSP platform for a given application.
5. Select DSP processors for building real-time applications.

UNIT-I

Introduction to Digital Signal Processing: A Digital signal processing system, the sampling process, discrete-time sequences, Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT), linear time-invariant systems, digital filters, decimation, and interpolation.

Learning Outcomes:

- Outline DSP algorithms to be implemented on a digital signal processing system
- Describe process of decimation and interpolation techniques

UNIT-II

Computational Accuracy in DSP: Implementations Number formats for signals and coefficients in DSP systems, Dynamic Range and Precision, Sources of Error in DSP Implementation, A/D Conversion Errors, D/A Conversion Errors

Learning Outcomes:

- Identify sources of errors in DSP implementation
- Estimate quantization no is e in ADCs

UNIT-III

Architecture for Programmable DSP Devices: DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Programmability and Program Execution, Speed Issues, Commercial Digital Signal Processing Devices, Data Addressing Modes of TMS320C54xx Processors, Memory space of TMS320C54xx Processors, TMS320C54xx Instructions and Programs

Learning Outcomes:

- Illustrate various building blocks of programmable DSP devices
- Identify memory space and addressing modes of TMS320C54xx Processors

UNIT-IV

Implementation of Basic DSP Algorithms The Q-notation, FIR Filters, IIR Filters, Interpolation Filters, PID Controller, Adaptive Filters, 2-D Signal Processing.

Learning Outcomes:

- Develop different types of digital filters for implementing on a DSP Processor
- Illustrate various adaptive filters for implementing on a DSP processor

UNIT-V

Implementation of FFT Algorithms: An FFT Algorithm for DFT Computation, A Butterfly Computation, Bit Reversed Index Generation, 4-point FFT Implementation on the TMS320C54xx, Computation of the Signal Spectrum.

Learning Outcomes:

- Test FFT Algorithms on TMS320C54xx Processors

Text Books:

1. B. Venkataramani and M. Bhaskar, Digital Signal Processors, Architecture, Programming and Applications, TMH, 2002.
2. Avtar Singh and S. Srinivasan, Digital Signal Processing, Thomson Publications, 2004.

References:

1. J.G. Proakis, Algorithms for Stat is tical Signal Processing, Pearson, 2002.
2. Jonatham Stein, Digital Signal Processing, John Wiley, 2005.
3. K. Padmanabhan, R. Vijayarajeswaran, Ananthi. S, A Practical Approach to Digital Signal Processing. New Age International, 2006/2009
4. Lapsley Tal., DSP Processor Fundamentals - Architectures & Features, S. Ch and & Co., 2000

Subject Code	Subject Name	L	T	P	C
R20ECE-PE4102.1	Mobile and Cellular Communications **(Professional Elective Course-4)**	3	0	0	3

Course Objectives:

- Familiarize the basic elements of cellular mobile radio system design and its performance criteria.
- Introduce the different antenna system designs for the reduction of interference and cell coverage in different terrains.
- Familiarize various cell site and mobile antennas for cellular mobile Communication systems.
- Illustrate the concepts of frequency management and channel assignment mechanisms in mobile Communications.
- Distinguish various h and off mechanisms and cell splitting techniques in mobile Communication systems.

Course Outcomes:

1. Demonstrate the fundamentals of cellular radio system design and its basic elements. (L2)
2. Analyze the impact of co-channel and non-co channel interference on signal quality, traffic performance, and cellular coverage in mobile networks. (L4)
3. Design antenna systems suitable for various mobile Communication scenarios, considering performance and coverage requirements. (L3)
4. Explain the radio channel assignment and frequency management used in mobile Communications. (L2)
5. Analyze and propose solutions for efficient h and off strategies, cell splitting techniques, and minimizing dropped call rates in cellular networks. (L4)

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 an Omni directional Antenna system, Cell splitting, consideration of the components of Cellular system.

Learning outcomes:

- 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 network for an 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:

- Understand the concept of Co-Channel and Non-co channel Interference. (L2)

Applications:

- To get peer-to-peer communication applications and 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:

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

Applications:

- Desired antenna configurations can be considered for any network
- To get more efficiency in any communication network, the 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 assignment to cell sites and mobile units, channel sharing and borrowing, sectorization, overlaid cells, non-fixed channel assignment.

Learning outcomes:

- 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
- Improve frequency spectrum reuse, spectrum efficiency time
- Invalid calls load reduced and improve the network efficiency.

UNIT –V

H and off Techniques: H and off, dropped calls and cell splitting, types of h and offs, h and off invitation, delaying h and off, forced h and off, mobile assigned h and off. Inter system h and off, cell splitting, microcells, vehicle locating methods, dropped call rates and their evaluation. Introduction to 4G, 5G, 6G wireless Networks.

Learning outcomes:

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

Applications:

- Wide area Communication services
- Uninterrupted mobile conversations

Text Books

1. Mobile Cellular Tele Communications–W.C.Y. Lee, Tata Mc Graw Hill, 2nd 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 Mc Graw Hills, 3rd Edition, 2006.
3. Mobile Cellular Communication –G. Sasibhushana Rao Pearson Wireless Communication and Networking John W. Mark and Weihua Zhqung, PHI, 2005.

Subject Code	Subject Name	L	T	P	C
R20ECE-PE4102.2	VLSI Testing &Testability **(Professional Elective Course-4)**	3	0	0	3

Course Objectives:

- Impart knowledge on the basic faults that occur in digital systems.
- 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.
- Provide exposure to approaches for introducing BIST into logic circuits, memories, and embedded cores.

Course Outcomes:

1. Model digital circuits at logic and RTL levels.
2. Simulate digital ICs in the presence of faults and evaluate the given test set for fault coverage.
3. Generate test patterns for detecting single stuck faults in combinational and sequential circuits.
4. Identify schemes for introducing testability into digital circuits with improved fault coverage.
5. Compare different approaches for introducing BIST into logic circuits, memories and embedded cores

UNIT- I

Introduction to Test and Design for Testability (DFT) Fundamentals, Modeling: Modeling digital circuits at logic level, register level and structural models. Levels of Modeling. 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 Modeling: 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.

Learning Outcomes:

- Show a given circuit in to a scan design. (L2)
- Analyze effect of logic built in self-test (a DFT technique) in VLSI circuits designing. (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 test ability. (L3)

Text Books

1. Miron Abramovici, 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
R20ECE-PE4102.3	Industrial IOT **(Professional Elective Course-4)**	3	0	0	3

Course Objective:

- To explore the IoT applications in industrial systems.
- To develop design skills in industrial IoT.
- To expose the state of art development in Industry 4.0 and its applications.
- To Design Software IIoT Systems
- To Experiment IoT based solutions for real time industrial applications

Course Outcomes:

1. Interpret industrial revolution and integration of different technologies as Industry 4.0. (L2)
2. Illustrate the Industrial Internet of Things Reference Architecture and industrial business processes. (L2)
3. Interpret the components of IIoT and Network Layer Protocols for data transmission. (L2)
4. Extend the Data acquisition and data analytics to IIoT and IIRA architecture. (L2)
5. Identify the application designs of IIoT in various industry domains. (L3)

UNIT-I

INDUSTRY 4.0: Cyber Physical Systems and Next Generation Sensors, Collaborative Platform and Product Lifecycle Management, Augmented Reality and Virtual Reality, Artificial Intelligence, Big Data and Advanced Analysis

Learning outcomes:

- Understand the concept of Industrial Revolution4.0(L1).
- Understand the different platforms used for IIOT Product development(L2)

UNIT-II

INDUSTRIAL IoT: IIoT-Introduction, Industrial IoT: Business Model and Reference Architecture: IIoT-Business Models, Industrial IoT- Layers: IIoT Sensing, IIoT Processing, IIoT Communication, IIoT Networking

Learning outcomes:

- Understand key IIoT concepts including identification, sensors, localization, wireless protocols, data storage and security (L2)
- Differentiate the different Architectures and business models to develop the Product. (L2)

UNIT-III

IIoT ANALYTICS: Big Data Analytic s and Software Defined Networks, Machine Learning and Data Science, Julia Programming, Data Management with Hadoop.

Learning outcomes:

- Identity Different machine Learning techniques used to develop IOT product(L3)
- Identify Data Management with Hadoop techniques used for IOT product development (L3)

UNIT-IV

IoT SECURITY: Industrial IoT Security and Fog Computing Cloud Computing in IIoT, Fog Computing in IIoT, Security in IIoT

Learning outcomes:

- Understand the different concepts involved in Fog Computing(L2)
- Examine the different techniques of Fog computing used for IOT Security. (L3)

UNIT-V

CASE STUDY: Industrial IoT- Application Domains: Oil, chemical and pharmaceutical industry, Applications of UAVs in Industries, Real case studies: Milk Processing and Packaging Industries, Manufacturing Industries.

Learning outcomes:

- Acquire knowledge how to do Projects in IOT domain(L3)
- Examine the different ongoing Projects in IIOT Domain(L3)

Text Books

1. Industry4.0: The Industrial Internet of Things", by Alasdair Gilchrist(Apress), 2017
2. Industrial Internet of Things: Cyber manufacturing Systems" by Sabina Jeschke, Chr is tian Brecher, Houbing Song, D and a B. Rawat (Springer), 2017

References

1. Hands-On Industrial Internet of Things: Create a powerful Industrial IoT by Giacomo Veneri, Antonio Capasso, Packt, 2018.

Subject Code	Subject Name	L	T	P	Credits
R20ECE-PE4102.4	RF Circuit Design **(Professional Elective Course-4)**	3	0	0	3

Course Objectives:

- Define the characteristics of passive components of RF Circuits.
- Understand the design principles of different stages of RF amplifiers.
- Characterize LNA (Low Noise Amplifier) design.
- Design various RF power amplifiers.
- Analyze various analog communication circuits.

Course Outcomes:

- Understand the characteristics of passive components of RF circuits (L1).
- Design various Radio Frequency (RF) amplifiers (L6).
- Construct LNA to integrate into Communication systems suitable for industrial applications (L6).
- Classify various types of RF power amplifiers (L2).
- Apply system design skills to develop analog communication circuits to build up a complex RF system (L3).

UNIT-I

Characteristics of passive components for RF circuits: Passive RLC networks. Transmission lines. Two-port network modeling, S-parameter model, The Smith Chart and its applications.

Active devices for RF circuits: Si Ge MOSFET, Ga Asp HEMT, HBT and MESFET. PIN diode. Device parameters and their impact on circuit performance.

Learning Outcomes:

- Understand the characteristics of passive RLC Circuits(L1)
- Construct transmission line and S-Parameter models for various passive components (L3).
- Understand the characteristics of various active devices for RF Circuits (L1)

UNI-II

RF Amplifier Design: single and multi-stage amplifiers. Review of analog filter design. Low-pass, high-pass, Band pass and Band -reject filters. Band width Estimation Methods. Voltage references and biasing.

Learning Outcomes:

- Classify various stages of Radio Frequency (RF) Amplifiers(L2).
- Build and review different types of analog filters (L3)

UNIT-III

Low No is e Amplifier design: noise types and their characterization, LNA topologies, power match vs. noise match. Linearity and large-signal performance.

Learning Outcomes:

- Develop an LNA to integrate in analog Communication systems (L6).

UNIT-IV

RF Power amplifiers: General properties. Class A, A Band C PAs. Class D, E and F amplifiers.

Learning Outcomes:

- Design various types of RF Power amplifiers(L2)

UNIT-V

Analog communication circuits: Modulation of power amplifiers. Mixers, phase-locked loops, oscillators and synthesizers. Design and performance characterization. Trans-receiver

design.

Learning Outcomes:

- Experiment with various RF Circuit components to develop analog communication circuits to build up a complex RF system (L3).

Textbooks

2. Behzad Razavi. 2000. Design of Analog CMOS Integrated Circuits (1 ed.). McGraw-Hill, Inc., New York, NY, USA.

Reference

1. The Design of CMOS Radio Frequency Integrated Circuits, Lee Thomas H, Cambridge University Press.
2. VLSI for wireless communication, Bosco Leung, Pearson Education

Subject Code	Subject Name	L	T	P	C
R20ECE-PE4102.5	Speech Signal Processing **(Professional Elective Course-4)**	3	0	0	3

Course Objectives:

- To impart knowledge on anatomy and physiology of Speech Production system and perception model.
- To instruct speech intime 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 homomorphic system and its use in extracting the vocal tract information from speech using strum and study various Speech Processing applications.

Course Outcomes:

- Formulate a vocal tract model based on the speech production mechanism.
- Solve features of speech in the time domain.
- Describe feature extraction techniques in the frequency domain.
- Use LPC coefficients for pitch and formant detection.
- Describe different speaker recognition systems.

UNIT –I

Fundamentals of Digital Speech Processing: Anatomy & Physiology of Speech Organs, The process of Speech Production, Acoustic Phonetics, Articulatory 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 Mechan is m(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 is, Comb filter, Wiener filter, Multi microphone Approach.

Learning Outcomes:

- Illustrate properties of convolution in Cepstrum analyze is of speech (L2)
- Apply Cepstrum analyze is 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 Signal s-L.R. Rabiner and S.W. Schafer. Pearson Education.
2. Speech Communications: Human &Machine-Douglas O'Shaughnessy, 2ndEd., Wiley India, 2000.
3. Digital Processing of Speech Signal s. L.R Rabinar and R W Jhaung, 1978, Pearson Education

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
R20ECE-PE4103.1	Satellite Communications (**Professional Elective-5**)	3	0	0	3

Course Objectives:

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

Course Outcomes:

- Apply Kepler's laws to determine various orbital parameters of satellite communication (L3)
- Characterize various satellite sub systems and its functionality(L2)
- Apply transmission theory to compute the link power budget and study different multi-access techniques for satellite Communication system(L3)
- Understand earth station technology, low orbits, and geostationary satellite s(L2)
- Illustrate basic principles of GPS and satellite navigation (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.

Learning Outcomes

- Illustrate the basic concepts of satellite communication and different Frequency allocations for satellite services.
- Understand the satellite orbits

Applications:

- Satellite Communication services

UNIT-II

Satellite Subsystems: Altitude and orbit control system, telemetry, tracking, Command and monitoring, power systems, Communication subsystems, Satellite antenna Equipment reliability and Space qualification

Learning Outcomes

- Analyze various satellite subsystems and its functionality

Applications

- Control systems and telemetry

UNIT-III

Satellite Link Design: Basic transmission theory, system no is e 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: Satellite Switched TDMA On board processing, DAMA, Code Div is ion Multiple access (CDMA), Spread spectrum transmission and reception.

Learning Outcomes

- Analyze the satellite orbits and link design for transmission &reception of signals
- Choose appropriate multiple access technique for a given satellite communication application

Applications

- Satellite Communication services

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.

Learning Outcomes

- Design satellite Communication system using geo satellites

Applications

- Antennas tracking systems

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.

Learning Outcomes

- Understand basic concepts of GPS and its architecture
- Explain about the basic principles of radio and satellite navigation

Applications

- Satellite navigation services
- GPS user location finding

Text Books

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

Reference Books:

1. Satellite Communication: Design Principles–M. Richharia, BS Publications, 2nd Edition, 2003.
2. Satellite Communication -D.C Agarwal, Khanna Publications, 5thEd
3. Fundamentals of Satellite Communications K.N. Raja Rao, PHI, 2004 Satellite Communications–Denn is Roddy, McGraw Hill, 2ndEdition, 1996

Subject Code	Subject Name	L	T	P	C
R20ECE-PE4103.2	SOC Architecture (**ProfessionalElective-5**)	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 Multi level Cache.
- Learn the SOC Design approach, Design and evaluation, Applications Like Image compression etc.

Course Outcomes

1. Understand the SoC architecture and SoC design approach
2. Design of processor architectures like micro architecture, VLIW and superscalar 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. Design of SoC for specific application like AES and JPEG compression

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:

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

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 Re is , 1st Ed., 2004, Springer

Reference Books

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

Subject Code	Subject Name	L	T	P	C
R20ECE-PE4103.3	Operating System for Embedded and IoT System (**Professional Elective-5**)	3	0	0	3

Course Objectives:

- To introduce the Basics of real time operating systems
- To educate the students on various IOT operating system tools
- To teach the students the micro python features and instructions
- To impart knowledge on building IoT withstm32cubedevelopment platform
- To explain the overview of Windows10 IoT core features.

Course Outcomes:

1. Understanding Free RTOS Techniques of Cube Software Tool.
2. Knowledge on Micro Python Features.
3. Understand and Acquire Knowledge on Micro python Hardware.
4. Apply Basic Data Structures and Functions of Micro Python.
5. KnowledgeonWindows10ForIotOperatingSystem.

UNIT-I

RTOS: Operating system Basics, Types of operating systems, Tasks, Process and Threads, Multiprocessing and Multitasking, Task Scheduling, Threads, Processes and Scheduling, Task communication, Task synchronization, Device Drivers

Learning Outcomes:

- Explain the different characteristics and constraining parameters of Realtime system. (L2)
- Summarize the processes and resources related to realtime systems. (L2)

UNIT-II

Processes, Tools, Toolchains and Hardware: Design to Code -A Practical Approach, The Stm32cube Software Tool, The Practical Tool Set, The Stm32 Graphical Tool- Stm32cube Mx Details, The Stm32cubehal, Free RTOS Configuration in A Cube Project, TheStm32cube Cubide Development Platform.

Learning Outcomes:

- Explain the difference characteristics and constraining parameters of realtime system. (L2)
- Explain the STM32 cubehal processes and development platform. (L2)

UNIT-III

Introducing Micropython: Micropython Features, Micropython Limitations, What Does Micropython Run On?, Experimenting With Python On Your Pc, How Micropython Works, Off And Running With Micropython

. **Learning Outcomes:**

- Compare the operating system characteristics of Micropython with real time operating system (L2).
- How Micro python works and running in realtime platform. (L2)

UNIT-IV

How To Program In Micropython: Basic Concepts, Basic Data Structures, Statements, Modularization; Modules, Functions, And Classes, Learning Python By Example.

Learning Outcomes:

- Analyze the Micropython Basics and Modules with an example(L4)
- Discuss the statements and modularization of Micropython. (L4)

UNIT-V

Introducing the Windows 10 IOT Core: Windows 10 IOT Core Features, Things You'll Need, Getting Started with Windows 10 IOT Core

Learning Outcomes:

- Outline the handling of timers and their services in Windows 10 IOT core. (L2)
- L is t the importance of Windows10IOTcore. (L2)

Text Books

1. Raj Kamal, Embedded Systems: Architecture, Programming and Design, 3rd edition, McGraw Hill Education, 2017...
2. Jim Cooling, Real-Time Operating Systems Book 2 - The Practice: Using Stm Cube, Freertos And the Stm32 Discovery Board (Engineering of Real-Time Embedded Systems) Jim Cooling, Isbn-10: 1973409933, Isbn-13: 978-1973409939.

References

1. Charles Bell, Micropython For the Internet of Things, A Beginner's Guide to Programming with Python on Microcontrollers, Apress
2. Charles Bell Windows 10 For the Internet of Things 1st Edition, Apress,

Subject Code	Subject Name	Hours			Credits
R20ECE-PE4103.4	Electromagnetic Interference &Electro Magnetic Compatibility (**Professional Elective-5**)	3	0	0	3

Course Objectives:

- To introduce basics of EMI, EMC.
- To explain concepts of EMI coupling mechanism and its mitigation technique.
- To convey current EMC standards and about various measurement techniques
- To introduce shielding techniques
- To transmit knowledge on EMI and EMC test equipment

Course Outcomes:

1. Describe sources of EMI and its victims(L2)
2. Analyze various coupling mechanisms (L4)
3. Assess various EMI mitigation techniques (L5)
4. Explain various EMI and EMC instruments(L2)
5. Categorize different shielding techniques(L2)

UNIT-I

Basic Theory: Introduction to EMI and EMC, Intra and inter system EMI, Elements of Interference, Sources and Victims of EMI, Conducted and Radiated EMI emission and susceptibility, Case Histories, Radiation hazards to humans, Various issues of EMC, EMC Testing categories, EMC Engineering Application.

Learning Outcomes

- Define sources of Electromagnetic Interference(L1)
- Explain the various issues, Case Histories and Test Categories of Electromagnetic Compatibility (L2).

UNIT-II

Coupling Mechan is m: Electromagnetic field sources and Coupling paths, coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radiative coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients.

Learning Outcomes

- Classify various coupling mechanisms (L2)
- Explain the concepts of Differential, Impedance, Inductive and Capacitive Coupling, Cable related emissions and Transient Sources (L2)

UNIT-III

EMI Mitigation Techniques: Working principle of Shielding and Murphy "s Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketing and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for large systems, Grounding for mixed signal systems, Filter types and operation, Surge protection devices, Transient protection.

Learning Outcomes

- Compare various EMI mitigation techniques(L2)
- Describe the Grounding strategies for large systems and mixed signal systems(L2)

UNIT-IN

Standards and Regulation: Need for Standards, Generic/General Standards for Residential and Industrial environment, Basic standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC,

ACEC, Electro Magnetic emission and susceptibility standards and specifications, MIL461E Standards.

Learning Outcomes

- Explain various standards for residential and industrial environment(L2)
- List the standard national and international EMI standardizing Organizations and Specifications (L1).

UNIT-V

EMI Test Methods and Instrumentation: Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, shielded chamber, Shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Antennas, Current probes, MIL -STD test methods, Civilian STD test methods. **Contemporary Issues:** Case studies on EMI & EMC problems in the field of defense and aerospace applications.

Learning Outcomes

- Classify different EMI test methods(L2)
- Describe the various Instrumentation required for EMI Tests(L2)
- List the different EMI/EMC problems in the present contemporary issues(L1)
- Identify the solutions to the problems occurred in the present defence and aerospace scenarios (L3)

Text Books:

1. Clayton Paul, "Introduction to Electro magnetic Compatibility", WileyInter-science 2006.

References:

1. V. Prasad Kodali, "Engineering Electromagnetic Compatibility", IEEE Press, 2006.
2. Henry W. Ott, "Electromagnetic compatibility Engineering", John Wiley & Sons, 2009.

Subject Code	Subject Name	L	T	P	C
R20ECE-PE4103.5	Digital Image and Video Processing (**Professional Elective-5**)	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:

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 color models for color image processing
4. Justify DCT and wave let 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-stat is tics, 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 d is continuities, 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 Ostermann and Ya–quin Zhang," Video processing and communication ", 1st edition, PHI

References:

1. Rafae lC. 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.
3. S Jayaraman, SE sakkirajan, T Veerakumar, "Digital Image processing ", Tata McGraw Hill.
4. M. Tekalp," Digital video Processing", Prentice Hall International

Subject Code	Subject Name	L	T	P	C
R20ECE-OE4103	Operating Systems Concepts **(OpenElective-3)**	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. Understand Mass Storage Management(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.

Multithreaded Programming: Overview, Multithreading models, Threading Issues.

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

Learning Outcomes: Student should be able to

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

UNIT-III:

Synchronization: Process Synchronization, The Critical-Section Problem, 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

- Analyze various solutions for process synchronization. (L4).
- 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, Dem and Paging, Page-Replacement Algorithms, Thrashing.

Learning Outcomes: Student should be able to

- Demonstrate the ability to implement various memory management techniques(L2)
- Illustrate various demand paging techniques. (L2).

UNIT-V:

File system Interface- the concept of a file, Access Methods, Directory and D is k 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, Device drivers

Learning Outcomes: Student should be able to

- Identify various file management and optimization techniques. (L2).
- Understand how data streams are exchanged between I\O subsystems. (L2).
- Analyze various storage structures to store the data in secondary memory. (L4).
- Analyze different disk scheduling algorithms. (L4).

Text Books:

1. Silberschatz A, Galvin P B, and Gagne G, Operating System Concepts, 9th edition, Wiley, 2013.
2. Tanenbaum A S, Modern Operating Systems, 3rd edition, Pearson Education, 2008. (for Inter process Communication and File systems).

References:

1. Tanenbaum A S, Woodhull A S, Operating Systems Design and Implementation, 3rd edition, PHI, 2006.
2. Dhamdhere D M, Operating Systems A Concept Based Approach, 3rd edition, Tata McGraw-Hill, 2012.
3. Stallings W, Operating Systems -Internals and Design Principles, 6th edition, Pearson Education, 2009.
4. Nutt G, Operating Systems, 3rdedition, Pearson Education, 2004.

Subject Code	Subject Name	L	T	P	C
R20CIT-OE4101	Introduction To Machine Learning **(Open Elective-3)**	3	0	0	3

Course Objectives:

- To familiarize with a set of well-known supervised unsupervised and semi-supervised learning algorithms.
- The ability to implement some basic machine learning algorithms
- 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.

Course Outcomes:

1. Familiarize the Basics of machine learning that make it useful to real- world Problems. (L2)
2. Apply regression algorithms for finding relationships between data variables and dec is ion 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. Identify the context of neural networks and deep learning algorithms(L2)

UNIT - I:

Introduction: Well-posed learning problems, designing a learning system, Perspectives and issues in machine learning. Applications of machine learning

Concept Learning

Concept learning and the general to specific ordering. Introduction, A concept learning task, Concept learning as search, Find-s: finding a maximally specific hypo the is , version spaces and the candidate elimination algorithm, Remarks on version spaces and candidate elimination, Inductive bias.

Learning Outcomes:

- Summarize the process of machine learning. (L2)
- Recognize various machine learning Applications. (L1)
- Recognize various steps in machine learning. (L1)
- Understand various candidate elimination algorithms (L2)

UNIT – II

Decision Tree Learning

Dec is ion tree representation, Appropriate problems for decision tree learning , the basic decision tree learning algorithm, Hypothes is space search in decision tree learning , Inductive bias in decision tree learning , Issues in decision tree learning

Learning Outcomes:

- Summarize the process of classification. (L2)
- Construct a decision tree for any sample data. (L3)

UNIT – III

Bayesian learning : Bayes theorem, Byes theorem and concept learning , Maximum likelihood and least squared error hypotheses , Maximum likelihood hypotheses for predicting probabilities, Bayes optimal classifier, an example learning to classify text, Bayesian belief networks

Learning Outcomes:

- Calculate Bayes probability for any given data(L4)
- Calculate Naïve Bayes probability. ((L4)

- Distinguish the process of Bayes and Naïve Bayes probability calculation(L4)

UNIT - IV:

Computational learning theory – 1: Probability learning an approximately correct hypothesis, Sample complexity for infinite Hypo the s is spaces, the mistake bound model of learning - Instance- Based learning - Introduction.

Learning Outcomes:

- Understand Probability learning and Instance- Based learning (L2)

UNIT - V

Computational learning theory – 2: K- Nearest Neighbor Learning , Locally Weighted Regression, Radial Bas is Functions, Case-Based Reasoning, Remarks on Lazy and Eager Learning

Learning Outcomes:

- Understand the concept of classification(L2)
- Distinguish lazy Lazy and Eager Learning . (L4)

Text Books:

1. Tom M . Mitchell, Machine Learning , MGH

Reference Books:

2. E the m Alpaydin, Introduction to machine learning , 2ndedition, PHI.
3. Kevin P. Murphy, "Machine Learning , "A Probabilistic Perspective, MIT Press, 2012

Subject Code	Subject Name	L	T	P	C
R20CSS-OE4101	**Mobile App Development (OpenElective-3)**	**3**	**0**	**0**	**3**

UNIT – I

Introduction to Android Operating System: Android OS design and Features – Android development framework, SDK features, Installing and running applications on Android Studio, Creating AVDs, Types of Android applications, Best practices in Android programming, Android tools. Android application components – Android Manifest file, Externalizing resources like values, themes, layouts, Menus etc., Resources for different devices and languages, Runtime Configuration Changes Android Application Lifecycle – Activities, Activity lifecycle, activity states, monitoring state changes

UNIT – II

Android User Interface: Measurements – Device and pixel density independent measuring UNIT–s Layouts–Linear, Relative, Grid and Table Layouts User Interface (UI) Components – Editable and non-editable Text Views, Buttons, Radio and Toggle Buttons, Checkboxes, Spinners, Dialog and pickers Event Handling–Handling clicks or changes of various UI components Fragments – Creating fragments, Lifecycle of fragments, Fragment states, Adding fragments to Activity, adding, removing and replacing fragments with fragment transactions, interfacing between fragments and Activities, Multi-screen Activities

UNIT – III

Intents and Broadcasts: Intent – Using intents to launch Activities, Explicitly starting new Activity, Implicit Intents, Passing data to Intents, Getting results from Activities, Native Actions, using Intent to dial a number or to send SMS Broadcast Receivers – Using Intent filters to service implicit Intents, Resolving Intent filters, finding and using Intents received within an Activity Notifications – Creating and D is playing notifications, Displaying Toasts

UNIT – IV

Pers is tent Storage: Files – Using application specific folders and files, creating files, reading data from files, listing contents of a directory Shared Preferences – Creating shared preferences, saving and retrieving data using Shared Preference

UNIT – V

Database – Introduction to SQLite database, creating and opening a database, creating tables, inserting retrieving an deleting data, Registering Content Providers, Using content Providers (insert, delete, retrieve and update)

Text Books:

Professional Android 4 Application Development, Reto Meier, Wiley India, (Wrox), 2012 Android Application Development for Java Programmers, James C Sheusi , Cengage Learning , 2013

References:

1. Beginning Android 4 Application Development, Wei-Meng Lee, Wiley India (Wrox), 2013

Course Code	Course Title	L	T	p	Credits
R20EEE-OE4101	Basic Electrical Distribution Systems **(OpenElective-3)**	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 with 'n' 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: Importance of voltage control, Methods of voltage control, Equipment for voltage control, Effect of shunt capacitors, Effect of series capacitors, Effect of AVB/AVRon voltage control**,** Line drop compensation and Voltage fluctuations.

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 re closures – 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 Turan Gonen, McGraw–hill Book Company.

Reference Books:

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

Subject Code	Subject Name	L	T	P	C
R20ECE-OE4102	Mechatronics **(OpenElective-3)**	3	0	0	3

Course Objectives:

- To introduce the integrative nature of Mechatronics.
- To describe the different components and devices of mechatronics systems
- To describe various applications and future trends of mechatronics systems

Course Outcomes:

1. Describe Mechatronics design process and mechatronics system devices(L2)
2. Illustrate Solid state electronic devices and its applications in various mechatronics systems (L2)
3. Identify the different types of electro mechanical systems and its applications (L4)
4. Analyze different types of Digital electronics and systems and its applications(L4)
5. Design of mechatronics systems for future trends. (L3)

UNIT I

Mechatronics systems – elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and d is advantages of mechatronics systems. Sensors and transducers, types, d is placement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

Learning Outcomes:

- Different examples for mechatronics systems (L1)
- Advantages of mechatronics systems(L2)
- Application of different types of Sensors and transducers(L1)

UNIT II

Solid state electronic devices-PN junction diode, BJT, FET, DIAC, TRIAC and LEDs.
Analog signal conditioning, operational amplifiers, no is e reduction, filtering.

Learning Outcomes:

- Different examples for Solid state electronic devices(L1)
- Different types of amplifiers and its applications (L1)

UNIT III

Hydraulic and pneumatic actuating systems - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems – basic principles and elements.

Learning Outcomes:

- Know about electro-pneumatic, hydro-pneumatic systems(L2)
- Applications of Mechanical actuating systems and electrical actuating systems(L4)

UNIT IV

Digital electronics and systems, digital logic control, micro processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control. Dynamic models and analogies, System response. Process Controllers – Digital Controllers, Programmable Logic Controllers

Learning Outcomes:

- Know about Digital electronics and systems(L2)
- Know about comparison of PLCs and computers(L2)
- Distinguish between Process Controllers and Programmable Logic Controllers(L4)

UNIT V

System and interfacing and data acquisition – Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing – data flow in DSPs, block diagrams, typical layouts, Interfacing motor drives. Design of mechatronics systems & future trends.

Learning Outcomes:

- How to interface the systems for the purpose of data acquisition(L2)
- Different types of ADC and DAC converters(L4)
- Design of mechatronics systems for future trends(L3)

Text Books:

1. Mechatronics Integrated Mechanical Electronics Systems/K P Ramach and ran, GK Vijaya Raghavan& MS Balasundaram/WILEY India Edition

References:

2. Mechatronics/SmailiA, MradF/Oxford Higher Education, Oxford University Press
3. Mechatronics Source Book/Newton C Braga/Thomson Publications, Chennai.
4. Mechatronics–N. Shanmugam/ Anuradha Agencies Publishers.
5. Mechatronics System Design/Devdas shetty/Richard/Thomson.
6. Mechatronics/M.D. Singh/J.G. Joshi/PHI.
7. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4thEdition / W. Bolton/ Pearson, 2012
8. Mechatronics – Principles and Application / Godfrey C. Onwubolu/Elsevier, Indian print

Subject Code	Subject Name	L	T	P	C
R20ECE-OE4104	Data Base Management System **(OpenElective-4)**	3	0	0	3

Course objectives:

- Learn the fundamental concepts of database systems.
- Enable students to design ER diagram for any customized applications
- Learn simple and Complex queries using SQL.
- Learn schema refinement techniques (Normalization).
- Knowledge about transaction and recovery techniques.

Course Outcomes:

1. Understand File System Vs Databases.
2. Design and implement ER-model and Relational models.
3. Construct simple and Complex queries using SQL.
4. Analyze schema refinement techniques.
5. Design and build database system for a given real world problem

UNIT-I

INTRODUCTION- Database Vs File System, RDBMS, Database Users, Data Models; Instance and Data Independence; Three Tier Schema Architecture, Database System Structure, RDBMS Design: Introduction, Entities, Attributes Entity Set, Relationship Set, Specialization, and Generalization.

Learning Outcomes: Student will be able to

- Distinguish between Database System and File System(L2)
- Design a database relational model using ER diagrams. (L5)

UNIT-II

Relational operations & BasicsQL, Relational Algebra, Relational Operations, Relational Calculus, Tuple And Domain Relational Calculus.: Database Languages, Data Types, Integrity Constraints, Simple And Nested Queries, Implementation Of Different Types Of Joins, Stored Procedures

Learning Outcomes: Student will be able to

- Understand relational operations and calculus(L1)
- Implement simple and complex queries for relational data (L3)

UNIT-III

SCHEMA REFINEMENT (NORMALIZATION): Types Of Anomalies, Concept Of Functional Dependency, Normalization, Advantages, Types Of Normal forms(1NF, 2NFAnd 3NF), Boyce-Codd Normal Form(BCNF), Fourth Normal Form(4NF) .Lossless Join And Dependency Preserving Decomposition, .

Learning Outcomes: Student will be able to

- Identify anomalies and remove redundancies using Normal Forms(L2)
- Understand lossy and lossless decomposition. (L3)

UNIT-IV

TRANSACTION MANAGEMENT: Transaction, Transaction States, ACID Properties, Schedule, Serializability And Types, Concurrent Control, Concurrency Control Protocols, Crash Recovery: Introduction To ARIES, The Log, Write-Ahead Log Protocol, Recovering From A System Crash

Learning Outcomes: Student will be able to

- Understand transaction and serializability schedules. (L1)
- Understand concurrency control protocols on transactions. (L1)

UNIT-V

File Organization and Indexing, Physical Storage Media, RAID, File Organization. Indexing, B & B+ Tree Index files, Hashing Vs Indexing

Learning Outcomes: Student will be able to

- Understand basic concepts of File Organization and storage(L1).
- Understand Indexing and hashing for file processing. (L1)

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 .
3. Introduction to Database Systems, 8/e C J Date, PEA..

Subject Code	Subject Name	L	T	P	C
R20CIT-OE4102	Object oriented Analysis and Design **(OpenElective-4)**	3	0	0	3

Course Objectives:

- The focus of this course is on design rather than implementation.
- Introducing the Unified Process and showing how UML can be used within the process.
- Case study experience with architecture, analysis and design.
- Programmatic interactions using UML diagrams.
- Analyze and design solutions to problems using object-oriented approach.

Course Outcomes:

1. Compare and contrast object-oriented analysis and design.
2. Create class diagrams that model both the domain model and design model of a software system.
3. Analyzed the conceptual model of UML.
4. Create interaction diagrams and o the r diagrams that model the dynamic aspects of a software system.
5. Detailed case study experience with architecture, analysis and design.

UNIT I

Introduction: The Structure of Complex systems, The Inherent Complexity of Software, Attributes of Complex System, Organized and D is organized Complexity, Designing Complex Systems, Evolution of Object Model, Foundation of Object Model, Elements of Object Model, Applying the Object Model.

Learning Objectives:

- Define object-oriented analysis and design (OOA/D).
- Illustrate a brief example of complex systems.
- Define fundamental object model.

UNIT II

Classes and Objects: Nature of object, Relationships among objects, Nature of a Class, Relationship among Classes, Interplay of Classes and Objects, Identifying Classes and Objects, Importance of Proper Classification, Identifying Classes and Objects, Key abstractions and Mechanisms.

Learning Objectives:

- Understanding relationship between classes and objects
- Identification of key abstractions and mechanisms.

UNIT III

Introduction to UML: Why we model, Conceptual model of UML, Architecture, Classes, Relationships, Common Mechanisms, Class diagrams, Object diagrams.

Learning Objectives:

- Understanding of conceptual model.
- Implementation of structural diagrams like class, object.

UNIT IV

Basic Behavioral Modeling: Interactions, Interaction diagrams, Use cases, Use case Diagrams, Activity Diagrams

Advanced Behavioral Modeling: Events and signals, state machines, processes and Threads, time and space, state chart diagrams.

Learning Objectives:

- Analyze interaction diagrams.

- Analyze use case & activity diagrams.
- Create state chart diagrams for classes and use cases.

UNIT V

Architectural Modeling: Component, Deployment, Component diagrams and Deployment diagrams.

Case Study: The Unified Library application.

Learning Objectives:

- Create component and deployment diagrams.
- Analyze different components and run time elements

Text books

1. Object-Oriented Analysis and Design with Applications Grady BOOCH, Robert A. Maksimchuk, Michael W.ENGLE, Bobbi J. Young, Jim Conallen, Kellia Houston, 3rd edition, 2013, PEARSON.
2. The Unified Modeling Language User Guide Grady Booch, James Rumbaugh, Ivar Jacobson, 12th Impression, 2012, PEARSON.

Reference

- Object-oriented analysis and design using UML Mahesh P. Matha, PHI
- Head first object-oriented analysis and design Brett D. McLaughlin, Gary Pollice, O'Reilly
- Object-oriented analysis and design with the Unified process John W. Satzinger,
- Robert B. Jackson, Stephen D. Burd, Cengage Learning

Subject Code	Subject Name	L	T	P	C
R20CSS-OE4102	Software Engineering **(OpenElective-4)**	3	0	0	3

Course Objectives:

- Explain the phases of Software Development.
- Teach the customer requirement gathering techniques.
- Teach Software Design techniques
- Demonstrate coding standards
- Apply the testing techniques on software

Course outcomes:

1. Outline the various software development models that meet industry needs (L2)
2. Summarize the techniques used to ga the r different types of requirements for software development (L2)
3. Apply the principles of a design engineering process to develop software architecture and design patterns(L3)
4. Evaluate coding standards and testing methods to improve proficiency in coding and testing (L4)
5. Describe the types of risks, risk management strategies, and software quality techniques such as McCall's quality factors and Six Sigma(L2)

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.

Learning Outcomes:

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

Applications:

- Various models for different projects

UNIT-2

Software Requirements Engineering: Functional & Non-functional requirements, Feasibility studies, Requirements Elicitation and Analysis, requirements validation, Software Requirements Specification, Process and System Models, context models, behavioral model, Data model.

Learning Outcomes:

- Explain software development model (L2)
- Define functional and non-functional requirements for software development(L1)
- Analyze user requirements for a software(L4)

Applications:

- Finding Functional &Non-functional requirements for banking system

UNIT-3

Design Engineering: Design concepts, data design, software architecture, Architectural styles and patterns, User interface design - Golden rules, User interface analysis and design, Effective Modular Design.

Learning Outcomes:

- At the end of the module, students will be able to:
- List the software architecture style for the given problem. (L1)
- Build Golden rules for the given problem(L3)
- User Interface Analysis and Design (L5)

Applications:

- Data designing for banking system

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.

Learning Outcomes:

- Implementation of coding standards(L6)
- Apply different Testing concepts(L3)

Applications:

- Applying testing techniques on any software project

UNIT-5

R is k Management: R is k types, strategies, Estimation and Planning. Software Quality. McCall Quality factors, Six Sigma for Software Quality, Quality Assurance and its techniques.

Applications: analyze the risks in any software project

Learning Outcomes:

- Evaluate different Risk management techniques. (L5)

Text books:

1. Roger S. Pressman, Software Engineering, A practitioners 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. KK Aggarwal and Yogesh singh, Software engineering, 3rdEdition, New age International publication, 2008

Subject Code	Subject Name	L	T	P	C
R20 EEE-OE4104	Energy Conservation and Auditing **(Open Elective-4)**	3	0	0	3

Course objectives:

- To discuss essential aspects of the current and future energy scenario.
- To acquire knowledge on energy auditing and the use of audit instruments for energy audits.
- To study energy conservation systems and their importance.
- To understand the methods of improving energy efficiency in different electrical systems.
- To calculate lifecycle costing analysis and return on investment on energy efficient technologies.

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

1. Understand the current energy scenario and importance of energy resources(L2).
2. Understand the concepts of energy audit and energy audit instruments. (L2)
3. Understand the importance of energy conservation and energy conservation systems (L2).
4. Analyze the performance of electrical utilities and its efficient improvement approaches (L4).
5. Analyze life cycle costing and investment return on energy efficient technologies (L3).

UNIT-I:

Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of a growing economy, energy intensity on a purchasing power parity (PPP) basis, long-term energy scenario, India energy scenario, energy pricing, energy security, and energy strategy for the future.

Learning Outcomes:

- Understand the Energy resources and future energy scenario (L2).
- Understand the India energy scenario(L2).

UNIT-II:

Energy auditing: Energy audit- Definitions- concept- types of energy audit- energy index-cost index. Energy auditing- general & detailed energy audit, energy audit instruments. energy saving potential- Industrial energy use, Representation of energy consumption- pie charts-Sankey diagrams- Load profiles.

Learning Outcomes:

- Understand the basic definitions and types of energy audit(L2).
- Make use of audit instruments for energy audit(L3) .

UNIT-III:

Energy Conservation: Energy conservation systems- energy conservation and its importance, need of energy conservation, short, medium and long-term energy conversation systems, Energy Conservation Act-2001 and its features. Maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution,

Learning Outcomes:

- Understand salient features of energy conservation act-2001(L2).
- Understand about energy conservation systems (L2).

UNIT-IV:

Energy Efficiency and Performance of Electrical Utilities: Electrical system: Electricity billing, maximum dem and control, Transformer losses & Energy efficient transformers. Distribution losses in industrial systems. Assessment of transmission and Distribution losses in power systems. Harmonics-causes-effects-overcoming.

Learning Outcomes:

- Understand the concept of different energy efficient electrical utilities(L2)
- Analyze the performance of electrical utilities and discuss the improvement methods (L4).

UNIT-V:

Economic Aspects and Analysis : Economics Analysis – Depreciation Methods – Time value of money– Rate of return – Present worth method – Replacement analysis – Life cycle costing analysis – Energy efficient motors (basic concepts). Economics of energy efficient motors and systems.

Learning Outcomes:

- Analyze different economic aspects in energy management(L4).
- Understand the basic concepts of energy efficient motors(L2).

Textbooks:

1. GuidebooksforNationalCertificationExaminationforEnergyManager/Energy Auditors Book-1, General Aspects (available online)
2. GuidebooksforNationalCertificationExaminationforEnergyManager/Energy Auditors Book-3, Electrical Utilities (available online)
3. Energy efficient electric motors by John .C. Andreas, Marcel Dekker Inc Ltd–2nd edition, 1995.
4. Amlan Chakrabarti, "Energy Engineering and management", PHI Publication.

Reference Books:

1. Energy management by W.R. Murphy &G. Mckay Butterworth, Elsevier publications. 2012
2. S.C. Tripathy, "Utilization of Electrical Energy and Conservation", Mc Graw-Hill, 1991.
3. Doty, Steven; Turner, Wayne C, Energy Management Hand book(8thEdition), Fairmont Press, Inc., 978-0-88173-707-3

Subject Code	Subject Name	L	T	P	C
R20MEC-OE4103	Nano Materials **(OpenElective-4)**	3	0	0	3

Course objective:

- The course conveys the basic concepts relevant to nanomaterial properties, synthesis ,
- characterization and applications
- define 'nanomaterials'
- list common applications for nanotechnology.
- Explain how nanotechnology has influenced the field of information technology

Course outcomes:

1. Understand importance of Nanomaterials(L2)
2. Explain the properties of Nano Materials (L2)
3. Illustrate the different synthesis process used for getting Nanomaterials (L2)
4. Describe the various characterization techniques used for getting Nanomaterials(L2)
5. Explain the applications of Nanomaterials(L2)

UNIT-1

Introduction: H is tory of nanoscience, definition of nanometer, nanomaterials, Nano technology. Classification of Nano materials.

Learning outcomes:

- Understand importance of Nano materials

UNIT-II

Properties Of Materials: Mechanical properties, electrical properties, dielectric properties, thermal properties, magnetic properties, opt to electronic properties. Effect of size reduction on properties, electronic structure of Nano materials.

Learning outcomes:

- Explain the properties of Nano Materials

UNIT-III

Synthesis Of Nanomaterial: Stop-down (Nanolithography, CVD), Bottom-up (Sol-get processing, chemical synthesis). Wet Deposition techniques, Self-assembly (Supramolecular approach).

Learning outcomes:

- Illustrate the different synthesis process used for getting Nano materials

UNIT-IV

Characterization: TEM, SEM and SPM technique, Fluorescence Microscopy and Imaging.

Learning outcomes:

- Describe the various characterization techniques used for getting Nanomaterials

UNIT-V

APPLICATIONS OFNANO TECHNOLOGY: Applications in material science, biology and medicine, surface science, energy and environment. Applications of Nano structured thin fins, applications of quantum dots.

Learning outcomes:

- Explain the applications of Nano materials

Text Books

1. Textbook of nanoscience and nanotechnology, B.S. Murtyetal. Universities Press
2. Nano: the essentials-T. Pradeep, Tata Mc Graw-Hill Publishers

Reference Books

1. Introduction to nanotechnology, Charles P. Poole, Wiley publishers

Subject Code	Subject Name	L	T	P	C
R20BSH-HM3101	Universal Human Values-2: Understanding Harmony	3	0	0	3

Course Objectives:

- Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence. (L3)
- Relate the harmony in the human being, family, society and nature/existence(L4)
- Outline and strengthening of self-reflection. (L2)
- Improvement of commitment and courage to act. (L5)
- Integrate the humanistic constitution and humanistic universal order. (L2)

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

1. Understand and apply value education principles to achieve continuous happiness and prosperity through self-exploration and balanced relationships (L2)
2. Understand the human being as a co-existence of self and body, distinguishing their needs and promoting harmony for overall well-being. (L2)
3. Cultivate harmony in family and society through trust, respect, and values, aiming for a universal human order. (L3)
4. Understand and realize harmony in nature through interconnectedness, self-regulation, and mutual fulfilment, perceiving existence as co-existence at all levels. (L2)
5. Apply the holistic understanding of human values and professional ethics to foster human is tic education, ethical conduct, and sustainable technologies in a universal human order. (L3)

UNIT-I:

Introduction to Value Education: Understanding Value Education- Self-exploration as the Process for Value Education- Continuous Happiness and Prosperity – Basic Human Aspirations- Right Understanding, Relationship and Physical Facility - Happiness and Prosperity – Current Scenario.

Learning Outcomes:

- Apply Human values to balance their life and profession (L3)
- Identify and incorporate the levels of human values(L2)

Application:

- Natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-d is liking

UNIT-II:

Harmony in the Human Being: Understanding Human being as the Co-existence of the Self and the Body- Distinguishing between the Needs of the Self and the Body-The Body as an Instrument of the Self -Understanding Harmony in the Self - Harmony of the Self with the Body.

Learning Outcomes:

- Distinguish physical facilities the self and body (L4)
- Related to proper upkeep of the body and practice the m in their daily routine. (L2)

Application:

- Differentiate between prosperity and accumulation.
- Discuss program for ensuring healthy dealing with disease

UNIT-III:

Harmony in the Family and Society: Harmony in the Family –Basic Unit of Human Interaction - Values in Human-to-Human Relationship - 'Trust' – Foundational Value in Relationship-'Respect'–Right Evaluation -Understanding Harmony in the Society -V is ion for the Universal Human Order.

Learning Outcomes:

- Interpreting Natural acceptance is always for living in harmony(L2)

- Exemplifying Right evaluation leads to fulfilment in relationship(L3)

Application:

- Reflect on relationships in family, hostel and institute as extended family, real life

examples, teacher-student relationship, goal of education etc., Gratitude as a universal value in relationships.

UNIT-IV:

Harmony in the Nature/Existence: Understanding Harmony in the Nature - Inter connected ness, self-regulation and Mutual Fulfilment among the Four Orders of Nature - Realizing Existence as Co-existence at All Levels - The Holistic Perception of Harmony in Existence.

Learning Outcomes:

- Organizing Confident that they can understand the whole existence made appropriate and holistic. (L2)
- Differentiate between the characteristics and activities of different orders able to see the interconnectedness in the nature(L3)

Application:

- Human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.

UNIT-V:

Implications of the Holistic Understanding – a Look at Professional Ethics : Natural Acceptance of Human Values - Definitiveness of (Ethical) Human Conduct - A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order – Competence in Professional Ethics-Holistic Technologies, Production Systems and Management Models.

Learning Outcomes:

- Present sustainable solutions to the problems in society and nature. (L2)
- Able to grasp the right utilization of their knowledge in their streams of Technology to ensure mutual fulfilment. (L3)

Application:

- Discuss Exercises and Case Studies will be taken up in Practice

Text Book

1. A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Rev is ed Edition, Excel Books, New Delhi, 2019. ISBN978-93-87034-47-1

Reference Books

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff(Book).
4. The Story of My Experiments with Truth-by Mohandas Karamch and Gandhi
5. Small is Beautiful-E. F Schumacher.
6. Slow is Beautiful-Cecile Andrews
7. Economy of Permanence-JC Kumarappa
8. Bharat Mein Angreji Raj -Pandit Sunderlal
9. Re discovering India-by Dharampal
10. Hind Swarajor Indian Home Rule-by Mohandas K.Gandhi
11. India Wins Freedom-Maulana Abdul Kalam Azad
12. Vivekananda-Romain Rolland (English)
13. Gandhi-Romain Rolland (English)

E-Resources:

1. https: //s is t. Sathya bama .ac.in/sist_coursematerial/uploads/SAIC4003.pdf
2. https: //gyansanchay.csjmu.ac.in/wp-content/uploads/2022/09/UHVE-2.0-Class-Notes-Part-1- of -4-1.pdf

Subject Code	Subject Name	L	T	P	C
R20ECE-SC4101	Programming Embedded and IoT Systems **(SkillOrientedCourse-5)**	0	1	2	2

Course Objectives:

- To understand basic file system, Install IDE of Arduino commands.
- To emphasize the design and function of single board computer as IoT device using Arduino and Raspberry Pi.
- To demonstrate python as a programming language to control real world peripherals using GPIO of Raspberry Pi.
- To designs mart control applications using various cloud services.
- To utilize various types of tools for a simple IoT application design.

Course Outcomes:

- Identify the various bash commands of linux for text-based system utilization. (L3)
- Construct simple device interfacing circuits with python programming on Raspberry Pi. (L3)
- Develop applications using PWM, SPI and other serial communication features of Raspberry Pi. (L3).
- Model a system with integration of Cloud platform for data monitoring from a sensor. (L3)
- Make use of analog interface and camera feature to develop applications. (L3)

List of Experiments:

1. Install IDE of Arduino and write a program using Arduino IDE to blink LED.
2. Digital I/O Interface -Multi color Led, IR Sensor, PIR, Slot Sensor.
3. Analog Read and Write-Potentiometer, Temperature Sensor, Led Brightness Control.
4. Dc Motor Control -Dc Motor Speed and Direction Control.
5. Fabrication and direction control of wheeled robot using Arduino and control with using Bluetooth/Wifi.
6. Serial Communication -Device Control.
7. Smart Home Android App Development using App Inventor and Arduino.
8. Control a servo motor using Arduino with an input given through a push button
9. To read the data from the RFID tag and display the information on the display board using Arduino
10. Demonstration of setup& working of Raspberry Pi. (Students have to prepare the report for the same.
11. Interface RGBLED with Raspberry Pi to obtain different colors and brightness using PWM.
12. Interface an ultrasonic sensor with Raspberry pi to print distance readings on the monitor when the sensor changes its position.
13. Post/read the data to/from the cloud via MQTT broker with a Raspberry Pi.
14. Send real-time sensor data to a smartphone using Raspberry Pi on board Bluetooth.
15. Interface Pi camera module using Raspberry Pi to perform operations of Pi Camera-API or Open CV library.
16. Implement an intruder alert system that alerts through email.
17. Implement remote monitoring of smoke alarm systems using Raspberry Pi.
18. Create a user interface using Blynk to control the API' s in Arduino.
19. Create a user interface using Tkinter to control the API' s in Raspberry Pi.

Text Books

1. Richard Blum, ArduinoProgrammingin24Hours, Sams Teach Yourself, Pearson Education, 2017
2. Donald Norris, Internet of things_ do-it-yourself projects with Arduino, Raspberry Pi, and Beagle Bone Black, 1st Edition, McGraw-Hill, 2015