B.E. Instrumentation and Control
2008 Course

B.E. Instrumentation and Control

Term I

Subject Code No.	Subject	Teaching Scheme Hrs./week			Examination Scheme				
		Lecture	Tutorial	Practical	Paper	Term work	Practical	Oral	Total
406261	Process Instrumentation	04	-	02	100	-	50	-	150
406262	Digital Control	04	-	02	100	50	-	-	150
406263	Project Engineering and Management	04	-	02	100	25	-	50	175
406264	Elective I	04	-	02	100	-	-	50	150
406265	Elective II	04	-	-	100	-	-	-	100
406266	Project Work	-	-	02	-	-	-	50	-
	Total	20		10	500	75	50	150	775

Term II

Subject Code No.	Subject	Teaching Scheme Hrs./week			Examination Scheme				
		Lecture	Tutorial	Practical	Paper	Term work	Practical	Oral	Total
406267	Process Dynamics and Control	04	-	02	100	25	-	50	175
406268	Industrial Automation	04	-	02	100	-	-	50	150
406269	Elective III	04	-	02	100	-	-	50	150
406270	Elective IV	04	-	-	100	-	-	-	100
406271	Project Work	-	-	06	-	100	-	50	150
	Total	16	-	12	400	125	-	200	725

Elective I (406264)	Elective II (406265)	Elective III(406269)	Elective IV(406270)
(A)Biomedical Instrumentation	(A) Environmental Instrumentation	(A)Advanced Biomedical Instrumentation	(A) Instrumentation in Agriculture
(B) Laser based Instrumentation	(B) Nano Instrumentation	(B) Fiber Optic Instrumentation	(B) Micro Electro Mechanical Systems
(C) Advanced Control Systems	(C) Advanced Digital Signal Processing	(C) Process Modeling and Optimization	(C) Digital Image Processing
(D) Building Automation-I	(D) Automobile Instrumentation	(D) Building Automation-II	Open Elective

406261:Process Instrumentation

Lectures: 4Hrs./ Week — Paper : 100 Marks
Practical: 2 Hrs./ Week — Practical : 50 Marks

Prerequisite: Basics of Principals of Sensors and Transducers, Control System Component and Process Loop Control

Unit 1: Process characteristics: Incentives for process control, Process Variables types and selection criteria,, Process degree of freedom, The period of Oscillation and Damping, Characteristics of physical System: Resistance, Capacitive and Combination of both.
Elements of Process Dynamics, Types of processes- Dead time, Single /multicapacity, self-Regulating /non self regulating, Interacting /noninteracting, 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

Unit2: 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 3: Feedback Control:
Basic principles, Elements of the feedback Loop, Block Diagram, Control Performance Measures for Common Input Changes, 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 4: MultiLoop & Nonlinear Systems:
Cascade control, Feed forward control, feedback-feedforward control, Ratio control, Selective Control , Split range control- Basic principles, Design Criteria , Performance, Controller Algorithm and Tuning, Implementation issues, 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 5 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 6: Intelligent Controllers:

Step analysis method for finding first, second and multiple time constants and deadtime**.** Model Based controllers: Internal Model control, Smith predictor, optimal controller, Model Predictive controller, Dynamic matrix controller (DMC). Self Tunning Controller. Fuzzy logic systems and Fuzzy controllers, Introduction, Basic Concepts of Fuzzy Logic, Fuzzy Sets, Fuzzy Relation, Fuzzy Graphs, and Fuzzy Arithmetic, Fuzzy If-Then Rules, Fuzzy Logic Applications, Neuro-FuzzyArtificial Neural networks and ANN controller,

List of Experiments:

1. Finding dynamic elements for any process. (T_D, T_S)
2. Analysis of Flow loop.
3. Analysis of Level loop.
4. Analysis of Temperature loop.
5. Analysis of Pressure loop.
6. Study of Cascade control loop.
7. Study of Ratio control/ Selective control. (any one)
8. Study of SLPC for process control.
9. Design and Implementation of Advance process controller. (ANN/Fuzzy/MPC) (May be implemented using any suitable software)
10. Study of non linear control elements.

(Students are expected to perform min. eight experiments)

Test Books:

1. Donald Eckman – Automatic Process Control, Wiley Eastern Limited
2. Thomas E Marlin - Process Control- Designing processes and Control Systems for Dynamic Performance, McGraw-Hill International Editions
3. Process control Systems-F.G.Shinskey,TMH
4. Computer Based Industrial Control –Krishna Kant, PHI
5. Handbook of Instrumentation -Process control –B.G.Liptak, chilton
6. Fundamentals of Process Control - Murrill ISA
7. Chemical Process Control- Stephanopoulos George, PHI
8. Applications concepts of Process control- By Murrill ISA
9. B.Wayne bequette Process Control:Modeling, Design and Simulation-by,PHI

Reference Books:

1. Process Instrumentation and control Handbook –Considine.
2. Fuzzy Logic with Engineering Applications, T.J.Ross.

406262 DIGITAL CONTROL

Teaching scheme
Lectures : 4 Hrs / Week
Practical : 2 Hrs/ week

Examination scheme
Theory : 100 Marks
Term Work : 50 Marks

Unit-1 Introduction to Discrete Time Control System

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

Unit-2 Pulse Transfer Function and Digital PID Controllers

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

Unit-3 Design of Discrete Time Control System by conventional methods

Stability analysis in Z-plane, Jury stability criterion, Bilinear transformations, Design based on the root locus method, Digital Controller Design using Analytical Design Method.

Unit-4 State Space Analysis of Discrete Time Control System

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

Unit-5 Pole Placement and Observer Design

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

Unit-6 Optimal Control

Quadratic Optimal Control and Quadratic performance index, Optimal state regulator through the matrix riccati equations, Steady State Quadratic Optimal Control.

Text Books

1. Discrete Time Control systems by K. Ogata, Prentice Hall, Second Edition, 2003.
2. Digital Control and State Variable Methods by M. Gopal, Tata McGraw Hill, 2003.

Reference Books

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

List of Experiments

(Perform any eight experiments using MATLAB out of following)

1) Find the Response of the Discrete Time Control System for any two 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) Discretization of continuous time state equation.
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.

406263: Project Engineering and Management

Teaching Scheme **Examination Scheme**
Lectures: 04 Hrs / Week **Theory: 100 Marks**
Practical: 02 Hrs / Week **Term Work: 25 Marks**
Oral: 50 Marks

Unit I:
Concept study and definition of Project Engineering and Management,
Basics of Project Management, Degree of Automation, Organization Structure, Interdepartmental, Interorganisational and Multi agency interaction involved in Project and their co ordination Project statement. The Project team. Types of Project.

Unit II:
Project Management:
Project Management, Definition and scope of project, Technical design, Planning and Scheduling. Life cycle phases, Statement of work (SOW), Project Specification, milestone scheduling, Work breakdown structure.
Cost and estimation: Types of estimates, pricing process, salary overheads, labor hours, materials and support costs.
Program evaluation and review techniques (PERT) and Critical path method (CPM), S-curve concept and crash time concepts, software used in project management; software features, classification, evaluation and implementation.

Unit III:
Project engineering documents and drawing:
P & I diagram based on Process Flow Sheet, 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.

Unit IV:
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. Plant layouts and General arrangement drawing (Plans and Elevation), Isometric of instrument piping, Loop wiring diagrams, installation sketches of filed instrument, BOM and MBOM.

Unit V:
Procurement activities:
Vendor registration, Tendering and bidding process, Bid evaluation, Purchase orders, 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.

Unit VI:
Control centers and Panels: Types, Design, Inspection and Specification, Control room engineering, 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.

PRACTICAL (Any 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,

TEXT AND REFERENCE BOOKS:

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).

406264 Elective I

406264 A: Biomedical Instrumentation

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

Examination Scheme:
Theory: 100 Marks
Oral: 50 Marks

Unit 1

Biopotential Measurement:

Electrode-Electrolyte interface, half-cell potential, Polarization- polarisable and non-polarizable electrodes, Ag/AgCl electrodes, Electrode circuit model; motion artifact. Body Surface recording electrodes for ECG, EMG, and EEG. Internal Electrodes-needle and wire electrodes. Micro electrodes- metal microelectrodes, Electrical properties of microelectrodes. Electrodes for electric stimulation of tissue,
Selection & specifications for the bio transducers to measure parameters, Biosensors

Ergonomic Design:

Ergonomic science and its importance in medical Instrument Design: e.g. Dental chair/Operation Table.

Unit 2:

Cardiovascular System:

Heart Structure, Cardiac Cycle, ECG Theory, ECG Electrodes, Electrocardiograph, Vectorcardiograph
Analog Signal Processing of Biosignals, Amplifiers, Transient Protection, Interference Reduction, Movement Artifact Circuits, Active Filters, Rate Measurement, Averaging and Integrator Circuits, Transient Protection Circuits

Unit 3:

Cardiovascular Measurements:

Heart Sounds, Phonocardiography, Blood Pressure Measurement (Invasive and Noninvasive), Blood Flow meters: Magnetic, Ultrasonic, Thermal Convection Methods, Cardiac Output Measurement (dye dilution method), Plethysmography

Unit 4:

Central Nervous System :

Brain & its parts, different waves from different parts of the brain, brain stem, cranium nerves, structure of neuron, Neuro muscular transmission, Electroencephalography, Evoked Response, EEG amplifier, Biofeedback

Classification of muscles:

Muscle contraction mechanism, Myoelectric voltages, Electromyography (EMG)

Unit 5:

Special Senses:

I. **Ear:** Mechanism of Hearing, Sound Conduction System, Basic Audiometer; Pure tone audiometer; Audiometer system Bekesy; Evoked response Audiometer system, Hearing Aids

II. **Vision:** Anatomy of Eye, Visual acuity, (Errors in Vision,) Slit Lamp, Tonometer, ophthalmoscope, Perimeter.

Unit 6:

Respiratory Instrumentation:

Natural Process of Breathing, O_2 and CO_2 Transport, Regulation of Breathing, Spirometers, airflow measurement, Oxygenators-Bubble Type, Membrane Type , Ventilators

Electrical Safety:

Significance of Electrical Danger, Physiological Effect of Current, Ground Shock Hazards, Methods of Accident Prevention

Electrical safety codes & standards. Protection of patients, power distribution and equipment design

Practicals:

Students are expected to perform minimum 8 practicals from the list mentioned below

List of Practicals:

1 To Study and Check Specifications of an ECG Recorder.

2 Ergonomic consideration in medical equipment design e.g. Dental chair/Operation Table

3 To Measure Blood Pressure Using Sphygmomanometer, Calibration of BP apparatus

4 Study of Audiometer

5 To record/monitor heart sounds using Electronic Stethoscope

6 To Develop a Photo-plethysmography Sensor for Pulse Rate Measurement

7 To Develop a Flow Type Sensor Using Thermistor for Expiratory Volume Measurement

8 To Design a Notch Filter for Power Line Frequency

9 To Design and Implement an ECG Amplifier

10 To Implement a Heart Rate Meter

11 To Study EEG/EMG

12 To Study Ophthalmic instruments

Books:

1. Human Physiology- The Mechanism of Body Function By Vander, Sherman, TMH Ed.1981
2. Introduction To Biomedical Equipment Technology By Carr & Brown

3. Biomedical Instrumentation and Measurements By Cromwell, 2nd edition, Pearson Education.
4. Handbook of Biomedical Instrumentation By R. S. Khandpur, TMH
5. Biomedical Digital Signal Processing, Tompkins, PHI
6. Biomedical Instrumentation, Arumugam
7. Text book of clinical Ophthalmology- Ronald Pitts Crick, Pang Khaw, 2nd Edition, World Scientific publication. ISBN 981-238-128-7
8. "MEDICAL INSTRUMENTATION" by JOHN G WEBSTER
9. "HAND BOOK OF BIOMEDICAL ENGINEERING" by JACOB KLIME.

406264 B: Laser based Instrumentation

Teaching Scheme (6 Hrs/week) **Examination Scheme (150 marks)**
Lecture: 4 Hrs/week **Paper: 100 marks**
Practical: 2 Hrs/week **Oral: 50 Marks**

UNIT 1: LASER FUNDAMENTALS, LASER TYPES AND LASER SAFETY
Properties of laser, Laser modes- axial and transverse, single mode operation. Frequency stabilization. Mode locking, Mode hopping, Q-switching techniques.
Classes of lasers: Doped insulator lasers, Semiconductor lasers, Gas lasers, Liquid Dye lasers.
Laser safety: Biological effects, safety standards, risk of exposure, laser hazard classification and assessment, laser safety system, safe industrial laser laboratory, laser eye protection, laser accidents.

UNIT 2: LASER TELEMETERS
Three main techniques for optical measurement of distance: Triangulation, time-of-flight telemeter and interferometry. Pulse telemeter, Sine-wave telemeter, Imaging telemeter, the LIDAR.

UNIT 3: LASER INTERFEROMETRY AND SPECKLE PATTERN INSTRUMENTS
Laser Interferometry: Basic Optical Interferometers, Performance parameters, Ultimate limits of performance, Laser vibrometry- short distance, medium distance and long distance vibrometry. Injection Interferometry, white light Interferometry.
Speckle pattern instruments: Speckle properties, speckle in single point interferometers and electronic speckle pattern Interferometry.

UNIT 4: LASER DOPPLER VELOCIMETRY
Principle of operation, performance parameters: Scale factor relative error, Accuracy of the Doppler Frequency, Size of sensing region, alignment and positioning errors etc.
Electronic processing of the Doppler signal: Time domain and Frequency domain processing. Optical configurations.

UNIT 5: LASER GYROSCOPES
The Sagnac effect, Basic gyro configurations. Ring Laser Gyros (RLG): Dithered RLG, Ring Zeeman laser gyro, performance of RLG. Fiber Optics Gyros (FOG): Open loop FOG, Requirements on FOG components, technology to implement FOG, Closed loop FOG, the resonant FOG MEMS gyro, Piezoelectric gyro.

UNIT 6: HOLOGRAPHY
The basic principles of Holography, viewing a hologram, volume hologram, multiplex hologram, white light reflection hologram. Measurement of strain, stress, bending moments and vibration by Holography, nondestructive testing, medical and dental research, solid mechanics.

LIST OF EXPERIMENTS

The study is limited to continuous He-Ne laser and red diode laser (easy availability)

1. Current-intensity relationship of a diode laser.
2. To study effect of diode current on spectral bandwidth of diode laser.
3. Electrical modulation of laser intensity, frequency modulation, pulse-width modulation.
4. Measurement of beam width, coherence length, divergence angle and beam profile of a laser.
5. Measurement of polarization angle of Glucose solution (experiment on polarized laser light).
6. Measurement of refractive index of glass using diode laser (measurement of Brewster's angle).
7. Measurement of distance by time-of-flight laser telemeter.
8. Measurement of hair diameter using a laser (experiment on interference).
9. Michelson interferometer with laser.

BOOKS

1. Optoelectronics, J. Wilson, Prentice-Hall of India.
2. Electro-Optical Instrumentation, Silvano Donati, Pearson Education, Inc., 2004.
3. Holographic Interferometry, Charles M. Vest, John Wiley & sons, 1979.
4. Laser electronics, Joseph T Verdeyen, Prentice-Hall of India Pvt. Ltd., second edition, -1993.

406264 C: ADVANCED CONTROL SYSTEMS

Teaching scheme **Examination scheme**

Lectures : 4 Hrs / Week Theory : 100 Marks

Practical : 2 Hrs/ week Oral : 50 Marks

UNIT-1 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-2 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-3 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-4 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 selftuning regulators.

UNIT-5 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 6 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.

REFERENCE BOOKS

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.

LIST OF EXPERIMENTS

* Perform any eight experiments using MATLAB out of following

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.
6. Analysis of Multivariable systems using step input
7. Any one Industrial Application of model reference control-a Survey.
8. Design of state observer
9. Design of linear filter.

406264 D: BUILDING AUTOMATION-I

Teaching Scheme
Lectures: 04 hrs. /week
Practical: 02 hrs. /week

Examination Scheme
Theory: 100 marks
Oral: 50 marks

Fire Alarm System

UNIT I:
Fundamentals: What is Fire? Fire modes, History, Components, and Principles of Operation
FAS Components: Field Components, Panel Components, Applications.
FAS Architectures: Types of Architectures, Examples

UNIT II:
FAS loops: Classification of loops, Examples.
Power Supply design for FAS.
Cause & effect matrix: Examples

UNIT III:
Fire Standards: FAS Design procedure in brief, NFPA 72A, BS 5839, IS

Security Systems

UNIT IV:
Fundamentals: Introduction to Security Systems, Concepts
Access Control System: Access Components, Access control system Design.

UNIT V:
CCTV: Camera: Operation & types, Camera Selection Criteria, Camera Applications, DVR
Based system, DVM, Network design, Storage design.
CCTV Applications: CCTV Applications
UNIT VI: Perimeter Intrusion: Concept, Components, Technology, Advanced Applications Security Design: Security system design for verticals

Practicals:

1. 4 Practicals on FAS
2. 4 Practicals on Security Systems

Text and reference books:

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- Heinemann
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)

14. Fire Alarm Guide for Property Managers by Morawski, E.; ISBN: 1430306890 EAN: 9781430306894 Publisher: Kessinger Publishing (2007

Elective II

406265 A: Environment Instrumentation

Teaching scheme **Examination scheme**
Lectures : 4 Hrs / Week Theory : 100 Marks

Unit-1: 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-2:
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-3:
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-4:
Waste water monitoring: 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.

Unit-5:
Air pollution: definitions, energy environment relationship, importance of air pollution, air pollution from thermal power plant, their characteristics & control. Air sampling methods & equipments, analytical methods for air pollution studies. Control of air pollution.

Unit-6:
Air monitoring: measurement of ambient air quality.
Flow monitoring: Air flow measurement, gas flow, non-open channel flow measurement, open channel waste water flow measurement. Rain water harvesting: necessity, methods, rate of NGOs municipal corporation, Govt., limitations. Quality assurance of storage water.

References:

Water treatment technology - Walter J. Weber
Air pollution engineering – M. N. Rao & H. V. N. Rao
Air pollution control technology – Wark & Warner
Environmental Instrumentation & Analysis Handbook- Randy D. Down.

406265 B: Nano Instrumentation

Teaching Scheme: **Examination Scheme:**
Lectures: 4hrs/week Theory-100 Marks

Unit I: Physical Principles of Nanostructure and Nanomaterials
Physical Properties of Nanoscale Structures:
Energy subbands and Density of states in nanoscale structure, electron transport in a two dimensional electron gas, resistance of ballistic conductor,landauer formula, transmission probability calculation, electron tunneling ,resonant tunneling devices, coupled nanoscale structures and super lattices ,Columb blockade, Quantization of thermal conductance in ballistic nanostructures, non ballistic electron propagation.
Nanotechnology: Deposition technique for nanoscale devices, nanolithography, self assembly technique
Nanomaterials: nanoparticales, nanowires, nanomagnetic materials, nanostructerd surfaces

Unit II: Instrumentation for Nanoscale Electronics
MEMS and NEMS:
Micro and nanocantilevers, frequency analysis Micro and nanocantilevers,
Quality factor and noise of cantilevers, magnetic and optical actuation of cantilevers
Scaning probe instrumentation for nanoelectronics:
The Atomic force Microscope (AFM), scanning tunneling Microscopy, scanning near field optical Microscopy

Unit III: Carbon Nanotube Devices
Physical properties: band structure and band modulation, electrical properties of CNT's
CNT based electronic Devices: The CNT Transistor, CNT based field emission Devices junction, hetrojunction and quantum confined structure based on carbon nanotube, microwave devices based on carbon nano tube, CNT based NEMS

Unit IV: Spintronics
Physical Principle of Spintronic Devices:
Spin relaxation mechanism, spin injection, and spin detection,
Spontaneous Devices: spin filter, spin valve, spin pump, spin diode, spin transistor,
Spin based optoelectronic devices, spintronic computation

Unit V: Electronic Devices Based On Nanostructures
Nanoscale FET transistor:
Downscaling the MOSFET dimension up to few nm, the ballistic FET, Microscopic devices at room temperature, resonant tunneling devices and circuits
Single electron transistor and related devices

Unit VI: Nanotransducers:

Design of nanotransducers, nanomechanical elements, nanomechanical sensors,nanometer precision position measurement, electrically controlled nanoactuators, chemically driven nanoactuators, quantum dots and localjization of elementary Particles,nano switches ,molecular switches, and logic element, particle Emitting nanotransducers, magnetic nanotransducers, chemical nanoscale sensors and actuators,

Optics-optoelectronic devices based on nanowires, optoelectronic devices based on nanoparticles

Text Books:

1. Nanoelectronics: Principles and Devices
   Mircea Dragoman, Diniela Dragoman, Artech House, Boston (2006)
2. Nanotechnology:An introduction to nanostructuring technique
   Michael Kohler, Wolfgang fritzsche, Wiley –VCH (2007)

Reference Book:

1. Handbook of Nanotechnology, Bhusan (Editor)
   Springer, Berlin Heidelberg New York (2010)

406265 C: Advanced Digital Signal Processing

Teaching scheme **Examination scheme**
Lectures : 4 Hrs / Week Theory : 100 Marks

Unit- 1: Multi rate Signal Processing:
Sampling, sampling rate conversion, filter structures, poly phase decomposition, digital filter design using decimators and interpolators, multistage decimators and interpolators.
Unit- 2: Linear Prediction:
Introduction to random signals, discrete time random signals, Innovations representation of a stationary random process, forward and backward linear prediction, solutions of the normal equations.
Unit- 3: Spectral Estimation:
Introduction, energy density spectrum, estimation of auto correlation and power spectrum of random signals, DFT in spectral estimation, power spectrum- parametric methods and non- parametric methods.
Unit- 4: Adaptive Filters:
Introduction, examples of adaptive filtering, the minimum mean square error criterion, Recursive least square algorithm, FIR adaptive filters, convergence of LMS algorithm.
Unit- 5: Digital Signal Processor:
Introduction to fixed point and floating point DSP processor, Features of TMS 320c67xx DSP processor, architecture of TMS 320c67xx 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.
Unit- 6: Time- Frequency Analysis:
Fourier Transform: Its power and Limitations, Short Time Fourier Transform, The Gabor Transform, Discrete Time Fourier Transform and filter banks, Continuous Wavelet Transform, Discrete Wavelet Transform, Haar Wavelet, Daubechies Wavelet.

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 D: Automobile Instrumentation

Teaching Scheme
Lecture: 4 Hrs/week

Examination Scheme
Paper: 100 marks

Unit-1
Fundamentals of Automotive Electronics: Open loop and closed loop systems-components for electronic engine management, vehicle motion control, Current trends in modern Automobiles

Unit-2
Electronic Fuel Injection and ignition systems: Introduction, Carburettor control system, throttle body ignition and multi port or point fuel injection, Advantages of electronic ignition system, Types of solid state ignition systems and their principle of operation, electronic spark timing control system,

Unit-3
Engine control system: Engine cranking and warm up control, Acceleration enrichment – Deacceleration leaning and idle speed control, integrated engine control system, exhaust emission control system, Engine performance testing

Unit-4
Automobile chassis electronic control system: Principle of electronic braking, automatic transmission electronic control circuit, cruise control circuit, the electronic steering control theory, ABS, ASR, ESP, and other electronic control method

Unit-5
Auto Body Electronic Control Technology: Automotive central locking and anti-theft system control technology, electronically controlled windows and doors and airbag technology, principle of control circuit components and characteristics.

Unit-6
Ergonomics and safety: Driver information system, lighting system components, battery monitoring and control, Air conditioning, steering control techniques, Automatic gear control systems,
Emission standards.

Texts books:

1. *William B. Riddens, "Understanding Automotive Electronics", 5th Edition, (Butterworth Heinemann Woburn), (1998).*
2. *Tom Weather Jr and Cland C. Hunter, "Automotive Computers and Control System",Prentice Hall Inc. ,New Jeresy.*

Reference books:

1. *Jiri Marek, Hans Peter trah, "Sensers Applications, Sensers for Automotive Technology" 1st Edition , Wiley*
2. *T. Mellard, Automotive Electronic Systems" 1987 by Heinenmann Professional*

406266: Project Work

Teaching scheme	**Examination scheme**
Practical : 2 Hrs / Week	Oral : 50 Marks

The oral examination means a comprehensive viva on the project work done in the first semester. The head of the department shall constitute the committee of senior faculty members for this viva examination.

406267 Process Dynamics and Control

Teaching scheme
Lectures: 4Hrs. / Week
Practical: 2 Hrs. / Week

Examination scheme
Paper: 100 Marks
Oral: 50 Marks
TW: 25 marks

Prerequisites: Process Instrumentation, Process Loop Components, Power Plant Instrumentation, Control System Design, Digital Control

Unit 1

Introduction to process control. Dynamics and stability of controlled systems. Dynamic behavior of linear and non-linear first-and second-order systems. The development of mathematical models to describe process dynamic behavior.

Unit 2

The Dynamics and Control of Heat Exchangers

Basic control strategies, dynamics of the heat exchangers, response to changes in steam temperature, measurement lag and control schemes

Unit 3

The Dynamics and Control of Boilers

Boiler basic controls (safety interlocks, single element, two and three element level control, shrink, swell effect, inverse response, feed forward control of feed water, dynamic compensation, fuel–air ratio, stochiometric calculations, steam temperature and pressure control) Boiler dynamics, burner management system, boiler optimization

Unit 4

The Stability and Control of Chemical Reactors

Types of reactions and reactors (overview),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 5

Dynamic Behavior and Control of Distillation Column

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 6

- Dynamic behavior and controls required in pumps and compressors
- Design aspects and control scheme development for Waste-Water Treatment plant

*** Students are expected to perform minimum 8 experiments based on the above topics**

***For term work the assignments e.g.**

- Modeling and Designing control strategies of a typical process
- Process simulation: using MATLAB Simulink, Simulation of different process
- Problems based on stability, frequency response etc.

Text Books

- Process Control : Peter Harriott, TMH
- Handbook of Instrumentation : Process control : B.G.Liptak, Chilton
- Process Control Systems : F. G. Shinskey, TMH
- Chemical Process Control : George Stephonopolous, PHI
- Computer based Industrial Control :Krishna Kant, PHI
- Process Control: Modeling, Design and Simulation : B. Wayne Bequette, PHI

Reference Books

- Boiler Control Systems : David Lindsley, Mc GRAW-HILL
- Process Dynamics and Control : Dale E. Seborg
- Process Instrumentation and control Handbook :Considine

406268 Industrial Automation

Teaching Scheme
Lectures: 4/week
Practical: 2/week

Examination Scheme
Paper: 100Marks
Oral: 50 Marks

Unit: 1 Introduction to Industrial Automation, Plant wide control systems and Automation Strategy.

Introduction to Industrial Automation, Role of automation in industries, Introduction to the types of manufacturing industries, Introduction to type of automation system, Benefits of automation. Introduction to Automation pyramid, Introduction to automation tools like PAC, PLC, SCADA, DCS, Hybrid DCS with reference to automation pyramid, Comparison of PLC, PAC, and SCADA on the basis of Performance criteria Control system audit, Performance criteria, Development of User Requirement Specifications (URS) for automation. Functional Design Specifications (FDS) for automation tools.

Unit: 2 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: 3 PLC Configuration, Applications and Machine automation

PLC programming methods as per IEC 61131, Developing programs using Sequential Function Chart, Functional Block Diagram, Analog control using PLC (PID controller configuration), Interfacing PLC to SCADA/DCS using communication link (RS232, RS485) , Protocols (Modbus ASCII/RTU) and OPC, Development stages involved for PLC based automation systems.
Introduction Computer Numerically Controlled (CNC) Machines, Basic CNC Principle, servo control, types of servo control for motion axes, Control system of CNC, Introduction to G-code.

Unit: 4 Distributed Control System Basics

DCS introduction, Various function Blocks, DCS components/block diagram, DCS Architecture of different makes, comparison of these architectures with automation pyramid, DCS specification, latest trend and developments, DCS support to Enterprise Resources Planning (ERP), performance criteria for DCS and other automation tools.

Unit: 5 Distributed Control System s Engineering and Design

DCS detail Engineering, configuration and programming, functions including database management, reporting, alarm management, diagnosis, Historical database management, security and user access management, communication, third party interfaces ,control, display etc. Enhanced functions like Advance process control, fuzzy logic, ANN

Unit: 6 Process safety and Safety Management Systems

Introduction to process safety, risk, 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

Practicals

1. Preparing URS and FDS for any small automation project.
2. Prepare cause and effect document for any small process and also develop logic diagram for the same.
3. Develop and implement any PLC and/or DCS program using FBD and SFC programming language.
4. Interfacing of PLC to any SCADA through Modbus protocol and/or OPC.
5. Interfacing of PLC to a DCS system through Modbus and/or OPC.
6. Developing and implementing any control loop using PLC system.
7. Developing and implementing any control loop using DCS system
8. Developing and configuring Graphic User Interface for any control loop.
9. Configuration of any HART device to PLC and/or DCS system.
10. Configuration of any Foundation Fieldbus device to PLC and /or DCS system.
11. Configure and implement different alarms in PLC and/or DCS system.
12. Configuring and implementing any Advance process control function like MPC/or Fuzzy/or ANN in a DCS system
13. Preparing a HaZOp document for any small process
14. Develop a G-code for any machining process.

Students are expected to perform any 8 experiments.

Books:

1. The management of control system: Justification and Technical Auditing, N.E. Bhttiha, ISA
2. Computer aided process control, S.K.Singh, PHI.
3. Understanding Distributed Process Systems For Control, Samuel Herb, ISA.
4. Programmable Logic Controllers: Principles and Applications, Webb &Reis, PHI.
5. Introduction to Programmable Logic Controllers, Garry Dunning, Thomson Learning.
6. Distributed computer control for industrial automation, Ppovik Bhatkar, Dekkar Pub.
7. Computer Based Process control, Krishna Kant, PHI
8. Mechatronics ,HMT, TMH publication.

406269 Elective III

406269 A: ADVANCED BIOMEDICAL INSTRUMENTATION

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

Examination Scheme:
Theory: 100 Marks
Oral: 50 Marks

Unit 1:

Life Saving Devices:

Pacemaker, Types of pacemakers: External & Internal, Defibrillators: AC & DC Defibrillator, Heart Lung Machine,

Elements of Intensive Care Monitoring:

Drug Delivery System, ICU layout: organization

Operating Room Instrumentation:

Electro surgical Unit, Anesthesia Machine

Unit 2:

Clinical Lab Instrumentation:

Blood and its composition and function, Blood Cell Counters, Electrophoresis, Pulse Oximetry, Conventional and Automated, Auto analyzers**.**

Introduction to telemetry & Telemedicine, The Health Level 7 protocol-implementation block diagram.

Unit 3:

Imaging Systems:

X Ray properties, Generation of X-rays, block diagram of X- Ray machine, image intensifier, Draw back 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 4:

Advanced Imaging Systems:

Radionuclide Imaging: Rectilinear Scanner, Scintillation Camera, Positron Emission Tomography, Single Photon Emission Computed Tomography , Ultrasound Imaging: Fundamentals of Acoustic propagation, Ultrasonic transducers and frequencies, A, B, M Scan and Echocardiography, Introduction to MRI & Thermography.

Unit 5:

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

Pain relief Instrumentation:

Diathermy: short wave, Microwave, Ultrasound diathermy

Unit 6:

Concept of Rehabilitation Engineering:

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

Kidney Instrumentation:

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

Practicals:

Students are expected to study minimum 8 equipments by visiting Clinics /hospitals

List of equipments

1 Study of Endoscope
2 Study of Electrosurgical Unit (Operating Room)
3 Study of Various Imaging Techniques
4 Study of Pacemakers
5 Study of Defibrillators
6 Study of Clinical Lab Instruments
7 Study of Short Wave Diathermy
8 Study of Dialysis equipment
9 Study of Clinical Lab Instrumentation
10 Study of ECG Telemetry System
11 Study of Rehabilitation equipments
12 Study of Diabetic Retinopathy Treatment using Laser

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

406269 B: Fiber Optic Instrumentation

Teaching Scheme	Examination Scheme
Lecture: 4 Hrs/week	Paper: 100 marks
Practical: 2 Hrs/week	Oral: 50 Marks

UNIT 1

Light and Waveguiding: Nature of light, Waveguiding principles, dielectric waveguide total internal reflection, evanescent wave, acceptance angle, numerical aperture, skew rays, single mode fibers, types and classification of fibers, special fibers.

UNIT 2

A. Transmission characteristics of optical fiber: Attenuation, Material absorption losses, scattering losses, bending losses, intramodal and intermodal losses, overall fiber dispersion, and dispersion modified losses, polarization, nonlinear phenomena.

B. Optical fiber measurements: measurements of attenuation, dispersion, refractive index profile, fiber cutoff wavelength, numerical aperture, OTDR.

UNIT 3

1. **Optical sources for optical fiber:** Lasers, LEDs
2. **Optical detectors for optical fiber:** PN diode, pin diode, avalanche diode.
3. **Optical fiber connection:** Fiber alignment and joint loss, splices, connectors, couplers.

UNIT 4: OPTICAL FIBER SENSING PRINCIPLES AND TECHNIQUES I

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

UNIT 5: OPTICAL FIBER SENSING PRINCIPLES AND TECHNIQUES.II

A. Fiber grating technology and Fiber Bragg grating interrogation techniques.

B. Distributed Optical Fiber Sensing.

UNIT 6: OPTICAL AMPLIFICATION 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.

LIST OF EXPERIMENTS

1. To study attenuation losses in optical fiber.
2. To study dispersion losses in optical fiber.
3. To study different splicing techniques.
4. To study OTDR.
5. To study characteristic curves of optical sources and detectors.
6. To measure numerical aperture of an optical fiber.
7. To study optical power meter.
8. Design of an optical fiber sensor.

BOOKS

1. Optical Fiber Sensing Technology, Jose Miguel Lopez-Higuera, John Wiley & Sons, 2002.
2. Optical Fiber Sensors, John Dakin and Brian Culshaw, Artech house, 1997
3. Optical Fiber Communications, John M. Senior, Prentice Hall of India,3rd edition.
4. Optical Fiber Communications, Gerd Keiser, McGraw Hill, 3rd edition, 2000
5. Electro-Optics Handbook, Ronald W. Waynant and Marwood N. Ediger, McGraw Hill, 2nd edition, 2000.
6. Fiber Optics Communications, Harold Kolimbris, Pearson Education, 2004.

406269 C: Process Modeling and Optimization

Teaching Scheme
Lecture: 4 Hrs/week
Practical: 2 Hrs/week

Examination Scheme
Paper: 100 marks
Oral: 50 Marks

Unit-1
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, process models of some typical systems in differential equations form, Gravity flow tank, Tanks in series, Tanks in parallel, 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-2

Modeling of Mechanical, Chemical systems: Reaction dynamics, Modeling the chemical reactions, CSTR models, Plug flow reactor model, modeling of flash drum, distillation columns, evaporators, dryers, heat exchangers.

Unit-3

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-4

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 , robust nests doylt stein criterion, skogestad and morari method .

Unit-5

Basic Concepts of Optimization.

Continuity of functions, Convex and Concave functions, Convex Region, Extremum of the objective functions, quadratic approximation

Unit-6

Optimization of unconstrained functions. Numerical methods for optimizing a function of one variable , scanning and bracketing procedures, Newton, Quasi-newton and secant methods, region elimination method, polynomial approximation methods, Multidimensional problem, evaluation of unidimensional search methods, unconstrained multivariable Optimization, simplex method, direct methods, indirect methods, steepest descent method secant methods.

References:

1. W. L. Luyben, Process, Modeling, Simulation and Control for Chemical Engineers by McGraw Hill, 1973
2. Thomas 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.

List of Experiments:

* Perform any eight experiments from following

1. Analysis of first/second order system by using step and ramp input.
2. Obtaining mathematical modeling of electrical/ mechanical system by first principle.
3. Obtaining 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

406269 D: BUILDING AUTOMATION II

Teaching Scheme
Lectures: 04 Hrs. /week
Practical: 02 Hrs. / week

Examination Scheme
Theory: 100 marks
Oral: 50 marks

UNIT I:
Fundamentals: Introduction to HVAC, HVAC Fundamentals, Basic Processes (Heating, Cooling
etc)
Basic Science: Air Properties, Psychometric Chart, Heat Transfer mechanisms, Examples.
Human Comfort: Human comfort zones, Effect of Heat, Humidity, Heat loss

UNIT II:
Processes: Heating Process & Applications (I.e. Boiler, Heater), Cooling Process & Applications
(I.e. Chiller), Ventilation Process & Applications (I.e. Central Fan System, AHU, Exhaust Fans),
Unitary Systems (VAV, FCU etc).

UNIT III:
Control Theory: Instrumentation Basics, Field components & use, DDC & applications
Architecture: Honeywell Architecture, BMS Components

UNIT IV:
Control Panel: HVAC Control Panel, MCC Basics, Panel Components
Communication: Communication Basics, Networks, BACNet, Modbus, LON

UNIT V:
ASHRAE Symbols
Energy Management: Advantages of BMS, Energy Savings concept & methods, Lighting control, Building Efficiency improvement, Green Building (LEED) Concept & Examples

UNIT VI:
Project Life Cycle: IBMS (HVAC, Fire & Security) project cycle, Project steps BMS Verticals: Applications of BMS, Examples Integration: IBMS Architecture, Normal & Emergency operation

Practicals:

1. **4 Practicals on HVAC**
2. **4 Practicals on BMS**

Text and reference books:

1. Understanding Building Automation Systems (Direct Digital Control, Energy Management, Life Safety, Security, Access Control, Lighting, Building Management Programs) (Hardcover) by Reinhold A. Carlson , Robert A. Di Giandomenico.
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 . Building Automation Online by McGowan; McGowan, John J.; ISBN: 0824746155
5. HVAC Control in the New Millennium by Hordeski; Hordeski, Michael F.; Marcel Dekker;
ISBN: 0824709152 EAN: 9780824709150 Publisher: Fairmont Press (2001) 16
6. HVAC Control System Design Diagrams by Levenhagen, John I.; ISBN: 0070381291 EAN: 9780070381292 Publisher: McGraw-Hill Professional Publishing (1998)
7 . HVAC Controls and Systems by Levenhagen, John I.Spethmann, Donald H.
ISBN: 0070375097 EAN: 9780070375093 Publisher: McGraw-Hill Professional Publishing

406270 Elective IV

406271 A: Instrumentation for Agriculture

Teaching Scheme **Examination Scheme**
Lecture: 4 Hrs/week Paper: 100 marks

Unit 1: Necessity of instrumentation & control for agriculture, engineering properties of soil: fundamental definitions & relationships, index properties of soil, permeability & seepage analysis, shear strength, Mohr's circle of stress, active & passive earth pressures, stability & slopes, Sensors: introduction to sonic anemometers, hygrometers, fine wire thermocouples, open & close path gas analysers,brief introduction to various bio-sensors.

Unit 2: 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 3: Irrigation systems: necessity, irrigation methods: overhead, centre pivot, lateral move, micro irrigation systems & it's performance, comparison of different irrigation systems, soil moisture measurement methods: resistance based method, voltage based method, thermal based method, details of gypsum block soil moisture sensor, irrigation scheduling, irrigation efficiencies, design considerations in irrigation channels.

Unit 4: Application of SCADA for DAM parameters & control, irrigation control management up- stream & down - stream control systems, green houses & instrumentation: ventilation, cooling & heating, wind speed, temperature & humidity, rain gauge carbon dioxide enrichment measurement & control.

Unit 5: Automation in earth moving equipments & farm equipments, application of SCADA & PLC in packing industry and cold storage systems, implementation of hydraulic, pneumatic & electronics control circuits in harvesters cotton pickers, tractor etc. classification of pumps: pump characteristics, pump selection & installation.

Unit 6: Leaf area length evaportranspiration, temperature, wetness & respiration measurement & data logging, electromagnetic radiations photosynthesis, infrared & UV bio sensor methods in agriculture, agrometrological instrumentation weather stations, surface flux measurement, soil water content measurement using time-domain reflectrometery(TDR),ground water occurrence confined & unconfined aquifers, evalution of aquifer properties, ground water recharge.

References:

1. Industrial instrumentation, "Patranabis", TMH.
2. Instrumentation handbook-process control, "B.G.Liptak", Chilton

3. Process control and instrumentation technology, “C.D. Johnson”, PHI
4. Wills B.A., “ Mineral Processing Technology”, 4th Ed.,Pergamon Press

406270 B: Micro Electro Mechanical Systems

Teaching Scheme: **Examination Scheme:**
Lectures: 4hrs/week Theory-100-Marks

Unit 1: Introduction
Microsystems versus MEMS, Micro fabrication, Smart Materials, Structures and Systems, Integrated Microsystems, Applications of Smart Materials and Microsystems

Unit 2: Micro Sensors, Actuators, Systems and Smart Materials
Silicon Capacitive Accelerometer, Piezoresistive Pressure Sensor , Conductometric Gas Sensor, An Electrostatic Comb-Drive, A Magnetic Micro relay, Portable Blood Analyzer , Piezoelectric Inkjet Print Head, Micromirror Array for Video Projection Smart Materials and Systems

Unit 3: Micro Fabrication Technique
Silicon as a Material for Micromachining, Thin-Film Deposition, Lithography, Etching, Silicon Micromachining Specialized Materials for Microsystems, Advanced Processes for Micro fabrication

Unit 4: Modeling of Solids in Microsystems
The Simplest Deformable Element: A Bar, Transversely Deformable Element: A beam, Energy Methods for Elastic Bodies, Heterogeneous Layered Beams, Bimorph Effect, Residual Stresses and Stress Gradients, Poisson Effect and the Anticlastic Curvature of Beams, Torsion of Beams and Shear Stresses, Dealing with Large Displacements, In-Plane Stresses

Unit 5: Finite Element Method

a. Need for Numerical Methods for Solution of Equations

Variational Principles, Finite Element Method, Finite Element Model for Structures with Piezoelectric Sensors and Actuators, Analysis of a Piezoelectric Bimorph Cantilever Beam

b. Modeling of Coupled Electromechanical Systems
Electrostatics, Coupled Electromechanics: Statics and Stability and Pull-In Phenomenon, Dynamics, Squeezed Film Effects in Electromechanics

Unit 6: **Electronics Circuits and Control for Micro and Smart Systems**
a. Semiconductor Devices, Electronics Amplifiers, Practical Signal Conditioning Circuits for Microsystems, Circuits for Conditioning Sensed Signals, Introduction to Control Theory, Implementation of Controllers

b. Integration of Micro and Smart Systems
Integration of Microsystems and Microelectronics, Microsystems Packaging

Text Book-

1. **Micro And Smart Systems** by G.K. Ananthasuresh, K.J. Vinoy, S. Gopalakrishnan, K.N. Bhat, V.K. Aatre : Wiley, India (2010)

References-

1. **Smart Material Systems and MEMS**: Design and Development Methodologies: Vijay K. Varadan, K. J. Vinoy, S. Gopalakrishnan , John Wiley & Sons Ltd,
2. **The MEMS Handbook:** Edited by Mohamed Gad-el-Hak, University of Notre Dame, CRC Press LLC

406270 C: Digital Image Processing

Teaching scheme | **Examination scheme**
Lectures : 4 Hrs / Week | Theory : 100 Marks

Unit- 1:
Introduction to Digital Image Processing:
Digital image representation, fundamental steps in image processing, elements of digital image processing systems, hardware for image processing system, Characteristics of image digitizer, Types of digitizer, Image digitizing components, Electronic image tube cameras, solid state cameras, scanners.

Unit- 2:
Fundamentals of Digital Image Processing:
Elements of visual perception, a simple image model sampling and quantization some basic relationship between pixels, image geometry, Basic transformations, Perspective transformation, Camera model and calibration, stereo imaging.

Unit- 3:
Image Transforms:
2-D Fourier transform, Discrete cosine transform, Short time Fourier transform, Gabor transform, Radon transform.

Unit- 4:
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. Introduction to color image processing

Unit- 5:
Image Restoration:
Degradation model, diagonalization of circulate and block-circulate matrices, algebraic approach to restoration, inverse filtering, least mean square (wiener) filter, constrained least squared restoration, invractive restoration.

Unit- 6:
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, Classifiers.
Edge Detection: derivative operators: Sobel, Prewittt, Canny, second order derivative, line detection.

Reference Books

1. R. C. Gonzalez and R. E. Woods, "Digital Image Processing", Pearson Education Asia, 2002.
2. A. K. Jain, "Fundamentals of Digital Image Processing", Prentice Hall of India Pvt Ltd, New Delhi, India, 1989.
3. K. R. Castleman, "Digital Image Processing", Prentice-Hall International, 1996.
4. R. C. Gonzalez and R. E. Woods, "Digital Image Processing using Matlab", Pearson Education Asia, 2002.

406270 D: Open Elective

Teaching Scheme	**Examination Scheme**
Lectures: 04 Hrs / Week	Theory: 100 Marks

It is expected to offer this elective form other branch. If the college / Institute wish to start new elective in collaboration with Industry, they are required to approve the elective by 31 December from university.

406271: Project Work

Teaching Scheme	**Examination Scheme**
Practical: 06 Hrs / Week	Term work: 100 Marks
	Oral: 50 Marks

For the term work the head of the department shall constitute the committee of senior faculty members and it should be duly signed by external examiner. The oral examination means a comprehensive viva on the project work done.