# FACULTY OF ENGINEERING

## Scheme of Instruction & Examination

(CBCS Curriculum for the Academic Year 2019-2020)

and

## Syllabi

## B.E. VII and VIII Semester

## of

## Four Year Degree Programme

## In

## Electronics and Communication Engineering

(With effect from the academic year 2019– 2020)

(As approved in the faculty meeting held on 25-06-2019)

Issued by

**Dean, Faculty of Engineering**

**Osmania University, Hyderabad – 500 007**

**2019**

# SCHEME OF INSTRUCTION & EXAMINATION
## B.E. VII - Semester
## (ELECTRONICS AND COMMUNICATION ENGINEERING)

| S. No. | Course Code | Course Title | Scheme of Instruction | | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | Contact Hrs/Wk | CIE | SEE | Duration in Hrs | |
| **Theory Courses** | | | | | | | | | | |
| 1 | **PC 701 EC** | Embedded System | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 2 | **PC 702 EC** | VLSI Design | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 3 | **PC 703 EC** | Microwave Techniques | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 4 | **ES 707 ME** | Industrial Administration and Financial Management | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 5 | | Professional Elective – II | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 6 | | Open Elective – II | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 7 | | Open Elective – III | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 8 | **MC 771 EG** | Human Values and Professional Ethics | 2 | - | - | 2 | 30 | 70 | 3 | - |
| **Practical/ Laboratory Courses** | | | | | | | | | | |
| 9 | **PC 751 EC** | Microwave Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 10 | **PC 752 EC** | Electronic Design & Automation Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 11 | **PW 761 EC** | Project Work – I | - | - | 4 | 4 | 50 | - | - | 2 |
| 12 | **SI 762 EC** | Summer Internship | ` | - | - | - | 50 | - | - | 2 |
| | | | **23** | **-** | **08** | **31** | **390** | **660** | | **27** |

| **Professional Elective – II** | | |
|---|---|---|
| S. No. | Course Code | Course Title |
| 1 | **PE 721 EC** | Mobile and Cellular Communications |
| 2 | **PE 722 EC** | Speech Signal Processing |
| 3 | **PE 723 EC** | Electronic Measurements and Instrumentation |
| 4 | **PE 724 EC** | Digital Signal Processor Architectures |

| **Open Elective – II** | | |
|---|---|---|
| S. No. | Course Code | Course Title |
| 1 | **OE 771 CE** | Green Building Technologies |
| 2 | **OE 772 CS** | Data Science Using R Programming |
| 3 | **OE 773 EC**** | Fundamentals of IoT |
| 4 | **OE 774 EE** | Non-Conventional Energy Sources |
| 5 | **OE 775 ME** | Entrepreneurship |

| **Open Elective – III** | | |
|---|---|---|
| S. No. | Course Code | Course Title |
| 1 | **OE 781 CE** | Road Safety Engineering |
| 2 | **OE 782 IT** | Software Engineering |
| 3 | **OE 783 EC**** | Principles of Electronic Communications |
| 4 | **OE 784 EE** | Illumination and Electric Traction systems |
| 5 | **OE 785 ME** | Mechatronics |

PC: Professional Course
PE: Professional Elective
L: Lectures T: Tutorials
P: Practical D: Drawing

**CIE:** Continuous Internal Evaluation

**SEE:** Semester End Examination (Univ. Exam)

**Note:** 1) Each contact hour is a Clock Hour
2) The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.

**Note-2:** * The students have to undergo a Summer Internship of four weeks' duration after VI semester and credits will be awarded in VII semester after evaluation.
** Subject is not offered to the students of ECE Department.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PC 701 EC** | **Embedded System** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **MPMC PC603EC COA PC505EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- Understand embedded systems, hardware and software components and design process of embedded system.
- List the RISC features of ARM core and study its architecture and instruction set.
- Acquire the knowledge about serial, parallel bus communication protocols and internet enabled systems-network protocols.
- Know about the steps, issues in the embedded system development process and different techniques for downloading embedded firmware into hardware.
- Familiarize with the different IDEs for firmware development for different family of processors/controllers and learn about different tools and techniques for embedded hardware debugging.

**Course Outcomes**

After completing this course, the student will be able to

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

**UNIT –I**

**Introduction to Embedded Systems:** Classification, Embedded Processor in a system, Embedded Hardware and Software: Processor embedded into a system, Processor selection for Embedded System, Embedded System-On–Chip, Design process in Embedded System, Characteristics and quality attributes of embedded systems, Design metrics and challenges in Embedded System design.

**UNIT-II**

**The Arm Processor Fundamentals and Instruction set:** RISC concepts with ARM Processors, Registers, Current Program status register, pipeline, Exception, Exceptions, Conditional execution, Interrupts and vector table, Core extensions, Architectural Revisions, Arm processors Families.

**Introduction to ARM Instruction Set:** Data processing instructions, Branch instructions, Data transfer instructions, Software interrupt, and Program status register instructions.

**UNIT-III**

**Serial Bus Communication protocols:** $I^2C$, CAN, USB, Fire wire-IEEE 1394 Bus standard, advanced serial high speed buses. Parallel Bus device protocols: ISA, PCI, PCI-X, ARM Bus, Advanced parallel high speed buses. Internet Enabled Systems-Network protocols: HTTP, TCP/IP, Ethernet.

**UNIT-IV**

**Embedded Software Development Process and Tools:** Embedded System design and co-design issues in system development process, Design cycle in the development phase for an Embedded Systems. Embedded software development tools: Host and Target Machines, Linker/Locators for embedded software, Embedded Software into the Target system.

**UNIT-V**

**Testing Simulation and Debugging Techniques and Tools:** Integration and testing of embedded hardware, testing methods, debugging techniques, Laboratory tools and target hardware debugging: Logic Analyser, simulator, emulator and in circuit emulator, IDE, RTOS Characteristics, Case Study: Embedded Systems design for automatic vending machines and digital camera.

***Suggested Readings:***

1. Raj Kamal, *"Embedded Systems-Architecture, Programming and Design," 2*/e, TMH, 2012.
2. Shibu K V, "Introduction to Embedded systems", 1/e, McGraw Hill Education, 2009.
3. David E. Simon, *"An Embedded software primer,"* Pearson Education, 2004.
4. Steve Furber, *"ARM System on chip Architecture,"* 2/e, Pearson Education.
5. Andrew N. Sloss, Dominic Symes, Chris Wright," ARM SYSTEM Developer's Guide Designing and Optimizing System Software" Elsevier 2015

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PC 702 EC** | **VLSI Design** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **ED PC302EC<br>STLD PC303EC<br>DSD PC506EC** | **3** | **1** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- Explain electrical properties of MOS and BiCMOS devices to analyse the behavior of inverters designed with various loads.
- Give exposure to the design rules to be followed to draw the layout of any logic circuit.
- Provide concept to design different types of Combinational and arithmetic circuits.
- Learn to design sequential logic circuits using CMOS transistor.
- Study the small signal model various amplifiers.

**Course Outcomes**

By the end of this course, the students will be able to

1. Analyse modes of operation of MOS transistor and its basic electrical properties
2. Draw stick diagrams and layouts for any MOS transistors and calculate the parasitic R&C
3. Analyse the operation of various arithmetic circuits.
4. Design sequential logic circuits using CMOS transistors
5. Understand the small signal model and characteristics of CMOS amplifiers

**UNIT - I**

**Introduction:** Introduction to IC Technology – MOS, PMOS, NMOS, CMOS & BiCMOS Technologies-Fabrication Process.

**Basic Electrical Properties:** Basic Electrical Properties of MOS and Bi-CMOS Circuits: Ids-Vds relationships, MOS transistor threshold Voltage, gm, gds, figure of merit; Pass transistor, NMOS Inverter, Various pull ups, CMOS Inverter analysis and design, Bi-CMOS Inverters.

**UNIT - II**

**VLSI Circuit Design Processes:** VLSI Design Flow, MOS Layers, Stick Diagrams, Design Rules and Layout, and Transistors Layout Diagrams for NMOS and CMOS Inverters and Gates, Scaling of MOS circuits, Limitations of Scaling.

**Gate Level Design:** Logic Gates and Other complex gates, Switch logic, Alternate gate circuits, Basic circuit concepts, Sheet Resistance RS and its concept to MOS, Area Capacitance Units, Calculations – RC Delays.

**UNIT - III**

**Subsystem Design:** Shifters, Adders: Carry skip, carry select, square root carry select, Manchester; ALU, Multipliers: Booth, Baugh-Woolley, High Density Memory Elements: SRAM, DRAM, ROM Design.

**UNIT - IV**

**Sequential Logic Design:** Behavior of Bi-stable elements, SR Latch, Clocked Latch and Flip-flop circuits, CMOS D latch and Edge triggered Flip flops.

**CMOS Testing:** CMOS Testing, Need for testing, Test Principles, Design Strategies for test, Chip level Test Techniques, System-level Test Techniques, Layout Design for improved Testability.

**UNIT - V**

**Analog VLSI Design**: Small signal model of MOSFETs, Simple CMOS current mirror, Common Source Amplifier, Source follower, Common Gate Amplifier, Source degenerated current mirror, Casode and Wilson current mirrors.

***Suggested Readings:***

1. Kamran Eshraghian, Eshraghian Dougles and A. Pucknell, "Essentials of VLSI circuits and systems", PHI, 2005 Edition.
2. Weste and Eshraghian, "Principles of CMOS VLSI Design", Pearson Education, 1999.
3. John.P. Uyemura, "Introduction to VLSI Circuits and Systems", JohnWiley, 2003.
4. John M. Rabaey, "Digital Integrated Circuits", PHI, EEE, 1997.
5. Wayne Wolf," Modern VLSI Design", Pearson Education, 3rd Edition, 1997.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PC 703 EC** | **Microwave Techniques** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **AWP PC602EC EMTL PC404EC** | **3** | **1** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- Understand the concept of Guided waves and its propagation in different modes (TE, TM, and TEM) between parallel planes and to find out applications of different parameters.
- Use of the concept of TE, TM & TEM waves in Waveguides (Rectangular and Circular) and evaluate different parameters &understand the operation of Cavity Resonators.
- Understand the concept of Microwave circuit and evaluate Scattering parameters of microwave components.
- Understand the high frequency limitations of conventional tubes and principle of bunching and velocity modulation analyse the operation of microwave tubes
- Understand principle and operation of Microwave solid state devices &evaluate the characteristics of devices & concept of strip lines, slot lines and fin lines.

**Course Outcomes**

After completing this course, the student will be able to

1. Analyse the propagation of Guided waves in different modes between parallel planes.
2. Evaluate different parameters (Like impedance, attenuation and quality factor.) for Rectangular & Circular Waveguides &Cavity Resonators.
3. Determine Scattering parameters of different microwave components and analyse their properties.
4. Integrate the concept of bunching and velocity modulation to summarize the operation of microwave tubes and the high frequency limitations of conventional tubes.
5. Analyse the principle, operation and characteristics of different microwave solid state devices

**UNIT-I**

**Guided Waves:** Propagation of TE, TM and TEM waves between parallel planes. Velocity of propagation, wave impedance, attenuation in parallel plane guides.

**UNIT-II**

**Waveguides:** TE and TM waves in rectangular and circular waveguides, Wave Impedance, Characteristic Wave Impedance, Attenuation and Q of waveguides. Cavity resonators, resonant frequency and Q, Applications of cavity resonator.

**UNIT-III**

**Microwave Circuits and Components:** Concept of Microwave circuit, Normalized voltage and current, Introduction to scattering parameters and their properties, S parameters for reciprocal and Non-reciprocal components- Magic Tee, Directional coupler, E and H Plane Tees and their properties, Attenuators, Phase Shifters, Isolators and circulators.

**UNIT-IV**

**Microwave Tubes:** High frequency limitations of conventional tubes, Bunching and velocity modulation, mathematical theory of bunching, principles and operation of two cavity, multi cavity and Reflex Klystron.

**Theory of crossed field interaction:** Principles and operation of magnetrons and crossed field amplifiers, TWT and BWO.

**UNIT-V**

Microwave Solid State Devices: Principles of operation, characteristics and applications of Varactor, PIN diode, GUNN diode and IMPATT diode.

Elements of strip lines, micro strip lines, slot lines and fin–lines.

***Suggested Readings:***

1. E. C. Jordan & Keith G. Balmain, "Electromagnetic Waves and Radiating Systems", 2/e, Pearson Education, 2006.
2. Samuel Y. Liao, "Microwave Devices and Circuits", 3/e, Pearson Education, 2003.
3. R. E. Collins, "Foundations for Microwave Engineering", 2/e, Wiley India Pvt. Ltd., 2012.
4. Annapurna Das and Sisir K. Das " Microwave Engineering ", McGraw Hill Education, Third edition, 2014
5. Skalnik, Krauss, Reich, *Microwave principles*, East West Press, 1976

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **HS 707 ME** | **Industrial Administration and Financial Management** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **MEA HS901MB** | **2** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To understand various types of organizational structures, manufacturing processes and importance of plant layout and the role of scheduling function in optimizing the utilization of resources.
- To understand the importance of quality, inventory control and concepts like MRP I and MRP II.
- To understand the nature of financial management and concepts like breakeven analysis, depreciation and replacement analysis.

**Course Outcomes**

After completing this course, the student will be able to

1. Understand the different phases of product life cycle, types of manufacturing systems, plant layout optimization problems and role of scheduling function in better utilization of resources
2. Understand the Fundamental concepts of quality control, process control, material control and appreciate the importance of MRP-I and MRP –II.
3. Know the different terminology used in financial management and understand the different techniques of capital budgeting and various types of costs involved in running an industrial organization.

**UNIT – I**

**Industrial Organization:** Types of various business organisations, Organisation structures and their relative merits and demerits. Functions of management.

Plant Location and Layouts: Factors affecting the location of plant and layout. Types of layouts and their merits and demerits.

**UNIT – II**

**Work Study**: Definitions, objectives of method study and time study. Steps in conducting method study. Symbols and charts used in method study. Principles of motion economy. Calculation of standard time by time study and work sampling. Performance rating factor. Types of ratings. Jobs evaluation and performance appraisal. Wages, incentives, bonus, wage payment plans.

**UNIT – III**

**Inspection and Quality Control:** Types and objectives of inspection S.Q.C., its principles. Quality control by chart and sampling plans. Quality circles, introduction to ISO.

**UNIT – IV**

**Optimization:** Introduction to linear programming and its graphical solutions. Assignment problems.

**Project Management:** Introduction to CPM and PERT. Determination of critical path.

**Material Management:** Classification of materials, Materials planning.

Duties of purchase manager. Determination of economic ordering quantities. Types of materials purchase.

**UNIT – V**

**Cost Accounting:** Elements of cost. Various costs. Types of overheads. Breakeven analysis and its applications. Depreciation. Methods of calculating depreciation fund. Nature of financial management. Time value of money. Techniques of capital budgeting and methods. Cost of Capital, Financial leverage.

***Suggested Readings:***

1. Pandey I.M., "Elements of Financial Management", Vikas Publications House, New Delhi, 1994.
2. Khanna O.P., "Industrial Engineering and Management", Dhanpat Rai & Sons.
3. Marshall/Bansal, "Financial Engineering", PHI.
4. Keown, "Financial Management", 9/e, PHI.
5. Chandra Bose, "Principles of Management &Administration", PHI.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 721 EC** | **Mobile and Cellular Communications** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To understand the concept and implementation of frequency reuse and Handoff techniques and to analyse interference and capacity enhancement.
- To appreciate the factors influencing outdoor and indoor propagation systems
- To analyse various multiple access protocols based on their merits and demerits.
- To visualize the system architectures and implementation of GSM and CDMA based mobile communication systems.
- To understand the concepts in various Mobile Technologies

**Course Outcomes**

After completing this course, the student will be able to

1. Understand the method of selection and reuse of a set of frequency channels, Base station requirement, signals required for communication and hand over between Base stations
2. Appreciate and understand the methods of electromagnetic wave propagation in cellular communication. The evaluation of the electromagnetic energy reaching the mobile unit.
3. Identify different a methods of mobile access technologies and which of them suitable for mobile cellular solutions. Understand process used for Bluetooth, ZigBee like low power devices
4. Explain features, authentication, operational details of GSM and CDMA mobile cellular systems along with data frame structure details.
5. The development and limitation of the preliminary and advanced generation of mobile systems. Present trends in Cellular communications and the future communication requirements.

**UNIT-I**

Basic Cellular system and its operation, frequency reuse, channel assignment strategies, Handoff process, factors influencing handoffs, handoffs in different Generations, Interference and system capacity, Cross talk, Enhancing capacity and cell coverage, Trunked radio system. Manual and Automatic Electronic Exchanges.

**UNIT-II**

Free space propagation model, three basic propagation mechanisms, practical link budget design using path loss models, outdoor propagation models: Durkin's model and indoor propagation model, partition losses. Small scale multipath propagation, Parameters of mobile multipath channels, types of small scale fading. Cell Tower Antenna/radiation pattern, Mobile antennas/ radiation patterns

**UNIT-III**

**Data multiple access Technologies in Communication**: FDMA, TDMA, SSMA, FHMA, CDMA, SDMA, Packet radio protocols, CSMA, Reservation protocols time Frame details.

**UNIT-IV**

**GSM:** Services and Features, System architecture, Radio Sub system, Channel Types, Frame structure and Signal processing.

**CDMA:** Digital Cellular standard IS-95, Forward Channel, Reverse Channel.

**UNIT-V**

**Comparison of Mobile communication Technologies:** 1G, 2G and 2.5G, technology Features of 3G and 4G and 5G, WLAN, Bluetooth, PAN, Trends in Radio and Personal Communications, UMTS system architecture and Radio Interface.

***Suggested Readings:***

1. Theodore.S. Rappaport, "Wireless Communications: Principles and Practice," 2/e, Pearson Education, 2010.
2. William. C.Y. Lee, "Mobile Communication Engineering," 2/e, Mc-Graw Hill, 2008.
3. T.L. Singal "Wireless Communication Systems," 1/e, TMH Publications, 2010.
4. William.C.Y. Lee, "Mobile Cellular Telecommunications: Analog and Digital Systems," 2/e, Mc-Graw Hill, 2011.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 722 EC** | **Speech Signal Processing** | | | | | | **Elective** |
| Prerequisites | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **DIP PE671EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- Understand the basic mechanism of human speech production.
- Understand digital representation of speech waveforms.
- Understand Short-time analysis and Synthesis techniques.
- Understand Speech Synthesizers.
- Understand the various problems with Automatic speech recognition.

**Course Outcomes**

After completing this course, the student will be able to

1. Grasp the basic mechanism of human speech production.
2. Understand digital representation of speech waveforms.
3. Do Short-time analysis and Synthesis techniques.
4. Analyse Speech Synthesizers.
5. Understand the various problems with Automatic speech recognition

**UNIT I**

**Introduction to Speech Processing:** The mechanism of Speech production, Acoustic Phonetics, Source-Filter model of speech production.

**Representation of Speech waveforms:** Delta modulation, Adaptive delta modulation, Differential PCM, Adaptive differential PCM.

**UNIT II**

**Time-domain models for Speech processing:** Short -Time Energy function, Zero crossing rate, End point detection, Pitch Period Estimation, Vector quantization. Format Tracking

**UNIT III**

**Speech Signal Analysis:** Short-Time Fourier analysis**,** Auto correlation function, Linear Predictive Analysis, Pitch Synchronous Analysis.

**Homomorphic Speech Processing:** The Complex Cepstrum of Speech and its properties, Applications of Cepstral Processing

**UNIT IV**

**Speech Synthesis:** Format Synthesis, Linear Predictive Synthesis, Introduction to Text-to-speech, Articulatory speech synthesis.

**Speech Coders:** Sub-band coding, Transforms coding, Channel decoder, Formant decoder, Linear Predictive decoder, Vector Quantizer coder.

**UNIT V**

**Automatic Speech Recognition:** Problems in Automatic Speech Recognition, Dynamic warping, Hidden Markov models, Speaker Identification / verification.

***Suggested Readings:***

1. L R Rabiner & R W Schafer, *"*Digital Processing of Speech Signals", PHI, 1978.
2. F J Owens, "Signal Processing of Speech", Macmillan, 2000.
3. Papamchalis, "Practical Approaches to Speech Coding", PHI, 1987.

4. Daniel Jurefskey & Jemes H. Martin, "*Speech and Language Processing*", Pearson Education, 2003.
5. Thomas W. Parsons, "*Voice and Speech Processing*", Mc GRAWHILL, 1986.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 723 EC** | **Electronic Measurements and Instrumentation** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **ED PC302EC**<br>**LICA PC501EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- Understand the different standards of measurements.
- Study different types of transducers.
- List various types of measurements and thermometers.
- Learn the design of digital voltmeters
- Study various types of bio-medical instruments.

**Course Outcomes**

After completing this course, the student will be able to

1. Describe characteristic of an instrument and state different Standards of measurements
2. Identify and explain different types of Transducers.
3. Draw and Interpret types of transducers.
4. Design and analyse the digital voltmeters and Prioritize the instruments.
5. Identify and classify types of Biomedical instruments.

**UNIT-I**

Accuracy, Precision, Resolution and Sensitivity. Errors and their types. Standards of measurement, classification of standards, IEEE standards.

**UNIT-II**

**Transducers:** classification, factors for selection of a transducer, transducers for measurement of velocity, acceleration. Passive electrical transducers- Strain gauges and strain measurement, LVDT and displacement measurement, capacitive transducer and thickness measurement. Active electrical transducers: Piezo electric, photo conductive, photo voltaic and photo emissive transducers.

**UNIT-III**

Characteristics of sound, pressure, power and loudness measurement. Microphones and their types. Temperature measurement, resistance wire thermometers, semiconductor thermometers and thermocouples.

**UNIT-IV**

Block diagram, specification and design considerations of different types of DVMs. Spectrum analysers. The IEEE488 or GPIB Interface and protocol. Delayed time base oscilloscope and Digital storage oscilloscope. Introduction to virtual instrumentation, SCADA. Data acquisition system block diagram.

**UNIT-V**

**Biomedical Instrumentation:** Human physiological systems and related concepts. Bio-potential electrodes Bio-potential recorders – ECG, EEG, EMG, X- ray machines and CT scanners, magnetic resonance and imaging systems, Ultrasonic Imaging systems.

***Suggested Readings:***

1. Albert D. Helfric, and William D. Cooper, “Modern Electronic Instrumentation and Measurement Techniques”, PHI, 2010.
2. H S Kalsi, “Electronic Instrumentation”, 3/e, TMH, 2011.
3. Robert A Witte, “Electronic Test Instruments: Analog and Digital Measurements”, 2/e, 2002.

4. Nakra B.C, and Chaudhry K.K., “Instrumentation, Measurement and Analysis”, TMH, 2004.
5. Khandpur. R.S., “Handbook of Bio-Medical Instrumentation”, TMH, 2003.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 724 EC** | **Digital Signal Processor Architectures** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **DSP PC 503 EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

To make the student familiar with the concepts of

- To study the importance of DSPs and the numeric formats
- To analyse the implementation considerations.
- To elaborate on architectures of PDSPs.
- To compare architectures of different types of DSPs.
- To understand the concepts of Memory and peripheral & device I/O interfacing.

**Course Outcomes**

After completing this course, the student will be able to

1. Comprehend the importance of DSPs.
2. Highlight their implementation considerations.
3. Explain the architectures for PDSPs.
4. Compare various architectures of DSPs.
5. Integrate DSP programmable devices with external peripherals and devices.

**UNIT-I**

**Major features of DSP Processors:** Differences between DSP and other general purpose processor architectures, their comparison and need for special ASPs, RISC and CISC CPUs.
Data representations and arithmetic, finite word length effects.

**UNIT-II**

**Implementation considerations:** Real time implementation considerations. Hardware looping, Interrupts, Stacks, Relative Branch support, Pipelining and Performance, Pipeline Depth, Interlocking, Branch effects, Interrupt effects, Pipeline Programming models, sources of errors. DSP Tools – Assembler, debugger, c-compiler, linker, editor, Code Composer Studio.
Applications: Adaptive filtering, Spectrum analysis, Echo Cancellation modems, Voice synthesis and recognition.

**UNIT-III**

**Architectures for Programmable DSP devices:** Basic Architectural features, DSP Computational Building Blocks, Bus Architecture and Memory, Data Addressing Capabilities, Address Generation Unit, Programmability and Program Execution, Speed Issues.

**UNIT-IV**

**Programmable Digital Signal Processors:** Fixed point DSPs – Architecture of TMS 320C5X, C54X Processors, Addressing modes, Assembly instructions, Pipelining and on-chip peripherals. Floating point DSPs - Architecture of TMS320-1X-Data formats, Floating Point operations, Addressing Modes, instructions, pipelining and peripherals.
Overview of AD and Motorola DSP CPUs; Their comparison with TI CPUs.

**UNIT-V**

**Memory and I/O Interfacing (C54X):** Memory space organization, External bus interfacing signals, Memory interface, Parallel I/O interface, Programmed I/O, Interrupts and I/O, Direct Memory Access

(DMA). Synchronous Serial Interface: A Multichannel buffered serial port (McBSP), a CODEC interface circuit. I/O interfacing with A/D converters.

***Suggested Readings:***

1. B. Venkataramani, M. Bhaskar, "Digital Signal Processors – Architecture, programming and Applications, Tata McGrawHill, 2nd ed., 2011.
2. Lapsley et al., "DSP Processor Fundamentals, Architectures & Features", S. Chand & Co, 2000.
3. Avtar Singh, S. Srinivasan, "Digital Signal Processing - Implementation using DSP Microprocessors with Examples from TMS32C54XX", Cengage Learning, 2004.
4. K. Shin, "DSP Applications with TMS 320 Family", Prentice Hall, 1987.
5. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing-Principles, Algorithms, and Applications", Prentice Hall of India, 2007.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 771 CE** | **Green Building Technologies** | | | | | | **Open Elective-II** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

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

**Course Outcomes**

After completing this course, the student will be able to

1. Define a green building, along with its features, benefits and rating systems.
2. Describe the criteria used for site selection and water efficiency methods.
3. Explain the energy efficiency terms and methods used in green building practices.
4. Select materials for sustainable built environment & adopt waste management methods.
5. Describe the methods used to maintain indoor environmental quality.

**UNIT-I**

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

**UNIT- II**

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

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

**UNIT-III**

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

**UNIT-IV**

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

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

**UNIT-V**

**Indoor Environmental Quality for Occupant Comfort and Wellbeing:** Daylighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics. Codes related to green buildings: NBC, ECBC, ASHRAE, UPC etc.

***Suggested Readings:***

1. IGBC Green Homes Rating System, Version 2.0., Abridged reference guide, 2013, Indian Green Building Council Publishers.
2. GRIHA version 2015, GRIHA rating system, Green Rating for Integrated Habitat Assessment.
3. *Alternative building materials and technologies* by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
4. *Non-Conventional Energy Resources* by G. D. Rai, Khanna Publishers.
5. *Sustainable Building Design Manual*, Vol.1 and 2, TERI, New Delhi 2004.
6. Mike Montoya, *Green Building Fundamentals*, Pearson, USA, 2010.
7. Charles J. Kibert*, Sustainable Construction - Green Building Design and Delivery*, John Wiley & Sons, New York, 2008.
8. Regina Leffers*, Sustainable Construction and Design*, Pearson / Prentice Hall, USA, 2009.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 772 CS** | **Data Science Using R Programming** | | | | | | **Open Elective-II** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

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

**Course Outcomes**

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

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

**UNIT – I**

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

**UNIT II**

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

**UNIT III**

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

**UNIT IV**

Introduction to R Programming, getting started with R: Installation of R software and using the interface, Variables and data types, R Objects, Vectors and lists, Operations: Arithmetic, Logical and Matrix operations, Data frames, functions, Control structures, Debugging and Simulation in R.

**UNIT V**

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

***Suggested Readings:***

1. Nina Zumel, Practical Data Science with R, Manning Publications, 2014.
2. Peter Bruce and Andrew Bruce, Practical Statistics for Data Scientists, O'Reilly, 2017.
3. Hadley Wickham and Garrett Grolemund, R for Data Science, O'Reilly, 2017.
4. Roger D Peng, R Programming for Data science, Lean Publishing, 2016.
5. Rafael A Irizarry, Introduction to Data Science, Lean Publishing,2016.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 773 EC** | **Fundamentals of IoT** | | | | | | **Open Elective-II** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

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

**Course Outcomes**

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

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

**UNIT - I**

**Introduction to Internet of Things:** Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT, IoT protocols, Logical Design of IoT: IoT functional Blocks, Communication Models, APIs, IoT enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics (Ref 1)

**IoT Applications**: Smart Home, Smart Cities, Smart Environment, Smart Energy, Smart Retail and Logistics, Smart Agriculture and Industry, Smart Industry and smart Health (Ref1)

**UNIT – II**

**Internet Principles and communication technology:** Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open Source Vs Closed Source. Prototyping Embedded Devices – Sensors, Actuators, Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling (Ref 2)

**UNIT – III**

**API Development and Embedded programming:** Getting started with API, writing a new API, Real time Reactions, Other Protocols, Techniques for writing embedded code: Memory management, Performance and Battery Life, Libraries, Debugging. (Ref 2)

Developing Internet of Things: IoT design Methodology, Case study on IoT System for weather monitoring (Ref 1)

**UNIT – IV**

**IoT Systems - Logical Design using Python:** Introduction to Python, Data Types and Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/Time Operations., Classes, Python packages for IoT (Ref 1 and Ref 3) IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi with Python - Controlling LED and LDR using Pi with python programming.

**UNIT – V**

**Cloud computing and Data analytics and IoT Product Manufacturing:** Introduction to Cloud storage models and Communication APIs, Amazon web services for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT (Ref 1). Case studies illustrating IoT Design – Smart Lighting, Weather Monitoring, Smart Irrigation. (Ref 1) Business model for IoT product manufacturing, IoT Start-ups, Mass manufacturing, Ethical issues in IoT. (Ref 2)

***Suggested Readings:***

1. Internet of Things (A Hands-On-Approach), Vijay Madisetti, Arshdeep Bahga, VPT Publisher, 1st Edition, 2014.
2. Designing the Internet of Things, Adrian McEwen (Author), Hakim Cassimally. Wiley India Publishers.
3. Fundamentals of Python, Kenneth A Lambert and B.L. Juneja, Cengage Learning
4. *Internet of Things* - Converging Technologies for smart environments and Integrated ecosystems, River Publishers.
5. *Internet of things* -A hands on Approach, Arshdeep Bahga, Universities press.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 774 EE** | **Non-Conventional Energy Sources** | | | | | | **Open Elective-II** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

To impart the knowledge of basics of different non-conventional types of power generation & power plants in detail so that it helps them in understanding the need and role of Non-Conventional Energy sources particularly when the conventional sources are scarce in nature

**Course Outcomes**

On completion of course the student will be able to:

1. Understand the different nonconventional sources and the power generation techniques to generate electrical power.
2. Understand the Solar energy power development and different applications.
3. Understand different wind energy power generation techniques and applications.
4. Design a prescribed engineering sub-system
5. Recognize the need and ability to engage in lifelong learning for further developments in this field.

**UNIT-I**

Review of Conventional and Non-Conventional energy sources - Need for non-conventional energy sources Types of Non- conventional energy sources - Fuel Cells - Principle of operation with special reference to H2 °2 Cell - Classification and Block diagram of fuel cell systems - Ion exchange membrane cell - Molten carbonate cells - Solid oxide electrolyte cells - Regenerative system- Regenerative Fuel Cell - Advantages and disadvantages of Fuel Cells-Polarization - Conversion efficiency and Applications of Fuel Cells.

**UNIT-II**

Solar energy - Solar radiation and its measurements - Solar Energy collectors -Solar Energy storage systems - Solar Pond - Application of Solar Pond - Applications of solar energy.

**UNIT-III**

Wind energy- Principles of wind energy conversion systems - Nature of wind - Power in the Wind-Basic components of WECS -Classification of WECS -Site selection considerations -Advantages and disadvantages of WECS -Wind energy collectors -Wind electric generating and control systems - Applications of Wind energy -Environmental aspects.

**UNIT- IV**

Energy from the Oceans - Ocean Thermal Electric Conversion (OTEC) methods - Principles of tidal power generation -Advantages and limitations of tidal power generation -Ocean waves - Wave energy conversion devices -Advantages and disadvantages of wave energy - Geo-Thermal Energy - Types of Geo-Thermal Energy Systems - Applications of Geo-Thermal Energy.

**UNIT-V**

Energy from Biomass - Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency - Biogas generation - Selection of site for Biogas plant - Classification of Biogas plants - Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation -Thermal gasification of biomass -Biomass gasifiers.

***Suggested Readings:***

1. Rai G.D, *Non-Conventional Sources of Energy,* Khandala Publishers, New Delhi, 1999.
2. M.M. El-Wakil, Power *Plant Technology.* McGraw Hill, 1984.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 775 ME** | **Entrepreneurship** | | | | | | **Open Elective-II** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To motivate students to take up entrepreneurship in future
- To learn nuances of starting an enterprise & project management
- To understand the design principles of solar energy systems, their utilization and performance evaluation
- To understand the behavioural aspects of entrepreneurs and time management

**Course Outcomes**

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

1. Understand Indian Industrial Environment, Entrepreneurship and Economic growth, Small and Large Scale Industries, Types and forms of enterprises.
2. Identify the characteristics of entrepreneurs, Emergence of first generation entrepreneurs, Conception and evaluation of ideas and their sources.
3. Practice the principles of project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis.
4. Apply the concepts of Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques
5. Understand the Behavioural aspects of entrepreneurs, Time Management, Various approaches of time management, their strengths and weakness. The urgency addiction and time management matrix.

**UNIT-I**

Indian Industrial Environment-competence, Opportunities and Challenges. Entrepreneurship and Economic growth. Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries. Types of enterprises.

**UNIT-II**

Identification and characteristics of entrepreneurs. Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas and their sources. Choice of Technology - Collaborative interaction for Technology development.

**UNIT-III**

Project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis, project financing in India.

**UNIT-IV**

Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques. Human aspects of project management. Assessment of tax burden.

**UNIT-V**

Behavioural aspects of entrepreneurs: Personality - determinants, attributes and models. Leadership concepts and models. Values and attitudes. Motivation aspects. Change behaviour. Time Management: Various approaches of time management, their strengths and weaknesses. The urgency addiction and time management matrix.

***Suggested Readings:***

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management",* Himalaya Publishing House, 1997
2. Prasanna Chandra, *"Project-Planning, Analysis, Selection, Implementation and Review",* Tata McGraw-Hill Publishing Company Ltd. 1995.
3. Stephen R. Covey and A. Roger Merrill, *"First Things First",* Simon and Schuster Publication, 1994.
4. G.S. Sudha, *"Organizational Behaviour",* 1996.
5. Robert D. Hisrich, Michael P. Peters, *"Entrepreneurship",* Tata Me Graw Hill Publishing Company Ltd., 5lh Ed., 2005.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 781 CE** | **Road Safety Engineering** | | | | | | **Open Elective-III** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **0** | **0** | **0** | **30** | **70** | **3** |

**Course Objectives**

- Introduction to various factors considered for road safety and management
- Explain the road safety appurtenances and design elements
- Discuss the various traffic management techniques

**Course Outcomes**

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

1. Prepare accident investigation reports and database
2. Apply design principles for roadway geometrics improvement with various types of traffic safety appurtenances/tools
3. Manage traffic including incident management

**UNIT – I**

**Road Accidents:** Causes, scientific investigations and data collection, Analysis of individual accidents to arrive at real causes, statistical methods of analysis of accident data, Basic concepts of Road accident statistics, Safety performance function: The empirical Bayes method Identification of Hazards road location. Application of computer analysis of accident data.

**UNIT – II**

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

**UNIT – III**

**Road Signs and Traffic Signals:** Classification, Location of Signs, measures of sign effectiveness, Types of visual perception, sign regulations, sign visibility, sign variables, Text versus symbols. Road Marking: Role of Road markings, Classification, visibility. Traffic Signals: Need, Signal face. Illumination and location of Signals, Factors affecting signal design, pedestrians' safety, fixed and vehicle actuated signals. Design of signa1s, Area Traffic control. Delineators, Traffic Impact Attenuators, Road side rest areas, Safety Barriers, Traffic Aid Posts.

**UNIT – IV**

**Traffic Management Techniques:** Integrated safety improvement and Traffic Calming Schemes, Speed and load limit, Traffic lights, Safety cameras, Tests on driver and vehicles, pedestrian safety issues, Parking, Parking enforcement and its influence on Accidents. Travel Demand Management; Methods of Traffic management measures: Restriction of Turning Movements, One-way streets, Tidal Flow Operation Methods, Exclusive Bus Lanes and Closing Side-streets; Latest tools and techniques used for Road safety and traffic management. Road safety issues and various measures for road safety; Legislation, Enforcement, Education and Propaganda, Air quality, Noise and Energy Impacts; Cost of Road Accidents.

**UNIT – V**

**Incident Management:** Introduction, Characteristics of Traffic Incidents, Types of Incidents, Impacts, Incident management process, Incident traffic management; Applications of ITS: Motorist information, Equipment used; Planning effective Incident management program, Best practice in Incident management

programs. National importance of survival of Transportation systems during and after all natural disasters especially cyclones, earthquakes, floods etc. and manmade disasters like sabotage, terrorism etc.

***Suggested Readings:***

1. Guidelines on Design and Installation of Road Traffic Signals, IRC:93.
2. Specification for Road Traffic Signals, IS: 7537-1974.
3. Principles and Practice of Highway Engineering by L.R. Kadiyali and N.B. Lal.
4. Hand Book of T.E. Myer Kutz, Editor McGraw Hill, 2004.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 782 CS** | **Software Engineering** | | | | | | **Open Elective-III** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To introduce the basic concepts of software development- processes from defining a product to shipping and maintaining that product
- To impart knowledge on various phases, methodologies and practices of software development
- To understand importance of software modelling using UML
- To understand the importance of testing in software development and study various testing strategies and software quality metrics.

**Course Outcomes**

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

1. Acquire knowledge about different software development processes and their usability in different problem domains.
2. Understand the process of requirements collection, analysing, and modelling requirements for effective understanding and communication with stakeholders.
3. Design and develop the architecture of real world problems towards developing a blueprint for implementation.
4. Use the UML language to design various models during software development life cycle.
5. Understand the concepts of software quality, testing and maintenance.

**UNIT-I**

**The software Problem:** Cost, Schedule and Quality, Scale and change, Software Processes: - Process and project, Component Software Processes, Software Development Process Models, Project management Process.

**UNIT-II**

**Software Requirements Analysis and Specification**: Value of a good SRS, Requirements Process, Requirements Specification, Functional Specification with Use Cases, Other approaches for analysis. Software Architecture: Role of Software Architecture Views, Component and connector view, Architectural styles for C & C view, Documenting Architecture Design, Evaluating Architectures.

**UNIT-III**

**Planning a Software Project**: Effort Estimation, Project Schedule and staffing, Quality Planning, Risk Management Planning, Project Monitoring Plan, Detailed Scheduling. Design: Design concepts, Function oriented Design, Object Oriented Design, Detailed Design, Verification, Metrics.

**UNIT-IV**

**Coding and Unit Testing**: Programming Principles and Guidelines, incrementally developing code, managing evolving code, unit testing, code inspection, Metrics. Testing: Testing Concepts, Testing Process, Black Box testing, White box testing, Metrics.

**UNIT-V**

**Maintenance and Re-engineering**: Software Maintenance, supportability, Reengineering, Business process Reengineering, Software reengineering, Reverse engineering; Restructuring, Forward engineering, Economics of Reengineering. Software Process Improvement: Introduction, SPI process, CMMI, PCMM, Other SPI Frameworks, SPI return on investment, SPI Trends.

***Suggested Readings:***

1. Pankaj Jalote, "Software Engineering- A Precise Approach", Wiley India, 2010.
2. Roger. S. Pressman, "Software Engineering - A Practitioner's Approach", 7th Edition, McGraw Hill Higher Education, 2010.
3. Deepak Jain, "Software Engineering", Oxford University Press, 2008.
4. Rajib Mall, "Fundamentals of Software Engineering", 4th Edition, PHI Learning, 2014.
5. Ian Sommerville, "Software Engineering", 10th Edition, Addison Wesley, 2015.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 783 EC** | **Principles of Electronic Communications** | | | | | | **Open Elective-III** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | **Credits** |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

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

**Course Outcomes**

1. Understand the working of analog and digital communication systems
2. Understand the OSI network model and the working of data transmission
3. Understand the evolution of communication technologies from traditional telephony systems to modern wireless communication systems.

**UNIT – I**

**Introduction to communication systems:** Electromagnetic Frequency Spectrum, Signal and its representation, Elements of Electronic Communications System, Types of Communication Channels.

**Signal Transmission Concepts:** Baseband transmission and Broadband transmission,

**Communication Parameters:** Transmitted power, Channel bandwidth and Noise, Need for modulation

**Signal Radiation and Propagation:** Principle of electromagnetic radiation, Types of Antennas, Antenna Parameters and Mechanisms of Propagation.

**UNIT – II**

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

**UNIT – III**

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

**UNIT – IV**

**Telecommunication Systems:** Telephones, Telephone system, Paging systems, Internet Telephony.

**Optical Communications:** Optical Principles, Optical Communication Systems, Fiber –Optic Cables, Optical Transmitters & Receivers, Wavelength Division Multiplexing.

**UNIT – V**

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

***Suggested Readings:***

1. *Principles of Electronic Communication Systems*, Louis E. Frenzel, 3e, McGraw Hill, 2008.
2. *Data Communications and Networking,* Behrouz A. Forouzan, 5e TMH, 2012.
3. Kennady, Davis, *Electronic Communications systems*, 4e, McGraw Hill, 1999.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 784 EE** | **Illumination and Electric Traction Systems** | | | | | | **Open Elective-III** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To introduce the students and understand Utilization of electrical energy for various applications like industrial heating, welding etc.,
- To understand the concept of illumination, and know the applications of various lamps to factory lighting, street lighting etc.
- To understand the concept of electrification of traction system

**Course Outcomes**

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

1. Design the resistive and inductive heating and calculate the requirements of heating power for an industrial need
2. Analyse the type of motor control required and select the type and rating of motor.
3. Understand and Design illumination for different application
4. Understand the traction and use of DC machines
5. Analyse the traction mechanics to arrive at a rating of drive.

**UNIT-I**

**Industrial Heating:** Advantages and methods of electric heating. Description, operation and performance of resistance ovens — Design of elements. Core type, Coreless type furnaces, High frequency eddy current heating, Dielectric heating. Arc furnace. Electric welding, Resistance welding, welding transformer and its rating, various types of Electric arc welding and electric resistance welding.

**UNIT-II**

**Schematic Utilization and Connection Diagrams for Motor Control:** Two supply sources for 3 phase Induction motors. Direct reversing, remote control operation, and jogging operating of Induction motor. Contactor control circuit. Push button control stations. Over load relays, limit switches, float switches. Interlocking methods for reversing control.

**UNIT-III**

**Illumination:** Introduction, nature and production of light, Sensitivity of the eye, Units of light. The inverse square law and cosine law, Solid angle, lighting calculations — Determination of M.S.C.P, Rousseau's construction, Discharge lamps, Sodium vapour lamps, Mercury vapour lamps — Fluorescent lamp, Starting and power factor corrections, Stroboscopic effects — Neon signs, Application to factory lighting, Street lighting and Flood lighting.

**UNIT-IV**

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

**Traction Motors:** Desirable characteristics, DC series motors, AC series motors 3-phase induction motors, DC motor series & parallel control, Energy saving.

**UNIT-V**

**Train Lighting:** Systems of train lighting — Special requirements of train lighting — Methods of obtaining unidirectional polarity — Methods of obtaining constant output — Single battery system — Double battery parallel block system — Principal equipment of double battery system — Coach wiring — Dynamo.

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

***Suggested Readings:***

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

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **OE 785 ME** | **Mechatronics** | | | | | | **Open Elective-III** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

Student has to understand the

- How to identify, formulate, and solve engineering problems
- The design a system, component, or process to meet desired needs within realistic constraints
- The how to use the techniques, skills, and modern engineering tools necessary for engineering practice
- The use of drive mechanisms and fluid power systems
- The use of industrial electronic devices
- The demonstrate the design of modern CNC machines, and Mechatronics elements

**Course Outcomes**

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

1. Model and analyse electrical and mechanical systems and their interconnection
2. Integrate mechanical, electronics, control and computer engineering in the design of Mechatronics systems
3. Do the complete design, building, interfacing and actuation of a Mechatronics system for a set of specifications
4. Be proficient in the use of fluid power systems in various Mechatronics applications
5. Demonstrate the use of industrial electronic devices
6. Demonstrate the design of modern CNC machines, and Mechatronics elements

**UNIT-I**

Introduction to mechanization & automation: Need of interface of electrical & electronic devices with mechanical elements, the concept of Mechatronics, Flow chart of Mechatronics system, elements of Mechatronics system, drive mechanisms, actuators, feedback devices and control system, application in industries and systems development

**UNIT-II**

Drive mechanisms: Feeding and indexing, orientation, escapement and sorting devices, conveyor systems Introduction to electrical actuators: A.C. servomotors, D.C. servomotors, stepper motors

**UNIT-III**

Introduction to fluid power systems: Industrial Pneumatics and hydraulics, merits of fluid power, pneumatic & hydraulic elements symbols, study of hydraulic control valves, pumps & accessories, hydraulic circuits & mechanical servo control circuits, Electro-hydraulic and Hydro pneumatic circuits

**UNIT-IV**

Introduction to industrial electronic devices: Diodes, Transistors, Silicon Controlled Rectifiers (SCR), Integrated Circuits (IC), Digital Circuits, Measurement systems & Data acquisition systems: sensors, digital to analog and analog-to-digital conversion, signal processing using operational amplifiers, introduction to microprocessor & micro controller, Temperature measurement interface and LVDT interface, Systems response

**UNIT-V**

Design of modern CNC machines and Mechatronics elements: machine structures, guide ways, spindles, tool monitoring systems, adaptive control systems, Flexible manufacturing systems, Multipurpose control machines, PLC programming

***Suggested Readings:***

1. William Bolton, Mechatronics: Electronic control systems in mechanical and electrical engineering, 6th edition, Pearson Education
2. HMT Ltd, Mechatronics, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1998
3. Michaels Histand & David G, Alciatore, Introduction to Mechatronics and Measurement Systems, Tata McGraw-Hill International Edition
4. Devdas Shetty, Richard A. Kolk, Mechatronics System Design, Cengage Learning
5. S.R. Majumdar, Oil Hydraulic Systems – Principles & Maintenance, McGraw-Hill Publishing Company Limited, New Delhi
6. Godfrey Onwubolu, Mechatronics: Principles and Applications, Butterworth-Heinemann

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **MC 771 EG** | **Human Values and Professional Ethics** | | | | | | **Mandatory** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **2** | **-** | **-** | **-** | **30** | **70** | **-** |

**Course Objectives**

Student has to understand the

- To develop a critical ability to distinguish between essence and form, or between what is of value and what is superficial, to life.
- To move from discrimination to commitment. It is to create an ability to act on any discrimination in a given situation.
- It encourages students to discover what they consider valuable. After learning the course, they should be able to discriminate between valuable and the superficial in real situations in their life.

**Course Outcomes**

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

1. It ensures students sustained happiness through identifying the essentials of human values and skills.
2. It facilitates a correct understanding between profession and happiness
3. It helps students understand practically the importance of trust, mutually satisfying human behavior and enriching interaction with nature.
4. Ability to develop appropriate technologies and management patterns to create harmony in professional and personal life.

**UNIT - I**

Course Introduction - Need, basic Guidelines, Content and Process for Value Education: Understanding the need, basic guidelines, content and process for Value Education. Self-Exploration - what is it? - its content and process; 'Natural Acceptance' and Experiential Validation - as the mechanism for self-exploration. Continuous Happiness and Prosperity - A look at basic Human Aspirations. Right understanding, Relationship and Physical Facilities - the basic requirements for fulfillment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly - A critical appraisal of the current scenario. Method to fulfill the above human aspirations: understanding and living in harmony at various levels.

**UNIT - II**

Understanding Harmony in the Human Being - Harmony in Myself!: Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Swasthya.

**UNIT - III**

Understanding Harmony in the Family and Society - Harmony in Human - Human Relationship: Understanding harmony in the Family the basic unit of human interaction. Understanding values in human - human relationship; meaning of justice and program for its fulfillment; Trust and Respect as the foundational values of relationship. Difference between intention and competence. Difference between respect and differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family)

**UNIT - IV**

Understanding Harmony in the nature and Existence - Whole existence as Coexistence: Understanding the harmony in the Nature. Interconnectedness and mutual fulfillment among the four orders of nature - recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all-pervasive space. Holistic perception of harmony at all levels of existence.

**UNIT - V**

Implications of the above Holistic Understanding of Harmony on Professional Ethics: Natural acceptance of human values, Definitiveness of Ethical Human Conduct, Basic for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.

***Suggested Readings:***

1. R. R. Gaur, R Sangal, G P Bagaria, 2009, A Foundation Course in Human Values and Professional Ethics.
2. Prof. K. V. Subba Raju, 2013, Success Secrets for Engineering Students, Smart Student Publications, 3rd Edition.Ivan IIIich, 1974, Energy & Equity, The Trinity Press, Worcester, and HarperCollins, USA
3. E. F. Schumancher, 1973, Small is Beautiful: a study of economics as if people mattered. Blond & Briggs, Britain.
4. A Nagraj, 1998 Jeevan Vidya ek Parichay, Divya Path Sansthan, Amarkantak. Sussan George, 1976, How the Other Half Dies, Penguin Press, Reprinted 1986
5. Smriti Shristava, "Human Values and Professional Ethics", Katson Publications,2007

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PC 751 EC** | **Microwave Lab** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **2** | **25** | **50** | **1** |

**Course Objectives**

- Understand the characteristics of RKO and Gunn oscillator.
- Measurement of frequency and wavelengths would be learnt by the student.
- VSWR various TEES would be understood by the student.
- Radiation pattern would be learnt by the student for horn antenna.
- How to Create, Simulate and analyse the different types of Microstrip Antennas by using EM simulation software.

**Course Outcomes**

After completing this course, the student will be able to

1. Analyse frequency, Wave length, SWR and Impedance for Reflex Klystron Oscillator by using its equation.
2. Evaluate of mode characteristics of Reflex klystron and V-I Characteristics of Gunn diode.
3. Analyse of the characteristics of Circulator, Isolator, Directional Coupler, Tees like (Magic tee, E & H plane tees) using the Scattering parameters.
4. Generate the Radiation pattern of different antennas like Yagi-Uda and Horn Antenna and measure the gain of the antennas.
5. Familiarize with the EM simulation software

**List of experiments**

1. Characteristics of Reflex Klystron oscillator, finding the mode numbers and efficiencies of different modes.
2. Characteristics of Gunn diode oscillator, Power Output Vs Frequency, Power Output Vs Bias Voltage.
3. Measurement of frequency and Guide wavelength calculation:
    a. Verification of the relation between Guide wavelength, free space wavelength and cut-off Wavelength of X- band rectangular waveguide.
    b. Verification of the straight line relation between $(1/\lambda g)^2$ and $(1/\lambda 0)^2$ and finding the dimension of the guide.
4. Measurement of low and high VSWRs: VSWR of different components like matched terminals, capacitive and inductive windows, slide screw tuner for different heights of the tuning posts etc.
5. Measurement of impedance for horn antenna, Matched load and slide screw tuner.
6. To find the S-parameters of Directional coupler.
7. To find the S-parameters of Tees: E plane, H plane and Magic Tee.
8. To find the S-parameters of Circulator.
9. Measurement of radiation patterns for basic microwave antennas like horn and parabolic reflectors in E-plane and H-plane. Also to finding the gain, bandwidth and beamwidth these antennas.
10. How to Create, Simulate and Analyse the Dipole Antenna Structure by using EM simulation software
11. How to Create, Simulate and Analyse a Microstrip Rectangular Patch Antenna by using EM simulation software
12. How to Create, Simulate and Analyse a Probe Feed Patch Antenna by using EM simulation software
13. How to Create, Simulate and Analyse a The Triangular Microstrip Antenna by using EM simulation software

**Note:** At least 10 experiments to be carried out during the semester

***Suggested Readings:***

1. M L Sisodia & G S Raghuvanshi, "Basic Microwave Techniques and Laboratory Manual", New Age International (P) Limited, Publishers.
2. Ramesh Garg, Prakash Bhartia, Inder Bahl and Apisak Ittipiboon "Microstrip Antenna Design HandBook" Artech House Publishers, 2001

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PC 752 EC** | **Electronic Design and Automation Lab** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **2** | **25** | **50** | **1** |

**Course Objectives**

- Familiarize with the usage of IDE tools and execution of programs using ARM processor.
- Know about the usage of various devices like LCD, Temperature sensor, Buzzer, Stepper Motor by interfacing them to LPC2148.
- Understand the designing and implementation of combinational and sequential logic circuits using Verilog HDL.
- Study of Mentor Graphics Tools
- Implement basic gates at transistor level

**Course Outcomes**

After completing this course, the student will be able to

1. Familiarize with the usage of IDE tools and program using various on chip like LCD, Temperature sensor, Buzzer, Stepper Motor by interfacing them to ARM Processor
2. Design the digital logic circuits in various modelling styles using Verilog HDL
3. Familiarize with VLSI CAD tools like Mentor Graphics / Cadence
4. Implement basic gates at transistor level
5. Implement the digital circuits at transistor level.

**PART-A**

Interfacing Programs using embedded C on ARM Micro Controller Kit

1. Program to interface 8-Bit LED and switch interface
2. Program to implement Buzzer interface on IDE environment
3. Program to display message in a 2 line x 16 characters LCD display and verify the result in debug terminal
4. Stepper motor interface
5. ADC & Temperature sensor LM35 interface
6. Transmission from kit and reception from PC using serial port.

**PART-B**

Implementation of programs using Verilog HDL code on FPGA Board

1. Adders / Subtractors
2. Multiplexer / Demultiplexer
3. Flip flops
4. Counters/Registers
5. Vending Machine controller
6. Multipliers

**PART C**

Transistor Level implementation of CMOS circuits using VLSI CAD tool

1. Basic Logic Gates: Inverter, NAND and NOR
2. Half Adder and Full Adder
3. 4:1 Multiplexer
4. 2:4 Decoder

**Note:** A minimum of 10 experiments to be performed and at least 3 experiments from each part to be performed.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PW 761 EC** | **Project Work - I** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **4** | **50** | **-** | **2** |

**Course Objectives**

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic literature survey and documentation
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

**Course Outcomes**

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The department can initiate the project allotment procedure at the end of VI semester and finalize it in the first two weeks of VII semester.

The department will appoint a project coordinator who will coordinate the following:

- Collection of project topics/ descriptions from faculty members (Problems can also be invited from the industries)
- Grouping of students (max 3 in a group)
- Allotment of project guides

The aim of project work is to develop solutions to realistic problems applying the knowledge and skills obtained in different courses, new technologies and current industry practices. This requires students to understand current problems in their domain and methodologies to solve these problems. To get awareness on current problems and solution techniques, the first 4 weeks of VII semester will be spent on special lectures by faculty members, research scholars, post graduate students of the department and invited lectures by engineers from industries and R&D institutions. After completion of these seminars each group has to formalize the project proposal based on their own ideas or as suggested by the project guide.

Seminar schedule will be prepared by the coordinator for all the students from the 5th week to the last week of the semester which should be strictly adhered to.

**Each group will be required to:**

1. Submit a one-page synopsis before the seminar for display on notice board.
2. Give a 30 minutes' presentation followed by 10 minutes' discussion.
3. Submit a technical write-up on the talk.

At least two teachers will be associated with the Project Seminar to evaluate students for the award of sessional marks which will be on the basis of performance in all the 3 items stated above.

The seminar presentation should include the following components of the project:

- Problem definition and specification
- Literature survey
- Broad knowledge of available techniques to solve a particular problem.
- Planning of the work, preparation of bar (activity) charts
- Presentation- oral and written.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **SI 762 EC** | **Summer Internship** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **-** | **50** | **-** | **2** |

**Course Objectives**

- Produce an accurate record of work performed during the Internship/Co-op
- Apply engineering knowledge to a problem in industry
- Produce a technical report
- Discuss work in a team environment, if relevant to the project
- Conduct herself/himself responsibly, safely, and ethically in a professional environment

**Course Outcomes**

After completing this course, the student will be able to

1. Get Practical experience of software design and development, and coding practices within Industrial/R&D Environments.
2. Gain working practices within Industrial/R&D Environments.
3. Prepare reports and other relevant documentation.

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

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

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

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

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

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

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

## SCHEME OF INSTRUCTION & EXAMINATION
## B.E. VIII - SEMESTER
## (ELECTRONICS AND COMMUNICATION ENGINEERING)

| S. No. | Course Code | Course Title | Scheme of Instruction | | | | Scheme of Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | L | T | P/D | Contact Hrs/Wk | CIE | SEE | Duration in Hrs | |
| **Theory Courses** | | | | | | | | | | |
| 1 | | Professional Elective – III | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 2 | | Professional Elective – IV | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 3 | | Professional Elective – V | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| **Practical/ Laboratory Courses** | | | | | | | | | | |
| 5 | **PW961 EC** | Project Work – II | - | - | 16 | 16 | 50 | 100 | - | 8 |
| | | | **09** | **-** | **16** | **25** | **140** | **310** | | **17** |

| **Professional Elective – II** | | | **Professional Elective – III** | | |
|---|---|---|---|---|---|
| S. No. | Course Code | Course Title | S. No. | Course Code | Course Title |
| 1 | **PE 821 EC** | Field Programmable Gate Arrays | 1 | **PE 831 EC** | Wireless Sensor Networks |
| 2 | **PE 822 EC** | Internet of Things | 2 | **PE 832 EC** | Global Navigational Satellite Systems |
| 3 | **PE 823 EC** | Neural Networks | 3 | **PE 833 EC** | System Verilog |
| 4 | **PE 824 EC** | Satellite Communications | 4 | **PE 834 EC** | Multirate Signal Processing |

| **Professional Elective – IV** | | |
|---|---|---|
| 1 | **PE 841 EC** | Real Time Operating Systems |
| 2 | **PE 842 EC** | Fuzzy Logic And Applications |
| 3 | **PE 843 EC** | Radar Systems |
| 4 | **PE 844 EC** | Digital Fault Tolerant Systems |

PC: Professional Course PE: Professional Elective
L: Lectures T: Tutorials P: Practical D: Drawing
**CIE:** Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

**Note:** 1) Each contact hour is a Clock Hour
2) The duration of the practical class is two clock hours, however it can be extended wherever necessary, to enable the student to complete the experiment

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 821 EC** | **Field Programmable Gate Arrays** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **DSD PC506EC<br>STLD PC303EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

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

**Course Outcomes**

After completing this course, the student will be able to

1. Design of ASIC's using implementation tools for simulation and synthesis.
2. Describe the architecture of FPGA's.
3. Discuss physical design using FPGA's and CAD tools.
4. Describe placement & routing algorithms.
5. Analyse verification and testing of Digital circuits.

**UNIT-I**

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

**UNIT-II**

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

**UNIT-III**

FPGA physical design, CAD tools, Power dissipation, FPGA Partitioning, Partitioning methods. Floor planning: Goals and objectives, I/O, Power and clock planning, Low-level design entry.

**UNIT-IV**

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

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

**UNIT-V**

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

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

***Suggested Readings:***

1. Pak and Chan, Samiha Mourad, *Digital Design using Field Programmable Gate Arrays*, Pearson Education, 1st edition, 2009.
2. Michael John Sebastian Smith, *Application Specific Integrated Circuits*, Pearson Education Asia, 3rd edition 2001.
3. S. Trimberger, Edr, *Field Programmable Gate Array Technology*, Kluwer Academic Publications, 1994.
4. John V. Oldfield, Richard C Dore, *Field Programmable Gate Arrays*, Wiley Publications.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 822 EC** | **Internet of Things** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

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

**Course Outcomes**

After completing this course, the student will be able to

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

**UNIT – I**

**Introduction to Internet of Things:** Definition and Characteristics of IoT, Physical Design of IoT: Things in IoT, IoT protocols, Logical Design of IoT: IoT functional Blocks, Communication Models, APIs, IoT enabling Technologies: Wireless Sensor Networks, Cloud Computing, Big Data Analytics (Ref 1)

**IoT Applications**: Smart Home, Smart Cities, Smart Environment, Smart Energy, Smart Retail and Logistics, Smart Agriculture and Industry, Smart Industry and smart Health (Ref1)

**UNIT – II**

**Internet Principles and communication technology:** Internet Communications: An Overview – IP, TCP, IP protocol Suite, UDP. IP addresses – DNS, Static and Dynamic IP addresses, MAC Addresses, TCP and UDP Ports, Application Layer Protocols – HTTP, HTTPS, Cost Vs Ease of Production, Prototypes and Production, Open Source Vs Closed Source. Prototyping Embedded Devices – Sensors, Actuators, Microcontrollers, SoC, Choosing a platform, Prototyping Hardware platforms – Arduino, Raspberry Pi. Prototyping the physical design – Laser Cutting, 3D printing, CNC Milling (Ref 2)

**UNIT – III**

**API Development and Embedded programming:** Getting started with API, writing a new API, Real time Reactions, Other Protocols, Techniques for writing embedded code: Memory management, Performance and Battery Life, Libraries, Debugging. (Ref 2)

Developing Internet of Things: IoT design Methodology, Case study on IoT System for weather monitoring (Ref 1)

**UNIT – IV**

**IoT Systems - Logical Design using Python:** Introduction to Python, Data Types and Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/Time Operations., Classes, Python packages for IoT (Ref 1 and Ref 3)

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

**UNIT – V**

**Cloud computing and Data analytics and IoT Product Manufacturing:** Introduction to Cloud storage models and Communication APIs, Amazon web services for IoT, Skynet IoT Messaging Platform. Introduction to Data Analytics for IoT (Ref 1). Case studies illustrating IoT Design – Smart Lighting, Weather Monitoring, Smart Irrigation. (Ref 1) Business model for IoT product manufacturing, IoT Start-ups, Mass manufacturing, Ethical issues in IoT. (Ref 2)

***Suggested Readings:***

6. Internet of Things (A Hands-On-Approach), Vijay Madisetti, ArshdeepBahga, VPT Publisher, 1st Edition, 2014.
7. Designing the Internet of Things, Adrian McEwen (Author), Hakim Cassimally. Wiley India Publishers.
8. Fundamentals of Python, Kenneth A Lambert and B.L. Juneja, Cengage Learning
9. *Internet of Things* - Converging Technologies for smart environments and Integrated ecosystems, River Publishers.
10. *Internet of things* -A hands on Approach, Arshdeep Bahga, Universities press.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 823 EC** | **Neural Networks** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **PTSP PC403EC DIP PE671EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To understand the functioning of biological neuron and its electronic implementation using different Neuron models
- The activation & synaptic dynamics of Neural Networks & its distinction
- To understand the concepts of pattern recognition tasks as applied to Neural Networks
- The concepts of Perceptron Neural Networks & train different Feed Forward Neural Networks
- To train different Feedback Neural Networks & their applications

**Course Outcomes**

After completing this course, the student will be able to

1. To differentiate between Biological Neuron & Artificial Neuron and different Neuron Models
2. To analyse activation & synaptic dynamics of Neural Networks
3. To summarize the Pattern Recognition Tasks & different Neural Network memories
4. To solve Perceptron XoR problem & write different training algorithms for Feed Forward Neural Networks
5. To understand & train different Feedback Neural Networks and their applications

**UNIT-I**

Introduction to Neural Networks, Description of Biological Neuron, Mathematical model of Artificial Neural Network, Classification of Neural Networks, Different Neuron models: McCulloch-Pitts Neuron model, Perceptron Neuron model and ADALINE Neuron model, Basic learning laws

**UNIT-II**

**Activation and Synaptic dynamics of Neural Networks**: Additive, Shunting and Stochastic activation models, Distinction between Activation and Synaptic dynamics models, Requirements of learning laws, Recall in Neural Networks.

**UNIT-III**

**Pattern Recognition Tasks**: Pattern association, pattern storage (LTM & STM), Pattern clustering and feature mapping, Neural Network Memory: Auto Associative Memory, Hetero Associative Memory, Bidirectional Associative Memory.

**UNIT-IV**

**Feed Forward Neural Networks:** Single layer & Multi layer Neural Networks, Perceptron Neural Networks solution of XoR problem, Perceptron Convergence Theorem, Back Propagation Neural Networks, its features, limitations & extensions, Kohonen Self-Organizing Networks & its applications

**UNIT-V**

**Feedback Neural networks**: Hopfield network, capacity and energy analysis of Hopfield Neural Network & its applications, Radial Basis Function Networks, its training algorithm & applications, Boltzmann machine, Boltzman learning law.

***Suggested Readings:***

1. B. Yeganaranarana, *Artificial Neural Networks*, Prentice Hall, New Delhi, 2007.

2. J.A. Freeman and D.M. Skapura, *Neural Networks Algorithms, Applications and Programming Techniques*, Addison Wesley, New York, 1999.
3. Simon Haykin, *Neural Networks (A Comprehensive Foundation)*, McMillan College Publishing Company, New York, 1994.
4. S.N. Sivanandam & M. Paul Raj, *Introduction to Artificial Neural Networks*, Vikas Publishing House Pvt Limited, 2009.
5. Richard O. Duda, Peter E Heart, David G. Stork, *Pattern Classification,* John Wiley & Sons 2002

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 824 EC** | **Satellite Communications** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **DC PC601EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

To make the student familiar with the concepts of

- To understand basics of satellite communications
- To study various effects on satellite communications and to understand types of antennas used.
- To study various components in satellite and satellite TV systems.
- To analyse and design satellite communication link and study various access techniques.
- To study various applications of satellite communications in practical world.

**Course Outcomes**

After completing this course, the student will be able to

1. Explain principle, working and operation of satellite.
2. Illustrate various effects on satellite communications and its antennas.
3. Explain various components in satellite and satellite TV systems.
4. Analyse and design satellite communication link
5. Illustrate role of satellite in various applications

**UNIT-I**

A Brief History of Satellite Communications, Overview and Indian Scenario of Satellite Communications, Kepler's Laws, Definitions of Terms for Earth-Orbiting Satellites, Orbital Elements, Apogee and Perigee Heights, Orbit Perturbations - Effects of a non-spherical earth, Atmospheric drag

**UNIT-II**

Antenna Look Angles, The Polar Mount Antenna, Limits of Visibility, Near Geostationary Orbits, Earth Eclipse of Satellite, Sun Transit Outage, Launching Orbits, Atmospheric Losses, Ionospheric Effects, Rain Attenuation, Other Propagation Impairments, Antenna Polarization, Polarization of Satellite Signals, Cross-Polarization Discrimination, Ionospheric Depolarization, Rain Depolarization, Ice Depolarization, Horn Antennas, The Parabolic reflector, Offset feed, Double-reflector antennas

**UNIT-III**

Power Supply, Attitude Control - Spinning satellite stabilization, Momentum wheel stabilization, Station Keeping, Thermal Control, TT&C Subsystem, Transponders - The wideband receiver, the input demultiplexer, the power amplifier, The Antenna Subsystem.

Receive-Only Home TV Systems - The outdoor unit, the indoor unit for analog (FM) TV, Master Antenna TV System, Community Antenna TV System, Transmit-Receive Earth Stations

**UNIT-IV**

Equivalent Isotropic Radiated Power, Transmission Losses, The Link-Power Budget Equation, System Noise, Carrier-to-Noise Ratio, The Uplink - Saturation flux density, Input backoff, Downlink - Output back-off, Effects of rain – Uplink & Downlink rain-fade margin, Combined Uplink and Downlink C/N Ratio Single Access, Preassigned FDMA, Demand-Assigned FDMA, Spade System, TDMA, Preassigned TDMA, Demand-assigned TDMA, Satellite-Switched TDMA, CDMA

**UNIT-V**

C-Band and Ku-Band Home Satellite TV, Digital DBS TV, DBS- TV System Design, DBS-TV Link Budget, Error Control in Digital DBS-TV, Master Control Station and Uplink, Installation of DBS- TV

Antennas, Satellite Radio Broadcasting, Digital Video Broadcast(DVB) Standards, Digital Video Broadcast – Terrestrial (DVB-T) Satellite Mobile Services, VSATs, Radarsat, Global Positioning Satellite System (GPS), Orbcomm, Iridium

***Suggested Readings:***

1. Dennis Roddy, "Satellite Communications", 4th Edition, Tata McGraw-Hill.
2. Timothy Pratt, Charles Bostian, Jeremy Allnutt, "Satellite Communications", 2nd Edition, John Wiley & Sons.
3. Wilbur L. Pritchard, Henri G. Suyderhoud, Robert A. Nelson, "Satellite Communication Systems Engineering", 2nd Edition, Pearson
4. Tri T. Ha, Digital Satellite Communication, Tata McGraw- Hill, Special Indian Edition 2009.
5. N. Agarwal, "Design of Geosynchronous Space Craft", Prentice Hall, 1986.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 831 EC** | **Wireless Sensor Networks** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **DCCN PE672EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- Determine network architecture, node discovery and localization, deployment strategies, fault tolerant and network security.
- Build foundation for WSN by presenting challenges of wireless networking at various protocol layers.
- Determine suitable protocols and radio hardware.
- Evaluate the performance of sensor network and identify bottlenecks.
- Evaluate concepts of security in sensor networks.

**Course Outcomes**

1. To understand network architecture, node discovery and localization, deployment strategies, fault tolerant and network security.
2. To understand foundation for WSN by presenting challenges of wireless networking at various protocol layers.
3. Study suitable protocols and radio hardware.
4. To understand the performance of sensor network and identify bottlenecks.
5. To understand concepts of security in sensor networks.

**UNIT-I**

Challenges for Wireless Sensor Networks-Characteristics requirements-required mechanisms, Difference between mobile ad-hoc and sensor networks, Applications of sensor networks- Enabling Technologies for Wireless Sensor Networks

**UNIT-II**

Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments

Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts.

**UNIT-III**

Physical Layer and Transceiver Design Considerations, MAC Protocols for Wireless Sensor Networks, Low Duty Cycle Protocols and Wakeup Concepts - S-MAC, Zigbee: IEEE 802.15.4 MAC Layer, The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.

**UNIT-IV**

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control. Operating Systems for Wireless Sensor Networks, Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming. Operating Systems for Wireless Sensor Networks, Sensor Node Hardware – Berkeley Motes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming.

**UNIT-V**

Security Architectures, Survey of Security protocols for Wireless Sensor Networks and their Comparisons.

***Suggested Readings:***

1. Holger Karl and Andreas Willig, *"Protocols and Architectures for Wireless Sensor Networks,"* John Wiley, 2005.
2. Feng Zhao and Leonidas J. Guibas, *"Wireless Sensor Networks - An Information Processing Approach,"* Elsevier, 2007.
3. FazemSohraby, Daniel Minoli, and TaiebZnati, "Wireless Sensor Networks- Technology, Protocols and Applications," John Wiley, 2007.
4. Anna Hac, "Wireless Sensor Network Designs," John Wiley, 2003.
5. Y Wang," A Survey of Security issues in Wireless Sensor Networks", IEEE Communications Survey and Tutorials, 2006.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 832 EC** | **Global Navigational Satellite Systems** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **DC PC601EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To understand fundamentals of Global Position System (GPS)
- To know the signal structures and error sources of GPS
- To study architectures of different GPS based augmentation systems.
- To learn the basic concepts of other GNSS constellations.
- To know the idea about Regional based navigation systems.

**Course Outcomes**

1. Familiarize with the GNSS fundamentals and GPS architecture.
2. Describe the different types of GNSS Signals and GNSS Datum.
3. Analyse the GPS errors and their modelling techniques.
4. Understanding various GPS data processing and GPS integration techniques.
5. Conceptualize the augmentation systems and regional navigation satellite systems.

**UNIT-I**

**GPS Fundamentals:** GPS Constellation, Principle of operation, GPS Orbits, Orbital mechanics and satellite position determination, Time references, Geometric Dilution of Precision: GDOP, VDOP, PDOP. Solar and Sidereal day, GPS and UTC time.

**UNIT-II**

**GPS Signal Structure:** GPS signals, C/A and P-Codes, GPS Signal generation, Spoofing and anti-spoofing. **Error sources in GPS:** Satellite and receiver clock errors, Ephemeris error, Atmospheric errors, Receiver measurement noise and UERE

**UNIT-III**

**GPS Augmentation systems:** Classification of Augmentations Systems, Relative advantages of SBAS and GBAS, Wide area augmentation system (WAAS) architecture, Local area augmentation system (LAAS) concept, GPS Aided GEO Augmented Navigation (GAGAN), European Geostationary Navigation Overlay Service (EGNOS) and MTSAT Satellite-based Augmentation System (MSAS). Differential GPS.

**UNIT-IV**

**Other GNSSs:** Architecture and features of Russian Global Navigation Satellite System (GLONASS), European Navigation System (Galileo), Chinese Global Navigation System (BieDou-2/COMPASS), GNSS Applications.

**UNIT-V**

**Regional Navigation Satellite Systems (RNSS):** Indian Regional Navigation Satellite System (IRNSS), Japan's Quasi-Zenith Satellite System (QZSS), Chinese Area Positioning System (CAPS).
**GPS Integration:** GPS/GIS, GPS/INS, GPS/Pseudolite, GPS/Cellular integrations.

***Suggested Readings:***

1. Rao G.S., "Global Navigation Satellite Systems – with Essentials of Satellite Communications", Tata McGraw Hill, 2010.
2. Sateesh Gopi, "Global Positioning System: Principles and Applications", TMH, 2005.
3. Elliot D. Kaplan, "Understanding GPS Principles and Applications", 2/e, Artech House, 2005.

4. Paul D Groves, "Principles of GNSS, Inertial, and Multi-Sensor Integrated Navigation Systems" Artech House Publishers, 2017
5. Basudeb Bhatta," Global Navigation Satellite Systems: Insights into GPS, GLONASS, Galileo, Compass", B.S. Publications, 2010

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 833 EC** | **System Verilog** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **DSD PC506EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- Understand about Verification and System Verilog as tool
- Gain knowledge about using the System Verilog Tool
- Learning the concept of OOP in verification
- Using the concept of OOP classes, connections and coding
- Learn verification techniques with an example

**Course Outcomes**

1. Understand the evolution and importance of System Verilog
2. Familiarize with the System Verilog tools
3. Apply the concepts of OOP in verification
4. Programming using the concepts of OOP classes, connections and coding.
5. Apply verification techniques

**UNIT-I**

System Verilog as a Verification Language, Main Benefits of Using System Verilog, Drawbacks of Using System Verilog, System Verilog Traps and Pitfalls, The Evolution of OOP and system Verilog, The Evolution of Functional Verification, The emergence of hardware verification languages, OOP and System Verilog

**UNIT-II**

**Teal Basics:** Main Components, Using Teal, simple test, Logging Output, Using Test Parameters, Accessing Memory, A memory example, Truss: A Standard Verification Framework: Overview, General Considerations, System Verilog considerations, An AHB example

**UNIT-III**

Overview, Sources of Complexity, Team dynamics, Creating Adaptable Code, Architectural Considerations to Maximize Adaptability. Designing with OOP: Overview, Keeping the Abstraction Level Consistent, using "Correct by Construction", The Value of Packages

**UNIT-IV**

**OOP classes:** overview, OOP Connections: Overview, How Tight a Connection, Types of Connections, Coding OOP: Overview, "If" Tests, Coding Tricks, Coding Idioms, Enumeration for Data, Integer for Code Interface.

**UNIT-V**

Overview, Theory of Operation, Verification environment, Verification IP, UART VIPs, Wishbone VIP, the verification dance, Running the UART Example, Configuration, VIP UART package, VIP UART configuration class, UART 16550 configuration class

***Suggested Readings:***

1. System Verilog for Design Stuart Sutherland, Simon Davidmann, Peter Flake, P. Moorby
2. Hardware Verification with SystemVerilog, An object-oriented Framework, Mike Mintz, Robert Ekendahl, Springer
3. J. Bhasker, "System Verilog Primer", B.S. Publication, 2013

4. Chris Spears, "SystemVerilog for Verification: A Guide to Learning the Testbench Language Features", 2006.
5. Ashok B Mehte, "SystemVerilog Assertions and Functional Coverage: Guide to Language, Methodology and Applications", Spinger, 2013

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 834 EC** | **Multirate Signal Processing** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **SATT PC304EC DSP PC503EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To introduce the fundamentals of Multirate signal processing and demonstrate the ability to solve problems in sample rate conversion, filter banks
- To Create efficient realizations for up sampling and down sampling of signals using the polyphase decomposition
- To develop the ability to design digital filter banks and half-band filters based on the techniques presented
- To develop the ability to design multilevel filter banks
- To Utilize MATLAB for signal analysis, digital filter design and wavelets

**Course Outcomes**

1. Able to solve problems in sampling rate conversion and filter banks
2. Design and implement perfect reconstruction filter bank systems
3. Able to implement multiphase and polyphase representation.
4. Analyse the various adaptive processing algorithms
5. Able to use wavelets in signal processing applications.

**UNIT-I**

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

**UNIT-II**

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

**Nyquist filters:** $L^{th}$-band filters, half band filters, Half-band High pass filter, Window Design of Half-Band Filter, Interpolation and decimation with Low Pass Half-Band Filters**,** Design of Linear-phase $L^{th}$ band FIR filters, Relation between Lth-Band filters and power complementary filters.

**UNIT-III**

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

**UNIT-IV**

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

**UNIT-V**

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

***Suggested Readings:***

1. J.G. Proakis. D.G. Manolakis. "Digital Signal Processing: Principles. Algorithms and Applications",3rd Edn. Prentice Hall India, 1999.
2. Vidyanathan PP, "Multi-rate Systems and Filter Banks," Pearson Education, 2008.
3. B. Widrow & S Stearns: Adaptive Signal Processing, PHI, 1985
4. Bruce W Suter, "Multi-rate and Wavelet Signal Processing." Volume 8, Academic Press, 1998.
5. K. P. Soman, K. I. Ramachandran, N. G. Resmi, PHI, Insight into wavelets from theory to practice

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 841 EC** | **Real Time Operating Systems** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **ES PC701EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- The functions performed by an Operating system
- To differentiate between real time systems and study the scheduling algorithms
- The concepts of process synchronization
- The elementary concepts of VxWorks
- The fundamental concepts of UNIX operating system

**Course Outcomes**

1. Classify various types of kernels and operating systems
2. Analyse various scheduling algorithms related to RTOS.
3. Summarize the Inter process communication tools.
4. Understand the elementary concepts of Vxworks
5. Enumerate the fundamental concepts of UNIX operating system

**UNIT – I**

Structures of Operating System (Monolithic, Microkernel, Layered, Exo-kernel and Hybrid kernel structures), Operating system objectives and functions, Virtual Computers, Interaction of OS and Hardware architecture, Evolution of operating systems, Batch, multi programming, Multitasking, Multiuser, parallel, distributed and real-time OS.

**UNIT – II**

**Hard versus Soft Real-Time System:** Jobs and Processors, release time, deadlines, and timing constraints, hard and soft timing constraints, hard real time systems, Uniprocessor Scheduling: Types of scheduling, scheduling algorithms: FCFS, SJF, Priority, Round Robin, UNIX Multi-level feedback queue scheduling, Thread scheduling, Multiprocessor scheduling concept, Real Time scheduling concept.

**UNIT – III**

**Concurrency:** Principles of Concurrency, Mutual Exclusion H/W Support, Software approaches, Semaphores and Mutex, Message passing, Monitors, Classical problems of Synchronization: Readers-Writers problem, Producer Consumer problem, Dining Philosopher problem. Deadlock: Principles of deadlock, Deadlock prevention, Deadlock Avoidance, Deadlock detection, An Integrated Deadlock Strategies.

**UNIT – IV**

**Elementary Concepts of VxWorks:** Multitasking, Task State Transition, Task Control – Task Creation and Activation, Task Stack, Task Names and IDs, Task Options, Task Information, Task Deletion and Deletion Safety. Memory Management – Virtual to Physical Address Mapping. Comparison of RTOS – VxWorks, µC/OS-II and RT Linux for Embedded Applications.

**UNIT-V**

**UNIX Kernel:** File System, Concepts of –Process, Concurrent Execution & Interrupts. Process Management – forks & execution. Basic level Programming with System calls, Shell programming and filters, UNIX Signals, POSIX Standards

***Suggested Readings:***

1. Andrew S. Tanenbaum, “Modern Operating Systems,” 4/e, Pearson Edition,2014.
2. Jane W.S. Liu, “Real Time Systems,” 1/e, Pearson Education, Asia, 2002.
3. Jean J Labrose,” Embedded Systems Building Blocks Complete and Ready-to-use Modules in C”, 2/e, CRC Press 1999.
4. Karim Yaghmour, Jon Masters, Gilad Ben-Yesset, Philippe Gerum”, Building Embedded Linux Systems, 2/e, O’ Reilly Media, 2008
5. Wind River Systems, “VxWorks Programmers Guide 5.5”, Wind River Systems Inc.2002

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 842 EC** | **Fuzzy Logic and Applications** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **DCCN PE672EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- The concepts of regular sets and Fuzzy sets
- To gain the knowledge of Fuzzy relations
- Different Fuzzification methods & Membership function
- Different Defuzzification methods
- Fuzzy Associative Memories, FAM system Architecture & its applications

**Course Outcomes**

1. To distinguish crisp sets & Fuzzy sets and perform operations on Fuzzy sets
2. Define Fuzzy relations & apply operations on different Fuzzy relations
3. To convert crisp sets to Fuzzy sets using different Fuzzification methods
4. To convert Fuzzy sets to Crisp sets using different Defuzzification methods
5. To understand Fuzzy Associative Memories & FAM system Architecture

**UNIT-I**

**Basics of Fuzzy sets:** Introduction to Fuzzy sets, Operation on Fuzzy sets, Properties of Fuzzy sets, Extensions of Fuzzy set concepts, Extension principle and its applications.

**UNIT-II**

**Fuzzy Relations:** Basics of fuzzy relations, Operations on fuzzy relations, Properties of Fuzzy relations, Fuzzy Equivalence & Fuzzy Tolerance relations, Various types of Binary fuzzy relations.

**UNIT-III**

**Membership Functions:** Features of the membership function, Fuzzification, Membership value assignments: Intuition, Inference, Rank ordering, Neural Networks.

**UNIT-IV**

**Defuzzification, Different Defuzzification methods:** Max-membership principle, Central method, weighted average method, Mean-max membership, Center of sums, Center of largest area, First (or last) of maxima.

**UNIT-V**

**Fuzzy Associative Memories:** FAMs as Mappings, Fuzzy Hebb FAMS, Bi-directional FAM theorem for Correlation-Minimum Encoding, Correlation-Product Encoding, Superimposing FAM rules, FAM system Architecture, Example of Invented pendulum, Basic structure and operation of Fuzzy logic control system, Applications of Fuzzy controllers.

***Suggested Readings:***

1. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, McGraw Hill, 1995.
2. C.T. Lin and C.S. George Lee, "Neural Fuzzy Systems", PHI, 1996.
3. Bant A KOSKO, "Neural Networks and Fuzzy Systems", PHI, 1994.
4. Altrock, C.V., "Fuzzy Logic and Neuro Fuzzy Applications explained", PHI, 1995.
5. John Harris, "Introduction to fuzzy logic applications", Springer, 2000.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 843 EC** | **Radar Systems** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **DC PC601EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- To understand RADAR system block diagram, applications and develop range equation.
- To study various parameters used to enhance range prediction such as receiver noise, noise temperature, integration of pulses etc.
- To understand the concept of CW radar and learn its variations, to study various types of displays in radar systems.
- To understand MTI radar and understand the limitations of MTI radar and non-coherent MTI radar.
- To understand radar tracking methods and study differences among them.
- To study and understand search radar and antennas.

**Course Outcomes**

1. Explain basics of RADAR system and will able to develop radar range equation. Illustrate the importance of various parameters in enhanced range estimation for accurate prediction
2. Illustrate various types of radars such as CW radar and their variations and displays in radar
3. Explain types of MTI radar and non-coherent MTI radar
4. Illustrate on radar tracking methods and differences among them
5. Explain search radars and various antennas used in radars

**UNIT-I**

**Radar Systems:** Description of basic radar system and its elements, Radar equation, Block diagram and operation of a radar, Radar frequencies, Application of Radar, Prediction of range performance, Minimum detectable signal, Receiver noise figure, Effective noise temperature, Signal to noise ratio, False alarm time and probability of false alarm, Integration of radar pulses, Radar cross-section of target, Pulse-repetition frequency and range ambiguities, System losses.

**UNIT-II**

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

**UNIT-III**

**MTI and Pulse Doppler Radar**: MTI radar, Delay line canceller, Multiple and staggered prf, Blind speeds, Limitations to MTI performance, MTI using range gated Doppler filters, pulse Doppler radar, Non-coherent radar.

**UNIT-IV**

**Tracking Radar:** Sequential lobbing, Conical scan, Mono-pulse-amplitude comparison and phase comparison methods, Tracking in range and in Doppler, Acquisition, comparison of trackers.

**UNIT-V**

**Search Radar:** Range equation, search scans, Effect of surface reflection, Line of Sight (LOS), propagation effects, Environmental noise. Radar Antennas: Antenna parameters- Parabolic reflector antennas, Cassegrain antenna, Cosecant - squared Antenna pattern.

***Suggested Readings:***

1. Skolnik, Merrill I, Introduction to Radar Systems, 3/e, MGH, 2002.
2. Barton. David K, Modern Radar System Analysis, 1/e, Aretech House, 2004.
3. Peebles PZ, 'Radar Principles', John – Willey, 2004.
4. Paul A Lynn, "Radar Systems" Springer, 1987
5. Harold Roy Reamer, "Radar Systems Principles", Springer, 1997

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PE 844 EC** | **Design of Fault Tolerant Systems** | | | | | | **Elective** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **STLD PC303EC** | **3** | **-** | **-** | **-** | **30** | **70** | **3** |

**Course Objectives**

- Gain the basic concepts and metrics of reliable systems.
- To be able to comprehend the methods involved in testing of circuits.
- Appreciating the techniques involved in developing reliable and fault tolerant modules using redundancy.
- Gain insight into practical applications of reliable systems.
- Study testability, built–in-test & self-test concepts.

**Course Outcomes**

1. To understand the basic concepts and metrics of reliable systems.
2. To understand the methods involved in testing of circuits.
3. Study the techniques involved in developing reliable and fault tolerant modules using redundancy.
4. Study practical applications of reliable systems.
5. To understand testability, built–in-test & self-test concepts.

**UNIT-I**

Failures and faults, Reliability and failure rate, Relation between reliability & mean time between failure, Maintainability & Availability, reliability of series and parallel systems. Modelling of faults. Test generation for combinational logic Circuits: conventional methods-path sensitization & Boolean difference. Random testing- transition count testing and signature analysis.

**UNIT-II**

Basic concepts, static, (NMR and use of error correcting codes), dynamic, hybrid and self-purging redundancy, Sift-out Modular Redundancy (SMR), triple modular redundancy, SMR reconfiguration.3

**UNIT-III**

Time redundancy, software redundancy, fail-soft operation, examples of practical fault tolerant systems, introduction to fault tolerant design of VLSI chips.

**UNIT-IV**

Design of totally self-checking checkers, checkers using m-out of a codes, Berger codes and low cost residue code, self-checking sequential machines, partially self-checking circuits. Fail safe Design: Strongly fault secure circuits, fail-safe design of sequential circuits using partition theory and Berger codes, totally self-checking PLA design.

**UNIT-V**

Basic concepts of testability, controllability and observability. The Reed-Muller expansion technique, level OR-AND-OR design, use of control and syndrome-testing design.

Built-in-test, built-in-test of VLSI chips, design for autonomous self-test, design in testability into logic boards.

***Suggested Readings:***

1. Parag K. Lala, “Fault Tolerant & Fault Testable Hardware Design”*,* PHI, 1985
2. Parag K. Lala, “Digital systems Design using PLD’s”*,* PHI 1990.
3. N.N. Biswas, “Logic Design Theory”, PHI 1990.

4. Konad Chakraborthy & Pinaki Mazumdar, Fault tolerance and Reliability Techniques for high – density random – access memories Reason, 2002.
5. Rolf Isermann "Fault Diagnosis Applications", Springer 2011.

| Course Code | Course Title | | | | | | Core / Elective |
|---|---|---|---|---|---|---|---|
| **PW 961 EC** | **Project Work - II** | | | | | | **Core** |
| Prerequisite | Contact Hours per Week | | | | CIE | SEE | Credits |
| | L | T | D | P | | | |
| **-** | **-** | **-** | **-** | **16** | **50** | **100** | **8** |

**Course Objectives**

- To enhance practical and professional skills.
- To familiarize tools and techniques of systematic literature survey and documentation
- To expose the students to industry practices and team work.
- To encourage students to work with innovative and entrepreneurial ideas

**Course Outcomes**

1. Demonstrate the ability to synthesize and apply the knowledge and skills acquired in the academic program to the real-world problems.
2. Evaluate different solutions based on economic and technical feasibility
3. Effectively plan a project and confidently perform all aspects of project management
4. Demonstrate effective written and oral communication skills

The aim of Project work –II is to implement and evaluate the proposal made as part of Project Work - I. Students can also be encouraged to do full time internship as part of project work-II based on the common guidelines for all the departments. The students placed in internships need to write the new proposal in consultation with industry coordinator and project guide within two weeks from the commencement of instruction.

The department will appoint a project coordinator who will coordinate the following:

1. Re-grouping of students - deletion of internship candidates from groups made as part of project Work-I
2. Re-Allotment of internship students to project guides
3. Project monitoring at regular intervals

All re-grouping/re-allotment has to be completed by the 1st week of VIII semester so that students get sufficient time for completion of the project.

All projects (internship and departmental) will be monitored at least twice in a semester through student presentation for the award of sessional marks. Sessional marks are awarded by a monitoring committee comprising of faculty members as well as by the supervisor. The first review of projects for25 marks can be conducted after completion of five weeks. The second review for another 25 marks can be conducted after 12 weeks of instruction.

Common norms will be established for the final documentation of the project report by the respective departments. The students are required to submit draft copies of their project report within one week after completion of instruction.

**Note:** Three periods of contact load will be assigned to each project guide.