Bansilal Ramnath Agarwal Charitable Trust’s
Vishwakarma Institute of Technology
(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Structure & Syllabus of
M.Tech. (Instrumentation and Control Engineering)

Pattern ‘A-17’
Effective from Academic Year 2017-18
(F.Y. M.Tech.)

Prepared by: - Board of Studies in Instrumentation & Control Engineering
Approved by: - Academic Board, Vishwakarma Institute of Technology, Pune

Signed by

Chairman – BOS  Chairman – Academic Board
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### Academic Information

Please visit www.vit.edu
Vision statement of Institute

To be globally acclaimed Institute in Technical Education and Research for holistic Socio-economic development

Mission statement of Institute

- To impart knowledge and skill based Education in collaboration with Industry, Academia and Research Organization
- To strengthen global collaboration for Students, Faculty Exchange and joint Research
- To prepare competent Engineers with the spirit of Entrepreneurship
- To Inculcate and Strength Research Aptitude amongst the Students and Faculty

Vision statement of Department

To be recognized as leading contributor in imparting technical education and research in Instrumentation & Control engineering for development of the society.

Mission statement of Department

- To deliver knowledge of Instrumentation and Control Engineering by strengthening involvement of Research institutions and industries in academics
- To build conducive environment for advanced learning through participation of faculty and students in collaborative research, consultancy projects, student exchange programs and internships
- To develop competent Engineers with entrepreneurial skills to address socio-economic needs.
Program Educational Objectives (PEO)

Programme: B. Tech. (Instrumentation and Control Engineering)

The Graduates would demonstrate

1. Core competency in Instrumentation and Control Engineering to cater to the industry and research needs.
2. Multi-disciplinary skills, team spirit and leadership qualities with professional ethics, to excel in professional career and/or higher studies.
3. Preparedness to learn and apply contemporary technologies for addressing impending challenges for the benefit of organization/society.
4. Knowledge of recommended standards and practices to design and implement automation solutions.

Program Outcomes

Engineering Post-Graduates will be able to:

PO1: An ability to independently carry out research /investigation and development work to solve practical problems

PO2: An ability to write and present a substantial technical report/document

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

Program Specific Outcomes (PSOs)

Graduates shall have the ability to:

1. Evaluate the performance of suitable sensors / Process components/ Electronic / Electrical components for building complete automation system.
2. Analyze real-world engineering problems in the area of Instrumentation and Control.
3. Design or Develop measurement / electronic / embedded and control system with computational algorithms to provide practical solutions to multidisciplinary engineering problems.
F.Y. M.Tech - Instrumentation and Control Engineering Structure Pattern A-17
with effect from Academic Year 2017-18 Semester –I

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**with effect from Academic Year 2018-19 Semester –I**

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SEMESTER I
IC501THP :: MEASUREMENT SYSTEM DESIGN

Credits: 04
Teaching Scheme: Theory: 3 Hours/Week
Project Assignment: 2 Hours/Week

Unit I: Basics of Measurement system (5 Hrs)
Measurement system Architecture: primary sensing element, variable conversion element, data presentation element, types of inputs, sensor dynamics, and static characteristics: static calibration, dynamic characteristics of sensor and system performance, errors in measurement and their statistical analysis, Units and standards.

Unit II: Process Sensor selection and signal conditioning (7 Hrs)
Sensor specifications and selection criteria for different process applications, Review of all major process parameters, Requirements of signal conditioning, Design of signal amplifiers such as preamplifiers, instrumentation amplifiers, bridge amplifiers, Filters, isolation amplifiers, Sample and hold circuit, modulators and demodulators, Analog to digital converters ICs etc.

Unit III: Sensor and signal conditioning Development (10 Hrs)
Sensor Designing criteria, development of related Signal conditioning circuitry, precautions required against environmental conditions, safety aspects, Sensor dynamics and mathematical analysis i.e. governing equations etc. for Capacitance level measurement, Bubbler method, Orifice designing, Rotameter, Pitot tube, LVDT, Ultrasonic flow and level measurement, thermocouples, RTDs, Thermistor, Strain gauge bridge, Piezo sensors, PH probes, Humidity sensors etc.

Unit IV: Special signal conditioning ICs (7 Hrs)
Study and designing of signal conditioning circuits using precision operational amplifier ICs such as AD620, AD524, AD594(thermocouple IC), Voltage to current converter ICs. XTR110, Isolation amplifier, IC HCNR200, etc.

Unit V: Enclosures importance and environmental testing (6 Hrs)
Functions of enclosures types of enclosures, materials for enclosure design, and various types Enclosure such as MEMA and DIN, IPxx types of enclosures, Enclosure selection criteria.
Environmental tests such as temperature, dust, humidity and others. Mechanical testing such as shock, vibration, impact etc. EMI and EMC testing such as ESD, noise susceptibility, transients etc.

Unit VI: Reliability Engineering (5 Hrs)
Definition, quality and reliability, causes of failures and unreliability. Types of failures, bath tub curve, Maintainability and availability. MTTF, MTBF etc. Designing for higher reliability and redundancy techniques.
Text Books:

Reference Books:
1. “Process Measurement”, Bela Liptak

List of Project areas:
1. Sensor selection, designing and finding Characteristics of the sensor for the given application
2. Designing of signal conditioning circuits for the given applications
3. Environmental testing enclosure designing

Course Outcomes:
The student will be able to –
1. To impart knowledge of measurement system (PO-1, 2,4,5 PSO-2)
2. To impart knowledge about principles and selection of sensors/ transducers and signal conditioning. (PO 1,2,4,5 PSO-2)
3. Emphasis on real time interfacing study of process parameter sensor and application (PO-1, 2,4,5 PSO-2,3)
4. To study sate of the art designing of signal conditioning circuits (PO-1, 2,4,5 PSO-2,3)
5. Various types of enclosure designing and instrument testing methods. (PO-1, 2,4,5 PSO-2,3)
6. Study of Reliability engineering aspect (PO-1, 2,4,5 PSO-2)
IC503THP :: PROCESS CONTROL

Credits: 04  
Teaching Scheme: Theory: 3 Hours/Week  
Project Assignment : 2 Hours/Week

Unit I  
Fundamentals of Process Control  
Elements of process control loop, Process Characteristics and their significance. Process gain, Process reaction curve, process time constant, step analysis method, finding time constant, dead time.

Unit II  
Feedback Controller Tuning  
Types of Controllers, Tuning methods, Selection of controller for specific application, Controller settings- evaluation criteria – 1/4th decay ratio, IEA, ISE, ITAE - determination of optimum settings for mathematically described process using time response and frequency response.

Unit III  
Stability Analysis and Performance of Feedback Control systems  
Concept of stability, Stability analysis of linear and linearised systems, principles, Bode Method, Controller tuning based on stability.  
Control Performance via closed loop frequency Response, Control system factors influencing control Performance.

Unit IV  
Control strategies  
Multi loop process control systems, Feedback-feed forward control, Cascade Control, Ratio Control, Selective Control, and Split-range Control with industrial applications.

Unit V  
Analysis of Multivariable Systems  
Process Interaction, Effects of Interaction, Block representation and transfer function matrix interaction, relative gain array, resiliency, Morari resiliency index, Niederlinsky index.

Unit VI  
Multivariable Control  
Singular Value Analysis, Selection of manipulated and Controlled Variables, Tuning of multiloop PID control systems, Decoupling and Multivariable control Strategies.
Text Books:


Reference Books:

2. “Chemical Process Control”, Stephanopoulos George, PHI.

Course Outcomes:

1. Determine process dynamics for systems
2. Design controllers for different process control applications
3. Investigate the stability of systems
4. Apply control strategies to single and multivariable processes
5. Analyze multivariable systems
6. Design decouplers for multivariable systems
IC505THP :: INDUSTRIAL AUTOMATION

Credits: 04  
Teaching Scheme: Theory: 3 Hours/Week  
Project Assignment: 2 Hours/Week

Unit 1: Industrial Control Devices  
(7 Hours)
Switches: construction, symbolic representation, working, application of toggle switch, slide switch, DIP switch, rotary switch, thumbwheel switch, selector switch, push button, limit switch, emergency switch, micro-switches, review of process switches, switch specifications.
Relays: construction, working, specifications, terminologies and applications of Electromechanical relay, hermetically sealed relay, reed relay, solid-state relays and timing relay.
Contactors: construction, working, specifications and applications of contactors. Comparison between relay and contactor.
Development of electrical wiring diagram using standard symbols of above components.

Unit 2: Automation and PLC Hardware  
(6 Hours)

Unit 3: Basics of PLC Programming  
(8 Hours)
PLC programming: Development of Relay Logic Ladder Diagram, Introduction to PLC Programming software Creating new application, addressing, Basic Instruction such as Set and Reset, Concept of Latching, PLC Timers and Counters, Applications Based on timers and Counters PLC Interfacing, PLC Programming languages as per IEC 61131-3 like LD, IL, ST, FBD, SFC

Unit 4: Advanced PLC Programming  
(6 Hours)
Advanced PLC Instructions such as Comparison Instruction, Data movement instructions, Logical Instruction, Mathematical Instruction, Special Mathematical instructions, Program flow control instructions. BIN, BCD Instructions, Upload / Download / Monitoring of Programming using advanced instructions for different applications, PID Control using PLC. Applications using advanced plc programming, HMI types, Interfacing with PLC.
Mechanical Components: Springs (compression, extension, torsion, flat, leaf and motor spring), Gears (spur, bevel, gear trains).
Unit 5: DCS and SCADA  (7 Hours)
DCS Introduction, Location of DCS in Plant, functions, advantages and limitations, Comparison of DCS with PLC, DCS components/ block diagram, Architecture, Functional requirements at each level, Database management. Layout of DCS, Controller Details, Redundancy, I/O Card Details, Junction Box and Marshalling Cabinets, Operator Interface, Workstation Layout, different types of control panels, types of Operating Station, Programming as per IEC 61131-3, Advantages, Overview of Programming Languages, Device Signal Tags, Configuration, Programming for Live Process, Selection of DCS, DCS plant layout., SCADA Concept of SCADA systems, Programming techniques for : Creation of pages, Sequencing of pages, Creating graphics & animation, Dynamos programming with variables, Trending, Historical data storage & Reporting, Alarm management, reporting of events and parameters.

Unit 6: Special Purpose Motors  (6 Hours)
Stepper motor: principle, types, terminologies, half-stepping and micro-stepping techniques, characteristics, specifications, applications.
Servomotors: construction, working, features, advantages, disadvantages, characteristics of AC and DC servomotor, comparison with stepper motor. AC and DC position and speed control. Synchros for error detector, position measurement and control.
DC Micro motors: types, construction, working, characteristics and applications.

List of Project areas:
1. Industrial control devices
2. Programmable Logic Controllers
3. Advanced PLC programming
4. Distributed Control Systems programming
5. HMI and SCADA programming

Text Books:
4. SCADA by Stuart A Boyer : ISA 1999

Reference Books:
Course Outcomes:
The students will be able to:
1. Comprehend and develop electrical wiring diagrams using industrial control devices for given application.
2. Understand basics of PLC hardware and automation systems.
3. Develop PLC programs for different applications.
4. Apply advanced instructions and mechanical components to solve complex problems of automation.
5. Understand the basics of DCS and SCADA systems.
6. Comprehend the special purpose motors and their applications.
ES501TH :: LINEAR ALGEBRA AND STATISTICS

Credits: 04  
Teaching Scheme: Theory: 4 Hours/Week

Unit 1: Vector Spaces (6 Hours)
Rank of a matrix and solution of Linear Systems, Vectors in n-dimension, Vector spaces and subspaces, Linear dependence and independence, Spanning set, Basis.

Unit 2: Linear Transformation:  
(7 Hours)
Linear Transformation, Range and kernel of LT, Isomorphism, Column space, Row space, Null space, Rank Nullity theorem, Orthogonal transformations and its geometrical interpretation. Coordinate systems, Change of basis.

Unit 3: Inner product spaces (7 Hours)

Unit 4: Eigen values and Eigen vectors (6 Hours)
Eigen values and Eigen vectors. symmetric matrices, Complex eigen values, minimal polynomial.

Unit 5: Applications of eigen values and eigen vectors (7 Hours)
Application of eigen values and eigen vectors to Discrete and continuous dynamical system.

Unit 6: Diagonalization (7 Hours)
Diagonalization over real and complex field, canonical representation, spectral decomposition, Quadratic forms, constrained optimization, The singular value decomposition, Applications to image processing and statistics.

Text Books:
1. Ron Larson and David C. Falvo; Linear Algebra: An Introduction; First Indian reprint 2010; Brooke/Cole, a part of Cengage Learning (Indian Edition).

Reference Books:
2. David C. Lay ; Linear Algebra and its Applications; 12th impression 2011; Pearson Education Inc.,
Course Outcomes:
The student will be able to –

1. Acquire the knowledge of vector spaces, linear transformations, Eigen values and eigen vectors, complex numbers and random variables. (PO1,2,4,PSO2)
2. Set up, solve and interpret linear systems, use matrix transformations. (PO1,2,4,PSO2)
3. Apply knowledge of inner product spaces to compute length of a vector, angle, distance between two vectors, to compute orthogonal basis using Gram-Schmidt process, compute and apply the knowledge of eigen-values and eigenvectors. (PO1,2,4,PSO2)
4. Represent complex numbers algebraically and geometrically, find roots algebraic equations and apply the knowledge of functions of complex numbers in problem solving. (PO1,2,4,PSO2)
5. Analyze and interpret probability distributions and perform regression analysis for statistical data. (PO1,2,4,PSO2)
IC551TH :: QUANTITATIVE APTITUDE - I

Credits: 02
Teaching Scheme: Theory: 2 Hours/Week

Unit 1: Numbers, Surds and Indices & Logarithms (7 Hours)
Numbers, Average, Decimal fractions, Problem on ages, Simplification, Problems on numbers, Square roots & cube roots, Logarithms, Surds and Indices, HCF and LCM of Numbers.

Unit 2: Time, distance and work (7 Hours)
Time and distance, Problems on trains, Boats and Streams, Time and Work, Pipes and Cisterns, Alligation or mixture

Unit 3: Measures of Statistical Data (6 Hours)
Percentage, Profit and loss, Ratio and Proportion, Simple interest, Compound interest, Partnership, Chain Rule.

Unit 4: Logical Reasoning (7 Hours)
Race and Games, Odd Man Out and Series, Number Series, Analogies, Logical Problems, Letter and Symbol Series, Statement and Conclusion, Artificial Language

Unit 5: Area, Volume, Permutation and Combinations (7 Hours)
Area, Volume and Surface Areas, Calendar, Clocks, Permutations and Combinations, Probability, Heights and Distances.

Unit 6: Data Interpretation (6 Hours)
Tabulations: Tabulations of Imports and Exports of Data, Analysis of Tabulated Data, Bar Graphs: Vertical or Horizontal Bars, Pie Charts: Pie Graphs, Central angle, Line Graphs.

Text Books
1. Quantitative Aptitude For Competitive Examinations”, Dr. R. S. Aggarwal, S. Chand.

Reference Books

Course Outcomes
The students will be able to:
1. improve their employability skills
2. improve aptitude, problem solving skills and reasoning ability
3. critically evaluate various real life situations by resorting to analysis of key issues and factors.
4. demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions.
ES502TH: RESEARCH METHODOLOGY

Credits: 02

Teaching Scheme: Theory: 2 Hours/Week
IC302THP :: CONTROL THEORY

Credits: 04

Teaching Scheme: Theory: 3 Hours/Week
Project Assignment: 2 Hours/Week

Unit I – Control system Analysis using State Variable methods
Introduction, State variable representation, conversion of state variable model to transfer function, conversion of transfer function to canonical state variable models, solution of state equations, concept of controllability and observability, Controllability and Observability tests

Unit II – State variable analysis of Digital Control system
State description of sampled continuous time plants, Sampling theorem, pulse transfer function, modified Z-transform, state description of system with Dead time, solution of State difference equation, controllability and Observability for discrete system., stability analysis.

Unit III – Controller Design
Stability improvement by state feedback, pole placement design, state regulator design, state observer design, Digital control system with state feedback, deadbeat control

Unit IV - Linear Quadratic Optimal Control
Concept of Lyapunov stability, Lyapunov functions for linear systems, parameter optimization and optimal control problems, quadratic Performance index, control configuration, optimal state regulator, optimal digital control systems

Unit V – Non linear system analysis and control
Common non linear system behavior, describing function fundamentals, describing functions of common non linearities, stability analysis by the describing functions, concept of phase plane analysis, system analysis on the phase plane, Adaptive control

Unit VI - Advance Control Strategies and Applications
Model reference adaptive control, sliding mode control, Neural Network, fuzzy logic model, Model Predictive Control

Text Books:

Reference books
Course Outcomes
The students will be able to
1) Learn State space representations towards analyzing and designing systems
2) Analyze the discrete systems through the use of Z- Transform, Determine the transfer function of a system containing a sampler and zero-order-hold. Analyze stability
3) Design a Controller or digital process control system, Determine the time and frequency domain responses of sampled-data control systems to arbitrary inputs.
4) Design a optimal controller, optimal state regulator
5) Describe non linearities mathematically, analyze on phase plane
6) Learn advanced control strategies

Lab Assignment and Course Projects
1) Lab Assignment 1 - finding transfer function of the process loops
2) Lab Assignment 2 – Tuning of PID controller by 3 different methods
3) Lab Assignment 3 – PID Implementation for process loop
4) Project 1 – Design and Implementation of State feedback controller for process loop
5) Project 2 – Design and Implementation of optimal controller or MPC for process loop

IC504THP :: PROCESS DYNAMICS AND IDENTIFICATION

Credits: 04  
Teaching Scheme: Theory: 3 Hours/Week  
Lab: 2 Hours/Week

Unit I
Control loops for unit operations
Development of control loops, Instrumentation scheme for Boiler, Heat Exchanger, Evaporator, Dryer, Distillation Column

Unit II
Model Predictive Control
Differences from Other Controllers, Types Basic concept of MPC, Dynamic Matrix Control, Quadratic DMC, Limitations of MPC, Advantages of MPC, Industrial MPC applications

Unit III
Adaptive control system
Introduction, Standard approaches, Self adaptive systems, Predictive approach, adaptive control by parameter estimation

Unit IV
Fuzzy Logic in Control applications
Introduction, Definitions, Considerations for design of controller based on fuzzy logic and neural networks, Design of PI controller using fuzzy logic for Process Control application, Case studies.

Unit V
Neural Networks in Control applications
Introduction, Definitions, Considerations for design of controller based on fuzzy logic and neural networks, Design of PI controller using fuzzy logic for Process Control application, Case studies.

Unit VI
Statistical Process Control
Introduction, Statistical distribution, Control charts, data collection and recording, Control chart analysis, Case studies in Chemical and Pulp and Paper industry.

Total Contact Hours: 42

Projects will be based on:
1. Implementation of MPC using Matlab/DCS/Lab view/Simulink
2. Implementation of Fuzzy Logic on control Loops in Process Control Lab using DCS/Lab view/ Matlab
3. Implementation of Neural networks on control Loops in Process Control Lab using DCS/Lab view/Matlab
Text Books:
3. “Tuning of Industrial Control Systems”, A. B. Corripio, ISA
5. “Statistical Process Control”, C. L. Mamzic, ISA

Reference Books:
2. “Chemical Process Control”, Stephanopoulos George, PHI.

Course Outcomes:
1. Select control loops for different unit operations
2. Understand Model Predictive Control
3. Design Adaptive control system for given application
4. Apply fuzzy logic for given application
5. Develop neural network for given application
6. Identify the use of Statistical control in process applications
IC506THP :: REAL TIME SIGNAL PROCESSING

Credits: 04

Teaching Scheme:
- Theory: 3 Hours/Week
- Project Assignment: 2 Hours/Week

Unit I: Introduction
(7 Hours)
Basic model of a Real-time systems (RTS), Characteristics of RTS, Applications of RTS, Safety & reliability, types of Real time tasks, Timing constraints – events in a RTS, Classification of timing constraints & examples, Modelling time constraints.

Unit II: Real Time Task Scheduling
(7 Hours)
Types of real time tasks & their characteristics, Task scheduling – concept, terminologies, scheduling algorithm, Clock-driven scheduling, hybrid schedulers, event-driven scheduling, EDF scheduling, RMA, Issues of RMA, issues in using RMA in practical situation.

Unit III: Resource Sharing & Task Scheduling in multiprocessors
(7 Hours)
Resource sharing among Real-Time Tasks, priority inversion, priority inheritance protocol (PIP), Highest Locker Protocol (HLP), Priority ceiling protocol (PCP), Issues in resource sharing, handling task dependencies, multiprocessor task allocation, dynamic allocation of tasks, fault-tolerant scheduling of tasks, clocks in distributed RTS, Centralized & Distributed Clock synchronization.

Unit IV: Commercial Real – Time Operating systems
(7 Hours)

Unit V: Real – Time Communication
(6 Hours)
Basic concepts, types of networks, QoS, traffic categorization, Real – time communication (RTC) in LAN, Soft & Hard RTC in a LAN, Bounded access protocol for LANs, performance comparison, RTC over packet switched networks, QoS framework, Routing, Resource Reservation, Rate control, QoS models, Applications of RTC.

Unit VI: Real – Time Databases
(6 Hours)
Basic concepts of databases, Real time databases (RTB) – application design issues, Characteristics of temporal data – temporal consistancy, Concurrency Control in RTB – locking - based concurrency control, Optimistic concurrency control protocols, speculative concurrency control, comparison of concurrency control protocols, Commercial RTB.
List of Project areas:
1. Portable multi-parameter logger for versatile applications.
2. Sensor nodes design & construction of storage house parameter monitoring system.
3. PIR sensor triggered motion detection & video surveillance systems for security applications.
4. On board Diagnostic system for automobiles diagnostics.
5. Realtime Wireless Vibration monitoring system.

Text Books:

Reference Books:

Course Outcomes:
The student will be able to:
1. Explain fundamentals real time systems.
2. Appreciate the use of task scheduling in real time systems.
4. Understand commercial real-time operating systems.
5. Understand the use of real-time communication in RTOS.
6. Understand the use of real-time database in RTOS.
IC508THP :: BATCH PROCESS CONTROL

Credits: 04

Teaching Scheme: Theory: 3 Hours/Week
Project Assignment: 2 Hours/Week

Unit 1: Introduction to batch control system (6 Hours)
Batch control system terminology, characteristics of batch processes, hierarchical batch model, control structure for batch systems, Role of standards in batch control systems, study of international standards and practices.

Unit 2: Standards for Batch Process (6 Hours)
Role of standards in batch control systems, study of International Standards and Practices such as S 88, S 95, USA FDA regulation, 21CFR 11 etc.

Unit 3: Control of batch Process (7 Hours)
General control requirements, safety interlocking, regulatory & discrete controls, sequential control of batch processes, control activities and process management, information handling for a batch process.

Unit 4: Design of batch control systems (7 Hours)
Batch management, recipe management, and production scheduling & information management. batch control system design, system requirements, system hardware/reliability requirement.

Unit 5: Specifications and data management (7 Hours)
Batch control system specifications and implementation, Information/display requirements, cost justification and benefits, data management.

Unit 6: Implementation & case studies (7 Hours)
Generic implementation of batch processes, case study of batch control system implementation for applications in food and beverages, pharmaceuticals etc.

List of Project areas:
1. Control and alarm strategy required for a given batch process.
2. Standards required for the given process.
3. Reliability required for the given process.
4. Specification and safety requirement for the given process

Text Books:

Reference Books:
Course Outcomes:
The student will be able to –
1. Understand the fundamentals of batch control system (PO-1, 2,4,5 PSO-2)
2. Understand the role of standards for batch process (PO 1,2,4,5 PSO-2)
3. Comprehend the control and management aspects of batch processes (PO-1, 2,4,5 PSO-2)
4. Design control strategies to batch processes (PO-1, 2,4,5 PSO-2)
5. Specify controls and data management system (PO-1, 2,4,5 PSO-2)
6. Implement control system for any given batch process (PO-1, 2,4,5 PSO-2)
IC510THP :: ESTIMATION TECHNIQUES

Credits: 04
Teaching Scheme: Theory: 3 Hours/Week
Project Assignment : 2 Hours/Week

Unit I
Random Variables and Distribution Functions
Discrete, continuous and mixed random variables, probability mass, probability density and cumulative distribution functions, mathematical expectation, uniform, binomial, geometric, Poisson, continuous uniform, exponential, gamma, Weibull, normal, lognormal, inverse Gaussian distributions

Unit II
Non-parametric methods of identification
Time domain and frequency domain methods of system identification: Time response analysis and correlation analysis, frequency response analysis, Fourier analysis and spectral analysis, estimating the disturbance spectrum.

Unit III
Parametric estimation method-I
Principles of parametric estimation methods, minimizing prediction errors, linear regressing and least squares method, Prediction error method, correlating prediction errors with past data.

Unit IV
Parametric estimation method-II
Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions, problems.

Unit V
Integral Transforms
Generalized transforms, orthogonality, 1D and 2D transforms like Fourier, DCT, Wavelet and their properties

Unit VI
Case studies
Text Books:


Reference Books:

IC512THP :: MECHATRONICS

Credits: 04

Teaching Scheme: Theory: 3 Hours/Week
Project Assignment: 2 Hours/Week (6 Hrs)

Unit I
Overview of Mechatronics
Introduction to mechatronics and design approach, block diagram, multidisciplinary scenario, system Interfacing, instrumentation and control systems, open loop and closed loop systems, microprocessor-based controllers and microelectronics, introduction to automation, micro- and nanotechnology

Mechanical components: springs (compression, extension, torsion, flat, leaf and motor spring), gears (spur, bevel, gear trains), mechanisms, bearings, gears, rack and pinion, ratchets, pawl, crank, sliders, cranks, cams, followers, chain and sprocket.

Mechanical components like couplings, belt, chain, pulleys, Geneva wheels, four-bar linkages.

Unit II

Hydraulic Components

Hydraulics: principle, block diagram, advantages, disadvantages, applications, hydraulic fluid properties and its selection.

Hydraulic components: hydraulic power pack, hydraulic pumps, actuator (cylinders and motors), hydraulic valves, filters, piping, heat exchangers and motors.

Hydraulic circuits: development of hydraulic circuits using standard symbols. Hydraulic circuits like meter in, meter out, reciprocating, speed control, sequencing of cylinders, direction control, deceleration, regenerative circuit, etc. troubleshooting in hydraulic circuits. Introduction to circuit design.

Unit III

Pneumatic Components

Pneumatics: principle, block diagram, advantages, disadvantages, applications.

Pneumatic components: pneumatic power Supply, types of pneumatic relay, FRL unit, pneumatic actuator (cylinders and air motors), pneumatic valves, Fluidic elements and its applications, development of pneumatic circuits, troubleshooting in pneumatic circuits.

Pneumatic circuits: development of pneumatic circuits using standard symbols, sequence diagram (step-displacement) for implementing pneumatic circuits, different pneumatic circuits like reciprocating, sequencing, anti-cycle repetition, block transfer, speed regulation, job sorting, electro-pneumatic circuits, etc.
Unit IV (7 Hrs)

Robot Fundamentals, Sensors and Actuators

Robot definition and classification, brief history of robotics, types of robots, advantages and disadvantages of robots, robot components, Robot terminologies like position, orientation, degree of freedom, configuration, workspace (reach), kinematics, dynamics, accuracy, repeatability, path, trajectory, robot joints, robot coordinates, robot reference frames, robot applications and social issues.

Robot sensors: sensor characteristics, position sensors, velocity sensors, acceleration sensors, force and pressure sensors, proximity sensors, light and infrared sensors, torque sensors, microswitches.

Robot actuators: characteristics of actuating systems, comparison of actuating systems, electric motors, microprocessor control of electric motors, magneto-strictive actuators, shape-memory type metals, speed reduction techniques.

Unit V (6 Hrs)

Robot Kinematics:


Unit VI (6 Hrs)

Trajectory Planning

Path vs. trajectory, joint-space vs. Cartesian-space descriptions, basics of trajectory planning, joint-space trajectory planning. Cartesian-space trajectories, continuous trajectory recording, Higher order trajectories. Robot differential motions and velocities.

Total Contact Hours : 40

Text Books

2. “Pneumatic Systems: Principles and Maintenance”, Majumdar,

Reference Books

1. “Industrial Hydraulic Technology”, Parker Motion & Control, Training Department.
Course Outcomes: The Students will be able to:

1. Explain the working of mechanical, hydraulic, pneumatic and robotic components.
2. Develop hydraulic and pneumatic circuits for given application.
3. Select and size the hydraulic and pneumatic components to solve a problem.
4. Identify, formulate and solve a problem using mechanical, hydraulic, pneumatic system and robot kinematics.
5. Estimate the robotic trajectory planning and robot dynamics parameters for given application.
IC514THP :: DIGITAL IMAGE PROCESSING

Credits: 04
Teaching Scheme: Theory: 3 Hours/Week
Project Assignment : 2 Hours/Week

Unit 1: Preliminaries of Image Processing (06 Hours)

Unit 2: Image Filtering, Enhancement and Segmentation (08 Hours)
Introduction and Overview, Point Processing methods, contrast enhancement, Histogram based methods. Linear filtering in spatial domain, frequency domain filtering, edge detection, Point and line detection, region and object segmentation.

Unit 3: X-Ray Imaging and Computed Tomography (06 Hours)
Introduction and Overview, Imaging with X-Ray, Radiation Dose Attenuation-Based X-Ray Imaging, Processing methods for X ray images, Computed Tomography, reconstruction methods; artifacts.

Unit 4: Magnetic Resonance Imaging (06 Hours)
Introduction and Overview, Physical and Physiological Principles of MRI, MR Imaging, Formulation of MRI Reconstruction. Functional MRI, Processing and Feature Extraction of MRI, Sources of Noise and Filtering Methods in MRI, Feature Extraction, Comparison of MRI with Other Imaging Modalities, Registration with MR Images

Unit 5: Ultrasound Imaging (08 Hours)

Unit 6: Positron Emission Tomography (06 Hours)
Introduction and Overview, Physical and Physiological Principles of PET, PET Signal Acquisition, PET Image Formation, Applications of PET, Processing and Feature Extraction of PET Images, Sources of Noise and Blurring in PET, Image Registration with PET

List of Project areas:
1. Design image processing algorithms for detecting abnormalities in typical X ray / CT images.
2. Implement optimized reconstruction algorithm for CT images.
3. Develop processing and feature extraction algorithms of Ultrasonic Images.
4. Develop processing and feature extraction algorithms of PET Images.
Text Books:

Reference Books:

Course Outcomes:
The student will be able to –
1. Apply various transforms on images and analyse the effect of sampling and quantization on images. (PO-1, 3, 5, 12, PSO-2, 3)
2. Design image enhancement, smoothing sharpening techniques. (PO-1, 3, 5, PSO-2,3)
3. Analyse X ray and CT images using image processing techniques. (PO-1, 2,3, 4,6, 7,12, PSO-1,2,3)
4. Design Processing and Feature Extraction algorithms for MRI Images. (PO-1, 2, 4, 5, 12, PSO-1, 2, 3)
5. Apply Processing and Feature Extraction algorithms for Ultrasonic Images. (PO-1, 2,3, 4, 12, PSO-1,2,3)
6. Design Processing and Feature Extraction algorithms for PET Images. (PO-1, 2,3, 4, 12, PSO-1,2,3)
IC516THP :: INTERNET OF THINGS

Credits: 04  Teaching Scheme: Theory: 3 Hours/Week
Project Assignment: 2 Hours/Week

Unit – 1: Introduction (6 Hours)

Unit 2: Embedded suite for IoT (6 Hours)
Physical device – Arduino / Raspberry Pi Interfaces, Hardware requirement of Arduino / Pi, Connecting remotely to the Arduino / Raspberry Pi, GPIO Basics, Controlling GPIO Outputs Using a Web Interface, – Programming, APIs / Packages, Arduino Interfaces, Integration of Sensors and Actuators with Arduino, Introduction to Python programming

Unit – 3: Connectivity Technologies and Communication Protocols in IOT (6 Hours)

Unit-4: Resource Management In The Internet of Things (6 Hours)

Unit-5: Internet of Things Privacy, Security and Governance (6 Hours)
Vulnerabilities of IoT, Security requirements, Threat analysis, Use cases and misuse cases, IoT security tomography and layered attacker model, Identity establishment, Access control, Message integrity, Non-repudiation and availability, Security model for IoT.

Unit-6: Business Models For The Internet of Things (6 Hours)
Text Books

Reference Books

Course Outcomes : At the end of this course, students will be able to:
1. Learn and demonstrate concepts of Internet of Things (PO 1, 3,)
2. Develop and demonstrate embedded tools usage for IOT. (PO 1, 3)
3. Understand, develop and demonstrate the connectivity technologies and protocols in IOT. (PO 1, 3)
4. Learn and demonstrate concepts of resource management, cloud and fog computing in the Internet of Things. (PO 1, 3)
5. Discuss Security issues in IOT (PO 1, 3)
6. Understand business models for the Internet of Things and demonstrate applications of IOT. (PO 1, 3)

Project Areas
1) Wi-Fi communication using Arduino / Raspberry Pi
2) GSM communication using Arduino / Raspberry Pi
3) Bluetooth communication using Arduino / Raspberry Pi
4) Android platform for IOT applications
5) Any one application of IOT utilizing IOT platforms
HS552TH :: QUANTITATIVE APTITUDE - II

Credits: 02  
Teaching Scheme: Theory: 2 Hours/Week

Unit 1: Area, Volume, Permutation and Combinations (7 Hours)
Area, Volume and Surface Areas, Calendar, Clocks, Permutations and Combinations, Probability, Heights and Distances.

Unit 2: Data Interpretation (7 Hours)
Tabulations: Tabulations of Imports and Exports of Data, Analysis of Tabulated Data, Bar Graphs: Vertical or Horizontal Bars, Pie Charts: Pie Graphs, Central angle, Line Graphs.

Unit 3: Probability (7 Hours)
Introduction to probability, Structure of probability, Results of probability, Revision of probability: BAYES’ RULE, and examples; Random variable and probability distribution: Discrete and Continuous distribution, Expected value and variance of a distribution.

Unit 4: Correlation & Regression Analysis (7 Hours)
Regression analysis (Linear only), Correlation analysis, Karl Pearson’s correlation coefficient, Spearman’s Rank correlation coefficient

Text Books
1. Quantitative Aptitude For Competitive Examinations”, Dr. R. S. Aggarwal, S. Chand.
3. Probability & Statistics for Engineers- Richard Johnson – Prentice Hall of India,
4. Statistics for Management- Richard Levin, Rubin - Prentice Hall of India,

Reference Books

Course Outcomes
The students will be able to:
1. improve their employability skills
2. improve aptitude, problem solving skills and reasoning ability
3. critically evaluate various real life situations by resorting to analysis of key issues and factors.
4. demonstrate various principles involved in solving mathematical problems and thereby reducing the time taken for performing job functions
HS553TH :: ENGINEERING ECONOMICS

Credits: 02
Teaching Scheme: Theory: 2 Hours/Week

(07 Hrs)

Unit I
Engineering Economic Analysis


(07 Hrs)

Unit II
Time Value of Money & Life Cycle Costing

Concept of Interest, Time Value of Money – Basis for comparison of alternatives, Discount Rate, Compound Rate, Present Worth, Future Worth, Annual Worth, Annuity, Perpetuity. Life Cycle Costing - Introduction, methodology, applications of LCC in industrial world, differentiation with traditional costing methods, Capital Budgeting: DCF & NDCF Techniques: Payback, Discounted Payback, ARR, IRR, NPV, Annual Worth, Cost Benefit Ratio

Numerical Applications on Time Value of Money

(07 Hrs)

Unit III
Concept of Demand and Supply


(07 Hrs)

Unit IV
Concept of Utility, Competition


Cases related with above concepts

Text Books
1. Theusen H.G., Engineering Economic Analysis, Prentice Hall of India
Reference Books

Course Outcomes:
Our students will be able to:
1. Analyze the effect of inflation, currency fluctuations, and taxes on decision making
2. Compare and select investment alternatives based on costs and time value of money
3. Analyze the impact of demand and supply on pricing of product and competition
4. Understand the concept of utility and competition and its relevance in business environment