SAVITRIBAI PHULE PUNE UNIVERSITY

Syllabus

B. E. Instrumentation & Control
(2012 Course)

DR. C. Y. PATIL

Chairman

(Board of Studies)

Instrumentation & Control Engineering

Savitribai Phule Pune University

Syllabus for B. E. Instrumentation and Control - 2012 course

SEMESTER- I

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME					
		TH	PR	In semester assessment	End Semester Assessment	PR	TW	OR	Total
406261	Process Instrumentation- I	4	2	30	70	50	-	-	150
406262	Project Engineering & Management	4	2	30	70	-	25	50	175
406263	Digital Control	4	2	30	70	-	25	-	125
406264	Elective- I	3	2	30	70	-	-	50	150
406265	Elective- II	3	-	30	70	-	-	-	100
406266	Project Stage- I	-	2	-	-	-	50	-	50
	Total	18	10	150	350	50	100	100	750

SEMESTER- II

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME					
		TH	PR	In semester assessment	End Semester Assessment	PR	TW	OR	Total
406267	Process Instrumentation- II	4	2	30	70	-	-	50	150
406268	Industrial Automation	4	2	30	70	-	-	50	150
406269	Elective- III	4	2	30	70	-	-	50	150
406270	Elective- IV	4	-	30	70	-	-	-	100
406271	Project Work	-	6	-	-	-	100	50	150
406272	Industrial Visit	-	-	-	-	-	50	-	50
	Total	16	12	120	280	-	150	200	750

Elective- I (406264)	Elective- II (406265)	Elective- III (406269)	Elective- IV (406270)
Advanced Bio-Medical Instrumentation	Opto- Electronics Instrumentation	Digital Image Processing	Smart Material and Systems
Building Automation- I	Environmental Instrumentation	Building Automation- II	Instrumentation in Agriculture and Food Processing
Advanced Control Systems	Robotics & Automation	Process Modelling & Optimization	Neural Network and Fuzzy Logic Control
Advanced Sensors	Sensor Networks	Virtual Instrumentation	Automobile Instrumentation
Advanced Digital Signal Processing	Fault Detection and Diagnosis	Computer Techniques and Applications	Open Elective

SEMESTER- I

406261: Process Instrumentation- I

Teaching Scheme:
Lectures: 4 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Practical: 50 Marks

Prerequisite: Sensors and Transducers, Automatic control systems, Control system component and Process loop control

Unit- I : Process Characteristics

Incentives for process control, Process Variables types and selection criteria,, Process degree of freedom, Characteristics of physical System: Resistance, Capacitive and Combination of both.

Elements of Process Dynamics, Types of processes- Dead time, Single /multi-capacity, self-Regulating /non self regulating, Interacting / non-interacting, Linear/non linear, and Selection of control action for them. Study of Liquid Processes, Gas Processes, Flow Processes, Thermal Processes in respect to above concepts

Unit- II : Analysis of Control Loop

Steady state gain, Process gain, Valve gain, Process time constant, Variable time Constant, Transmitter gain, Linearising a equal percentage valve, Variable pressure drop. Analysis of Flow Control, Pressure Control, Liquid level Control, Temperature control, SLPC-features, faceplate, functions, MLPC- features, faceplate, functions, SLPC and MLPC comparison. Scaling: types of scaling, examples of scaling

Unit- III: Feedback Control

Elements of the feedback Loop, Block Diagram, Response to Set-point changes and Disturbances, PID Controller Algorithms, Control Performance Measures, Selection of Variables for Control Approach to Process Control. Factors in Controller Tuning, Determining Tuning Constants for Good Control Performance, Correlations for tuning Constants, Fine Tuning of the controller tuning Constants. The performance of feedback Systems, Practical Application of Feedback Control: Equipment Specification, Input Processing, Feedback Control Algorithm, Output Processing.

Unit- IV : MultiLoop & Nonlinear Systems

Basic principles, Design Criteria, Performance, Controller Algorithm and Tuning, Implementation issues of Cascade control, Feed forward control, feedback-feedforward control, Ratio control, Selective Control , Split range control. Examples and any special features of the individual loop and industrial applications.

Nonlinear Elements in Loop: Limiters, Dead Zones, Backlash, Dead Band Velocity Limiting, Negative Resistance, Improvement in nonlinear process performance through:

Deterministic Control Loop Calculations, Calculations of the measured variable, final control element selection, cascade control design, Real time implementation issues.

Unit- V : Multivariable Control

Concept of Multivariable Control: Interactions and it's effects, Modelling and transfer functions, Influence of Interaction o the possibility of feedback control, important effects on Multivariable system behavior Relative Gain Array, effect of Interaction on stability and Multiloop Control system. Multiloop control Performance through: Loop Paring,tuning, Enhancement through Decoupling, Single Loop Enhancements.

Unit- VI : Process control Design

Defining the problem, measurements, final elements, Process Operability, Control Structure, Control Algorithm, Control for safety, performance Monitoring. Managing the Design Process: Sequence of design steps, hierarchy of control structure, process Decomposition, Integrating the control design methods, key guidelines.

List of Experiments :

Students are expected to perform Minimum 8 Experiments

1. Develop a FOPDT/SOPDT model of any process.
2. Effect of control actions on system with dead time and integrating systems(Using MATLAB).
3. Study of Flow loop/Study of Level loop.
4. Study of Temperature loop.
5. Study of Pressure loop.
6. Finding best tuning values based on any performance criteria.
7. Study of Cascade control loop.
8. Study of Ratio control/ Selective control. (any one)
9. Study of SLPC for process control..
10. Study of non linear control elements

Text Books:

1. Automatic Process Control: Donald Eckman, Wiley Eastern Limited.
2. Process Control- Designing processes and Control Systems for Dynamic Performance: Thomas E Marlin, McGraw-Hill International.
3. Instrument Engineers' Handbook : Process control : B.G. Liptak, Chilton.
4. Chemical Process Control : George Stephonopolous, PHI.
5. Process Control: Modeling, Design and Simulation : B. Wayne Bequette, PHI.
6. Process control Systems-F.G. Shinskey, TMH.

References

1. Process Instrumentation and control Handbook –Considine.
2. Fundamentals of Process Control - Murrill ISA
3. Applications concepts of Process control- By Murrill ISA

406262: Project Engineering and Management

Teaching Scheme:
Lectures: 4 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Oral: 50 Marks, Term Work: 25 Marks.

Unit- I

Concept study and definition of Project Engineering and Management,

Basics of Project Management, Definition and objectives of Project Management, Stages of Project Management, Project Planning Process, Establishing Project organization. Organization Structure, The Project team, Roles and responsibilities of project team members and team leader, Interactions involved in Project and their co-ordination project statement.

Unit- II

Work definition: Defining work content, Time Estimation Method, Project Cost Estimation and budgeting, Project Risk Management, Project scheduling and Planning Tools: Work Breakdown structure. Program evaluation and review techniques (PERT) and Critical path method (CPM), Life cycle phases, Statement of work (SOW), Project Specification, milestone scheduling.
Project cash flow analysis, Project scheduling with resource Constraints: Resource Leveling and Resource Allocation. Time Cost Trade-off: Crashing Heuristic.
Project Implementation: Project Monitoring and Control with PERT/Cost, Computers applications in Project Management, Contract Management, Project Procurement Management; Post Project Analysis.

Unit- III

Project engineering documents and drawing:

P & I diagram based on Process Flow Sheet, P & ID symbols for process loops like temperature, flow, level, pressure, etc. Material balance sheet and Temperature pressure sheet, Methods of tagging and nomenclature scheme based on ANSI / ISA standards.

Standards used in instrumentation project: ISA S5.1, S5.3, S5.4, S5.5 and S5.20, ANSI, & NFPA. Instrument index sheet, installation sketches, specification sheets.

Collection and study of project engineering documents and software like INTools, MS-Project, Primavera.

Unit- IV

Detailed Project engineering: Plant layouts and General arrangement drawing (Plans and Elevation), Isometric of instrument piping, installation sketches of filed instrument.
Cable Engineering (Class of conductors, Types, Specification and Application), Selection of cables with respect to specific application, Cable identification schemes, Cable trays, Basic Wiring Practice,

wire numbering & numbering methods. Failsafe wiring Practice, Hazardous area classifications & its effect on design, Loop wiring diagrams, BOM and MBOM. Earthling and Grounding for General, Power and Signal.

Unit- V

Procurement activities: Vendor registration, Tendering and bidding process, Bid evaluation, Purchase orders, Pre-Qualification Evaluation of Vendor, Kick-off meeting, Vendor documents, drawing and reports as necessary at above activities.

Construction activities: Site conditions and planning, Front availability, Installation and commissioning activities and documents require at this stage. Cold Commissioning and hot commissioning.

Unit- VI

Control centres and Panels: Types, Design, Inspection and Specification, Control room layout and engineering, Types of operating Stations, Intelligent Operator Interface (IOI). Panel testing Procedure. On site inspection and testing (SAT), Installation sketches, Contracting, Cold Commissioning and hot commissioning, Customer Acceptance Test (CAT), Factory Acceptance Test (FAT), Performance trials and final hand over. Calibration records, Test and inspection reports.

List of Experiments :

Students are expected to perform Minimum 8 Experiments

1. Study of standards and symbols (ANSI / ISA Std.)
2. Study of specification sheets.
3. Development of Process & Instrument diagram of typical process.
4. Development of Loop Wiring diagram.
5. Cable scheduling.
6. GA and mimic diagram of a control panel.
7. Development of Bar charts for certain project.
8. Preparation of Inquiry, Quotation, Comparative statement, Purchase orders, SAT, FAT and CAT, Inspection reports for control panel / transmitter/ control valve / recorder.
9. Hands on experience for engineering management software such as MS Project,/ Primavera/ INTools.

Text Books & References:

1. Applied instrumentation in process industries by Andrew & Williams (Gulf Publishing).
2. Management systems by John Bacon (ISA)
3. Process control Instrument Engineers Hand book by Liptak.
4. Project Management A System Approach to Planning, Scheduling and Controlling by Harold Kerzner (Van Nostrand Reinhold Publishing)
5. Instrument Installation Project Management (ISA).
6. successful Instrumentation & Control Systems Design, by Michael D. Whitt (ISA).

406263: Digital Control

Teaching Scheme:
Lectures: 4 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Term Work: 25 Marks

Unit- I

INTRODUCTION TO DISCRETE TIME CONTROL SYSTEM

Basic building blocks of Discrete time Control system, Sampling Theorem, Choice of sampling rate and multirate sampling, Z transform and Inverse Z transform for applications for solving differential equations, Impulse sampling, Effect of data digitization and finite word length, Reconstruction: Data Hold, Mathematical model of zero order hold

Unit- II

PULSE TRANSFER FUNCTION AND DIGITAL CONTROLLERS

The pulse transfer function, pulse transfer function of Open loop and 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, Design of Deadbeat Controller.

Unit- III

STABILITY ANALYSIS OF DISCRETE TIME CONTROL SYSTEM

Stability regions in S-plane, W-plane and Z-plane and mapping between the three planes, Stability tests for discrete system, Jury stability criterion, Bilinear transformations, Digital Controller Design using Analytical Design Method.

Unit- IV

DESIGN OF DISCRETE TIME CONTROL SYSTEM - STATE SPACE APPROACH

Relation between State equations and pulse transfer function, Solution of discrete time state space equations, Cayley-Hamilton Theorem, Pulse transfer function matrix, Eigen Values, Eigen Vectors and Matrix Diagonalization, Discretization of continuous time state space equations, Various Canonical forms, Similarity transformations.

Unit- V

POLE PLACEMENT AND OBSERVER DESIGN

Concept of Controllability and Observability, Useful transformations in state space analysis and design, Pole placement design by state feedback, Stability improvement by state feedback, State observers.

Unit- VI

INTRODUCTION TO OPTIMAL CONTROL

Basics of Optimal Control, Performance Indices, Quadratic Optimal Control and Quadratic performance index, Optimal state regulator through the matrix riccati equations, Steady State

Quadratic Optimal Control

List of Experiments :

Students are expected to perform Minimum 8 Experiments

1. Find the Response of the Discrete Time Control System for standard inputs.
2. Unit step Response of Discrete Time Control System using Digital PID controller.
3. Design of deadbeat controller for Discrete Time Control System.
4. Determine effect of sampling period on stability of Discrete Time Control System.
5. Design State space model from the given PTF.
6. Investigation of the controllability and Observability of a system.
7. Design of control system using pole placement technique.
8. Design of State observer.
9. Design of Discrete Time Control System based on minimization of quadratic performance index.
10. The solution of steady state quadratic optical control using riccati equation.
11. Design of a control system by 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.

References:

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.

406264- Elective- I: A) Advanced Bio- Medical Instrumentation

Teaching Scheme:
Lectures: 3 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Oral: 50 Marks

Course Objective (COs):

- ✓ To understand the advanced biomedical nstruments used in hospitals.
- ✓ To review the basic concept of medical Imaging systems.
- ✓ To understand the concept of various biomedical instruments and technologies.

Course Outcomes (COCs):

a. Ability to design, calibrate and use various biomedical equipments.
b. Ability to select appropriate method for the particular applications
c. Ability to apply concept for appropriate use of various biomedical techniques and Instruments.

Unit- I
Clinical Lab Instrumentation:
Blood and its composition and function, Auto-analyzers, Blood Cell Counters, Pulse Oximetry,
Introduction to telemetry & Telemedicine

Unit- II
Imaging Systems:
X ray properties, Generation of X-rays, block diagram of X- Ray machine, image intensifier, Drawback of x-ray imaging, CT Scanning, basic CT scanning system, Types of gantries, gray scale [Hounsfield No.], image reconstruction techniques in tomography, image artifacts

Unit- III
Advanced Imaging Systems:
Radionuclide Imaging: Positron Emission Tomography, Single Photon Emission Computed Tomography, Ultrasound Imaging: Fundamentals of Acoustic propagation, Ultrasonic transducers and frequencies, A, B, M Scan and Introduction to MRI operating principle.

Unit- IV
Life Saving Devices:
Pacemaker, Types of pacemakers: External & Internal, Defibrillators: AC & DC Defibrillator, Heart Lung Machine.

Diathermy:
Electro surgical diathermy (ESU),
Short wave, Microwave, Ultrasound diathermy

Unit- V

Laser applications in Medicine:

Types of Lasers, Properties of Laser, Interaction of Lasers with Tissues -Thermal and Non thermal, Basic Endoscopes system & its characteristics, Laser Applications in ophthalmology- Diabetic Retinopathy , Glaucoma and Retinal hole and detachment treatment , Dermatology- Tattoo, port wine treatment

Unit- VI

Concept of Rehabilitation Engineering:

Orthrotics & Prosthetic devices, overview of various orthrotics & prosthetic devices along with its materials. Wheelchair Types, Materials used in wheelchair,

Kidney Instrumentation:

Kidney Structure, structure of nephron, Regulation of Water and Electrolyte Balance, Artificial Kidney-types (Coil type, parallel plate Type), Dialysis System, Lithotripsy

List of Experiments :

Students are expected to perform Minimum 8 Experiments and visit to hospital.

1. Clinical Lab Instrumentation: Auto-analyzer, blood cell counters etc.
2. Basic Telemetry system: ECG Telemetry System
3. Electrosurgical Unit (Operating Room).
4. Imaging Techniques'-ray and CT scan
5. Advanced Imaging Techniques –Ultra sound and Nuclear imaging
6. Pacemaker & Defibrillator
7. Short Wave Diathermy
8. Ophthalmic/ Dermatological LASER treatment
9. Basic Endoscope
10. Rehabilitation equipments
11. Lithotripsy
12. Dialyzer machine

Text Books:

1. Medicine and Clinical Engineering By Jacobsons & Webster, PHI
2. Introduction To Biomedical Equipment Technology By Carr & Brown
3. Biomedical Instrumentation and Measurements By Cromwell, PHI
4. Handbook of Biomedical Instrumentation By R. S. Khandpur, TMH
5. The Biomedical Engineering Handbook, Bronzino, IEEE Press
6. Applied Chemical Engineering Feenberg,
7. Principles of Medical Imaging.-By: K. Kirk Shung, Michael B. Smith, Benjamin Tsui.-Pub: Academic Press.
8. Medical Laser Applications -By Carruth
9. Medical Lasers & their safe Use - By Sliney & Trokal

406264- Elective- I: B) Building Automation- I

Teaching Scheme:
Lectures: 3 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Oral : 50 Marks

Unit- I:
Introduction to intelligent buildings and Building automation systems

- What is intelligent building?
- Intelligent architecture and structure
- Facilities management vs. intelligent buildings
- Lifecycle of building
- Evolution of intelligent buildings
- What is BAS? Different systems in BAS which includes HVAC, security, fire, lighting systems. Importance of each system in BAS.
- Process of BAS design, Role of different stakeholders (Architect, contractor, consultant, application engineer and engineer) in BAS system design.
- Comfort parameters for human being- temperature, humidity, flow, pressure, clean air, Co2%.

Unit- II
Comfort parameters for human being and measurement in BMS system

- Temperature, Heat, Specific Heat, Sensitive Heat & Latent Heat, Enthalpy, Entropy
- Heat Transfer - Conduction, Convection, Radiation
- Working Principle, Characteristics of different types of temperature sensors- RTD, Thermister, Thermocouple, Bimetallic strip
- Humidity, Specific Humidity, Relative Humidity, Due point, Saturation point
- Dry bulb & Wet bulb temperature, Working principle of Psychrometer
- Working principle of different types of relative humidity sensors- capacitive type. Different types of mounting for humidity sensors in BAS
- Psychrometric chart-Introduction to different axis in Psychrometric chart- wet bulb temperature, dry bulb temperature, relative humidity, specific heat, enthalpy, dew point.
- Pressure, Static Pressure, Velocity pressure, Absolute Pressure, Gauge Pressure, Vacuum Pressure, Differential Pressure, Sealed Pressure
- Working Principal of Different types of Pressure Sensors- Diaphragm type, Piezoelectric sensors
- Different types of mounting for Pressure sensors in duct, rooms and pipes
- Working of principal and construction of different air flow sensors – Anemometer flow meters, thermal dispersion flow meter, Flow measuring station, measurement of flow using velocity pressure sensors

- Working of principal and construction of different water flow sensors – Turbine flow meters, Magnetic Flow meter, Orifice, Venturi, Pitot tube, Nozzle, Corollis, Ultrasonic flow meter
- Different types of mounting for air & water flow meters
- Measurement of CO2 level in air
- Clean air, grade of filtration, ozonisation and UV treatment
- Other Parameters affecting building operation- Building load for Chilled water and hot water system, Working principal of BTU meter, BTU meter mounting,

Unit- III

HVAC Basic Concepts- Systems (Air Side)- Air handling unit

- Concept of Air handling unit. Design, working of different components in AHU- damper, filter, cooling coil, heating coil, fan, heat recovery wheel, humidifier.
- Working, configuration, characteristics for different types of dampers- Parallel blade, opposed blade, round damper. Damper Sizing , damper authority
- Design and working of different types of AHU with combination of- 100% outdoor air, mixed air, constant volume, variable volume, dual duct, single duct.
- Operation of different modes in AHU- humidification, dehumidification, static pressure control, volume matching, warm up mode, night purge mode, cooling, heating, economiser mode.
- Heat recovery techniques- plate heat exchanger, heat recovery wheel, and glycol heat recovery.
- Use of different types of AHU for different applications.
- Tracking of different processes in psychometric chart for 100% outdoor air AHU and mixed air AHU- humidification, dehumidification, dry cooling, dry heating.

Unit- IV

HVAC Basic Concepts- Systems (Air Side)- Terminal Unit

- Concept of Variable Air Volume (VAV) system-Design, working, use of different types of VAV- CAV, cooling only, with reheat, series fan powered, parallel fan powered, pressure dependent, supply-exhaust VAV, and dual duct VAV.
- Design, working, use of radiation coil, chilled beam, CRAC unit, VRV systems, unit heater, Fan coil unit and unit ventilator

Unit- V

HVAC Basic Concepts- Systems (Plant Side)- Chilled water system & Hot water system

<u>Chilled Water Systems:</u>

- Concept of refrigeration cycle. Working, mechanical configuration of different types of components used in refrigeration cycle- evaporator, condenser, compressor, expansion valve. Difference between air cooled chiller and water cooled chiller. Working, mechanical configuration of different types of cooling towers. Concept and working of Absorption chiller. Concept and working of heat pump.

- Design, working of different types of chilled water system- single chiller system, series chiller system, parallel chiller system. Working of different components of chilled water system- decoupler line, bypass line, primary circuit, secondary circuit, and condenser pumps. Concept of free cooling- direct waterside, series waterside, parallel waterside free cooling.
- Sequencing of chilled water plant

<u>Hot water systems:</u>

- Working and design of different types of boilers- fire tube, water tube, packaged boiler.
- Control of boiler- 7 element control, fuel-air ratio control.
- Working and design of different types of heat exchanger.
- Concept of geothermal system, Working, design of different types of hot water system- with boilers, heat exchanger with steam input, heat exchanger with hot water input, geothermal system, solar system and combination of all listed systems.
- Sequencing of Boiler Plant

Unit- VI
BAS System Architecture

- BAS System Hierarchy –Field level components, Direct Digital Control (DDC), Supervisory Controller, Server, Operator Workstation (OWS)
- Different communication protocol and addressing concepts
  - Open Protocols -BACnet, LON, Profibus, Modbus, M-bus,
  - Proprietary Protocols- N2, CBUS,
- Introduction to wireless – Wireless filed devices, controllers, routers, coordinators

List of Experiments:

1. To study IBMS System
2. To study Psychometric chart and various parameters
3. To study various comfort parameters for human being temperature, humidity, flow, pressure, clean air, Co2%.
4. To study different types of Air Handling Units
5. To study various terminal unit systems (CAV, VAV, FCU, UV)
6. To study Chilled Water System and loops
7. To study Hot Water System and loops
8. To study Architecture of BAS system
9. To study building loads and BTU metering

Text Books & References:

1. HVAC Systems Design Handbook, Fifth Edition by Roger W. Haines
2. HVAC Fundamentals, volume 1 to 3 by James E. Brumbaugh
3. Basics of Air Conditioning by ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0004 for online shopping)

4. All About AHU’s by ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0005 for online shopping)
5. Chillers Basics by ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0009 for online shopping)
6. HVAC Handbook Part-1 by Indian Society of Heating, Refrigerating & Air Conditioning Engineers
7. Handbook – Industrial Ventilation Application 2004 by Inidian Society of Heating, Refrigerating & Air Conditioning Engineers
8. Fundamentals Of Refigeration by Indian Society of Heating, Refrigerating & Air Conditioning Engineers
9. Ventilation Handbook by Indian Society of Heating, Refrigerating & Air Conditioning Engineers

406264- Elective- I: C) Advanced Control System

Teaching Scheme:
Lectures: 3 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Oral: 50 Marks

Unit- I

NON-LINEAR SYSTEMS

Types of non-linearity, typical examples, singular points, Phase plane analysis, Limit cycles, linearization, Describing functions. Need for model reduction, Dominant pole concept. Model reduction via partial realization. Time moment matching and pade approximation, Hankel norm model reduction.

Unit- II

STABILITY

Stability concepts - Equilibrium points - BIBO and asymptotic stability, Lyapunov Theory, Definitions (Stability and Functions). Direct method of Lyapunov, Application to non-linear problems. Stability analysis by describing function method –jump resonance. Frequency domain stability criteria, Popov's method and is extensions.

Unit- III

MODEL REFERENCE ADAPTIVE CONTROL

Different configurations and classifications of MRAC - Mathematical description - Direct and indirect model reference adaptive control - MIT rule for continues time MRAC systems -Lypunov approach and hyper stability approach for continuous time and discrete time MRAC systems - Multivariable systems - Stability and convergence studies.

Unit- IV

SELF TUNING REGULATORS

Different approaches to self-tuning - Recursive parameter estimation Implicit and explicit STR -LQG self-tuning - Convergence analysis Minimum variance and pole assignment approaches to multivariable self tuning regulators.

Unit- V

RECENT TRENDS AND APPLICATIONS OF ADAPTIVE CONTROL

Recent trends in self-tuning Robustness studies multivariable system. Model updating. General-purpose adaptive regulator. Application to Process control components and systems. Industrial Applications.

Unit- VI
OPTIMAL CONTROL
Problem formulation, necessary conditions of optimality, state regulator problem. Matrix Riccati equation, infinite time regulator problem, output regulator and tracking problems. Pontryagin‟s minimum principles, time, and optimal control problem. Dynamic programming. Linear Quadratic Regulator, model matching based on Linear Quadratic optimal regulator. Observer design, Linear optimal filter.

List of Experiments :
Students are expected to perform Minimum 8 Experiments .
1. Analysis of first order/second order non-linear system.
2. Effect of Dominant pole and Critical pole on system performance.
3. Stability analysis of first order/ second order system by describing function method.
4. Obtain the stability of a system by Frequency domain criteria.
5. Study of Direct/indirect model reference adaptive control system.
6. Study of multivariable self-tuning regulators.
7. Analysis of Multivariable systems using step input
8. Any one Industrial Application of model reference control-a Survey.
9. Design of state observer
10. Design of linear filter.

Text Books & References:

1. Chalam, V.V., "Adaptive Control Systems", Techniques & Applications, Marcel Dekker, Inc. NY and Basel. 1987.
2. Eveleigh, V.W., "Adaptive Control and Optimisation Techniques". McGraw-Hill, 1967.
3. Narendra and Annasamy, "Stable Adaptive Control Systems", Prentice Hall, 1989.
4. Astry, S. and Bodson, M., "Adaptive Control", Prentice Hall,1989.
5. M. Vidyasagar, "Nonlinear Systems Analysis", 2nd Ed., Prentice Hall, 1993.
6. Hassan K. Khalil, "Nonlinear Systems", Third Edition, Prentice Hall, 2002.
7. William S. Levine (Editor), "The Control Handbook(Electrical Engineering Handbook Series)", CRC Press, March 1996.
8. Nagrath I.J., and Gopal, M., "Control system Engineering" Wiley Eastern Reprint 1995.
9. Kirk D.E., "Optimal control theory-an introduction", Prentice Hall, N.J. 1970.
10. Gopal. M., "Modern control system Theory", Wiley Eastern Ltd., 2nd Edition Reprint 1995.
11. Graham C., Goodwill, S. F. Graebe and M. E. Salgado,"Control
12. System Design" Prentice Hall India, New Delhi, 2002.

406264- Elective- I: D) Advanced Sensors

Teaching Scheme:
Lectures: 3 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Oral: 50 Marks

Unit- I
Sensor Characteristics
Transfer function, span (full-scale input), full-scale output, accuracy, calibration, calibration error, hysteresis, nonlinearity, saturation, repeatability, dead band, resolution, special properties, output impedance, excitation, dynamic characteristics, environmental factors, reliability, and application characteristics.

Unit- II
Review of Fundamentals of sensors
Review of transducers for various parameters like temperature, pressure, flow, level, humidity, acceleration, vibration, density etc.

Unit- III
Sensors fabrication
Design considerations and selection criterion as per standards, Sensor fabrication techniques, process details, and latest trends in sensor fabrication

Unit- IV
Sensors
Theory and classifications of chemical sensors, biosensors, fiber optic sensors, gas sensors etc.

Unit- V
Smart sensors
Smart sensor basics, signal conditioning and A/D conversion for sensors, examples of available ICs and their applications.

Unit- VI
Applications
Chemical sensors, biosensors, fiber optic sensors, gas sensors

List of Experiments :
Students are expected to perform Minimum 6 Experiments

1. Study of fabrication procedure for sensor.
2. To study and find characteristics of any chemical sensor.
3. To study of different materials used for biosensors.

4. Design of smart sensor and its signal conditioning.
5. Study of gas sensors and its industrial applications.
6. Design of application for any IC sensors.
7. Implementation of fiber optic sensor application.
8. Implementation of gas sensor application.

Text Books & References:

1. Principles of Measurement systems John P. Bentley, Third edition 2000, Pearson Education Asia pvt. Ltd.
2. Sensors and Transducers, D. Patranabis, Second Edition Prentice Hall of India Pvt. Ltd. New Delhi, 2006
3. Middlehook S. and Audet S. A., "Silicon Sensors", Academic Press, London 1999.
4. Sensors, Nanoscience, Biomedical engineering and instruments, Richard C. Dorf, CRC Press, Taylor and Francis group USA, third edition, 2006
5. Fiber optics Communication and other applications, Henry Zanger, Cynthia Zanger, Macmillan publishing company, New York, 1991
6. Biosensors, Raj Mohan Joshi, First Edition, ISHA Books, Delhi, 2006.
7. Robotics and Industrial Automation, R.K.Rajput, S.Chand & company Ltd., First edition, 2008.
8. Transducers and Instrumentation, D.V.S.Murty, Second edition, PHI publication, Second edition, 2010.
9. Handbook of modern sensors: physics, designs, and applications, Jacob Fraden, Third edition.
10. Understanding Smart Sensors, Randy Frank, Second edition, Artech House sensors library.
11. Sensors Handbook, Sabrie Soloman, McGraw-Hill , 1999
12. Smart Sensors, Chapman, P., ISA Publications,1995

406264- Elective- I: E) Advanced Digital Signal Processing

Teaching Scheme:
Lectures: 3 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Oral: 50 Marks

Unit- I

Time frequency analysis, the need for time frequency analysis, Time frequency distribution, Short time Fourier Transform, Wigner distribution.

Unit- II

Multirate digital signal processing: Basic multirate operation (up sampling, down sampling), Efficient structures for decimation and interpolation, Decimation and interpolation with polyphase filters, Noninteger sampling rate conversion , Efficient multirate filtering Applications.

Unit- III

Stochastic Processes: Introduction, WSS signals and linear systems, spectral factorization, models of stochastic processes, vector processes.

Unit- IV

Spectral estimation: Periodogramm-based nonparametric methods: Periodogram, Bartlett's method, Welch's method, Blackman-Tukey method . Parametric methods for power spectrum estimation: ARMA modeling, Yule- Walker equation and solution.

Unit- V

Adaptive filtering : Principles of Adaptive filtering , LMS and RMS Algorithms, Applications in noise and echo cancellation, Homomorphic Signal Processing , homomorphic system for convolution, properties of complex-spectrum, Applications of homomorphic deconvolution.

Unit- VI

Digital Signal Processor (Like TMS320C67XX, ADSP-21XX, SHARC) :Introduction to fixed point and floating point DSP processor, Features of DSP processor, architecture of DSP processor, architecture features: computational units, bus architecture memory, data addressing, address generation unit, program control, program sequencer, pipeling, interrupts, features of external interfacing, on-chip peripherals, hardware timers, host interface port, clock generators, SPORT.

List of Experiments :

Students are expected to perform Minimum 8 Experiments using MATLAB or equivalent

1. Spectrogram analysis of Speech signal uisng STFT,WVD, etc.
2. Interpolation of signal.
3. Decimation of Signal.
4. Power spectrum Estimation: Parametric method.
5. Power spectrum Estimation: non-Parametric method.

6. LMS Adaptive filterring.
7. RMS Adaptive filtering.
8. Homomorphic Signal Processing Application.
9. Linear Convolution using DSP processors.

Text Books:

1. J. Proakis , Charles M. Rader, Fuyun Ling, Christopher L. Nikias, „Advanced Digital Signal Processing‟, (Macmillan Coll Div) (1992)
2. Glenn Zelniker, Fred J. Taylor, „Advanced Digital Signal Processing‟, (CRC Press) (1994)

REFERENCES:

1. J. Proakis , Charles M. Rader, Fuyun Ling, Christopher L. Nikias, „Digital Signal Processing‟, (Macmillan Coll Div)
2. A.V.Oppenheim and R.W.Schafer, "Discrete time Signal Processing", (Prentice Hall) (1992)
3. Haykins, "Adaptive Filter theory", (Prentice Hall) (1986)
4. Dr. Rulph Chassaing , " Digital Signal Processing and Application with the TMS 320c6713 and TMS 320c6716", Wilay Publication.
5. Raghuveer. M. Rao, Ajit S.Bopardikar, Wavelet Transforms, Introduction to Theory and applications, Pearson Education, Asia, 2000.
6. Introduction to Wavelets and Wavelet Transform: C. S. Burrus, Ramesh and A. Gopinath, Prentice Hall Inc.

406265- Elective- II: A) Opto- Electronics Instrumentation

Teaching Scheme:
Lectures: 3 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.

Unit- I

Laser instrumentation: Basic properties of Laser light, single mode operation, frequency stabilization, mode-locking, Q-switching in laser system, applications of lasers, holography and high energy applications.

Unit- II

Basics of fiber optics: Plane, circularly and elliptical polarized light, Brewster angle, total internal reflection, losses in optical fibers, measurement of splice loss, bend loss, attenuation, refractive index profile, numerical aperture, dispersion and bandwidth.

Unit- III

Sources and dectectors for optical fibers, selection, design considerations and characteristics of optical fiber system, optical fiber connection, fiber alignment and joint loss, splices, connectors, couplers.

Unit- IV

Optical amplifiers and integrated optics: Optical amplifiers, fiber amplifiers, integrated optics, integrated optical device beam splitters, directional couplers and switches, modulators, polarization transformation and frequency translators, optoelectronic integration.

Unit- V

Optical fiber sensors: Introduction to fiber optic sensing: Advantages and disadvantages of FOS, Transduction technique based on intensity modulation: evanescent field, coupling, encoding based position sensors.

Unit- VI

Applications of Fiber grating technology, Distributed Optical Fiber Sensing, Optical Gyroscopes, Laser interferometers, Speckle-pattern instruments and laser-doppler velocimetry

Text Books:

1. Optoelectronics, J. Wilson, Prentice-Hall of India.
2. Electro-Optical Instrumentation, Silvano Donati, Pearson Education, Inc., 2004.
3. Optical Fiber Communications, John M. Senior, Prentice Hall of India,3rd edition.
4. Optical Fiber Sensors, John Dakin and Brian Culshaw, Artech house, 1997

406265- Elective- II: B) Enviromental Instrumentation

Teaching Scheme:
Lectures: 3 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.

Unit- I

Introduction:

Necessity of instrumentation & control for environment, sensor requirement for environment. Instrumentation methodologies: Ultraviolet analyzers, total hydrocarbon analyzers using flame ionization detector, Gas chromatography in environmental analysis, photo ionization, portable & stationary analytical instruments.

Unit- II

Quality of water:

Standards of raw & treated water, sources of water & their natural quality, effects of water quality. Water quality parameters: Thermal conductivity, detectors, Opacity monitors, pH analyzers & their application, conductivity analyzers & their application. Water treatment: Requirement of water treatment facilities, process design.

Unit- III

Sedimentation & flotation:

General equation for settling or rising of discrete particles, hindered settling, effect of temperature, viscosity, efficiency of an ideal settling basin , reduction in efficiency due to various causes, sludge, storage & removal, design criteria of settling tank, effect of temperature on coagulation. Ground water monitoring: Level measurement in ground water monitoring wells, laboratory analysis of ground water samples, instrumentation in ground water monitoring, instrumentation in assessment of soil & ground water pollution.

Unit- IV

Waste Water and Flow Monitoring System

Automatic waste water sampling, optimum waste water sampling locations, and waste water measurement techniques. Instrumentation set up for waste water treatment plant. Latest methods of waste water treatment plants.

Flow monitoring: Non-open channel flow measurement, open channel waste water flow measurement. Rain water harvesting: necessity, methods, role of NGOs & municipal corporation.

Unit- V

Air Pollution and Sound Monitoring Systems

Definitions, energy environment relationship, importance of air pollution, Air sampling methods & equipments, analytical methods for air pollution studies. Control of air pollution. Sound pollution: basics of sound pollution, its effect to environment. Acoustic noise measurement & monitoring.

Unit- VI

Instruments in Weather station

Instruments in Weather station like Barometer, Rain gauge, Ceilometer etc.,Global environmental analysis, Virtual Instruments in Environmental Engineering Laboratory, Rover Environmental Monitoring station (REMS).

References:

1. Water treatment technology - Walter J. Weber.
2. Air pollution engineering – M. N. Rao & H. V. N. Rao.
3. Air pollution control technology – Wark & Warner.
4. Environmental Instrumentation & Analysis Handbook- Randy D. Down..
5. Environmental Instrumentation & Analysis Handbook,Randy D. Down & Jay H. Lehr, Wiley.
6. Environmental Engineering- Peany Howard S, Donal R Rowe and George Tacho Banoylous Teddy.
7. Environmental noise pollution, Patrick F. Cunniff, Wiley, May-1977 .
8. Environmental Engineering and Science, Gilber M Masters, Pearson Education (1997)

406265- Elective- II: C) Robotics & Automation

Teaching Scheme:
Lectures: 3 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.

Unit- I

Robot anatomy-Definition, law of robotics, History and Terminology of Robotics-Accuracy and repeatability of Robotics-Simple problems Specifications of Robot-Speed of Robot-Robot joints and links-Robot classifications-Architecture of robotic systems-

Unit- II

Introduction to automation: Components and subsystems, basic building block of automation, manipulator arms, wrists and end-effectors. Transmission elements: Hydraulic, pneumatic and electric drives. Gears, sensors, materials, user interface, implications for robot design, controllers.

Unit- III

Machine Vision: Introduction, Low level & High level vision, Sensing & Digitising, Image processing & analysis, Segmentation, Edge detection, Object description & recognition, Interpretation, Applications

Unit- IV

Kinematics, dynamics and control: Object location, three dimensional transformation matrices, inverse transformation, kinematics and path planning, Jacobian work envelope, manipulator dynamics, dynamic stabilization, position control and force control, present industrial robot control schemes.

Unit- V

Robot programming: Robot programming languages and systems, levels of programming robots, problems peculiar to robot programming, control of industrial robots using PLCs.

Unit- VI

Automation and robots: Case studies, multiple robots, machine interface, robots in manufacturing and non-manufacturing applications, robot cell design, selection of a robot.

References:

1. S.R. Deb, Robotics Technology and flexible automation, Tata McGraw-Hill Education., 2009
2. Mikell P Groover & Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, Technology programming and Applications, McGraw Hill, 2012.
3. Richard D. Klafter, Thomas .A, Chri Elewski, Michael Negin, Robotics Engineering an

Integrated Approach, Phi Learning., 2009.
4. Francis N. Nagy, Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc., 1987.
5. P.A. Janaki Raman, Robotics and Image Processing an Introduction, Tata McGraw Hill Publishing company Ltd., 1995.
6. Carl D. Crane and Joseph Duffy, Kinematic Analysis of Robot manipulators, Cambridge University press, 2008.
7. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., “Robotics control, sensing, vision and intelligence”, McGraw Hill Book co, 1987
8. Craig. J. J. “Introduction to Robotics mechanics and control”, Addison- Wesley, 1999.
9. Ray Asfahl. C., “Robots and Manufacturing Automation”, John Wiley & Sons Inc.,1985.

406265- Elective- II: D) Sensor Networks

Teaching Scheme:
Lectures: 3 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.

Unit- I

Introduction:

Sensing and Sensors, Sensor Classifications, Wireless Sensor Networks, History of Wireless Sensor Networks (WSN), Communication in a WSN, important design constraints of a WSN like Energy, Self-Management, Wireless Networking, Decentralized Management, Design Constraints, Security etc.

Unit- II

Applications

Structural health monitoring - sensing seismic events, single damage detection using natural frequencies, multiple damage detection using natural frequencies, multiple damage detection using mode shapes, coherence, piezoelectric effect, traffic control, health care - available sensors, pipeline monitoring, precision agriculture, active volcano, underground mining.

Unit- III

Node architecture

The sensing subsystem, Analog-to-Digital converter, the processor subsystem, architectural overview, microcontroller, digital signal processor, application-specific integrated circuit, field programmable gate array (FPGA), comparison, communication interfaces, serial peripheral interface, inter-integrated circuit, the IMote node architecture, The XYZ node architecture, the Hogthrob node architecture.

Unit- IV

Fundamentals of wireless digital communication

Basic components, source encoding, the efficiency of a source encoder, pulse code modulation and delta modulation, channel encoding, types of channels, information transmission over a channel, error recognition and correction, modulation, modulation types, quadratic amplitude modulation, signal propagation.

Unit- V

Medium Access Control

Overview, contention-free medium access, contention-based medium access, wireless MAC protocols, characteristics of MAC protocols in sensor networks, contention-free MAC protocols, contention-based MAC protocols, hybrid MAC protocols.

Unit- VI

Network Layer

Overview, routing metrics, flooding and gossiping, data-centric routing, proactive routing, on-demand routing, hierarchical routing, location-based routing, QoS-based routing protocols.

References:

1. Fundamentals of wireless sensor networks : theory and practice - Waltenegus Dargie, Christian Poellabauer, A John Wiley and Sons, Ltd., Publication.
2. Wireless Sensor Networks: Architectures and Protocols, Edgar H. Callaway Jr. and Edgar H. Callaway
3. Protocols and Architectures for Wireless Sensor Networks, Holger Karl and Andreas Willig, John Wiley & Sons.
4. Wireless Sensor Networks, Cauligi S. Raghavendra, Krishna M. Sivalingam and Taieb Znati, Springer..

406265- Elective- II: E) Fault Detection & Diagnosis

Teaching Scheme:
Lectures: 3 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.

Course Objective (COs):

- ✓ To understand the fault detection and isolation of industrial processes and systems, additionally to fault tolerant control with a special emphasis to model based techniques.
- ✓ To review the basic concept of fault detection systems.
- ✓ To understand the concept of fault diagnosis systems.

Course Outcomes (COCs):

1. Ability to design fault tolerant controllers for given processes
2. Ability to select appropriate fault detection method for the given system
3. Ability to implement fault-tolerant control systems for a simple industrial process

Program Outcomes (POs):

a. Ability to apply knowledge from undergraduate engineering and other disciplines to identify, formulate, solve, novel advanced instrumentation engineering along with process and automation problems that require advanced knowledge within the field
b. Ability to understand and design advanced instrumentation systems and conducts experiments, analyze and interpret data.
c. Ability to exhibit the skills to use contemporary engineering tools, software and equipment to analyze problems.

Unit- I

Introduction to Fault Detection and Diagnosis: Scope of FDD:- Types of faults and different tasks of Fault Diagnosis and Implementation - Different approaches to FDD: Model free and Model based approaches. Classification of Fault and Disturbances- Different issues involved in FDD- Typical applications.

Unit- II

ANALYTICAL REDUNDANCY CONCEPTS:

Introduction- Mathematical representation of Faults and Disturbances: Additive and Multiplicative types – Residual Generation: Detection, Isolation, Computational and stability properties – Design of Residual generator – Residual specification and Implementation.

Unit- III

Plant availability and process reliability:

Ways of improving plant availability, MTBF and MTTF, the reliability function, failure rate, bathtub curve, probability relationships, simple reliability estimation. **Estimation of frequency of occurrence of a hazard:** The logic tree approach, set theory and Boolean algebra, application to probability, Boolean manipulation. **Fault tree analysis:-** logic symbols, minimal cut set, logic gates, fault tree quantification. **Event tree analysis (ETA)** – notation, event tree construction, advantages and disadvantages of ETA. **Failure mode and Effect Analysis (FMEA)** – methodology, criticality analysis, corrective action and follow-up.

Unit- IV

Design of Structured Residuals: Introduction- Residual structure of single fault Isolation: Structural and Canonical structures- Residual structure of multiple fault Isolation: Diagonal and Full Row canonical concepts – Introduction to parity equation implementation and alternative representation.

Design of Directional structured Residuals: Introduction – Directional Specifications: Directional specification with and without disturbances – Parity Equation Implementation – Linearly dependent column.

Unit- V

FAULT MODELING

Basics of Faults & Tests : Exhaustive Tests, Pseudo exhaustive Tests, Pseudorandom Tests, Deterministic Tests, **Types of Faults:** Stuck-at Faults, Bridging Faults, Bridging Fault Classification , IDDq Faults , Delay Faults

Unit- VI

Advanced level issues and design involved in FDD:

Introduction of Residual generation of parametric fault – Robustness Issues –Statistical Testing of Residual generators – Application of Neural and Fuzzy logic schemes in FDD – Case study.

References:

1. Janos J. Gertler, Fault *Detection and Diagnosis in Engineering systems*, 2nd Edition, Macel Dekker, 1998.
2. Sachin. C. Patwardhan, *Fault Detection and Diagnosis in Industrial Process* – Lecture Notes, IIT Bombay, February 2005.
3. Rami S. Mangoubi, *Robust Estimation and Failure detection*. Springer-Verlag-London 1998.
4. L.H. Chiang, E.L. Russell and R.D. Braatz, “Fault Detection and Diagnosis in Industrial Systems” – Springer-Verlag-London 2001.
5. R. Isermann, Fault-Diagnosis Systems An Introduction from Fault Detection to Fault Tolerance, Springer Verlag, 2006.
6. Lees F.P. Loss Prevention in the Process Industries second edition. Butterworths, London, 1996.
7. AIChE/CCPS, Guidelines for Chemical Process Quantitative Risk Analysis second edition. Centre for Chemical Process Safety, American Institute of Chemical Engineers, New York, 2000.
8. William R. Simpson and John W. Sheppard, System Test and Diagnosis, Kluwer Academic Publishers, 1994, ISBN 0-7923-9475-5.

406266- Project Stage- I

Teaching Scheme:

Lectures: 4 Hrs/ Week

Practical: 2 Hrs/ Week

Examination Scheme:

Paper: (30+70) 100 Marks

In semester Assessment: 30 Marks

End Semester Assessment: 70 Marks

Term Work: 50 Marks

The term work will consists the comprehensive viva on the project work done in the first semester. The head of the department should constitute the committee of senior faculty members from the department/ institute for this viva examination. The students have to give presentation on the work done and prepare a report.

SEMESTER- II

406267- Process Instrumentation- II

Teaching Scheme:
Lectures: 4 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Oral: 50 Marks

Prerequisites: Process Instrumentation-I, Process Loop Components, Unit Operations & Power Plant Instrumentation, Control System Design, Digital Control.

Unit- I

Introduction to process control

Process dynamics and mathematical model, Representatives of process control problems, Dynamics of first order and second order behavior, The development of mathematical models to describe process dynamic behavior.

Unit- II

Heat Exchangers Controls

Types, gain and time constants, degrees of freedom. Basic controls in Heat exchangers, Steam Heaters, Condensers, fired heaters and vaporizers. Advanced Control - Override, Feed forward Control.

Unit- III

Boiler Controls

Types, Components, Boiler controls like Drum level control (1,2,3,5 element), Air-fuel ratio control, Combustion controls, Steam temperature and pressure control, Safety interlocks, Burner management system, start-up and shut-down procedures, boiler safety standards, boiler inspection procedures, Boiler load calculation, Boiler optimization.

Unit- IV

Chemical Reactor Controls

Types of reactions and reactors, factors governing the conduct of reaction, stability of reactors, time constant, effects of lag, flow control, temperature control, pH control, end point detection of continuous and batch reactors. Sequential & logic control in batch process, batch production management.

Unit- V

Distillation Column Controls

Mass and Energy balance, column feed control, column pressure control, control of overhead and bottom composition, distillate reflux flow control. Frequency response, lag in liquid and vapor flow, concentration lag, predicting the behavior of control system

Unit- VI

Pumps, Compressors Controls

Pumps: Types, Basic Controls, Multi-pump system controls. Compressors: Types, Basic Controls, Multi-compressor system controls.

Students are expected to perform minimum 8 experiments based on the above Topics OR

1. Design of controller for higher-order processes (MATLAB Simulation)
2. Design of controllers for multivariable processes (MATLAB Simulation)
3. Design of controller for nonlinear systems (MATLAB Simulation)
4. Design of controller for chemical reactor /evaporator/dryer (MATLAB Simulation)
5. Study of boiler controls (Using DCS*)
6. Study of distillation column controls (Using DCS*)
7. Study of pumps and compressor controls (Using DCS*)
8. Process Control Instrumentation – A case study on waste water treatment plant
9. Process Control Instrumentation – A case study on any plant

**- Optional.*

Text Books:

1. Instrument Engineers' Handbook : Process control : B.G. Liptak, Chilton.
2. Optimization of Industrial Unit Processes - Bela G. Liptak.
3. Chemical Process Control : George Stephonopolous, PHI
4. Process Dynamics and Control : Dale E. Seborg
5. Process Control: Modeling, Design and Simulation : B. Wayne Bequette, PHI

References:

1. Boiler Control Systems : David Lindsley, Mc GRAW-HILL
2. Boiler Control Systems Engineering: G. F. Gilman, ISA.
3. Process Instrumentation and control Handbook :Considine

406268- Industrial Automation

Teaching Scheme:
Lectures: 4 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Oral: 50 Marks

Unit- I

Control Systems and Automation Strategy

Evolution of instrumentation and control, Role of automation in industries, Benefits of automation, Introduction to Descriptive automation tools PLC, DCS, SCADA, Hybrid DCS/PLC, Automation strategy evolution, Control system audit, and performance criteria.

Unit- II

Instrumentation Standard Protocols

Definition of protocol, Introduction to Open System Interconnection (OSI) model, Communication standard (RS232, RS485), Modbus (ASCII/RTU), Introduction to third party interface, concept of OPC (Object linking and embedding for Process Control), HART Protocol: Introduction, frame structure, programming, implementation examples, benefits, advantages and limitation.
Foundation Fieldbus H1: Introduction, frame structure, programming, implementation examples, benefits, advantages and limitation. Comparison of HART, Foundation Fieldbus, Devicenet, Profibus, Controlnet, Industrial Ethernet

Unit- III

Programmable logic controllers (PLC)

Introduction, architecture, definition of discrete state process control, PLC Vs PC, PLC Vs DCS, relay diagram, ladder diagram, ladder diagram examples, relay sequencers, timers/counters, high speed counter, PTO, PWM and PID blocks in PLC, PLC design, study of at least one industrial PLC.

Unit- IV

Advance Applications of PLC and SCADA

PLC programming methods as per IEC 61131, PLC applications for batch process using SFC, Analog Control using PLC, PLC interface to SCADA/DCS using communication links (RS232, RS485) and protocols (Modbus ASCII/RTU)

Unit- V

Distributed Control Systems

DCS introduction, functions, advantages and limitations, DCS as an automation tool to support Enterprise Resources Planning, DCS Architecture of different makes, specifications, configuration and programming, functions including database management, reporting, alarm management, communication, third party interface, control, display etc. Enhanced functions viz. Advance Process Control, Batch application, Historical Data Management, OPC supports, Security and Access Control etc.

Unit- VI

Process safety and Safety Management Systems

Introduction to process safety, ESD systems, safety interlocks, risk terminologies, consequence and risk, risk measurement, Process Hazard Analysis (PHA), Hazard and operability study (HaZOp), Safety Integrity Level (SIL), Introduction to IEC61511 standard for Functional safety , protection layers, Safety Instrumented System: function, architecture, safety life cycle, Application of safety system

List of Experiments :

Students are expected to perform Minimum 8 Experiments (any 3 from 3 to 6 are compulsory)

1. Case study of Industrial PLC/PLC trainer.
2. Case study of Industrial DCS trainer.
3. Ladder diagram implementation using combinations of different timers. (Any application)
4. Ladder diagram implementation using combinations of different timers and counters. (Any application)
5. Ladder diagram implementation using HSC, PTO, PWM. (Any one application)
6. Developing and implementing any control loop using PID block in PLC system.
7. Developing and implementing any control loop using SCADA system.
8. Developing and implementing any control loop using DCS system
9. Developing and configuring Graphic User Interface for any control loop.
10. Configuration of any HART device to PLC and/or DCS system.
11. Configuration of any Foundation Fieldbus device to PLC and /or DCS system.
12. Configure and implement different alarms in PLC and/or DCS system.
13. Configuring and implementing any Advance process control function like MPC/or Fuzzy/or ANN in a DCS system.
14. Design and implementation of ESD system

Reference:

1. Distributed Computer Control for Industrial Automation, Poppovik Bhatkar, Dekkar Publications
2. Programmable Logic Controllers: Principles and Applications, Webb and Reis, PHI.
3. Computer Aided Process Control, S. K. Singh, PHI.
4. Introduction to Programmable Logic Controllers, Garry Dunning, Thomson Learning.
5. Computer Based Process Control, Krishna Kant, PHI
6. The Management of Control System: Justification and Technical Auditing, N. E. Battikha, ISA.

406269- Elective- III: A) Digital Image Processing

Teaching Scheme:
Lectures: 4 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Oral: 50 Marks

Unit- I

Fundamentals of Digital Image Processing: Digital image representation, fundamental steps in image processing, Elements of digital image processing systems, Image fundamentals: Gray, Color and Black and white. Color image models : RGB, CMY, HIS, etc models. Various Image Format, Sampling and quantization, Relationship between pixels, Statistical parameters (w.r.t. DIP) : Mean, standard deviation, variance, SNR, PSNR etc.

Unit- II

Image Transforms: Basic transformations, Perspective transformation, 2-D Transforms: Fourier transform, Discrete cosine transform, Short time Fourier transform, Gabor transform, Radon transform, SVD, Wavelet Transforms, Hough Transform, Watershed Transform

Unit- III

Image Enhancement: Enhancement by point processing, spatial filtering, enhancement in the frequency domain. Contrast intensification: linear stretching, non-linear stretching, histogram specification, low contrast stretching. Smoothing: Image averaging, mean filter, order statistics filter, edge preserving smoothing. Sharpening: High pass filtering, homomorphic filtering.

Unit- IV

Image Analysis: Segmentation: detection of discontinuities, edge linking and boundary detection, thresholding, region -oriented segmentation Representation and description: Representation schemes, descriptors, regional descriptors, pattern and pattern classes, Introduction Classifiers.

Unit- V

Image Compression: Need, Lossy and lossless compression, Huffman, RLE, LZW, Vector Quantisation, Shift codes, Arithmetic coding, BTC, Transform based compression: JPEG, MPEG, JPEG 2000, etc., properties of image compression schemes.

Unit- VI

Applications of DIP: Biometrics, Biomedical, Agricultural, Military, Space, etc.

List of Experiments :

Students are expected to perform Minimum 8 Experiments

1. Study of various image formats and their handling in Matlab.
2. Study of statistical properties mean, standard deviation, variance, etc.
3. Histogram specifications.

4. Gray level transformations such as contrast stretching, negative, power law transformation etc.
5. Spatial Domain filtering- smoothing & sharpening filters.
6. Frequency domail filtering, DFT/IDFT of given image.
7. DCT/IDCT of given image.
8. Edge detection using Sobel, Prewitt and Roberts operators.
9. Image Compression Using any method.
10. Case Study Digital Imaging Device.

Text Books:

1. Gonzalez and Woods, "Digital Image Processing with Matlab", Pearson Education,
2. Arthur Weeks Jr., "Fundamentals of Digital Image Processing", Prentice-Hall International.
3. Madhuri Joshi, "Digital Image Processing", Prentice-Hall International.
4. A. K. Jain, *Fundamentals of Digital Image Processing,* Prentice Hall of India.
5. K. R. Castleman, *Digital Image Processing*, Prentice-Hall International.
6. Pratt William, "Digital Image Processing", John Wiley & Sons

406269- Elective- III: B) Building Automation- II

Teaching Scheme:
Lectures: 4 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Oral: 50 Marks

Unit- I

Introduction to Fire Alarm System

What is Fire?, Fire alarm System-The History, Need for Fire alarm System, Basic Fire Alarm System, Classification of Fire Alarm System, Conventional Fire Alarm System, Addressable Fire Alarm System, Principles of Operations, Panel Components, Its Applications, FAS architecture: Types of Architecture and Examples

Unit- II

Fire Alarm Detection System Requirement

Stages of Fire Alarm System, Component within Fire Alarm System, Specific Function within Component Within Fire alarm System, Important Codes-NFPA72 IS 2189 BS 5839,Critical Parameters in Facility Environment, FAS Loops-Classification of Loops and Examples, Power Supply Requirement and its designing parameters, Battery Calculations and Its Requirement and design

Unit- III

Fire Alarm System Details Standards

- Network terminology, Classification of Cables, Class of Cables-Types and distance Supported
- Fire terminology
- Types of Relay and its Working principle
- Working Principles of Fire Alarm devices and its working Application in building safety
- Components of fire alarm detection system
- SLC wiring and its classification
- Cause and effect Matrix-Fire alarm system
- Concepts of Water leak detection system
- Concepts of VESDA (Very early smoke detection system)

Unit- IV

Fire Suppression System

- Basics of fire suppression system
- Fire hydrants
- Type of devices used for fire suppression (Flow Switch, Tamper Switch)
- FM-200 and Novec based gas suppression system

- Concepts of ABORT, Manual Release, Manual Pull type of devices

Unit- V

Introduction to Smart building and Security Systems

- Basic Concepts of Access Control System.
- Basic Component of Access Control System
- Benefits of Access Control System
- Cable Used in Access Control System and Its Terminology
    - Cat 5, RG-6, RG-59, RG-11
    - Difference between Straight cable and Cross Cable

- Access Control System Devices –Its features and Working principles
  Antipassback, Forgiveness, Two man Rule, Time and Attendance, Guard Tour, Elevator Control
- Protocols for access Control system:-LON, Modbus, Backnet, Wiegand
- Secure and Non Secure Concept
- Card Technology Overview –Smartcard, Proximity Card, MI fare Cards
- Access control Engineering Overview
- Need of Access Control of System
- System Architecture of Access Control System

Unit- VI

Introduction to CCTV (Closed Circuit Television System), Intrusion and Guard Tour System

CCTV:

- Basic of CCTV system, System Architecture of CCTV System
- Types of Camera –Fixed, PTZ, Analog, Digital
- Terminology for Cameras
  CIF, Mpeg, MP4, POE and Concepts
- Camera Connectivity
- Video Management System: DVR, DVM, NVR
- Video Analytics
- Camera Calculations Parameters
  Resolution, Compression, Image Connectivity, Recording, Motion%, FPS, Bandwidth-Concepts, Storage Tape, PPF (Pixel per foot), Levels of Resolutions, Distance and Width Approximate Compression techniques

Intrusion and Guard Tour System

- Basics and Technology used in the Intrusion system.
- Application of Intrusion System

List of Experiments :

Students are expected to perform Minimum 8 Experiments

1. To study Fire Alarm System (FAS) and its architecture
2. To study FAS loops and classifications
3. To study FAS power supply requirements and calculation
4. To study battery calculations and requirements
5. To study SLC wiring, loops and classifications
6. To study cause and effect matrix-Fire alarm system
7. To study architecture of access control system and it's components
8. To study CCTV System Architecture and types of cameras
9. To study VMS (Video management system)
10. To study Intrusion system, technology and application

References:

1. Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs) (Hardcover) by Reinhold A. Carlson (Author), Robert A. Di Giandomenico (Author).
2. Building Automation: Control Devices and Applications by In Partnership with NJATC (2008).
3. Building Control Systems, Applications Guide (CIBSE Guide) by The CIBSE (2000).
4. Design of Special Hazards and Fire Alarm Systems by Robert Gagnon (2007).
5. Security/Fire Alarm Systems: Design, Installation, and Maintenance by John E. Traister (1995).
6. CCTV (Newnes) by Vlado Damjanovski (1999).
7. Security, ID Systems and Locks: The Book on Electronic Access Control (Newnes) by Joel Konicek and Karen Little (1997).
8. Integrated Security Systems Design: Concepts, Specifications, and Implementation (v. 1) by Thomas L. Norman CPP PSP CSC (2007).
9. Access Control Systems: Security, Identity Management and Trust Models by Benantar, Messaoud, ISBN: 0387004459 EAN: 9780387004457 Publisher: Springer (Published: 12/2005).
10. Building Automation Online by McGowan; McGowan, John J.; ISBN: 0824746155.
11. CCTV by Damjanovski, Vlado; ISBN: 0750671963 Edition: 3 Publisher: Butterworth- Heineman.
12. CCTV for Security Professionals by Machette, Alan; Matchett, Alan R.; ISBN: 0750673036 ,Publisher: Butterworth-Heinemann (2003).
13. CCTV Surveillance: Analog and Digital Video Practices and Technology by Kruegle, Herman, ISBN: 0750677686 EAN: 9780750677684 Edition: 2 Publisher: Butterworth-Heinemann (2006)

406269- Elective- III: C) Process Modeling and Optimization

Teaching Scheme:
Lectures: 4 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Oral: 50 Marks

Unit- I

Modeling and Simulations

Introduction, Types of models, modeling of process control systems in time domain and frequency domain, Fitting polynomials in the step test data. Lagrange Interpolation formula, Least square fitting.

Fundamental laws: Continuity equations, Energy Equations, Equations of motion, transport Equations, Equations of state, Equilibrium and Chemical Kinetics.

Process models of some typical systems in differential equations form, , dead time, first and second order models, higher order models, Modeling of first and second order electrical systems, mechanical systems, electromechanically systems and oscillatory systems.

Unit- II

Modeling of Mechanical, Chemical systems:

Gravity flow tank, Tanks in series, Tanks in parallel Reaction dynamics, Modeling the chemical reactions, CSTR models, Plug flow reactor model, modeling of flash drum, distillation columns, evaporators, dryers, heat exchangers.

Unit- III

Process Identification:

Identification of physical processes, off-line and on-line identification, Step testing, pulse testing, sine wave testing, ATV identification method, prediction error methods, introduction to numerical algorithm for subspace state space identification, Least square method, Relationships among time, Laplace and frequency domain.

Unit- IV

Analysis of multivariable systems.

Open loop and close loop characteristics equations, multivariable Nyquist plot, Loci plot, Niederlinski index, Resiliency, Morari Resiliency Index (MRI), interaction relative gain array (Bristol array) Inverse Nyquist array , robustness Doyle stein criterion, skogestad and morari method .

Unit- V

Basic Concepts of Optimization:

Optimization: Concept, need, Essential features of optimization Problem, Concepts of objective functions, Equality and Inequality Constraints, Payback period, Return of Investment, Net present

Value, Internal Rate of Return.

Classification of optimization problem based on Existence of constrains, Nature of design variables, Physical Structure of the problem, Equation Involved, Permissible values, of design variable, Deterministic Nature of the variables, separability of the variable, Number of objective functions. Continuity of functions, Convex and Concave functions, Convex Region, Extremum of the objective functions, quadratic approximation, Feasible region.

Unit- VI

Optimization Techniques:

Unconstrained Functions One Dimensional: Numerical methods for optimizing a function of one variable , scanning and bracketing procedures, Newton, Quasi-Newton and Secant methods, Multidimensional problem, evaluation of unidimensional search methods.

Unconstrained Multivariable Optimization, Simplex method, Direct Methods, Indirect Methods, Steepest Descent method.

Linear Programming : Basics of Linear Programming, Simplex Algorithm

List of Experiments :

Students are expected to perform Minimum 8 Experiments

1. Analysis of first/second order system by using step and ramp input.
2. Simulation of mathematical modeling of electrical/ mechanical system by first principle.
3. Simulation of mathematical modeling of liquid level system.
4. Study of distillation columns.
5. Study of Heat Exchanger.
6. Identification of second order process by prediction error method and compare it with modeling by first principle.
7. Obtaining unknown parameters of second order process by least square technique.
8. Obtaining Relative gain array of any MIMO physical system.
9. Obtaining inverse Nyquist array of any Physical system.
10. Design of optimal control system by using quadratic approximation.
11. Analysis and comparisons of Quasi-Newton and secant methods.
12. Finding optimal solution using Simplex Method system.

References:

1. W. L. Luyben, Process, Modeling, Simulation and Control for Chemical Engineers• by McGraw Hill, 1973.
2. homas Edgar, David Himmelblau, Optimization of Chemical Processes• Second edition, McGraw Hill, 2001.
3. W. F. Stoecker, Design of Thermal Systems International Education, McGraw hill 1989.
4. J. Malley, Practical Process Instrumentation and Control • McGraw Hill.

5. Deo Narsingh ,System Simulation with digital Computer • Prentice Hall India, New Delhi.
6. Singiresu S.Rao,Engineering Optimization (Therory & Practice),third Edition,New Age International(p) Ltd,Publishers.

406269- Elective- III: D) Virtual Instrumentation

Teaching Scheme:
Lectures: 4 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Oral: 50 Marks

Course Objectives:

1. Understand the basic components of Virtual Instrumentation system.
2. Learn the developing VIs based on Lab VIEW software.
3. To learn to develop applications based on Virtual Instrumentation system.

Course Outcomes:

By the end of the course, students should be able to

1. Understand the structure of Virtual Instruments.
2. Develop applications using Virtual Instrumentation software.

Unit- I

Introduction:

Virtual Instrumentation: Historical perspective - advantages - block diagram and architecture of a virtual instrument – Conventional Instruments versus Traditional Instruments - data-flow techniques, graphical programming in data flow, comparison with conventional programming. VI Debugging Techniques, Help and Resources for LabVIEW

Unit- II

VI Programming Techniques

VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, local and global variables, State machine, string and file I/O, Instrument Drivers, Publishing measurement data in the web, Internet Connectivity.

Unit- III

Data Acquisition

Introduction to data acquisition on PC, Sampling fundamentals, Input- Output techniques and buses. Latest ADCs, DACs, Digital I/O, counters and timers, Software and hardware installation, Calibration, Resolution, Data acquisition interface requirements – Issues involved in selection of Data acquisition cards – Data acquisition cards with serial communication - VI Chassis requirements. SCSI, PCI, PXI system controllers, Ethernet control of PXI. Networking basics for office & Industrial applications, VISA and IVI, MyDAQ, MycRIO, cRIO, CRIO RT, ELVIS.

Unit- IV

VI Toolsets

Use of Analysis tools, Fourier transforms, power spectrum, correlation methods, windowing and filtering. Application of VI in process control designing of equipments like oscilloscope, Digital multimeter, Design of digital Voltmeters with transducer input Virtual Laboratory, Web based Laboratory , Control and Simulation Toolkit, PID Control.

Unit- V

Math Toolsets

Linear algebra, trigonometry, optimization toolset, math script and formula nodes, elementary and special functions, integral and differential equations. Matlab interface. Hybrid Programming Concept

Unit- V

APPLICATIONS

Distributed I/O modules- Application of Virtual Instrumentation: Instrument Control, Development of process database management system,

Simulation of systems using VI, Development of Control system, Industrial Communication, Image acquisition and processing, Motion control. Development of Virtual Instrument using GUI, Real-time systems, Embedded Controller, OPC, HMI / SCADA software, Active X programming, Motion Control.

List of Experiments :

Students are expected to perform Minimum 8 Experiments

1. Installation and configuration of software
2. Preparing simple VIs (learning front panel and block diagram environment).
3. Study of different data types in LabVIEW
4. Developing simulation examples using the LabVIEW software.
5. Developing VI using signal processing toolkit.
6. Developing VI using Control system toolkit.
7. Developing VI using DSP toolkit.
8. Hardware software interfacing.
9. Developing Web based application using Vis.
10. Developing application to interface with Matlab.
11. Creating SubVIs and Its usage in High Level Applications
12. Data Acquisition in LabVIEW

References:

1. LabVIEW Graphical programming, Gray W. Johnson, Richard Jennings, 4th ed. The McGraw-Hill.
2. Virtual Instrumentation Using LabVIEW, Sanjay Gupta, 2nd ed. Tata McGraw-Hill.
3. Robert H. Bishop, ‘Learning with Lab-view’, Prentice Hall, 2003
4. Hands on Introduction to LabVIEW for Scientists and Engineers, John Essick, Oxford University Press.
5. Virtual Instrumentation using LabVIEW, Jovitha Jerome, Kindle edition, PHI
6. 'LabVIEW for everyone',Lisa K Wells & Jeffrey Travels, Prentice Hall, 1997

406269- Elective- III: E) Computer Techniques and Applications

Teaching Scheme:
Lectures: 4 Hrs/ Week
Practical: 2 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.
Oral: 50 Marks

Prerequisites:

Students must be good at 'C' programming and logic development

Unit- I

Operating System Overview

Concepts of Operating System and its services, Types of operating systems

Process Management: Concept, scheduling, operations on process

CPU scheduling: Basic concepts, CPU scheduling algorithms

Deadlocks: Characterization, Handling, Recovery Disk scheduling algorithms

Unit- II

Memory Management: Address Binding, Overlays, Swapping, Contiguous memory allocation, Paging, Segmentation

Virtual memory: Concept, Demand paging, Prepaging, Page size considerations, Page replacement algorithms, Thrashing

File system management: Concept, file access methods, directory structures, file allocation methods

Unit- III

Parallel Computers: Basic concepts, Types of parallelism, Intertask dependencies, classification of parallel computers, vector computers, Array processors, Systolic Arrays

Real Time & embedded System OS: Concepts, Types, their differences, Handheld Operating Systems. Interrupt Routines in RTOS environment, RTOS Tasks and their Scheduling models, Strategy for synchronization between the processes,

Data compression: Overview of Information Theory, Huffman Coding, Loss less and lossy compression.

Unit- IV

Computer Communication: ISO-OSI Seven Layer model, The TCP/IP reference model Introduction to LAN, LAN topologies, IEEE standards for networking- IEEE 802.3, IEEE 802.4, IEEE 802.5, Circuit switching and Packet switching networks, Features and capabilities of TCP/IP, Industrial Ethernet, Introduction to IEEE 1394, IEEE 488(GPIB), its configuration and advantages.

Unit- V

ARM Processor Architecture

Introduction to ARM processors architecture and features of ARM9 and ARM10E core families. System hardware, Interrupt structure and Applications of ARM7 Processor, its Architecture, Programmer's model, Modes of operation, Interrupt Structure and Applications. Comparison with ARM9.

Architecture of ARM7TDMI processor, Functional Block diagram, Software, Programming model, Registers, operating Modes

Unit- VI

Software Testing

Software Development Life Cycle and its models: a. Linear Sequential b. Rapid development c. Incremental d. Component based

Software Analysis, Software Design, Software Implementation

Software Testing: fundamentals, white box, black box testing, control structure testing, specific environment testing, comparison testing, orthogonal testing, strategic approach to testing, unit testing, integrated testing, validation testing, system testing, CASE tools

Software debugging: Standard guidelines, debugging techniques- use of break points, test macros, output files for sampled inputs, instruction set simulation, laboratory tools

Software maintenance: Preventive, Corrective, Adaptive, Enhancement, System Re-engineering

List of Experiments :

Students are expected to perform Minimum 8 Experiments

1. CPU scheduling algorithms.
2. Huffman Coding.
3. PC to PC Communication.
4. (4-7) Simple programs for ARM processor using Embedded IDE (simulation software Kiel for ARM [free evaluation versions available]) covering:
   a. Assembly Language, Directives, and Basic ARM Examples
   b. Binary Arithmetic and Bit Manipulations
   c. ARM Memory Map Details, Linking and Loading
8. Generate a test plan format for an application as a case study
9. Theoretical Study of the software testing guidelines

References:

1. Operating System Concepts by Silberschatz, Galvin, Gagne
2. Advanced MS DOS programming by Ray Duncan, 2nd edition, bpb publications
3. Parallel Computer architecture and programming by V. Rajaraman, C. SivaRam Murthy, PHI
4. Computer Architecture and Parallel processing by Kai Hwang, Faye Briggs, McGraw Hill International Editions
5. Computer Networks Protocols, Standards and Interfaces by Uyless Black, PHI
6. Computer Networks by Andrew Tanenbaum, Prentice Hall.
7. Introduction To Data Compression by Khalid Sayood, Morgan Kaufmann Publishers, Inc.

8. High Speed Networks TCP/IP and ATM design principles by William Stallings.
9. Embedded System Architecture Programming Design by Rajkamal, Tata Graw Hill Publication Second Edition, 2008.
10. Programming and Customizing the ARM7 Microcontroller by Myke Predko, McGraw-Hill Professional, 2009
11. ARM System-On-Chip Architecture by Steve Furber, Pearson Publication, second edition, 2000
12. Software Engineering, A practitioner's Approach, 6th edition, McGraw Hill International Editions
13. Software Engineering by Ian Somerville, 4^{th} edition, Addison Wesley publication
14. Effective methods for software testing by William E Perry, third edition, Wiley India Publication
15. www.interfacebus.com
16. www.arm.com

406270- Elective- IV: A) Smart Materials and Systems

Teaching Scheme:
Lectures: 4 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.

Objectives:

To familiarize students with the structure and physical properties of smart materials and systems used in Instrumentation Engineering.

Unit- I

- Smart materials, their properties, distribution by type.
- The development of smart materials and structures.

Unit- II

- Shape Memory Material, Shape memory alloys, Shape Memory Ceramics, Shape memory polymers
- Piezo and Ferroelectric Materials - Piezoelectricity, Piezoresistivity, Ferroelectricity
- Dielectric Material-Dielectric Elastomers, Electrostrictive Elastomers

Unit- III

- Ionic Materials- Conductive Polymers, Ionomeric Polymer, Metal Composites, Carbon Nanotubes, Liquid Crystals
- Magnetic Material- Magnetostriction, Magnetorheological Fluid , Superconductors
- Other Smart Materials- Introduction, Self-Healing Materials , Polymer Gels, Electro-Rheological (ER) fluids

Unit- IV

- Sensors Smart Systems:
  Introduction, Conductometric sensors, Capacitive sensors, Piezoelectric sensors, Accelerometer sensors, Piezoresistive sensors.
- Actuators for Smart Systems:
  Electrostatic transducers, Electromagnetic transducers, Electrodynamic transducers, Piezoelectric transducers, Electrostrictive transducers, Magnetostrictive transducers, Electrothermal actuators.

Unit- V

Introduction to MEMS, Silicon Fabrication Techniques for Smart Materials in MEMS, Deposition techniques for thin films in MEMS, Evaporation, Sputtering , Chemical Vapor Deposition, Epitaxial Growth of Silicon, Thermal Oxidation for Silicon Dioxide, Lithography, Photolithography, Lift-Off Technique, Etching (Isotropic), Silicon Micromachining, Bulk Micromachining, Surface Micromachining

Unit- VI

Application of Smart Systems for Airbags, Biocompatible system (Healthcare) - Dosing System , Lab on Chip

References:

1. Vijay, K., Varadan K., Vinoy J. Gopalakrisham S.: Smart Material Systems and MEMS: Design and Development Methodologies , Willey 2006
2. Micro And Smart Systems by G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre : Wiley, India (2010).
3. Addington, M. , Schodek, Daniel L.: Smart materials and new technologies, Architectural Press, 2005.
4. Brain Culshaw – Smart Structure and Materials Artech House – Borton. London-1996..
5. Srinivasan A.V., Michael McFarland D., Smart Structure analysis and design, CambridgeUniversity Press, 2001

406270- Elective- IV: B) Instrumentation in Agriculture and Food Processing

Teaching Scheme:
Lectures: 4 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.

Unit- I
Introduction

Necessity of instrumentation & control for agriculture, engineering properties of soil: fundamental definitions & relationships, index properties of soil, permeability & seepage analysis, shear strength, Mohrs circle of stress, active & passive earth pressures, stability & slopes, Sensors: introduction to sonic anemometers, hygrometers, fine wire thermocouples.

Unit- II
Instrumentation in Process industry

Flow diagram of sugar plant & instrumentation set up for it, flow diagram of fermenter & control(batch process),flow diagram of dairy industry & instrumentation set up for it, juice extraction control process & instrumentation set up for it.

Unit- III
Instrumentation in Irrigation and Green house System

Irrigation systems: necessity, irrigation methods: overhead, centre pivot, lateral move, micro irrigation systems , soil moisture measurement methods: resistance based method, voltage based method, thermal based method, details of gypsum block, irrigation scheduling, irrigation efficiencies, Application of SCADA for DAM parameters & control.

Green houses & instrumentation: ventilation, cooling & heating, wind speed, temperature & humidity, rain gauge carbon dioxide enrichment measurement & control.

Unit- IV
Instruments in Agriculture

Automation in earth moving equipments & farm equipments, implementation of hydraulic, pneumatic & electronics control circuits in harvesters cotton pickers, tractor etc. classification of pumps: pump characteristics, pump selection & installation. Agrometrological instrumentation weather stations, surface flux measurement, soil water content measurement using time-domain reflectrometery(TDR).

Unit- V
Food Processing

Definition, Food quality measurement , food safety and standards bill 2005, central committee for food standards, Agmark, Bureau of Indian Standards, Codex Standards, recommended international code of hygiene for various products, Design consideration: cold storage, atmospheric controller and preservatives; biosensors.

Unit- VI

Automation in Food Industry

Application of SCADA & PLC in food packing industry, Trends in modern food processing, Equipments for creating and maintaining controlled atmosphere.

References:

1. Industrial instrumentation, “Patranabis”, TMH.
2. Handbook of Instrumentation -Process control –B.G.Liptak, Chilton.
3. Irrigation : Theory and Practice, Michael. A.M, Vikas Publishing House Pvt Ltd, 2008.
4. Process control and instrumentation technology, “C.D. Johnson”, PHI.
5. Mineral Processing Technology, Wills B.A., 4th Ed.,Pergamon Press.
6. Automatic Control for food processing system, R.G.Moreira, T.P.Coulate, 2001.

406270- Elective- IV: C) Neural Network and Fuzzy Based Systems

Teaching Scheme:
Lectures: 4 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.

Course Objective

- To create awareness of principle components like fuzzy logic, neural networks which is important from perspective of auto-tuning controllers.
- Healthy integration of all these techniques has resulted in extending the capabilities of the technologies to more effective and efficient problem solving methodologies.

Learning Outcomes

Upon completion of the course, you should be able to:

- Identify and describe different auto-tuning controller techniques their roles in building intelligent controls.
- Recognize the feasibility of applying a soft computing methodology for a particular problem
- Apply fuzzy logic and reasoning to handle uncertainty and solve engineering control problems.
- Apply neural networks to pattern classification and regression problems.

Unit- I

Neural Networks-1(Introduction & Architecture)

Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory.

Unit- II

Neural Networks-II (Back propagation networks)

Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; back propagation learning methods, effect of learning rule co-efficient ;back propagation algorithm, factors affecting back propagation training, applications

Unit- III

Fuzzy Logic-I (Introduction)

Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion.

Unit- IV

Fuzzy Logic –II (Fuzzy Membership, Rules)

Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzificataions, Fuzzy Controller, Industrial applications.

Unit- V

Fuzzy Logic Based Control:

Fuzzy Controllers: Preliminaries – Fuzzy sets in commercial products – basic construction of fuzzy controller – Analysis of static properties of fuzzy controller – Analysis of dynamic properties of fuzzy controller – simulation studies –case studies – fuzzy control for smart cars**.**

Unit- VI

Neuro – Fuzzy and Fuzzy – Neural Controllers

Neuro – fuzzy systems: A unified approximate reasoning approach – Construction of rule bases by self-learning: System structure and learning algorithm – A hybrid neural network based Fuzzy controller with self-learning teacher. Fuzzified CMAC and RBF network based self-learning controllers.

Text Books:

1. S. Rajsekaran& G.A. VijayalakshmiPai, "Neural Networks, Fuzzy Logic and Genetic Algorithm:Synthesis and Applications" Prentice Hall of India.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India.
3. Kosco B, Neural Networks and Fuzzy Systems: A Dynamic Approach to Machine Intelligence, Prentice Hall of India, New Delhi, 1992.
4. Jacek M. Zuarda, Introduction to Artificial Neural Systems -, Jaico Publishing House, 1997.
5. Klir G.J and Folger T.A, Fuzzy sets, Uncertainty and Information, Prentice Hall of India, New Delhi 1994.

References:

1. Siman Haykin,"Neural Netowrks". Prentice Hall of India
2. N.P.Padhy," Artificial Intelligence and Intelligent Systems" Oxford University Press.
3. Kumar Satish, "Neural Networks" Tata McGraw Hill
4. Bose and Liang, Artificial Neural Networks, Tata Mc-graw Hill, 1996.
5. Simon Haykin, Neural Networks, ISA, Research Triangle Park, 1995.

406270- Elective- IV: D) Automobile Instrumentation

Teaching Scheme:
Lectures: 4 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.

Unit- I
FUNDAMENTALS OF AUTOMOTIVE INSTRUMENTATION
Current trends in automotive electronic engine management system, electromagnetic interference suppression, electromagnetic compatibility, electronic dashboard instruments, onboard diagnostic system, security and warning system.

Unit- II
BATTERIES AND STARTING SYSTEM
Principle and construction of lead acid battery, characteristics of battery, rating capacity and efficiency of batteries, various tests on batteries, maintenance and charging. Condition at starting, behavior of starter during starting, series motor and its characteristics, principle and construction of starter motor, working of different starter drive units, care and maintenances of starter motor, starter switches.

Unit- III
INJECTION AND IGNITION SYSTEM
Heat release in the diesel engine and need for control of fuel injection. Inline injection pump - Rotary Pump and injector– Construction and principle of operation, Electronic control of these pumps. Common rail and unit injector system – Construction and principle of operation. Ignition fundamentals, solid state ignition systems, high energy ignition distributors, Electronic spark timing and control. Combined ignition and fuel management systems. Dwell angle calculation, Ignition timing calculation.

Unit- IV
SENSORS AND ACTUATORS
Introduction, basic sensor arrangement, Types of sensors such as - oxygen sensors, Crank angle position sensors -Fuel metering, vehicle speed sensor and detonation sensor -Altitude sensor, flow sensor. Throttle position sensors, solenoids, stepper motors, relays, sensor for speed, throttle position, exhaust oxygen level, manifold pressure, crankshaft position, coolant temperature, exhaust temperature, air mass flow for engine application. Solenoids, stepper motors, relay.

Unit- V
CHARGING SYSTEM AND LIGHTING
Generation of direct current, shunt generator characteristics, armature reaction, third brush regulation, cutout. Voltage and current regulators, compensated voltage regulator, alternators principle and constructional aspects and bridge rectifiers, new developments. Lighting system:

insulated and earth return system, details of head light and side light, LED lighting system, head light dazzling and preventive methods – Horn, wiper system and trafficator.

Unit- VI

SAFETY, COMFORT AND EMISSION SYSTEMS

Seat belt, regulations, automatic seat belt tightener system, collapsible steering column, tiltable steering wheel, air bags, electronic system for activating air bags, bumper design for safety. NVH (noise, vibration and harshness) of chassis, engines and power train, ride quality and sound quality; heating, ventilation and air conditioning systems. Steering and mirror adjustment, central locking system, Garage door opening system, tyre pressure control system, rain sensor system, environment information system, Principle of operation of emission measuring instruments, emission test procedures – FTP, Euro and Bharat norms.

Text Books:

1. "BOSCH Automotive Handbook", 8th Edition, Bentley publishers, 2011
2. Allan Bonnick, "Automotive Computer Controlled Systems", 2011.
3. Tom Weather Jr and Cland C.Hunter, "Automotive Computers and Control system", Prentice Hall Inc., New Jersey.
4. Young A. P & Griffiths L, "Automobile Electrical and Electronic Equipments", English Languages Book Society & New Press, 1990.
5. Santini Al, "Automotive Electricity and Electronics", Cengage Learning, 2012.
6. Tom Denton, "Automotive Electrical and Electronic System", SAE International, 2004.
7. William B. Ribbens, "Understanding Automotive Electronics", 6th Edition, Newnes, 2003.
8. Norm Chapman, "Principles of Electricity and electronics for the Automotive Technician", Delmar Cengage Learning, 2008.
9. Judge A.W, "Modern Electrical Equipment of Automobiles", Chapman & Hall, London, 1992.
10. Michael F. Hordeski, "Alternative Fuels: The Future of Hydrogen", The Fairmont Press, Inc., 2008.
11. Rajput R. K, "A textbook of Internal Combustion Engines", 2nd edition, Laxmi Publications (P) Ltd, 2007.
12. "Society of Automotive Engineers", Alternative Fuels: Fuel Cells and Natural Gas, Society of Automotive Engineers, Incorporated, 2000.
13. Thipse S. S, "Alternative Fuels: Concepts, Technologies and Developments", Jaico Publishing House, 2010.
14. "Engine Management", Second Edition, Robert Bosch GmbH, 1999.
15. Eric Chowaniety, "Automobile Electronics", SAE Publications 1995.

406270- Elective- IV: E) Open Elective

Teaching Scheme:
Lectures: 4 Hrs/ Week

Examination Scheme:
Paper: (30+70) 100 Marks
In semester Assessment: 30 Marks
End Semester Assessment: 70 Marks.

It is expected to offer this elective from other branch with condition that the course contents should not be the same. If the college / Institute wish to start new elective in collaboration with Industry, they are required to approve the elective from university with prior information and permission from BOS Chairman.

406271- Project Work

Teaching Scheme:
Practical: 6 Hrs/ Week

Examination Scheme:
Term Work: 100 Marks.
Oral: 50 Marks

For the term work the head of the department should constitute the committee of senior faculty Members. A progressive report has to be maintained and should be shown to the external examiner at the time of final exam. The students have to give presentation and a project report has to be prepared. In the project report an evaluation certificate should be there duly signed by external examiner. The oral examination means a comprehensive viva on the project work done.

406272- Industrial Visit

Teaching Scheme:

Examination Scheme:

Term- Work : 50 Marks

The Institute should arrange 2 full days Industrial visit related to Instrumentation and control Industry. The students should submit visit report file with detailed information. Generally, students are expected to study following points in the Industrial Visit.

- Process block diagram
- List of Process variables and control variables
- List of Sensors and transducers and criterion for selection
- Control loops
- List of Control system components and process loop components
- Level of Automation

It is suggested that students should identify the reasons for control strategy, implemented by the industry.