# NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

# SCHEME OF INSTRUCTION AND SYLLABI
# FOR M.TECH PROGRAMS

## Effective from 2019-20

# DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

# NATIONAL INSTITUTE OF TECHNOLOGY WARANGAL

## VISION

Towards a Global Knowledge Hub, striving continuously in pursuit of excellence in Education, Research, Entrepreneurship and Technological services to the society

## MISSION

- Imparting total quality education to develop innovative, entrepreneurial and ethical future professionals fit for globally competitive environment.
- Allowing stake holders to share our reservoir of experience in education and knowledge for mutual enrichment in the field of technical education.
- Fostering product oriented research for establishing a self-sustaining and wealth creating centre to serve the societal needs.

## DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

## VISION

Create an Educational environment to prepare the students to meet the challenges of modern electronics and communication Industry through state of art technical knowledge and innovative approaches.

## MISSION

- To create learning, Development and testing environment to meet ever challenging needs of the Electronic Industry.
- To create entrepreneurial environment and industry interaction for mutual benefit.
- To be a global partner in training human resources in the field of chip design, instrumentation and networking.
- To associate with international reputed institution for academic excellence and collaborative research.

# MASTER OF TECHNOLOGY

# ELECTRONICS AND COMMUNICATION ENGINEERING

## Specialization: Electronic Instrumentation and Embedded Systems

## SCHEME AND SYLLABI

## COURSE CURRICULUM FOR THE M.TECH PROGRAMME IN

## ELECTRONIC INSTRUMENTATION

# GRADUATE ATTRIBUTES

The Graduate Attributes (GAs) are the knowledge skills and attitudes which the students have at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

1. Scholarship of Knowledge: Acquire in-depth knowledge of specific discipline or professional area, including wider and global perspective, with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge, and integration of the same for enhancement of knowledge.
2. Critical Thinking: Analyze complex engineering problems critically; apply independent judgment for synthesizing information to make intellectual and/or creative advances for conducting research in a wider theoretical, practical and policy context.
3. Problem Solving: Think laterally and originally, conceptualize and solve engineering problems, evaluate a wide range of potential solutions for those problems and arrive at feasible, optimal solutions after considering public health and safety, cultural, societal and environmental factors in the core areas of expertise.
4. Research Skill: Extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data, demonstrate higher order skill and view things in a broader perspective, contribute individually/in group(s) to the development of scientific/technological knowledge in one or more domains of engineering.
5. Usage of modern tools: Create, select, learn and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities with an understanding of the limitations.
6. Collaborative and Multidisciplinary work: Possess knowledge and understanding of group dynamics, recognize opportunities and contribute positively to collaborative-multidisciplinary scientific research, demonstrate a capacity for self-management and teamwork, decision-making based on open-mindedness, objectivity and rational analysis in order to achieve common goals and further the learning of themselves as well as others.
7. Project Management and Finance: Demonstrate knowledge and understanding of engineering and management principles and apply the same to one’s own work, as a member and leader in a team, manage projects efficiently in respective disciplines and multidisciplinary environments after consideration of economic and financial factors.
8. Communication: Communicate with the engineering community, and with society at large, regarding complex engineering activities confidently and effectively, such as, being able to comprehend and write effective reports and design documentation by adhering to appropriate standards, make effective presentations, and give and receive clear instructions.
9. Life-long Learning: Recognize the need for, and have the preparation and ability to engage in life-long learning independently, with a high level of enthusiasm and commitment to improve knowledge and competence continuously.
10. Ethical Practices and Social Responsibility: Acquire professional and intellectual integrity, professional code of conduct, ethics of research and scholarship, consideration of the impact of research outcomes on professional practices and an understanding of responsibility to contribute to the community for sustainable development of society.
11. Independent and Reflective Learning: Observe and examine critically the outcomes of one’s actions and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

# PROGRAM EDUCATIONAL OBJECTIVES

| PEO | PROGRAM EDUCATIONAL OBJECTIVES (PEOs) |
|---|---|
| PEO1 | Analyze the characteristics, process of transduction and design & develop suitable signal conditioning circuits for the accurate measurements of various physical variables. |
| PEO2 | Estimate the errors, quality & reliability and analyze the total system stability in electronic instrumentation systems. |
| PEO3 | Acquire knowledge and skill in the state of art technologies by fostering innovation and invention to meet current challenges in the field of industrial automation. |
| PEO4 | Enhance knowledge to design & develop advanced instrumentation systems for remote monitoring and control applications. |
| PEO5 | Communicate effectively and convey ideas using modern engineering tools and demonstrate leadership skills in multidisciplinary environment. |
| PEO6 | Perceive lifelong learning as a means of enhancing knowledge base and skills necessary to contribute to the improvement of their profession and community. |

## Mapping of Mission statements with program educational objectives

| **Mission** | **PEO1** | **PEO2** | **PEO3** | **PE04** | **PEO5** | **PE06** |
|---|---|---|---|---|---|---|
| To create learning, Development and testing environment to meet ever challenging needs of the Electronic Industry. | 3 | 3 | 3 | 3 | | |
| To create entrepreneurial environment and industry interaction for mutual benefit. | 1 | 2 | 2 | 3 | | |
| To be a global partner in training human resources in the field of chip design, instrumentation and networking. | | 1 | 1 | 3 | 2 | 3 |
| To associate with international reputed institution for academic excellence and collaborative research. | | | | 2 | 3 | 3 |

# PROGRAM OUTCOMES

| PO.Nos | **Program Outcomes (POs)** |
|---|---|
| PO1 | Analyze static and dynamic characteristics of sensors/transducers and their Transduction Principles in Instrumentation systems. |
| PO2 | Analyze and design suitable signal conditioning circuits for transducers from the given specifications. |
| PO3 | Understand methods of spectral estimation for statistically varying signals and system identification. |
| PO4 | Employ isolation, guarding, grounding and shielding techniques for avoiding stray pickups, noise and EMI/EMC. |
| PO5 | Design & implement analog to digital interfacing circuits for real time applications |
| PO6 | Develop efficient architectures for improving system performance in terms of speed, power consumption, and accuracy. |
| PO7 | Design and develop application specific embedded systems for automation. |
| PO8 | Understand mother board bus structure, operating system issues, device drivers and design & develop PC add-on cards to interface external circuits. |
| PO9 | Develop Test environment using CAD tools for integrated instrumentation system and embedded systems. |
| PO10 | Develop and apply DSP algorithms for advanced digital signal/image processing (statistical and adaptive) applications. |
| PO11 | Identify and Solve the problems using advanced data analytic techniques like AI and ML |
| PO12 | Develop and encourage collaborative and interdisciplinary research; Pursue life-long learning as a means of enhancing the knowledge and skills. |

# PO-GA Matrix

| PO | GA1 | GA2 | GA3 | GA4 | GA5 | GA6 | GA7 | GA8 | GA9 | GA10 | GA11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| PO1 | 2 | 2 | 1 | 1 | 3 | 1 | 1 | 1 | | 1 | 2 |
| PO2 | 2 | 3 | 2 | 1 | 2 | | 1 | 1 | 1 | | 1 |
| PO3 | 2 | 2 | 3 | 2 | 2 | 2 | 1 | | 2 | | 1 |
| PO4 | 2 | 2 | 3 | 3 | 2 | 1 | | 1 | 1 | 1 | |
| PO5 | 2 | 3 | 2 | 3 | 3 | 1 | | 1 | 1 | 1 | |
| PO6 | 1 | 2 | 3 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | |
| P07 | 3 | 2 | 2 | 3 | 3 | 1 | 1 | 1 | | 1 | 1 |
| PO8 | 2 | 2 | 2 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | |
| PO9 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | | 1 | | 1 |
| PO10 | 3 | 2 | 1 | 1 | 2 | 1 | | 1 | | | |
| PO11 | | | 1 | 2 | 1 | 3 | 2 | 1 | | 1 | |
| PO12 | 2 | | | 2 | | | | | 3 | | |

1: Slightly 2: Moderately 3: Substantially

# Mapping of POs and PEOs

| PEO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PEO1 | 3 | 3 | 2 | | | 2 | | | 2 | 2 | 1 | 2 |
| PEO 2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | |
| PEO 3 | 1 | 1 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | |
| PEO 4 | 1 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | |
| PEO 5 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 |
| PEO 6 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 3 | 3 |

1*: Slightly* *2: Moderately* 3: Substantially

# COURSE CURRICULUM FOR THE M.TECH PROGRAMME INELECTRONIC INSTRUMENTATION

## I Year I Semester

| Sl. No. | Course Code | Course Title | L | T | P | Credits |
|---|---|---|---|---|---|---|
| 1. | EC5101 | Transducers and Signal Conditioning circuits | 3 | 0 | 0 | 3 |
| 2. | EC5102 | Advanced Digital System Design | 3 | 0 | 0 | 3 |
| 3. | EC5103 | Embedded System Design | 3 | 0 | 0 | 3 |
| 4. | | Elective-I | 3 | 0 | 0 | 3 |
| 5. | | Elective–II | 3 | 0 | 0 | 3 |
| 6. | | Elective-III | 3 | 0 | 0 | 3 |
| 7. | EC5104 | Transducers and Signal Conditioning Laboratory | 0 | 0 | 4 | 2 |
| 8. | EC5105 | Digital Design and Embedded Systems Lab | 0 | 0 | 4 | 2 |
| 9. | EC5191 | Seminar | 0 | 0 | 2 | 1 |
| **Total** | | | | | | **23** |

### I Year II Semester

| Sl. No. | Course Code | Course Title | L | T | P | Credits |
|---|---|---|---|---|---|---|
| 1. | EC5151 | Intelligent Instrumentation | 3 | 0 | 0 | 3 |
| 2. | EC5152 | Industrial automation and control | 3 | 0 | 0 | 3 |
| 3. | EC5153 | Hardware/Software Co-design | 3 | 0 | 0 | 3 |
| 4. | | Elective –IV | 3 | 0 | 0 | 3 |
| 5. | | Elective –V | 3 | 0 | 0 | 3 |
| 6. | | Elective-VI | 3 | 0 | 0 | 3 |
| 7. | EC5154 | Advanced Instrumentation Lab | 0 | 0 | 4 | 2 |
| 8. | EC5155 | SoC design and Industrial Automation Lab | 0 | 0 | 4 | 2 |
| 9. | EC5192 | Seminar | 0 | 0 | 2 | 1 |
| **Total** | | | | | | **23** |

### II Year I Semester

| S.No | Course No | Course name | Credits |
|---|---|---|---|
| 1 | EC6192 | Comprehensive Viva | 2 |
| 2 | EC6149 | Dissertation Part A | 9 |
| **Total** | | | **11** |

### II Year II Semester

| S.No | Course No | Course name | Credits |
|---|---|---|---|
| 1 | EC6199 | Dissertation Part B | 18 |

**Total No. of credits - 75**

# Credit Structure

| Credits | Sem I | Sem II | Sem III | Sem IV | Range |
|---|---|---|---|---|---|
| **CORE** | **09** | **09** | 00 | 00 | **18** |
| **Electives** | **09** | **09** | 00 | 00 | **18** |
| **Lab courses** | **04** | **04** | 00 | 00 | **08** |
| **Seminar** | 01 | 01 | 00 | 00 | **02** |
| **Comprehensive viva-voce** | 00 | 00 | **02** | 00 | **02** |
| **Project** | 00 | 00 | **09** | **18** | **27** |
| **Total credits** | **23** | **23** | **11** | **18** | **75** |

# List of Electives

| S.No | Course No | Course Title |
|---|---|---|
| Elective-I | EC 5111 | Quality and Reliability of Electronic Systems |
| | EC 5112 | Digital Control Systems |
| | EC 5113 | FPGA Design |
| | | |
| Elective-II | EC 5114 | Spectral Estimation |
| | EC 5115 | Optimization Techniques |
| | EC 5116 | VLSI system design |
| | | |
| Elective-III | EC 5117 | Communication Protocols for Instrumentation |
| | EC 5118 | Advanced DSP |
| | EC 5119 | VLSI DSP Architectures |
| | | |
| Elective-IV | EC 5161 | Hardware Programming languages |
| | EC 5162 | Advanced Image Processing |
| | EC 5163 | Embedded Real Time Operating Systems |
| | | |
| Elective V | EC 5164 | Display devices and Technologies |
| | EC 5165 | Machine Learning and Applications |
| | EC 5166 | Data Acquisition Systems and design |
| | | |
| Elective-VI | EC 5167 | Bio-Medical Instrumentation |
| | EC 5168 | IOT for Industrial Applications |
| | EC 5169 | Advanced Computer Architecture |

| EC5101 | Transducers And Signal Conditioning Circuits | PCC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | Choose Suitable sensor/transducer for a given physical variable and understand its principle, characteristics and determine order of the sensor. |
| CO2 | Measure displacement, pressure, flow, temperature variables. |
| CO3 | Design suitable signal conditioning circuit for sensor/transducers. |
| CO4 | Analyze the bridge circuits for calculating L, C, R |
| CO5 | Understand noise reduction using grounding and shielding techniques. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | | | | | | | | | 1 | 2 |
| CO2 | 3 | 3 | | | 1 | | | | | | 2 | 2 |
| CO3 | 3 | 3 | | 2 | 1 | | | | | | 2 | 2 |
| CO4 | 3 | 3 | | 2 | | | | | | | 1 | 2 |
| CO5 | | 2 | 2 | 3 | | | | | | | | 2 |

**Detailed Syllabus:**

**Generalised Performance characteristics of Instruments**: Functional elements of an instrument, generalized performance characteristics of instruments- static characteristics, dynamic characteristics, Experimental determination of measurement system parameters, loading effects under dynamic conditions.

**Transducers:** For Motion and Dimensional Measurements: Relative displacement, translation and rotational resistive potentiometers, resistance strain gauges, LVDT, capacitance pickups. Piezo-electric transducers.*FOR FORCE MEASUREMENT:* Bonded strain gauge transducers, variable reluctance pickup, torque measurement dynamometers. *FOR PRESSURE MEASUREMENT:* Manometers, elastic transducers, very high pressure transducers, thermal conductivity gauges. *FOR FLOW MEASUREMENT:* Hot-wire and hot-film anemometers, electromagnetic flow meters, laser Doppler velocity meter. *FOR TEMPERATURE MEASUREMENT:* Thermal expansion methods, thermometers (liquid in glass), Thermocouples-materials, Thermistors, Junction semiconductors and Sensors. Smart sensors, MEMS and Nano Sensors.

**Signal Conditioning Circuits:***INTRODUCTION:* Need for pre-processing, identification of signal conditioning blocks and their characteristics. *BRIDGE CIRCUITS:* Analysis of DC and AC bridges with applications.

**Operational Amplifiers:**Deviation from ideal characteristics of Op-amps., Design of offset and drift compensation circuits, Frequency compensation. Inverting amplifier, non-inverting amplifier, summer/difference amplifier, practical integrator and differentiator circuits, charge amplifiers and impedance converters, voltage to current and current to voltage converters, Current booster for output stage, logarithmic circuits, precision rectifiers and comparator with and without hysteresis, active filters.

**Instrumentation Amplifiers & Isolation Amplifiers:** Specifications and use of instrumentation amplifiers for signal conditioning circuits using commercial ICs. Necessity for isolation amplifiers, industrial and medical applications of isolation amplifiers, Grounding and Shielding.

**Reading:**


1. Measurement systems -Application and Design, DOEBELIN, E.O., McGraw Hill, 4th Ed.1990
2. Handbook of Operational Amplifier Circuit Design, DAVID F STOUT and MILTON KAUFMAN.


**References:**


1. Instrumentation Systems and Devices, Rangan, Mani, Sarma., Tata McGraw Hill. 2nd ed
2. Transducers and Instrumentation, Murthy, D.V.S.,PHI, New Delhi.
3. Smart Sensors and MEMS: Intelligent Devices and Microsystems for Industrial Applications edited by S Nihtianov, A. Luque, Wood head publishing.

| EC5102 | Advanced Digital System Design | PCC | 3-0-0 | 3 credits |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | Analyze the digital circuits for different applications |
| CO2 | Develop Specifications for digital systems |
| CO3 | Design and develop the digital circuits using VHDL and Verilog |
| CO4 | Develop test strategies for digital systems |
| CO5 | Design robust digital systems |

**Mapping of COs and POs:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | 3 | | 3 | 2 | 2 | | | 2 |
| CO2 | | | | | | | 2 | | 3 | | | 2 |
| CO3 | | | | | 3 | | 2 | | 2 | | | 2 |
| CO4 | | | | 2 | 3 | | 2 | | 3 | | | 2 |
| CO5 | | | | | 3 | | 2 | | | | | 2 |

**Detailed Syllabus:**

**INTRODUCTION:** Digital System Design Process, EDA tools and design viewpoints, Behavioral, dataflow, and gate level descriptions.

**HARDWARE DESCRIPTION LANGUAGES:** VHDL and Verilog modeling concepts, Behavioral and Structural architecture descriptions: Concurrent and Sequential statements, Event driven Simulation.

**BUILDING BLOCKS FOR DIGITAL SYSTEMS**: Tristate buffers, multiplexers, latches, flip-flops, registers, counters, arithmetic and logic circuits (ALU Design), Finite State Machines.

**DESIGN METHODOLOGY:** Synchronous Systems, Top-Down Design, Register Transfer Level Design, Algorithmic State Machines, and Synthesis from VHDL.

**IMPLEMENTATION ISSUES:** Design Case Studies**,** Hardware Testing & Design for testability, test vectors, fault analysis for combinational and sequential circuits. Timing and signal conventions, synchronization, Signaling Circuits: Terminations, Transmitter and receiver circuits. Microprogramming, Micro-programme sequencer 2910. Introduction to Programmable Logic Devices (FPGAs, CPLDs).

**Reading:**

**1.** William I Fletcher: An Engineering approach to Digital Design, Eastern Economy Edition, PHI Limited, 2000

2. Digital System Engineering: William J Dally and John W Poulton Published by Cambridge University Press
3. A VHDL Primer: JayaramBhasker Published by Prentice-Hall India
4. Digital Design and Verilog fundamentals: Joseph Cavanaugh Published by CRC Press.
5. The Art of Digital Design: An Introduction to Top down design: Franklin P Processer And David E Winkel Published by Prentice-Hall.
6. Digital Systems Design: Charles H.Roth,Jr., LIzy Kurian John.

| EC 5103 | | Embedded System Design | PCC | 3-0-0 | 3 Credits |
|---|---|---|---|---|---|

**Pre-requisites**: Knowledge of Digital system design.

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

| | |
|---|---|
| **CO1** | Understand the evolution of microprocessors and microcontrollers and its architectures |
| **CO2** | Understand the evolution and architectures of ARM processors. |
| **CO3** | Analyse and understand the instruction set and development tools of ARM |
| **CO4** | Understand the architectural features of ARM cortex M4 microcontrollers. |
| **CO5** | Understand the exception, interrupts and interrupt handling schemes |
| **CO6** | Understand the hardware and interfacing peripheral devices to ARM cortex M4 |

**Mapping of course outcomes with program outcomes:**

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | 1 | | | 2 | | | | 2 | | | 2 |
| CO2 | | | | | 2 | 2 | | | 2 | | | 2 |
| CO3 | | | | | 2 | | | | 2 | | | 2 |
| CO4 | | 1 | | | 2 | | | | 1 | | | 2 |
| CO5 | | | | | 2 | | | | 1 | | | 1 |
| CO6 | | 1 | | | 2 | | | | 1 | | | 1 |

**Detailed Syllabus:**

I. **Introduction to Embedded Systems:**
Embedded systems Overview, Characteristics of embedded computing applications. Design Challenges, Common Design Metrics, Embedded systems Design flow. Processor Technology, IC Technology, Trade-offs.

II. **Specification Techniques:**
State charts, Modelling Hierarchy, Specification Description Language (SDL), Petri Nets, embedded systems modelling with petri Nets, Unified Modelling Language (UML), Activity diagram, class diagram, component diagram, use-case diagram, sequence diagram. UML specification examples.

III. **Introduction to ARM Processors:**
Introduction to ARM processors, Evolution of ARM processors, pipeline organization, ARM Processor cores and CPU cores. Introduction to ARM Cortex-M Processors, ARM Cortex-M4 processor's architecture, Programmer's model, Special registers, Operation Modes, Memory map, Memory access attributes and overview of Interrupts and exceptions.

IV. **ARM Cortex-M4 programming:** Assembly basics, Instruction set, Data transfer, Data processing, conditional and branch instructions, barrier and saturation operations, Cortex-

M4-specific instructions,Thumb2 instructions, Keil Microcontroller Development Kit for ARM, Typical program compilation flow, Sample arithmetic and logical assembly language programs

V. **Embedded Systems Interfacing:** Serial Peripheral Interface (SPI), Inter-Integrated Circuit (I2C),RS-232,Universal Serial Bus(USB),CAN, IrDA, Bluetooth, PCI and AMBA bus protocols.

VI. **Cortex-M4 Implementation and applications:** Detailed block diagram,Busintefaces on cortex-M4,External PPB interface, typical connections, reset types and signals. Getting started with µVision. Applications: Flashing of LEDS using Shift Register, Interfacing stepper motor, Interfacing temperature sensor, Interfacing ADC, Interfacing Real Time Clock, Interfacing of Analog Key pad

**TEXT BOOKS:**


1. Joseph Yiu, The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors, Newnes Publications; 3rd edition, 2013.
2. Ata Elahi-Trever Arjeski, “ARM Assembly language with hardware experiment”,Springer Int. Publishing ,2015.
3. SantanuChattopadhya, “Embedded System Design”,PHI , 2nd Edition.
4. Frank Vahid and Tony Givargis, “Embedded System Design”, John Wiley & sons Inc.3rd Edition.


**REFERENCE BOOKS:**


1. Wrox, “ Professional Embedded ARM Development”
2. William hohl and Christoper Hinds, “ARM assembly language fundamentals and Techniques”CRC,2nd edition,2015.

| EC5111 | Quality And Reliability Of Electronic Systems | PEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | Understand the concept of reliability and its significance. |
| CO2 | Investigate a particular failure case based on systematic procedure. |
| CO3 | Plot reliability and survival graph for the given data of a product. |
| CO4 | Suggest a suitable method for the availability and maintenance of equipment. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | | | | | | | | | 1 | 2 |
| CO2 | 3 | 3 | | | 1 | | | | | | 2 | 2 |
| CO3 | 3 | 3 | | 2 | 1 | | | | | | 2 | 2 |
| CO4 | 3 | 3 | | 2 | | | | | | | 1 | 2 |

**Detailed Syllabus:**

**INTRODUCTION:** Definition and Importance of Quality and Reliability

**CONCEPTS OF RELIABILITY**: Causes of failure, Life characteristic pattern, Modes of failure, Measures of Reliability, Derivation of the Reliability Function, Reliability Specifications

**FAILURE ANALYSIS TECHNIQUE:** Failure investigation, Data collections, Data forms, Data Sources, Reliability Analysis, Use of Probability distributions, Calculation of performance parameters, Survival curves and their Calculation, Calculation of failure rate, application of Weibull Distribution.

**SYSTEM RELIABILITY & MODELING**: Types of Systems, Series, Parallel, Series-Parallel, and Parallel-Series system, Standby Systems, Types of Standby redundancy. Reliability of different systems, nature of reliability problems in electronic equipment, selection of components.

**SIMULATION & RELIABILITY PREDICTION**: Generation of Random Numbers, Generation of random observations from a probability distribution, Applicability of Monte-Carlo Method, Simulation languages.

**MAINTAINABILITY AND AVAILABILITY**: Objectives of maintenance, designing for optimum maintainability and measure of maintainabilityAvailability: Uptime ratio, down time ratio and system availability

**QUALITY RELIABILITY AND SAFETY**: Reliability and Quality Control, Quality Circles, Safety factor, increasing safety factors and Case Studies

**Reading:**


1. A.K.Govil, Reliability Engineering, TMH, 1983
2. B.S.Dhillion, Reliability Engineering in Systems Design and Operation, Van No strandReinhold Co., 1983

**References :**

1. 1.A.E.Green and A.J.Bourne Reliability Technology, Wiley-Interscience, 1972
2. 2.Lecture Notes – CEDT Bangalore

| EC5112 | Digital Control Systems | PEC | 3-0-0 | 3 credits |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | Apply principles of control theory to model physical sampled-data systems. |
| CO2 | Represent discrete time systems under the form of z-domain transfer functions and state-space models. |
| CO3 | Analyze stability, transient response and steady state behavior of linear discrete-time systems. |
| CO4 | Design digital control schemes using transform techniques and state space methods. |
| CO5 | Implement digital control schemes against system specifications. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | 3 | | | | | | | 3 | | |
| CO2 | | | | | | | | | | 3 | | |
| C03 | | | | | | 3 | | | | 2 | | |
| C04 | | | | | | | | | | 3 | | |
| CO5 | | | | | | | | | | 3 | | |

**Detailed Syllabus:**

**Introduction to digital control Systems:**Introduction, Discrete time system representation, Mathematical modeling of sampling process, Data reconstruction

**Modeling discrete- time systems by pulse transfer function:** Revisiting Z - transform, Mapping of s-plane to z-plane, Pulse transfer function, Pulse transfer function of closed loop system, Sampled signal f low graph

**Ti me response of discrete systems :** Transient and steady state responses, T i me response parameters of a proto type, second order system

**Stability analysis of discreteTime systems:** Jury stability test, Stability analysis using bi - linear transformation

**Design of sampled data control systems:** Root locus method, Controller design using root locus, Root locus based controller design, Nyquist stability criteria, Bode plot, Lead compensator design using Bode plot, Lag compensator design using Bode plot, Lag- lead compensator design in frequency domain

**Discrete state space model :**Introduction to state variable model, Various canonical forms, Characteristic equation, state transition matrix, Solution to discrete state equation.

**Controllability, observabilityand stability of discrete state spacemodels**: Controllability and observability, Stability, Lyapunov stability theorem

**Optimal control:** Basics of optimal control, Performance indices, Linear Quadratic Regulator (LQR) design

**Text Book:**

1. Digital control systems (Second Edition) by Kuo, Oxford University Press

**Reference:**


1. Fadali and Visioli, Digital Control Engineering, 2nd Edition, Academic Press
2. H. Troy Nagle, Digital Control System Analysis and Design, 3rd Edition, Charles L. Phillips, Prentice Hall (1995)
3. Constantine Houpis, Digital Control Systems, Theory hardaware and Software, 2 Edition, McGrahil Publication Limited
4. Dogan Ibrahim, Microcontroller Based Applied Digital Control, Wiley; 1st edition, 2006.

| EC5113 | FPGA DESIGN | PEC | 3-0-0 | 3 credits |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| **CO1** | Understand FPGA design flow. |
| **CO2** | Understand the building blocks of commercially available FPGA/CPLDs |
| **CO3** | Develop VHDL/Verilog models and synthesize targeting for Vertex, Spartan FPGAs |
| **CO4** | Develop parameterized library cells and implement system designs using parameterized cells |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | 1 | | 3 | | 2 | 1 | | 2 |
| CO2 | | | | | 3 | | 3 | | 2 | | | 1 |
| C03 | | | | | 2 | 1 | 1 | 1 | 2 | 1 | | 2 |
| C04 | | | | | 2 | | 3 | | 2 | | | |

**Detailed Syllabus:**

**INTRODUCTION TO FPGAs:** Evolution of programmable devices, FPGA Design flow, Applications of FPGA.

**DEISGN EXAMPLES USING PLDs:** Design of Universal block, Memory, Floating point multiplier, Barrel shifter.

**FPGAs/CPLDs:** Programming Technologies, Commercially available FPGAs: Xilinx's Vertex and Spartan, Actel's FPGA, Altera's FPGA/CPLD, Building blocks of FPGAs/CPLDs, Configurable Logic block functionality, Routing structures, Input/output Block, Impact of logic block functionality on FPGA performance, Model for measuring delay.

**CASE STUDY –** Applications using Kintex-7, Viretex-7, Artix-7

**Text Books:**

1. John V. Old Field, Richrad C. Dorf, Field Programmable Gate Arrays, Wiley, 2008.
2. Data sheets of Artix-7, Kintex-7, Virtex-7 .
3. Stephen D. Brown, Robert J. Francis, Jonathan Rose, Zvonko G. Vranesic, Field Programmable Gate Arrays, 2nd Edition, Springer, 1992.

| EC5114 | Spectral Estimation | PEC | 3-0-0 | 3 credits |
|---|---|---|---|---|

**Prerequisites:**None

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

| | |
|---|---|
| CO1 | Estimate the Power Spectra for data sequences using various Nonparametric methods and evaluate the quality of the spectral estimate. |
| CO2 | Comprehend Parametric methods of spectral estimation (AR, MA and ARMA model) |
| CO3 | Estimate the Power Spectra using Minimum variance and Burg methods. |
| CO4 | Apply various techniques like Minimum Probability of Error, Neyman-Pearson criterion and Matched Filter to detect Signals buried in Noise. |
| CO5 | Comprehend the concepts and methods for the estimation of higher-order spectra. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | | 3 | | | | | | | | | 2 |
| CO2 | | 2 | 3 | | | | | | | | | 2 |
| CO3 | 1 | | 3 | | | | | | | | | 2 |
| CO4 | | | 2 | | | | | | | | | 1 |
| CO5 | | 1 | 3 | | | | | | | | | 1 |

**Detailed Syllabus:**

**Spectral Estimation**: Introduction, Principal Approaches to Spectral Estimation, Computation of Energy Density Spectrum, Estimation of Autocorrelation and Power Spectrum of Random Signals: The Periodogram, Use of FFT in Power Spectrum Estimation.

**Non-parametric Methods for Power Spectrum Estimation:** The Bartlett Method – Averaging Periodogram, The Welch Method – Averaging Modified Periodograms, The Blackman and Tukey Method – Smoothing the Periodograms, Performance Characteristics of Nonparametric Power Spectrum Estimators, Comparison of Spectral Estimators, Computational Requirements for the Nonparametric Power Spectrum Estimators.

**Parametric Methods for Power Spectrum Estimation:** Innovations representations of a stationary random process, AR, MA and ARMA models,Relationships between Autocorrelation and Model Parameters, The Yule-Walker Method for the AR Model Parameters, The Burg Method for the AR Model Parameters, Selection of AR Model Order, MA and ARMA Models for Power Spectrum Estimation, properties of linear prediction error filters, AR lattice and ARMA lattice ladder filters, Minimum Variance Spectral Estimation, Eigen Analysis Algorithms for Spectral Estimation: Eigen-decomposition of the Autocorrelation Matrix for Sinusoids in White Noise, MUSIC Algorithm, ESPRIT Algorithm.

**Detection of Signals in Noise:** Introduction, Optimum Detection Algorithms – Minimum Probability of Error, Neyman-Pearson Criterion for Radar. Detection of Variable Amplitude Signals – Matched Filters, Detection of Random signals.

**Introduction to Higher-order spectral analysis:** Polyspectra, Moments and cumulants, Cumulant spectra, Conventional methods for estimation of Higher-order spectra.

**Reference Books:**


1) J. G. Proakis and D.G Manolakis, "DSP Principles, Algorithms and Applications", PHI, 3rd Edition, 2000.
2) Steven M. Kay, " Modern Spectral Estimation, Theory and Applications",Pearson, 2010.
3) M. Schwartz and L. Shaw, " Signal Processing – Discrete Spectral Analysis, Detection and Estimation" , McGraw Hill, 1975
4) ChrysostomosL.Nikias, AthinaP.Petropulu, "Higher-order Spectra Analysis", prentice hall signal processing series, 1993.

| EC5115 | Optimization Techniques | PEC | 3-0-0 | 3 credits |
|---|---|---|---|---|

**Prerequisites:**None
**Course Outcomes:**Upon successful completion of this course, the student will be able to

| | |
|---|---|
| CO1 | Ability to formulate mathematical models of real world problems |
| CO2 | Understand the major limitations and capabilities of deterministic operations |
| CO3 | Handle, solve and analyze problems using linear programming and other mathematical programming algorithms. |
| CO4 | Solve various multivariable optimization problems |
| CO5 | Use search techniques methods to find optimal solutions of Non-Linear Problems |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | **2** | | | | | | | | | | |
| **CO2** | | | **3** | | | | | **2** | | | | |
| **CO3** | | **2** | | | | **3** | | | | | | |
| **CO4** | | **2** | | | | | | | | | | |
| **CO5** | | | | | | | | | | | **2** | |

**Detailed Syllabus:**

**Introduction:** Statement of an optimization problem, Classification of optimization problems, Overview of various optimization Techniques, Classical optimization techniques: Single variable optimization, Multivariable optimization, the simplex optimization technique, Test Functions, Examples

**Unconstrained optimization:** Definitions and existence conditions, General properties of minimization algorithms, Line search, the gradient method, Newton's method, least square Algorithm.

**Constrained optimization:** Active Constraints versus In-active constraints, Transformations, penalty functions

**Genetic algorithm (GA):** Fundamentals of Genetic algorithm, History, Basic concepts, working principle, Applications of GA for standard Bench mark test functions.

**Swarm intelligence:** Main inspiration source, early variants of PSO, Basic particle swarm optimization, Initialization techniques, Theoretical investigations and parameter selection, Design of PSO algorithm using computational statistics, Termination conditions. Application of PSO, Standard test function optimization.

**Differential Evaluation:** Classical differential evaluation- An outline, Mutation, cross over, selection, Teaching Learning Based Optimization (TLBO), Applications of TLBO for standard Bench mark test functions, Case studies

**Reference Books:**


1. Richard W Daniels, An Introduction to Numerical Methods and Optimization Techniques, Elsevier North Holland Inc,
2. Milani Mitchel, An introduction to Genetic algorithms, MIT Press, 1998
3. AE Eiben and J.E Smith, Introduction to Evolutionary Computing, Springer 2010
4. S Rajasekharan, G.A Vijaya Lakshmi Pai, Neural Networks, Fuzzy logic, and Genetic algorithms, Synthesis and Applications, Prentice hall of India, 2007
5. Weifan Wang, Xuding Zhu, Ding-Zhu Du, Combinatorial Optimization and Applications:5th International Conference, Springer Publications, 2011

| EC5116 | VLSI System Design | PEC | 3-0-0 | 3 credits |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | Model the behavior of a MOS Transistor |
| CO2 | Understanding CMOS Inverter |
| CO3 | Design combinational and sequential circuits using CMOS gates |
| CO4 | Identify the sources of power dissipation in a CMOS circuit. |
| CO5 | Analyze SRAM cell and memory arrays |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | 1 | 2 | | 2 | | | 2 |
| CO2 | | | | | | 2 | 1 | | 2 | | | 2 |
| C03 | | | | | | 1 | 2 | | 3 | | | 2 |
| C04 | | | | | | 1 | 2 | | 2 | | | 2 |
| C05 | | | | | | 2 | 2 | | 2 | | | 2 |

**Detailed Syllabus:**

MOS Transistors, CMOS Logic, CMOS Fabrication and Layout, Design Partitioning, Fabrication, Packaging, and Testing**,** MOS transistor Theory, Long Channel I-V Characteristics, C-V Characteristics, Non-Ideal I-V Effects, DC Transfer Characteristics.

The CMOS Inverter: The Static CMOS Inverter -An Intuitive Perspective, Evaluating the Robustness of the CMOS Inverter: The Static Behavior, Performance of CMOS Inverter: The Dynamic Behavior.

CMOS Processing Technology, CMOS Technologies, Layout Design Rules, CMOS Process Enhancements, Technology-Related CAD Issues, Manufacturing Issues, Circuit Simulation- A SPICE Tutorial, Device Models, Device Characterization, Circuit Characterization, Interconnect Simulation. Combinational Circuit Design, Circuit Families, Silicon-On-Insulator Circuit Design, Sub Threshold Circuit Design, Sequential Circuit Design, Circuit Design of Latches and Flip-Flops, Static Sequencing Element Methodology, Sequencing Dynamic Circuits, Synchronizers, Wave Pipelining.

Power, Sources of Power Dissipation, Dynamic Power, Static Power, Energy-Delay Optimization, Low Power Architectures, Robustness, Variability, Reliability, Scaling, Statistical Analysis of Variability, Variation-Tolerant Design. Delay, Transient Response, RC Delay Model, Linear Delay Model, Logical Effort of Paths, Timing Analysis Delay Models, Datapath Subsystems, Addition/Subtraction, One/Zero Detectors, Comparators, Counters, Boolean Logical Operations, Coding, Shifters, Multiplication.

Array Subsystems, SRAM, DRAM, Read-Only Memory, Serial Access Memories, Content-Addressable Memory, Programmable Logic Arrays, Robust Memory Design, Special-Purpose Subsystems.

CMOS Testing-The need for testing, Manufacturing test principles, Design strategies for test, Chip level test techniques, System level test techniques, Layout design for improved testability.

**Text Books:**

1. CMOS VLSI Design – A Circuits and Systems Perspective, Neil H.E. Weste, David Harris, Ayan Banerjee, 3rd Edition, Pearson Education, 2006.
2. Principles of CMOS VLSI DESIGN: A Systems Perspective, Neil H. E. Weste , Kamran Eshraghian, 2nd Edition., Pearson Education, 2006.

**Reference Books:**

1. Jan M RABAEY, Digital Integrated Circuits, 2nd Edition, Pearson Education, 2003.
2. Basic VLSI Design –Douglas A. Pucknell, Kamran Eshraghian, 3rd Edition. Prentice Hall of India PVT.Ltd.,1994.

| EC5117 | **Communication Protocols for Instrumentation** | **PEC** | **3-0-0** | **3 Credits** |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | Quantitative analysis of individual components of industrial data communications. |
| CO2 | Analysis and specification of serial communication protocol standards. |
| CO3 | Understanding the error detection, cable shielding techniques to avoid straypickups, noise. |
| CO4 | Systematicunderstanding and development of industrial communication protocols. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | 1 | | | | 2 | | | | | | |
| CO2 | | | 2 | | | | | | | | | |
| C03 | | | 2 | | | | | | | | 2 | |
| C04 | | | | | | 2 | | | | | 2 | |

**Detailed Syllabus:**

**Overview:** Standards, OSI model, Protocols, Physical standards, Modern instrumentation and control systems, PLCs, Smart instrumentation systems, Communication principles and modes, error detection, Transmission, UART.

**Serial communication standards:** Standards, serial data communication interface standards, EIA-RS232 interface standard, RS-449, RS-422, RS-423 and RS-485 standards, Troubleshooting and testing with RS-485, GPIB standard, USB interface.

**Error Detection, Cabling and Electrical Noise**: Errors, Types of error detection, control and correction, copper and fiber cables, sources of electrical noise, shielding, cable ducting and earthling.

**Modems and Multiplexers:** Synchronous and Asynchronous modes, flow control, modulation techniques, types of a modem, modem standards, terminal and statistical multiplexers.

**Communication Protocols:** Flow control protocols, XON/XOFF, BSC, HDLC and File transfer protocols, OSI model and layers, ASCII protocols, Modbus protocol.

**Industrial Protocols:** Introduction to HART protocol, Smart instrumentation, HART physical layer, HART data link layer, HART application layer, ASD_i interface, Seriplex, CANbus, Devicenet, Profibus, FIP bus, Fieldbus.

**Local Area Networks**:Circuitaand packet switching, Network topologies, Media access control mechanisms, LAN standards, Ethernet protocol, Token ring protocol

**Text Book:** Practical data communications for instrumentation and control: John Park, Steve Mackay, Edwin Wright, Elsevier Newnes Publisher, 2008.

| | | | | |
|---|---|---|---|---|
| **C5118** | **Advanced Digital Signal Processing** | **PEC** | **3-0-0** | **3 credits** |

**Prerequisites:**None

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

| | |
|---|---|
| CO1 | Understand the properties, functioning of DCT,KLT and wavelet transforms for 1- D and 2D-signals. |
| CO2 | Implement adaptive filter algorithms for applications in noise cancellation, de-convolution, enhancement and channel equalization. |
| CO3 | Apply higher order spectra for solving Non-Gaussian, non-linear stochastic problems. |
| CO4 | Design a decimator or interpolator for the given specifications. |
| CO5 | Implement DSP Processors in application problems. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | 3 | | | | | | | 3 | 2 | 1 |
| CO2 | | | | | | | | | | 3 | 2 | |
| C03 | | | | | | 3 | | | | 2 | 2 | 1 |
| C04 | | | | | | | | | | 3 | 2 | 1 |
| CO5 | | | | | | | | | | 3 | | 1 |

**Detailed Syllabus:**

**Transform techniques:** Discrete cosine transforms(DCTs), Discrete sine transforms(DSTs), KL transforms, Hadamard transforms, Walsh transforms and Wavelet transforms, Applications of DCTs and Wavelets.

**Adaptive Filter theory**: Stochastic gradient based algorithms– LMS algorithm, stability analysis, Mean-squared error behavior. Convergence analysis, Normalized LMS algorithm, Gradient adaptive lattice algorithm. Prediction, filtering and smoothing, adaptive equalization, noise cancellation, blind de-convolution, adaptive IIR filters, RLS algorithms-GRLS, Gauss-Newton and RML.

**Multirate signal processing:** Decimation, Interpolation, polyphase filters and their structures, Sub-band coding of speech signals, filter banks, Quadrature mirror filters.

**Optimum linear filters:** Wiener filters for filtering and prediction, FIR wiener filter, orthogonality principle in LMS estimation, IIR wiener filter, state-space (Kalman) filters, Method of least squares, data windowing, principle of orthogonality, Innovation process, statement of the kalman filtering problem, Estimation of the state using innovations process, Riccati equation, filtering, kalman filter as the unifying basis for RLS filters.

**Digital Signal Processors:** Programmable DSP architectures, multiport memory, Special addressing modes, on chip peripherals, Architecture of TMS320 C5X/6X, Bus structure, Programmecontroller, CALU, IDEX, ARCER, ALU, BMAR, on chip memory,TMS320C5X

Assembly language, Instruction pipelining in C5X, Applications programs in C5X.

**Applications:** Radar signal, Bio-medical signal and speech signal processing techniques

**Text Books:**

1. DSP– Principles, Algorithms and Applications– JG Proakis, DG Manolakis,3rd Edition, PHI Private Ltd., 2001.
2. Adaptive Filter Theory–S. Haykin, 2nd Edition, PRENTICE HALL., 2001
3. Modern Digital Signal Processing-2nd Edition, V.Udayashankara, PHI, 2012.
4. Digital Signal Processors – B.Venkataramani, M.Bhaskar, TMH, 2002.

**REFERENCES:**


1. Modern spectral estimation– SM Kay, PHIntnl,1997.
2. Advanced Digital Signal Processing – Proakis, C.M. Rader, Fuyun, Ling C.L. Nikias, Mcmillan Publishing Company, New York,1992.
3. Modern Digital signal processing –An Introduction– Prabhakar S. Naidu, NarosaPublishing House,2003.
4. Adaptive Signal processing–B. Widrow& D. Stearns, PH Int 1987
   OptimumSignalProcessing;AnIntroduction–S.J.Orfanidis,SecondEdition,McGraw–Hill Book Company, 1992.

| EC5119 | VLSI Digital Signal Processing Architectures | PEC | 3-0-0 | 3credits |
|---|---|---|---|---|

**Prerequisites:**None

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

| | |
|---|---|
| CO1 | Architect programmable DSP devices optimizing the performance. |
| CO2 | Design efficient architectures, algorithms and circuits improving size, power consumption, and speed and round-off noise. |
| CO3 | Translate effective algorithm design to integrated circuit implementations. |
| CO4 | Comprehend various sources of errors in implementation of DSP algorithms and device means to control them while implementing the DSP systems as per the specifications demanded by applications. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 1 | | | 1 | 2 | 1 | | | 2 | | 2 | 1 |
| CO2 | | 1 | | | 3 | 1 | 1 | | 2 | | 2 | 1 |
| CO3 | 1 | | 1 | | 2 | | | | 2 | | 2 | |
| CO4 | | | 1 | | 2 | | | | 2 | | 2 | 2 |

**Overview of VLSI Technology and ASIC Design** : Implementation Strategies for Digital ICs, CAD Tool for ASICs, Full- Custom/Custom ASICs , Custom FPGA Platforms ,Digital ASIC Design, Issues in Digital Integrated Circuit Design , Quality Metrics of Digital Designs , Digital IC Components , Timing Issues in Digital ICs.

**VLSI Digital Signal Processing Architectures:** Introduction to Digital Signal Processing Systems o Typical DSP Algorithms (FFT, DFT, LMS, RLS…), Representation of Signal Processing Algorithms, Signal- flow, Data- flow and Dependence Graphs, Iteration Bound.

**VLSI Architecture Techniques:** Pipelining,: Parallel Processing , Pipelining and Parallel Processing for Low Power Design , Retiming Techniques , Unfolding , Folding , Register Minimization Techniques, Systolic Architecture Design , FIR Systolic Arrays.

**Synchronous and Asynchronous Pipeline** : Synchronous Pipeline and Clocking Styles o Wave Pipelining Asynchronous Pipeline o Implementation of Computational Units Bit- Level Arithmetic Architectures o Arithmetic Circuits Number Systems and their Effect on Implementation Redundant, Floating- point Representations/Operations , Shifters/Adders/ Comparators, Parallel/Bit- serial Multipliers, Redundant Arithmetic, Finite Word Length Effect, Floating- point to Fixed- point simulation techniques, Parallel and Pipelined Digital Filter Design, Low- Power Design.

**Architectures for Programmable DSP devices**: Introduction, Basic architectural features, Bus architecture and memory. Data addressing, address generation unit, programmability and program execution, speed issues, features for external interfacing, Architectural Trends in recent DSP processors.

**Text Book:**

1. K. K. Parhi, VLSI Digital Signal Processing Systems: Design and Implementation, Wiley, 1999
2.

**Referrences:**


1. Peter Pirsch, Architectures for Digital Signal Processing. Chichester, John Wiley & Sons, 1998.
2. Mahesh Mehendale and Sunil D. Sherlekar, VLSI Systhesis of DSP Kernels: Algorithms and Architectural Transformations. Boston, Kluwer Academic Publishers, 2001.
3. S. Y. Kung, VLSI Array Processor. Englewood Cliffs, NJ: Prentice-Hall, 1988.

| EC5151 | Intelligent Instrumentation | PCC | 3-0-0 | 3 credits |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | To develop the design methodologies for measurement and instrumentation of real world problems. |
| CO2 | To be study the concepts of intelligent sensor devices, their performance characteristics and signal and system dynamics. |
| CO3 | To address the issues in dealing signal conditioning operations such as calibration, linearization and compensation. |
| CO4 | To use artificial intelligence in sensor signal processing to solve real world problems. |
| CO5 | To deal with interfacing protocols in wireless networking platform. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | | | | | | | 2 | 2 | 2 | | |
| CO2 | 2 | | | | 2 | 2 | | | | | | |
| C03 | 2 | | | | | | | 2 | 2 | | | |
| C04 | | | | | | | | | 2 | | 3 | 2 |
| C05 | | | | | | | | 2 | 2 | | | |

**Detailed Syllabus:**

**Introduction**: intelligent instrumentation, definition, types of instruments, static and dynamic characteristics of instruments, Historical Perspective, Current status, software based instruments.

**Intelligent Sensors**: Classification, Smart sensors , Monolithic Integrated Smart Sensors,Hybrid Integrated Smart Sensors, Cogent Sensors, Soft or Virtual sensors, self-adaptive, self-validating sensors, Soft Sensor Secondary Variable Selection, Rough Set Theory , Model Structures. Self-Adaptive Sensors, Self-Validating Sensors, VLSI Sensors,Temperature Compensating Intelligent Sensors, Pressure Sensor

**Linearization, Calibration, and Compensation:**

Analog Linearization of Positive and Negative Coefficient Resistive Sensors.Higher-Order Linearization , Quadratic Linearization , Third-Order Linearization Circuit, Nonlinear ADC- and Amplifier-Based Linearization, Interpolation, Piecewise Linearization, Microcontroller-Based Linearization, Lookup Table Method, Artificial Neural Network–Based Linearization, Nonlinear Adaptive Filter–Based Linearization, Sensor Calibration, Conventional Calibration Circuits , Offset Compensation, Error and Drift Compensation, Lead Wire Compensation.

**Sensors with Artificial Intelligence:**

Artificial Intelligence, Sensors with Artificial Intelligence, Multidimensional Intelligent Sensors, AI for Prognostic Instrumentation, ANN-Based Intelligent Sensors, Fuzzy Logic–Based Intelligent Sensors.

**Intelligent Sensor Standards and Protocols:**

IEEE 1451 Standard, STIM, TEDS, NCAP, Network Technologies, LonTalk, CEBUS, J1850 Bus, 1 Signal Logic and Format, MI Bus, Plug-n-Play Smart Sensor Protocol

**Text Books:**


1. ManabendraBhuyan, “Intelligent Instrumentation: Principles and Applications” CRC Press, 2011.
2. G. C. Barney, “Intelligent Instrumentation”, Prentice Hall, 1995.
3. J.B DIXIT, A. yadavLaxmi Publications, Ltd., 01-Sep-2011

| EC5152 | Industrial Automation and Control | PCC | 3-0-0 | 3 credits |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | Understand the use of block diagrams, State Diagram & the mathematical basis for the design of control systems. |
| CO2 | Design and tune process (PID) controllers. |
| CO3 | Alternate way of thinking about cascade control that leads to improved performance. |
| CO4 | Draw a PID (Process & Instrumentation Diagram) for effective plant wide control strategies. |
| CO5 | Employ high-level PLC control systems in the computer integration of a process. |
| CO6 | Implement the skills required for automation, control and monitoring of industrial processes. |
| CO7 | Consider aspects of the automation system as network communication. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | 2 | | 1 | | | | | | | |
| CO2 | | | | | | | | | | | 3 | 2 |
| C03 | | | 2 | | | | | | | | | |
| C04 | | | | | | | | | | | 3 | 2 |
| C05 | | | | | 1 | 2 | 2 | | | | 2 | |
| C06 | | | | | | | | | | 2 | 2 | 2 |
| C07 | | | | | 1 | | | | | | 2 | 2 |

**Detailed Syllabus:**

**Introduction**: Introduction to Industrial automation system, Evaluation of automation from technology perspectives, Benefits and Impact of Automation on Manufacturing and Process Industries; Architecture of Industrial Automation Systems.

Mathematical Modeling of Physical processes, Block Diagram and State space representations, Dynamic response Analysis, Controller/ compensator Design based on root locus and Bode plot approach.

**Process Control**: Controller Tuning, Feedforward and Ratio Control, Predictive Control, Control of Systems with Inverse Response, Cascade Control, Advanced Control Schemes

**Piping and Instrumentation Diagrams(P&ID):** P&ID symbols , Components Included in P&ID diagrams Line numbering, Valve numbering , Equipment identification, Interpreting P&IDs - valves , equipment , Vessels Pumps , Heat exchangers , Compressors , control & safety systems,

**Sequence Control**: Introduction to programmable logic controller, Hardware, Internal Architecture, I/o Devices, Ladder and functional programming, Relay Ladder Logic, Scan Cycle, RLL Syntax, Structured Design Approach, Advanced RLL Programming.

**Distributed control systems:** Evaluations of traditional control systems, Architecture of Simple DCS, Functional Components of DCS, their features and applications: SCADA systems, overview of SCADA systems, Communication Technologies, Program development tools, operator Interface, Networking of Sensors, Actuators and Controllers The Fieldbus , The Fieldbus Communication Protocol, Higher Level Automation Systems.

**Reference Books:**

1. F. G Shinskey Process Control Systems, McGrahill Publications.
2. B. R. Mehta , Y. J. Reddy IndustrialProcess Automation Systems Design and ImplementationElsvier.
3. Industrial Instrumentation, Control and Automation, S. Mukhopadhyay, S. Sen and A. K. Deb, Jaico Publishing House, 2013

| EC5153 | Hardware / Software Co-Design | PCC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | Understand Hardware/Software Co-design |
| CO2 | Model the data flow and implement the same through software and hardware. |
| CO3 | Design the Control Flow on Transistor Structures |
| CO4 | Understand the design principles in SoC Architecture |
| CO5 | Design CORDIC and Crypto coprocessor. |

**Mapping of COs with POs**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | 2 | | 2 | | | 1 | | 1 |
| **CO2** | | | | | 2 | 1 | 2 | | | | | 2 |
| **CO3** | | | | | 2 | | 3 | | | 1 | | 1 |
| **CO4** | | | | | 2 | 1 | 2 | | | | | 2 |
| **CO5** | | | | | 2 | | 1 | | | 1 | | 2 |

**Detailed Syllabus:**

**The Nature of Hardware and Software:** Introducing Hardware/Software Co-design, The Quest for Energy Efficiency, The Driving Factors in Hardware/Software Co-design, The Dualism of Hardware Design and Software Design.

**Data Flow Modeling and Transformation:** Introducing Data Flow Graphs, Analyzing Synchronous Data Flow Graphs, Control Flow Modeling and the Limitations of Data Flow, Transformations.

**Data Flow Implementation in Software and Hardware:** Software Implementation of Data Flow, Hardware Implementation of Data Flow, Hardware/Software Implementation of Data Flow.

**Analysis of Control Flow and Data Flow**: Data and Control Edges of a C Program, Implementing Data and Control Edges, Construction of the Control Flow Graph4.4 Modern Bipolar, Transistor Structures, Construction of the Data Flow Graph.

**Finite State Machine with Datapath:** Cycle-Based Bit-Parallel Hardware, Hardware Modules, Finite State Machines with Datapath, FSMD Design Example: A Median Processor.

**System on Chip**: The System-on-Chip Concept, Four Design Principles in SoC Architecture, SoC Modeling in GEZEL. Applications: Trivium Crypto-Coprocessor, CORDIC Co-Processor.

**Text Books:**

1. Patrick Schaumont, A Practical Introduction to Hardware/Software Co-design, Springer, 2010.
2. Ralf Niemann, Hardware/Software Co-Design for Data flow Dominated Embedded Systems, Springer, 1998.

| **EC5161** | **Hardware Programming Languages** | **PEC** | **3-0-0** | **3 Credits** |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | Understand the basic concepts of embedded C/C++ and Python |
| CO2 | Understand real-world software development challenges |
| CO3 | Develop the programs for real time application using C++ and python |

**Mapping of COs with POs**

| CO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | | | | | 1 | | | | 2 | | 3 | 2 |
| **CO2** | | | | | 1 | | | | 2 | | 3 | 2 |
| **CO3** | | | | | 1 | | | | 2 | | 3 | 2 |

Course Objectives This course introduces core programming basics—including data types, control structures, algorithm development, and program design with functions—via the Python programming language. The course discusses the fundamental principles of Object-Oriented Programming, as well as in-depth data and information processing techniques.
Students will solve problems, explore real-world software development challenges, and create practical and contemporary applications.

**Embedded C/C++ Programming**

Review of data types –scalar types-Primitive types-Enumerated types-Subranges, Structure types-character strings –arrays-FunctionsIntroduction to Embedded C-Introduction, Data types Bit manipulation, Interfacing C with Assembly.

Embedded programming issues -Reentrancy, Portability, Optimizing and testing embedded C programs.

Modelling Language for Embedded Systems: Modeling and Analysis of Real-Time and Embedded systems
Linear data structures–Stacks and Queues implementation of stacks and Queues-Linked List -Implementation of linked list, Sorting, Searching, Insertion and Deletion,

Nonlinear structures –Trees and Graphs Object Oriented programming basics using C++ and its relevance in embedded systems.

**Python Programming**

**The concept of data types;** variables, assignments; immutable variables; numerical types; arithmetic operators and expressions; comments in the program; understanding error messages; Conditions, boolean logic, logical operators; ranges; Control statements: if-else, loops (for, while); short-circuit (lazy) evaluation

**Strings and text files;** manipulating files and directories, os and sys modules; text files: reading/writing text and numbers from/to a file; creating and reading a formatted file (csv or tab-separated).
String manipulations: subscript operator, indexing, slicing a string; strings and number system: converting strings to numbers and vice versa. Binary, octal, hexadecimal numbers

**Lists, tuples, and dictionaries;** basic list operators, replacing, inserting, removing an element; searching and sorting lists; dictionary literals, adding and removing keys, accessing and replacing values; traversing dictionaries.

**Design with functions:** hiding redundancy, complexity; arguments and return values; formal vs actual arguments, named arguments. Program structure and design. Recursive functions.
Classes and OOP: classes, objects, attributes and methods; defining classes; design with classes, data modeling; persistent storage of objects

**Simple Graphics and Image Processing:** “turtle” module; simple 2d drawing - colors, shapes; digital images, image file formats, image processing Simple image manipulations with 'image' module (convert to bw, greyscale, blur, etc).

**Graphical user interfaces;** event-driven programming paradigm; tkinter module, creating simple GUI; buttons, labels, entry fields, dialogs; widget attributes - sizes, fonts, colors layouts, nested frames

**Prescribed Text Books:**


1. C Programming language, Kernighan, Brian W, Ritchie, Dennis M
2. “Embedded C”,MichaelJ. Pont, Addison Wesle
3. Fundamentals of Python: First Programs by Kenneth Lambert, Course Technology publishing, Cengage Learning, 2012 ISBN-13: 978-1-111-82270-5

| EC5162 | ADVANCED IMAGE PROCESSING | PEC | 3-0-0 | 3credits |
|---|---|---|---|---|

**Prerequisites:**None

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

| | |
|---|---|
| CO1 | Interpret, Analyze, model and Process the Image data using appropriate methods, algorithms and software tools. |
| CO2 | Analyze and evaluate an image processing system and suggest enhancements to improve the system performance. |
| CO3 | Apply suitable tools to develop, simulate and demonstrate the working of image processing systems as per the application needs. |
| CO4 | Specify and design optimal processing techniques for the given Imaging problem to efficiently use the available hardware and software tools. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | | 3 | 3 | 2 |
| CO2 | | | | | | | | | | 3 | 3 | 2 |
| CO3 | | | | | | | | | | 3 | 3 | 2 |
| CO4 | | | | | | | | | | 3 | 3 | 2 |

**Detailed Syllabus:**

**Review of Digital Image Processing:** Image Acquisition, Image Enhancement.

**Image Segmentation and Morphological Operations**:

Image Segmentation: Point Detections, Line detection, Edge Detection-First order derivative – Prewitt and Sobel. Second order derivative – LoG, DoG, Canny. Edge linking, Hough Transform, Thresholding – Global, Adaptive. Otsu's Method. Region Growing, Region Splitting and Merging.Morphological Operations: Dilation, Erosion, Opening, Closing, Hit-or-Miss transform, Boundary Detection, Thinning, Thickening, Skeleton.

**Image Transforms:** Two Dimensional Orthogonal and Unitary Transforms – Properties of Unitary Transforms – One Dimensional DFT – Two Dimensional DFT – Cosine Transforms – Sine transforms – Hadamard Transforms – Haar Transforms – Slant transforms, KLT, wavelet transform.

**Image Segmentation and Recognition** - Image Segmentation, Face/Object/Activity: Likelihood Ratio Testing, PCA, LDA, Subspace LDA, Kernel methods, Discriminate EM, Support Vector Machines, and PCNSA. Image compression, Feature based Recognition, Image database: ORL, Stanford, NRSA.

**Shape Analysis - Landmark shape & Continuous curves:** Landmark Shape - Procrustes distance, tangent coordinates, Classification & Registration, Continuous curves: Finite dim - Fourier descriptors & B-splines, Infinite dim - Level Set Representation, Segmentation using level sets - edge & region based, Shape tracking.

**Text Books:**

1. Rafael C. Gonzalez and Richard E. Woods, “Digital Image Processing”, Third Edition, - Pearson Education
2. Lim J S, Two-dimensional signal and image processing, Prentice Hall, 1990.
3. Pattern Recognition and Image Analysis, Earl Gose and Richard Johnsonbaugh Steve Jost, PHI.

**Reference Books:**

1. Rafael C. Gonzalez, Richard E. Woods, and Steven L. Eddins, “Digital Image Processing Using MATLAB”, Second Edition, - Tata McGraw Hill Publication
2. S Jayaraman, S Esakkirajan, T Veerakumar, “Digital Image Processing”, Tata McGraw Hill Publication
3. Jain A K, Fundamentals of digital image processing, Prentice Hall, 1989.
4. Chan T. and Shen J., Image Processing and Analysis, SIAM, 2005.

| EC5163 | Embedded and Real Time Operating Systems | PEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | Identify the functioning of embedded systems for different applications. |
| CO2 | Develop embedded system programming skills. |
| CO3 | Design, implement and test an embedded system. |
| CO4 | Identify the unique characteristics ofreal-time embedded systems. |

**Mapping of COs and POs:**

| PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 | 1 | 2 | | 1 | 1 | 2 | 2 |
| | | | | 1 | | 2 | | 2 | 1 | 2 | 2 |
| | | | | 1 | 1 | 2 | | 3 | 1 | 2 | 2 |
| | | | | 1 | | 3 | | 1 | 1 | 2 | 2 |

**Detailed Syllabus:**

**Introduction to Embedded Computing:** Embedded systems Overview, Characteristics ofembedded computing applications, Design Challenges, Common Design Metrics, Processor Technology, IC Technology, Trade-offs.

**The Process of Embedded System Development:** The development process,Requirements, Specification, Architecture Design, Designing Hardware and Software components, system Integration and Testing.

**Hardware platforms:** Types of Hardware Platforms, Single board computers, PC Add-oncards, custom-built hardware platforms, ARM Processor, CPU performance, CPU power consumption, Bus-based computer systems, Memory devices, I/O devices ,component interfacing, Designing with microprocessors, system level performance analysis.

**Program Design and Analysis:** components for Embedded programs, Models ofprograms, Assembly, Linking, and loading, basic compilation techniques, software performance optimization ,program level energy and Power analysis, Program validation and Testing.

**Real-Time Operating Systems:** Architecture of the kernel, Tasks and Task Scheduler,Scheduling algorithms, Interrupt Service Routines, Semaphores, Mutex, Mailboxes, Message queues, Event Registers, Pipes, Signals, Timers, Memory management, Priority Inversion problem. Overview of off-the shelf operating systems-MicroC/OS II, Vxworks, RT Linux.

**Text Books:**

1. Wayne Wolf: Computers as Components-Principles of Embedded Computer System Design, Morgan Kaufmann Publisher-2006.
2. David E-Simon: An Embedded software Primer, Pearson Education, 2007.
3. K.V.K.K. Prasad Real-Time Systems: Concepts Design and Programming, Dreamtech Press,2005.

| EC5164 | DISPLAY DEVICES AND TECHNOLOGIES | PEC | 3-0-0 | 3 credits |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | Understand the basics of Optics and its properties. |
| CO2 | Study the semiconductor TFT Technology and its processing techniques. |
| CO3 | Identify sources of error their reduction techniques and prepare an error budget for a given DAS that include DAC and ADC. |
| CO4 | Study the Principles, construction of display devices such as CRT, LED, and LCD and projection systems. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | | | | | | | | | | | |
| CO2 | | 2 | | | | 2 | | | | | | |
| C03 | | 2 | | | | 2 | | | | | | |
| C04 | | 2 | | | | 3 | | | 2 | | | |

**Detailed Syllabus:**

Properties of Light, Geometric Optics, Optical Modulation; Vision and Perception: Anatomy of Eye, Light Detection and Sensitivity, Spatial Vision and Pattern Perception, Binocular Vision and Depth Perception; Driving Displays: Direct Drive, Multiplex and Passive Matrix, Active Matrix Driving, Panel Interfaces, Graphic Controllers, Signal Processing Mechanism; Power Supply: Fundamentals, Power Supply Sequencing.

Display Glasses, Inorganic Semiconductor TFT Technology, Organic TFT Technology; Transparent Conductors, Patterning Processes: Photolithography for Thin Film LCD, Wet Etching, Dry Etching; Flexible Displays: Attributes, Technologies Compatible with Flexible Substrate and Applications, TFT Signal Processing Techniques; Touch Screen Technologies: Introduction, Coatings, Adhesive, and Interfaces with Computer Mechanism.

Inorganic Phosphors, Cathode Ray Tubes, Vacuum Florescent Displays, Filed Emission Displays; Plasma Display Panels, LED Display Panels; Inorganic Electroluminescent Displays: Thin Film Electroluminescent Displays, AC Powder Electroluminescent Displays; Organic Electroluminescent Displays: OLEDs, Active Matrix for OLED Displays; Liquid Crystal Displays: Fundamentals and Materials, Properties of Liquid Crystals, Optics and Modeling of Liquid Crystals; LCD Device Technology: Twisted Numeric and Super twisted Numeric

Displays, Smectic LCD Modes, In-Plane Switching Technology, Vertical Aligned Nematic LCD Technology, Bistable LCDs, Cholesteric Reflective Displays; LCD Addressing, LCD Backlight and Films, LCD Production, Flexoelectro-Optic LCDs.

**Paper like and Low Power Displays:** Colorant Transposition Displays, MEMs Based Displays, 3-D Displays, 3-D Cinema Technology, Autostereoscopic 3- D Technology, Volumetric and 3-D Volumetric Display Technology, Holographic 3-D Technology; Mobile Displays: Trans-reflective Displays for Mobile Devices, Liquid Crystal Optics for Mobile Displays, Energy Aspects of Mobile Display Technology.

**Microdisplay Technologies:** Liquid Crystals on Silicon Reflective Micro display, Transmissive Liquid Crystal Microdisplay, MEMs Microdisplay, DLP Projection Technology; Microdisplay Applications: Projection Systems, Head Worn Displays; Electronic View Finders, Multifocus Displays, Occlusion Displays, Cognitive Engineering and Information Displays; Display Metrology, Standard Measurement Procedures, Advanced Measurement Procedures: Spatial Effects, Temporal Effects, Viewing Angle, Ambient Light; Display Technology Dependent Issues, Standards and Patterns, Green Technologies in Display Engineering.

**Referrence book:**

1. Handbook of Visual Display Technology , Janglin Chen, Wayne Cranton,Mark Fihn

| EC5165 | Machine Learning | PEC | 3-0-0 | 3 credits |
|---|---|---|---|---|

- **Prerequisites:** Linear algebra, Programming knowledge, and differential calculus.

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

| | |
|---|---|
| CO1 | Understand the key algorithms and theory of Machine learning. |
| CO2 | Understand the Artificial Neural Networks |
| CO3 | Design and implement machine learning solutions to classification, regression, and clustering problems |
| CO4 | Evaluate and interpret the results of the algorithms. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | | | 2 | | 3 | 2 |
| CO2 | | | | | | | | | 2 | | 3 | 2 |
| C03 | | | | | | | | | 2 | | 3 | 2 |
| C04 | | | | | | | | | 2 | | 3 | 2 |

**Detailed Syllabus:**

- Introduction to the course, recap of linear algebra and probability theory basics.
- Linear Regression, Ridge Regression, Sensitivity Analysis, Multivariate Regeression.
- Bayesian Classification: Naive Bayes, Parameter Estimation (ML, MAP), Sequential Pattern Classification.
- Evaluation and Model Selection: ROC Curves, Evaluation Measures, Significance tests.
- Non-parametric Methods: k-Nearest Neighbours, Parzen Window.
- Discriminative Learning models: Logistic Regression, Perceptrons, Artificial Neural Networks, Support Vector Machines.
- Dimensionality Reduction: Principal Component Analysis, Fischer's Discriminant Analysis.
- Decision Trees: Splitting Criteria, CART.
- Ensemble Methods: Boosting, Bagging, Random Forests.
- Clustering: Partitional, Hierarchical, density based clustering.

**Text Book**


1. Pattern Recognition and Machine Learning, Christopher Bishop, Springer 2006.


**Reference Books**


1. Introduction to Statistical Learning, Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Springer, 2013.

2. Pattern Classification, 2nd Ed., Richard Duda, Peter Hart, David Stork, John Wiley & Sons, 2001.
3. “Machine Learning” by Tom M. Mitchell, Tata McGraw Hill Education(India) Edition 2013

| EC5166 | Data Acquisition Systems and Design | PEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | Understand the principles of data acquisition, configurations, characteristics and specifications of various components used in DAS. |
| CO2 | Analyze the conversion logic employed in the different ADC’s and DAC’s. |
| CO3 | Familiarize PC Hardware and interfacing bus protocols. |
| CO4 | Recognize various interfacing issues of DAC’s & ADC’s to a PC. |
| CO5 | Design and develop the PC based DAQ systems. |

**Mapping of course outcomes with program outcomes**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | 2 | | | | | | | | 1 | |
| CO2 | 2 | | | | 2 | 2 | | | | | | |
| C03 | | | | | | 3 | | 2 | | | 1 | |
| C04 | 2 | | | | 3 | 2 | | | | | 1 | |
| C05 | 2 | | | | | 3 | | 3 | 2 | | 1 | |

**Detailed Syllabus:**

**Introduction to data acquisition systems:** Data acquisition systems configurations–components. Analog multiplexers and sample & hold circuits- specifications and design considerations.

**ADCs &DACs:**Specifications & Characteristics, Types of DACs & ADCS- Serial, parallel, direct, indirect, hybrid, monolithic and Sigma-delta ADCs.

**Hardware organization of PC for data acquisition:** Motherboard components, operation of interrupts, operation of DMA, Memory, Expansion bus standards (ISA,EISA,PCI,CompatPCI,PXI), operating system issues and device drivers

**Plug-in Data acquisition boards:** A/D & D/A boards, sampling techniques, single ended vs differential signals, resolution, accuracy and dynamic range.

**External data acquisition systems:** Data acquisition via a serial link RS232 and USB, data acquisition using GPIB(IEEE-488). Case studies on USB DAQ system and PXI-based DAQ system.

**Text books:**

1. PC interfacing and data acquisition –Kevin James;Newnes publications Ltd., 2000
2. Practical data acquisition for Instrumentation and control systems-John park and Steve Mackay Newness publications Ltd., 2003
3. PC based Instrumentation concepts and Practice –Mathivanan: PHI, 2007
4. ‘Data Converters’, G.B.Clayton; the Macmillan Press Ltd.1983
5. ‘Users Handbook of D/A and A/D Converters’, E.R. Hnatek

| EC5167 | Bio-Medical Instrumentation | PEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisites:** None

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

| | |
|---|---|
| CO1 | Model biological systems. |
| CO2 | Comprehend the principles of transducers in bio-instrumentation. |
| CO3 | Analyze the ECG, EEG and EMG. |
| CO4 | Measure bio medical signal parameters. |
| CO5 | Study pace makers, defibrillators, surgical instruments etc. |

**Mapping of COs and POs:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | 3 | | | | | | | 3 | | |
| CO2 | | | 3 | | | | | | | 3 | | 2 |
| CO3 | | | | | | | | | | 3 | | 2 |
| CO4 | | | | | | | | | | 3 | | |
| CO5 | | | | | | | | | | 3 | | 2 |

**Detailed Syllabus:**

**BASICS OF BIOMEDICAL INSTRUMENTATION**: Terminology, Medical Measurements constraints, Classification of Biomedical Instruments, Introduction to biological system modelling; Electrical and ionic properties of cellular membranes, Sources and theories of bioelectric potentials.

**BIOMEDICAL TRANSDUCERS**: Types of transducers used in Bio-instrumentation. Recording electrodes, Electrodes theory, Biopotential electrodes, Biochemical electrodes

**BIOMEDICAL SIGNAL MEASUREMET BASICS**: Bioamplifiers, Measurement of PH,oxygen and carbondioxide

**THERAPEUTIC AND PROSTHETIC DEVICES**: Cardiac Pacemakers, defribillators, Hemodynamics&Hemodialysis,Ventilators, InfantIncubators, Surgical Instruments, Therapeutic Applications of the Laser.

**CARDIOVASCULAR MEASUREMENTS**: Blood flow, pressure; Cardiac output andimpedance measurements; Pleathysmography, Measurement of Heart sounds, An

Introduction to Electrocardiography (ECG), Elements of Intensive care monitoring heart-rate monitors; Arrhythmia monitors.

**EEG & EMG**: Anatomy and Functions of Brain, Bioelectric Potentials from Brain, RestingRhythms, Clinical EEG, Instrumentation techniques of electroencephalography, Electromyography

**MEDICAL IMAGING SYSTEMS**: Radiography, MRI, Computed Tomography, Ultrasonography

**NONINVASIVE INSTRUMENTATION:** Temperature Measurements, Principlesof Ultrasonic Measurements, Ultrasonic and its applications in medicine.

**BIOTELEMETRY**: Introduction to Biotelemetry, Physiological parameters adaptable tobiotelemetry, Biotelemetry System Components, Implantable units and Applications of Telemetry in Patient Care.

**Reading:**


1. L.A.Geddes and Wiley, Principles of Biomedical Instrumentation L.E.Baker (2nd Ed.)

2. L. Cromwell, Biomedical Instrumentation and Measurements, Prentice Hall.

3. John G. Webster (Ed.), Medical Instrumentation – Application and Design, 3rd Edition, John Wiley & Sons Inc.

| EC5168 | IOT for Industrial Applications | PEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

Prerequisites: None

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

| | |
|---|---|
| CO1 | UnderstandIOTdesignrequirements |
| CO2 | Comparevarioustechnologiesandprotocols |
| CO3 | Studystorageandintelligentanalytics |
| CO4 | Analyzesecurityrequirementsalongwiththreatmodel |
| CO5 | Designandexperimentvarioususecases |

Mapping of course outcomes with program outcomes

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | 2 | | | | 1 | 2 |
| CO2 | | | | | | | 2 | | | | 1 | 2 |
| CO3 | | | | | | | 2 | | | | 1 | 2 |
| CO4 | | | | | | | 2 | | | | 1 | 2 |
| CO5 | | | | | | | 2 | | | | 1 | 2 |

**Detailed Syllabus:**

**Architectures:**IoT and the connected world, Architecture of IoT, Security issues, Opportunities for IoT

**The Web of Things:** Linked data, Enterprise data, Importance of security, privacy, and authenticity, Industry standards, Web of Things layer as the driver for IoT systems

**Lessons from the Internet:** Relevance of Internet to network of Things, network management, security, mobility and longevity, desirable features of a distributed architecture for a system of things

**Technologies:** Wireless protocols, Connectivity options, Low-power design, range extension techniques, data-intensive IoT.

**Data storage and analysis:** Managing high rate sensor data, Processing data streams, Data consistency in an intermittently connected or disconnected environment, Identifying outliers and anomalies.

**Security in IOT:** Threat models, Defensive strategies and examples

**Use cases:** Smart Buildings, Smart health, Home automation, Location tracking

**Smart Cities:** Collection of information including opportunistic sensing, crowd sensing, and adhoc sensing Response of the system including analytics and optimization, distributed action, people as intelligent actuators, the risk for cyber-attacks in centralized and distributed systems, MAC Layer Protocols for IoT

Text Books:


1. Designing the Internet of Things Adrian McEwen, Hakim Cassimally Wiley 2013

2. Enterprise IoT  NaveenBalaniCreateSpace Independent Publishing Platform 2016

| EC5169 | Advanced Computer Architecture | PEC | 3-0-0 | 3 Credits |
|---|---|---|---|---|

**Prerequisite**: Digital System Design and Computer Architecture.

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

| | |
|---|---|
| CO1 | Understand the micro-architectural design of processors. |
| CO2 | Evaluate performance of different architectures with respect to various parameters |
| CO3 | Analyze performance of different ILP techniques |
| CO4 | Identify cache and memory related issues in multi-processors |
| CO5 | Understand the concept of NOC |

**Mapping of COs and POs:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | | | | | | | 2 | | 1 | | 1 | 2 |
| CO2 | | | | | | | 2 | | 1 | | 1 | 2 |
| C03 | | | | | | | 2 | | 1 | | 1 | 2 |
| C04 | | | | | | | 2 | | 1 | | 1 | 2 |

**Introduction to high performance computing,** RISC philosophy and overview of pipelined architecture. Performance evaluation of pipelined architecture. Limitations of scalar pipelines,Instruction level parallelism,

**superscalar architecture:** Instruction flow optimization, Handling branches, Advanced optimization in instruction flow, register flow techniques: Register renaming and out of order execution.

**Advanced data flow techniques:** Instruction reuse and value prediction, Memory data flow, Advanced memory data flow architectures ,performance evaluation of superscalar architectures.

**Multi-threading,** Simultaneous multithreaded (SMT) architectures, SMT architecture: Choices, SMT performance on various designs, SMT architecture: OS impact and adaptive architectures.

**Multiscalar architecture,** Multi-core Architectures, Multicore Interconnect – NOC, Network-on-Chip, Cache Coherence, Cache Consistency model, Dynamic Core architectures, GP-GPU Architecture, CPU-GPU Integration.

**References :**


1. J.L. Hennessy, and D.A. Patterson, Computer Architecture: A quantitative approach, Fifth Edition, Morgan Kaufman Publication, 2012
2. J.P. Shen and M.H. Lipasti, *Modern Processor Design*, MC Graw Hill, Crowfordsville, 2005.