**SYLLABUS**

**FOR**

**TWO-YEAR M. TECH. PROGRAMME**

**IN**

**ELECTRONICS AND INSTRUMENTATION**



|  |
| --- |
| **NAAC – A Grade** |

**DEPARTMENT OF INSTRUMENTATION & ELECTRONICS ENGINEERING**

**COLLEGE OF ENGINEERING & TECHNOLOGY**

**(An Autonomous and Constituent College of BPUT, Odisha)**

**Techno Campus, Mahalaxmi Vihar, Ghatikia,**

**Bhubaneswar-751029, Odisha, INDIA**

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**COURSE: M. Tech. (IE – Electronics and Instrumentation)**

**Duration: 2 years (Four Semesters)**

**Abbreviations Used: U= UG, I= Integrated, P= PG**

**PC= Professional Core PE= Professional Elective OE= Open Elective**

**LC= Lab Course MC= Mandatory Course AC= Audit Course**

**L= Lectures P= Practical/Laboratory IA\*= Internal Assessment**

**T= Tutorial PA= Practical Assessment EA=End-Semester Assessment**

**\*Internal Assessment Max. Mark (30 marks) consists of Mid Semester (20 marks) and Quiz+Assignment (10 marks)**

**Subject Code Format:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** |
| **Prog (U/I/P)** | **Type (PC/PE/OE/LC/MC/AC)** | | **Department (CE/EE/IE/ME/…)** | | **Semester (1/2/…/0)** | **Serial No. (1/2/3/…/99)** | |

**1st SEMESTER**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl. No.** | **Subject**  **Type** | **Subject Code** | **Subject**  **Name** | **Teaching Hours** | | | **Credit** | **Maximum Marks** | | | |
| **L** | **T** | **P** | **IA** | **EA** | **PA** | **Total** |
| 1 | Core 1 | PPCIE101 | Instrumentation Devices and Systems | 3 | 0 | 0 | 3 | 30 | 70 | - | 100 |
| 2 | Core 2 | PPCIE102 | Process Dynamics and Control | 3 | 0 | 0 | 3 | 30 | 70 | - | 100 |
| 3 | Professional Elective 1  (Any One) | PPEIE101 | Analytical Instrumentation | 3 | 0 | 0 | 3 | 30 | 70 | - | 100 |
| PPEIE102 | Intelligent & Smart Instrumentation |
| PPEIE103 | Biomedical Instrumentation & Signal Processing |
| 4 | Professional Elective 2  (Any One) | PPEIE109 | Advanced Control Systems (IE) | 3 | 0 | 0 | 3 | 30 | 70 | - | 100 |
| PPEIE119 | Robotics |
| 5 | Mandatory | PMCMH101 | Research Methodology & IPR | 2 | 0 | 0 | 2 | 30 | 70 | - | 100 |
| 6 | Lab 1 | PLCIE101 | Advanced control system Lab | 0 | 0 | 4 | 2 | - | - | 100 | 100 |
| 7 | Lab 2 | PLCIE102 | Instrumentation System Design Lab | 0 | 0 | 4 | 2 | - | - | 100 | 100 |
| **Total** | | | | **14** | **0** | **8** | **18** | **150** | **350** | **200** | **700** |
| 8 | Audit 1 | Any one subject from Appendix-I | | | | | | | | | 100 |
| **Grand Total** | | | | | | | | | | | **800** |

**2nd SEMESTER**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl. No.** | **Subject**  **Type** | **Subject Code** | **Subject**  **Name** | **Teaching Hours** | | | **Credit** | **Maximum Marks** | | | |
| **L** | **T** | **P** | **IA** | **EA** | **PA** | **Total** |
| 1 | Core 3 | PPCIE201 | Industrial Instrumentation | 3 | 0 | 0 | 3 | 30 | 70 | - | 100 |
| 2 | Core 4 | PPCIE202 | Digital Integrated Circuit Design | 3 | 0 | 0 | 3 | 30 | 70 | - | 100 |
| 3 | Professional Elective 3  (Any One) | PPEIE201 | Digital Control System | 3 | 0 | 0 | 3 | 30 | 70 | - | 100 |
| PPEIE202 | Fiber Optics & LASER Instrumentation |
| PPEIE203 | Industrial Automation |
| 4 | Professional Elective 4  (Any One) | PPEIE213 | Analog Signal Processing | 3 | 0 | 0 | 3 | 30 | 70 | - | 100 |
| PPEIE214 | Bio MEMS and Nano Technology |
| PPEIE215 | Microcontroller & Embedded Systems |
| 5 | Practical 1 | PPRIE201 | Mini Project with Seminar | 0 | 0 | 4 | 2 | - | - | 100 | 100 |
| 6 | Lab 3 | PLCIE201 | VLSI Design Lab | 0 | 0 | 3 | 2 | - | - | 100 | 100 |
| 7 | Lab 4 | PLCIE202 | Advanced Instrumentation Lab | 0 | 0 | 4 | 2 | - | - | 100 | 100 |
| **Total** | | | | **12** | **0** | **12** | **18** | **120** | **280** | **300** | **700** |
| 8 | Audit 2 | Any one subject from Appendix-II | | | | | | | | | 100 |
| **Grand Total** | | | | | | | | | | | **800** |

**3rd SEMESTER**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl. No.** | **Subject**  **Type** | **Subject Code** | **Subject**  **Name** | **Teaching Hours** | | | **Credit** | **Maximum Marks** | | | |
| **L** | **T** | **P** | **IA** | **EA** | **PA** | **Total** |
| 1 | Professional Elective 5  (Any One) | PPEIE301 | Soft Computing | 3 | 0 | 0 | 3 | 30 | 70 | - | 100 |
| PPEIE302 | Advanced Process Control |
| PPEIE303 | Digital Image Processing |
| 2 | Open Elective | Any one subject from Appendix-III | | 3 | 0 | 0 | 3 | 30 | 70 | - | 100 |
| 3 | Project 1 | PPRIE301 | Phase-I Dissertation | 0 | 0 | 20 | 10 | - | - | 100 | 100 |
| **Total** | | | | **6** | **0** | **20** | **16** | **60** | **140** | **100** | **300** |

**4th SEMESTER**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sl. No.** | **Subject**  **Type** | **Subject Code** | **Subject**  **Name** | **Teaching Hours** | | | **Credit** | **Maximum Marks** | | | |
| **L** | **T** | **P** | **IA** | **EA** | **PA** | **Total** |
| 1 | Project 2 | PPRIE401 | Phase-II Dissertation | 0 | 0 | 32 | 16 | - | - | 100 | 100 |
| **Total** | | | | **0** | **0** | **32** | **16** | **-** | **-** | **100** | **100** |

**Abstract of Credit and Marks Distribution**

|  |  |  |  |
| --- | --- | --- | --- |
| **Sl. No.** | **Semester** | **Maximum Credits** | **Maximum Marks** |
| 1 | 1st Semester | 18 | 800 |
| 2 | 2nd Semester | 18 | 800 |
| 3 | 3rd Semester | 16 | 300 |
| 4 | 4th Semester | 16 | 100 |
| **Total** | | **68** | **2000** |

**NB:**

* **Any one of the Courses in Appendix-I is to be Decided by the Concerned Department for Audit-1 (1st Sem)**
* **Any one of the Courses in Appendix-II is to be Decided by the Concerned Department for Audit-2 (2nd Sem)**
* **Any one of the Courses in Appendix-III is to be Decided by the Concerned Department for Open Elective (3rd Sem)**

**Semester-1**

**Core 1: Instrumentation Devices & Systems (PPCIE101)**

**Prerequisites:** Electrical and Electronics measurements

**Course Outcomes:**

At the end of this course students will be able to

1. Identify the characteristics required while choosing a sensor.
2. Select a suitable resistance sensor for measurement of displacement, temperature, strain / pressure / force.
3. Analyze measurements using Thermocouple, Piezoelectric, Hall Effect Type, Photoelectric, Electrochemical and Digital transducers.

**Module I**

Measurement, Instrumentation & Calibration: Instrument Classification, Performance Characteristics, Static Characteristics, Dynamic Characteristics, Errors in measurement, Gross Error, Systematic Error, Estimation of Systematic Error, Computation of Precise Values. Mechanical Transducers: Basics of Temperature Measurement: Bimetallic Element, Fluid Expansion System. Basics of Pressure Measurement: Manometers, Ring-Balance Manometer, Bell type Manometer, Thin Plate Diaphragms, Membranes, Corrugated Diaphragms and Capsules, Bellows Element, Bourdon Tube Element. Basics of Force Measurement: Helical Spiral Springs, Cantilever Beams, Beams held at both ends, Diaphragm Elements, Column type Load Cells, Proving Ring type Load Cells. Basics of Torque Measurement: Torsion Bar, Flat-Spiral Spring. Basics of Flow Measurement: Pitot-Static Tube, Flow-Obstruction Elements, Centrifugal Force Element, Static Vane Elements, Rotating Vane Systems, Rotameter Float System.

**Module II**

Passive Electrical Transducers: Resistive Transducers: Resistance Thermometers, Thermistors, Semiconductor Temperature Sensors, Errors in Temperature Measurements, Resistive Displacement Transducers, Resistive Strain Transducer, Unbonded Strain Gauge, Bonded Strain Gauge, Sources of Errors, Temperature Compensation, Circuitry for Strain Gauge Instrumentation, Semiconductor Strain Gauges, Temperature Effects on Semiconductor Gauges, Linearity, Linearization and Temperature Compensation. Inductive Transducers: Inductive Thickness Transducers, Inductive Displacement Transducers, Induction Potentiometer, Movable Core Type Inductive Transducers, Linear Variable Differential Transformer, Eddy Current Type Inductive Transducer. Capacitive Transducers: Capacitive Thickness Transducer, Capacitive Displacement Transducers, Proximity Transducer, Capacitive Strain Transducer, Variable Area Capacitive Transducer, Capacitive Tachometer, Capacitive Pressure Transducers, Capacitive Microphone, Capacitive Level Transducer, Capacitive Moisture Transducer, Capacitive Hygrometer.

**Module III**

Active Electrical Transducers

Thermoelectric Transducers: Thermoelectric Phenomena, Common Thermocouple Systems; Piezoelectric Transducers: Piezoelectric Materials, Ferroelectric Materials, Piezoelectric Semiconductors, Piezoelectric Force Transducers, Piezoelectric Strain Transducer, Piezoelectric Torque Transducer, Piezoelectric Pressure Transducer, Piezoelectric Acceleration Transducer; Magnetostrictive Transducers: Magnetostriction Phenomenon, Magnetostrictive Force Transducer, Magnetostrictive Acceleration Transducer, Magnetostrictive Torsion Transducer; Hall Effect Transducers: Application of Hall Transducer. Photoelectric Transducers: Photoelectric Phenomenon, Photoconductive Transducers, Photovoltaic Transducers, Photo emissive Transducers, Phototransistor, Photomultiplier, Photo counter. Electrochemical Transducer: Basics of Electrode Potentials, Reference Electrode, Indicator Electrode, Measurement of pH, Measurement of Bioelectric Signals. Digital Transducers: Digital Displacement Transducers, Optical Encoders, Digital Tachometers.

**Text Books:**

1. D.V.S. Murty, Transducers & Instrumentation, PHI Learning Pvt. Ltd., New Delhi, 2009.
2. Ernest O. Doebeline, Measurement Systems Application & Design, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 5th Edition.

**Reference Books:**

1. C.S. Rangan, G.R. Sarma and V.S.V. Mani, Instrumentation Devices & Systems, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. B.C. Nakra and K.K. Chaudhry, Instrumentation Measurement and Analysis, McGraw Hill Education (India) Pvt. Ltd.
3. Alan S. Morris, Measurement and Instrumentation Principles, Elsevier – a Division of Reed Elsevier India Pvt. Ltd.

**Core 2: Process Dynamics and Control (PPCIE102)**

**Prerequisites:** Control System Engineering, Hydraulics and fluid machines, Thermodynamics

**Course Outcomes:**

At the end of this course students will be able to

1. Design the parameters of various controller and tuning
2. Model and simulate the processing plant
3. Analyze the utility of actuators and valves in processing plants

**Module I**

MATHEMATICAL MODELLING OF PROCESSES

Introduction to Process control– Evolution of process control, Concept, definition and types of processes, Benefits, difficulties and requirements of process control implementation, classification of process variables, open loop Vs closed loop systems, Servo Vs regulatory control, Feedback and feed forward control configuration, Step in synthesis of a control system. Need for process control –Hardware elements of a process control system – Need of Mathematical modelling –Mathematical model of level, pressure, thermal processes.

**Module II**

VARIOUS CONTROLLERS AND ITS CHARACTERISTICS

Classification of Controllers- Continuous Controller-P- Controller, I-Controller, D-Controller, I-Controllers, PD-Controllers, ID-Controllers- Discontinuous controllers- ON-OFF Controllers-Two Position-Three Position –Multi position Controllers-Design of Various Controllers (P, I, D, PI, PD, PID Controllers). Closed loop response- PI- Controllers, PD- Controllers, PID-Controllers in closed loop.

**Module III**

CONTROLLER DESIGN AND FINAL CONTROL ELEMENTS

Need for controller tuning -Tuning of PID controllers using Process reaction curve method, and Z-N tuning method. – IAE, ISE and ITAE– Optimum controller tuning using Evaluation criteria

Introduction to Final Control Elements- Final Control Operation-Signal Conversion-Actuators-Pneumatic Actuators-Types of control valves - Valve positioner and its importance –Characteristics of Control Valve-Control valve sizing - Cavitation and flashing-Valve characteristics and types-Selection Criteria for control valves, Electrical and Hydraulic Actuators.

**Text Books:**

1. Johnson .C.D, “Process Control Instrument Technology”, Prentice Hall Inc., 2004.
2. Surekha Bhanot, “Process Control – Principles and applications” Oxford University Press.

**References Books:**

1. Bequette. B.W, “Process Control Modeling, Design and Simulation”, Prentice Hall ofIndia, 2004.
2. Seborg. D.E, Edgar. T.F and Mellichamp. D.A, “Process Dynamics and Control”, Wiley John and Sons, 2nd Edition, 2003.

**PE 1: Analytical Instrumentation (PPEIE101)**

**Prerequisite:** Basic chemistry

**Course Outcomes:**

At the end of this course students will be able to

1. Select the required instruments for spectroscopic analysis.
2. Separate the constituents from a complex mixture using the knowledge of chromatography.
3. Evaluate different online and offline processes and identify suitable instruments for analysis of gaseous, liquid or solid substance.
4. Evaluate the physical properties of samples using PH meters and conductivity meters.
5. Measure the composition of dissolved oxygen, sodium, silica elements present in the given samples quantitatively
6. Analyze the interaction of electromagnetic radiations with matter and apply analytical techniques to accurately determine the elements present in the given sample.

**Module I**

Fundamentals of Analytical Instruments: Elements of an Analytical Instrument, Intelligent Analytical Instrumentation Systems, PC-based Analytical Instruments. Spectrophotometers: Ultraviolet and Visible Absorption Spectroscopy, Calorimeters, Photometers, Different types of Spectrophotometers, Sources of Errors and Calibration, Infrared Spectrophotometers – Basic Components and Types, Sample Handling Techniques, Flame Photometers – Principle, Constructional Details, Types and accessories, Atomic Absorption Spectrophotometers and their instrumentation.

**Module II**

Chromatography: Gas Chromatograph – Basic Parts of a Gas Chromatograph, Methods of Measurement of Peak Areas, Liquid Chromatograph – Types, High Pressure Liquid Chromatograph. pH meters and Ion Analyzers: Principle of pH Measurement, Electrodes for pH Measurement, pH Meters, Ion Analyzers, Blood pH Measurement.

Gas Analyzers: Measurement of Blood pCO2 and pO2, Industrial Gas Analyzers – Types, Paramagnetic Gas Analyzer, Infrared Gas Analyzers, Industrial gas Analyzers Based on Other Methods.

**Module III**

Principles of Nuclear Magnetic Resonance: Nuclear Magnetic Resonance (NMR) Spectroscopy – Principle, Types and Construction details of NMR Spectrometers.

Radiochemical Instruments: Fundamentals of Radiochemical Methods, Radiation Detectors, Liquid Scintillation Counters, Gamma Spectroscopy. X-Ray Spectrometers: Instrumentation for X-Ray Spectrometry, X-Ray Diffractometers, X-Ray Absorption Meters, Electron Probe Micro analyzer.

**Text Book:**

1. Handbook of Analytical Instruments – by R.S. Khandpur, TMH Education Pvt. Ltd.

**Reference Books:**

1. Instrumental Methods of Analysis – by Willard H.H., Merrit L.L., Dean J. A. and Seattle F.L., CBS Publishing and Distributors, 6th edition, 1999
2. Instrument Technology – by Jones B.E., Butterworth Scientific Publ., London, 1987. Mechanical and Industrial Measurements by Jain R.K., Khanna Publishing, N Delhi, 2nd edition, 1992.
3. Principles of Instrumental Analysis – by Skoog D.A. and West D.M., Holt Sounder Publication, Philadelphia, 1985.
4. Instrumental Analysis – by Mann C.K., Vickerks T.J. &Gullick W.H., Harper and Row
5. Instrumental Methods of Chemical Analysis - E.W. Ewing, McGraw-Hill.
6. Instrumentation, Measurement and Analysis - B.C. Nakra and K.K. Chowdhurry, TMH.
7. Measurement and Instrumentation: Trends and Applications - M.K. Ghosh, S.Sen and S. Mukhopadhyay (ed.), Ane Books, New Delhi, 2008.

**PE 1: Intelligent and Smart Instrumentation (PPEIE102)**

**Prerequisite:** Engineering Mathematics, Semiconductor devices, Microprocessor

**Course Outcomes:**

At the end of this course students will be able to

1. Evaluate the performance of an instrumentation system.
2. Analyze the characteristics a measurement system and can apply corrective actions, if required, by using the linearization and compensation techniques for better performance of the system.
3. Apply the techniques studied in this subject to design intelligent instrumentation systems for measurement of different parameters of industrial importance.
4. Calibrate different sensors.

**Module I**

Introduction, Types of instrumentation systems, Intelligence Instrumentation, Components of intelligence Instrumentation system, Semiconductor sensors, Array-Based sensors.

Intelligent sensors: Introduction, Classification, Smart sensors, Monolithic Integrated Smart sensors, Hybrid Integrated Smart sensors, Cogent sensors.

**Module II**

Temperature compensating intelligent sensors: Effect of temperature on sensors, temperature compensation techniques, temperature compensation in sensors, Microcontroller-Based compensation.

**Module III**

Linearization: Analog Linearization of Positive Coefficient Resistive Sensors, Linearization of Positive Coefficient Resistive Sensors, Microcontroller-Based Linearization

Calibration: Sensor Calibration, Conventional Calibration Circuits, Resistor Adjustment-Based Analog Calibration, Digitally Programmable Resistor, Offset Calibration

Compensation: Offset Compensation, Error and Drift Compensation

**Text Book**

1. Manabendra Bhuyan, Intelligent Instrumentation Principles and Application, CRC Press, 2011

**Reference Books**

1. J.B. Dixit, Amit Yadav, Intelligence Instrumentation for Engineers, University Science Press,2010.

**PE 1: Biomedical Instrumentation & Signal Processing (PPEIE103)**

**Pre-requisites:** OPAMP based analog circuits, physiological system of the human, various sensors to measure temperature, flow, pressure, Dynamical and statistical properties of Instrument.

**Course Outcomes:**

At the end of this course students will be able to

1. Analyze various biomedical signals and their properties.

2. Apply various Electronics circuits in the field of biomedical instrumentation.

3. Comprehend biomedical signals using various transformation techniques.

4. Record and monitor biomedical signals in PC based instrumentation system

5. Design analog circuits to reduce noises in biomedical systems.

**Module I**

Introduction: Physiological systems of the body, Basic medical instrumentation system, Sources of biomedical signals, Origin of bioelectric potentials, Examples of biomedical signals: ECG, EEG, EMG, PCG, EMG, VMG, VAG, ENG, EGG, Block diagram description of electrocardiograph (ECG) and electroencephalograph (EEG).

Physiological Transducers: Introduction, performance characteristics of transducers, displacement, position and motion transducers, transducers for body temperature measurement, blood flow and pressure measurement, biosensors, smart sensors, General principle of electrode and its applications.

**Module II**

General considerations for signal conditioners, Preamplifiers, Sources of noise in low level measurements, biomedical signal analysis and processing techniques: FT, FFT, STFT, Laplace transform, Wavelet transform,

**Module III**

Noise fundamental: Noise description, Types of analog noises, Low and high frequency noise, Noise Bandwidth, noise calculation, Noise in biomedical circuits and components

Filtering for removal of artefacts: Random noise, structured noise and physiological interference, stationary versus nonstationary processes, Illustration of the Problem with Case-studies, Time-domain Filters, and Frequency-domain Filters.

**Text Books**

1. R. S. Kandpur, Handbook of Biomedical Instrumentation, 3rd Edition, TMH Publication, 2003
2. Rangaraj M. Rangayyan, Biomedical Signal analysis, A case –Study approach, John Wiley,2014.
3. Analog Signal Processing by R. Pallas Arney, J. G Webster Wiley .

**Reference Books**

1. Wills J. Tompkins, Biomedical Digital Signal Processing, PHI.
2. M. Akay, Time Frequency and Wavelets in Biomedical Signal Processing, IEEE Press, 1998.
3. Cromwell, Biomedical Instrumentation and Measurements, 2nd Edition, Pearson Education.
4. E. N. Bruce, Biomedical Signal Processing and Signal Modelling, John Wiley, 2001.

**PE 2: Advanced Control Systems (IE) (PPEIE109)**

**Pre-requisites**- Control System Engineering-I

**Course Outcomes:**

At the end of this course students will be able to

1. Analyze discrete-time mathematical models in both time domain (difference equations, state equations) and z-domain (transfer function using z-transform).
2. Design pole-assignment controller and the specific design procedures
3. Develop state-space models
4. Design state feedback controller and state observer
5. Acquire knowledge of state space and state feedback in modern control systems, pole placement, design of state observers and output feedback controllers.
6. Analyze the uncertainty of the system using Fuzzy controller.

**Module I**

State Space Analysis of Discrete Time Control System State space representation of discrete time systems, Solution of discrete time state space equations, Pulse transfer function matrix, Eigen Values, Eigen Vectors and Matrix Diagonalization, Discretization of continuous time state space equations, Similarity transformations.

Controllability and Observability. Discretization of continuous time state equations. Solution of state difference equation, controllability and Observability tests for Digital Control Systems.

**Module II**

Compensation Network, Lead compensation, Lag Compensation, Lag –Lead Compensation, parallel Compensation, Comparison between Lag and Lead Compensation. Stability of discrete time Systems. Stability improvement by state feedback, pole placement design and full order observers and reduced order observer.

**Module III**

Lyapunov stability Analysis. Basic concepts, Lyapunov’s first and second methods Stability definitions, Stability theorems, Lyapunov functions for linear and non-linear systems.

Introduction to Fuzzy control: Fuzzy sets and linguistic variables, The fuzzy control scheme, Fuzzification and defuzzufication methods, Examples, Comparison between conventional and fuzzy control.

**Text Books: -**

1. Digital Control And State Variable Methods 3rd Edition,M.Gopal, Tata McGraw–Hill (Sep-08)
2. Control Systems Engineering, I. J. Nagrath, M. Gopal, New Age International (2010)
3. Optimal Control Theory: An Introduction. Donald E. Kirk, Dover Publications (30-apr-04)

**Reference Books**

1. Digital Control Systems Second Edition, Benjamin C. Kuo , Oxford University Press (2007)
2. M. Gopal, "Modern Control System Theory", Wiley Eastern Ltd., New Delhi.

**PE 2: Robotics (PPEIE119)**

**Prerequisites:** Sensors, 3-D Coordinates and Vectors

**Course Outcomes:**

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

1. Select required degree of freedom, arm / wrist configurations and Identify design and control issues in robotics.
2. Design transformation matrices for rotation / translation of arms / frames.
3. Analyze direct / inverse kinematic models and apply solution techniques.
4. Identify sensors for robotic applications. (Electrical sensor, Acoustic sensor, Optical sensor, Pneumatic sensor, Vision sensor)

**Module I**

Introduction to Robotics : Evolution of Robots and Robotics; Laws of Robotics; What is and What is not a Robot; Progressive Advancement in Robots; Robot Anatomy: Links, Joints and Joint Notation Scheme, Degrees of Freedom (DOF), Required DOF in a Manipulator, Arm Configuration (Cartesian, Cylindrical, Polar, Articulated), Wrist Configuration, The End-Effector;

Human Arm Characteristics; Design and Control Issues; Manipulation and Control; Sensors and Vision; Programming Robots; The Future Prospects; Bio-robotics and Humanoid Robotics; Notations.

Coordinate Frames, Mapping and Transforms : Coordinate Frames: Mapping, Mapping between Rotated Frames, Mapping between Translated Frames, Mapping between Rotated and Translated Frames; Description of Objects in Space; Transformation of Vectors: Rotation of Vectors, Translation of Vectors, Combined Rotation and Translation of Vectors, Composite Transformation; Inverting a Homogeneous Transform; Fundamental Rotation Matrices: Principal Axes Rotation, Fixed Angle Representation, Eular Angle Representations, Equivalent Angle Axis Representation.

**Module II**

Symbolic Modelling of Robots – Direct Kinematic Model ,Mechanical Structure and Notations; Description of Links and Joints; Kinematic Modelling of the Manipulator; Denavit-Hartenberg Notation; Kinematic Relationship between Adjacent Links; Manipulator Transformation Matrix.

The Inverse Kinematics: Manipulator Workspace; Solvability of Inverse Kinematic Model: Existence of Solutions, Multiple Solutions; Solution Techniques; Closed Form Solutions: Guidelines to Obtain Closed Form Solutions.

**Module III**

Robotics Sensors and Vision: The meaning of Sensing: The Human Sensing, The Problem of Robot Sensing; Sensors in Robotics: Status Sensors, Environment Sensors, Quality Control Sensors, Safety Sensors, Workcell Control Sensors, Classification of Robotic Sensors; Kinds of Sensors Used in Robotics: Acoustic Sensors, Optic Sensors, Pneumatic sensors, Force / Torque Sensors, Optical Encoders, Choosing the Right Sensor; Robotic Vision; Industrial Applications of Vision-Controlled Robotic Systems: Presence, Object Location, Pick and Place, Object Identification, Visual Inspection, Visual Guidance; Process of Imaging; Architecture of Robotic Vision Systems: Stationary and Moving Camera; Image Acquisition: Vidicon Tube, Charge-Coupled Device (CCD); Description of Other Components of Vision System: Illumination, Analog-to-Digital Conversion and Frame Grabber, Image Processing; Image Representation: Digitization, A Binary Image, Image Resolution; Image Processing: Image Improvement, Segmentation, Smoothing, Object Descriptors, Object Recognition.

**Text Books:**

1. R. K. Mittal and I. J. Nagrath, Robotics and Control, Tata McGraw Hill Education Pvt. Ltd., New Delhi.

**Reference Books**

1. S. R. Deb and S. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill Education Pvt. Ltd., New Delhi.
2. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, Robotics Control, Sensing, Vision and Intelligence, McGraw Hill Book Company, International Edition.
3. Saeed B. Niku, Introduction to Robotics Analysis, Systems, Applications, Prentice Hall of India Pvt. Ltd., New Delhi.

**MC: Research Methodology & IPR (PMCMH101)**

**Module I:**

Introduction to RM: Meaning and significance of research. Importance of scientific research in decision making. Types of research and research process. Identification of research problem and formulation of hypothesis. Research Designs.

Types of Data: Primary data Secondary data, Design of questionnaire; Sampling fundamentals ad sample designs, Methods of data collection, Measurements and Scaling Techniques, Validity & Reliability Test.

**Module II:**

Data Processing and Data Analysis-I, Data editing, Coding, Classification and Tabulation, Descriptive and Inferential Analysis, Hypothesis Testing- Parametric Test (z test, t test, F test) and non-parametric test (Chi square Test, sign test, Run test, Krushall-wallis test).

**Module III:**

Data Analysis II: Multivariate Analysis- Factor Analysis, Multiple Regression Analysis. Discriminant Analysis, Use of Statistical Packages.

**Reference Books:**

1. Research Methodology, Chawla and Sondhi, Vikas

2. Research Methodology, Paneerselvam, PHI

**Course Outcomes:**

**CO1:** Understood the Meaning of research problem, Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

**CO2:** Got the knowledge of How to get new ideas (Criticizing a paper) through the Literature Survey (i.e. Gap Analysis).

**CO3:** Understood the Filing patent applications- processes, Patent Search, Various tools of IPR, Copyright, Trademarks.

**CO4:** Understood How to apply for Research grants and Significance of Report Writing, Steps in Report Writing, Mechanics and Precautions of Report Writing, Layout of Research Report.

**CO5:** Got the knowledge of How to write scientific paper & Research Proposal - Structure of a conference and journal paper, how (and How Not) to write a Good Systems Paper:

**Lab 1: Advanced Control System Lab (PLCIE101)**

**Prerequisites:** Control Systems, MATLAB

**Course Outcomes:**

The Students will be able to

1) Analyze the linear and non-linear systems using Lyapunov method.

2) Determine P, PI, PID responses of closed loop system.

3) Design lead, lag and lead-lag compensator using frequency domain method.

4) Test Controllability and observability of continuous and discrete control system.

**LIST OF EXPERIMENTS**

1. Design and analyze PID control system using 2nd and 3rd order system.
2. Stabilize PID control system using Ziegler-Nichol’s method.
3. Design of level controller using PI Controller.
4. Design lead compensator network using MATLAB and analyze the network using MATLAB / Simulink.
5. Design lag compensator network using MATLAB and analyze the network using MATLAB / Simulink.
6. Design of lead –lag compensator to stabilize an unstable system.
7. Controllability & Observability test of a continuous control system using MATLAB / Simulink Software.
8. Controllability & Observability test of a discrete control system using MATLAB / Simulink Software.
9. Study and analyze stepper motor using PLC.
10. Study of synchro transmitter and receiver.
11. Design Boost convertor using Fuzzy logic controller.
12. Stability test of state space analysis by Lyapunov’s theorem.
13. Design Digital Kalman filter using MATLAB.
14. Study and analyze 2nd order transfer function using control system simulator.

**Lab 2: Instrumentation System Design Lab (PLCIE102)**

**Prerequisites:** Sensors and Transducers, Multisim, MATLAB

**Course Outcomes:**

The Students will be able to

1) Analyze Active and passive filters.

2) Design of Charge amplifier and Voltage regulated power supply.

3) Determine characteristics of orifice plate and rotameter.

**LIST OF EXPERIMENTS**

1) Characteristics of Instrumentation amplifier using Multisim and hardware implementation.

2) Design of LVDT using Phase sensitive demodulator and low pass filter.

3) Design of Active and Passive filters using Multisim.

4) Design of I /V and V/I converter using Multisim.

5) Design of Charge Amplifier using Multisim.

6) Design of Voltage Regulated power supply using Multisim.

7) Study of Orifice plate and Rotameter.

8) Design of Signal conditioning circuit for Strain Gauge.

9) Study Resistance Vs Temp characteristics of Thermistors using MATLAB.

10) Design of D/A Converter using Multisim.

**Audit -1**

**[To be decided by the Department]: Refer Appendix-I**

**Semester-2**

**Core 3: Industrial Instrumentation (PPCIE201)**

**Prerequisite:** Sensor/Transducer

**Course outcomes:**

After successful completion of the course, student will be able to

1. Find suitable sensor for measurement of liquid level, density, viscosity, seismic displacement, gyroscopic position, moisture, humidity, dew point, gas analysis, force, torque, pressure, nuclear radiation.
2. Apply feedback techniques using inverse transducer, transducer balancing system, servo operated system useful for industrial automation.
3. Apply techniques and select configuration for smart / micro sensors (IR / Ultrasonic / Fibre Optic / Chemical) for industrial instrumentation.

**Module I**

Mechanical Transducers: Basics of Density Measurement: Hydrometer System, Air Bubbler System, U-Tube Weighing System.

Basics of Liquid Level Measurement: Float Element, Level to Pressure Converter, Level to Force Converter.

Basics of Viscosity Measurement: Viscosity to Pressure Converter, Viscosity to Torque Converter, Viscosity to Displacement Converter.

Displacement to Pressure Transducer, Seismic Displacement Transducer, Basics of Gyroscope, Rate Gyro, Integrating Gyro.

Passive Electrical Transducers: Temperature measurement of Fluid in Motion, Thermal Radiation Detectors, Hot Wire Resistance Transducers, Hot Wire Level Transducer, Hot Wire Pressure Transducers, Thermal Conductive Gauge, Gas Analysis for composition, Hot Wire Anemometer.

**Module II**

Strain Gauge Applications: Calibration of Strain Gauges, Experimental Stress Analysis, Stress-Strain Relationships, Strain-Gauge Transducer Systems, Strain-Gauge Force Transducer, Strain-Gauge Flow Transducer, Strain-Gauge Accelerometers, Strain-Gauge Torque Transducer, Strain-Gauge Pressure Transducer.

Resistive Pressure Transducer, Resistive Moisture Transducers, Moisture Content of Solids, Concentration of Electrolytic Solutions, Relative Humidity of Gases, Resistive Magnetic Flow Transducers, Resistive Optical Radiation Transducers.

Ionization Transducers: Ionization Vacuum Gages, Ionization Displacement Transducer, Nuclear Radiation Transducers, Ionization Chamber, Proportional Counter, Geiger-Müller Counter, Scintillation Counter, Solid State Transducer for Radiation, Radioactive Vacuum Gages, Radioactive Thickness Gauge, Radioactive Level Gauges.

**Module III**

Feedback Transducer Systems

Introduction, Feedback Fundamentals, Inverse Transducers, Temperature Balance System, Self Balancing Potentiometers, Self Balancing Bridges, Heat Flow Balance Systems, Beam Balance Systems, Servo Operated Manometer, Feedback Pneumatic Load Cell, Servo Operated Electromagnetic Flow Meter, Feedback Accelerometer System, Integrating Servo, Automated Measurement of Dew Point, Non-Contact Position Measurement, Biomorph Position Control System, Other Applications of Feedback.

Development in Sensor Technology

Introduction; Semiconductor Sensors: Basics, Materials and Techniques; Smart Sensors: Definition of Smart Sensor, Configuration of Smart Sensor; Micro sensors: Introduction, A Micro size Microphone, Inertial Sensors, Hall Effect Sensors, Polymer Sensor; IR Radiation Sensors: Basics, Thermal Detectors, Quantum Detectors, IR Thermometry; Ultrasonic sensors: Introduction, Basics of Ultrasonics, Sonar, Ultrasonic Sensing System, Ultrasonic Flow Meters, Doppler Flow Meter, Cross Correlation Flow Meter, Surface Acoustic Wave (SAW) Sensors, Coriolis type Flowmeter; Fibre Optic Sensors: introduction, Basics, Typical Fibre Optic Sensors, Fibre Optic pH Sensor, Fibre Optic Humidity Sensor; Chemical Sensors: Introduction, Semiconductor Gas Detectors, Ion Selective Electrodes, Conductometric Sensors, Mass Sensor; Bio Sensors: Introduction, Biosensor Structure, Biomedical Sensors, Quartz Crystal Microbalance.

**Text Books:**

1. D.V.S. Murty, Transducers & Instrumentation, PHI Learning Pvt. Ltd., New Delhi, 2009.
2. Ernest O. Doebeline, Measurement Systems Application & Design, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 5th Edition.

**Reference Books**

1. C.S. Rangan, G.R. Sarma and V.S.V. Mani, Instrumentation Devices & Systems, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
2. B.C. Nakra and K.K. Chaudhry, Instrumentation Measurement and Analysis, McGraw Hill Education (India) Pvt. Ltd.
3. Alan S. Morris, Measurement and Instrumentation Principles, Elsevier – a Division of Reed Elsevier India Pvt. Ltd.

**Core 4: Digital Integrated Circuit Design (PPCIE202)**

**Pre-requisites**

Student should have prior knowledge of fundamental circuit analysis techniques and basic electronics backgrounds, including BJT, MOSFET and digital circuits. A course on VLSI Design is preferable

**Course Outcomes:**

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

1. Apply the basics of Fabrication and Layout for different CMOS Integrated Circuits designs.

2. Formulate and solve problems in Digital Integrated Circuit design and implementation.

3. Analyse and synthesize digital logic CMOS circuits of LSI complexity

4. Acquire technical competence in Digital Integrated Circuit design Implementation

**Module I**

Introduction-NMOS Logic, CMOS Logic Gates, Transfer Curves and Noise Margins, Gate Delays and Rise and Fall Times, Transient Response, RC Approximation to the Transient Response of a CMOS Inverter

Processing and Layout - CMOS Processing, Bipolar Processing, CMOS Layout and Design Rules, Advanced CMOS Processing

**Module II**

Traditional MOS Design- Pseudo-NMOS Logic and Gate Design, Transistor Equivalency, CMOS Logic and Gate Design Transmission-Gate and Fully Differential CMOS Logic-Transmission-Gate Logic Design, Differential CMOS Circuits CMOS Timing and I/O Considerations- Delay of MOS Circuits, Input/ Output Circuits Latches, Flip-Flops, and Synchronous System Design-CMOS Clocked Latches, CMOS Flip-flops, Synchronous System Design Techniques, Synchronous System Examples

**Module III**

Advanced CMOS Logic Design-Pseudo-NMOS and Dynamic Pre-charging, Domino-CMOS Logic, No-Race-Logic, Single-Phase Dynamic Logic, Differential CMOS, Dynamic Differential Logic Digital Integrated System Building Blocks- Multiplexors and Decoders, Barrel Shifters, Counters, Digital Adders, Digital Multipliers, Programmable Logic Arrays

Integrated Memories- Static Random-Access Memories, Static Random-Access Memory Storage Cells Address Buffers and Decoders, Dynamic Random-Access Memories, Read-Only Memories.

**Textbook:**

1. Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, Digital Integrated Circuits – A Design Perspective, 2nd edn., Pearson Education, 2003. ISBN: 8178089912.
2. Ken Martin, Digital Integrated Circuit Design, Oxford University Press, 2000.

**Recommended Reading:**

1. K. Eshraghian, and N.H.E. Weste, Principles of CMOS VLSI Design – a Systems Perspective, 2nd edition., Addison Wesley, 1993.
2. Wayne Wolf, Modern VLSI Design System–on–Chip Design, 3rd Edition, Pearson Ed, 2003.
3. M. Michael Vai, VLSI Design, CRC Press, 2001.
4. John P. Uyemura, CMOS Logic Circuit Design, Springer (Kluwer Academic Pub), 2001.

**PE 3: Digital Control System (PPEIE201)**

**Prerequisite:**

Mathematics, Linear Control System

**Course outcomes:**

After successful completion of the course, student will be able to,

1. Understand mathematical models of linear discrete-time control systems using transfer functions and state-space models.
2. Analyze transient and steady state behaviors of linear discrete time control systems.
3. To design controllers and observers for linear discrete-time control systems so that their performance meets specified design criteria.
4. To design digital controllers, assess their design through the constraint specifications.

**Module I**

Introduction to Discrete Time Control System Basic building blocks of Discrete Time Control system, Sampling Theorem, Z transform and Inverse Z transform for applications for solving differential equations, Mapping between the S-plane and the Z-plane, Impulse sampling and Data Hold

**Module II**

Pulse Transfer Function and Digital PID Controllers The pulse transfer function, pulse transfer function of Closed Loop systems, Pulse transfer function of Digital PID controller, Velocity & Position forms of Digital PID Controller, Realization of Digital Controllers, Deadbeat response and ringing of poles.

**Module III**

Design of Discrete Time Control System by conventional methods Stability analysis in Z-plane, Jury stability criterion, Bilinear transformations, Design based on the root locus method, Digital Controller Design using Analytical Design Method. Optimal Control Quadratic Optimal Control and Quadratic performance index, Optimal state regulator through the matrix riccati equations, Steady State Quadratic Optimal Control.

**Text Books:**

1. Discrete Time Control systems by K. Ogata, Prentice Hall, Second Edition, 2003.

2. Digital Control and State Variable Methods by M. Gopal, Tata McGraw Hill, 2003.

**Reference Books:**

1. Digital control of Dynamic Systems by G.F. Franklin, J. David Powell, Michael Workman 3rd Edition, Addison Wesley, 2000.
2. Digital Control Engineering by M. Gopal, Wiley Eastern Ltd, 1989.
3. Digital Control by Kannan Moudgalya, John Wiley and Sons, 2007.
4. Digital Control by Forsytheand W. and Goodall R.N McMillan,1991.
5. Digital Control Systems by Contantine H. Houpis and Gary B. Lamont, Second Edition, McGraw-Hill International, 2002.

**PE 3: Fiber Optics and Laser Instrumentation (PPEIE202)**

**Prerequisite:**

1. Basic Electronics

2. Knowledge in optical fibers

**Course Outcomes:**

Upon successful completion of this course, a student will be able to,

1. Analyze the characteristics of different types of optical fibers and propagation of light through them.
2. Analyze absorption losses, scattering losses and dispersion in an optical fiber.
3. Evaluate the characteristics of different optical signals coming out of optical fibre.
4. Design optical systems for measurement of different parameters.
5. Analyze the characteristics Laser.
6. Apply the knowledge of optical fibers and Lasers for different industrial and medical applications.

**Module I**

Optical Fibers and their Properties

Principles of light propagation through a fiber, Different types of fibers and their properties, Transmission characteristics of optical fiber, Absorption losses, Scattering losses, Dispersion, Optical fiber measurement. Optical sources, Optical detectors, LED-LD-PIN and APD.

**Module II**

Laser Fundamentals

Fundamental characteristics of Lasers, Three level and four level lasers, Properties of laser, Laser modes, Resonator configuration, Q-switching and mode locking, Cavity dumping.

Types of lasers: gas lasers, solid lasers, liquid lasers, semiconductor lasers.

**Module III**

Industrial Application of Optical Fibers

Fiber optic sensors, Fiber optic instrumentation system, Interferometric method of measurement of length, Measurement of pressure, temperature, liquid level and strain, Fiber optic gyroscope.

Industrial Application of Lasers

Laser for measurement of distance, length, velocity, acceleration, Material processing, Laser heating, welding, melting and trimming of materials, Removal and vaporization. Medical applications of lasers, Laser and tissue interaction, Laser instruments for surgery, Application of Laser for removal of tumors, brain surgery, plastic surgery, gynecology and oncology.

**Textbooks:**

1. John and Harry, Industrial Lasers and their Applications, McGraw Hill, 1974.

2. Senior J.M., Optical Fiber Communication Principles and Practice, Prentice Hall,1985.

**Reference Books:**

1. John F Read, Industrial Applications of Lasers, Academic Press, 1978

2. Monte Ross, Laser Applications, McGraw Hill, 1968

3. Keiser G., Optical Fiber Communication, McGraw Hill, 1991

4. Jasprit Singh, Semiconductor Optoelectronics, McGraw Hill, 1995

5. Ghatak A.K and Thiagarajar K, Optical Electronics Foundation Book, TMH, New

**PE 3: Industrial Automation (PPEIE203)**

**Prerequisite:**

1. Operation of different types of sensors and their characteristics

2. Knowledge in control system

**Course Outcomes:**

1. Identify a particular sensor for specific application based on its static and dynamic characteristics
2. Analyze the error occurred because of installation and measurement by an instrument
3. Evaluate the appropriate control strategy for specific process
4. Design a scheme to automate simple processes
5. Analyze sensors to be used at different places of power plant
6. Apply different safety measures to avoid hazardous condition in industry

**Module I**

Introduction: Performance characteristics, Dynamic Calibration, Errors: An Overview, Statistical Error Analysis, Reliability and Related Topics.

Special Control Structures: Cascade Control, Feedforward Control, Feedforward-Feedback Control Configuration, Ratio Control, Selective Control, Adaptive Control, Adaptive Control Configuration.

**Module II**

Industrial Automation: Programmable Logic Controllers: Introduction, Principles of operation, Architecture, Programming (Programming Languages, Ladder Diagram, Boolean Mnemonics) Distributed Control: Distributed vs. Centralized, Advantages, Functional Requirements, System Architecture, Distributed Control Systems (DCS). Real-time Programming: Multi-tasking, Task Management, Inter-task Communication.

**Module III**

Power Plant Instruments: Introduction, the Power Plant Scheme, Pressure, Temperature, Flow and Level, Vibration and Expansion, Analysis, Flue Gas Analysis

Hazard and Safety: Initial consideration, Enclosures, Intrinsic Safety, Prevention of Ignition, Methods of Production, Analysis Evaluation and Construction

**Text Books:**

1. Principles of Industrial Instrumentation, Third Edition, D Patranabis, Tata McGraw Hill Education Private Limited, New Delhi
2. Process Control: Principles and Applications, Surekha Bhanot, Oxford University Press, 2010.
3. Computer-Based Industrial Control, Krishna Kant, PHI,2009.

**Reference Books:**

1. Process control (Instrument Engineer Handbook), by Bela G. Liptak, Butterworth Heinemann Publication, 3rd Edition.
2. Process/Industrial Instruments and Controls Handbook, Gregory K. Mc Millian Editor-in-Chief, Douglas M. Considine Late Editor-in-Chief.

**PE 4: Analog Signal Processing (PPEIE213)**

**Prerequisites:**

1. Basic knowledge about OPAMP circuits.

2. Knowledge of transfer functions and their stability in analog domain is required.

3. Differential equations and their solution technique.

4. Basic Idea about various standard signals and their properties.

**Course Outcomes:**

1. Analyze and Design linear and non-linear circuits using OPAMP and know their applications.
2. Comprehend the design aspects of instrumentation amplifier using OPAMP and their limitations.
3. Design and realize Phase locked loop (PLL) and apply PLL in different electronics system.
4. Design & realize RC active filters circuits.
5. Evaluate various analog noises and their impact in different analog circuits.

**Module I**

Introduction: Review of Operational Amplifier Fundamentals, Op-amp applications: DC and AC amplifiers. DC and AC Coupled voltage follower, Use μ741 and LF411 IC in instrumentation System, Non-linear application of OPAMP: Basic comparator, Zero Crossing Detector, Schmitt Trigger, Comparator Characteristics, Limitation of OP-AMP as Comparator ,OP-AMP as Voltage Limiter, Positive voltage limiter and Negative voltage limiter

**Module II**

Phase locked loops (PLL): Ex-OR Gates and multipliers as phase detectors, Block Diagram of IC PLL, Working of PLL and Applications of PLL.

Liner Analog Functions: Addition, Subtraction, Differentiation, Integration, Impedance Transformation and AC/DC Signal

Conversion: Signal Rectification, Peak and Valley Detection, rms to dc Conversion, Amplitude Demodulation Other Nonlinear Analog Functions: Voltage Comparison, Voltage Limiting (Clipping), Logarithmic Amplifiers, Analog Multipliers, And Analog Dividers

**Module III**

Analog Filters: Introduction to filtering and filter design, components for filter implementation, active low-pass, high-pass, band-pass, band-reject and all-pass filters – design and realization, Frequency Response of different types of filters, Switch capacitance filter.

**Text Books:**

1. Analog Signal Processing, by Ramon Pallas-Areny John G. Webster, Wiley Publications, Students edition.

**References Books**

1. Design with Operational Amplifiers and Analog Integrated Circuits by Sergio Franco, TMH Publications, 3rd Edition.
2. Op-Amps and Linear Integrated Circuits by Ramakanta A. Gayakwad, PHI Publications, 4th Edition.

**PE 4: Bio MEMS and Nanotechnology (PPEIE214)**

**Prerequisites:**

Physics, Mechanics, Nanoscience

**Course Outcome:**

Upon successful completion of this course, a student will be able to,

1. To compute different methods for Processing MEMS materials
2. To analyze Characteristic techniques of micro system fabrication process
3. To expose the students to the evolution of Nano technology
4. To impart knowledge to the students about nano materials and various nano measurements techniques

**Module I**

MEMS and Microsystems: Introduction to MEMS and Microsystems, typical MEMS and Microsystem products, Application of Microsystems in industries, Materials for MEMS and Microsystems, Microsystem fabrication processes, wafer bonding. Overview of Micromanufacturing – Bulk micromachining, Surface micromachining, LIGA Process. Working principles of Microsystems – Micro sensors and actuators-pressure sensors, thermal sensors, magnetic sensors and micro actuation using SMA and Piezoelectric crystals. MagMEMS Materials.

**Module II**

MEMS and Micro Fluidic Systems: Principle of MOEMS – Light modulator, beam splitter, digital micro-mirror device, light detectors and optical switch. Micro-fluidic system – Fluid actuation method, Di-electrophoresis, Electro wetting, Micro fluid Dispenser, Micro needle, Micro pumps. Application of Bio MEMS: Healthcare, drug delivery, electronic nose, biochip.

**Module III**

Introduction to Nanotechnology: Essence of Nano electronics, Properties of Nanomaterials, Fullerenes and Carbon nanotubes (CNTs), Semiconductor nanoparticles, metal nanoclusters, Nano composites. Introduction to carbon nanostructure, Nano fabrication methods. Medical applications of Nanotechnology: Nanomaterials in human body, Drug synthesis and delivery, Nano biomedicine and diagnostic. Social and economic contexts: Making choices in the development of Biomedical Nanotechnology.

**Text Books:**

1. Tai-Ran Hsu, “MEMS and Microsystems, Design and manufacture “, McGraw Hill, 2002.
2. Nitaigour Premchand Mahalik , “ MEMS “ , McGraw Hill , fifth reprint, 2011.
3. Marc J Madou, “Fundamentals of Microfabrication and Nanotechnology”, CRC Press, 2011.

**Reference Books:**

1. Neelina H. Malsch, “Biomedical Nanotechnology”, CRC Press, 2005.
2. Ellis Meng, “Biomedical Microsystems”, CRC Press, 2011.

**PE 4: Microcontroller & Embedded Systems (PPEIE215)**

**Prerequisites:**

Knowledge of programming of assembly language programme.

**Course outcomes:**

Upon successful completion of this course, a student will be able to,

1. Learn basic hardware of various microcontrollers and embedded systems

2. Assembly and programming concepts

3. Hardware interfacing of microcontroller with LCD and keyboard interfacing.

4. Introduction to ARM processor and Raspberry Pi with Python

**Module I**

The 8051 Microcontrollers: Microcontrollers and embedded processors, Overview of the 8051 family. 8051 assembly language programming, I/O port programming, 8051 Addressing modes, Arithmetic, logic instructions and programs. 8051 Timer programming: programming 8051 timers, Counter programming, programming timers 0 and 1in 8051. 8051 Serial port programming: 8051 connection to RS 232, 8051 Serial port programming in assembly, programming the second serial port. Interrupt programming in assembly and C):8051 Interrupts, programming timer Interrupts, programming external H/W Interrupts, Interrupt priority in the 8051/52.Interrupt programming in C. LCD interfacing and keyboard interfacing.

**Module II**

PIC Microcontrollers: History and features, PIC architecture and assembly language programming, Branch, Call and Time delay loop, PIC I/O port programming, Bank switching, Table processing, Macros and Modules, PIC programming.PIC 18 Timer.

**Module III**

ARM embedded systems: RISC design philosophy, ARM design philosophy, ARM processor fundamentals. AVR Architecture and assembly language programming, arithmetic and logic instructions and assembly language programming Raspberry Pi: About the board, Linux on Raspberry Pi, Raspberry Pi interfaces, programming Raspberry Pi with Python.

**Text Books:**

1. The 8051 Microcontroller and Embedded Systems by Muhammad Ali Mazidi and J.C Mazidi, Pearson.
2. PIC Microcontroller and Embedded Systems by Muhammad Ali Mazidi and R.D Mckinlay, Pearson.
3. Internet of Things-A Hands On Approach by Arshdeep Bahga and Madisetti,Universities Press.

**Reference Books:**

1. ARM System Developer’s Guide by Andrew N. Sloss, D. Symes and C. Wright, MK Publishers, ELSEVIER
2. Advanced microcontrollers and peripherals by K.M Bhurchandi and A.K ray, TMH
3. PIC microcontrollers for beginners by Nebojsa Matic

**Mini Project with Seminar (PPRIE201)**

**[To be decided by the Department]**

**Lab 3: VLSI Design Lab (PLCIE201)**

**Pre-requisites:**

Basic Programming Skills, Digital Electronics Lab

**Course Outcomes:**

On completion of this lab course the students will be able to:

1. Demonstrate a clear Understanding in hardware design language Verilog/ VHDL and simulate and synthesize circuits
2. To analyze the results of logic and timing simulations and to use these simulation results to debug digital systems.
3. Model a Combinational/ Sequential circuit using hardware description language Verilog/VHDL and validate its functionality
4. Design and implement a sub system on a FPGA board.

**List of Experiments using HDL (VHDL/ Verilog)**

1. Design of basic and Universal Gates
2. Design of 2:1 Mux using other basic gates.
3. Design of 2 to 4 Decoder/ 3 to 8 Decoder.
4. Design of Half-Adder, Full Adder, Half Substractor, Full Substractor.
5. Design of 8:3 Priority Encoder.
6. Design of 4 Bit Binary to Grey code Converter, Design of 4 Bit Binary to BCD Converter using sequential statement.
7. Design an 8 Bit parity generator (with for loop and Generic statements).
8. Design of 2’ s Complement for 8-bit Binary number using Generate statements.
9. Design of all type of Flip-Flops using ( if-then-else) Sequential Constructs
10. Design of Shift Registers
11. Design of Synchronous universal shift registers
12. Design of counters
13. Implementation of Memory
14. Design of Barrel Shifters
15. Design of Digital Multipliers
16. Design of functions based on Programmable Logic Arrays
17. Design of ALU

**Lab 4: Advanced Instrumentation Lab (PLCIE202)**

**Circuit design using Micro wind/ Cadence**

1. CMOS Inverter.
2. CMOS NOR/NAND gates.
3. CMOS XOR/XNOR gates.
4. CMOS OR/NOR gates.
5. CMOS Multiplexer.

**Audit-2**

**[To be decided by the Department]: Refer Appendix-II**

**Semester-3**

**PE 5: Soft Computing (PPEIE301)**

**Prerequisites:**

Set Theory, linear and complex algebra, Anatomy of human brain.

**Course Outcomes:**

Upon successful completion of this course, a student will be able to,

1. Acquire the concepts of fuzzy sets, knowledge representation using fuzzy rules, approximate reasoning, fuzzy inference systems, and fuzzy logic control and other machine intelligence applications of fuzzy logic.
2. Realize the fundamental theory and concepts of neural networks, neuro-modeling, several neural network paradigms and its applications.
3. Analyze the basics of an evolutionary computing paradigm known as genetic algorithms and its application to engineering optimization problems.
4. Evaluate and compare solutions by various soft computing approaches for a given problem.

**Module I**

Fuzzy Logic: Introduction to Neuro Fuzzy and soft computing, Basic Concepts of Fuzzy Logic, Fuzzy vs. Crisp Set, Linguistic variables, Membership Functions, Operations of Fuzzy Sets, Fuzzy If-Then Rules, Variable Inference Techniques, Fuzzy reasoning, Basic Fuzzy Inference Algorithm, De-fuzzification.

**Module II**

Neural Networks: Artificial Neural Network and Introduction, Learning Rules, Knowledge Representation and Acquisition, Different Methods of Learning. Algorithms of Neural Network: Feed-forward, Error Back Propagation, Hopfield Model, Character retrieval using Hopfield network, MLP Network, ART Networks, RBFN, Difference between MLP and RBFN, Neuro-Fuzzy hybrid systems, Hopfield network. Application of Neural Network.

**Module III**

Evolutionary computing: Genetic Algorithms- Basic concepts, encoding, fitness function, reproduction. Optimization Fundamentals: Definition, Classification of Optimization Problems, Unconstrained and Constrained Optimization, Optimality Conditions. Differences of GA and traditional optimization methods. Basic genetic programming.

**Text Books:**

1. J.S.R. Jang, C.T. Sun and E. Mizutani, “Neuro-fuzzy and Soft Computing”, PHI.
2. F. O Kary and C.de Silva, “Soft computing and Intelligent Systems Design-Theory, Tools and applications”, PHI.
3. S. Haykins, “Neural Networks: a comprehensive foundation”. PHI.
4. D. E Goldberg, Genetic Algorithms in search optimization & Machine learning. Addison Wesley ,3rd Edition.

**Reference Books:**

1. Principles of soft computing by S.N. Sivanandam & S.N. Deepa.
2. S. Rajasekaran, G.A. Vijaylakshmi Pai, Neural Networks, Fuzzy Logic, and Genetic Algorithms,” PHI.
3. Soft computing by K. Vinoth Kumar.

**PE 5: Advance Process Control (PPEIE302)**

**Prerequisites:**

Modelling and Simulation, Modern Control Systems Design

**Course Outcomes:**

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

1. Apply different methods for Controller tuning.
2. Identify various controller that can be used for specific problems in an industrial context.
3. Design controllers for interacting multivariable systems.
4. Design digital control systems.

**Module I**

Review of Systems: Review of first and higher order systems, closed and open loop response. Response to step, impulse and sinusoidal disturbances. Transient response. Block diagrams. Stability Analysis: Frequency response, design of control system, process identification. PI Controller tuning - Ziegler-Nichols and Cohen-Coon tuning methods, Bode and Nyquist stability criterion. Process identification.

**Module II**

Special Control Techniques: Advanced control techniques, cascade, ratio, feed forward, adaptive control, Smith predictor, internal model control, model based control systems. Multivariable Control Analysis: Introduction to state-space methods, Control degrees of freedom analysis and analysis, Interaction, Bristol arrays, Niederlinski index - design of controllers, Tuning of multivariable PI controllers, Design of multivariable DMC and MPC.

**Module III**

Sample Data Controllers: Basic review of Z transforms, Response of discrete systems to various inputs. Open and closed loop response to step, impulse and sinusoidal inputs, closed loop response of discrete systems. Design of digital controllers. Introduction to PLC and DCS.

**Text Books:**

1. D.R. Coughanour, S.E. LeBlanc, Process Systems analysis and Control, McGraw-Hill, 2nd Edition, 2009.
2. D.E. Seborg, T.F. Edger, and D.A. Millichamp, Process Dynamics and Control, John Wiley and Sons, 2nd Edition, 2004.

**Reference Books:**

1. B.A. Ogunnaike and W.H. Ray, Process Dynamics, Modelling and Control, Oxford Press, 1994.
2. B.W. Bequette, Process Control: Modeling, Design and Simulation, PHI, 2006.
3. S. Bhanot, Process Control: Principles and Applications, Oxford University Press, 2008.

**PE 5: Digital Image Processing (PPEIE303)**

**Prerequisites:**

Basic knowledge in Digital Signal Processing, Knowledge of engineering mathematics including transform theory and matrix algebra is an advantage

**Course Outcomes:**

Students who successfully complete the course will be able to:

1. Review the fundamental concepts of a digital image processing system.

2. Analyze images in the frequency domain using various transforms.

3. Evaluate the techniques for image enhancement and image restoration.

4. Categorize various compression techniques.

5. Interpret Image compression standards.

6. Interpret image segmentation and representation techniques.

**Module I**

Introduction: Digital Image Fundamentals, Image Transforms: Fourier, Hadamard, Walsh, Discrete cosine and Hotelling Transforms.

Image Enhancement: Histogram modification, Histogram equalization, Smoothing, Filtering, Sharpening, Homomorphic filtering.

Image Restoration: Degradation Models, PSF, circulant and block - circulant matrices, deconvolution, restoration using inverse filtering, Wiener filtering and maximum entropy-based methods.

**Module II**

Image Segmentation: Pixel classification, Bi-level thresholding, Multi-level thresholding, P-tile method, Adaptive thresholding, Spectral & spatial classification, Edge detection, Hough transform, Region growing.

Image compression: Fundamental concepts of image compression - Compression models - Information theoretic perspective - Fundamental coding theorem - Lossless Compression: Huffman Coding- Arithmetic coding - Bit plane coding - Run length coding - Lossy compression: Transform coding - Image compression standards.

**Module III (10 Hours)**

Image Registration: Match measurement, Matching of binary pattern, Distortion tolerant matching, Applications of image registration techniques.

Morphological Image Processing: Dilation, Erosion, Duality, Opening, Closing, Hit-or-Miss Transformation, Basic morphological algorithm, Extraction of connected components, Thinning.

**Texts Book:**

1. R. C. Gonzalez, R. E. Woods, Digital Image Processing, Pearson Education. II Edition.,2002
2. A.K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.

**Reference Book:**

1. W. K. Pratt, Digital image processing, Prentice Hall, 1989

**Open Elective**

**[To be decided by the Department]: Refer Appendix-III**

**Project 1: (PPRIE301)**

**[To be decided by the Department]: Dissertation (Phase-I)**

**Semester-4**

**Project 2: (PPRIE401)**

**[To be decided by the Department]: Dissertation (Phase-II)**