# FACULTY OF ENGINEERING

## Scheme of Instruction & Examination (AICTE Model Curriculum)

## and

## Syllabi

## B.E. VII and VIII Semesters of

## Four Year Degree Programme in

## ELECTRONICS & COMMUNICATION ENGINEERING

(With effect from the Academic Year 2023 - 2024)
(As approved in the Faculty Meeting held on 14/08/2023)

Issued by

**Dean, Faculty of Engineering**
**Osmania University, Hyderabad – 500 007**
**2023**

# 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 Course** | | | | | | | | | | |
| 1 | PC416EC | Microwave Theory and Techniques | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 2 | PE5XXEC | Professional Elective-III | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 3 | PE5XXEC | Professional Elective-IV | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 4 | OE6XXYY | Open Elective-II | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| **Practical/Laboratory Course** | | | | | | | | | | |
| 5 | PC460EC | Embedded systems and IoT applications lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 6 | PC461EC | Microwave Lab | - | - | 2 | 2 | 25 | 50 | 3 | 1 |
| 7 | PW702EC | Summer Internship | - | - | - | - | 50 | - | - | 2 |
| 8 | PW703EC | Major Project Phase-I | - | - | 2 | 2 | 50 | - | 3 | 2 |
| **Total** | | | **12** | **-** | **6** | **18** | **270** | **380** | **21** | **18** |

**PC:** Professional Core **PE:** Professional Elective **OE:** Open Elective
**PW**: Project Work

**L:** Lecture **T:** Tutorial **P:** Practical **D:** Drawing
**CIE:** Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

**EC:** Electronics and Communication Engineering

**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.

| **Professional Elective-III** | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| 1 | PE509EC | Satellite Communication |
| 2 | PE510EC | Embedded System Design |
| 3 | PE511EC | Fundamentals of Artificial Intelligence and Machine Learning |
| 4 | PE512EC | Fuzzy Logic for Neural Network Applications |

| **Professional Elective-IV** | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| 1. | PE513EC | IC Verification using SystemVerilog |
| 2 | PE514EC | Optical Fiber Communication |
| 3 | PE515EC | Cellular and Mobile Communications |
| 4 | PE516EC | Electromagnetic Interference and Compatibility |
| 5 | PE517EC | Digital Signal Processors and Architecture |

| **Open Elective – II** | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| 1 | OE621AE | Automotive Maintenance * |
| 2 | OE811CE | Green Building Technologies * |
| 3 | OE802CS | Data Science Using R Programming * |
| 4 | OE603EE | Non-Conventional Energy Sources * |
| 5 | OE604EE | Transducers and Sensors * |
| 6 | OE 816 IT | Cyber Security * |
| 7 | OE621ME | Industrial Robotics * |
| 8 | OE603EC | Fundamentals of IoT* |
| 9 | OE604EC | Fundamentals of Neural Networks * |

***NOTE:** These subjects will not be offered to students of parent department

# MICROWAVE THEORY AND TECHNIQUES

| **PC416EC** | |
|---|---|
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: EMTL (PC405EC), AWP (PC412EC)* | |

**Course Objectives:**

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| 1. To understand the concept of Microwave signal propagation |
| 2. To comprehend Microwave signal generation and amplification techniques. |
| 3. To study the parameters of various components used in Microwave design. |

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

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|---|
| 1. Analyze 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 analyze 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. Analyze the principle, operation and characteristics of different microwave solid state devices. |

| **UNIT – I** |
|---|
| **Guided Waves:** Electromagnetic waves between parallel plates, Propagation of Transverse Electric(TE), Transverse Magnetic (TM) and Transverse Electro Magnetic (TEM) waves between parallel planes. Velocity of propagation, attenuation in parallel plane guides, wave impedance. |
| **UNIT – II** |
| **Waveguides:** Transverse Electric (TE) and Transverse Magnetic (TM) waves in rectangular and circular waveguides, Wave Impedance, Characteristic Wave Impedance,Attenuation and Quality factor 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 and their applications. |

**Suggested Reading:**


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|---|---|
| 1. | E. C. Jordan & Keith G. Balmain, 'Electromagnetic Waves and Radiating Systems', 2nd edition, Pearson Education, 2006. |
| 2. | Samuel Y. Liao, 'Microwave Devices and Circuits', 3rd edition, Pearson Education, 2003. |
| 3. | R. E. Collins, "Foundations for Microwave Engineering", 2nd ediiton, Wiley India Pvt. Ltd., 2012. |
| 4. | Annapurna Das and Sisir K. Das 'Microwave Engineering ', McGraw Hill Education, Third edition, 2014. |
| 5. | Skolnik, Krauss, Reich, 'Microwave principles', East West Press, 1976. |
| 6. | https://onlinecourses.nptel.ac.in/noc20_ee91/preview |

# PROFESSIONAL ELECTIVE-III

# SATELLITE COMMUNICATION

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|---|---|
| **PE509EC** | |
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| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: Digital Communication (PC413EC)* | |

**Course Objectives:**

1. To study basic principles and various effects on satellite communications.
2. To familiarize about the various components in satellite and satellite TV systems.
3. To provide knowledge on the design of satellite communication link and study various access techniques as well as real time applications of satellite communications.

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

1. Illustrate the basic orbital mechanics of satellite operations.
2. Illustrate the orbital perturbations, launch vehicles and orbital effects on satellite communication systems.
3. Understand various components in satellite systems.
4. Analyse and design satellite space communication link.
5. Understand the operating principle of Direct Broadcast Satellite TV, Radio and satellite mobile services.

**UNIT – I**

**Introduction:** A Brief History of Satellite Communications, Overview and Indian Scenario of Satellite Communications. Orbital Mechanics: Kepler's Laws of Planetary Motion, Satellite orbit, Locating the Earth-Orbiting Satellites, Orbital Elements: Apogee and Perigee Heights, Geostationary Satellite Orbit (GSO), Low earth Orbit (LEO) and Elliptical Orbit. Look Angle Determination.

**UNIT – II**

**Orbital Perturbations, Launchers and Effects:** Orbit Perturbations-Longitudinal and Inclination Changes, Orbit Determination. Launches and types of Launch Vehicles: Expendable Launch Vehicle (ELV), Placing Satellites into GSO. Orbital Effects on Communication Systems: Doppler Shift, Range Variations, Solar Eclipse and Sun Transit Outage.

**UNIT – III**

**Satellite System:** Satellite Subsystems-Power Supply, Attitude and Orbit Control System (AOCS), Telemetry, Tracking, Command and Monitoring (TTC&M), Communication Subsystems-Communication Systems and Transponders Satellite Antennas: Basic Types and Relationships. Equipment for space qualification, redundancy, reliability analysis using bath tub curve

**UNIT – IV**

**The Space Link:** Effective Isotropic Radiated Power, Transmission Losses, Link Power Budget Equation, System Noise, Carrier-to-Noise Ratio, Uplink- Saturation flux density, Input backoff, Downlink - Output back-off, Effects of Rain - Uplink and 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**

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| **Direct Broadcast Satellite TV, Radio and Satellite Services:** 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, Satellite Mobile Communication, VSATs, Radarsat, Introduction to GNSS, Satellite phones. |

**Suggested Reading:**


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|---|---|
| 1. | Timothy Pratt, Charles W. Bostian, and Jeremy E. Allnutt, "Satellite Communications",Wiley-India, 2nd Edition, 2002. |
| 2. | Dennis Roddy, "Satellite Communications", McGraw-Hill Education, 4th Edition, 2006. |
| 3. | Wilbur L. Pritchard, Henri G. Suyderhoud, and Robert A. Nelson, "Satellite Communication Systems Engineering", Pearson Education India, 2nd Edition, 2003. |
| 4. | Tri T. Ha, "Digital Satellite Communication", McGraw-Hill Education, 2nd Edition,2017. |
| 5. | N. Agarwal, "Design of Geosynchronous Space Craft", Prentice Hall, 1986. |

# EMBEDDED SYSTEM DESIGN

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| **PE510EC** | |
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| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: Microprocessor & Microcontroller (PC409EC)* | |

**Course Objectives:**

1. Study hardware and software components and design process of an embedded system
2. Introduce the RISC features of ARM core and study its architecture and instruction set.
3. Familiarize with the different IDEs for firmware development for different family of processors/controllers and study about different tools and techniques for embedded hardware debugging.

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

1. Classify different types of embedded systems with hardware and software components and discuss the challenges in design
2. Enumerate the instruction set of ARM Processor by studying the architecture of ARMcore
3. Acquire knowledge on the serial and parallel communication protocols.
4. Apply modern engineering tools necessary for integrating software and hardware components in embedded system design
5. Summarize different tools and techniques for embedded hardware debugging.

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

**UNIT – III**

**Serial Bus Communication protocols**: Inter Integrated Circuit**(**I2C), Controller Area Network(CAN), Universal Serial Bus (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

**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**

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| **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, Case Study: Embedded Systems design for automatic vending machines and digital camera. |

**Suggested Reading:**


| | |
|---|---|
| 1. | Raj Kamal, *"Embedded Systems-Architecture, Programming and Design," 3*/e, TMH 2017 |
| 2. | Andrew N. Sloss, Dominic Symes, Chris Wright," ARM System Developer's Guide Designing and Optimizing System Software", Elsevier 2004 |
| 3. | Shibu K V, "Introduction to Embedded systems", 2/e, McGraw Hill Education 2017 |
| 4. | David E. Simon, *"An Embedded software primer,"* Pearson Education 1999 |
| 5. | Steve Furber, *"ARM System on chip Architecture,"* 2/e, Pearson Education 2000 |
| 6. | https://archive.nptel.ac.in/courses/108/102/108102169/# |

# FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

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|---|---|
| **PE511EC** | |
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| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: Probability Theory and Stochastic Process (ES304EC)* | |

**Course Objectives:**

1. Study the foundations and Applications of AI.
2. Familiarize with Probabilistic Reasoning and other search algorithms
3. To design Bayesian Networks and Markov model and aspects of Reinforcement learning.

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

1. Identify problems that are amenable to solution using State space search algorithms.
2. Understand and analyze working of an AI technique using Heuristic search.
3. Understand and design the Bayesian Networks.
4. Understand and apply the concepts of Markov Decision process.
5. Apply of AI concepts to Reinforcement Learning.

**UNIT – I**

**Overview and Search Techniques:** Introduction to AI, Problem Solving, State space search, Blind search: Depth first search, Breadth first search, Informed search: Heuristic function, Hill climbing search, Best first search, A* & AO* Search, Constraint satisfaction problem; Game tree, Evaluation function, Mini-Max search, Alpha-beta pruning, Games of chance.

**UNIT – II**

**Knowledge Representation (KR):** Introduction to KR, Knowledge agent, Predicate logic, Inference rule & theorem proving forward chaining, backward chaining, resolution; Propositional knowledge, Boolean circuit agents; Rule Based Systems, Forward reasoning: Conflict resolution, backward reasoning: Structured KR: Semantic Net - slots, inheritance,Conceptual Dependency.

**UNIT – III**

**Handling uncertainty and Learning**: Source of uncertainty, Probabilistic inference, Bayes's theorem, Limitation of naïve Bayesian system, Bayesian Belief Network (BBN); Machine learning, Basic principal, Utility of ML, Different Paradigms of Machine Learning, Challenges in ML, Hypothesis Evaluation, Applications of ML.

**UNIT – IV**

**Learning and Classifiers:** Linear Regression, Multiple linear Regression, Decision Trees: Classification Trees, Regression Trees, Measures of Impurity for Evaluating Splits in Decision Trees: Information Gain, Gain Ratio and Gini Index, Clustering: K-Means Clustering, Hierarchical Clustering, Density-based Clustering.

**UNIT – V**

**Dimensionally Reduction:** Principal Component Analysis- Eigen values, Eigen vectors, Orthogonality, Linear Discriminate Analysis, Support vector Machines (SVM) –Hyperplanes, Linearly separable data, Optimal Separating Hyperplane, Kernel trick,Kernel functions.

**Case Study:** Predicting price of pre-owned cars/Classifying personal income.

**Suggested Reading:**


| | |
|---|---|
| 1. | Stuart Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", 4th Edition, Pearson 2022 |
| 2. | Elaine Rich and Kevin Knight, "Artificial Intelligence", 3rd Edition, Tata McGraw Hill.2017 |
| 3. | Shai Shalev-Shwartz and Shai Ben-David, "Understanding Machine Learning: From Theory to Algorithms", 1st Edition, Cambridge University Press.2014 |
| 4. | Ethem Alpaydın, "Introduction to Machine learning", 2nd Edition, MIT press 2010 |
| 5. | M.Gopal, "Applied Machine Learning", 2nd Edition, McGraw Hill Education (India) 2021 |
| 6 | https://nptel.ac.in/courses/106105077 |

# FUZZY LOGIC FOR NEURAL NETWORK APPLICATIONS

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|---|---|
| **PE512EC** | |
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| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite:* ***Digital Electronics (ES303EC)*** | |

**Course Objectives:**

1. To familiarize with the concepts of regular sets, Fuzzy sets & Fuzzy relations
2. To comprehend Membership functions, Different Fuzzification & Defuzzification methods
3. To study Fuzzy Associative Memories, FAM system Architecture and its applications

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

1. Distinguish Crisp sets & Fuzzy sets and perform operations on Fuzzy sets
2. Define Fuzzy relations & apply operations on different Fuzzy relations
3. Convert crisp sets to Fuzzy sets using different Fuzzification methods
4. Convert Fuzzy sets to Crisp sets using different Defuzzification methods
5. 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: Other kind of Fuzzy sets, Further operations on Fuzzy sets, Extension principle and its applications: Operations of Type-2 Fuzzy sets, Consistency Degree of Two Fuzzy sets.

**UNIT – II**

Fuzzy Relations: Basics of Fuzzy relations, Fuzzy relation representation, Graph representation of binary Fuzzy relation: Bipartite graph, Simple Fuzzy graph, Operations on Fuzzy relations, Properties of Fuzzy relations, Various types of Binary fuzzy relations: Similarity relations, Resemblance relations & Fuzzy Partial Ordering.

**UNIT – III**

Properties of Membership functions, Fuzzification: Membership Functions, Features of the Membership function, Fuzzification, Comparisons of Fuzzy sets and Crisp or Fuzzy readings, Different Fuzzification methods: Intuition, Inference, Rank ordering, Neural Networks, Genetic Algorithms, Inductive Reasoning.

**UNIT – IV**

**Defuzzification:** Defuzzification to scalars, Different Defuzzification methods: Max membership principle (Height method), Centroid method (Center of area or Center of gravity), Weighted average method, Mean max membership (Middle-of-maxima), 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

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| system Architecture, Example of Invented pendulum, Fuzzy logic control (FLC) system: Basic structure and operation of FLC system, Applications of Fuzzy controllers. |

**Suggested Reading:**


| | |
|---|---|
| 1. | Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, John Wiley & Sons, Third Edition 2010 |
| 2. | C.T. Lin and C.S.George Lee, "Neural Fuzzy Systems", PH PTR, 2006. |
| 3. | Bant A KOSKO, "Neural Networks and Fuzzy Systems", PH PTR, 2012. |
| 4. | Altrock, C.V., "Fuzzy Logic and Neuro Fuzzy Applications explained", PH PTR, 2000. |
| 5. | George J.Klir, Bo Yuan, “Fuzzy Sets & Fuzzy Logic”, Prentice Hall PTR, 2010. |
| 6 | https://nptel.ac.in/courses/106105077 |

# PROFESSIONAL ELECTIVE-IV

# IC VERIFICATION USING SYSTEM VERILOG

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|---|---|
| **PE513EC** | |
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| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: VLSI Design (PC414EC)* | |

**Course Objectives:**

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| 1. Understand the Front-end design and verification techniques |
| 2. Acquire knowledge of SystemVerilog language. |
| 3. Learn about randomization in SystemVerilog, its blocks and functions |

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

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|---|
| 1. Understand about basic OOP, its classes and objects |
| 2. Learn about different data types, arrays, queues, Structures and Unions. Understand tasks,functions, void functions and statements |
| 3. Learn different verification processes and data types. |
| 4. Understand about Inter Process Communication, packages, compiler directives, parameters |
| 5. Understand Randomization in SystemVerilog |

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| **UNIT – I** |
| Verification Guidelines: Introduction, Verification Process, Plan, Methodology Manual, Basic Testbench Functionality, Directed Testing, Methodology Basics, Constrained-Random Stimulus, Functional Coverage, Testbench Components, Layered Testbench. |
| **UNIT – II** |
| Data Types, Arrays: dynamic array, associative array, array manipulation methods, locator methods, ordering methods, reduction methods, iterator index querying. queues. structures and unions. If statement, loops: while loop, do while loop, forever loop, for loop, foreach loop, break and continue, functions and tasks, processes: fork join, fork join_any, fork join_none. |
| **UNIT – III** |
| Classes, accessing unallocated memory, class assignment, an array of objects, static properties and methods in classes, this keyword in classes, shallow copy, deep copy, inheritance, super keyword in classes, virtual keyword in classes, abstract class, polymorphism, scope resolution operator, extern method, parameterized classes, data encapsulation and hiding, local access qualifier, protected access qualifier, constant class properties, typedef class**.** |
| **UNIT – IV** |
| Randomization, if-else in constraints, implication operator in constraint, foreach loop in constraint, dist keyword in constraints, inheritance in constraint, function in constraint, disable randomization, static constraints, unique constraint, bidirectional constraint, solve before in constraint, inline constraints, soft constraint, randomization methods: pre_randomize and post_randomize, randcase. |
| **UNIT – V** |
| Inter Process Communication: events, nonblocking events, wait_order in events, merging events, passing an event, semaphores, mailbox, interface: modport, clocking block, virtual interface. program block, casting, packages, compiler directives, parameters, final block, named blocks, statement labels. |

**Suggested Reading:**


| | |
|---|---|
| 1. | System Verilog for Verification: A Guide to Learning the Testbench Language Features, Chris Spear, Springer 2006. |
| 2. | A System Verilog Primer J. Bhaskar, Publisher: ISBN: 9788178002804, BS Publications,2022. |
| 3. | Writing Testbenches Using SystemVerilog, Janick Bergeron, Springer, 2006. |
| 4. | SystemVerilog for Design: A Guide to Using SystemVerilog for Hardware Design and Modeling, 2nd Edition, Stuart Sutherland, Simon Davidman and Peter Flake, Springer 2004 |
| 5. | Writing Testbenches: Functional Verification of HDL Models, Second edition, Janick Bergeron, Kluwer Academic Publishers, 2003. |
| 6 | https://archive.nptel.ac.in/courses/106/103/106103116/ |

# OPTICAL FIBER COMMUNICATION

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|---|---|
| **PE514EC** | |
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| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: Digital Communication (PC413EC)* | |

**Course Objectives:**

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| 1. Understand operating principles of light sources and detectors used in optical transmitters and Receivers. |
| 2. Design an optical link in view of loss and dispersion. |
| **3.** Understand various configurations, Losses and dispersion through optical fiber. |

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

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|---|
| 1. Analyze the losses inserted in an optical fiber |
| 2. Study of material used and underlying principles of optical signal generation |
| 3. Design of optical detection systems |
| 4. Design an optical link in view of loss and dispersion. |
| 5. Study of modes of optical communication through optical waveguides |

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| **UNIT – I** |
| **Optical fibers:** Evolution of fiber optic system, Elements of Optical Fiber Transmission link, Ray Optics, Optical Fiber Modes and Configurations, Mode theory of Circular Waveguides, Overview Low frequency data transportation of Modes and Key concepts, Linearly Polarized Modes, Single Mode Fibers and Graded Index fiber |
| **UNIT – II** |
| **Attenuation and Dispersion:** Attenuation - Absorption losses, Scattering losses, Bending Losses, Core and Cladding losses, Signal Distortion in Optical Waveguides-Information Capacity determination, Group Delay, Material Dispersion, Waveguide Dispersion, Signal distortion in SM fibers-Polarization Mode dispersion, Intermodal dispersion, Pulse Broadening in Guided Index fibers, Mode Coupling |
| **UNIT – III** |
| **Optical Sources, Amplifiers and Coupling:**Direct and indirect Band gap materials, LED structures, Light source materials, Quantum efficiency, LED power, Modulation of LED, laser Diodes, Modes and Threshold condition. Rate equations, External Quantum efficiency, Resonant frequencies, Laser Diodes, Temperature effects, Introduction to Quantum laser, Fiber amplifiers, Power Launching and coupling, Lensing schemes, Fiber-to-Fiber joints, Fiber splicing. |
| **UNIT – IV** |
| **Photo detectors & Receivers:**PIN and APD diodes, Photo detector noise, SNR, Detector Response time, Avalanche Multiplication Noise, Comparison of Photo detectors, Fundamental Receiver Operation, preamplifiers, Error Sources, Receiver Configuration, Probability of Error, Quantum Limit. |
| **UNIT – V** |
| **Digital Links and Optical Networks:** Point-to-Point link system considerations -Link Power budget, Rise - time budget, Noise Effects on System Performance, Operational Principles of WDM and |

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| Applications. Erbium-doped Amplifiers Introductory concepts of SONET/SDH Network Multiple signal interface in fibers, Bandwidth utilization, Interface with nano-electronic devices. |

**Suggested Reading:**


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|---|---|
| 1. | Gourd Keiser, "Optical Fiber Communication," 4/e, TMH, 2000. |
| 2. | J.Senior, "Optical Communication, Principles and Practice," PHI, 1994. |
| 3. | J.Gower, "Optical Communication System," PHI, 2001. |
| 4. | Binh, "Digital Optical Communications," First Indian Reprint 2013, (Taylor & Francis), Yesdee Publications. |
| 5. | MMK.Liu, Principles and Applications of Optical Communications, TMH, 2010 |
| 6 | https://onlinecourses.nptel.ac.in/noc23_ee80/preview |

# CELLULAR AND MOBILE COMMUNICATIONS

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|---|---|
| **PE515EC** | |
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| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: Digital communication(PC413EC)* | |

**Course Objectives:**

1. To understand the concept and implementation of frequency reuse and Handoff techniques and to analyse interference and capacity enhancement.
2. To appreciate the factors influencing outdoor and indoor propagation systems
3. To understand the concepts in various Mobile Technologies.

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

1. Understand the method of selection and reuse of a set of frequency channels, Base station requirement.
2. Appreciate and understand the methods of electromagnetic wave propagation in cellular communication.
3. Identify different a methods of mobile access technologies and which of them suitable for mobile cellular solutions.
4. Explain features, authentication, operational details of GSM and CDMA mobile cellular system.
5. Understand the development and limitation of the preliminary and advanced generation of mobile systems and the present trends.

**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, 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 Reading:**


| | |
|---|---|
| 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 |
| 5. | Nishith D. Tripathi and Jeffrey H. Reed,"Cellular Communications A Comprehensive and Practical Guide" Wiley 2014. |
| 6 | https://archive.nptel.ac.in/courses/108/106/106106167/# |

# ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY

| **PE516EC** | |
|---|---|
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: EMTL(PC405EC), AWP(PC412EC)* | |

**Course Objectives:**

| |
|---|
| 1. To learn the various sources of Electromagnetic Interference. |
| 2. To familiarize the fundamentals those are essential for product design with EMC compliance. |
| 3. To understand the various EMC pre compliance measurement. |

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

| |
|---|
| 1. Analyze the different EM coupling principles and its impact on performance of electronic system. |
| 2. Understand the concept of EMI / EMC related to product design. |
| 3. Have broad knowledge of various aspect of EMC and its standards. |
| 4.Ensure that a designed system conforms itself to certain standard through a thorough understanding of various standards in different countries. |
| 5.Have broad knowledge of various EM radiation measurement techniques. |

| **UNIT – I** |
|---|
| **Introduction to EMI and EMC**- EM environment, Historical Notes, Problems of EMI, Frequency Conservation, Assignment & spectrum, practical experiences, Occurrence of EMI, Concepts of EMI/EMC-definitions, Sources of noise, Natural and Nuclear Sources of EMI, Conducted and Radiated Emissions and Susceptibility. Introduction – EMI Testing and Compliance Tests, ESD, EMP. |
| **UNIT – II** |
| **Conducted and radiated emission** -power supply line filters-common mode and differential mode current-common mode choke- switched mode power supplies. Modeling of filter for suppression of EMI in the design, choice of various electronic components, Pulse Interference Immunity, LISN. |
| **UNIT – III** |
| **Shielding techniques**- shielding effectiveness-shield behavior for electric and magnetic field, **Grounding techniques-** signal ground-single point and multi point grounding-system ground- common impedance coupling -common mode choke-Digital circuit power distribution and grounding. |
| **UNIT – IV** |
| **EMI Measurements:** Introduction to various instruments used in the measurements and their characteristics, Radiated Interference Measurements, Conducted Interference Measurements, Pitfalls in EMI Measurements, Measurements of pulsed EMI. |
| **UNIT – V** |
| **Contact protection**- arc and glow discharge-contact protection network for inductive loads-C, RC, RCD protection circuit- inductive kick back. RF and transient immunity-transient protection network-RFI mitigation filter-power line disturbance- ESD- human body model- ESD protection in system design. |

**Suggested Reading:**


| | |
|---|---|
| 1. | H. W. Ott, Electromagnetic Compatibility Engineering, 2nd edition, John Wiley & Sons, 2011, ISBN: 9781118210659. |
| 2. | C. R. Paul, Introduction to Electromagnetic Compatibility, 2nd edition, Wiley India, 2010, ISBN: 9788126528752. |
| 3. | K. L. Kaiser, Electromagnetic Compatibility Handbook, 1st edition, CRC Press, 2005. ISBN: 9780849320873. |
| 4. | Kodali, V.P., "Engineering EMC- Principles, Measurements, Technologies and Computer Models", 2nd Ed., IEEE Press, NY, 2000. |
| 5. | IMPACT, EMI/EMC for Engineering Colleges, RSTE , 1997. |
| 6 | https://archive.nptel.ac.in/courses/108/106/108106138/ |

# DIGITAL SIGNAL PROCESSORS AND ARCHITECTURE

| | |
|---|---|
| **PE517EC** | |
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: Digital Signal Proccessing(PC408EC)* | |

**Course Objectives:**

| |
|---|
| 1. The architectures of digital signal processors and design aspects of digital signal processing algorithms. |
| 2. The memory and external input/output peripheral interface with programmable DSP processor. |
| 3. The realization of digital filters and fast fourier transform algorithms of the signal spectrum on host DSP processor. |

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

| |
|---|
| 1. Explain the floating point and fixed-point arithmetic number representation systems for processing signal in digital signal processor. |
| 2. Compare the architectural features of general-purpose processors and digital signal processors. |
| 3. Use the instruction sets of TMS320C54XX processor for implementing assembly language programs. |
| 4.Make use of memory and input/output peripherals to interface the programmable DSP devices for increasing time response of a system |
| 5. Analyze IIR and FIR Filters on programmable digital signal processors using Q15 Format. |

| |
|---|
| **UNIT – I** |
| **Introduction to digital signal processing:** Digital signal-processing system, discrete Fourier Transform (DFT) and Fast Fourier transform (FFT), differences between DSP and other micro processor architectures; **Number formats**: Fixed point, floating point and block floating point formats, IEEE-754 floating point, dynamic range and precision, relation between data word size and instruction word size; Sources of error in DSP implementations: A/D conversion errors, DSP computational errors, D/A conversion errors, Q-notation. |
| **UNIT – II** |
| **Architecture of Programmable DSPs:**Multiplier and multiplier accumulator, modified bus structures and memory access in PDSPs, multiple access memory, multiport memory, SIMD, VLIW architectures, pipelining, special addressing modes in PDSPs, on-chip peripherals. |
| **UNIT – III** |
| **Overview of TMS320c54xx processor**: Architecture of TMS320C54XX DSPs, addressing modes, memory space of TMS320C54XX processors. Program control, instruction set and programming, on-chip peripherals, interrupts of TMS320C54XX processors, pipeline operation. |
| **UNIT – IV** |

| |
|---|
| **Interfacing memory and i/o peripherals to PDSPs** :Memory space organization, external bus interfacing signals, memory interface, parallel I/O interface, programmed I/O, interrupts and I/O, direct memory access (DMA) |
| **UNIT – V** |
| **Implementations of basic DSP algorithms** The Q-notation, convolution, correlation, FIR filters, IIR filters, interpolation filters, decimation filters, an FFT algorithm for DFT filters computation of the signal spectrum. |

**Suggested Reading:**


| | |
|---|---|
| 1. | Avatar Singh and S. Srinivasan, Digital Signal Processing Thomson Publications, 1st Edition, 2004. |
| 2. | B. Ventakaramani, M. Bhaskar, Digital Signal Processors Architecture Programming and Applications, Tata McGraw- Hill, 1st Edition, 2006. |
| 3. | K Padmanabhan, R. Vijayarajeswaran, Ananthi. S, A Practical Approach to Digital Signal Processing, New Age International, 1st Edition, 2006. |
| 4. | Ifeachor E. C., Jervis B. W, Digital Signal Processing: A practical approach‖, Pearson Education, PHI/, 2nd Edition, 2002 |
| 5. | Peter Pirsch, Architectures for Digital Signal Processing, John Wiley, 1st Edition, 2007. |
| 6 | https://archive.nptel.ac.in/courses/117/105/117105145/# |

# EMBEDDED SYSTEMS AND IOT APPLICATIONS LAB

| | |
|---|---|
| **PC460EC** | |
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 25 marks* | *SEE:- 50 Marks* |
| *Credits: 1* | |
| *Prerequisites: Microprocessor & Microcontroller Lab(PC455EC)* | |

**Course Objectives:**

| |
|---|
| 1. Familiarize with the usage of IDE tools and execution of programs using ARM processor |
| 2. Understand the usage of various devices like LCD, Temperature sensor, Buzzer, Stepper Motor by interfacing them to LPC2148. |
| 3. Study the designing and implementation of IoT applications using Arduino/RPi |

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

| |
|---|
| 1. Understand the usage of IDE tools |
| 2. Develop interfacing applications like display devices and input devices using ARM Processor |
| 3. Develop program using ARM processor to read the sensor values and display them |
| 4. Develop the IoT applications using Arduino/Raspberry Pi |
| 5. Utilize the thingspeak cloud to display the sensor values |

| **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 |
| 4. Program to interface stepper motor Stepper motor and rotate in clockwise and anticlock wise direction |
| 5. Program to interface a Temperature sensor LM35 and read the values and display it |
| **6.** Program to demonstrate serial communication i.e to transmit from kit and receive from PC using serial port. |
| **PART-B** |
| **Interfacing Programs using C / Python ProgrammingArduino / Raspberry Pi Kit for IoT Applications** |
| 7. Interface a Push button with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed |
| 8. Interface Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED at sensor detection. |
| 9. Interface LCD with Arduino/Raspberry Pi and write a program to display a message on it. |
| **10.** Interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings |
| 11. Interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed. |
| 12. Interface Bluetooth unit with Arduino/Raspberry Pi and write a program to turn LED ON/OFF |

| |
|---|
| when "1"/"0" is received from smart phone using Bluetooth. |
| 13. Program to upload temperature and humidity data to thingspeak cloud using Arduino/Raspberry Pi |

**Note:** A minimum of 10 experiments to be performed and at least 5 experiments from each part to be performed.

# MICROWAVE LAB

| **PC 461 EC** | |
|---|---|
| | |
| *Instruction:2 periods per week* | *Duration of SEE:- 3 Hours* |
| *CIE: 25 marks* | *SEE:- 50 Marks* |
| *Credits: 1* | |
| *Prerequisite: EMTL (PC405EC), AWP (PC412EC)* | |

**Course Objectives:**

| |
|---|
| 1. Understand the characteristics of Reflex Klystron Oscillator and Gunn oscillator. |
| 2. Measurement of frequency and wavelengths would be learnt by the student. |
| 3. VSWR various TEES would be understood by the student. |

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

| |
|---|
| 1. Analyze 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. Analyze 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. Understand the characteristics of Microwave Sources. |

| **List of experiments** |
|---|
| 1. To find and verify characteristics of Reflex Klystron oscillator, mode numbers and efficiencies of different modes |
| 2. To find and verify characteristics of Gunn diode oscillator, Power Output Vs Frequency, Power Output Vs Bias Voltage |
| 3. Tomeasure and verify frequency and guide wavelength calculation using microwave bench setup. |
| 4. To measure low and high VSWR of different components like matched terminations. |
| 5. To measure impedance of horn antenna. |
| 6. To measure and verify the S-parameters of Directional coupler. |
| 7. To measure and verify the S-parameters of Tees: E plane, H plane and Magic Tee. |
| 8. To measure and verify the S-parameters of Circulator. |
| 9. To measure radiation patterns for basic microwave antennas like horn and parabolic reflectors in E-plane and H-plane. Also to finding the gain, bandwidth and beam width these antennas. |
| 10. To design, Simulate and Analyze the Dipole Antenna Structure by using EM simulation software |
| 11. To design, Simulate and Analyze a Micro strip Rectangular Patch Antenna by using EM simulation software |
| 12. To design, Simulate and Analyze a Probe Feed Patch Antenna by using EM simulation software |
| 13. To design, Simulate and Analyze a The Triangular Micro strip Antenna by using EM simulation software |

**Suggested Reading:**

| | |
|---|---|
| 1. | M L Sisodia& G S Raghuvanshi, 'Basic Microwave Techniques and LaboratoManual', New Age International (P) Limited, Publishers 2009 |
| 2. | Ramesh Garg, PrakashBhartia, InderBahl and ApisakIttipiboon 'Microstrip Antenna Design HandBook' Artech House Publishers, 2001. |

# SUMMER INTERNSHIP

| | |
|---|---|
| **PW702EC** | |
| | |
| *Instruction: -* | *Duration of SEE:- -* |
| *CIE: 50 marks* | *SEE:- -* |
| *Credits: 2* | |
| *Prerequisites: -* | |

**Course Objectives:**

| |
|---|
| 1.To get involved in design, development and testing practices followed in the industry. |
| 2. To enhance technical writing skills in reporting as per the industry standards. |
| 3**.** To participate in teamwork and preferably as part of a multi-disciplinary team. |

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

| |
|---|
| 1.Apply knowledge and skills learned in company/industry/organization to real-world problems. |
| 2.Demonstrate knowledge of contemporary issues related with engineering in general. |
| 3.Effectively use new tools and technologies for solving engineering problems. |
| 4.Gain experience related to working practices within Industrial/R&D Environments. |
| 5.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 Organizations/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 coordinator (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. |

| |
|---|
| 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 VI semester and credits will be awarded after evaluation in VII semester. |

# MAJOR PROJECT PHASE-I

| | |
|---|---|
| **PW703EC** | |
| | |
| *Instruction: 6 periods per week* | *Duration of SEE:- -* |
| *CIE: 50 marks* | *SEE:- -* |
| *Credits: 2* | |
| *Prerequisites: -* | |

**Course Objectives:**

| |
|---|
| 1. To familiarize tools and techniques of systematic literature survey and documentation.` |
| 2. To expose the students to industry practices and team work. |
| 3. To encourage students to work with innovative and entrepreneurial ideas |

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

| |
|---|
| 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. |
| 5. Find relevant sources (e.g., library, Internet, experts) and gathers information for preparing reports and other relevant documentation. |

| |
|---|
| 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. |

# OPEN ELECTIVE – II

# FUNDAMENTALS OF IOT

| | |
|---|---|
| **OE603EC** | |
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: NIL* | |

**Course Objectives:**

| | |
|---|---|
| **1.** | To discuss fundamentals of IoT and its applications and requisite infrastructure |
| **2.** | To describe Internet principles and architecture and applications relevant to IoT |
| **3.** | To discuss private and security aspects of IoT system |

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

| | |
|---|---|
| 1. | Understand IoT technology and research directions. |
| 2. | Comprehend various protocols and architecture of IoT |
| 3. | Design simple IoT systems with IoT reference model |
| 4. | Understand the various applications of IoT |
| 5. | Comprehend the different privacy and security approaches at IoT. |

**UNIT – I**

**IoT& Web Technology:** The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

**UNIT – II**

**M2M to IoT**: A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

**UNIT – III**

**IoTArchitecture:** State of the Art – Introduction, State of the art, Architecture Reference Model-Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture-Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

**UNIT – IV**

**IoTApplications:** IoT Physical Devices and Endpoints: Raspberry Pi, Interfaces of Pi, Programming pi - Controlling LED and LDR using Pi, Opinions on IoT Application and Value for Industry, Home Management, Smart Cities, Smart Environment, Smart Energy, Smart Retail and Logistics, Smart Agriculture and Industry, Smart Industry and eHealth.

**UNIT – V**

**Internet of Things Privacy**:Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security.

**Suggested Reading:**


| | |
|---|---|
| 1. | Adrian McEwen, Hakim Classically, "Designing the Internet of Things", Wiley India Publishers,2014. |
| 2. | Vermesan, Ovidiu and Peter Friess, eds. Internet of things: converging technologies for smart environments and integrated ecosystems. River publishers, 2013. |
| 3. | VijayMadisetti and ArshdeepBahga, 'Internet of Things(A Hands-onApproach)',1stedition, VPT, 2014. |
| 4. | Francis DaCosta, 'Rethinking the Internet of Things: A Scalable Approach to Connecting Everything', 1st edition, Apress Publications, 2013. |
| 5. | Cuno Pfister, 'Getting Started with the Internet of Things', O'Reilly Media, 2011. |
| 6 | https://onlinecourses.nptel.ac.in/noc23_cs83/preview |

# FUNDAMENTALS OF NEURAL NETWORKS

| **OE604EC** | |
|---|---|
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: NIL* | |

**Course Objectives:**

| |
|---|
| 1. Study the functioning of biological neuron and its electronic implementation |
| 2. Familiarize with the concepts of pattern recognition tasks as applied to Neural Networks |
| 3. Introduce the different Feedback Neural Networks & their applications.. |

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

| |
|---|
| 1. Differentiate between Biological Neuron & Artificial Neuron and different Neuron Models. |
| 2. Analyze activation & synaptic dynamics of Neural Networks. |
| 3. Summarize the Pattern Recognition Tasks & different Neural Network memories. |
| 4. Solve Perceptron XOR problem & write different training algorithms for Feed Forward Neural Networks |
| 5. Understand & train different Feedback Neural Networks and their applications. |

| **UNIT – I** |
|---|
| **Introduction to Neural Networks**: Biological Neuron and Biological Neural network,Mathematical model of Artificial Neuron, Neuron models: McCulloch-Pitts (MP)model,Perceptron model and ADALINE model, Neural Network Topologies, Classification of Classification of Neural Networks and Architectures of Feed Forward, Feedback Neural Networks. |
| **UNIT – II** |
| **Activation,Synaptic dynamics of Neural Networks and Neuron Learning**: Distinction between Activation and Synaptic dynamics of neuron models, Requirements of learning laws. Supervised and Unsupervised learning. Learninglaws: Hebbian learning, Perceptron learning, Delta learning, LMS learning. Reinforcement learning. Competitive learning. |
| **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. Design of logic OR, AND, NOT gates and single bit memory element using MP model. |
| **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 and applications, Stochastic Neural learning and networks, Simulated Annealing, Boltzmann machine, Boltzman learning law. |

**Suggested Reading:**


| | |
|---|---|
| 1. | B.Yeganaranarana, "Artificial Neural Networks", PrenticeHall, NewDelhi 1999 |
| 2. | J.A.Freemanand D.M.Skapura, "Neural Networks Algorithms, Applications and Programming Techniques", Addison Wesley, NewYork. 1991 |
| 3. | Simon Haykin, "Neural Networks (A Comprehensive Foundation)", McMillan College Publishing Company, New York 1995 |
| 4. | S.N.Sivanandam&M.Paul Raj, "Introduction to Artificial Neural Networks", Vikas Publishing House Pvt Limited. |
| 5. | Richard O.Duda Peter E Heart, David G.Stork, "Pattern Classification", John Wiley & Sons.2001 |
| 6 | https://nptel.ac.in/courses/117105084 |

# 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 Course** | | | | | | | | | | |
| 1 | PE5XXEC | Professional Elective-V | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 2 | PE5XXEC | Professional Elective-VI | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| 3 | OE6XXYY | Open Elective-III | 3 | - | - | 3 | 30 | 70 | 3 | 3 |
| **Practical/Laboratory Course** | | | | | | | | | | |
| 4 | PW704EC | Major Project Phase-II | - | - | 18 | 18 | 50 | 100 | 3 | 8 |
| **Total** | | | **9** | **-** | **18** | **27** | **140** | **310** | **12** | **17** |

**PE:** Professional Elective **OE:** Open Elective **PW:** Project Work

**L:** Lecture **T:** Tutorial **P:** Practical **D:** Drawing
**CIE:** Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

**EC:** Electronics and Communication Engineering

**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.

| **Professional Elective-V** | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| 1. | PE517EC | Speech Signal Processing |
| 2. | PE518EC | Wireless Sensor Networks |
| 3. | PE519EC | Nano Technology and its Applications |
| 4. | PE520EC | Radar Systems |

| **Professional Elective-VI** | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| 1. | PE521EC | Design of Fault Tolerant Systems |
| 2. | PE522EC | Real Time Operating Systems |
| 3. | PE523EC | Global Navigational Satellite Systems |
| 4. | PE524EC | Computer Vision and Pattern Recognition |

| **Open Elective – III** | | |
|---|---|---|
| **S. No.** | **Course Code** | **Course Title** |
| 1 | OE631AE | Automotive Maintenance * |
| 2 | OE603CE | Road Safety Engineering * |
| 3 | OE605EE | Smart Building Systems* |
| 4 | OE606EE | Programmable Logic Controllers * |
| 5 | OE604IT | Software Engineering * |
| 6 | OE603ME | Mechatronics* |
| 7 | OE605EC | Principles of Embedded Systems * |
| 8 | OE606EC | Fundamentals of Fuzzy Logic* |

***NOTE:** These subjects will not be offered to students of parent department

# PROFESSIONAL ELECTIVE-V

# SPEECH SIGNAL PROCESSING

| | |
|---|---|
| **PE517EC** | |
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: Digital Signal Processing (PC$)*EC)* | |

**Course Objectives:**

| |
|---|
| 1. Understand the basic mechanism of human speech production and digital representation of speech wave forms. |
| 2. Understand Short-time analysis, Synthesis techniques and Speech Synthesizers. |
| 3. Understand the various problems with Automatic speech recognition. |

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

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

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| **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 Reading:**


| | |
|---|---|
| 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 |
| 6. | https://archive.nptel.ac.in/courses/117/105/117105145/# |

# WIRLESS SENSOR NETWORK

| **PE518EC** | |
|---|---|
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisites: DCCN (PE672EC)* | |

**Course Objectives:**

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|---|
| 1.To make students understand the basics of wireless sensor network. |
| 2. To understand the concept of networking in WSN. |
| 3. To introduce the hardware and software platforms and tool in WSN |

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

| |
|---|
| 1. To understand deployment strategies, challenges and technologies for WSN. |
| 2. To understand network architecture. |
| 3. Describing the communication, energy efficiency computing, storage and transmission . |
| 4.Establishing the infrastructure and simulation |
| 5..Explain the concept of security ,and attacks in WSN and Introduction to 5G |

| **UNIT – I** |
|---|
| Introduction to Wireless Sensor Networks WSN, Current Trends. 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. Operating system and execution environment, Introduction to Tiny OS. |
| **UNIT – III** |
| Physical Layer and Transceiver Design Considerations, MAC Protocols for WSN, Low duty cycle protocols and Wakeup Concepts-S-MAC, Zigbee MAC Layer, Mediation device proto Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses.Routing Protocols- Energy-Efficient Routing, Geographic Routing. Programming Management. |
| **UNIT – IV** |
| Topology Control, Clustering, Time Sync, Localization and Positioning, Sensor Tasking.Operating Systems for Wireless Sensor Networks, Sensor Node Hardware – Berkeley Modes, Programming Challenges, Node-level software platforms, Node-level Simulators, State-centric programming. Network slicing for industrial WSN |
| **UNIT – V** |
| Security Architectures, Survey of Security protocols for Wireless Sensor Networks and their Comparisons. 5G network Architecture, 5G Challenges in WSN and its Scope.Real time applications of WSN: Autonomy, Green Houses, Robustness and Reliability.SWOT (Strength, Weakness, Opportunities, and Threat) Analysis of WSNs. |

**Suggested Reading:**


| | |
|---|---|
| 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 |
| 5. | WaltenegusDargie, Christian Poellabauer,"Fundamental of wireless sensor networks-theory and Practice" , john Wiley& sons Publication ,2011. |
| 6 | https://archive.nptel.ac.in/courses/106/105/106105160/ |

# NANOTECHNOLOGY AND ITS APPLICATIONS

| | |
|---|---|
| **PE519EC** | |
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisites: VLSI Design (*PC414EC*)* | |

**Course Objectives:**

1. To understand the classification of systems in Nano technology and Nano materials
2. To analyze the Nano Structured materials applications using TEM
3. To understand the principles of Nano electronic devices

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

1. Understand the classification of systems in Nano technology and Nano materials
2. Describe the characteristics of Nano Materials
3. Demonstrate the Nano Structured materials application using TEM
4. Analyze the applications of Nano technology.
5. Understand the principles of Nano electronic devices.

**UNIT – I**

Emergence of nanotechnology with special reference to Feynman. Definition of anostructures. Building blocks of nanotechnology, Time and length scale in structures, energy landscapes. Nano sized effects: Surface to Volume Ratio, Energy at the Nanoscale-Quantum Effects. Classifications of Nano systems: 1D, 2D, 3D. Size Dependent Properties Nanomaterials.

**UNIT – II**

**Synthesis and Characterization of Nanomaterials-**Introduction, Sol-gel method, Ball milling. Physical methods & Chemical methods with examples: Inert gas condensation, Arc discharge, plasma synthesis & Nanocrystals by chemical reduction, photochemical synthesis, electrochemical synthesis. Semiconductor nanocrystals by arrested precipitation, Nano chemical routes.

**UNIT – III**

**Nano structured material's Applications-**Metal-Metal Nano composites, Polymer-Metal Nano composites, Dielectric and CMR based nanocomposites. Nano Semiconductors, MRAM devices. Thermo Electric Materials (TEM):Concept of phonon, Thermal conductivity, Specific heat, Exothermic & Endothermic processes. One dimensional TEM, Composite TEM, Applications.

**UNIT – IV**

**Applications of Nanotechnology-**Industrial applications of nanomaterials, in the areas of electronics, photonics, biology, health and environment, remediation of pollution, photocatalysis and other nanocatalysts, global warming. Toxicity of nanoparticles, exposure to nanoparticles and CNTs and influence on respiratory systems.

| **UNIT – V** |
|---|
| **Nanoelectronics:** Nanoscale MOSFET–Resonant Tunneling Transistor Single-Electron Transistors; Single-Electron Dynamics; Nanorobotics and Nano manipulation; Mechanical Molecular Nanodevices; Nanocomputers: Optical Fibers for Nano devices; Photochemical Molecular Devices; DNA-Based, Gas-Based Nanodevices. |

**Suggested Reading:**


| | |
|---|---|
| 1. | Charles P. Poole, Frank J. Owens, "*Introduction to Nanotechnology*", Wiley Inter science,2003. |
| 2. | Mick Wilson, Kamal Kannangara & Geoff Smith, "*Nanotechnology: Basic Science &Emerging Technologies*," Overseas Press India Private Limited, 2005. |
| 3. | A. Inoue & K. Hashimoto(Eds.), "*Amorphous and Nanocrystalline Materials: Preparation, Properties and Applications*," Springer, 2013 |
| 4. | K.Goser,P. Glosekotter and J.Dienstuhl, "*Nanoelectronics and nanosystems : fromtransistors to molecular and quantum devices",* Springer 2005 |
| 5. | *Properties and applications",*Imperial College Press, 2006. |
| 6 | https://archive.nptel.ac.in/courses/117/108/117108047/ |

# RADAR SYSTEMS

| | |
|---|---|
| **PE 520 EC** | |
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisites: Digital Communications (PC413EC)* | |

**Course Objectives:**

| |
|---|
| 1.To derive Radar equation and its dependence on various parameters. |
| 2.To understand the concept of Doppler effect and get acquainted with the working principles of different types of Radars for surveillance &Tracking. |
| 3.To explain the designing of a Matched Filter and understand Radar Receivers, displays and antennas. |

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

| |
|---|
| 1.Demonstrate the basic principle of Radar system and develop Radar range equation. Illustrate the importance of various parameters to enhance range estimation for accurate prediction. |
| 2.Illustrate and understand the functioning of CW Radar, their variations and displays in Radar. |
| 3.Explain types of MTI, non-coherent MTI Radar |
| 4.Illustrate on radar tracking methods and differences among them. |
| 5.Derive the matched filter response characteristics and explain about antennas used in radars. |

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| **UNIT – I** |
| **Radar Systems:**Description of basic Radar system and its elements, Radar equation, block diagram and operation of a Radar, Radar frequencies, applications 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,blindspeeds, limitations to MTI performance, MTI using range gated Doppler filters, Pulse DopplerRadar, non-coherent Radar. |
| **UNIT – IV** |
| **Tracking Radar:** Sequential lobing, conical scan, mono-pulse-amplitude comparison and phase comparison methods, tracking in range and in Doppler, acquisition, comparison of trackers. |
| **UNIT – V** |

| |
|---|
| **Detection of Radar signals in noise:** Matched filter receiver – response characteristics and derivation, correlation function and cross-correlation receiver, efficiency of non-matched filters, matched filter with non-white noise<br>**Radar Antennas:** Antenna parameters- Parabolic reflectorantennas, Cassegrain antenna,Cosecant - squared antenna pattern, Introduction to Phased array antennas – Basic conceptsradiation pattern, beam steering and beam width changes. |

**Suggested Reading:**


| | |
|---|---|
| 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, 3/e, 2021. |
| 5. | Harold Roy Reamer, "Radar Systems Principles", Springer, 1997 |

# PROFESSIONAL ELECTIVE-VI

# DESIGN OF FAULT TOLERANT SYSTEMS

| **PE521EC** | |
|---|---|
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: Digital Electronics (EC303EC) & Electronic Devices(PC401EC)* | |

**Course Objectives:**

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|---|
| 1. Gain the basic concepts and metrics of reliable systems and able to comprehend the methods involved in testing |
| 2. Appreciating the techniques involved in developing reliable and fault tolerant modules using redundancy and Gain insight into practical applications of reliable systems. |
| 3. Study testability, built–in-test & test compression in concepts. |

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

| |
|---|
| 1. Apply the metrics like MTBF, MTTR and Availability to calculate reliability of a system. |
| 2. Acquire knowledge on conventional test generation techniques to test combinational and sequential logics. |
| 3. Gain the knowledge on techniques involved in developing reliable and fault tolerant modules using redundancy. |
| 4. Acquire knowledge on Design for testability concepts. |
| 5. Apply design for testability (DFT) techniques to improve observability and controllability of circuits and gain knowledge on test data compression and IDDQ testing. |

| **UNIT – I** |
|---|
| **Basic concepts of Reliability:** Failures and faults, Reliability and failure rate, Relation between reliability & mean time between failure, Maintainability & Availability, reliability of series and parallel systems. Modeling of faults , Test generation for combinational logic Circuits: conventional methods-path sensitization & Boolean difference. Random testing- transition count testing and signature analysis. |
| **UNIT – II** |
| **Fault Tolerant Design-I:** Basic concepts, static redundancy- Triple modular redundancy(TMR),NMR and use of error correcting codes, dynamic, hybrid and self purging redundancy, Sift-out Modular Redundancy (SMR),Fault tolerant design of memory system using error detection and correcting using hamming codes. |
| **UNIT – III** |
| **Fault Tolerant Design-II**: Time redundancy, software redundancy, fail-soft operation, Practical fault tolerant systems- Space shuttle, COPRA and ESS. Introduction to fault tolerant design of VLSI chips. Self checking circuits: Design of totally self checking checkers, checkers using m-out of n codes, self totally checking PLA design. |
| **UNIT – IV** |
| **Design for testability:** Ad-hoc methods, Full scan design, Partial scan design, Boundary scan Built-in self-test: RAM BIST Logic BIST Random and weighted random pattern testability BIST Pattern generator and response analyzer, Scan-based BIST architecture Test point insertion for improving random testability. |
| **UNIT – V** |
| **Test Data Compression:** Test stimulus compression Test response compaction, IDDQ testing, IDDQ detect |

defects, IDDQ test patterns, measurement, Case studies, Limitations of IDDQ Testing Design for IDDQ testability. Analog/Mixed-signal testing: Measurement DSP-based testing, IEEE 1149.4 High-speed IO testing.

**Suggested Reading:**


| | |
|---|---|
| 1. | Parag K. Lala, "Fault Tolerant & Fault Testable Hardware Design",PHI, 2007 |
| 2. | Parag K. Lala, "Digital systems Design using PLD's", BS Publication 2003. |
| 3. | Laung-Terng Wang, Cheng-Wen Wu, Xiaoqing Wen "Test Principles and Architectures: Design for Testability" Elsevier, 2006. |
| 4. | MironAbramovici, Melvin A. Breuer and Arthur D. Friedman, Digital Systems Testing and Testable Design, John Wiley & Sons Inc 1990. |
| 5. | Ml Bushnell And V D Agrawal "Essentials Of Electronic Testing For Digital, Memory And Mixed-Signal Vlsi Circuits", Kluwer Academic Publishers-2000 |

# REAL TIME OPERATING SYSTEMS

| **PE522EC** | |
|---|---|
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: Computer Organization and Architecture (EC404EC)* | |

**Course Objectives:**

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|---|
| 1. To introduce the principles shared by different real-time operating systems and their use in the dev embedded multitasking application software. f circuits. |
| 2. To provide broad understanding of Real Time Operating Systems. |
| 3. To understand the applications of these Real Time features using case studies. |

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

| |
|---|
| 1. Explain the concepts of a real time operating systems and compare its features with a general-purpose OS |
| 2. Analyze various scheduling algorithms related to RTOS. |
| 3. Summarize the concepts related to concurrency, synchronization and deadlock. |
| 4. Compare different real time operating systems. |
| 5. Explain the file system of RTOS. |

| **UNIT – I** |
|---|
| Operating Systems, Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage Management, Protection and Security, Kernel Data Structures, Computing Environments, Open-Source Operating Systems, Introduction to Real time operating systems. |
| **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, Multilevel feedback queue scheduling, Thread scheduling, Multiprocessor scheduling concept, RealTime scheduling concept, Differences between real time and non real time scheduling. |
| **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, Recovery from Deadlock |
| **UNIT – IV** |
| Elementary Concepts of VxWorks: Multitasking, Task State Transition, Task Control – Task Creation and Activation, |

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|---|
| 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** |
| 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 Reading:***


| | |
|---|---|
| 1. | Operating System Concepts – Abraham Silberschatz, Peter Baer Galvin, Greg Gagne, 8th edition, Wiley-India, 2009 |
| 2. | Andrew S. Tanenbaum, 'Modern Operating Systems', 4/e, Pearson Edition,2014. |
| 3. | Jane W.S.Liu, "Real Time Systems," 1/e, Pearson Education, Asia, 2002. |
| 4. | Jean J Labrose, 'Embedded Systems Building Blocks Complete and Ready-to-use Modules in C', 2/e, CRC Press 1999. |
| 5. | Wind River Systems, 'VxWorks Programmers Guide 5.5', Wind River Systems Inc.2002 |
| 6. | https://onlinecourses.nptel.ac.in/noc20_cs16/preview |

# GLOBAL NAVIGATION SATELLITE SYSTEMS

| **PE523EC** | |
|---|---|
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: Digital Communication (PC413EC)* | |

**Course Objectives:**

1. Study the fundamentals, signal structures and error sources of Global Position System(GPS).
2. Introduce the architectures of different GPS based augmentation systems
3. Familiarize with the basic concepts of other GNSS constellations

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

1. Understand the fundamentals of GPS
2. Describe the different types of GNSS Signals and GNSS Datum.
3. Analyze the GPS errors and their modeling techniques.
4. Explain various GPS data processing and GPS integration techniques.
5. Discuss the augmentation systems and regional navigation satellite systems

**UNIT – I**

**GPS Fundamentals:** Basics of satellite communications**,** trilateration, transit**,** 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, SPS and PPS services, GPS co-ordinate system-ECI, ECEF and WGS-84.

**UNIT – II**

**GPS Signal Structure and GPS modernization:** 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, GPS modernization-new GPS III Satellites, new operational control segment, future applications and its current status.

**UNIT – III**

**GPS Augmentation systems:** Differential GPS. Classification of Augmentations Systems, operating principles of different types of SBAS- Wide area augmentation system (WAAS) architecture, GPS Aided GEO Augmented Navigation (GAGAN), European Geostationary Navigation Overlay Service (EGNOS), MTSAT Satellite-based Augmentation System (MSAS) etc. SBAS current status. Ground based augmentation systems(GBAS)/Local area augmentation system (LAAS) concept, National and International Status of implementation of LAAS. Relative advantages and limitations of SBAS over GBAS.

**UNIT – IV**

**Various 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):** Navigation with Indian Constellation ( NavIC), Japan's Quasi-Zenith Satellite System (QZSS), Chinese Area Positioning System (CAPS). **GPS Integration:** GPS/GIS, GPS/INS, GPS/Pseudolite, GPS/Cellular integrations. |

**Suggested Reading:**


| | |
|---|---|
| 1. | Elliot D. Kaplan, "Understanding GPS Principles and Applications", 2/e, Artech House 2005 |
| 2. | Rao G.S., "Global Navigation Satellite Systems – with Essentials of Satellite Communications", TMH 2010 |
| 3. | Sateesh Gopi, "Global Positioning System: Principles and Applications", 5/e, TMH 1999 |
| 4. | Paul D Groves, "Principles of GNSS, Inertial, and Multi-Sensor Integrated Navigation Systems", Artech House Publishers 2008 |
| 5. | Basudeb Bhatta," Global Navigation Satellite Systems: Insights into GPS, GLONASS, Galileo, Compass", B.S. Publications 2010 |
| 6 | https://onlinecourses.nptel.ac.in/noc21_ce77 |

# COMPUTER VISION AND PATTERN RECOGNITION

| **PE524EC** | |
|---|---|
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite: Digital Image & Video Processing (PC501EC)* | |

**Course Objectives:**

1. To review image processing techniques and understand shape and region analysis for computer vision.
2. To study some applications of computer vision algorithms.
3. To study some fundamental concepts, theories, and algorithms for pattern recognition and its application.

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

1. Implement fundamental image processing techniques required for computer vision.
2. Perform binary shape analysis and shape recognition using boundary tracking techniques.
3. Understand the ideas to develop applications using computer vision techniques.
4. Understand the concept of pattern recognition and different paradigms for pattern recognition.
5. Understand the theory, benefits, inadequacies and possible applications of various pattern recognition algorithms.

**UNIT – I**

**Image Processing Foundations:** Review of image processing techniques , operations , thresholding techniques , edge detection techniques ,corner and interest point detection ,mathematical morphology ,texture.

**UNIT – II**

**Shapes and Regions:** Binary shape analysis , connectedness , object labelling and counting , size filtering ,distance functions , skeletons and thinning , deformable shape analysis , boundary tracking procedures ,, active contours , shape models and shape recognition , centroidal profiles, handling occlusion , boundary length measures , boundary descriptors.

**UNIT – III**

**Applications:** Application: Photo album , Face detection , Face recognition , Eigen faces , Active appearance and 3D shape models of faces Application: Surveillance , foreground background separation – particle filters, tracking and occlusion. Application: In-vehicle vision system for locating roadways.

**UNIT – IV**

**Introduction to Pattern Recognition:** Data Sets for Pattern Recognition and different Paradigms, Data Structures for Pattern Representation, Representation of Clusters, Proximity Measures, Size of Patterns, Abstractions of the Data Set, Feature Extraction and Selection.

**UNIT – V**

**Nearest Neighbour Based Classifier:** Nearest Neighbour Algorithm, Variants of the NN Algorithm and its use for Transaction Databases.

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|---|
| **Clustering:** Importance and its types, Clustering Large Data Sets.An Application-Hand Written Digit Recognition: Description of the Digit Data and its Preprocessing, Classification Algorithms, Selection of Representative Patterns and results. |

**Suggested Readings:**


| | |
|---|---|
| **1.** | Computer Vision: Models, Learning, and Inference - Simon J. D. Prince, Cambridge University Press, 2012 |
| **2.** | Feature Extraction & Image Processing for Computer Vision - Mark Nixon and Alberto S. Aquado - Third Edition, Academic Press, 2012 |
| **3.** | Computer & Machine Vision - E. R. Davies- Fourth Edition, Academic Press, 2012 |
| **4.** | Pattern Recognition: An Algorithmic Approach - M. Narasimha Murthy, V. Susheela Devi, Springer Pub, 1st Edition. |
| **5.** | Pattern Recognition and Classification – Geoff Dougherty, Springer Pub, 2013. |
| **6.** | https://onlinecourses.nptel.ac.in/noc23_ee119/preview |

# MAJOR PROJECT PHASE-II

| | |
|---|---|
| **PW704EC** | |
| | |
| *Instruction: -18 hrs per week* | *Duration of SEE:- 3 hrs* |
| *CIE: 50 marks* | *SEE:- 100 marks* |
| *Credits: 8* | |

**Course Objectives:**

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|---|
| 1. To familiarize tools and techniques of systematic literature survey and documentation. |
| 2. To expose the students to industry practices and team work. |
| 3. To encourage students to work with innovative and entrepreneurial ideas |

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

| |
|---|
| 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. |
| 5. Find relevant sources (e.g., library, Internet, experts) and gathers information for preparing reports and other relevant documentation. |

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| The aim of Major Project Phase–II is to implement and evaluate the proposal made as part of Major Project Phase-I. Students can also be encouraged to do full time internship as part of Major Project Phase–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 |
| Major Project Phase-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 for 25 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. |

# OPEN ELECTIVE – III

# PRINCIPLES OF EMBEDDED SYSTEMS

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|---|---|
| **OE 605 EC** | |
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisites: NIL* | |

**Course Objectives:**

1. To understand the fundamentals of embedded systems.
2. To study the block diagram and advanced hardware fundamentals
3. To study the software architecture of embedded systems.

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

1. Acquire an overview of what an embedded system implies.
2. Understand the architecture of a microprocessor and microcontroller to enable to design embedded applications using them.
3. Apply theoretical learning to practical real time problems for automation.
4. Understand how to build and debug an embedded system application.
5. Analyze and design real world applications and interface peripheral devices to the microprocessor

**UNIT – I**

**Fundamentals of embedded systems:** Definition of Embedded system, Examples of Embedded Systems, Typical Hardware, Terminology, Gates, A few other basic considerations, Timing Diagrams, Memory.

**UNIT – II**

**Advanced hardware fundamentals:** Microprocessors, Buses, Direct Memory access, Interrupts, Other Common Parts, Built-Ins on the Microprocessor, Problem, Conventions used in Schematics, Microprocessor Architecture, Interrupts Basics, Shared Data Interrupt Latency.

**UNIT – III**

**Software architecture of embedded systems:** Round- Robin, Round-Robin with Interrupts, Function-Queue- Scheduling Architecture, Real- Time Operating System Architecture, Selecting an Architecture.

**UNIT – IV**

**Embedded software development tools:** Host and Target Machines, Cross ROM compilers, Cross Assemblers and Tool Chains, Linkers /Locaters for Embedded Software, Getting Embedded Software into Target System: PROM programmers, Emulators, In-Circuit Emulators.

**UNIT – V**

**Debugging techniques:** Testing on your host machine, case study, Instruction Set –details .Simulators-brief study The assert Macro - Using Laboratory Tools.

**Suggested Reading:**


| | |
|---|---|
| 1. | David. E. Simon, "An Embedded Software Primer", Low price edition, Pearson Education, New Delhi, 2006. |
| 2. | Frank Vahid and Tony Givargis "Embedded System Design: A Unified Hardware/Software. Approach". John Wiley & Sons, October 2001. |
| 3. | Rajkamal, "Embedded systems: Programming, architecture and Design", second edition, McGraw-Hill Education (India), March 2009. |
| 4. | Shibu K V, "Introduction to Embedded systems", 1/e, McGraw Hill Education,2009. |
| 5. | Andrew N. Sloss, Dominic Symes, Chris Wright," ARM System Developer's Guide Designing and Optimizing System Software" Elsevier2015. |
| 6 | https://archive.nptel.ac.in/courses/108/102/108102169/# |

# FUNDAMENTALS OF FUZZY LOGIC

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| **OE606EC** | |
| | |
| *Instruction: 3 periods per week* | *Duration of SEE:- 3 hours* |
| *CIE: 30 marks* | *SEE:- 70 marks* |
| *Credits: 3* | |
| *Prerequisite:NIL* | |

**Course Objectives:**

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| 1. The concepts of regular sets, Fuzzy sets & Fuzzy relations |
| 2. Membership functions, Different Fuzzification&Defuzzification methods |
| 3. Fuzzy Associative Memories, FAM system Architecture |

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

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| 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 |

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| **UNIT – I** |
| Basics of Fuzzy sets: Introduction to Fuzzy sets, Crisp sets Vs Fuzzy sets, Operation on Fuzzy sets, Properties of Fuzzy sets, Extensions of Fuzzy set concepts: Other kind of Fuzzy sets, Further operations on Fuzzy sets, Extension principle: Operations of Type-2 Fuzzy sets, Consistency Degree of Two Fuzzy sets. |
| **UNIT – II** |
| Fuzzy Relations: Basics of Fuzzy relations, Fuzzy relation representation, Graph representation of binary Fuzzy relation: Bipartite graph, Simple Fuzzy graph, Operations on Fuzzy relations, Properties of Fuzzy relations, Various types of Binary fuzzy relations: Similarity relations, Resemblance relations & Fuzzy Partial Ordering. |
| **UNIT – III** |
| Properties of Membership functions, Fuzzification: Membership Functions, Features of the Membership function, Fuzzification, Comparisons of Fuzzy sets and Crisp or Fuzzy readings, Different Fuzzification methods: Intuition, Inference, Rank ordering, Neural Networks, Genetic Algorithms, Inductive Reasoning. |
| **UNIT – IV** |
| Defuzzification: Defuzzification to scalars, Different Defuzzification methods: Max membership |

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| principle (Height method), Centroid method (Center of area or Center of gravity), Weighted average method, Mean max membership (Middle-of-maxima), Center of sums, Center of largest area, First (or last) of maxima. |
| **UNIT – V** |
| Fuzzy Associative Memories (FAM): FAMs as Mappings, Fuzzy Hebb FAMs, Bi-directional FAM theorem for Correlation-Minimum Encoding, Correlation-Product Encoding, Superimposing FAM rules, FAM system Architecture, Fuzzy logic control (FLC) system: Basic structure and operation of FLC system. |

**Suggested Reading:**


| | |
|---|---|
| 1. | Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, John Wiley & Sons, Third Edition 2010. |
| 2. | C.T. Lin and C.S.George Lee, "Neural Fuzzy Systems", PH PTR, 2006. |
| 3. | Bant A KOSKO, "Neural Networks and Fuzzy Systems", PH PTR, 2012. |
| 4. | Altrock, C.V., "Fuzzy Logic and Neuro Fuzzy Applications explained", PH PTR, 2000. |
| 5. | George J.Klir, Bo Yuan, “Fuzzy Sets & Fuzzy Logic”, Prentice Hall PTR, 2010. |
| 6. | https://onlinecourses.nptel.ac.in/noc21_ee49/preview |