# COURSE STRUCTURE(R19)
# AND
# DETAILED SYLLABUS
# (III YEAR)

# ELECTRONICS & COMMUNICATION ENGINEERING

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


**LENDI INSTITUTE OF ENGINEERING AND TECHNOLOGY**
An Autonomous Institution
Approved by AICTE & Permanently Affiliated to JNTUK, Kakinada
Accredited by NAAC with "A" Grade and NBA (CSE, ECE, EEE & ME)
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**DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING**
**B. Tech III-Year Course Structure and Syllabus –R19**

| **III YEAR –I SEMESTER** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course** | **Category** | **L** | **T** | **P** | **Credits** |
| 1 | R19ECE-PC3101 | Integrated Circuits and applications | PC | 3 | 0 | 0 | 3 |
| 2 | R19ECE-PC3102 | Microprocessor and Microcontrollers | PC | 3 | 0 | 0 | 3 |
| 3 | R19ECE-PC3103 | Analog and Digital Communications | PC | 3 | 0 | 0 | 3 |
| 4 | R19ECE-PC3104 | Antennas and Wave Propagation | PC | 3 | 0 | 0 | 3 |
| 5 | R19ECE-PE3101.1<br>R19ECE-PE3101.2<br>R19ECE-PE3101.3<br>R19ECE-PE3101.4 | **Professional Elective-I**<br>1. Electronic Measurements Instrumentation<br>2. Bio-Medical Engineering<br>3. EMI/EMC<br>4. Embedded System Design | PE | 3 | 0 | 0 | 3 |
| 6 | R19ECE-PC3105 | Integrated Circuits and applications Lab | PC | 0 | 0 | 3 | 1.5 |
| 7 | R19ECE-PC3106 | Analog and Digital Communications Lab | PC | 0 | 0 | 3 | 1.5 |
| 8 | R19ECE-PC3107 | Microprocessor and Microcontrollers Lab | PC | 0 | 0 | 3 | 1.5 |
| 9 | R19ECE-SD3101 | Hardware Design Engineering Lab | SD | 0 | 0 | 3 | 0 |
| 10 | R19BSH-MC3102 | Entrepreneurship & Incubation | MC | 2 | 0 | 0 | 0 |
| 11 | R19BSH-MC3101 | Employability Skills -2 | MC | 0 | 0 | 3 | 0 |
| 12 | R19ECE-MC3101 | MOOCS-3 | MC | 0 | 0 | 0 | 0 |
| 13 | R19ECE-SI3101 | Summer Internship-1 (Evaluation) | SI | 0 | 0 | 0 | 0 |
| | | | | **Total** | | | **19.5** |
| **Honors Course -2/Minor Course-2** | | | | | | | |

| III YEAR –II SEMESTER | | | | | | | |
|---|---|---|---|---|---|---|---|
| **S. No.** | **Course Code** | **Course** | **Category** | **L** | **T** | **P** | **Credits** |
| 1 | R19ECE-PC3201 | Microwave Engineering | PC | 3 | 0 | 0 | 3 |
| 2 | R19ECE-PC3202 | VLSI | PC | 3 | 0 | 0 | 3 |
| 3 | R19ECE-PC3203 | Digital Signal Processing | PC | 3 | 0 | 0 | 3 |
| 4 | R19ECE-PE3201.1<br>R19ECE-PE3201.2<br>R19ECE-PE3201.3<br>R19ECE-PE3201.4 | **Professional Elective-II**<br>1. Information Theory and Coding<br>2. Analog IC Design<br>3. Real time Operating systems<br>4. Internet of Things | PE | 3 | 0 | 0 | 3 |
| 5 | R19CSE-OE3201<br>R19EEE-OE3201<br>R19CSE-OE3202<br>R19MEC-OE3201 | **Open Elective-1**<br>1. OOPs through JAVA<br>2. Power Electronics<br>3. Introduction to AI<br>4. Robotics | OE | 3 | 0 | 0 | 3 |
| 6 | R19ECE-PC3204 | VLSI Lab | PC | 0 | 0 | 3 | 1.5 |
| 7 | R19ECE-PC3205 | Digital Signal Processing Lab | PC | 0 | 0 | 3 | 1.5 |
| 8 | R19ECE-PC3206 | Antenna Modeling and Microwave Engineering lab | PC | 0 | 0 | 3 | 1.5 |
| 9 | R19ECE-PJ3201 | Social Relevant Project | PJ | 0 | 0 | 1 | 0.5 |
| 10 | R19BSH-MC3201 | Intellectual Property Rights (IPR) & Patents | MC | 3 | 0 | 0 | 0 |
| 11 | R19ECE-MC3201 | MOOCS-4 | MC | 0 | 0 | 0 | 0 |
| | | | | **Total** | | | **20** |
| ***Honors Course -3/Minor Course-3** | | | | | | | |
| **Summer Internship-2( After Third Year & evaluated during IV-I Semester)** | | | | | | | |

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

**L-Lecture, T-Tutorial, P-Practical, C-Credits*

**III Year –I Semester Syllabus**

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PC3101 | Integrated Circuits and Applications | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To introduce the basic building blocks and operation of linear integrated circuits.
- To understand the linear and non-linear applications of operational amplifiers.
- To acquire the knowledge in analysis and design of different types of active filters and analog multipliers using op-amps.
- To learn the internal structure, operation and applications of different analog ICs such as Timers and PLL.
- To understand the various types of ADCs and DACS using ICs.

**Course Outcomes:**

1. Understand the internal components and characteristics of Op-Amp (L1).
2. Understand the various linear and non-linear applications using Op-amps(L2).
3. Analyze active filters using Op-amp and understand the frequency response of the amplifier configurations (L3).
4. Understand thoroughly the function of ICs such as 555 and PLL(L4).
5. Acquire the knowledge about various techniques of ADCs and DACs(L5).

**Unit -1**

**Introduction to Operational Amplifiers:** Differential Amplifier- DC and AC analysis of Dual input Balanced output Configuration and Properties of other differential amplifier configuration, Introduction and Classification of IC's, basic information of Op-Amp IC741 Op-Amp and its features, Op-Amp internal circuit, Op-Amp characteristics - DC and AC, Op-Amp parameters and Measurments.

**Applications**:

1.Op-amps are used as amplifier
2.Op-amps used as voltage regulator current regulator
2. Op-amps used as Oscillators and waveform generators.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Understand the internal components and pin diagram of Op-Amp (L1).
2. Understand the characteristics of Op-Amp (L1).

**Unit-2**

**Linear Applications of OP-AMPS:** Inverting and Non-inverting amplifier, adder, Difference amplifier, Integrator and differentiator, Instrumentation amplifier, AC amplifier, V to I and I to V converters.

**Non-Linear Applications of OP-AMPS:** Sample and Hold circuits, Log and Anti log Amplifiers, Comparators, Schmitt trigger, Precision rectifiers, Triangular and Square wave generators.

**Applications**:

1.sign changer, scale changer, inverting, and non-inverting amplifier.
2. Integrator, differentiator, and its application in analog computer.
3. Used as a conversion circuits.
4. Different circuits using op amps are analysed with input and output signal waveforms.

**Learning Outcomes:**

At the end of this unit the student will be able to

1.Understand the linear applications using Op-amps(L2).
2. Understand the non-linear applications using Op-amps(L2).

**Unit- 3**

**Active Filters:** Introduction, Design and Analysis of Butterworth active filters – 1st order, 2nd order low pass and high pass filters, band pass, band reject and all pass filters.
Analog Multiplier using Emitter Coupled Transistor Pair, multiplier and divider.

**Applications**:

1. Active filters are used in communication systems for suppressing noise
2. Active filters are used in biomedical instruments
3. Used in Pre-amplification, Equalization, Tone Control in Audio Systems
4. They are used in Radio tuning to a specific frequency

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Analyze active filters using Op-amp and understand the frequency response(L3).
2. Able to design a filter using Op-amp(L3).

**Unit- 4**

**Timers:** Introduction to 555 timer, functional diagram, Multivibrators – A stable Multivibrators, Monostable Multivibrators description, functional diagram and Applications, Schmitt trigger.

**Phased Locked Loop:** Introduction, block schematic, principles and description of individual blocks of 565 PLL, PLL Applications for AM detection, FM detection, FSK modulation and demodulation and Frequency synthesizing and clock synchronisation, VCO, Applications of VCO (566).

**Applications**:

1. PLL is used to synthesize new frequencies
2. Recovery of clock timing information from a data stream such as from a disk drive
3. VCOs are used in function generators
4. VCOs are used in Electronic jamming equipment.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Understand the function of 555 IC(L4).
2. Understand thoroughly the function of PLL and VCO(L4).

**Unit- 5**

**Analog to Digital and Digital to Analog Converters:** Introduction, Different types of ADCs – Flash type, Successive Approximation type, Dual Slope type, A/D Converter using Voltage-to-Time Conversion, Different types of DACs -weighted resistor type, R-2R Ladder type, R - 2R Ladder types, DAC and ADC Specifications.

**Voltage Regulators:** Introduction, Three terminal fixed and adjustable voltage regulators - IC 723 general purpose regulator.

**Applications**:

1. DACs can in Televisions and mobile phones to convert digital data to analog audio signal.
2. DACs can in music players to convert digital data to analog audio signal.
3. ADCs can used in microcontrollers, digital signal processing.
4. ADCs can used in digital storage oscilloscopes, scientific instruments etc.,

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Understand various techniques of ADCs (L5).
2. Understand various techniques of DACs(L5).

**Text Books**

1. Linear Integrated Circuits – D. Roy Choudhury, New Age International (p) Ltd, 2nd Edition,2003.
2. Op-Amps & Linear ICs - Ramakanth A. Gayakwad, PHI,1987.

**References**

1. Operational Amplifiers & Linear Integrated Circuits –Sanjay Sharma ; SK Kataria& Sons;2nd Edition,2010
2. Design with Operational Amplifiers & Analog Integrated Circuits – Sergio Franco, McGraw Hill, 1988.
3. OP AMPS and Linear Integrated Circuits concepts and Applications, James M Fiore, Cenage Learning India Ltd.
4. Operational Amplifiers & Linear Integrated Circuits–R.F.Coughlin& Fredrick Driscoll, PHI, 6th Edition.
5. Operational Amplifiers & Linear ICs – David A Bell, Oxford Uni. Press, 3rd Edition
6. Digital Fundamentals - Floyd and Jain, Pearson Education

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PC3102 | Microprocessors and Microcontrollers | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To explain the working of 8085 using its architectural features.
- To show the development of 8085 based assembly programming for simple problems.
- To provide 8086 architecture and its working modes of operations.
- To design different 8086 interfaces with various peripheral IC's.
- To make use of 8051 microcontroller integrated features to program simple applications.

**Course Outcomes:**

1. Illustrate the working of 8085 microprocessor architectural features. **(L2)**
2. Make use of addressing modes, instruction set and assembly language for simple programs of 8085 microprocessors. **(L3)**
3. Extend the working of 8-bit 8085 microprocessor to 16-bit 8086 microprocessor with its architectural features. **(L2)**
4. Develop programming and interfacing of various peripheral devices to 8086 with support of ICs 8255, 8259, 8257 and 8251. **(L3)**
5. Utilize the architecture functions of 8051 with understanding of memory, parallel ports, serial ports, timers and interrupts for simple application programs. **(L3)**

**Unit 1**

**Introduction to 8085 Microprocessor:** Basic microprocessor system-working, 8085 Microprocessor Architecture, register organization, Pin Diagram, Flag Register, Instruction Cycle, Timing Diagram.

**Applications:**

1. Illustrate the functioning of 8051 microprocessor with its internal organization.

**Learning Outcomes:**

1. At the end of this unit students will be able to summarize features of a 8085 microprocessor. **(L2)**
2. At the end of this unit students will be able to explain about Instruction cycle and timing diagram of 8085. **(L2)**

**Unit 2**

**8085 Microprocessor Programming**: Interrupts of 8085, instructions set of 8085 and addressing modes, programming of 8085 with examples.

**Applications**:

1. Construct the machine code generation like arithmetic, logical, string, branch and machine controlling instructions.

**Learning Outcomes:**

1. At the end of this unit students will be able to develop assembly language programs for various problems. **(L3)**
2. At the end of this unit students will be able to explain about ISR and interrupt structure of 8085. **(L2)**

**Unit 3**

**8086 Microprocessor:** Introduction**,** Register Organization of 8086, Architecture, Pin Diagram, Memory segmentation and organization, Stack functions, Interrupt structure of 8086. Minimum and maximum mode microprocessor system, Timing diagram and General Bus operation.

**Applications:**

1. Can develop 8086 based systems in minimum or maximum mode configuration.

**Learning Outcomes:**

1. At the end of this unit students will be able to summarize features of a 8086 microprocessor **(L2).**
2. At the end of this unit students will be able to explain about Instruction cycle and timing diagram of 8086 **(L2).**

**Unit 4**

**Programming and interacting with 8086:** Addressing Modes, Instruction Set of 8086, Assembler Directives, Assembly Language Programming: Simple programs, Procedures and Macros Program. Memory Interfacing, Programmable Peripheral Interface 8255, Programmable Interrupt Controller 8259, Programmable Communication Interface 8251 USART, DMA Controller 8257.

**Applications**:

1. Design of interfacing 8086 with 8255 for peripheral control, 8251 interfacing asynchronous and synchronous digital signals for digital transmission system.

**Learning Outcomes:**

1. At the end of this unit students will be able to understand instruction set of 8086 microprocessors. **(L2)**
2. At the end of this unit students will be able to develop assembly language programs for various problems. **(L3)**
3. At the end of this unit students will be able to demonstrate memory & I/O interfacing with 8086. **(L3)**

**Unit 5**

**Intel 8051 Microcontroller:** 8051 Microcontroller Architecture, Microcontroller 8051 pin diagram, 8051 Ports, Internal and External Memory, Counters and Timers, Serial Communication in 8051, Interrupts in 8051, Addressing Modes, Instruction set of 8051, simple programs and peripheral Interface.

**Applications**:

1. Construct the controller programs like addition, subtraction, multiplication, division, shift, rotate and control of peripherals.

**Learning Outcomes:**

1. At the end of this unit students will be able to distinguish between microprocessor and a microcontroller. **(L2)**
2. At the end of this unit students will be able to describe architecture and features of Intel 8051 microcontroller. **(L2)**
3. At the end of this unit students will be able to develop assembly language programs to perform various operations using 8051. **(L3)**

**Text Books**


1. Ramesh S Gaonkar, Microprocessor Architecture Programming and Applications with the 8085, 6th edition, Penram International Publishing, 2013
2. K M Bhurchandi, A K Ray, Advanced Microprocessors and Peripherals, 3rd edition, McGraw Hill Education, 2017.
3. Microcontrollers and application, Ajay. V. Deshmukh, TMGH,2005


**References**


1. The 8085 microprocessor: Architecture, programming and interfacing- K.Uday Kumar, B.S.Umashankar,2008
2. D.V.Hall, Microprocessors and Interfacing. TMGH, 2nd edition.
3. Barry B.Brey, "The Intel Microprocessors: Architecture, Programming and Interfacing", PHI, 6th Edition.
4. Kenneth J. Ayala, The 8051 Microcontroller, 3rd edition, Cengage Learning, 2004.
4. The 8051 microcontrollers, architecture and programming and applications-K. Uma Rao, Andhe Pallavi, Pearson Education, 2009.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PC3103 | Analog and Digital Communications | 3 | 0 | 0 | 3 |

**Course Objectives:**

- Familiarize with the various techniques for analog modulation and demodulation of signals
- Develop the ability to classify and understand various functional blocks of radio transmitters and receivers
- Familiarize the basic techniques for generating and demodulating various pulse modulated signals
- Familiarize various digital modulation techniques and calculation of their error probabilities
- Understand the concept of entropy and different source coding techniques.

**Course Outcomes:**

After undergoing the course, students will be able to

1. Differentiate various Analog modulation and demodulation schemes and their spectral characteristics (L1)
2. Demonstrate various functional blocks of radio transmitters and receivers(L2)
3. Understand the performance of different waveform coding techniques for the generation and digital representation of the signals (L2)
4. Determine the probability of error for various digital modulation schemes(L3)
5. Analyze different source coding techniques.(L3)

**Unit 1**

**Amplitude Modulation:** Need for modulation, Amplitude Modulation - Time and frequency domain description, single tone modulation, power relations in AM waves, Generation of AM waves - Switching modulator, Detection of AM Waves - Envelope detector,

**Unit 2**

**Types of Amplitude Modulation:** DSBSC modulation - time and frequency domain description, Generation of DSBSC Waves - Balanced Modulators, Coherent detection of DSB-SC Modulated waves, COSTAS Loop, SSB modulation - time and frequency domain description, frequency discrimination and Phase discrimination methods for generating SSB, Demodulation of SSB Waves.

**Applications**:

1. Amplitude modulation is used in a variety of applications. Broadcast transmissions, Air band radio, single side band, quadrature amplitude modulation
2. In order to transmit 2 channel stereo signals, **DSB** signals are used in Television and FM broadcasting.
3. SSB-SC modulation techniques are used in mobile communication, telemetry, military communications, navigation and amateur radio

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Understand the need for modulation, time domain and frequency domain representation (L1).

2. Understand the different modulation techniques of AM, DSB-SC,SSB-SC,VSB-SC (L1).

**Unit 3**

**Angle Modulation:** Basic concepts of Phase Modulation, Frequency Modulation: Single tone frequency modulation, Spectrum Analysis of Sinusoidal FM Wave using Bessel functions, Narrow band FM, Wide band FM, Constant Average Power, Transmission bandwidth of FM Wave – Generation of FM Signal- Armstrong Method, Detection of FM Signal: Balanced slope detector, Phase locked loop, Comparison of FM and AM., Concept of Pre-emphasis and

de-emphasis. Noise Figure of the Receiver, Noise Performance of Continuous Wave Modulation, Figure of Merit

**Applications**:

1. Angle modulation is used in telecommunications transmission systems.
2. Frequency modulation is widely used for **FM** radio broadcasting, telemetry, radar, seismic prospecting, and monitoring newborns for seizures via EEG, two-way radio systems, sound synthesis, magnetic tape-recording systems and some video-transmission systems.
3. Phase modulation is widely used for transmitting radio waves and is an integral element of many digital transmission coding schemes that support an ample range of wireless technologies such as GSM, Satellite television, and Wi-Fi.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Understand the frequency and phase modulation and demodulation techniques(L1).
2. Able to calculate the figure of merit for different modulation techniques (L3).

**Unit 4**

**Pulse Digital Modulation :** Time Division Multiplexing, Types of Pulse modulation, PAM (Single polarity, double polarity) PWM: Generation & demodulation of PWM, PPM, Generation and demodulation of PPM, TDM Vs FDM, Companding, Noise in PCM, Inter symbol Interference, Delta Modulation, Differential Pulse Code Modulation.

**Applications**:

1. FM transmitters are commonly used for playing portable audio devices on car radios They are also used to broadcast a stationary audio source, like a computer or a television, around a home.
2. Pulse and digital modulation techniques are used in Ethernet communication, many micro-controllers for generating control signals.
3. These techniques are used in Photo-biology, an electronic driver for LED lighting.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Understand the concepts of different types of transmitters and receivers. (L1).
2. Understand pulse digital modulation techniques. (L1).

**Unit 5**

**Digital Modulation Techniques and Data Transmission**: Introduction, ASK, FSK, PSK, DPSK, DEPSK, QPSK, M-ary PSK, ASK, FSK, similarity of BFSK and BPSK. Base band signal receiver, probability of error, the optimum filter, matched filter, probability of error using matched filter, coherent reception, non-coherent detection of FSK, calculation of error probability of ASK, BPSK, BFSK,QPSK.

**Applications**:

1. Digital nodulation techniques are used in QPSK, CDMA, Cellular service, Wireless local loop, Digital video broadcasting-satellite.

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Understand the digital modulation and demodulation tecniques (L1).
2. Able to calculate probability of error for ASK, FSK, BPSK, BFSK, QPSK (L3).

**Applications**:

**Learning Outcomes:**

At the end of this unit the student will be able to

1. Able to calculate entropy for different message signals. (L3).
2. Analyze different coding techniques. (L3)

**Textbooks**

1. Analog and Digital Communications – Simon Haykin, John Wiley, 2005.
2. Electronics Communication Systems-Fundamentals through Advanced-Wayne Tomasi, 5th Edition, 2009, PHI.

**Reference Books**

1. Principles of Communication Systems - Herbert Taub, Donald L Schilling, GoutamSaha, 3 rd Edition, McGraw-Hill, 2008.
2. Electronic Communications – Dennis Roddy and John Coolean , 4th Edition , PEA, 2004
3. Electronics & Communication System – George Kennedy and Bernard Davis, TMH 2004
4. Analog and Digital Communication – K. Sam Shanmugam, Willey ,2005
5. Modern Analog and Digital Communication – B.P.Lathi, Oxford reprint, 3rd edition, 2004.
6. Digital Communications – John Proakis, TMH, 1983. Communication Systems Analog & Digital – Singh &Sapre, TMH, 2004.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PC3104 | Antennas and Wave Propagation | 3 | 0 | 0 | 3 |

**Course Objectives**

- To introduce radiation mechanisms and basic characteristics of antennas.
- To illustrate the different types of arrays and their radiation patterns.
- To illustrate mathematical expressions and their application for complete design of different antennas.
- To introduce design concepts of micro-strip antennas.
- To understand the concepts of radio wave propagation in the atmosphere.

**Course Outcomes:**

1. Describe how antenna converts the electrical energy to electromagnetic wave and vice versa and able to define basic antenna parameters. (L2)
2. Demonstrate the concept of near field and far field, calculate the radiation of wired antennas and types of arrays and capable to characterize simple arrays based on their applications.(L2)
3. Derive expressions related to radiation mechanisms for antennas like helical, Aperture and lens antennas.(L3)
4. Design of various antennas namely microstrip antennas, horn antennas, DRA etc., for a given application and also its measurements.(L5)
5. Discuss various EM wave propagation methods in ionosphere and troposphere and also mathematical aspects of wave propagation.(L3)

**Unit 1**

**Antenna Characteristics:** Radiation mechanism and current distribution, Antenna Parameters - radiation pattern, directivity, gain, Input impedance, polarization, bandwidth, HPBW, Reciprocity, effective aperture, vector effective length, antenna temperature, Friis transmission formula

**Applications:**

1. Gain and directivity can be calculated for different antennas in any communication systems

**Unit Outcomes:**

1. Understand radiation mechanism and basic antenna characteristics (L2)
2. Compute radiation intensity, gain and directivity of antennas (L3)

**Unit 2**

**Wire and Antenna Arrays:** Wire and antenna arrays: Radiation resistance and directivity and other characteristics of short dipole, monopole, half-wave dipole. Linear array and pattern multiplication, two-element array, uniform array, binomial array, broadside and end-fire arrays. Rhombic antennas, Yagi-Uda array, Turnstile Antenna.

**Applications:**

1. Different types of antennas used in the communication systems
2. Gain and directivity can be improved by using different array element antennas.

**Unit Outcomes:**

1. Derive expressions for radiation resistance, directivity of wire antennas (L3)
2. Obtain radiation pattern of various array antennas using pattern multiplication (L3)
3. Compare radiation pattern and other antenna parameters of broadside and endfire array antennas (L4)

**Unit 3**

**Broadband and Microwave Antennas:** Helical antenna - axial and normal modes, log-periodic Array, spiral antenna Aperture Antennas and Lens Antennas: Slot antenna, pyramidal and conical horn antennas, reflector Antenna: flat plate, corner and parabolic reflectors - common curved reflector shapes, Feed mechanisms. Lens Antennas - Introduction, Geometry of Non-metallic Dielectric Lenses, Zoning, Tolerances

**Applications:**

1. These antennas are used in radar and satellite communications

**Unit Outcomes:**

1. Understand basic principles of aperture and lens antennas (L2)
2. Design aperture and lens antennas (L5)

**Unit 4**

**Micro-strip Antennas and Antenna Measurements:** Micro-strip Antennas and Antenna Measurements: Basic characteristics, feeding methods, methods of analysis - Design of Rectangular and Circular patch Antennas. Introduction to Dielectric Resonator Antennas-Different feeding methods of DRAs and mode analysis. Introduction to Smart Antennas - Concept of adaptive beam forming. Measurement of Antenna Parameters, basic setup, radiation pattern measurement, gain, directivity.

**Applications:**

1. Satellite communication and wireless communication.
2. Television broadcasting

**Unit Outcomes:**

1. Describe feeding methods for micro-strip antennas and Dielectric Resonator Antennas(L2)
2. Design rectangular and circular patch antennas for given specifications (L5)
3. Describe the Measurement techniques of Antenna parameters(L2)

**Unit 5**

**Radio Wave Propagation:** Concepts of Propagation. Ground Wave Propagation– Characteristics, Parameters, Wave Tilt.

**Sky Wave Propagation** – Formation of Ionospheric Layers and their Characteristics, Mechanism of Reflection and Refraction,Critical Frequency, MUF and Skip Distance, Optimum Frequency,LUHF, Virtual Height, Ionospheric Abnormalities, Ionospheric Absorption.Fundamental Equation for Free-Space Propagation, Basic Transmission Loss Calculations.

**Space Wave Propagation**– Mechanism, LOS and Radio Horizon. Tropospheric Wave Propagation – Radius of Curvature of path, EffectiveEarth's Radius, Effect of Earth's Curvature, M-curves and Duct Propagation, Tropospheric Scattering.

**Applications:**

1. Line-of-sight communication

**Unit Outcomes:**

1. Understand effects of earth's magnetic field on wave propagation (L2)
2. Analyze tropospheric propagation and derive the expression for received field strength (L4)
3. Identify layers in ionosphere and their ionization densities (L1)

**Text Books**


1. John D. Kraus, Ronald J. Marhefka, Ahmad S. Khan, Antennas and Wave Propagation, TMH Edition
2. Jordan, E.C. and Balmain. K. G., Electromagnetic Waves and Radiating Systems, Prentice-Hall Publications

## References


1. A.R. Harish and M. Sachidananda, Antennas and Wave Propagation, Oxford University Press, 2007.
2. Constantine A. Balanis, Antenna Theory-Analysis and Design, Wiley Publication
3. R.E. Crompton, Adaptive Antennas, John Wiley Publication
4. Aldo Petosa, Dielectric Resonator Antennas, Artech House Publications

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PE3101.1 | **Electronic Measurements and Instrumentation (Professional Elective-1)** | **3** | **0** | **0** | **3** |

**Course Objectives:**

- To familiarize functional characteristics of AC and DC voltmeter, ammeter and ohmmeter.
- To introduce different signal generators and wave analysers used in electronic instrumentation.
- To provide a functional behaviour of various Types of CRO's, CRT's and Probes used in analysing signals.
- To introduce various types of AC and DC Bridges used in electronic measurements.
- To understand how different types of Transducers used for measurement of physical parameters like force, pressure, velocity, humidity and displacement.

**Course Outcomes:**

1. Acquire knowledge about the concept and type of measuring instruments such as voltmeter, ammeter and ohmmeter used based on the requirements.
2. List different type of signal generators and wave analyzers are used for signal analysis at various environments.
3. Analysis of signals using lissajous patterns, measurement frequency in various CRO's for different applications.
4. Examine the AC and DC bridges for the measurement of resistance, unknown capacitance and Inductance.
5. Measure various physical parameters such as humidity and velocity using different types of sensors.

**Unit 1**

Performance characteristics of instruments, Static characteristics, Accuracy, Resolution, Precision, Expected value, Error, Sensitivity. Errors in Measurement, Dynamic Characteristics-speed of response, Fidelity, Lag and Dynamic error. DC Voltmeters- Multi-range, Range extension/Solid state and differential voltmeters, AC voltmeters- multi range, range extension, shunt. Thermocouple type RF ammeter, Ohmmeters series type, shunt type, Multi-meter for Voltage, Current and resistance measurements.

**Applications:**

1. DC voltmeters and AC voltmeters, and ohmmeters are used in every power systems
2. Multi meters,voltage and current measurements are used in every communication systems.

**Learning Outcomes:**

**1.** Acquire knowledge about the concept and type of measuring instruments such as voltmeter, ammeter and ohmmeter used based on the requirements.

**Unit2**

Signal Generator- fixed and variable, AF oscillators, Standard and AF sine and square wave signal generators, Function Generators, Square pulse, Random noise, sweep, Arbitrary waveform. Wave Analyzers, Harmonic Distortion Analyzers, Spectrum Analyzers, Digital Fourier Analyzers.

**Applications:**

1. In every inverter oscillators are used
2. Spectrum analyzers, function generators are being used in power systems,

**Learning Outcomes:**

1. List different type of signal generators and wave analyzers are used for signal analysis at various environments.

**Unit 3**

Oscilloscopes CRT features, vertical amplifiers, horizontal deflection system, sweep, trigger pulse, delay line, sync selector circuits, simple CRO, triggered sweep CRO, Dual beam CRO, Dual trace oscilloscope, sampling oscilloscope, storage oscilloscope, digital readout oscilloscope, digital storage oscilloscope, Lissajous method of frequency measurement, standard specifications of CRO, probes for CRO- Active & Passive, attenuator type.

Applications:

1. CROs, Oscilloscopes, and attenuators are being used in TV broadcasting .
2. Oscilloscopes , Storage oscilloscopes ,and attenuators are used in every communication systems.

Learning Outcomes:

1. Analysis of signals using lissajous patterns, measurement frequency in various CRO's for different applications.

**Unit 4**

AC Bridges Measurement of inductance- Maxwell's bridge, Anderson bridge. Measurement of capacitance - Schearing Bridge. Wheat stone bridge. Wien Bridge, Errors and precautions in using bridges. Q-meter.

**Applications:**

1. AC bridges are used in every communication systems and power systems

**Learning Outcomes:**

1. Examine the AC and DC bridges for the measurement of resistance, unknown capacitance and Inductance.

**Unit 5**

Transducers- active & passive transducers : Resistance, Capacitance, inductance; Strain gauges, LVDT, Piezo Electric transducers, Resistance Thermometers, Thermocouples, Thermistors, Sensistors, Measurement of physical parameters force, pressure, velocity, humidity and displacement, Data acquisition systems.

**Applications:**

1. Transducers are used to measure the physical parameters such as temperature, pressure, and velocity in communication systems.

**Learning Outcomes:**

**1.** Measure various physical parameters such as humidity and velocity using different types of sensors.

**Textbooks**

1. Electronic instrumentation, second edition - H.S.Kalsi, Tata McGraw Hill, 2004.

2. Modern Electronic Instrumentation and Measurement Techniques – A.D. Helfrick and W.D. Cooper, PHI, 5th Edition, 2002.

**ReferenceS**

1. Electronic Instrumentation & Measurements - David A. Bell, PHI, 2nd Edition, 2003.

2. Electronic Test Instruments, Analog and Digital Measurements - Robert A. Witte, Pearson Education, 2nd Ed.
2004.

3. Electronic Measurements & Instrumentations by K. Lal Kishore, Pearson Education - 2005.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PE3101.2 | Bio-Medical Engineering (Professional Elective-1) | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To explain the importance of various sources of bio-electric potentials in human body.
- To enhance the knowledge of various electrodes and transducers used for measuring bio-electrical potentials.
- To familiarize mechanisms of cardiovascular and respiratory systems and their measuring equipments.
- To introduce elements of patient care & monitoring system and various therapeutic & prosthetic devices.
- To provide fundamentals of various diagnostic techniques and introduce the concepts of bio-telemetry.

**Course Outcomes:**

At the end of the Course, the Student will be able to:

1. Identify various sources of bio-electric potentials in man-instrumentation system. (L3)
2. Interpret how electrodes and transducers are involved in biomedical engineering concepts. (L2)
3. Outline the anatomy of Cardiovascular and respiratory system and their measuring instruments. (L2)
4. Summarize the functionality of patient care & monitoring equipments used to identify the malfunction of human body. (L2)
5. Identify the different diagnostic imaging techniques and monitors, recorders and electrical accident prevention methods. (L3)

**Unit 1**

**Introduction to Biomedical Instrumentation:** Age of Biomedical Engineering, Development of Biomedical Instrumentation, Man Instrumentation System, Components of the Man-Instrument System, Physiological System of the Body, Problems Encountered in Measuring a Living System, Sources of Bioelectric Potentials, Muscle, Bioelectric Potentials, Sources of Bioelectric Potentials, Resting and Action Potentials, Propagation of Action Potential, Bioelectric Potentials-ECG, EEG and EMG, Envoked Responses.

**Applications:**

1. Biomedical instrumentation is used in many applications such as ECG, EEG, EMG, etc.

**Learning outcomes:** At the end of the unit, the student will be able to

1. Explain the components of Biomedical instrumentation.(L2)
2. Classify various Physiological systems of the human body.(L4)

**Unit 2**

**Electrodes and Transducers**: Introduction, Electrode Theory, Biopotential Electrodes, Examples of Electrodes, Basic Transducer Principles, Biochemical Transducers, The Transducer and Transduction Principles, Active Transducers, Passive Transducers, Transducers for Biomedical Applications, Pulse Sensors, Respiration Sensor, Transducers with Digital Output.

**Applications:**

1. The transducers are mainly used in every biomedical instruments to study the pulse rate, respiration and heart beat etc.

**Learning outcomes:** At the end of the unit, the student will be able to

1. Describe the origin of bio potentials and explain the role of biopotential electrodes(L2)
2. Classify various Transducers (L2)

**Unit 3**

**Cardiovascular System and Measurements:** The Heart and Cardiovascular System, Electro Cardiography, Blood Pressure Measurement, Measurement of Blood Flow and Cardiac Output, Measurement of Heart Sound, Plethysmography.

**Measurements in the Respiratory System:** The Physiology of the Respiratory System, Tests and Instrumentation for The Mechanics of Breathing, Respiratory Therapy Equipment.

**Applications:**

2. The main application of this unit is to measurement of the heartbeat , BP and ECG
3. The respiratory system and breathing.

**Learning outcomes:** At the end of the unit, the student will be able to

1. Explain and contrast measurement principles for blood flow, pressure and volume as well as respiratory variables.(L2)
2. Make use of various tests and equipment of Respiratory system.(L3)

**Unit 4**

**Patient Care And Monitoring:** Elements of Intensive-Care Monitoring, Patient Monitoring Displays, Diagnosis, Calibration and Repair ability of Patient-Monitoring Equipment, Other Instrumentation for Monitoring Patients, Organization of the Hospital for Patient-Care Monitoring, Pacemakers, Defibrillators, Radio Frequency Applications of Therapeutic use.

**Therapeutic and Prosthetic Devices**: Audiometers and Hearing Aids. Myoelectric Arm, Laparoscope, Ophthalmology Instruments, Anatomy of Vision,. Electro physiological Tests, Ophthalmoscope, Tonometer for Eye Pressure Measurement. Diathermy, Clinical Laboratory Instruments, Biomaterials, Stimulators.

**Applications:**

1. In every hospital, patient care and monitoring system consist of biomedical instruments such as transducers, pacemakers, and sensors etc.

**Learning outcomes:** At the end of the unit, the student will be able to

1. Outline the design of cardiac pacemakers, Stimulators and defibrillators(L2)
2. Experiment with various instruments to perform physiologicl tests.(L3)

**Unit 5**

**Diagnostic Techniques and Bio-Telemetry:** Principles of Ultrasonic Measurement, Ultrasonic Imaging, Ultrasonic Applications of Therapeutic Uses, Ultrasonic Diagnosis, X-Ray and Radio-Isotope Instrumentations, CAT Scan, Emission Computerized Tomography, MRI, Introduction to Biotelemetry, Physiological Parameters Adaptable to Biotelemetry, The Components of Biotelemetry System, Implantable Units, Telemetry for ECG Measurements during Exercise, Telemetry for Emergency Patient Monitoring.

**Monitors, Recorders and Shock Hazards:** Biopotential Amplifiers, Monitors, Recorders, Shock Hazards and Prevention, Physiological Effects and Electrical Current, Shock Hazards from Electrical Equipment, Methods of Accident Prevention, Isolated Power Distribution System.

**Applications:**

1. X-rays, MRI, ECG, etc instruments are used in hospitals .
2. Recorders, Amplifiers, and power distributed systems etc are used in hospitals.

**Learning outcomes:** At the end of the unit, the student will be able to

**1.** Explain basic principles of Ultrasonic Imaging (L2)
**2.** Explain the components of Biotelemetry system.(L2)
3. Identify, explain and judge patient safety issues related to biomedical instrumentation.(L3)
4. Discuss various Amplifiers, Monitors and Recorders.(L6)

**Text Books**


**1.** "Bio-Medical Electronics and Instrumentation", Onkar N. Pandey, Rakesh Kumar, Katson Books.

**2.** "Bio-Medical Instrumentation", Cromewell , Wiebell, Pfeiffer


**References**


1. "Introduction to Bio-Medical Equipment Technology", 4th Edition, Joseph J. Carr, John M. Brown, Pearson Publications.
2. "Hand Book of Bio-Medical Instrumentation", Instrumentation", Kandahar. McGrawHill

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PE3101.3 | EMI/EMC (Professional Elective-1) | 3 | 0 | 0 | 3 |

**Course Objectives:**

1. Imparting knowledge on the importance of EMC and EMC compliance.
2. Providing exposure to EMI sources, mitigation, and measurement techniques/standards to guarantee the correct working modalities.
3. Understand various centered techniques for EMI filters, suppression device and components.
4. Providing exposure to the guidelines for reduced EMI in PCB design.
5. Understanding the EMI measurements and familirazize the various chambers and standards for EMI/EMC.

**Course Outcomes:**

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

1. Understand the concepts related to EMI and EMC, and differentiate between conducted and radiated emission.
2. Differentiate the types of EMI coupling mechanisms. Earthing, shielding effectiveness.
3. Apply a proper EMI control technique for a specific identified EMI problem.
4. Design an EMC model for PCBs.
5. Describe about various Radiated EMI Measurements techniques and chambers; understand the standards for EMI and EMC.

**Unit-1**

**Concepts of EMI/EMC:** EMI/EMC definitions – Units - Sources of EMI: Classification, Lightning, ESD, NEMP - Conducted and radiated emission - Conducted and radiated susceptibility – Intra and inter system EMI - In band interference - Spectrum conservation - Radiation hazard - Specific Absorption Rate (SAR).

**Unit-2**

**Coupling Principles & EMI Control Techniques – I:** Conductive coupling: Common-mode, Differential-mode - Inductive coupling - Capacitive coupling - Radiative coupling
Grounding: Earthing principle, system grounding - Shielding: Shielding theory and shielding effectiveness, Shielding integrity at discontinuities, Conductive coatings, Cable shielding, Bonding: Shape and material for bond strap - general guidelines for good bonds.

**Unit-3**

**EMI Control Techniques- II:** EMI Filters: Characteristics of filters, Impedance mismatch effects, Lumped element filters, Power line filter design, Common mode filter, Differential mode filter - EMI suppression devices and components: EMI suppression cables, EMC connectors, EMC gaskets, Isolation transformers, Transient and surge suppression devices.

**Unit-4**

**EMC Design of PCBs:** RF Sources in PCB - SMD / through hole components, Pins, Basic loops, Differential vs Common mode - Board layout: Grounds and Power, ground bounce, Power distribution for two-layer boards, Power supply decoupling, Board zoning, Signal traces, Cross talk, Trace routing - Cables and connectors.

**Unit-5**

**EMI Measurements & Standards:** Radiated interference measurements: Open area test site measurement, anechoic chamber, TEM cell; Reverberating chamber –
Conducted interference measurements: Characterization of conduction currents voltages, Conducted EM noise on power supply lines.
Military standards, IEEE/ ANSI Standards, EMC compliance for wireless devices, Radio Equipment Directive (RED).

**Text Book(s)**


1. Henry W.Ott, Noise Reduction Techniques in Electronic Systems, 2011, 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey.
2. V.P. Kodali, Engineering EMC Principles, Measurements and Technologies, 2010,2nd Edition, IEEE Press, New York.
3. Bernard Kieser, ―Principles of Electromagnetic Compatibility, Artech House 3rd Edition.
4. Henry W. Ott, ―Electromagnetic Compatibility Engineering, A John Wiley & Sons publication


**Reference Books**


1. Clayton R.Paul, Introduction to Electromagnetic compatibility, 2010, 2nd Edition, John Wiley & Sons, Inc., Hoboken, New Jersey.
2. Patrick G. André and Kenneth Wyatt, EMI Troubleshooting Cookbook for Product Designers 2014, 1 st Edition, SciTech Publishing, UK.
3. Tim Williams, ―EMC for Product Designer‖, Elsevier.
4. PR Chatterton, ―Electromagnetic Theory to practical design, Wiley.
5. Sonia Ben Dhia, ―Electromagnetic Compatibility as Integrated Circuits, Springer.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PE3101.4 | **Embedded System Design (Professional Elective-1)** | 3 | 0 | 0 | 3 |

**Course Objectives:**

1. To introduce major components of an embedded system
2. To explain different characteristics and quality attributes of embedded systems.
3. To expose role of firmware, and device driver programming.
4. To explain implementation of hardware and software co-design in embedded system
5. To explain embedded software development tools and debugging techniques.

**Course Outcomes:** A Student can able to:

1. Interpret embedded system and its hardware and software(L3).
2. Identify different characteristics and quality attributes of embedded systems.(l2)
3. Explain role of firmware, and device driver programming(L2).
4. Illustrate different types of operating systems and Multitasking(L2).
5. Apply embedded Software development tools and Design and develop the embedded system(L3).

**Unit 1**

**Introduction to Embedded Systems:** What is embedded system, embedded systems vs. general computing systems, history of embedded systems, and classification of embedded systems, major application areas of embedded systems, purpose of embedded systems, Design process in embedded systems, skills required for an embedded system designer, Design process and Design examples of embedded systems.

**Learning Outcomes**:

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

**Unit 2**

**Typical Embedded System:** A typical embedded system, Core of embedded system, Memory, Sensors & actuators, Communication Interface, Embedded firmware, other system components, Characteristics and Quality attributes of embedded system.

**Learning Outcomes:**

1 Discuss different types of embedded systems(L2).
2 Discuss Characteristics and Quality attributes of embedded system (L2).

**Unit 3**

**Embedded Firmware Development:** Programmed I/O, ISR concept, Interrupt service Mechanism, Period for context switching, Interrupt latency and deadline, DMA, device driver programming.

**Learning Outcomes:**

1 Understand role of fireware (L2)
2. Understand device driver programming(L2)

**Unit4**

**RTOS and Hardware& software Co-design:** 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, Fundamental Issues in Hardware Software Co-Design, Hardware Software Trade-offs.

**Learning Outcomes:**

1. Understand and apply hardware & software architectures (L2)
2. Describe scheduling of Tasks (L2)

**Unit 5**

**Embedded Software development tools and debugging techniques :** Embedded Software development tools, Host and target systems, cross compilers, linkers, locators for embedded systems. Getting embedded software in to the target system. Debugging techniques. Testing on host machine, Instruction set emulators, logic analyzers. In-circuit emulators and monitors, Laboratory tools.

**Learning Outcomes:**

2. Understanding and use tools for Embedded Software development(L2)
3. Burning embedded software in to the target system(L3)
4. Apply debugging techniques (L3)

**Text Books**


1. Shibu K V, Introduction to Embedded Systems, 2nd edition, McGraw Hill Education,2017.
2. Raj Kamal, Embedded Systems: Architecture, Programming and Design, 3rd edition, McGraw Hill Education, 2017.


**References**


1. Embedding system building blocks, Labrosse, via CMP publishers.
2. Computers as Components-principles of Embedded computer system design, Wayne Wolf, Elseveir.
3. Ali Mazidi Mohammed Gillispie, Mazide Janice, "The 8051Microcontroller and Embedded Systems using assembly& C", 2nd Edition, Pearson Education, 2009.
4. An Embedded Software Primer, David E. Simon, Pearson Education.
5. The 8051 Microcontroller, Third Edition, Kenneth J.Ayala, Thomson.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PC3105 | Integrated Circuits and Applications Lab | 0 | 0 | 3 | 1.5 |

**Course Objectives:**

1 Demonstrate the working and functional characteristics of different analog ICs.
2 Familiarize the students with various applications of IC 741.
3. Construct various waveform generator circuits using IC 741, IC 565 and IC 566.
4 Design various multi-vibrator circuits using IC 555 timer.
5. Familiarize with various fixed voltage and variable Voltage Regulator using ICs and digital to analog converters (DAC).

**Course Outcomes:**

At the end of the course, students will be able to:
1. Identify the functionality of IC's 741,IC 555,IC 565 and IC 1496 (L1).
2. Make use of IC 741 to model Inverting and Non-Inverting adder, subtractor, comparator, integrator and differentiator and various active filters (L2).
3. Develop various waveform generator circuits using IC 741, IC 565 and IC566(L3).
4. Construct various multi-vibrator circuits using IC 555 timer (L4).
5. Build various fixed voltage and variable Voltage Regulator using ICs and binary weighted R-2Rladder digital to analog converters using IC 741(L5).

**List of Experiments:**

Minimum of Twelve Experiments has to be performed and also simulate with using Spice Software

1. Study of OP AMPs – IC 741, IC 555, IC 565, IC 566, IC 1496 – functioning, parameters and Specifications.
2. Inverting and Non-Inverting Amplifiers using Op Amps.
3. OP AMP Applications – Adder, Subtractor, Comparator Circuits.
4. Integrator and Differentiator Circuits using IC 741.
5. Active Filter Applications – LPF, HPF (first order)
6. Active Filter Applications – BPF, Band Reject (Wideband) and Notch Filters.
7. IC 741 waveform Generators-Sine, Square wave and Triangular Waves.
8. IC 555 Timer – Monostable Operation Circuit.
9. IC 555 Timer – Astable Operation Circuit.
10. Schmitt Trigger Circuits – using IC 741 and IC 555.
11. IC 565 – PLL Applications.
12. Voltage Regulator using IC 723.
13. Three Terminal Voltage Regulators – 7805, 7809, 7912.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PC3106 | Analog and Digital Communications Lab | 0 | 0 | 3 | 1.5 |

**Course Objectives:**

Students undergoing this course, are expected to

- Outline the basics modulation and demodulation techniques in analog/digital communication systems using hardware and MATLAB software.
- Illustrate various types of modulation / demodulation techniques.
- Explain the importance of pre-emphasis and de-emphasis in Frequency modulation.
- Recall different analog/digital pulse modulation techniques
- To analyse and design different source coding techniques experimentally and also to impart industry oriented learning.

**Course Outcomes:**

After undergoing the course, students will be able to

1. Demonstrate various modulation and demodulation circuits in analog/digital communications using hardware and Matlab tools.
2. Examine the modulation and demodulation techniques such as Amplitude modulation, DSB-SC and Frequency modulation.
3. Design pre-emphasis and de-emphasis circuits for Frequency Modulation transmitter and receiver.
4. Demonstrate the various pulse modulation and pulse code modulation techniques
5. Experiment with multiplexing and de-multiplexing techniques and companding techniques in a digital communication system.

**List of Experiments:**

1. Amplitude Modulation, Frequency Modulation - Mod. & Demod.
2. AM - DSB SC - Mod. & Demod.
3. Diode Detector
4. Pre-emphasis & De-emphasis
5. Pulse Amplitude Modulation - Mod. & Demod.
6. Pulse Width Modulation & Demodulation
7. Pulse Position Modulation & Demodulation
8. Time division multiplexing.
9. Pulse code modulation, Differential pulse code modulation.
10. Delta modulation.
11. Frequency Shift Keying Generation and Detection
12. Phase shift keying , Differential phase shift keying.
13. Companding .
14. Source Encoder and Decoder

**Note:**

- Minimum 12 experiments should be conducted:
- All these experiments are to be simulated first using MATLAB, COMSIM or any other simulation package and then to be realized in hardware.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PC3107 | Microprocessors And Microcontrollers Lab | 0 | 0 | 3 | 1.5 |

**Course Objectives:**

- To impart the basic instructions of 8086 microprocessor for implementation of arithmetic, logical, BCD and ASCII operations.
- ToDemonstrate various string, branching and process control instructions for implementation of different array-based operations.
- To Explain the mechanism of DOS based interrupt handling service and interfacing peripheral control ICs like 8255 and 8259 with demonstrated examples.
- To Explain the procedure of interfacing 8051 microcontroller with timers, parallel ports.
- To Demonstrate the usage of 8051 as embedded controller with real world applications like traffic light, LCD etc.

**Course Outcomes:**

1. Utilize the knowledge of Assembly language and assembler directives for programming in 8086 and 8051 with focus towards their limited arithmetic operations.
2. Extend the knowledge of 8086 to string operations towards different data structures.
3. Make use of DOS/BIOS services and Peripheral Control ICs to utilize different input and output functions of a 8086 based microcomputer system.
4. Utilize the 8051 features to produce Delay and Interrupt functions needed for embedded system design.
5. Model real world applications with peripherals interfacing 8051 microcontroller.

**List of Experiments:**

**Intel 8086 (16-bit Microprocessor)- Assembly Language Programming using MASM/TASM.**

1. Perform simple arithmetic operations.
2. Construct program for Addition of an array of BCD numbers stored in packed form.
3. Implement Sorting an array of random 8-bit binary numbers.
4. Produce the reverse of the given string.
5. Show the logic work of Deleting a Character from a String.
6. Convert ASCII code to packed BCD code.
7. Make use of DOS/BIOS functions to convert BCD code to 7-Segment Display code.
8. Demonstrate the DOS/BIOS functions in reading the key strokes with echo.
9. Utilize 8255 to program the working of Stepper Motor.
10. Interfacing with a 8259 interrupt controller.

**Intel 8051 (8-bit Microcontroller)- Assembly Language and C Programming experiments using Keil uvision IDE.**

1. Demonstrate Delay generation Methods.
2. Utilize the timer function and interrupts to count external events.
3. Demonstrate the working of Elevator model using 8051 microcontroller.
4. Implement the function of traffic signal model using 8051 microcontroller.
5. Display the given message on LCD.

***Conduct project works on 8051 microcontroller**

**Text Books**:

1. K M Bhurchandi, A K Ray, Advanced Microprocessors and Peripherals, 3rd edition, McGraw Hill Education, 2017.
2. Raj Kamal, Microcontrollers: Architecture, Programming, Interfacing and System Design, 2nd edition, Pearson, 2012.

**References:**

1.D.V.Hall, Microprocessors and Interfacing. TMGH, 2nd edition.
2.Barry B.Brey, "The Intel Microprocessors: Architecture, Programming and Interfacing", PHI, 6th Edition.
3.Microcontrollers and application, Ajay. V. Deshmukh, TMGH,2005.
4.Kenneth J. Ayala, The 8051 Microcontroller, 3rd edition, Cengage Learning, 2004.

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| SUBJECT CODE | SUBJECT NAME | L | T | P | CREDITS |
|---|---|---|---|---|---|
| R19ECE-SD3101 | **Hardware Design Engineering Lab (Skill Development Course)** | 0 | 0 | 3 | 0 |

**Course Objectives:**

- Introduce PCB Design tools and embedded systems design tools and hardware programmers.
- Give skills in both simulation and practical implementation of the basic building blocks of a microcontroller including timers, counters, I/O techniques and requirements.
- Introduce both simulation and practical implementation of the of a microcontroller including Interrupts, A/D conversion, serial communications.
- It develops an ability to use appropriate sensors and actuators for design and integrate hardware and software for microcontroller systems.
- It provides the basics of real time embedded systems and the internet of things. This helps students to design and develop small IOT applications.

**Course Outcomes:**

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

1. Acquire the knowledge of PCB designing tools (L2).
2. Acquire the knowledge of 8051 microcontrollers and embedded "C" Programming (L3).
3. Design Interfacing of LEDs and 7-Segment Displays with 8051(L2).
4. Design Interfacing of ADC and Electric Motor with Arduino (L3).
5. Develop a Circuit on PCB using Soldering Techniques and testing methods. (L3).

**List of Experiments:**

1. Introduction to Proteus Software.
2. Circuit Simulations on Proteus Software.
3. Interfacing of LED and Switches with 8051.
4. (a) Interfacing of 7-seg display with 8051.
   (b) Interfacing of Motor Driver IC(L293D) with 8051
5. (a) Interfacing of ADC (Temperature Sensor) with 8051.
   (b) Interfacing of Keypad with 8051
6. (a) Transmission of data from Microcontroller (8051)
   (b) Interfacing of Outside Peripherals with 8051(Receiving Data)
7. Arduino Based Traffic Light Controller.
8. (a) DHT11 Humidity Sensor on Arduino.
   (b) Control a DC Motor using Arduino and Motor Driver IC.
9. (a) Interfacing 7 Segment Display with Arduino.
   (b) Interfacing LCD with Arduino.
10. Serial Communication using Arduino.
11 . Soldering and Testing of given electronic Circuit.
12. Project Implementation.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19BSH-MC3102 | **Entrepreneurship and Incubation (Mandatory Course)** | **3** | **0** | **0** | **0** |

**Course Objectives:**

- Creation of environment and facilities to educate students and assist in identifying products, preparation of proposals, financing facilities, helping in developing testing, marketing and management.
- Guidance in development of new innovative products, services, processes and techniques.
- Providing technical and financial services through the members of the society and/or collaborating individuals, industries.
- Set up/promote of an idea either independently or jointly in establishment of start up.
- Influence the attitude of students towards Science, Technology and Entrepreneurship.

**Course outcomes:**

1. Enriches the knowledge of Entrepreneurial behaviour, and skill development.
2. Initiate business ideas that have value in the end-market.
3. Identify the validity of idea and its unique selling proportion.
4. Comprehend opportunity and challenges of-start up (L2)
5. Analyze various Government and non Government financial resource.

**Unit 1**

**Fundamentals of Entrepreneurship**

Fundamentals of Entrepreneurship – Characteristics of Entrepreneurs –Myths of Entrepreneurship -Role of Entrepreneurs in Indian economy – Social and Ethical Perspectives of Entrepreneurship.

**Case lets:** Business cases of TATA, Infosys, Bajaj Auto.

**Learning Outcomes:**

At the end of this unit students will be able to:

1. Interpret the concepts of entrepreneurship and the characteristics of an entrepreneur. (L2)
2. Explain the significance of entrepreneurship in the economic development of a nation.(L3)

**Unit 2**

**Ideation and Evaluation of Business Ideas**

Opportunity identification – Ideations process - Sources of business ideas – Role of creativity – Sources of Innovation –Technological Innovation And Entrepreneurship -Business Idea Evaluation - Product/ Service design – Design Thinking – Customer.

**Case lets:** Business cases of OYO, Paytm and Flipkart/ Smartmart

**Activity:** Idea generation in groups.

**Learning Outcomes:**

1. At the end of this unit students will be able to:
2. Choose the right business ideas. (L3)
3. Explain the business idea evaluation process. (L2)

**Unit 3**

**Feasibility Analysis and Business plan**

Thrust areas of entrepreneurship - Techno-economic feasibility assessment- Financial feasibility – Market feasibility – Preparation of Business plan – Business canvas & Lean canvas- Challenges & Pitfalls in selecting new venture.

**Activity:** Preparation of business plan (draft)

**Learning Outcomes:**

At the end of this unit students will be able to:

1. recall different forms of business organizations.(L1)
2. Develop and analyze business canvas. (L4)

**Unit 4**

**Business Incubation and startups**

Fundamentals of business incubation - Business incubator models - Services of incubators - Start-ups-practical applications and challenges-start up strategy -blue ocean strategy vs red ocean strategy.

**Activity:** Business plan presentation.

**Learning Outcomes:**

At the end of this unit students will be able to:

1. Describe/define the process of business incubation/incubators (L2)
2. Select a suitable incubator and build a feasible business model. (L3)

**Unit 5**

**Financial resources**

Sources of finance – Bootstrapping - Government Support – Financial & Non-financial– Venture Capitalists & Angel Investors.

**Activity:** Business plan final version

**Learning Outcomes:**

At the end of this unit students will be able to:

1. Knowledge about various sources of finance for entrepreneurship. (L2)
2. Organize opportunities Seed capital /Angel financiers and understand operation.(L3)

**Text Book**:

1. T.V Rao, Donald F. Kuratko, Entrepreneurship,A South-Asian Perspective, Cengage Learning, 2012
2. DatsyDavies,Indian Startups, Amazon Asia-Pacific Holdings Private Limited, 2016

**Reference Books:**

- P.N.Rath, Sarjue Pandita, Entrepreneurship: Startup India & Stand up India, Lexicon Publishing House, 2018
- MadhurimaLall, Shikha Sahai, Entrepreneurship, Excel Books (P) Ltd. 2008
- Rajeev Roy, Entrepreneurship, Oxford Higher Education. 2011
- H. Nandan, Fundamentals of Entrepreneurship, PHI Learning (P) Ltd, 2013

**Web Resources:**

https://www.startupindia.gov.in/
https://strategyzer.com/canvas/business-model-canvas
https://canvanizer.com/new/lean-canvas
https://msme.gov.in/
https://t-hub.co/
http://www.apinnovationsociety.com/index.php
https://aim.gov.in/atal-incubation-centres.php
https://nptel.ac.in/courses/110/106/110106141/

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19BSH-MC3101 | **Employability Skills – 2** (Mandatory Course) | 0 | 0 | 2 | 0 |

**Course Objectives**

- Encourage use of a wide range of grammatical structures and vocabulary in speech and writing
- Demonstrate good writing skills for effective paraphrasing, argumentative essays, and formal correspondence
- Provide training and opportunities to develop fluency in English through participation informal group discussions and presentations using audio-visual aids
- Knowing the best practices at the workplace to perform well in the interview.
- Encouraging smart self-learning, communication skills that focus on employability.

**Course Outcomes**

1. understand the grammatical forms of English and the use of these forms in specific communicative and career context
2. use a wide range of reading comprehension strategies appropriate to texts, to retrieve information
3. strengthen their ability to write paragraphs, essays, emails and summaries
4. Improve their speaking ability in English both in terms of fluency and comprehensibility by participating in Group discussion and oral assignments
5. prepare their own resume and answer interview related questions unhesitatingly with acceptable soft skills

**Unit 1**

**Preparing for Written Assessment [6 Hours]**

**Grammar: Articles**: Know how to use different types of Articles**,** use articles appropriately in context Identify errors in the use of articles, **Prepositions**: Learn to use prepositions in context, Identifying errors in the use of prepositions, Look at the different functions of Prepositions, **Tenses**: understand the different form of tense used in sentences, know the various purposes of using different Tense forms, Use appropriate tense forms of verbs in context, Identify the errors in the use of tense forms, **Concord**: Know how to identify Subject-Verb-Agreement in sentences, Use SVA appropriately in Context, identify the errors in the use of SVA, **Voices**:Know when to use Active or Passive Voice, Convert Active sentences to Passive ones,Relative Clause: Know what relative pronouns are, know when to use relative clauses,know the functions of Relative Clauses.

**Soft Skills: Leadership**:Introduction to Leadership, Leadership Power, Leadership Styles, Leadership in Administration. **Interpersonal Relations**:Introduction to Interpersonal Relations, Analysis of different ego states, Analysis of Transactions, Analysis of Strokes, Analysis of Life position

**Learning Outcomes**

At the end of the module, the learners will be able to

- Comprehend the factors that influence use of grammar and vocabulary in speech and writing(L3)
- Produce a range of valid grammatical sentences in the real world situations and professional environment.(L3)
- develop employability skills through Leadership skills and interpersonal skills (L3)

## Unit 2

**Reading Comprehension** **[6 Hours]**

**Purposes & Strategies of Reading**:know the general purpose of Reading,assess your skills of reading ,develop reading Strategies **Skimming for details**:Skim through a variety of passages, understand how skimming will orient you to the text, **Identifying main Ideas**:Identify the main ideas in the give text,Look for supporting statements in a passage, understand how the writer supports main ideas with details **Scanning for information:**Scan passages for factual information, understand how scanning can help find certain answers quickly,know how to look for factual answers,**drawing inferences:**Understand how to draw inferences,infer meanings while reading passages, **vocabulary**:Learn strategies to understand difficult words used in the passage,Apply strategies of reading to understand a variety of passages,**practise tests**

**Soft Skills:Communication:** Introduction to Communication, Flow of Communication, Listening, Barriers of Communication, How to overcome barriers of communication. **Stress Management**:Introduction to Stress, Causes of Stress, Impact Stress, Managing Stress

**Learning Outcomes**

At the end of the module, the learners will be able to

- assess the reading skill by developing reading strategies (L3)
- Understand the skimming & scanning techniques orients to identify the theme,purpose and statements.(L2)
- develop employability skills through communication skills and stress management(L3)

## Unit 3

**Writing paragraphs & Essays** **[6 Hours]**

**Features of Good Writing**:understand what makes a piece of writing good,Analyse & discuss some samples of good & bad writing, **Gathering Ideas**: Discuss various techniques for gathering ideas before you start writing, practice some of the techniques that can be used in the Prewriting stage ,**Purposes of Writing:**understand the importance of purpose of writing,explore various purpose of writing,choose content & language based on the purpose **Writing for Specific audience:**Study ways of tailoring content to suit a target audience,analyse text to deduce the target audience,discuss how language is used to suit the target audience **organizing ideas:**understand the importance of organising ideas in a text,Learn the different ways of organising ideas,practice organising ideas while writing **Writing an introduction:**Know the importance of a good introduction, understand the different ways in which writers catch the attention of readers, **Developing supporting ideas:**Learn how to develop your ideas in a paragraph, discuss a variety of supporting ideas ,**Writing a conclusion:**Learn the different parts of a conclusion, Practice writing an effective conclusion **Using linkers:**Learn the different types of Linkers or cohesive devices, Discuss why it is important to use connectors in writing,**Choosing the right words:**Discuss why writers make a careful choice of language,Learn how to select language to make the intended impact, **Writing film & book reviews:** Learn the different categories of books & films,Know the elements which go into analysing books & films,Write your own film & book reviews **Common errors in writing, editing & proofreading**.:Practice correcting errors in basic sentence structure,Learn to proof-read & edit your draft before writing the final version

**Soft Skills: Group Dynamics and Team Building:** Importance of groups in organization,Interactions in group, Group Decision Taking, Team Building, Interaction with the Team, How to build a good team?

**Learning Outcomes**

At the end of the module, the learners will be able to

- produce logically coherent argumentative essays (L3)

- understand the use of passive voice in academic writing (L2)
- use appropriate vocabulary to express ideas and opinions (L2)
- develop employability skills through group dynamics and team building (L3)

**Unit 4**

**Preparing for oral Assignment [6 Hours]**

**Group Discussion:**Group Discussions as a tool for selection, skills for GD,Leadership & Problem-Solving Skills, Types of GD, Group Dynamics, Roles & Functions: Beginning, Presenting, Elaborating, Roles & Functions: Clarifying, Synthesising & Challenging, Roles & Functions: Agreeing, Disagreeing & Summarizing., Etiquette: Body Language & Time Management, GD Activities

**Soft Skills: Conflict Management**: Introduction to Conflict, Causes of Conflict, Managing Conflict **Time Management:** Time as a Resource, Identify Important Time Wasters, Individual Time Management Styles, Techniques for better Time Management.

**Learning Outcomes**

At the end of the module, the learners will be able to

- participate in group discussions using appropriate conventions and language strategies and develop advanced listening skills for in-depth understanding of academic text(L3)
- collaborate with a partner to make discussions (L2)
- develop employability skills through conflict management and time management(L3)

**Unit 5**

**Interview Skills [6 Hours]**

**Purpose of interviews:**Know what recruiters looking for during Interviews,Become familiar with the process of career search, understand your skills,interests,achievements and attitude better **Preparing a Resume:**Understand what a job application is,know the details to be included in a CV,Know how to lay out details of a CV & prepare CV on your own **Writing a Cover Letter:**Study the information which is included in a cover letter.Learn how to organise information in a cover letter ,**Before and at the interview:**Learn how to prepare for an interview,learn how to behave during the interview, discuss what the interviewer might assess you on **Answering FAQs about yourself & your families:**Learn how to answer questions about yourself & family, Learn how to identify & talk about your strengths and Weaknesses **Answering FAQs about Likes & Dislikes:**Learn to choose interests which will be relevant to your Interview.learn to speak about your likes & Dislikes **Answering FAQs about Justifying your candidature:**Know what you need to say to answer a question about yourself, Be able to answer questions about your suitability for a job **Answering FAQs about Priorities,Attitudes & Biases:**Understand what your priorities will be in a job & learn to talk about them,learn to correct understanding of your attitude, biases & prejudice, if any, towards others,know positive qualities that are valued at work **Answering FAQs about Professional goals:** Become aware of the things you need to keep in mind while choosing a job,Set goals for your professional growth & plan how to achieve them **Public Speaking: Planning, Practice & Delivery:**Plan one minute speeches on simple topics, understand how to capture the audience's attention, be able to create strong closing statements.

**Soft Skills:Motivation:** Introduction to Motivation, Relevance and types of Motivation, Motivating subordinates, Analysis of Motivation

**Learning Outcomes**

At the end of the module, the learners will be able to

- prepare a CV with a cover letter to seek internship/ job (L2)
- understand the structure of Interviews and familiar with frequently asked questions while interview and how to respond to it (L3)
- develop employability skills through motivation and analysis of motivation (L3)

## ASSESSMENT

The learners will demonstrate their knowledge and abilities through completion of the following required assessments while or at the end of this course. —1 Quiz, 1 GD, 2 Activities on Interview Readiness and Softskills, 1 Personal Interview

### Quiz: (10M)

Quiz is conducted on Grammar, Vocabulary and Reading Comprehension. The Quiz consists of 50 questions and will be scaled down to 10 Marks. Duration of the quiz is 1hr 30 Min only and it is Computer Based Test (CBT)

### GD:(10 M)

1. Each student has to perform 5 Group Discussions during the course which fetches them 5 Marks.
2. The Final Assessment through one formal GD by the External Examiner is for 10 marks that are scaled down to 5 marks .

### The GD will be assessed on the following criteria :

1. Content (3M)
2. Body Language(2M)
3. Group dynamics & Leadership Skills (3M)
4. Communication Skills (2M)

### Activities on Interview Readiness:(10M)

The external Examiner assess on Interview readiness

1) **Tell something about Yourself (5M)**
   Assessment Parameters:
   - Initiation
   - Confidence level
   - Body Language
   - Attention Grabbing
2) **JAM (5M):**Student will be given a topic on-Spot and will be assessed by the External examiner on

Flow of Speech (2M)

- Accuracy and Language (2M)
- Confidence (1M)

### Soft Skills:(10M)

Student will be Assessed on

- Presentation of his/her Readiness of Interview (Grooming) with Prepared Resume (5M)
- Aptitude based question/Case study/Behavior based Question (5M)

### Resume:(10 M)

Each student is required to submit 3 independently written Resumes during the course. Specific requirements for each one are accessed on the following Link: https://docs.google.com/document/d/1W15961dOEnIxlnMm9BKyO8L9WIa7nPbEfgR-9DT_m Rg/edit?usp=sharing

### Grading:

| Assessment Model | Points |
|---|---|
| Quiz | **10** |
| Resume | **10** |
| GD | **10** |
| Soft Skills Activity | **10** |
| Personal Interview | **10** |
| Total | **50** |

**Pass Criterion:**

1. Student has to Secure 30 Marks to pass this examination
2. Student who is having an achievement certificate of any National or International Level Quiz/Psychometric Analysis, he/she has to secure a Minimum 20 Marks in this examination (Certificate+20 Marks) to pass the summative exam.
3. Clearing all categories is mandatory. Need to get 60% in each category
4. 20M +Certificate=Successful or 30M+No certificate=Successful

**III Year –II Semester**

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PC3201 | Microwave Engineering | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To introduce the working and characteristics of microwave passive and active devices.
- To teach modes of propagation of EM waves through microwave transmission lines.
- To outline the performance of various microwave devices.
- To introduce concepts of MICs
- To demonstrate microwave measurements

**Course Outcomes:**

1. Explain basic concepts of waveguides, passive and active microwave devices (L2)
2. Compute microwave signal parameters, power output and efficiency of microwave active devices (L4)
3. Derive field expressions for microwave transmission lines, power gain and efficiency of microwave devices (L4)
4. Compare various performance parameters of microwave amplifiers and oscillators (L5)
5. Describe fabrication of strip lines and MICs (L2)

**Unit 1**

**Waveguides:** Introduction, Microwave Spectrum and Bands, Applications of Microwaves. Rectangular Waveguides — Solution of Wave Equations in Rectangular Coordinates, TE/TM mode analysis, Expressions for Fields, Characteristic Equation and Cut-off Frequencies, Dominant and Degenerate Modes, Sketches of TE and TM mode fields in the cross-section, Mode Characteristics — Phase and Group Velocities, Wavelengths and Impedance Relations, Illustrative Problems. Rectangular Guides: Power Transmission and Power Losses, Impossibility of TEM Mode. Cavity Resonators— Introduction, Rectangular Cavities, Dominant Modes and Resonant Frequencies, Q Factor and Coupling Coefficients.

**Learning outcomes:**

- List applications of microwaves (L1)
- Understand concepts of wave propagation and microwave transmission lines (L2)
- Analyze various modes of propagation in the waveguides (L4)
- Determine microwave signal parameters (L3)

**Applications:**

- They are extensively used in Microwave ovens.
- Waveguides are used for broadcasting and radar installations.
- They are used in space crafts.

**Unit 2**

**O- type and M-type Tubes:** Limitations of conventional devices at microwave frequencies- Two-cavity klystrons - Reentrant cavities, Velocity-modulation process, Bunching process, output power, Reflex klystrons - velocity modulation, power output and efficiency.

Helix Travelling - wave Tubes (TWTs) - slow-wave structures, amplification process, gain consideration

Magnetron oscillators - cylindrical, linear and coaxial magnetrons.

**Learning outcomes:**

- Understand limitations of conventional devices at high frequencies (L2)
- Explain velocity modulation and bunching phenomenon in linear beam and cross field tubes (L2)
- Compute output power and efficiency of microwave tubes (L3)

**Applications:**

- used in microwave receivers as a low noise RF amplifier
- are used in high power pulsed radars and ground based radars

**Unit 3**

**S- Parameters and Microwave Passive Components :** S-parameter formulation of microwave network, properties of S-parameters- Waveguide Tees, Magic Tees, Hybrid rings (Rat-Race circuits), Coupling Mechanisms — Probe, Loop, Aperture types. Waveguide Discontinuities — Waveguide Windows, Tuning Screws and Posts, Matched Loads. Waveguide Attenuators — Different Types, Resistive Card and Rotary Vane Attenuators; Waveguide Phase Shifters — Types, Dielectric and Rotary Vane Phase Shifters, Waveguide Multiport Junctions, Waveguide corners, bends and twists, two-hole directional coupler, Circulators and Isolators - S-matrix for directional coupler, magic tee and circulator.

**Learning outcomes:**

1. Understand properties of S –parameters (L2)
2. Explain working of microwave passive devices (L2)
3. Formulate S-matrix for various microwave passive devices (L5)

**Applications:**

- Used in Reflectometer that provides measurement of forward power and reflected power
- Used in Leveled generator

**Unit 4**

**Microwave Semiconductor Devices:** Gunn Effect - Ridley-Watkins-Hilsum Theory - Modes of operation.

Read diode - physical description, output power and quality factor

IMPATT diodes-physical structure, Negative resistance, power output and efficiency

BARITT diodes-physical description, principle of operation

Parametric devices - physical structure, Manley-Rowe power relations - Parametric Amplifiers

Operation of PIN and Tunnel Diodes, High Electron Mobility Transistors (HEMTs) - structure, operation and performance characteristics MOSFETs - structure, modes of operation

**Learning outcomes:**

- State Gunn effect (L1)
- Explain principle of operation of microwave semiconductor diodes and transistors (L2)
- Analyze process of parametric amplification (L4)

**Applications:**

- IMPATT diode, the BARITT is used in microwave signal generation, often in applications including burglar alarms
- IMPATT are used in microwave links, continuous-wave radars, and electronic countermeasures

**Unit 5**

**STRIP LINES, MICs and Measurements:**Microstrip lines - characteristic impedance, losses and Q-factor.

Parallel strip lines - distributed parameters, characteristic impedance, attenuation losses

Microwave integrated circuits - substrate, conductor, dielectric and resistive materials

Fabrication process related with HMIC and MMIC.

Microwave Measurements- Power, frequency and wave length, VSWR and impedance measurements.

**Application:**

**Monolithic Microwave Integrated Circuits** are available for amplification of small signal as well as for frequency conversion

**Learning outcomes:**

- Understand electromagnetic field patterns of strip lines (L2)
- Calculate characteristic impedance, dielectric constant and return loss for given strip line (L4)
- Describe microwave bench setup for various microwave measurements (L2)

**Text book**

1. Samuel Y. Liao, 'Microwave Devices and Circuits', PHI Edition.

**References**

1. Om P Gandhi, Microwave Engineering and Applications, Pergamon Press.
2. David M. Pozar, Microwave Engineering, Wiley Edition
3. Mathew M. Radmanesh, RF and Microwave Electronics, Prentice-Hall publication.
4. Jordan and Balmain, Electromagnetic Waves and Radiating Systems, PHI, 1995.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PC3202 | **VLSI** | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To give exposure to different steps involved in the fabrication of ICs using MOS transistor.
- To explain electrical properties of MOS devices.
- To introduce design rules and scaling effects in CMOS technology.
- To study behavior of inverters designed with various loads.
- To provide concepts required to design combinational and sequential circuits using CMOS and latest Trends in VLSI Design.

**Course Outcomes:**

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

1. Describe fabrication process and characteristics of a MOSFET (L2)
2. Derive the scaling effects on device parameters (L4)
3. Estimate the MOS inverter delay, noise margin and driving capabilities (L6)
4. Design CMOS digital combinational logic circuits (L4)
5. Outline latest trends in CMOS technology (L2)

**Unit 1**

**Introduction to MOSFETs:** Introduction to IC technology, Fabrication process: nMOS, pMOS and CMOS. Ids versus Vds Relationships, Aspects of MOS transistor Threshold Voltage, MOS transistor Trans, Output Conductance and Figure of Merit. nMOS Inverter, Pull-up to Pull-down Ratio for nMOS inverter driven by another nMOS inverter, and through one or more pass transistors. Alternative forms ofpull-up, The CMOS Inverter, Latch-up in CMOS circuits, Bi-CMOS Inverter, Comparison between CMOS and BiCMOS technology.

**Unit Outcomes:**

- Outline CMOS fabrication process flow and λ-based design rules (L2)
- Derive the electrical parameters of MOS transistor (L4)
- Derive the driving parameters of Inverters (L4)

**Applications:**

- used for switching and amplifying electronics signals in the electronic devices
- can be used in electronic DC relay

**Unit 2**

**MOS and Bi-CMOS Circuit Design Processes:** MOS Layers, Stick Diagrams, Design Rules and Layout, General observations on the Design rules, 2µm Double Metal, Double Poly, CMOS/BiCMOS rules, 1.2µm Double Metal,Double Poly CMOS rules, Layout Diagrams of NAND and NOR gates and CMOS inverter, Symbolic Diagrams Translation to Mask Form.

Scaling of MOS Circuits: Scaling models and scaling factors, Scaling factors for device parameters, Limitations of scaling, Limits due to sub threshold currents, Limits on logic levels and supply voltage due to noise and current density.

**Unit Outcomes:**

1. Outline MOS design rules (L2)
2. Draw stick diagrams and layouts for MOS gates (L3)
3. Estimate scaling effects on device parameters (L5)

**Applications:**

- Stick diagrams are useful for planning the layout and routing of integrated circuits
- CMOS used in microcontrollers, static RAM, registers, microchips and other digital circuits

**Unit 3**

**MOS INVERTERS:** Inverters with resistive load, MOSFET load; CMOS inverter: Voltage transfer characteristics, Noise margins, switching characteristics, calculation of delay times; effect of load on switching characteristics and driving large loads, logical effort of paths.

**Unit Outcomes:**

- Draw VTC of a CMOS inverter and estimate the switching threshold ($V_{SP}$ ) for different $(\beta p/\ \beta n)$ ratios (L3)
- Find Noise Margins and propagation delays for skewed inverters (unloaded) (L5)
- Size cascaded inverters for driving large capacitance loads (L4)

**Applications:**

- Scaling scenarios for wire capacitance

**Unit 4**

**Digital circuits using CMOS:** Pseudo NMOS, Pass transistor, transmission gates, Dynamic logic, Domino logic, Differential cascode voltage switch logic, design of combinational circuits, design of sequential circuits, timing requirements.

**Unit Outcomes**:

- Compare CMOS and pseudo-NMOS inverters with respect to area and speed (L2)
- Compare TG logic and Pass Transistor logic gates (L2)
- Distinguish between static and dynamic logic styles (L4)
- Evaluate performance of simple arithmetic circuits designed using CMOS (L5)
- Estimate max. frequency of a latch using timing parameters such as set-up time, hold time, skew etc (L5)

**Applications:**

- Flash memory chip designing
- Used to design application-specific integrated circuits (ASICs)

**Unit 5**

**Trends in CMOS technology:** SOI, FINFET and multi-gate FET, 2D materials based FETs, On-chip interconnects. Coping with Interconnects: Capacitive, Resistive and Inductive parasitic, Advanced Interconnect Techniques, Power Grid and Clock design: Power Distribution Design, Clocking and Timing Issues.

**Unit Outcomes:**

- Compare characteristics of a MOSFET with those of FINFET (L4)
- Estimate global interconnect delay on a VLSI chip (L5)
- Describe on-chip clocking strategies for minimizing clock skew (L2)

**Applications:**

- MOSFET transistor researchers are exploring device structure and channel material changes to enable further generations of MOSFET scaling

**Text Books**


1. Essentials of VLSI Circuits and Systems - Kamran Eshraghian, Douglas and A. Pucknell and Sholeh Eshraghian, Prentice-Hall of India Private Limited, 2005 Edition.
2. Neil H.E. Weste and David Harris, CMOS VLSI Design: A circuits and systems perspective, 4th Edition, Pearson Education, 2015.
3. Jan M RABAEY, Digital Integrated Circuits, 2nd Edition, Pearson Education, 2003.


**References**


1. VLSI Design-Black Book By Dr. K.V.K.K. Prasad, Kattula Shyamala, Kogent Learning Solutions Inc.2012 Edition.
2. Sung-Mo Kang, Yusuf Leblebici, Chulwookim, Digital Integrated Circuits: Analysis and Design, 4 th Edition, McGraw Hill Education, 2016.
3. BehzadRazavi, Design of Analog CMOS Integrated Circuits, 2nd Edition, McGraw Hill Education, 2016.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| **R19ECE**-PC3203 | **Digital Signal Processing** | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To describe discrete time signals and systems.
- To teach importance of FFT algorithm for computation of Discrete Fourier Transform.
- To expose various implementations of digital filter structures.
- To present FIR and IIR Filter design procedures.
- To outline need of Multi-rate Processing.

**Course Outcomes:**

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

1. Formulate difference equations for the given discrete time systems (L6)
2. Apply FFT algorithms for determining the DFT of a given signal (L3)
3. Compare FIR and IIR filter structures (L5)
4. Design digital filter IIR from the given specifications (L6)
5. Design digital filter FIR from the given specifications (L6)

**Unit 1**

Introduction to Digital Signal Processing: Discrete time signals & sequences, Classification of Discrete time systems, stability of LTI systems, LTI system Properties. Solution of Linear constant coefficient difference equations , frequency domain representation of discrete time signals and systems. Review of Z-transforms.

**Learning Outcomes:**

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

1. Describe importance of Digital Signal processing (L2)
2. Describe LTI system Properties (L2)
3. Summarize properties of Discrete time systems and Z-transforms (L2)

Applications

1. Converting a continuously changing waveform into a series discrete levels
2. Spectrum analyzer

**Unit 2**

Discrete Fourier Series and Fourier Transforms: Properties of discrete Fourier series, DFS representation of periodic sequences, Discrete Fourier transforms: Properties of DFT, linear filtering methods based on DFT.

**Learning Outcomes:**

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

1. Describe the properties of DFT
2. Determine DFT of a given sequence using linear filtering methods (L3)

**Applications**

1. The detection of the frequencies of a pair of sinusoidal signals, called tones, employed in telephone signalling
2. Equalizer in audio and video signal processing.

**Unit 3**

Fast Fourier Transforms: Properties of FFT, - Radix-2 decimation in time and decimation in frequency FFT Algorithms, Inverse FFT.

**Learning Outcomes:**

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

**1.** Determine time sequence from the given spectrum of a signal using FFT algorithms (L3)
2. Determine the inverse FFT

**Applications**

**2.** Shaping of the signal spectrum

3. FFT algorithms in video and audio signal processing

**Unit 4**

Design of IIR Digital Filters and Realizations: Analog filter approximations – Butter worth and Chebyshev, Design of IIR Digital filters from analog filters, Design Examples, Analog and Digital frequency transformations. Basic structures of IIR systems, Transposed forms.

**Learning Outcomes:**

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

1. Design IIR filter from the given analog transfer function (L5)
2. Describe features of IIR Filter structures (L2)

**Applications**

1. The applications of IIR filters include the removal of the noise or interference, passing of certain frequency components.
2. an equalization of a small monitor loudspeaker

**Unit 5**

Design of FIR Digital Filters and Realizations: Characteristics of FIR Digital Filters, frequency response. Design of FIR digital filters using window techniques and frequency sampling technique, comparison of IIR & FIR filters, basic structures of FIR systems.

**Learning Outcomes:**

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

1. Design FIR Digital Filter using windowing techniques for the given specifications (L5)
2. Identify basic structures of given FIR systems (L3)

Applications

1. Phase can be made exactly linear
2. Equalizer for audio and video processing

**Text Books**


1. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms, and Applications, Pearson Education, 2007.
2. A.V.Oppenheim and R.W. Schaffer, Discrete Time Signal Processing ,PHI.
3. B.Venkataramani, M. Bhaskar, Digital Signal Processors – Architecture, Programming and Applications, TATA McGraw Hill, 2002.


**References**


1. Andreas Antoniou, Digital Signal Processing, TATA McGraw Hill, 2006
2. MH Hayes, Digital Signal Processing, Schaum's Outline series, TATA Mc-Graw Hill, 2007.
3. Robert J. Schilling, Sandra L. Harris, Fundamentals of Digital Signal Processing using Matlab, Thomson, 2007.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PE3201.1 | Information Theory & Coding **(Professional Elective-2)** | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To impart the information theory techniques for maximum utilization of the channel.
- To introduce the concepts of source coding, channel capacity and bandwidth relations.
- To summarize the various linear block coding techniques.
- To show the use of various cyclic and BCH codes.
- To familiarize with various convolution codes and compression in image and video systems.

**Course Outcomes:**

1. Explain entropy of binary memory less source and its extension to discrete memory less source(L2).
2. Derive equations for entropy mutual information and channel capacity for all types of channels(L2).
3. Identify the basic equations of linear block codes for digital communication systems(L3)
4. Design a digital communication system by selecting an appropriate error correcting codes for a particular application (L6).
5. Apply the convolution codes based on Viterbi algorithm for digital communication system(L3)

**UNIT 1**

**Information Theory and Source Coding:** Uncertainty, information, entropy and its properties, entropy of binary memory less source and its extension to discrete memory less source, source coding theorem, data compression, prefix coding, Huffman coding,

**Learning outcomes:** Student will be able to

1. Analyze information rate of a discrete memory less source coding (L4).
2. Select a suitable lossy data compression technique for a given situation(L3)

**Applications: Information theory used in**

1. **Data compression**
2. **Cryptology**

**UNIT 2**

**Discrete Channels:** Binary Symmetric Channel, mutual information &its properties, Channel capacity, channel coding theorem and its application to BSC, Shannon's theorem on channel capacity, capacity of a channel of infinite bandwidth, bandwidth - S/N trade off, practical communication systems in light of Shannon's theorem, Fading channel, channels with memory.

**Learning outcomes:** at the end of the unit the student can able to

1. Understand channel capacities and properties using Shannon's Theorems(L2);
2. calculate the capacity of typical digital communication channels(L3)

**Applications:**

1. in **the deep space applications and in wireless communication systems**

**UNIT 3**

**Groups, Fields And Linear Block Codes:** Galois field and its construction in GF(2m ) and its basic properties, vector spaces and matrices in GF(2), Linear block codes, systematic codes and its encoding circuit, syndrome and error detection, minimum distance, error detecting and correcting capabilities of block code, decoding circuit, Hamming code and their applications. Modified linear codes

**Learning outcomes:** Students will demonstrate the ability to

1. Select and design simple linear block error correcting codes(L3).

2. Demonstrate the mathematical theory of linear channel codes for error detection and correction techniques applied in communication system(L2).
3. Explain the field extensions and Galois theory of an digital codes(L2)

**UNIT 4**

**Cyclic Codes And Bch Codes:** Basic properties of Cyclic codes, Generator and parity check matrix of cyclic codes, encoding and decoding circuits, syndrome computation and error detection, cyclic Hamming codes, encoding and decoding of BCH codes, error location and correction.

**Learning outcomes:** Students will demonstrate an ability to

3. Implement cyclic block codes using feedback shift register logic circuits(L3).

**Applications:**

**1.** for **error correction or detection**
**2.** used to correct double errors and burst errors

**UNIT 5**

**Convolutional Codes:** Introduction to convolution code, its construction and Viterbi algorithm for maximum likelihood decoding. Automatic repeat request strategies and their throughput efficiency considerations.

**Learning outcomes:** Students will demonstrate ability to

**1.** Select and design simple convolution codes(L3).

**Applications:**

1. in the deep space applications and in wireless communication systems
2. used extensively to achieve reliable data transfer in numerous applications, such as digital video, radio, mobile communications

**Textbooks**


1. Lathi B. P., Modern Analog and Digital Communication Systems, Oxford Univ. Press
2. Shu Lin and Costello, Error Control Coding Fundamentals and Applications, 2nd Edition, Pearson.
3. Sklar, Digital Communication, Pearson Education Asia.


**Reference Books**


3. Haykin Simon, Digital Communication, Wiley Publ.
2. Proakis, Digital Communication, McGraw Hill.
3. Schaum's Outline Series, Analog and Digital Communication, TMH.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PE3201.2 | Analog IC Design (Professional Elective-2) | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To educate that ICs are similar to discrete component circuits with special constraints.
- To expose to these constraints and make them design the ICs.
- To make them capable of arriving at a suitable architecture for a given function, realized in IC form.
- To compare and contrast the CMOS amplifiers based circuits for various applications.

**Course Outcomes:** At the end of the Course, the Student will be able to

1. Apply mathematics and physics to derive first order and second order MOSFET models (L3)
2. Compare basic current mirror, and Wilson current mirror characteristics (L2)
3. Classify the simple CMOS amplifiers and analyze their performance (L2)
4. Identify the errors in a differential amplifier due to device mismatch (L3)
5. Evaluate performance of comparators (L5)

**UNIT -1**

**MOS Devices and Modeling:** The MOS Transistor, Passive Components- Capacitor & Resistor, Integrated circuit Layout, CMOS Device Modeling - Simple MOS Large-Signal Model, Other Model Parameters, Small Signal Model for the MOS Transistor, Computer Simulation Models, Sub-threshold MOS Model.

**Learning outcomes**: At the end of the unit, the student will be able to

1. Relate resistors, capacitors, diodes and BJTs as MOS ICs (L2)
2. Obtain first order and second order mathematical models for a MOSFET (L1)
3. Illustrate basic CMOS amplifier configurations with different types of loads (L2)

**Applications:**

2. Microprocessor designs.
3. Flash memory chip designing.
4. Used to design application-specific integrated circuits (ASICs)

**UNIT -2**

**Analog CMOS Sub-Circuits:** MOS Switch, MOS Diode, MOS Active Resistor, Current Sinks and Sources, Current Mirrors Current mirror with Beta Helper, Degeneration, Cascode current Mirror and Wilson Current Mirror, Current and Voltage References, Band gap Reference.

**Learning outcomes**: At the end of the unit, the student will be able to

1. Distinguish between a MOSFET current source and a current sink (L4)
2. Compare and contrast basic current mirror with Widlar and Wilson current mirrors (L2)
3. Evaluate performance of Zener and Band gap references (L5)

**Applications:**

1. A precision current sink can be used to generate a voltage bias for sensors, amplifiers, and other analog circuits
2. current mirror is used to provide bias currents and active loads to circuits.
3. also be used to model a more realistic current source

**UNIT -3**

**CMOS Amplifiers :** Inverters, Differential Amplifiers, Cascode Amplifiers, Current Amplifiers, Output Amplifiers, High Gain Amplifiers Architectures.

**Learning outcomes**:At the end of the unit, the student will be able to

1. Analyze CS amplifier with different types of loads and compare their gain and $Z_{out}$(L4)

**2.** Analyze performance of a CMOS cascade amplifier and their architectures (L4)
3. Compare cascode and folded cascode amplifier performances (L2)

**Applications:**

CMOS amplifiers are **used in computers, audio systems, smartphones, cameras, telecommunication systems, biomedical circuits, and many other systems**.

**UNIT -4**

**CMOS Operational Amplifiers :** Design of CMOS Op Amps, Compensation of Op Amps, Design of Two-Stage Op Amps, Power- Supply Rejection Ratio of Two-Stage Op Amps, Cascode Op Amps, Measurement Techniques of OP Amp.

**Learning outcomes**: At the end of the unit, the student will be able to

**1.** Find gain, BW and phase characteristics of two and three stage CMOS OPAMPS (L1)
2. Improve gain and output impedance of an OPAMP by cascade technique (L6)
3. Suggest process and temperature independent compensation techniques for CMOS OPAMPs (L6).

**Applications:**

1. used extensively in signal conditioning, filtering or to perform mathematical operations such as add, subtract, integration and differentiation.
2. CMOS operational amplifier for wireless intraocular pressure recordings.

**UNIT -5**

**Comparators :** Characterization of Comparator, Two-Stage, Open-Loop Comparators, Other Open-Loop Comparators, Improving the Performance of Open-Loop Comparators, Discrete-Time Comparators.

**Learning outcomes**:At the end of the unit, the student will be able to

1. Distinguish between different open loop comparators.(L2)
2. Evaluate performance of open loop comparators.(L5)

**Applications:**

**1.** used in Analog to Digital converter (ADC)

**Text Books**

1. CMOS Analog Circuit Design - Philip E. Allen and Douglas R. Holberg, Oxford University Press, International Second Edition/Indian Edition, 2010.
2. Analysis and Design of Analog Integrated Circuits- Paul R. Gray, Paul J. Hurst, S. Lewis and R. G. Meyer, Wiley India, Fifth Edition, 2010.

**Reference Books**

1. Analog Integrated Circuit Design- David A. Johns, Ken Martin, Wiley Student Edn, 2013.
2. Design of Analog CMOS Integrated Circuits- BehzadRazavi, TMH Edition.
3. CMOS: Circuit Design, Layout and Simulation- Baker, Li and Boyce, PHI.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19PE-PE3201.3 | Real Time Operating Systems (Professional Elective-2) | 3 | 0 | 0 | 3 |

**Course Objectives:**

1. To understand the fundamental parameters of a real time systems and difference to general operating system.
2. To summarize the various functions of operating system and the changes needed for real time operations.
3. To familiarize with task and its properties and task based communication methods.
4. To impart with services and objects related to I/O, Timers and Interrupts etc.
5. To understand the structure and functioning of various of practical real time operating systems.

**Course Outcomes:** At the end of the Course, the Student will be able to

1. Outline the characteristic functions of real time systems.(L2)
2. Summarize the operating system functions and the characteristics changes of real time operating system.(L2)
3. Analyze various real time scheduling algorithms.(L4)
4. Outline the I/O, timer and interrupt specific objects and methods.(L2)
5. Illustrate the functioning of few real time operating systems.(L2)

**UNIT I**

**Real Time Systems**: Typical Real Time Application, Hard Vs Soft Real Time Systems, a Reference Model of Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency Functional Parameters, Resource Parameters of Jobs and Parameters of Resources.

**Learning Outcomes:** At the end of the unit, the student will be able to

1. Explain the difference characteristics and constraining parameters of real time system.(L2)
2. Summarize the processes and resources related to real time systems.(L2)

**Applications:**

Automated Car Assembly Plant,
Chemical Plant

**UNIT II**

**Real Time Operating Systems :** Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, Task States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency. Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Uses .

**Learning Outcomes:** At the end of the unit, the student will be able to

1. Compare the operating system characteristics of general purpose operating system and real time operating system (L2).
2. Explain the process management and process synchronization functions of real time operating systems.(L2)

**Applications:**

- Airlines reservation system.
- Air traffic control system.

## UNIT III

**Approaches To Real Time Scheduling:** Clock Driven, Weighted Round Robin, Priority Driven, Dynamic Vs State Systems, Effective Release Times and Dead Lines, Offline Vs Online Scheduling.

**Objects, Services and I/O**

Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem.

**Learning Outcomes:** At the end of the unit, the student will be able to

1. Explain various real time scheduling algorithms for real time operating systems.(L2)
2. Summarize various methods in handling input and output operations of real time operating system.(L2)
3. List various services and structures related in handling I/O subsystem of RTOS.(L1)

**Applications:**

1. Online Project management

## UNIT - IV:

**Exceptions, Interrupts and Timers:** Exceptions, Interrupts, Applications, Processing of Exceptions and Spurious Interrupts, Real Time Clocks, Programmable Timers, Timer Interrupt Service Routines (ISR), Soft Timers, Operations.

**Learning Outcomes:** At the end of the unit, the student will be able to

1. Outline the handling of timers and their services in RTOS.(L2)
2. Interpret the function and utilization of exceptions and interrupts in a RTOS.(L2)

**Applications:**

1. Networked Multimedia Systems.
2. Command Control Systems.

## UNIT - V

**Case Studies of RTOS:** RT Linux, MicroC/OS-II, Vx Works, Embedded Linux, Tiny OS, and Basic Concepts of Android OS.

**Learning Outcomes:** At the end of the unit, the student will be able to

1. Outline the working models of different practical RTOS.(L2)
2. Extend the characteristics functions of RTOS towards application development in a practical RTOS.(L2)

**Applications:**

1. Linux
2. Windows

## Text Books


1. Real Time Concepts for Embedded Systems – Qing Li, Elsevier, 2011
2. Jane W.S. Liu, “Real Time Systems”, Pearson Education.
3. Embedded Systems- Architecture, Programming and Design by Rajkamal, 2007, TMH.


## References


1. Richard Stevens, “Advanced Unix Programming”.
2. C.M.Krishna, KANG G. Shin, “Real Time Systems”, McGraw.Hill
3. Embedded Linux: Hardware, Software and Interfacing – Dr. Craig Hollabaugh
4. VxWorks Programmers Guide

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PE3201.4 | Internet of Things (Professional Elective-2) | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

1. To present interconnection and integration of the physical world and the cyber space.
2. To demonstrate applications of Internet of Things
3. To educate building blocks and characteristics of Internet of Things
4. To introduce communication protocols used in Internet of Things
5. To impart knowledge on design & develop IoT devices

**COURSE OUTCOME**S:

At the end of the Course, the Student will be able to:

1. Describe the concepts of IoT along with its applications(L2).
2. Identify different types of sensors, actuators and communication Protocols(L3).
3. Understand the Architecture and programming of Arduino Uno and Raspberry pi(L2)
4. Build a prototype using Arduino Uno and Raspberry pi(L6).
5. Design an IoT applications based on various types of case studies(L6).

**UNIT-I**

**INTRODUCTION TO INTERNET OF THINGS:** Microprocessor vs. Microcontroller, Definitions of IoT, Embedded System Vs IOT, Characteristics of IoT, Design Principles of IoT, IoT Architecture and Protocols, IoT Architecture , IoT Protocols, OSI Model, Organizational Levels , Enabling Technologies for IoT, IoT Levels , IoTvs M2M.

**Learning Outcomes:** At the end of the unit, the student will be able to

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

**Applications:**

1. **Smart city**
2. **Smart Home**

**UNIT-II**

**IOT DESIGN:** Definitions of Sensors, Sensors Classification, Working Principle of Sensors, Criteria to Choose a Sensor, Generation of Sensors, IoT Design Methodology ,Design Methodology, Challenges in IoT Design, IoT System Management, IoT Servers.

COMMUNICATION PROTOCOLS: CoAP, MQTT, XMPP, DDS,AMQP, REST,HTTP

**Learning Outcomes**: At the end of the unit, the student will be able to

1. Classify different sensors and Actuators.(L2)
2. Explain different Communication technologies. (L2)
3. Understand the basics of communication protocols. (L2)

**Applications:**

1. **Data transmission**
2. **Bluetooth**

**UNIT-III**

**BASICS OF ARDUINO AND RASPBERRY PI:** Introduction to Arduino ,Arduino Uno, Arduino Mega , Arduino Nano , Arduino IDE ,Steps to Install Arduino IDE , Basic Commands for Arduino , LCD Commands , Serial Communication Commands Programming with Arduino, Basics of Raspberry Pi ,Introduction to Raspberry Pi ,Raspberry Pi Components, Installation of NOOBS on SD Card, Installation of Raspbian on SD Card., Installation of Libraries on Raspberry Pi Getting the Static IP Address of Raspberry Pi , Programming on Raspberry Pi.

**Learning Outcomes:**

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

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

**Applications:**

**robot/motor control, miniaturized applications, UAVs, sensor networks**

**UNIT-IV**

**INTERFACING WITH RASPBERRY PI AND AURDUINO:** Programming to interface analog & digital sensor, Actuators, Python and Arduino with Pyfirmata, Python GUI with Tkinter and Arduino, Data Acquisition with Python and Tkinter, Blynk Application with Raspberry Pi

**Learning Outcomes:** At the end of the unit, the student will be able to

1. Apply various types of operations on basic Arduino programs.(L3)
2. Develop programs using Raspberry Pi. (L3)
3. Develop an interface between sensors and Raspberry Pi. (L3)

**Applications:**

**Used in Media streamer, Arcade machine, Tablet computer, Home automation, Carputer, Internet radio**, Controlling robots, Cosmic Computer

**UNIT-V**

**CASE STUDIES ILLUSTRATING IOT DESIGN:** Design of several case studies based on Arduino and Raspberry Pi : Home Automation, smart Environment, Smart cities, Logitics, Smart Energy

**Applications:**

1. Smart city
2. Smart Home

**Learning Outcomes:** At the end of the unit, the student will be able to

1. Describe various applications of IoT (L2)
2. Demonstrate the prototypes using Arduino with external devices.(L2)
3. Design a basic prototype IoT systems for various applications(L6)

**Text Books**


1. Rajesh Singh, Anita Gehlot, Lovi Raj Gupta, Bhupendra Singh, and Mahendra Swain " INTERNET OF THINGS WITH RASPBERRY PI AND ARDUINO", CRC Press
2. Vijay Madisetti and ArshdeepBahga, Internet of Things (A Hands-on-Approach), 1st Edition, VPT, 2016.
3. Jain, Prof. Satish, Singh, Shashi, Internet of Things and its Applications, 1st Edition, BPB, 2020.


**Reference Books**


1. Internet of Things: Architecture, Design Principles And Applications, Rajkamal, McGraw Hill Higher Education
2. Getting Started with the Internet of Things CunoPfister , Oreilly
3. Richard Blum,Arduino Programming in 24 Hours, Sams Teach Yourself,Pearson Education,2017
4. Donald Norris, Internet of things_ do-it-yourself projects with Arduino, Raspberry Pi, and Beagle Bone Black,1st Edition, McGraw-Hill,2015

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19CSE-OE3201 | **Oops through Java (Open Elective-1)** | 3 | 0 | 0 | 3 |

**Course Objectives:**

1. To understand the structure and environment of Java.
2. To implement the relationship between objects.
3. To apply data hiding strategy in objects.
4. To implement text processing and error handling.
5. To organize data using different data structures.
6. To create multi threaded graphical user interface applications.

**Course Outcomes:**

1. Understand the environment of JRE and Control Statements.
2. Implement real world objects using class Hierarchy.
3. Implement generic data structures for iterating distinct objects.
4. Implement error handling through exceptions and file handling through streams.
5. Design thread-safe GUI applications for data communication between objects.

**Unit I**

**Java Environment and Program Structure:** History of Java, Features, Applications, Java Installation - JDK and JRE, JVM Architecture, OOPS Principles, Class and Object, Naming Convention, Data Types, Type Casting, Type Conversion, Wrapper classes, Operators, instance of operator, Command Line Arguments, Decision making, Arrays, and Looping statements.

**Learning Outcomes:** Student will be able to

1. Understand architecture of Java Virtual Machine.(L2)
2. Understand the structure of java program and its environment. (L2)

**Unit II**

**Class Hierarchy & Data Hiding:** Property, Method, Constructor, Inheritance (IS-A) , Aggregation and Composition (HAS-A), this and super, static and initialize blocks, Method overloading and overriding, static and final keywords, Types of Inheritance, Compile time and Runtime Polymorphism, Access Specifiers and scope, packages and access modifiers, Abstract class, Interface, Interface Inheritance, Achieving Multiple Inheritance, Class casting, Object Cloning, Inner Classes.

**Learning Outcomes:** Student will be able to

1. Understand the class hierarchy and their scope. (L2)
2. Implement relationship between objects. (L3)
3. Understand data hiding and nested classes. (L2)
4. Implement data type casting and cloning of objects. (L3)

**Unit III**

**Strings and Collections: String:** Methods, StringBuffer and StringBuilder, StringTokenizer, **Collections:** Exploring java.util.*, Scanner, Iterable, Collection Hierarchy, Set, List, Queue and Map, Comparable and Comparator, Iterators: foreach, Enumeration, Iterator and ListIterator.

**Learning Outcomes:** Student will be able to

1. Understand the usage of String and its properties and methods.(L2)
2. Understand data structures and Iterators. (L2)
3. Create the data structures and implement different utility classes. (L3)

**Unit IV**

**IO and Error Handling: IO Streams:** Exploring java.io.*, Character and Byte Streams, Reading and Writing, Serialization and De-serialization,

**Error Handling:** Error vs Exception, Exception hierarchy, Types of Exception, Exception

handlers, User defined exception, Exception propagation.

**Learning Outcomes:** Student will be able to

1. Understand character and byte streams. (L2)
2. Understand the hierarchy of errors and exceptions. (L2)
3. Implement data streams and exception handlers. (L3)

**Unit V**

**Threads and GUI:**

**Multi Threading:** Process vs Thread, Thread Life Cycle, Thread class and Runnable Interface, Thread synchronization and communication.

**GUI:** Component, Container, Applet, Applet Life Cycle, Event delegation model, Layouts, Menu, MenuBar, MenuItem.

**Learning Outcomes:** Student will be able to

1. Understand the Thread Life Cycle and its scheduling.(L2)
2. Implement the synchronization of threads. (L2)
3. Create graphical components using Abstract window toolkit. (L3)

**Text Books**


1. The complete Reference Java, 8th edition, Herbert Schildt, TMH.
2. Programming in JAVA, Sachin Malhotra, SaurabhChoudary, Oxford.
3. Introduction to java programming, 7th edition by Y Daniel Liang, Pearson.
4. Java: How to Program, 9th Edition (Deitel) 9th Edition.
5. Core Java: An Integrated Approach, Java 8 by R. Nageswara Rao.


**Reference Books**


1. Swing: Introduction, JFrame, JApplet, JPanel, Componets in Swings, Layout Managers in
2. Swings, JList and JScrollPane, Split Pane, JTabbedPane, JTree, JTable, Dialog Box.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19EEE-OE3201 | **Power Electronics (Open Elective-1)** | 3 | 0 | 0 | 3 |

**Course Objectives:**

- To study the characteristics of power semiconductor devices and the TURN ON and TURN OFF process of the switches.
- To study the process of converting fixed AC to variable DC using thyristor as a switch.
- To analyze the process for step down and step up the DC voltage.
- To study and analyze the operation of 1-Φ and 3-Φ voltage source inverter.
- To analyze the operation of AC-AC converters.

**Course Outcomes:** At the end of this course, the students will be able to

1. Explain the characteristics of power semiconductor devices and the process of Turn-on and Turn-off semiconductor switches. (L2)
2. Design the controlled rectifier circuits with R and RL-Loads. (L5)
3. Design the DC to DC choppers. (L5)
4. Analyze the operation of AC-AC converters. (L4)
5. Demonstrate the operation of single and their phase voltage source inverters. (L2)

**UNIT-I**

**Power Semiconductor Switching Devices;** Thyristor family: Silicon controlled rectifiers (SCR), GTO, TRIAC-Static, Dynamic and Gate characteristics of SCR; Turn-on and Turn-off methods of Thyristor-Snubber Circuit-Transistor Family: Power MOSFET, Power IGBT.

**Learning outcomes:** The students are able to

- Explain the characteristics of power semiconductor switching devices. (L2)
- Design the snubber circuit for thyristors. (L5)

**UNIT-II**

**AC-DC Controlled rectifiers:** Single-phase half-wave controlled Rectifier with R and RL load-with and without freewheeling diode-single phase full-wave controlled rectifiers: center tapped and Bridge configurations with R load, RL load and RLE load -with and without freewheeling diode; Single phase semi controlled rectifier with R load, RL load and RLE load - Effect of source inductance in single phase fully controlled bridge rectifier with continuous conduction only. Three-phase controller rectifiers-Three phase half wave, Semi and full wave-controlled rectifiers with R and RL loads-performance analysis of controlled rectifiers-Dual converters-Numerical Problems.

**Learning outcomes:** The students are able to

- Analyse the operation of single-phase controlled rectifiers. (L4)
- Understand the operation of three phase-controlled rectifiers. (L2)

**UNIT-III**

**DC-DC Choppers :** Elementary chopper-Duty ratio-control strategies: time ratio control and current limit control-Analysis of Buck, Boost, and Buck-Boost converters in continuous and discontinuous conduction modes of operation-output voltage equations-inductor current and output voltage ripples-Expressions for Critical inductance and capacitance-Numerical Problems- Applications.

**Learning outcomes:** The students are able to

- Understand the operation of different types of DC-DC converters (L2)
- Analyze the operation of buck, boost and Buck-Boost converters. (L4)

## UNIT-IV

**AC Voltage Controllers and Cycle Converters:** Single-phase AC-AC regulator- phase angle control and integrated cycle control with R and RL load – For continuous and discontinuous conduction- 3-Phase AC-AC regulators with R load only-single phase cyclo-converter with R and RL load-Numerical problems.

**Learning outcomes:** The students are able to

- Analyze the operation of the voltage regulator (L4).
- Understand the concept of cyclo-converter (L2).

## UNIT-V

**Inverters:** Single-phase voltage source inverter-single phase half bridge and full bridge inverters with R and RL load-Fourier Analysis of single-phase inverter output voltage-Current source inverter-Three phase square wave inverters -$120^0$ conduction and $180^0$ conduction modes of operation-PWM inverters-modulation index-Total harmonic distortion analysis-Introduction to Multilevel Inverters-Numerical Problems.

**Learning outcomes:** The students are able to

- Analyze the operation of single-phase inverter with square wave modulation. (L4)
- Evaluate the operation of voltage source inverter with sinusoidal modulation. (L2)
- Design the power circuit of a three-phase voltage source inverter. (L5)
- Analyze the voltage waveforms at different switching states of the VSI inverter. (L2)

## Textbooks


1. Power Electronics – by P.S.Bhimbra, Khanna Publishers.
2. M. H. Rashid, “Power electronics: circuits, devices, and applications”, Pearson Education India, 2009.
3. N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.


## Reference Books


1. R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2007.
2. Power Electronics: Essentials & Applications by L.Umanand, Wiley, Pvt. Limited,India, 2009
3. Power Electronics : by M.D.Singh , K.B.Khanchandani, Tata McGraw-Hill Publications


**Web Links:**

1 https://swayam.gov.in/nd1_noc20_ee97/preview
2 https://nptel.ac.in/courses/108/105/108105066/

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19CSE-OE3202 | **Introduction to Artificial Intelligence(AI) (Open Elective-1)** | 3 | 0 | 0 | 3 |

**Course Objectives:** The objective of this course is to

- Become familiar with basic principles of AI toward problem solving, inference, perception, knowledge representation, and learning.
- Elucidate the basic knowledge representation, problem solving, and learning methods of Artificial Intelligence.
- Assess the applicability, strengths, and weaknesses of the basic knowledge representation, problem solving, and learning methods in solving particular engineering problems

**Course Outcomes:**

1. Demonstrate fundamental understanding of the evaluation of Artificial Intelligence (AI) and its foundations.
2. Apply basic principles of AI in solutions that require problem solving, perception, knowledge representation, and learning.

3.Design experiments with various AI concepts and analyze results

4.Show the importance of artificial intelligence and planning in solving real world problems.

5.Create interactive and rational system using appropriate learning techniques also, to measure the level of user satisfaction and efficiency of the expert system and ANN

**UNIT-I:**

**INTRODUCTION:** Philosophy of artificial intelligence, Definitions - Evolution of AI - Applications of AI, Classification of AI- Intelligent Agents: Agents and Environment-Nature of Environment-Structure Environment.

**Learning Outcomes:** At the end of this unit the student will be able to

1. Understand the importance of AI. (L2)
2. Illustrate the applications of AI (L2)

**UNIT-II**

**SEARCHING BASED PROBLEM SOLVING**: Problem Solving Agent - Blind Search- Performance measures - Informed Search: Introduction to Heuristics-Variants of heuristic search-uniform cost, A*, Greedy - Overview of Hill Climbing –Simulated Annealing – Genetic Algorithms – Adversarial Search – Minimax, Alpha beta pruning

**Learning Outcomes:** At the end of this unit the student will be able to

1. Apply mathematics and science in engineering applications. (L3)
2. Apply various algorithms for digital image processing and computer vision. (L3)

**UNIT-III**

**KNOWLEDGE REPRESENTATION AND REASONING:** Logical systems – Knowledge Based systems, Propositional Logic – Constraints, Predicate Logic– First Order Logic, Inference in First Order Logic, Ontological Representations and applications Knowledge representation and reasoning through logic

**Learning Outcomes:** At the end of this unit the student will be able to

1. Understanding of the subject related concepts and of contemporary issues. (L2)
2. Illustrate the applications Knowledge representation. (L2)

**UNIT-IV**

**PLANNING:** Planning Problem – Planning with State Space Search – Partial order Planning – Planning and Acting in the Real World: Conditional Planning – Re-planning Agents, Robotics-Action

**Learning Outcomes:** At the end of this unit the student will be able to

1. Develop techniques and modern engineering tools for engineering practice.(L3)
2. Understand the problem solving techniques.(L2)

**UNIT-V**

**LEARNING SYSTEMS:** Machine learning, Forms of Learning – Types - Supervised, unsupervised, reinforcement Learning, Learning Decision Trees, soft computing- Artificial Neural Network.

**Learning Outcomes:** At the end of this unit the student will be able to

1. Understand concepts of Machine Learning algorithms and their limitations. (L2)
2. Understand the application of Artificial Neural Networks (L2)

**Text Book(s)**


1. David L. Poole and Alan K. Mack worth, "Artificial Intelligence: Foundations of Computational Agents", Second Edition, Cambridge University Press, 2017
2. Authors, book title, year of publication, edition number, press, place
3. Tom Mickiewicz & Josh Zheng,Getting started with Artificial Intelligence, Published by O'Reilly Media,2017
4. Stuart Russell and Peter Norvig Artificial Intelligence - A Modern Approach, Prentice Hall, 3rd edition, 2011.


**Reference Books**


1. Aurelian Géron, Hands on Machine Learning with Scikit-Learn and Tensor Flow [Concepts, Tools, and Techniques to Build Intelligent Systems], Published by O'Reilly Media, 2017.
2. Elaine Rich, Kevin Knight and Shiv Shankar B. Nair, Artificial Intelligence, 3rd edition, Tata McGraw Hill, 2009.
2. Wolfgang Ertel," Introduction to Artificial Intelligence", Second Edition, Springer, 2017.
3. Stephen Lucci and Danny Kopec," Artificial Intelligence in the 21st Century, Second Edition, Mercury Learning and Information, 2015.
4. Deepak Khemani, "A First Course in Artificial Intelligence", McGraw Hill Education, 2013.
5. Miroslav Kubat," An Introduction to Machine Learning", Springer, 2016.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19MEC-OE3201 | Robotics<br>(Open Elective-1) | 3 | 0 | 0 | 3 |

**Course Objectives:**

The objectives of this course are to

- Define the fundamental concepts of industrial robotic technology.
- Apply the basic mathematics to calculate kinematic forces in robot manipulator.
- Apply the basic mathematics to calculate dynamic forces in robot manipulator.
- Understand the robot controlling and programming methods.
- Illustrate concept of robot vision system.

**Course Outcomes:**

After completing the course, the student will be able to,

1. Explain fundamentals of Robots. (L2)
2. Apply kinematics and differential motions and velocities. (L3)
3. Demonstrate control of manipulators. (L2)
4. Understand robot vision. (L2)
5. Develop robot cell design and programming. (L3)

**UNIT – I**

**Fundamentals of Robots:** Introduction, definition, classification and history of robotics, robot characteristics and precision of motion, advantages, disadvantages and applications of robots.Introduction to matrix representation of a point in a space a vector in space, a frame in space, Homogeneous transformation matrices, representation of a pure translation, pure rotation about an axis.

**Applications:** welding , material handling

**Learning outcomes:**

At the end of this unit, the student will be able to

- Explain a robot and homogeneous transformations. (L2)
- Compare the types of robot manipulators based on applications.(L2)
- Outline the advantages, disadvantages and applications of robot. (L2)
- Explain the robot characteristics. (L2)

**UNIT – II**

**Kinematics of robot:** Forward and inverse kinematics of robots- forward and inverse kinematic equations for position and orientation, Denavit-Hartenberg(D-H) representation of forward kinematic equations of robots, the inverse kinematic of robots, degeneracy and dexterity, simple problems with D-H representation.

**Applications:** pick and place robot, robot arm trajectory planning

**Learning outcomes:**

At the end of this unit, the student will be able to

- Evaluate D-H notations for simple robot manipulator.(L5)
- Identify the position of robot gripper within work volume. (L3)

**UNIT – III**

**Differential motions and Velocities:** Introduction, differential relationship, Jacobian, differential motions of a frame-translations, rotation, rotating about a general axis, differential transformations of a frame. Differential changes between frames, differential motions of a robot and its hand frame, calculation of Jacobian, relation between Jacobian and the differential operator, Inverse Jacobian.

**Applications:** Material Handling Robot

**Learning outcomes:**

At the end of this unit, the student will be able to

- Select Jacobian, Lagrange-Euler and Newton- Euler formations to solve manipulatordynamic problems. (L3)
- Explain the concepts of manipulator kinematics and dynamics. (L2)

**UNIT – IV**

**Control of Manipulators**: Open- and close-loop control, the manipulator control problem, linear control schemes, characteristics of second-order linear systems, linear second-order SISO model of a manipulator joint, joint actuators, partitioned PD control scheme, PID control Scheme, computer Torque control, force control of robotic manipulators, description of force-control tasks, force control strategies, hybrid position/force control, impedance force/torque control.

**Applications:** Welding robots, painting robots

**Learning outcomes:**

At the end of this unit, the student will be able to

- Explain the basic concepts of robot controlling systems. (L2)
- Outline PD and PID control schemes. (L2)
- Apply force control strategies to determine the forces in robot. (L3)
- Explain the force control and torque control techniques. (L2)

**UNIT – V**

**Robot Vision:** Introduction, architecture of robotic vision system, image processing, image acquisition camera, image enhancement, image segmentation, imaging transformation, Camera transformation and calibrations, industrial applications of robot vision. Robot Cell **Design and Programming:** Robot cell layouts-Robot centred cell, In-line robot cell, considerations in work cell design, work cell control, inter locks, error detection, work cell controller. methods of robot programming, WAIT, SIGNAL, and DELAY commands, Robotic languages, VAL system.

**Applications:** Humanoid Robot

**Learning outcomes:**

At the end of this unit, the student will be able to

- Identify the components of robot vision system. (L3)
- Illustrate the industrial applications of robot vision system. (L2)
- List the various methods of robot programming. (L1)
- Design the robot cell for simple manufacturing system. (L6)
- Explain the concepts of work cell control, inter locks and error detection. (L2)

**TEXT BOOKS**


1. Mikell P. Groover and Mitchell Weiss, Roger N. Nagel,Nicholas G.Odrey , Industrial Robotics — Mc Graw Hill,
2. R K Mittal and I J Nagrath, Robotics and control, Illustrated Edition, Tata McGraw Hill India


**REFERENCES**


3. Saeed B. Niku, Introduction to Robotics – Analysis, System, Applications, 2nd Edition, John Wiley & Sons.
4. H. Asada and J.J.E. Slotine, Robot Analysis and Control, 1st Edition Wiley- Interscience
5. Robert J. Schillin, Fundamentals of Robotics: Analysis and control, Prentice-Hall Of India Pvt. Limited,
6. Mohsen shahinpoor, A robot Engineering text book, Harper & Row Publishers,1987.
7. John.J.Craig Addison, Introduction to Robotics: Mechanics and Control, Wesley, 1999.
8. K.S. FU, R.C. Gonzalez and C.S.G Lee, Robotics: Control, sensing, vision, and intelligence . Mc Graw Hill, 1987.
9. Richard D. Klafter, Thomas Robotic Engineering an integrated approach, PHI publications 1988.

| SUBJECT CODE | SUBJECT NAME | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PC3204 | VLSI Lab | 0 | 0 | 3 | 1.5 |

**COURSE OBJECTIVES:**

**1.** To Train on mentor graphics environment for design of VLSI circuits
**2.** To design different VLSI circuits using Mentor Graphics Tool.
**3.** To draw corresponding layout to perform simulation and verification of designed circuits.
4. To familiarize the design rules in layout drawing in tool.
5. To perform LVS and Analyze the performance metrics of designed circuits.

**Course Outcomes:**

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

1. Understand the environment of mentor graphics and its design flow (L2)
2. Design of CMOS logic circuits and analyze the parameters(L3)
3. Create the layout of digital circuits(L4)
4. Apply the design rules and analyze their significance on MOS circuits(L4)
5. Ability to design/ develop custom logic circuits/systems(L5)

**Note:** The students are required to design the schematic diagrams using CMOS logic and to draw the layout diagrams to perform the following experiments using 130nm/90nm technology with the Industry standard EDA Tools.

**List of Experiments:**

1. Design and Implementation of an Inverter
2. Design and Implementation of Universal logic Gates
3. Design and Implementation of Full Adder
4. Design and Implementation of Full Subtractor
5. Design and Implementation of multiplexer
6. Design and Implementation of Decoder
7. Design and Implementation of RS-Latch
8. Design and Implementation of JK Flip-flop
9. Design and Implementation of asynchronous counter
10. Design and Implementation of static RAM cell

**Software Required:**

i. Mentor Graphics Software / Equivalent Industry Standard Software.
ii. Personal computer system with necessary software to run the programs and to implement.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PC3205 | **Digital Signal Processing Lab** | 0 | 0 | 3 | 1.5 |

**Course Objectives:**

1. Explain the DSP processor architecture and signal processing tools
2. study the linear and circular convolution methods for discrete time LTI systems.
3. Demonstrate the analog and digital filters(IIR,FIR)based on the modes(Low pass, High pass) of operations.
4. Examine the spectral analysis of a signal using N-point Fast Fourier Transform (FFT) algorithm and power spectral density.
5. Study of various DSP Processors.

**Course Outcomes:**

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

1. Outline the TMS 320C 5X/6X processor architecture & its instructions and demonstrate the working environment of MATLAB & CC Studio for signal processing applications
2. Understand the handling of discrete/digital signals using MATLAB and analyze the response of discrete time LTI systems using linear and circular convolution methods.
3. Design and implementation of FIR filters using windowing techniques such as Rectangular, Triangular and Kaiser.
4. Design and implementation of analog and IIR low pass and high pass filters.
5. Apply the N-point Fast Fourier Transform (FFT) algorithm on one dimensional signals and analyze the power spectral density of a given signals.

**List of Experiments**

Minimum of Twelve Experiments has to be implemented in software Using MATLAB / CC Studio

1. To study the architecture of DSP chips – TMS 320C 5X/6X Instructions.
2. To generate basic elementary signals like unit impulse, unit step, unit ramp signal and Exponential signals using Matlab
3. To find Impulse response of first order and second order systems
4. To verify linear convolution
5. To find frequency response of a given system given in (Transfer Function/ Differential equation form).
6. To verify the circular convolution.
7. To design FIR filter (LP/HP) using windowing technique
   a. Using rectangular window
   b. Using triangular window
   c. Using Kaiser window
8. To Implement IIR filter (LP/HP) on DSP Processors
9. To find DFT / IDFT of given Discrete Time signal
10. MATLAB program to generate sum of sinusoidal signals
11. MATLAB program to find frequency response of analog LP/HP filters
12. Determination of Power Spectrum of a given signal(s)
13. To find the FFT of given 1-D signal and plot.
14. Implementation of Decimation,Interpolation Process
15. Implementation of I/D sampling rate converters.

**Text Books**

1. Digital Signal Processing, Principles, Algorithms, and Applications: John G. Proakis, Dimitris G.Manolakis, Pearson Education / PHI, 2007.
2. Fundamentals of Digital Signal Processing using Matlab – Robert J.Schilling, Sandra L. Harris, Thomson, 2007

**Reference Books**

1. Digital Signal Processors – Architecture, Programming and Applications, B.Venkataramani, M.Bhaskar, TATA McGraw Hill, 2002.
2. Digital Signal Processing – K Raja Rajeswari, I.K. International Publishing House.

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PC3206 | **Antenna Modeling & Microwave Engineering Lab** | **0** | **0** | **3** | **1.5** |

**Course Objectives:**

- Mathematical simulation and CAD of antennans with various feeding mechanisms and microwave components using an EM solver.
- Familiarize the students regarding the estimation of antenna performance using various metrics in the EM solver.
- Understanding the various microwave soures and components involved in Microwave Bench setup for Microwave measurements.
- Make use of the Electromagnetic solver for the functional verification of various microwave components.
- Identify suitable microwave component for wave propagation and to obtain ability to assess the component level performance in both simulation and measurement.

**Course Outcomes:**

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

1. Identify basic antenna parameters and simulate an antenna model as per the required operating characertristics(L3).
2. Optimize the performance of the antenna as per the requirement and can develop research-oriented thinking(L3).
3. Understand and analyzing the microwave signal generation characteristics (L4).
4. Measure various microwave characteristics using bench setup (L5).
5. Model, simulate and analyze the microwave components like circulator and magic-tee (L6).

**List of Experiments:**

Minimum of Twelve Experiments has to be performed

**Part-A** Antenna Design and Simulation (Any five experiments)

1. Design and Study of Ultra-High Frequency (UHF) Dipole Antenna.
2. Design and Study of Conical Horn Antenna.
3. Design of Rectangular Patch Antenna with Probe feed and Microstrip Line Feed.
4. Design and Optimization of Slot Coupled Patch Antenna.
5. Design of Two-Element Microstrip Array Antenna with Corporate Feeding.
6. Design and analysis of a Monofilar Helical Antenna

**Part-B** Microwave Engineering (Any seven experiments)

7. Reflex Klystron Characteristics.
8. Attenuation Measurement
9. Directional Coupler Characteristics.
10. Impedance and Frequency Measurement.
11. Gunn Diode Characteristics
12. Scattering parameters of Circulator (both Simulation and Experimental).
13. Scattering parameters of Magic Tee (both Simulation and Experimental).

**Equipment required for Laboratories:**

1. Regulated Klystron Power Supply, Klystron mount
2. VSWR Meter
3. Micro Ammeter
4. Multi meter
5. CRO
6. GUNN Power Supply, Pin Modulator
7. Crystal Diode detector
8. Microwave components (Attenuation)
9. Frequency Meter
10. Slotted line carriage
11. Probe detector
12. Wave guide shorts
13. SS Tuner
14. Directional Coupler
15. E, H, Magic Tees
16. Circulators, Isolator
17. Matched Loads
18. Ansys HFSS Software

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19ECE-PJ3201 | **Social Relevant Project** | 0 | 0 | 1 | 0.5 |

**Course Objectives:**

- To help students sharpen their intellectual qualities like creative thinking, analytical abilities, teamwork, and communication skills.
- To create a platform for students to demonstrate their practical competence.
- To encourage students to apply their subject knowledge gained in the degree course.

**Course Outcomes:**

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

1. Acquire technical knowledge on fundamental aspects in electronics and communication Engineering to solve complex engineering problems for real time applications.
2. Identify the work based on past experiences and from literature survey for specific Problems in the field of Engineering.
3. Design or develop a software/Hardware model for a specific problem useful for society/environment real time issues by following ethical values.
4. Creating a platform in use of modern tools to work individually or as a team inculcating leadership qualities.
5. Identify suitable applications leading to enhanced knowledge in project management and lifelong learning.

**List of Domains**

Students will develop Social Relevant Projects in any one of the Following domains.

1. Embedded and IOT
2. VLSI and Microelectronics
3. Antennas and Microwave
4. Communications & Neural networks
5. Image processing & Video Processing

| Subject Code | Subject Name | L | T | P | C |
|---|---|---|---|---|---|
| R19BSH-MC3201 | Intellectual Property Rights And Patents (Mandatory Course) | 3 | 0 | 0 | 0 |

**Course Objectives:**

- Outline and impart knowledge of Intellectual property rights on trademarks, copyrights and patents and also agencies responsible for IPR(L2)
- Comprehend the awareness of copyright law and various rights acquired by the owner or original creators.(L2)
- Illustrate the patent law, registration process and grants, protects in India and abroad.(L3)
- Relate to significance of trademark and service mark in business Organisations and its infringement.(L2)
- Assess and maintain the protection of trade secret in the organisation and also emerging trends in cyber security and cybercrimes.(L3)

**Course Outcomes:**

1. Knowledge on Intellectual Property Law, Innovations and Inventions of Trade related Intellectual
2. Property Rights.(L3)State the principles and rights afforded by Copyright. (L3)
3. Analyze Patent Requirements, Patent Law, Infringement and Litigation.(L3)
4. Outline the registration Processesof Trade Mark and Dilution of Ownership of Trade mark (L2)
5. 5. State the main ideas of Employee Confidentiality Agreement and Trade Secret Litigation and also identify the legal procedures to prevent cybercrimes. (L2)

**Unit 1**

**Introduction to Intellectual Property Rights (IPR):** Introduction to IPRs, Basic concepts and need for Intellectual Property – International Instruments and IPR - WIPO - TRIPS – WTO -Laws Relating to IPR - IPR Tool Kit - Agencies for IPR Registration – Emerging trends in IPR - Use and Misuse of Intellectual PropertyRights.

**Learning Outcomes:**

At the end of this unit student will be able to:

- Knowledge about the elements of IPR (L3)
- Learn International Instruments and emerging areas of IPR (L1)
- Assess Agencies responsible for Registration and laws related to IPR(L3)

**Application:** Applicability and relativity between elements of Intellectual property rights and creating innovative ideas.

**Unit 2**

**Copyrights and Neighboring Rights:** Introduction to Copyrights – Principles of Copyright Protection – Law Relating to Copyrights Subject Matters of Copyright – Copyright Ownership – Transfer and Duration – Right to Prepare Derivative Works –Rights of Distribution – Rights of Performers – Copyright Registration – Limitations – Infringement of Copyright – Relief and Remedy – Semiconductor Chip Protection Act.

**Learning Outcomes:**

At the end of this unit student will be able to:

- Identify how one can generate economic wealth through copyrights(L3)
- Support the various concepts related to protection, promotion and enforcement of copy rights(L2)
- Knowledge of Limitations and Infringement of Copyrights. (L3)

**Application:** Practice of copyrights case and Identification of the infringement to the owner of the copy right.

**Unit 3**

**Patents:** Introduction to Patents - Laws Relating to Patents in India – Patent Requirements – Patent Search - Patent Registration and Granting of Patent - Ownership and Transfer — Infringement of Patent – Compulsory Licensing — Patent Cooperation Treaty – New developments in Patents – Software Protection and Computer related Innovations.

**Learning Outcomes:**

At the end of this unit student will be able to:

- Describe the registration process of Patents (L2)
- Gain knowledge of infringement of patents and their remedies(L3)
- Generalize on Patents, Software protection and Computer related Innovations.( L3)

**Application:** Checking the eligibility for several patents and suggest remedies for problems through case study.

**Unit 4**

**Trademarks:** Introduction to Trademarks – Laws Relating to Trademarks – Functions of Trademark – Marks Covered under Trademark Law - Trade Mark Registration – Trade Mark Maintenance – Transfer of rights - Likelihood of Confusion - Dilution of Ownership – Trademarks Claims and Infringement – Remedies- Case study.

**Learning Outcomes:**

At the end of this unit student will be able to:

- Knowledge on registration and maintenance of trademarks (L3)
- Illustrate procedure for trademark claims (L2)
- Elaborate on transfer of rights in Trademarks (L3)

**Application:** Compare and contrast different trademarks and know how to register trademark

**Unit 5**

**Trade Secrets& Cyber Law :** Introduction to Trade Secrets – General Principles - Laws Relating to Trade Secrets - Maintaining Trade Secret – Physical Security – Employee Confidentiality Agreements – Breach of Contract – Trade Secret Litigation . Cyber Law and Cyber Crime Introduction to Cyber Law – Information Technology Act 2000 - Protection of Online and Computer Transactions - Cyber Crimes - Prevention and Punishment - Case study.

**Learning Outcomes:**

At the end of this unit student will be able to:

- Assess the level of physical security (L3)
- Outline Employee Confidentiality Agreements (L2)
- Gain knowledge of prevention and punishment of cybercrimes(L3)
- Understand the various levels of liability of network providers(L2)

**Application**

1. Adapt how to protect trade secret physically and from the employees of the organization.
2. Choose and exhibit various securities to access like biometrics, login passwords, facial recognition, UID number, which protects the individual properties.

**Text Books**


1. Fundamentals of IPR for Engineers- Kompal Bansal &Parishit Bansal, B. S. Publications,2013
2. Intellectual Property -Deborah E.Bouchoux ,Cengage Learning, New Delhi.,2012
3. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012


**References Books:**


1. Intellectual property rights- PrabuddhaGanuli., Tata Mcgraw hill, 2012.
2. Intellectual property rights M.Ashokkumar and Mohd.Iqbal Ali:, Serials Publications, 2015
3. Intellectual Property Rights (Patents & Cyber Law), Dr. A. Srinivas. Oxford University Press, New Delhi, 2015.
4. Intellectual Property- Richard Stim, Cengage Learning, New Delhi, 2012.
5. S. V. Satakar, ―Intellectual Property Rights and Copy Rights, EssEss Publications, New Delhi,2002


**Web links**:

1. http://www.ipindia.gov.in/patents.htm
2. http://www.ipindia.gov.in/trade-marks.htm
3. https://copyright.gov.in/
4. http://www.wipo.int/portal/en/index.html
5. https://indiankanoon.org/