**JNTUH COLLEGE OF ENGINEERING HYDERABAD**

**(AUTONOMOUS)**

**M.Tech. (Embedded Systems)**

**ELECTRONICS AND COMMUNICATION ENGINEERING**

**COURSE STRUCTURE**

**SEMESTER – I**

| S. No. | Course Type | Course Title | L | T | P | Credits |
|---|---|---|---|---|---|---|
| 1 | Core 1 | Embedded System Design | 3 | 0 | 0 | 3 |
| 2 | Core 2 | Embedded Programming | 3 | 0 | 0 | 3 |
| 3 | P E - 1 | Professional Elective 1 | 3 | 0 | 0 | 3 |
| 4 | P E - 2 | Professional Elective 2 | 3 | 0 | 0 | 3 |
| 5 | Lab 1 | Embedded System Lab | 0 | 0 | 4 | 2 |
| 6 | Lab 2 | Embedded Programming Lab | 0 | 0 | 4 | 2 |
| 7 | | Research Methodology and IPR | 2 | 0 | 0 | 2 |
| 8 | Aud 1 | Audit Course 1: English for Research Paper Writing | 2 | 0 | 0 | 0 |
| | | **Total** | **16** | **0** | **8** | **18** |

**SEMESTER – II**

| S. No. | Course Type | Course Title | L | T | P | Credits |
|---|---|---|---|---|---|---|
| 1 | Core 3 | System on Chip Architectures | 3 | 0 | 0 | 3 |
| 2 | Core 4 | Digital Control Systems | 3 | 0 | 0 | 3 |
| 3 | P E – 3 | Professional Elective 3 | 3 | 0 | 0 | 3 |
| 4 | P E – 4 | Professional Elective 4 | 3 | 0 | 0 | 3 |
| 5 | Lab 3 | Digital Controllers and Applications Lab | 0 | 0 | 4 | 2 |
| 6 | Lab 4 | FPGA Design Lab | 0 | 0 | 4 | 2 |
| 7 | | Technical Seminar | 0 | 0 | 4 | 2 |
| 8 | Aud 2 | Audit Course 2: Value Education | 2 | 0 | 0 | 0 |
| | | **Total** | **14** | **0** | **12** | **18** |

**SEMESTER - III**

| S. No. | Course Type | Course Title | L | T | P | Credits |
|---|---|---|---|---|---|---|
| 1 | P E – 5 | Professional Elective 5 | 3 | 0 | 0 | 3 |
| 2 | **O E** | Open Elective | 3 | 0 | 0 | 3 |
| 3 | Dissertation | Dissertation Phase - I | 0 | 0 | 20 | 10 |
| | | **Total** | **06** | **0** | **20** | **16** |

**SEMESTER - IV**

| S. No. | Course Type | Course Title | L | T | P | Credits |
|---|---|---|---|---|---|---|
| 1 | Dissertation | Dissertation Phase - II | -- | -- | 32 | 16 |
| | | **Total** | **--** | **--** | **--** | **16** |

**Professional Elective 1**

1. Digital Systems Design
2. Embedded Real Time Operating Systems
3. Advanced Microcontrollers
4. CMOS Digital Integrated Circuit Design

**Professional Elective 2**

1. Reliability Engineering
2. Intelligent Control
3. Sensors and Actuators
4. Modern Control Theory

**Professional Elective 3**

1. High Performance Networks
2. Mobile Computing
3. Artificial Intelligence
4. Advanced Computer Networks

**Professional Elective 4**

1. Wireless Sensor Networks
2. Communication and Networking Technologies for IOT
3. Design of Fault Tolerant Systems
4. ANN and Deep Learning

**Professional Elective 5**

1. Robotics
2. Embedded Software Engineering
3. System design aspects of IOT
4. Hardware and Software co-design

**Open Elective**

1. Principles of Signal Processing

# EMBEDDED SYSTEMS DESIGN

**M.Tech. I Year I-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** Microprocessor and Microcontrollers

**Course Objectives**

1. To provide an overview of Design Principles of Embedded System.
2. To provide clear understanding about the role of firmware , operating systems in correlation with hardware systems.

**Course Outcomes**

1. Expected to understand the selection procedure of Processors in the Embedded domain.
2. Design Procedure for Embedded Firmware.
3. Expected to visualize the role of Real time Operating Systems in Embedded Systems
4. Expected to evaluate the Correlation between task synchronization and latency issues

**UNIT I**

**Introduction to Embedded Systems**

Definition of Embedded System, Embedded Systems Vs General Computing Systems, History of Embedded Systems, Classification, Major Application Areas, Purpose of Embedded Systems, Characteristics and Quality Attributes of Embedded Systems.

**UNIT II**

**Typical Embedded System**

Core of the Embedded System: General Purpose and Domain Specific Processors, ASICs, PLDs, Commercial Off-The-Shelf Components (COTS), Memory: ROM, RAM, Memory according to the type of Interface, Memory Shadowing, Memory selection for Embedded Systems, Sensors and Actuators, Communication Interface: Onboard and External Communication Interfaces.

**UNIT III**

**Embedded Firmware**

Reset Circuit, Brown-out Protection Circuit, Oscillator Unit, Real Time Clock, Watchdog Timer, Embedded Firmware Design Approaches and Development Languages.

**UNIT IV**

**RTOS Based Embedded System Design**

Operating System Basics, Types of Operating Systems, Tasks, Process and Threads,
Multiprocessing and Multitasking, Task Scheduling.

**UNIT V**

**Task Communication**

Shared Memory, Message Passing, Remote Procedure Call and Sockets, Task Synchronization: Task Communication/Synchronization Issues, Task Synchronization Techniques, Device Drivers, How to Choose an RTOS.

**TEXTBOOKS**

1. Introduction to Embedded Systems - Shibu K.V, Mc Graw Hill.

**REFERENCES**

1. Embedded Systems - Raj Kamal, TMH.
2. Embedded System Design - Frank Vahid, Tony Givargis, John Wiley.
3. Embedded Systems – Lyla, Pearson, 2013
4. An Embedded Software Primer - David E. Simon, Pearson Education.

# EMBEDDED PROGRAMMING

**M.Tech. I Year I-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** C Language Programs

**Course Objectives**

1. To explore the difference between general purpose programming languages and Embedded Programming Language.
2. To provide case studies for programming in Embedded systems.

**Course Outcomes**

1. Expected to learn the basics of Embedded C with reference to 8051.
2. Understand how to handle control and data pins at hardware level.
3. Capable of introducing into objective nature of Embedded C.
4. Understand the specifications of real time embedded programming with case studies.

**UNIT I**

**Programming Embedded Systems in C**

Introduction ,What is an embedded system, Which processor should you use, Which programming language should you use, Which operating system should you use, How do you develop embedded software, Conclusions

**Introducing the 8051 Microcontroller Family**

Introduction, What's in a name, The external interface of the Standard 8051, Reset requirements ,Clock frequency and performance, Memory issues, I/O pins, Timers, Interrupts, Serial interface, Power consumption ,Conclusions

**UNIT II**

**Reading Switches**

Introduction, Basic techniques for reading from port pins, Example: Reading and writing bytes, Example: Reading and writing bits (simple version), Example: Reading and writing bits (generic version), The need for pull-up resistors, Dealing with switch bounce, Example: Reading switch inputs (basic code), Example: Counting goats, Conclusions

**UNIT III**

**Adding Structure to your Code**

Introduction, Object-oriented programming with C, The Project Header (MAIN.H), The Port Header (PORT.H), Example: Restructuring the 'Hello Embedded World' example, Example: Restructuring the goat-counting example, Further examples, Conclusions

**UNIT IV**

**Meeting Real-Time Constraints**

Introduction, Creating 'hardware delays' using Timer 0 and Timer 1, Example: Generating a precise 50 ms delay, Example: Creating a portable hardware delay, Why not use Timer 2?, The need for 'timeout' mechanisms, Creating loop timeouts, Example: Testing loop timeouts, Example: A more reliable switch interface, Creating hardware timeouts, Example: Testing a hardware timeout, Conclusions

**UNIT V**

**Case Study**

Intruder Alarm System-Introduction, The software architecture, Key software components used in this example, running the program, the software, Conclusions

**TEXTBOOKS**

1. Embedded C by **Michael J. Pont** , A Pearson Education

**REFERENCES**

1. PICmicro MCU C-An introduction to programming, The Microchip PIC in CCS C By Nigel Gardner

# DIGITAL SYSTEM DESIGN

**(PE-1)**

**M.Tech. I Year I-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** Switching Theory and Logic Design

**Course Objectives**

1 To provide extended knowledge of digital logic circuits in the form of state model approach.
2 To provide an overview of system design approach using programmable logic devices.
3 To provide and understand of fault models and test methods.
4 To get exposed to the various architectural features of CPLDS and FPGAS.
5 To learn the methods and techniques of CPLD & FPGA design with EDA tools.
6 To expose software tools used for design process with the help of case studies.

**Course Outcomes**

1 To understands the minimization of Finite state machine.
2 To exposes the design approaches using ROM's, PAL's and PLA's.
3 To provide in depth understanding of Fault models.
4 To understands test pattern generation techniques for fault detection.
5 To design fault diagnosis in sequential circuits.
6 To provide exposure to various CPLDS and FPGAS available in market.
7 To acquire knowledge in one hot state machine design applicable to FPGA.
8 To get exposure to EDA tools.
9 To provide understanding in the design of flow using case studies.

**UNIT I**

**Programmable Logic Devices**

The concept of programmable Logic Devices, SPLDs, PAL devices, PLA devices, GAL devices, CPLD-Architecture, Xilinx CPLDs- Altera CPLDs, FPGAs-FPGA technology, architecture, virtex CLB and slice- Stratix LAB and ALM-RAM Blocks, DSP Blocks, Clock Management, I/O standards, Additional features. [TEXTBOOK-1]

**UNIT II**

**Analysis and derivation of clocked sequential circuits with state graphs and tables**

A sequential parity checker, Analysis by signal tracing and timing charts-state tables and graphs-general models for sequential circuits, Design of a sequence detector, More Complex design problems, Guidelines for construction of state graphs, serial data conversion, Alphanumeric state graph notation. [TEXTBOOK-2]

**UNIT III**

**Sequential circuit Design**

Design procedure for sequential circuits-design example, Code converter, Design of Iterative circuits, Design of a comparator, Design of sequential circuits using ROMs and PLAs, Sequential circuit design using CPLDs, Sequential circuit design using FPGAs, Simulation and testing of Sequential circuits, Overview of computer Aided Design. [TEXTBOOK-2

**UNIT IV**

**Fault Modeling and Test Pattern Generation**

Logic Fault Model, Fault detection & redundancy, Fault equivalence and fault location, Fault dominance, Single stuck at fault model, multiple Stuck at Fault models, Bridging Fault model.

Fault diagnosis of combinational circuits by conventional methods, path sensitization techniques, Boolean difference method, KOHAVI algorithm, Test algorithms-D algorithm, Random testing, transition count testing, signature analysis and test bridging faults. [TEXTBOOK-3 & Ref.1]

**UNIT V**

**Fault Diagnosis in sequential circuits**

Circuit Test Approach, Transition check Approach, State identification and fault detection experiment, Machine identification, Design of fault detection experiment. [Ref.1]

**TEXTBOOKS**

1. Digital Electronics and design with VHDL- Volnei A. Pedroni, Elsevier publications.
2. Fundamentals of Logic Design-Charles H.Roth,Jr. -5th Ed.,Cengage Learning.
3. Logic Design Theory-N.N.Biswas,PHI

**REFERENCES**

1. Digital Circuits and Logic Design-Samuel C.LEE,PHI 2008
2. Digital System Design using programmable logic devices- Parag K.Lala, BS publications.

## EMBEDDED REAL TIME OPERATING SYSTEMS
## (PE–1)

**M.Tech. I Year I-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** Computer Organization and Operating System

**Course Objectives**

The objectives of this course are:

1. To provide broad understanding of the requirements of Real Time Operating Systems.
2. To make the student understand, applications of these Real Time features using case studies.

**Course Outcomes**

1. Be able to explain real-time concepts such as preemptive multitasking, task priorities, priority inversions, mutual exclusion, context switching, and synchronization, interrupt latency and response time, and semaphores.
2. Able explain how tasks are managed.
3. Able to explain how the real-time operating system implements time management.
4. Be able to work with real time operating systems like RT Linux, Vx Works, MicroC /OS- II, Tiny OS.

**UNIT – I**

**Introduction:** Introduction to UNIX/LINUX, Overview of Commands, File I/O,( open, create, close, lseek, read, write), Process Control ( fork, vfork, exit, wait, waitpid, exec).

**UNIT – II**

**Real Time Operating Systems:** Brief History of OS, Defining RTOS, The Scheduler, Objects, Services, Characteristics of RTOS, Defining a Task, asks States and Scheduling, Task Operations, Structure, Synchronization, Communication and Concurrency.

Defining Semaphores, Operations and Use, Defining Message Queue, States, Content, Storage, Operations and Use

**UNIT – III**

**Objects, Services and I/O:** Pipes, Event Registers, Signals, Other Building Blocks, Component Configuration, Basic I/O Concepts, I/O Subsystem

**UNIT – IV**

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

**UNIT – V**

**Case Studies of RTOS:** RT Linux, Free RTOS, Vx Works, Embedded Linux, Xenomai OS.

**TEXT BOOKS**

1. Real Time Concepts for Embedded Systems – Qing Li, Elsevier, 2011

**REFERENCES**

1. Embedded Systems- Architecture, Programming and Design by Rajkamal, 2007, TMH.
2. Advanced UNIX Programming, Richard Stevens
3. Embedded Linux: Hardware, Software and Interfacing – Dr. Craig Hollabaugh

# ADVANCED MICROCONTROLLERS
## (PE -1)

**M.Tech. I Year I-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** Microprocessors and Microcontrollers

**Course Objectives**

1. Explore the architecture and instruction set of ARM processor.
2. To provide a comprehensive understanding of various programs of ARM Processors.
3. Learn the programming on ARM Cortex M.

**Course Outcomes**

After completing this course the student will be able to:

1. To explore the selection criteria of ARM processors by understanding the functional level trade off issues.
2. Explore the ARM development towards the functional capabilities.
3. Expected to work with ASM level program using the instruction set.
4. Understand the architecture of ARM Cortex M and programming on it.

**UNIT I**

**ARM Embedded Systems**

RISC design philosophy, ARM design philosophy, Embedded system hardware, Embedded system software.

**ARM Processor Fundamentals**

Registers, Current Program Status Register, Pipeline, Exceptions Interrupts and Vector Table, Core Extensions, Architecture Revisions, ARM Processor Families.

**Architecture of ARM Processors**

Introduction to the architecture, Programmer's model- operation modes and states, registers, special registers, floating point registers, Behavior of the application program status register(APSR)-Integer status flags, Q status flag, GE bits, Memory system-Memory system features, memory map, stack memory, memory protection unit (MPU), Exceptions and Interrupts-what are exceptions?, nested vectored interrupt controller(NVIC), vector table, Fault handling, System control block (SCB), Debug, Reset and reset sequence.

**UNIT II**

**Introduction to the ARM Instruction Set**

Data processing instructions, branch instructions, load-store instructions, software interrupt instructions, program status register instructions, loading constants, ARMv5E extensions, Conditional execution.

**Introduction to the Thumb Instruction Set**

Thumb Register Usage, ARM-Thumb Interworking, Other Branch Instructions, Data Processing Instructions, Single-Register Load-Store Instructions, Multiple-Register Load-Store Instructions, Stack Instructions, Software Interrupt Instruction.

**UNIT III**

**Technical Details of ARM Cortex M Processors**

General information about Cortex-M3 and cortex M4 processors-Processor type, processor architecture, instruction set, block diagram, memory system, interrupt and exception support, Features of the cortex-M3 and Cortex-M4 Processors-Performance, code density, low power, memory system, memory protection unit, interrupt handling, OS support and system level features, Cortex-M4 specific features, Ease of use, Debug support, Scalability, Compatibility.

**UNIT IV**

**Instruction SET of ARM Cortex M**

Background to the instruction set in ARM Cortex-M Processors, Comparison of the instruction set in ARM Cortex-M Processors, understanding the assembly language syntax, Use of a suffix in instructions, Unified assembly Language (UAL), Instruction set, Cortex-M4-specific instructions, Barrel shifter, Accessing special instructions and special registers in Programming.

**UNIT V**

**Floating Point Operations**

About Floating Point Data,Cortex-M4 Floating Point Unit (FPU)- overview, FP registers overview, CPACR register, Floating point register bank, FPSCR, FPU->FPCCR, FPU-> FPCAR, FPU->FPDSCR, FPU->MVFR0, FPU->MVFR1. ARM Cortex-M4 and DSP Applications: DSP on a microcontroller, Dot Product example, writing optimized DSP code for the CortexM4-Biquad filter, Fast Fourier transform, FIR filter.

**TEXTBOOKS**

1. ARM System Developer's Guide Designing and Optimizing System Software by Andrew N. SLOSS, Dominic SYMES, Chris WRIGHT, Elsevier Publications, 2004.
2. The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors by Joseph Yiu, Elsevier Publications, 3rd Ed.,

**REFERENCES**

1. Arm System on Chip Architectures – Steve Furber, Edison Wesley, 2000.
2. ARM Architecture Reference Manual – David Seal, Edison Wesley, 2000.

## CMOS DIGITAL INTEGRATED CIRCUIT DESIGN
## (PE-1)

**M.Tech. I Year I-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**UNIT I**

**MOS Design:** Pseudo NMOS logic- Inverter, Inverter threshold voltage, output high voltage, Output low voltage, gain at gate threshold voltage, transient response, rise time, fall time, pseudo NMOS logic gates, transistor equivalency, CMOS inverter logic.

**UNIT II**

**Combinational MOS logic circuits**

MOS logic circuits with NMOS loads, Primitive CMOS logic gates- NOR and NAND gates, Complex logic circuits design- realizing Boolean expressions using NMOS gates and CMOS gates, AOI and OIA gates, CMOS full-adder, cmos transmission gates, designing with transmission gates.

**UNIT III**

**Sequential MOS logic circuits**

Behavior of bistable elements, SR Latch, Clocked Latch and Flip-flop circuits, CMOS D Latch and edge triggered flip-flop.

**UNIT IV**

**Dynamic Logic Circuits**

Basic principle, Voltage Bootstrapping, Synchronous dynamic pass transistor circuits, Dynamic CMOS transmission gate logic, high performance dynamic CMOS circuits.

**UNIT V**

**Semiconductor Memories**

Types, RAM array Organization, DRAM- types, operation, leakage currents in DRAM cell and refresh operation, SRAM - operation , leakage currents in SRAM cells, Flash memory- NOR flash and NAND flash.

**TEXTBOOKS**

1. Digital Integrated Circuit Design- Ken Martin, Oxford University Press, 2011.
2. CMOS Digital Integrated Circuit Analysis and Design – Sung Mo Kang, Yusuf Leblebici, TMH, 3rd Ed., 2011.

**REFERENCES**

1. Introduction to VLSI Systems: A Logic, Circuit and System Perspective- Ming Bo Lin, CRC Press, 2011
2. Digital Integrated Circuits: A Designs Perspective - Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, 2nd Ed., PHI.

# RELIABILITY ENGINEERING
## (PE-2)

**M.Tech. I Year I-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** None

**Course Objectives**

1. To comprehend the concept of Reliability and Unreliability
2. Derive the expressions for probability of failure, Expected value and standard deviation of Binominal distribution, Poisson distribution, normal distribution and weibull distributions.
3. Formulating expressions for Reliability analysis of series-parallel and Non-series parallel systems
4. Deriving expressions for Time dependent and Limiting State Probabilities using Markov models.

**Course Outcomes**

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

1. Apply fundamental knowledge of Reliability to modeling and analysis of series-parallel and Non-series parallel systems.
2. Solve some practical problems related with Generation, Transmission and Utilization of Electrical Energy.
3. Understand or become aware of various failures, causes of failures and remedies for failures in practical systems.

**Unit I**

Rules for combining probabilities of events, Definition of Reliability. Significance of the terms appearing in the definition. Probability distributions: Random variables, probability density and distribution functions. Mathematical expectation, Binominal distribution, Poisson distribution, normal distribution, weibull distribution.

**Unit II**

Hazard rate, derivation of the reliability function in terms of the hazard rate. Failures: Causes of failures, types of failures (early failures, chance failures and wear-out failures). Bath tub curve. Preventive and corrective maintenance. Modes of failure. Measures of reliability: mean time to failure and mean time between failures.

**Unit III**

Classification of engineering systems: series, parallel and series-parallel systems- Expressions for the reliability of the basic configurations.

Reliability evaluation of Non-series-parallel configurations: Decomposition, Path based and cutest based methods, Deduction of the Paths and cut sets from Event tree.

**Unit IV**

Discrete Markov Chains: General modeling concepts, stochastic transitional probability matrix, time dependent probability evaluation and limiting state probability evaluation of one component repairable model. Absorbing states.

Continuous Markov Processes: Modeling concepts, State space diagrams, Stochastic Transitional Probability Matrix, Evaluating time dependent and limiting state Probabilities of one component repairable model. Evaluation of Limiting state probabilities of two component repairable model.

**UNIT V**

Approximate system Reliability analysis of Series systems, parallel systems with two and more than two components, Network reduction techniques. Minimal cutest/failure mode approach.

**TEXTBOOKS**

1. "Reliability evaluation of Engineering systems", Roy Billinton and Ronald N Allan, BS Publications.
2. "Reliability Engineering", Elsayed A. Elsayed, Prentice Hall Publications.

**REFERENCES**

1. "Reliability Engineering: Theory and Practice", By Alessandro Birolini, Springer Publications.
2. "An Introduction to Reliability and Maintainability Engineering", Charles Ebeling, TMH Publications.
3. "Reliability Engineering", E. Balaguruswamy, TMH Publications.

# INTELLIGENT CONTROL
## (PE-2)

**M.Tech. I Year I-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** None

**Course Objectives**
1. Gaining an understanding of the functional operation of a variety of intelligent control techniques and their bio-foundations
2. The study of control-theoretic foundations
3. Learning analytical approaches to study properties

**Course Outcomes**
Upon the completion of this course, the student will be able to
1. Develop Neural Networks, Fuzzy Logic and Genetic algorithms.
2. Implement soft computing to solve real-world problems mainly pertaining to control system applications

**Unit I**
Introduction and motivation. Approaches to intelligent control. Architecture for intelligent control. Symbolic reasoning system, rule-based systems, the AI approach. Knowledge representation. Expert systems.

**Unit II**
Concept of Artificial Neural Networks and its basic mathematical model, McCulloch-Pitts neuron model, simple perceptron, Adaline and Madaline, Feedforward Multilayer Perceptron. Learning and Training the neural network. Data Processing: Scaling, Fourier transformation, principal-component analysis.

**Unit III**
Networks: Hopfield network, Self-organizing network and Recurrent network. Neural Network based controller Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab-Neural Network toolbox. Stability analysis of Neural-Network interconnection systems.

**Unit IV**
Genetic Algorithm: Basic concept of Genetic algorithm and detail algorithmic steps, adjustment of free parameters. Solution of typical control problems using genetic algorithm. Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems.

**Unit V**
Introduction to crisp sets and fuzzy sets, basic fuzzy set operation and approximate reasoning. Introduction to fuzzy logic modeling and control. Fuzzification, inferencing and defuzzification. Fuzzy knowledge and rule bases. Fuzzy modeling and control schemes for nonlinear systems. Fuzzy logic control for nonlinear time-delay system. Implementation of fuzzy logic controller using Matlab fuzzy-logic toolbox. Stability analysis of fuzzy control systems.

**TEXTBOOKS**

1. Simon Haykins, Neural Networks: A comprehensive Foundation, Pearson Edition, 2003.
2. T.J.Ross, Fuzzy logic with Fuzzy Applications, Mc Graw Hill Inc, 1997.
3. David E Goldberg, Genetic Algorithms.
4. John Yen and Reza Langari, Fuzzy logic Intelligence, Control, and Information, Pearson Education, Indian Edition, 2003.

**REFERENCES**

1. M.T.Hagan, H. B. Demuth and M. Beale, Neural Network Design, Indian reprint, 2008.
2. Fredric M.Ham and Ivica Kostanic, Principles of Neurocomputing for science and Engineering, McGraw Hill, 2001.
3. N.K. Bose and P.Liang, Neural Network Fundamentals with Graphs, Algorithms and Applications, Mc - Graw Hill, Inc. 1996.
4. Yung C. Shin and Chengying Xu, Intelligent System - Modeling, Optimization and Control, CRC Press, 2009.
5. N.K.Sinha and Madan M Gupta, Soft computing & Intelligent Systems - Theory & Applications, Indian Edition, Elsevier, 2007.
6. Witold Pedrycz, Fuzzy Control and Fuzzy Systms, Overseas Press, Indian Edition, 2008

# SENSORS AND ACTUATORS

**(PE–2)**

**M.Tech. I Year I-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** None

**Course Objectives**

1. To Learn about Electro mechanical sensors.
2. To Learn the use of the thermal sensors and magnetic sensors for embedded system.
3. To learn the basics of radiation sensors, smart sensors and actuators.

**Course Outcomes**

1. Students will gain knowledge to interface various sensors and actuators in embedded applications.

**UNIT I**

**Sensors/Transducers**

Principles – Classification – Parameters – Characteristics - Environmental Parameters (EP) – Characterization.

**Mechanical and Electromechanical Sensors**

Introduction – Resistive Potentiometer – Strain Gauge – Resistance Strain Gauge – Semiconductor Strain Gauges -Inductive Sensors: Sensitivity and Linearity of the Sensor –Types-Capacitive Sensors:– Electrostatic Transducer– Force/Stress Sensors Using Quartz Resonators – Ultrasonic Sensors, Humidity Sensors.

**UNIT II**

**Thermal Sensors**

Introduction – Gas thermometric Sensors – Thermal Expansion Type Thermometric Sensors – Acoustic Temperature Sensor – Dielectric Constant and Refractive Index thermosensors – Helium Low Temperature Thermometer – Nuclear Thermometer – Magnetic Thermometer – Resistance Change Type Thermometric Sensors –Thermoemf Sensors– Junction Semiconductor Types– Thermal Radiation Sensors –Quartz Crystal Thermoelectric Sensors – NQR Thermometry – Spectroscopic Thermometry – Noise Thermometry – Heat Flux Sensors, IR Sensors.

**Magnetic sensors**

Introduction – Sensors and the Principles Behind – Magneto-resistive Sensors – Anisotropic Magnetoresistive Sensing – Semiconductor Magnetoresistors– Hall Effect and Sensors – Inductance and Eddy Current Sensors– Angular/Rotary Movement Transducers – Synchros – Synchro-resolvers - Eddy Current Sensors – Electromagnetic Flowmeter – Switching Magnetic Sensors SQUID Sensors.

**UNIT III**

**Radiation Sensors**

Introduction – Basic Characteristics – Types of Photosensistors/Photo detectors– X-ray and Nuclear Radiation Sensors– Fiber Optic Sensors.

**Electro analytical Sensors**

Introduction – The Electrochemical Cell – The Cell Potential - Standard Hydrogen Electrode (SHE) – Liquid Junction and Other Potentials – Polarization – Concentration Polarization-– Reference Electrodes - Sensor Electrodes – Electro ceramics in Gas Media.

**UNIT IV**

**Smart Sensors**

Introduction – Primary Sensors – Excitation – Amplification – Filters – Converters – Compensation– Information Coding/Processing - Data Communication – Standards for Smart Sensor Interface – The Automation.

**Sensors –Applications**

Introduction – On-board Automobile Sensors (Automotive Sensors)– Home Appliance Sensors – Aerospace Sensors — Sensors for Manufacturing –Sensors for environmental Monitoring.

**UNIT V**

**Actuators**

Pneumatic and Hydraulic Actuation Systems- Actuation systems – Pneumatic and hydraulic systems - Directional Control valves – Presure control valves – Cylinders - Servo and proportional control valves – Process control valves – Rotary actuators.

Mechanical Actuation Systems- Types of motion – Kinematic chains – Cams – Gears – Ratchet and pawl – Belt and chain drives – Bearings – Mechanical aspects of motor selection.

Electrical Actuation Systems-Electrical systems -Mechanical switches – Solid-state switches Solenoids – D.C. Motors – A.C. motors – Stepper motors.

**TEXTBOOKS**

1. Patranabis – "Sensors and Transducers" –PHI Learning Private Limited.
2. W. Bolton – "Mechatronics" –Pearson Education Limited.

# MODERN CONTROL THEORY

**(PE–2)**

**M.Tech. I Year I-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** Control Systems

**Course Objectives:**

- To understand concepts Linear mathematical preliminaries and representation of multi-input multi-output systems
- To understand concepts of modern control system.
- To understand the concepts of state variables analysis for LTIV systems.
- To understand the concepts of controllability and observability
- To expose the design aspects of state feedback controllers and observers
- To understand the concepts and analysis of non-linear systems.
- To understand the concepts of the stability for LTIV and non-linear systems

**Course Outcomes:** Upon completion of this course, students should be able to:

- Develop state space models for dynamical systems and real time systems.
- Find the analysis of dynamical systems.
- To test and analyze the dynamical systems for controllability and observability.
- Apply the concept of design state feedback controllers and observers to meet desired specifications.
- Characterize and analyze the dynamical systems.
- Determine the stability of any given dynamical systems.

**UNIT I: Mathematical Preliminaries and State Variable Analysis:**

Fields, Vectors and Vector Spaces – Linear combinations and Bases – Linear Transformations and Matrices – Scalar Product and Norms. The concept of state – State space model of Dynamic systems – Time invariance and Linearity – Non uniqueness of state model – State diagrams for Continuous-Time State models - Existence and Uniqueness of Solutions to Continuous-Time State Equations – Solutions of Linear Time Invariant Continuous-Time State Equations – State transition matrix and it's properties. Complete solution of state space model due to zero input and due to zero state.

**UNIT II: Controllability and Observability:**

General concept of controllability – Controllability tests, different state transformations such as diagonalization, Jordon canonical forms and Controllability canonical forms for Continuous-Time Invariant Systems – General concept of Observability – Observability tests for Continuous-Time Invariant Systems – Observability of different State transformation forms.

**UNIT III: State Feedback Controllers and Observers:**

State feedback controller design through Pole Assignment, using Ackkermans formula– State observers: Full order and Reduced order observers.

**UNIT IV: Non-Linear Systems:**

Introduction – Non Linear Systems - Types of Non-Linearities – Saturation – Dead-Zone - Backlash – Jump Phenomenon etc; Linearization of nonlinear systems, Singular Points and its types– Describing function–describing function of different types of nonlinear elements, – Stability analysis of Non-Linear systems through describing functions. Introduction to phase-plane analysis, Method of Isoclines for Constructing Trajectories, Stability analysis of nonlinear systems based on phase-plane method.

**UNIT V: Stability Analysis:**

Stability in the sense of Lyapunov, Lyapunov's stability and Lypanov's instability theorems - Stability Analysis of the Linear continuous time invariant systems by Lyapunov second method – Generation of Lyapunov functions – Variable gradient method – Krasooviski's method.

**TEXT BOOKS :**

1. M.Gopal, Modern Control System Theory, New Age International - 1984
2. Ogata. K, Modern Control Engineering, Prentice Hall - 1997

**REFERENCES:**

1.N K Sinha, Control Systems, New Age International – 3rd edition.
2.Donald E.Kirk, Optimal Control Theory an Introduction, Prentice - Hall Network series - First edition.

## EMBEDDED SYSTEMS LABORATORY

**M.Tech. I Year I-Semester**

| L | T | P | C |
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**List of Experiments**

1. **Functional Testing Of Devices**
   Flashing the OS on to the device into a stable functional state by porting desktop environment with necessary packages.
2. **Exporting Display On To Other Systems**
   Making use of available laptop/desktop displays as a display for the device using SSH client & X11 display server.
3. **GPIO Programming**
   Programming of available GPIO pins of the corresponding device using native programming language. Interfacing of I/O devices like LED/Switch etc., and testing the functionality.
4. **Interfacing a Bluetooth connector and control the Bluetooth operated devices(Test on atleast two devices).**
5. **ON/OFF Control Based On Light Intensity**
   Using the light sensors, monitor the surrounding light intensity & automatically turn ON/OFF the high intensity LED's by taking some pre-defined threshold light intensity value.
6. **Battery Voltage Range Indicator**
   Monitor the voltage level of the battery and indicating the same using multiple LED's (for ex: for 3V battery and 3 led's, turn on 3 led's for 2-3V, 2 led's for 1-2V, 1 led for 0.1-1V & turn off all for 0V)
7. **Dice Game Simulation**
   Instead of using the conventional dice, generate a random value similar to dice value and display the same using a 16X2 LCD. A possible extension could be to provide the user with option of selecting single or double dice game.
8. **Displaying RSS News Feed On Display Interface**
   Displaying the RSS news feed headlines on a LCD display connected to device. This can be adapted to other websites like twitter or other information websites. Python can be used to acquire data from the internet.
9. **Porting Openwrt To the Device**
   Attempt to use the device while connecting to a wifi network using a USB dongle and at the same time providing a wireless access point to the dongle.
10. **Hosting a website on Board**
    Building and hosting a simple website(static/dynamic) on the device and make it accessible online. There is a need to install server(eg: Apache) and thereby host the website.
11. **Webcam Server**
    Interfacing the regular usb webcam with the device and turn it into fully functional IP webcam & test the functionality.
12. **FM Transmission**
    Transforming the device into a regular fm transmitter capable of transmitting audio at desired frequency (generally 88-108 Mhz)

**Note :** Devices mentioned in the above lists include Arduino, Raspbery Pi, Beaglebone

## EMBEDDED PROGRAMMING LABORATORY

**M.Tech. I Year I-Semester**

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**List of Programs:**

1. Write a simple program to print “hello world”
2. Write a simple program to show a delay.
3. Write a loop application to copy values from P1 to P2
4. Write a c program for counting the no of times that a switch is pressed & released.
5. Illustrate the use of port header file (port M) using an interface consisting of a keypad and liquid crystal display.
6. Write a program to create a portable hardward delay.
7. Write a c program to test loop time outs.
8. Write a c program to test hardware based timeout loops.
9. Develop a simple EOS showing traffic light sequencing.
10. Write a program to display elapsed time over RS-232 link.
11. Write a program to drive SEOS using Timer 0.
12. Develop software for milk pasteurization system.

**Mini Project**

Develop & implement a program for intruder alarm system.

## RESEARCH METHODOLOGY AND IPR

**M.Tech. I Year I-Semester**

| L | T | P | C |
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**Course Objectives:**

- To understand the research problem
- To know the literature studies, plagiarism and ethics
- To get the knowledge about technical writing
- To analyze the nature of intellectual property rights and new developments
- To know the patent rights

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

- Understand research problem formulation.
- Analyze research related information
- Follow research ethics
- Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
- Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general & engineering in particular.
- Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

**UNIT-I:**

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

**UNIT-II:**

Effective literature studies approaches, analysis, Plagiarism, Research ethics

**UNIT-III:**

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

**UNIT-IV:**

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Copyleft and Creative Commons Licensing. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

**UNIT-V:**

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

**TEXT BOOKS:**

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

**REFERENCES:**

1. Ranjit Kumar, 2nd Edition , "Research Methodology: A Step by Step Guide for beginners"
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall , "Industrial Design", McGraw Hill, 1992.
4. Niebel , "Product Design", McGraw Hill, 1974.
5. Asimov , "Introduction to Design", Prentice Hall, 1962.
6. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

## ENGLISH FOR RESEARCH PAPER WRITING
## (AUDIT COURSE-I)

**M.Tech. I Year I-Semester**

| L | T | P | C |
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**Course Objectives**: To help students:
1. Understand the essentials of writing skills and their level of readability
2. Learn about what to write in each section
3. Ensure qualitative presentation with linguistic accuracy.

**Course Outcomes:** Students will be able to:
1. Understand writing skills and level of readability
2. Write title, abstract, different sections in research paper
3. Develop the skills needed while writing a research paper

**Syllabus**

**Unit 1** Overview of a Research Paper- Planning and Preparation- Word Order- Useful Phrases - Breaking up Long Sentences-Structuring Paragraphs and Sentences -Being Concise and Removing Redundancy -Avoiding Ambiguity

**Unit 2** Essential Components of a Research Paper- Abstracts- Building Hypothesis-Research Problem - Highlight Findings- Hedging and Criticizing, Paraphrasing and Plagiarism, Chapterisation

**Unit 3** Introducing Review of the Literature – Methodology - Analysis of the Data-Findings - Discussion- Conclusions-Recommendations.

**Unit 4** Key skills needed for writing a Title, Abstract, and Introduction

**Unit 5** Appropriate language to formulate Methodology, incorporate Results, put forth Arguments and draw Conclusions

**Suggested Reading:**

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)
Model Curriculum of Engineering & Technology PG Courses [Volume-I]
2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

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# SYSTEM ON CHIP ARCHITECTURES

**M.Tech. I Year II-Semester**

| L | T | P | C |
|---|---|---|---|
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**Prerequisite:** Embedded System Design.

**Course Objectives**

The objectives of this course are:

1. To introduce the architectural features of system on chip.
2. To provides information on interconnection necessities between computational block and memory block.

**Course Outcomes**

On completion of this course the student will be able to:

1. Introduction to SOC Architecture and design.
2. Processor design Architectures and limitations
3. To acquires the knowledge of memory architectures on SOC.
4. To understands the interconnection strategies and their customization on SOC.

**UNIT I**

**Introduction to the System Approach**

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

**UNIT II**

**Processors**

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

**UNIT III**

**Memory Design for SOC**

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

**UNIT IV**

**Interconnect Customization and Configuration**

Inter Connect Architectures, Bus: Basic Architectures, SOC Standard Buses , Analytic Bus Models, Using the Bus model, Effects of Bus transactions and contention time. SOC Customization: An overview, Customizing Instruction Processor, Reconfiguration Technologies, Mapping design onto Reconfigurable devices, Instance- Specific design, Customizable Soft Processor, Reconfiguration - overhead analysis and trade-off analysis on reconfigurable Parallelism.

**UNIT V**

**Application Studies / Case Studies**

SOC Design approach, AES algorithms, Design and evaluation, Image compression – JEPG compression.

**TEXTBOOKS**

1. Computer System Design System-on-Chip by Michael J. Flynn and Wayne Luk, Wiely India Pvt. Ltd.
2. ARM System on Chip Architecture – Steve Furber –2nd Eed., 2000, Addison Wesley Professional.

**REFERENCES**

1. Design of System on a Chip: Devices and Components – Ricardo Reis, 1st Ed., 2004, Springer
2. Co-Verification of Hardware and Software for ARM System on Chip Design (Embedded Technology) – Jason Andrews – Newnes, BK and CDROM
3. System on Chip Verification – Methodologies and Techniques –Prakash Rashinkar, Peter Paterson and Leena Singh L, 2001, Kluwer Academic Publishers

## DIGITAL CONTROL SYSTEMS

**M.Tech. I Year II-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** Control Systems

**Course Objectives:**

- To understand the fundamentals of digital control systems representations, z-transforms
- To understand analysis of discrete complex domain: Z-Transforms
- To understand the concepts of state variables analysis for discrete LTIV systems.
- To understand the concepts of controllability and observability of discrete time systems
- To get exposed the design aspects of controllers and for discrete time systems
- To understand the concepts of the stability for discrete LTIV systems
- To understand the design aspects of observers for discrete time systems.

**Course Outcomes:** At the end of this course, students will demonstrate the ability to

- Obtain discrete representation of LTI systems.
- Find the state space analysis of discrete time systems.
- Test and analyze the controllability and observability for discrete time systems
- Analyze stability of discrete time systems using various methods
- Design and analyze digital controllers.
- Design state feedback controllers and observers.

### UNIT-I: REPRESENTATION OF DISCRETE TIME SYSTEMS

Basics of Digital Control Systems. Discrete representation of continuous systems. Sample and hold circuit. Mathematical Modeling of sample and hold circuit. Effects of Sampling and Quantization. Choice of sampling frequency. ZOH equivalent.

Z-Transforms, Mapping from s-plane to z plane, Properties of Z-Transforms and Inverse Z Transforms. Pulse Transfer function: Pulse transfer function of closed loop systems. Solution of Discrete time systems. Time response of discrete time system, Steady State errors.

### UNIT-II: DISCRETE TIME STATE SPACE ANALYSIS

State space representation of discrete time systems, Conversion of pulse transfer function to state space models and vice-versa, Solving discrete time state space equations, State Transition Matrix, Pulse Transfer Function Matrix. Discretization of continuous time state space equations. Concept of Controllability, stabilizability, observability, reachability – Controllability and observability tests. Effect of pole zero cancellation on the controllability & observability.

### UNIT-III: STABILITY ANALYSIS OF DISCRETE TIME SYSTEM

Concept of stability in z-domain, Stability analysis discrete time system: by Jury test, using bilinear transformation. Stability Analysis of discrete time systems using Lyapunov methods.

### UNIT-IV: DESIGN OF DIGITAL CONTROL SYSTEM BY CONVENTIONAL METHODS

Design and realization of digital PID Controller, Design of discrete time controllers with bilinear transformation, Design of digital control system with dead beat response, Practical issues with dead beat response design.

### UNIT-V: DEISGN STATE FEEDBACK CONTROLLERS AND OBSERVERS

Design of discrete state feedback controllers through pole placement, Design of Discrete Observer for LTI System: Design of full order and reduced observers, Design of observer-based controllers.

**TEXT BOOKS:**

1. K. Ogata, "Digital Control Engineering", Prentice Hall, Englewood Cliffs, 1995.
2. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
3. V, I, George and C. P. Kurian, Digital Control Systems, CENGAGE Learning, 2012

**REFERENCES:**

1. G. F. Franklin, J. D. Powell and M. L. Workman, "Digital Control of Dynamic Systems", Addison-Wesley,1998.
2. B.C. Kuo, "Digital Control System", Holt, Rinehart and Winston, 1980.

## HIGH PERFORMANCE NETWORKS
## (PE-3)

**M.Tech. I Year II-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** Computer Networks, AWSN

**Course Objectives**

The main objectives of the course are:

1. To study about the services offered by communication networks.
2. To learn about issues and challenges in providing QoS in Ad-Hoc wireless networks.
3. To learn about QoS solutions of MAC and Network Layers.
4. Study about QoS Frame work for Ad-Hoc wireless networks
5. To learn the Next Generation Hybrid wireless networks

**Course Outcomes**

After completing this course the student will be able to:

1. Understand the features and services offered by communication networks.
2. Understand methods to improve QoS in networks.
3. Acquire the knowledge about various QoS models, QoS solutions of MAC layer and Network layer
4. Understand the features, architectures and functions of various Next generation Hybrid wireless networks.

**UNIT I**

Types of Networks, Network design issues, Data in support of network design. Network design tools, protocols and architecture. Streaming stored Audio and Video, Best effort service, protocols for real time interactive applications, Beyond best effort, scheduling and policing mechanism, integrated services, and RSVP-differentiated services.

**UNIT II**

**Quality of Service in Ad Hoc Wireless Network**

Real-Time Traffic Support in Ad Hoc Wireless Networks, QoS Parameters in Ad Hoc Wireless Networks, Issues and Challenges In Providing QoS in Ad Hoc Wireless Networks - Classifications of QoS solutions- Classifications of QoS Approaches, Layer-Wise Classification of Existing QoS Solutions,

**MAC Layer Solutions**- Cluster TDMA, IEEE802.11e, IEEE802.11 MAC Protocol - Distributed Coordination Function, Point Coordination Function, QoS Support Mechanisms of IEEE802.11e, Enhanced Distributed Coordination Function, Hybrid Coordination Function.

**UNIT III**

**NETWORK LAYER SOLUTIONS**

QoS Routing Protocols, Ticket-Based QoS Routing Protocol, Predictive Location-Based QoS Routing Protocol, Trigger-Based Distributed QoS Routing Protocol, QoS-Enabled Ad Hoc On-Demand Distance Vector Routing Protocol, Bandwidth Routing Protocol, On-Demand QoS Routing Protocol, On-Demand Link-State Multipath QoS Routing Protocol, Asynchronous Slot Allocation Strategies

**UNIT IV**

**QoS frame work for Ad Hoc Wireless Networks**

QoS Models-Flexible QoS Model for Mobile Ad Hoc Networks Advantages and Disadvantages

QoS Resource Reservation Signaling-MRSVP: A Resource Reservation Protocol for Cellular Networks, Limitations of Adapting MRSVP for Ad Hoc Wireless Networks.

INSIGNIA-Operation of INSIGNIA Framework, Releasing Resources in INSIGNIA, Route Maintenance, Advantages and Disadvantages, INORA- Coarse Feedback Scheme, Class-Based Fine Feedback Scheme, Advantages and Disadvantages.

SWAN-SWAN Model, Local Rate Control of Best-Effort Traffic, Source-Based Admission Control of Real-Time Traffic, Impact of Mobility and False Admission, Regulation Algorithms- Source-Based Regulation, Network-Based Regulation, Advantages and Disadvantages of SWAN.

**UNIT V**

**Hybrid Wireless Networks**

Introduction, Next-Generation Hybrid Wireless Architectures - Classification of Hybrid Architectures, The MCN Architecture, The MADF Architecture, The iCAR Architecture, The HWN Architecture, The SOPRANO Architecture, The MuPAC Architecture, The TWiLL Architecture, The A-GSM Architecture, The DWiLL Architecture, The UCAN Architecture, A Qualitative Comparison, Open Issues in the Next-Generation Hybrid Architectures, Routing In Hybrid Wireless Networks- Base-Assisted Ad Hoc Routing, Base-Driven Multi-Hop Bridging Routing Protocol, SMCN Routing Protocol, DWiLL Routing Protocol.

**TEXTBOOKS**

1. Ad Hoc Wireless Networks Architectures and Protocols C. Siva Ram Murthy B.S. Manoj, Prentice Hall, 6th Edition, 2008.
2. High-Performance Communication Networks - Warland J., Varaiya P., Morgan Kaufmann,1996.

**REFERENCES**

1. Ad Hoc and Sensor Networks Theory and Appications- Carols de Morais Cordeiro and Dharma prakash Agrawal, World Scientific
2. Wireless and Mobile Networks Concepts and Protocols- Dr. Sunil Kumar S. Manvi and Mahabaleshwar S. Kakkasageri.
3. Telecommunications Network Design Algorithms - Kershenbaum A , Tata McGraw Hill,1993.

# MOBILE COMPUTING
## (PE-3)

**M.Tech. I Year II-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisites:** Computer Networks, Advanced Operating Systems

**Course Objectives**

1. To make the student understand the concept of mobile computing paradigm, its novel applications and limitations.
2. To understand the typical mobile networking infrastructure through a popular GSM protocol
3. To understand the issues and solutions of various layers of mobile networks, namely MAC layer, Network Layer & Transport Layer
4. To understand the database issues in mobile environments & data delivery models.
5. To understand the ad hoc networks and related concepts.
6. To understand the platforms and protocols used in mobile environment.

**Course Outcomes**

1. Able to think and develop new mobile application.
2. Able to take any new technical issue related to this new paradigm and come up with a solution(s).
3. Able to develop new ad hoc network applications and/or algorithms/protocols.
4. Able to understand & develop any existing or new protocol related to mobile environment

**UNIT I**

**Introduction**

Mobile Communications, Mobile Computing – Paradigm, Promises/Novel Applications and Impediments and Architecture; Mobile and Handheld Devices, Limitations of Mobile and Handheld Devices.GSM – Services, System Architecture, Radio Interfaces, Protocols, Localization, Calling, Handover, Security, New Data Services, GPRS, CSHSD, DECT.

**UNIT II**

**(Wireless) Medium Access Control (MAC)**

Motivation for a specialized MAC (Hidden and exposed terminals, Near and far terminals), SDMA, FDMA, TDMA, CDMA, Wireless LAN/(IEEE 802.11)

**Mobile Network Layer**

IP and Mobile IP Network Layers, Packet Delivery and Handover Management, Location Management, Registration, Tunneling and Encapsulation, Route Optimization, DHCP.

**UNIT III**

**Mobile Transport Layer**

Conventional TCP/IP Protocols, Indirect TCP, Snooping TCP, Mobile TCP, Other Transport Layer Protocols for Mobile Networks.

**Database Issues**

Database Hoarding & Caching Techniques, Client-Server Computing & Adaptation, Transactional Models, Query processing, Data Recovery Process & QoS Issues.

**UNIT IV**

**Data Dissemination and Synchronization**

Communications Asymmetry, Classification of Data Delivery Mechanisms, Data Dissemination, Broadcast Models, Selective Tuning and Indexing Methods, Data Synchronization – Introduction, Software, and Protocols

**UNIT V**

**Mobile Ad hoc Networks (MANETs)**

Introduction, Applications & Challenges of a MANET, Routing, Classification of Routing Algorithms, Algorithms such as DSR, AODV, DSDV, Mobile Agents, Service Discovery.

**Protocols and Platforms for Mobile Computing**

WAP, Bluetooth, XML, J2ME, JavaCard, PalmOS, Windows CE, Symbian OS, Linux for Mobile Devices, Android.

**TEXTBOOKS**

1. Jochen Schiller, "Mobile Communications", Addison-Wesley, Second Edition, 2009.
2. Raj Kamal, "Mobile Computing", Oxford University Press, 2007, ISBN: 0195686772

**REFERENCES**

1. The CDMA 2000 System for Mobile Communications – Vieri Vaughi, Alexander Damn Jaonvic – Pearson.
2. Adalestein - Fundamentals of Mobile & Parvasive Computing, 2008, TMH.

# ARTIFICIAL INTELLIGENCE
## (PE-3)

**M.Tech. I Year II-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite**

**Course Objectives**

1. To learn the difference between optimal reasoning vs human like reasoning
2. To understand the notions of state space representation, exhaustive search, heuristic search along with the time and space complexities
3. To learn different knowledge representation techniques
4. To understand the applications of Al: namely Game Playing, Theorem Proving, Expert Systems, Machine Learning and Natural. Language Processing

**Course Outcomes**

1. Possess the ability to formulate an efficient problem space for a problem expressed in English.
2. Possess the ability to select a search algorithm for a problem and characterize its time and space complexities.
3. Possess the skill for representing knowledge using the appropriate technique.
4. Possess the ability to apply Al techniques to solve problems of Game Playing, Expert Systems, Machine Learning and Natural Language Processing.

**UNIT I**

Introduction, History, Intelligent Systems, Foundations of AI, Sub areas of AI, Applications. Problem Solving – State-Space Search and Control Strategies: Introduction, General Problem Solving, Characteristics of Problem, Exhaustive Searches, Heuristic Search Techniques, Iterative-Deepening A*, Constraint Satisfaction. Game Playing, Bounded Look-ahead Strategy and use of Evaluation Functions, Alpha-Beta Pruning

**UNIT II**

**Logic Concepts and Logic Programming**

Introduction, Propositional Calculus, Propositional Logic, Natural Deduction System, Axiomatic System, Semantic Tableau System in Propositional Logic, Resolution Refutation in Propositional Logic, Predicate Logic, Logic Programming. Knowledge Representation: Introduction, Approaches to Knowledge Representation, Knowledge Representation using Semantic Network, Extended Semantic Networks for KR, Knowledge Representation using Frames.

**UNIT III**

**Expert System and Applications**

Introduction, Phases in Building Expert Systems, Expert System Architecture, Expert Systems Vs Traditional Systems, Truth Maintenance Systems, Application of Expert Systems, List of Shells and Tools. Uncertainty Measure – Probability Theory: Introduction, Probability Theory, Bayesian Belief Networks, Certainty Factor Theory, Dempster-Shafer Theory.

**UNIT IV**

**Machine-Learning Paradigms**

Introduction. Machine Learning Systems.Supervised and Unsupervised Learning. Inductive Learning. Learning Decision Trees (Text Book 2), Deductive Learning. Clustering, Support Vector Machines.

Artificial Neural Networks: Introduction, Artificial Neural Networks, Single- Layer Feed-Forward Networks, Multi-Layer Feed-Forward Networks, Radial- Basis Function Networks, Design Issues of Artificial Neural Networks, Recurrent Networks.

**UNIT V**

**Advanced Knowledge Representation Techniques**

Case Grammars, Semantic Web Natural Language Processing: Introduction, Sentence Analysis Phases, Grammars and Parsers, Types of Parsers, Semantic Analysis, Universal Networking Knowledge.

**TEXTBOOKS**

1. Saroj Kaushik. Artificial Intelligence. Cengage Learning, 2011.
2. Russell, Norvig: Artificial intelligence, A Modern Approach, Pearson Education, Second Edition. 2004.

**REFERENCES**

1. Rich, Knight, Nair: Artificial intelligence, Tata McGraw Hill, Third Edition 2009.

# ADVANCED COMPUTER NETWORKS
## (PE-3)

**M.Tech. I Year II-Semester**

| L | T | P | C |
|---|---|---|---|
| 3 | 0 | 0 | 3 |

**Prerequisite:** Computer Networks

**Course Objectives**

1. To study the WLAN and WPAN architecture and protocols
2. To know about WiMAX services, 802.16 standard, cellular telephony & satellite networks.
3. To study the techniques to improve QoS.in Networks
4. To learn about the basic concepts of Ad hoc wireless Networks
5. To know about various Routing Protocols in Ad hoc Networks.
6. To learn the concepts of Wireless Sensor Networks, architecture and various data dissemination and data gathering techniques

**Course Outcomes**

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

1. Acquire the knowledge about Wireless LANs, Bluetooth and WiMAX standards, architecture and their sub-layers.
2. Understand congestion control mechanisms and techniques to improve Quality of Service in switched networks
3. Get the basic concepts of Ad hoc wireless networks and its protocols and issues related to QoS, energy management, scalability and Security.
4. Explain about Wireless Sensor Network architecture, data dissemination & data gathering techniques and will be able to address the issues and challenges in designing Sensor Networks.

**Unit I**

**Wireless LANs**

Architectural Comparison, Characteristics, Access Control, IEEE 802.11 Project: Architecture, MAC Sub layer, Addressing Mechanism, Physical Layer

**Bluetooth**

Architecture, Bluetooth Layers

**WiMAX**

Services, IEEE Project 802.16, Cellular Telephony: operation,1G,2G,3G,4G, Satellite Networks, GEO, MEO and LEO Satellites

**Unit II**

**Congestion Control and Quality of Service**

Data Traffic, Congestion, Congestion Control, Quality of Service, Techniques to Improve QoS, Integrated Services, Differentiated Services, QoS in Switched Networks

**Queue Management**

Passive-Drop trial, Drop front, Random drop, Active- early Random drop, Random Early detection.

**Unit III**

**AD HOC WIRELESS NETWORKS**

Introduction, Cellular and Ad hoc Wireless Networks, Application of Ad Hoc Wireless Networks, Issues in Ad Hoc Wireless Networks, Medium Access Scheme, Routing, Multicasting, Transport Layer

Protocols, Pricing Scheme, Quality of Service Provisioning, Self-Organization, Security, Addressing and Service Discovery, Energy Management, Scalability, Deployment Considerations, Ad Hoc Wireless Internet

**Unit IV**

**Quality of Service in Ad Hoc Wireless Networks**

Introduction, Real Time Traffic Support in Ad Hoc Wireless Networks, QoS Parameters in Ad Hoc Wireless Network, Issues and Challenges in providing QoS in Ad Hoc Wireless Networks, Classification of QoS Solutions: MAC Layer Solutions, Cluster TDMA, IEEE 802.11e, DBASE, Network Layer Solutions, QoS Routing Protocols, Ticket Based QoS Routing Protocol, Predictive Location Based QoS routing protocol, Trigger Based Distributed QoS Routing Protocol, QoS enabled AODV Routing Protocol, Bandwidth QoS Routing Protocol, On Demand QoS Routing Protocol, On Demand Link-State Multipath QoS Routing Protocol, Asynchronous Slot Allocation Strategies. QoS Frameworks for Ad Hoc Wireless Networks.

**Unit V**

**Wireless Sensor Networks**

Introduction, Application of Sensor Network , Comparison with Ad hoc Wireless Networks, Issues and challenges in Designing a Sensor Network, Sensor Network Architecture, Layer Architecture, Cluster Architecture, Data Dissemination Flooding, Gossiping, Rumor Routing, Sequential Assignment Routing, Direct Diffusion, Sensor Protocols for Information via Negotiation, Cost- Field Approach, Geography Hash Table, Small Minimum Energy Communication Network, Data Gathering, Direct Transmission, Power Efficient Gathering for Sensor Information Systems, Binary Scheme, Chain Based Three-Level Scheme.

**TEXTBOOKS**

1. Ad Hoc Wireless Networks: Architectures and Protocols - C. Siva Ram Murthy and B.S.Manoj, 2004, PHI
2. Data Communications and Networking - B. A.Forouzan, 5th , 2013, TMH.

**REFERENCES**

1. Data Communications and Computer Networks - Prakash C. Gupta, 2006, PHI.
2. Data and Computer Communications - William Stallings, 8th ed., 2007, PHI.

**WIRELESS SENSOR NETWORKS**

(PE-4)

**M.Tech. I Year II-Semester**

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**Prerequisite:** 1.Computer Networks

**UNIT 1:**

**Introduction:** Components of a wireless sensor node, Motivation for a Network of Wireless Sensor Nodes, Classification of sensor networks, Characteristics of wireless sensor networks, Challenges of wireless sensor networks, Comparison between wireless sensor networks and wireless mesh networks, Limitations in wireless sensor networks, Design challenges, Hardware architecture, Applications.

**Node Architecture:** The Sensing Subsystem, the Processor Subsystem, Communication Interfaces, Prototypes.

**UNIT –2:**

**Medium Access Control Protocols for Wireless Sensor Networks**

Introduction,Background,Fundamentals of MAC Protocols, Performance Requirements, Common Protocols, MAC Protocols for WSNs, Schedule-Based Protocols, Random Access-Based Protocols, Sensor-MAC Case Study, Protocol Overview, Periodic Listen and Sleep Operations, Schedule Selection and Coordination, Schedule Synchronization, Adaptive Listening, Access Control and Data Exchange, Message Passing, IEEE 802.15.4 LR-WPANs Standard Case Study, PHY Layer, MAC Layer

**UNIT – 3:**

**Routing Protocols for Wireless Sensor Networks**

Introduction, Background, Data Dissemination and Gathering, Routing Challenges and Design Issues in Wireless Sensor Networks, Network Scale and Time-Varying Characteristics, Resource Constraints, Sensor Applications Data Models, Routing Strategies in Wireless Sensor Networks, WSN Routing Techniques, Flooding and Its Variants, Sensor Protocols for Information via Negotiation, Low-Energy Adaptive Clustering Hierarchy, Power-Efficient Gathering in Sensor Information Systems, Directed Diffusion, Geographical Routing.

**UNIT – 4:**

**Transport Control Protocols for Wireless Sensor Networks**

Traditional Transport Control Protocols, TCP (RFC 793), UDP (RFC 768), Mobile IP, Feasibility of Using TCP or UDP for WSNs, Transport Protocol Design Issues, Examples of Existing Transport Control Protocols, CODA (Congestion Detection and Avoidance), ESRT (Event-to-Sink Reliable Transport), RMST (Reliable Multisegment Transport), PSFQ (Pump Slowly, Fetch Quickly), GARUDA, ATP (Ad Hoc Transport Protocol), Problems with Transport Control Protocols, Performance of Transport Control Protocols, Congestion, Packet Loss Recovery.

**UNIT – 5:**

**Node and Network Management:** Power Management, Local Power Management aspects, Dynamic Power Management, Conceptual Architecture.

**Time Synchronization:** Clocks and the Synchronization Problem, Time Synchronization in Wireless Sensor Networks, Basics of Time Synchronization, Time Synchronization Protocols.

**Localization:** Ranging Techniques, Range-Based Localization, Range-Free Localization, Event- Driven Localization.

**TEXT BOOKS:**

1. WaltenegusDargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks: Theory and Practice”, Wiley 2010.
2. Kazem Sohraby, Daniel Minoli ,Taieb Znati,” Wireless Sensor Networks, Technology, Protocols, and Applications” Wiley 2007
3. Mohammad S. Obaidat, SudipMisra, “Principles of Wireless Sensor Networks”, Cambridge, 2014.

4. Holger Karl, Andreas Willig, "Protocols and Architectures for wireless sensor networks" Wiley, 2005.

**REFERENCE BOOKS:**

1. Ian F. Akyildiz, Mehmet Can Vuran , "Wireless Sensor Networks", Wiley, 2010.
2. C.S. Raghavendra, K.M. Sivalingam, TaiebZnati, "Wireless Sensor Networks", Springer, 2010
3. C. Sivarammurthy& B.S. Manoj, "Adhoc Wireless Networks",1st Edition, PHI,2004.
4. Fei Hu., Xiaojun Cao, "Wireless Sensor Networks",1st Edition, CRC Press, 2013.
5. Carlos de MoraisCordeiro&DharmaprakashAgarwal," Adhoc& wireless sensor, 2nd edition, World Scientific & Imperial college press, 2006.
6. Sunil Kumar, S. Manvi, Mahabalaseshwar, "Wireless & sensor mobile networks concepts and protocols" Wiley, 2010.

## COMMUNICATION AND NETWORK TECHNOLOGIES FOR IOT

**(PE–4)**

**M.Tech. I Year II-Semester**

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**UNIT-I**

**Introduction to IoT**

Flavor of the Internet of Things, Technology of the Internet of Things & Enchanted Objects, Design Principles for Connected Devices, Calm and Ambient Technology, Web Thinking for Connected Devices, First-Class Citizens On The Internet, Thinking About Prototyping, Sketching, Familiarity, Prototypes and Production, Open Source versus Closed Source, Closed Source for Mass Market Projects, Tapping into the Community.

**UNIT-II**

**IoT Paradigm**,

Why the IoT Is Strategically Sound, Brewing and Blossoming Trends in IT Space, Envisioning the Internet of Things Era, Device-to-Device/Machine-to-Machine Integration Concept, Explaining the Aspect of Device-to-Cloud (D2C) Integration, Describing the Sensor-to-Cloud Integration Concept, Emerging IoT Flavors, Prominent IoT Realization Technologies, Cloud-to-Cloud (C2C) Integration, and Device-to-Cloud (D2C) Integration.

**UNIT-III**

**Wireless Technologies for IoT Ecosystem**

Introduction, Architecture for IoT Using Mobile Devices, Mobile Technologies for Supporting IoT Ecosystem, Energy Harvesting for Power Conservation in the IoT System, Mobile Application Development Platforms and Use of IoT, Low Power Wide Area Networking Technologies, Direct & Indirect Device Connectivity Topology of LPWAN, LoRa WaN.

**UNIT-IV**

**Protocols for the IoT Ecosystem**

Introduction, Layered Architecture for IoT, Protocol Architecture of IoT, Routing Protocol, IEEE 802.15.4, Bluetooth Low Energy, ZigBee, Protocols for IoT Service Discovery, Prominent IoT Service Discovery Products, IP Addresses, Infrastructure Protocols, Static IP Address Assignment, Dynamic IP Address Assignment, IPV6, TCP and UDP Ports, Application Layer Protocols.

**Enablement Platforms for IoT Applications**

IoT Building Blocks, IoT or Sensor Data Gateway, Application Enablement Platforms, IoT Application Enablement Platforms, IoT and M2M Sensor Data Platform, IoT Data Analytics Platforms, IoT Data Virtualization Platforms, IoT Edge Data Analytics.

**UNIT-V**

**Integration Technologies of IoT**

Introduction, IoT Portion for Smarter Enterprises and Environments, Sensor and Actuator Networks, IoT Device Integration Concepts, Device Profile for Web Services, Open Service Gateway, Scalability, Robustness, openHAB, Remote OSGi, Device Integration Protocols and Middleware, Data Distribution Bus, Message Queue Telemetry Transport, Extensible Messaging and Presence Protocol, Protocol Landscape for IoT.

**Smart Use Cases of IoT**

Introduction, Collaboration Platforms, Geospatial Platforms, Open Access to Public Data, Smart Industrial Use Cases of IoT, Smart Lighting for Energy Conservation, Smart Transportation Systems, Smart Homes/Buildings, Smarter Homes—Middleware Platforms, Smart Education Systems Using Wearable Devices

**Text Book**

1. "The Internet of Things Enabling, Technologies, Platforms and Applications" by Pethuru Raj and Anupama C.Raman CRC Press Taylor & Francis Group.
2. "Designing the Internet of Things " by Adrain McEwen , Hakim Cassimally Wiley 1st Edition

# DESIGN OF FAULT TOLERANT SYSTEMS
## (PE–4)

**M.Tech. I Year II-Semester**

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**Prerequisite:** Digital System Design with PLDS

**Course Objectives**

1. To provide or broad understanding of fault diagnosis and tolerant design Approach.
2. To illustrate the framework of test pattern generation using semi and full automatic approach.

**Course Outcomes**

On completion of this course the student will be able to:

1. To acquire the knowledge of fundamental concepts in fault tolerant design.
2. Design requirements of self check-in circuits
3. Test pattern generation using LFSR
4. Design for testability rules and techniques for combinational circuits
5. Introducing scan architectures.
6. Design of built-in-self test.

**UNIT I**

**Fault Tolerant Design**

Basic concepts: Reliability concepts, Failures & faults, Reliability and Failure rate, Relation between reliability and mean time between failure, maintainability and availability, reliability of series, parallel and parallel-series combinational circuits.

Fault Tolerant Design: Basic concepts-static, dynamic, hybrid, triple modular redundant system (TMR), 5MR reconfiguration techniques, Data redundancy, Time redundancy and software Redundancy concepts. [TEXTBOOK-1]

**UNIT II**

**Self Checking circuits & Fail safe Design**

Self Checking Circuits: Basic concepts of self checking circuits, Design of Totally self checking checker, Checkers using m out of n codes, Berger code, Low cost residue code.

Fail Safe Design: Strongly fault secure circuits, fail safe design of sequential circuits using partition theory and Berger code, totally self checking PLA design. [TEXTBOOK-1]

**UNIT III**

**Design for Testability**

Design for testability for combinational circuits: Basic concepts of Testability, Controllability and observability, The Reed Muller's expansion technique, use of control and syndrome testable designs.

**Design for testability by means of scan**

Making circuits Testable, Testability Insertion, Full scan DFT technique- Full scan insertion, flip-flop Structures, Full scan design and Test, Scan Architectures-full scan design, Shadow register DFT, Partial scan methods, multiple scan design, other scan designs.[TEXTBOOK-2]

**UNIT IV**

**Logic Built-in-self-test**

BIST Basics-Memory-based BIST,BIST effectiveness, BIST types, Designing a BIST, Test Pattern Generation-Engaging TPGs, exhaustive counters, ring counters, twisted ring counter, Linear feedback shift register, Output Response Analysis-Engaging ORA's, One's counter, transition counter, parity checking, Serial LFSRs, Parallel Signature analysis, BIST architectures-BIST related terminologies, A

centralized and separate Board-level BIST architecture, Built-in evaluation and self test(BEST), Random Test socket(RTS), LSSD On-chip self test, Self –testing using MISR and SRSG, Concurrent BIST, BILBO, Enhancing coverage, RT level BIST design-CUT design, simulation and synthesis, RTS BIST insertion, Configuring the RTS BIST, incorporating configurations in BIST, Design of STUMPS, RTS and STUMPS results. [TEXTBOOK-2]

**UNIT V**

**Standard IEEE Test Access Methods**

Boundary Scan Basics, Boundary scan architecture- Test access port, Boundary scan registers, TAP controller, the decoder unit, select and other units, Boundary scan Test Instructions-Mandatory instructions, Board level scan chain structure-One serial scan chain, multiple-scan chain with one control test port, multiple-scan chains with one TDI,TDO but multiple TMS, Multiple-scan chain, multiple access port, RT Level boundary scan-inserting boundary scan test hardware for CUT, Two module test case, virtual boundary scan tester, Boundary Scan Description language. [TEXTBOOK-2]

**TEXTBOOKS**

1. Fault Tolerant & Fault Testable Hardware Design- Parag K.Lala, 1984,PHI
2. Digital System Test and Testable Design using HDL models and Architectures -Zainalabedin Navabi, Springer International Edition.

**REFERENCES**

1. Digital Systems Testing and Testable Design-Miron Abramovici, Melvin A.Breuer and Arthur D. Friedman, Jaico Books
2. Essentials of Electronic Testing- Bushnell & Vishwani D.Agarwal,Springers.
3. Design for Test for Digital IC's and Embedded Core Systems- Alfred L. Crouch, 2008, Pearson Education.

**ARTIFICIAL NEURAL NETWORKS & DEEP LEARNING**
**(PE–4)**

**M.Tech. I Year II-Semester**

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**UNIT-I :**

**Fundamental Concepts, Models & Learning Rules of Artificial Neural Systems**

**Artificial Neuron Models:** Biological Neuron, Mcculloch-pitts Neuron Model, Activation Functions, Boltzman Neuron Model, Models of Artificial Neural Networks : Feed forward Network, Feedback Network, Neural Processing, Learning and Adaption : Supervised, Unsupervised and Reinforcement Learning.

**Neural Network Learning Rules:** Hebbian Learning Rule, Perception Learning Rule, Delta Learning Rule Widrow –Hoff Rule, Correlation Learning Rule, Winner –Take – All Learning Rule, Outstar Learning Rule, Summary of Learning Rules.

**Single Layer Feed Forward Networks:**

Classification Model, Features and Decision Regions, Discriminant Functions, linear Machine and Minimum Distance Classification, Non – Parametric Training Concept, Training and Classification Using the Discrete Perceptron: Algorithm and Examples. Single Layer Continuous Perceptron Networks for Linearly Separable Classification, Perceptron Convergence Theorem, Multi Category Single Layer Perceptron Networks.

**UNIT –II**

**Multi Layer Feed Forward Networks:**

Linearly Non- Separable, Pattern Classification, Delta Learning Rule for Multi Perception, Generalized Delta Learning Rule. Feed Forward Recall and Error Back Propagation Training ; Examples of Error Back Propagation, Training Errors, Learning Factors ; Initial Weights Cumulative Weight Adjustment Versus Incremental Updating, Steepness of Activation Function, Learning Constant, Momentum Method, Network Architecture Versus Data Representation, Necessary Number of Hidden Neurons. Application of Back Propagation Networks in Pattern Recognition and Image Processing.

**UNIT –III :**

**Associative Memories:**

Basic Concepts of Linear Associative, Basic Concepts of Dynamical Systems, Mathematical Foundation of Discrete Time Hop field Networks. Mathematical Foundation of Gradient- Type Hop Field Networks, Transient Response of Continuous Time Networks, Example Solution of Optimization Problems; Summing Networks with Digital Outputs, Minimization of the Traveling salesman tour length, Solving Simultaneous Linear Equations, Boltzman machines, Bidirectional Associative Memory; Multidirectional Associative Memory, Associative Memory of Spatio-temporal Patterns.

**UNIT – IV :**

**Matching and Self-Organizing Networks:**

Hamming net and MAXNET Unsupervised learning of clusters, Clustering and similarity measures Winner take all learning, recall mode, initializing of weights, separability limitations, Counter propagation networks, Feature mapping: Self organizing feature maps, Cluster discovery networks (ART1).

**UNIT – V :**

Introduction to Simple Deep Feed forward Neural Network, Hidden Units and their Activation Functions, Architecture Design, Regularization Methods for Deep learning: Early Slopping, Drop out.

**Convolutional Neural Networks:** Introduction to CNN, Convolution operation, Pooling, Normalization, Application in Computer Vision-Image Net, Sequence Modeling- VGG Net, LeNet.

**Recurrent Neural Networks:** RNN Topologies, Difficulty in Training RNN, Long Short Term Memory(LSTM):Architecture and Learning Strategy.

**TEXT BOOKS:**

1. Introduction to Artificial Neural Systems – J.M.Zurada, Jaico Publishers.
2. Ian Good fellow, Yoshva Bengio, Aaron Courville, Deep Learning,MIT Press,2016.
3. Introduction Neural Networks using MATLAB 6.0 – S.N. Shivanandam, S. Sumathi, S. N.Deepa, 1/e, TMH,New Delhi

**REFERENCE BOOKS:**

1. Elements of Artificial Neural Networks – Kishan Mehrotra, Chelkuri K. Mohan, Sanjay Ranka, Penram International.
2. Artificial Neural Network – Simon Haykin,2nd Ed., Pearson Education
3. Artificial Neural Networks – Dr.B. Yagananarayana, 1999,PHI, New Delhi.
4. Fundamental of Neural Networks- Laurene Fausett.

## DIGITAL CONTROLLERS AND APPLICATIONS LAB

**M.Tech. I Year II-Semester**

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Perform the following experiments in real time by interfacing with the related hardware.

1.PWM pulse generation
2.Three phase voltage monitoring using A/D converter.
3.Three phase current monitoring using A/D converter.
4.Speed monitoring of AC motor.
5.Sine PWM pulse generation.
6.Inverter output voltage control.
7.Control of AC motor using UFD.
8. Control of DC motor using DC drive.

## FPGA DESIGN LAB

**M.Tech. I Year II-Semester**

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**Design, Simulate, Synthesize the following circuits targeting 7 series FPGA**

1. 8-bit-bit low power high speed adder a. Carry save adder b. Carry skip adder
2. High Speed and low power 16/32/64-bit adder using an 8-bit adder
3. 8x8 Braun multiplier
4. 16x16 bit multiplier using IP Core.
5. A Clock divider
6. FIFO using IP core
7. 8 bit ALU
8. Circular Buffer
9. 2D RAM Array
10. Implement MAC unit targeting Artix 7 FPGA employing low power techniques while meeting target speed

# VALUE EDUCATION
## (AUDIT COURSE-II)

**M.Tech. I Year II-Semester**

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**Course Objectives**: To help the students:
1. Understand value of education and self- development
2. Imbibe good values
3. Know about the importance of character

**Course outcomes:** Students will be able to:
1. Acquire knowledge about self-development
2. Learn the importance of Human values
3. Develop the overall personality

**Syllabus**

**Unit1** Values and Self-development – Social Values and Individual Attitudes. Work Ethics, Indian Vision of Humanism. Ethical Standards and Principles. Value Judgments

**Unit2** Importance of Cultivating Values. Sense of Duty. Devotion, Self-reliance, Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. National Unity. Patriotism. Love for Nature, Discipline

**Unit 3** Personality and Behavior Development - Soul and Scientific Attitude- Integrity and Discipline. Punctuality- Compassion and Benevolence - Positive Thinking- Composure and Equipoise- Dignity of Labour. Universal Brotherhood and Religious Tolerance. True Friendship. Happiness Vs Suffering- Aware of Self-destructive Habits. Association and Cooperation. Eco-friendly Consciousness

**Unit4** Character and Competence – Values of Scriptures- Self-management and Good health. Science of Reincarnation. Equality, Nonviolence, Humility, Role of Women- Secular Thinking- Mind your Mind, Self-control- Non Ethnocentric Behavior

**Suggested Readings**

1. Chakroborty, S.K. "*Values and Ethics for organizations Theory and practice*", Oxford University Press, New Delhi. 1998.
2. Dostoyevsky, Fyodor, Constance Garnett, and Ernest J. Simmons. *Crime and Punishment*. New York: Modern Library, 1950. Print.
3. Galsworthy, John. *Justice***.** Czechia, Good Press, 2019.
4. TED Talks

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# ROBOTICS

**(PE–5)**

**M.Tech. II Year I-Semester**

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**Prerequisite:**
Introduction to Signals, Systems & Circuits
Analytical Foundations of Electronics and Communication Engineering,
Linear Systems
Elements of Control

**Course Objectives**
1. This introductory course is valuable for students who wish to learn about robotics through a study of industrial robot systems analysis and design.
2. This course is suited to students from engineering and science backgrounds that wish to broaden their knowledge through working on a subject that integrates multi-disciplinary technologies.

**Course Outcomes**
Upon the completion of this course, the student will be able to:
1. Describe the various elements that make an industrial robot system
2. Discuss various applications of industrial robot systems
3. Analyze robot manipulators in terms of their kinematics, kinetics, and control
4. Model robot manipulators and analyze their performance, through running simulations using a MATLAB-based Robot Toolbox
5. Select an appropriate robotic system for a given application and discuss the limitations of such a system
6. Program and control an industrial robot system that performs a specific task.

**UNIT – I**
**Introduction & Basic Definitions:** History pf robots-robot anatomy, Coordinate Systems , Human arm Characteristics , Cartesian , Cylindrical, Polar, coordinate frames , mapping transform.

**UNIT – II**
**Kinematics – Inverse Kinematics:** Kinematics , Mechanical structure and notations , description of links and joints , Denavit Hatenberg notation , manipulator transformation matrix , examples inverse kinematics.

**UNIT – III**
**Differential Motion – Statics – Dynamic Modeling:** Velocity Propagation along links, manipulator Jacobian – Jacobian singularities – Lagrange Euler formulation Newton Euler formulation basics of trajectory planning.

**UNIT – IV**
**Robot Systems : Actuators Sensors and Vision:** Hydraulic and Electrical Systems Including Pumps, valves, solenoids, cylinders, stepper motors, Encoders and AC Motors Range and use of sensors, Microswitches, Resistance Transducers, Piezo-electric, Infrared and Lasers Applications of Sensors : Reed Switches, Ultrasonic, Barcode Readers and RFID – Fundamentals of Robotic vision.

**UNIT – V**

**Robots and Applications.: I**ndustrial Applications – Processing applications – Assembly applications, Inspection applications , Non Industrial applications.

**TEXTBOOKS**

1. Robotics and Control : R.K. Mittal and I.J. Nagarath, TMH 2003.
2. Introduction to Robotics – P.J. Mckerrow, ISBN: 0201182408
3. Introduction to Robotics – S. Nikv, 2001, Prentice Hall,
4. Mechatronics and Robotics: Design & Applications – A. Mutanbara, 1999, CRC Press.

**REFERENCES**

1. Robotics – K.S. Fu, R.C. Gonzalez and C.S.G. Lee, 2008, TMH.

# EMBEDDED SOFTWARE ENGINEERING
## (PE – 5)

**M.Tech. II Year I-Sem**

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**UNIT I**

**Software Engineering of Embedded and Real-Time Systems**

Software engineering, Embedded systems, Embedded systems are reactive systems, Real-time systems, Soft and Hard Real-Time systems, Efficient execution and the execution environment, Resource management, Challenges in real-time system design.

**UNIT II**

The embedded system software build process, Distributed and multi-processor architectures, Software for embedded systems, Super loop architecture, Power-save super loop, Window lift embedded design, Hardware abstraction layers (HAL) for embedded systems, HW/SW prototyping, Industry design chain, Different types of virtual prototypes, Architecture virtual prototypes, Software virtual prototypes.

**UNIT III**

**Events, Triggers and Hardware Interface to Embedded Software**

Events and triggers, Event system, Event handle, Event methods, Event data structure, Reentrancy, Disable and enable interrupts, Semaphores, Implementation with Enter/ExitCritical, Event processing, Integration, Triggers, Blinking LED, Design idea, Tick timer, Trigger interface, Trigger descriptor, Data allocation, SetTrigger, IncTicks, Making it reentrant, Initialization, Real-time aspects, Introduction to Hardware Interface, Collaboration, System integration, Launching tasks in hardware, Debug hooks, Compile-time switches, Build-time switches, Run-time switches, Self-adapting switches, Difficult hardware interactions, Testing and troubleshooting.

**UNIT IV**

**Embedded Software Programming and Operating Systems**

Introduction, Principles of high-quality programming, Readability, Maintainability, Testability, Starting the embedded software project, Libraries from third parties, Team programming guidelines, Syntax standard, Conditional compilation, Foreground/background systems, Real-time kernels, RTOS (real-time operating system), Critical sections, Task management, Preemptive scheduling, Context switching, Interrupt management, Non-kernel-aware interrupt service routine (ISR), Processors with multiple interrupt priorities, The clock tick (or system tick), Wait lists, Time management, Resource management, Synchronization, Message passing, Flow control,
Clients and servers, Memory management

**UNIT V**

**Software Reuse and Performance Engineering in Embedded Systems**

Kinds of software reuse, Implementing reuse by layers,Arbitrary extensibility, Ebedded Software for Performance, The code optimization process, Using the development tools, Compiler optimization

**TEXTBOOKS**

1. Software Engineering for Embedded Systems: Methods, Practical Techniques, and Applications, by Oshana, Robert; Kraeling, Mark, "Newnes" Publishers, 2013.

**SYSTEM DESIGN ASPECTS OF IOT**

**(PE-5)**

**M.Tech. II Year I-Semester**

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**Pre-requisite:**

**Course Objectives**

The objectives of the course are to

1. Understand the concepts of Internet of Things and able to build IoT applications.
2. Learn the programming and use of Arduino and Raspberry Pi boards.
3. Known about data handling and analytics in SDN.

**Course Outcomes**

Upon completing this course, the student will be able to

1. Known basic protocols in sensor networks.
2. Program and configure Arduino boards for various designs.
3. Python programming and interfacing for Raspberry Pi.
4. Design IoT applications in different domains.

**UNIT I**

Definition and Characteristics of IoT, Physical Design of IoT: Things in IOT, IOT Protocols, Logical Design of IoT: IOT functional Blocks, Communication Models, Communication APIs, IOT levels and deployment templates, Sensor Networks, Sensors and Actuators, ADCs and DACs

Machine-to-Machine Communications, Difference between IoT and M2M, Interoperability in IoT, Software defined Network (SDN) and NFV for IoT

**UNIT II**

**Domain Specific IOTs**

Home Automation: Smart Lighting, Smart Appliances, Intrusion Detection, Smoke/ Gas detector; Smart Cities: Smart Parking, Smart Lighting,Smart Roads, Structural Health Monitoring, Surveillance, Emergency Response, Environment: Weather Monitoring, Air Pollution Monitoring, Noise Pollution Monitoring, Forest Fire Detection, River Floods Detection, Energy: Smart Grids, Renewable Energy Systems, Prognostics, Retail: Inventory Management, Smart Payments, Smart Vending Machines, Logistics: Route Generation and Scheduling, Fleet Tracking, Shipment Monitoring, Remote Vehicle Diagnostics, Agriculture: Smart Irrigation, Green House Control, Industry: Machine Diagnosis and Prognosis, Indoor Air Quality Monitor, Health and Life Style: Health and Fitness Monitoring, Wearable Electronics.

**UNIT III**

**Arduino and IOT**:

Introduction XBee module, Interfacing with XBee, Pin diagram, updating Firmware: AT Commands and API, Configuring XBee as Coordinator, Router, Building an XBee-ZB Mesh Network and Testing.

Arduino Programming: Arduino models and Clones,Arduino IDE, Integration of Sensors and Actuators with Arduino :Sketch for blinking of LED, Building an Aurdino Temperature and Humidity Sensor,Using an Arduino as a Data Collector for XBee Sensor Nodes

**UNIT IV**

**Applied Python Programming with Raspberry Pi**: Introduction to Python programming, Introduction to Raspberry Pi modules, Installing a Boot image in Pi, GPIO pins of Pi, Sketch for blinking of LED using Pi, Building an Raspberry Pi Temperature and Humidity Sensor,Building a Raspberry Barometric Pressure Sensor Node, Creating a Raspberry Pi Data Collector for XBee Sensor Nodes,

**UNIT V**

**Data Analytics for IOT**

Apache Hadoop: Map Reduce Programming Model, Hadoop Map Reduce Job Execution, Map Reduce Job Execution Workflow, Hadoop Cluster Setup, Using Hadoop MapReduce for Batch Data Analysis: Hadoop YARN, Apache Oozie: Setting up Oozie, Oozie Workflows for IoT Data Analysis, Apache Spark, Apache Storm : Setting up a Storm Cluster, Using Apache Storm for Real-time Data Analysis: REST-Based approach, WebSocket-based Approach.

**TEXT BOOKS**

1. Internet of Things: A Hands-on Approach, by ArshdeepBahga and Vijay Madisetti.
2. Beginning Sensor networks with Arduino and Raspberry Pi – Charles Bell, Apress, 2013.

**REFERENCES**

1. The Internet of Things: Enabling Technologies, Platforms, and Use Cases, by Pethuru Raj and Anupama C. Raman (CRC Press)
2. Fundamentals of Wireless Sensor Networks: Theory and Practice - WaltenegusDargie, Christian Poellabauer.
3. Make sensors: Terokarvinen, kemo, karvinen and villeyvaltokari, 1st Ed., MakerMedia, 2014.

# HARDWARE AND SOFTWARE CO-DESIGN
## (PE-5)

**M.Tech. II Year I-Semester**

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**Prerequisite:** Advanced Computer Architecture, Embedded System Design**.**

**Course Objective:**

1. To provide a broad understanding of the specific requirement of Hardware and soft ware integration for embedded system

**Course Outcomes:**

1. To acquire the knowledge on various models
2. To explore the interrelationship between Hardware and software in a embedded system
3. Acquire the knowledge of firmware development process and tools
4. Understand validation methods and adaptability.

**UNIT –I**

**Co- Design Issues:** Co- Design Models, Architectures, Languages, A Generic Co-design Methodology. **Co- Synthesis Algorithms:** Hardware software synthesis algorithms: hardware – software partitioning distributed system cosynthesis.

**UNIT –II**

**Prototyping and Emulation:** Prototyping and emulation techniques, prototyping and emulation environments, future developments in emulation and prototyping architecture specialization techniques, system communication infrastructure.

**Target Architectures:** Architecture Specialization techniques, System Communication infrastructure, Target Architecture and Application System classes, Architecture for control dominated systems (8051-Architectures for High performance control), Architecture for Data dominated systems (ADSP21060, TMS320C60), Mixed Systems.

**UNIT –III**

**Compilation Techniques and Tools for Embedded Processor Architectures:** Modern embedded architectures, embedded software development needs, compilation technologies, practical consideration in a compiler development environment.

**UNIT –IV**

**Design Specification and Verification:** Design, co-design, the co-design computational model, concurrency coordinating concurrent
computations, interfacing components, design verification, implementation verification, verification tools, interface verification

**UNIT –V**

**Languages for System – Level Specification and Design-I:** System – level specification, design representation for system level synthesis, system level
specification languages,

**Languages for System – Level Specification and Design-II:** Heterogeneous specifications and multi language co-simulation, the cosyma system and lycos system.

**TEXT BOOKS**

1. Hardware / Software Co- Design Principles and Practice – Jorgen Staunstrup, Wayne Wolf – 2009, Springer.
2. Hardware / Software Co- Design - Giovanni De Micheli, Mariagiovanna Sami, 2002, Kluwer Academic Publishers

**REFERENCES**

1. A Practical Introduction to Hardware/Software Co-design -Patrick R. Schaumont - 2010 – Springer

# PRINCIPLES OF SIGNAL PROCESSING
# (OE)

**M.Tech. II Year I-Sem**

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**Course Objectives**

1. This gives the basics of Signals and Systems required for all Engineering related courses.
2. To understand the basic characteristics of LTI systems.
3. To know the signal transmission requirements.
4. This gives basic understanding of signal statistical properties and noise source concepts.

**Course Outcomes**

Upon completing this course, the student will be able to

1. Differentiate various signal functions.
2. Understand the characteristics of linear time invariant systems.
3. Understand the concepts sampling theorem.
4. Determine the Spectral and temporal characteristics of Signals.
5. Understand the concepts of Noise in Communication systems.

**UNIT I**

**Signal Analysis**

Analogy between Vectors and Signals, Orthogonal Signal Space, Signal approximation using Orthogonal functions, Mean Square Error, Closed or complete set of Orthogonal functions, Orthogonality in Complex functions, Classification of Signals and systems, Exponential and Sinusoidal signals, Concepts of Impulse function, Unit Step function, Signum function.

**UNIT II**

**Signal Transmission through Linear Systems**

Linear System, Impulse response, Response of a Linear System, Linear Time Invariant(LTI) System, Linear Time Variant (LTV) System, Transfer function of a LTI System, Filter characteristic of Linear System, Distortion less transmission through a system, Signal bandwidth, System Bandwidth, Ideal LPF, HPF, and BPF characteristics, Convolution and Correlation of Signals, Concept of convolution in Time domain and Frequency domain, Graphical representation of Convolution.

**UNIT III**

**Sampling Theorem**

Graphical and analytical proof for Band Limited Signals, Impulse Sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, Effect of under sampling – Aliasing, Introduction to Band Pass Sampling.

**UNIT IV**

**Temporal characteristics of signals**

**C**oncept of Stationarity and Statistical Independence. First-Order Stationary Processes, Time Averages and Ergodicity, Cross Correlation and Auto Correlation of Functions, Properties of Correlation

Functions, Cross-Correlation Function and Its Properties. Power Spectrum and its Properties, Relationship between Power Spectrum and Autocorrelation Function.

**UNIT V**

**Noise sources**

Resistive/Thermal Noise Source, Arbitrary Noise Sources, Effective Noise Temperature, Noise equivalent bandwidth, Average Noise Figures, Average Noise Figure of cascaded networks, Narrow Band noise, Quadrature representation of narrow band noise & its properties.

**TEXT BOOKS**

1. Signals, Systems & Communications - B.P. Lathi , B.S. Publications, 2013.
2. Probability, Random Variables & Random Signal Principles - Peyton Z. Peebles, TMH, 4th Edition, 2001.

**REFERENCES**

1. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawabi, 2 Ed.
2. Fundamentals of Signals and Systems - Michel J. Robert, 2008, MGH International Edition.
3. Random Processes for Engineers-Bruce Hajck, Cambridge unipress,2015

4 .Statistical Theory of Communication – S.P Eugene Xavier, New Age Publications, 2003