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<td>UG  Rules and Regulations</td>
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INSTRUMENTATION AND CONTROL ENGINEERING

S.Y. B. Tech.
Effective from 2008-09
### I-Semester

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### II-Semester

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### CURRICULUM STRUCTURE THIRD YEAR - B.TECH
(Effective From 2009-10)

#### I-Semester

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CURRICULUM STRUCTURE – FINAL YEAR B. TECH
(Effective from 2010-11)

I-Semester

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II-Semester

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IE 401  PROCESS INSTRUMENTATION

**Teaching Scheme**

Lectures : 3 hrs/week

**Examination Scheme**

Mid-Sem - 30
Assignments, Quiz - 20
End-Sem Exam - 50

**Unit 1**

**Process Characteristics**
Types of processes (dead time single & multi capacity, self & non-self regulating, interacting & non-interacting, Linear & non-linear), Process gain, process reaction curve, process time constant & constant step analysis method for finding time constant, dead time, dynamic elements in control loops, PID control of processes, Process simulator.

**Unit 2**

**Analysis & properties of some common loops**
Flow, pressure level, temperature, composition, pH etc., linear & non-linear controllers, review of PID with limitations (offset, saturation in D, & reset windup) rate before reset, PID variations & tuning, digital controller(position & velocity algorithms, effect of sampling time) hardware structures, features & specification, single loop & multi loop controller & the application programs (PID, Timer, counter, dead time, lead lag, linearise, add-subtract-muti-div. of two input signals temp, pressure compensation of gas flow, sq. root, median selector, pattern program, radio set, adaptive gain, feed forward, valve lineariser etc.) non-linear controller-two state, three state, proportional time, dual mode optimal switching.

**Unit 3**

**Multi loop & multivariable process control systems**

**Unit 4**

**Control Systems for various processes**
Development of control loops, Design aspects and selection criterion for filed instruments and instrumentation scheme for boiler, compressors, pumps, chiller, evaporators, dryer, cooling tower, distillation column, CSTR.

**Unit 5**

**Development of control loops**
Unit 6

Control valve design
Designing control valve for gas, vapor, and liquid. Effects and remedies of cavitations, flashing condition, noise, control valve linearizer, valve auxiliary parts, flow characteristics of valve control effects of load changes, high pressure & high temperature service, control valves, installed range ability & viscosity correction for control valve. Control valve application & selection, valve sizing by ANSI/ISA-S-75.01 std. valve capacity & testing by ANSI/ISA-S-75.02 std. Control valve seat leakage, Valve noise calculation & reduction method, Smart valve package. Intelligent-smart actuators, design considerations for actuators (solenoid, pneumatic, hydraulic, digital field bus actuators). Design of orifice plates and related international standards.

Text Books
• Process Control Systems by F. G. Shinskey, TMH.
• Process Control by B. G. Liptak
• Computer based Industrial control by Krishna Kant, PHI
• Feedback controllers: Tuning, Applications & Design by F. G. Shinskey, TMH, 4th ed.
• Process Control Instrumentation. D. Johnson, PHI.

Reference Books
• Batch Control, T.G. Fisher, ISA.
• Distillation column control ISA Publication
• ISA Handbook of Control Valves.
• Process Instrumentation and control Handbook by Considine, MGH.
• Continuous Process Control, ISA.

IE 402 PROJECT ENGINEERING AND MANAGEMENT

Teaching Scheme
Lectures : 2 hrs/week

Examination Scheme
Mid-Sem -30
Assignments, Quiz -20
End-Sem Exam-50

Unit 1
Definition of project purpose, scope, time, quality and organization structure. Basic and detailed engineering: Degree of automation, Project S curves, manpower considerations, inter-department and inter organization interactions, Multi agency interaction. Types of projects and types of contracts e.g. EPC, BOOT etc.

Unit 2

**Unit 3**

(07)


**Unit 4**

(07)

Procurement activities: Vendor registration, tendering and bidding process, bid evaluation, purchase orders, vendor documents, drawings and reports as necessary at above activities. Construction activities: Site conditions and planning, front availability, installation and commissioning activities and documents require/generated at this stage. Factory Acceptance Test (FAT), On-site inspection and testing (SAT) installation sketches, bill of material, Quantity surveying, contracting, cold commissioning and hot commissioning, CAT (Customer Acceptance Test), performance trials and final hand-over.

**Unit 5**

(07)

Management functions: Controlling, directing, project authority, responsibility, accountability, interpersonal influences and standard communication formats, project reviews. Project planning and scheduling, life cycle phases, the statement of work (SOW), projects specifications, bar charts, milestones, schedules, work breakdown structures, cost breakdown structures and planning cycle.

**Unit 6**

(07)
Cost and estimation: Types and estimates, pricing process, salary and other overheads, man-hours, materials and support costs. Program evaluation and review techniques (PERT) and critical path method (CPM), estimating activity time and total program time, total PERT/CPM planning crash times, software's used in project management.

Text Books
- Applied instrumentation in process industries by Andrew and Williams, Gulf publishing.
- Project management: A systems approach to planning Scheduling and Controlling by Harlod Kerzner, Van Nostrand, Reinhold publishing.

Reference Books
- Management systems, John Bacon, ISA.
- Batch control systems, T.G. Fisher, ISA.
- Instrument installation project management, ISA.

IE 403 INDUSTRIAL AUTOMATION

Teaching Scheme

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<tr>
<th>Unit 1</th>
<th>Unit 2</th>
<th>Unit 3</th>
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<tr>
<td>Plant wide Control Systems and Automation Strategy</td>
<td>Advance Applications of PLC and SCADA</td>
<td>Instrumentation Standard Protocols</td>
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Examination Scheme

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Unit 1

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

Unit 2

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 3

Instrumentation Standard Protocols
HART Protocol introduction, frame structure, programming, implementation examples, Benefits, Advantages and Limitations. Foundation Fieldbus H1 introduction, structure, programming, FDS configuration, implementation examples, Benefits, Advantages and Limitations. Comparison with other fieldbus standards including Device net, Profibus,
Controlnet, CAN, Industrial Ethernet etc.

Unit 4  (07)

Distributed Control Systems Basics
DCS introduction, functions, advantages and limitations, DCS as an automation tool to support Enterprise Resources Planning, DCS Architecture of different makes, Latest trends and developments.

Unit 5  (07)

Distributed Control Systems Engineering and Design
DCS detail engineering, 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 support, Security and Access Control etc. Performance Criteria for DCS and other automation tools.

Unit 6  (07)

Application development and Automation for industry verticals
Application development and automation for following industries - Power, Water and Waste Water Treatment, Food and Beverages, Cement, Pharmaceuticals, Automobile and Building Automation.

Text Books
• Distributed Computer Control for Industrial Automation by PoppovikBhatkar, Dekkar Publications.
• Programmable Logic Controllers: Principles and Applications by Webb and Reis, PHI.
• Computer Aided Process Control by S.K.Singh, PHI
• Introduction to Programmable Logic Controllers by Garry Dunning, Thomson Learning.

Reference Books
• The Management of Control System: Justification and Technical Auditing, by N.E.Battikha, ISA
• Computer Based Process Control by Krishna Kant, PHI

IE 404 - 1  MEDICAL INSTRUMENTATION

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
Mid-Sem - 30
Assignments, Quiz -20
End-Sem Exam- 50

Unit 1  (06)
Biopotential measurement, Cell Structure, Basic Cell functions, Origins of bio-potentials, electrical activity of cells, biological Control Concept, Electrode-electrolyte interface, Half cell Potential, Polarisable and nonpolarisable electrode, Electrode circuit model, Body surface recording electrodes for ECG, EMG and EEG, internal electrodes - needle and wire electrodes, electrodes for electric stimulation of tissue, Various biomedical transducers.

Unit 2 (08)
Central Nervous systems - Receptors, sensory pathways and motor systems, processing sensory information, neural, neuromuscular, sensory muscular and sensory measurements, biofeedback, evoked response, electroencephalography (EEG), EEG amplifier. Classification of muscles - Muscle contraction mechanism, Myoelectric voltages, Electromyography (EMG).

Unit 3 (08)
Cardio-vascular system - structure of heart, rhythmicity, pacemaker cell, ECG theory, ECG electrodes, Electrocardiograph, vector cardiograph. Bio-signal amplifiers and signal processing, basic requirement, Op-amp circuit, transient protection, interference reduction circuits, active filters, rate measurement, averaging and integrator circuits, Examples of physiological signals and systems including feedback systems.

Unit 4 (07)
Cardiovascular Measurements and therapeutic devices Heart sound, Phonocardiography, Blood pressure measurement (invasive and noninvasive), Blood flow meter - Magnetic and ultrasound, Cardiac Output measurement, Plethysmography. Life saving devices pacemakers and defibrillators, heart lung machine.

Unit 5 (08)

Unit 6 (08)
Biomaterials - Structure and property relationships in materials, ceramics and polymers, Interactions of materials with the human body, composite materials concepts and applications, Implementation problems - inflammation, rejection, corrosion, structural failure.

Text Books
- Introduction to Biomedical Equipment Technology by Carr and Brown, Pearson LPE.
- Medical Instrumentation Application and Design by John G. Webster, John Wiley & Sons Pvt. Ltd.
- Biomedical Instrumentation and Measurements by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Pearson Education.
IE 404 - 2  POWER PLANT INSTRUMENTATION

Teaching Scheme

Lectures : 3 hrs/week

Examination Scheme

Mid-Sem - 30
Assignments, Quiz -20
End-Sem Exam- 50

Unit 1  
(07)
Power plant: Unit, overview, Types of boiler, Exhaust Gas Boilers and Incinerators, turbine generators, condensers, material handling systems. Comparison of thermal power plant, hydroelectric power plant, Nuclear power plant, solar power plant, Wind power plant.

Unit 2  
(07)
Boiler Instrumentation: Control and optimization, Combustion control, air to fuel ratio control, 3-element drum level control, steam temperature and pressure control, oxygen/CO2 in flue gases, furnace draft, boiler interlocks, sequence event recorder, supervisor control, data acquisition controls, burner management systems and controllers. Start-up and shut-down procedures, Boiler safety standard, Boiler inspection procedures. Boiler load calculation, boiler efficiency calculation.

Unit 3  
(07)
Instrumentation for Boiler ancillaries viz. water treatment, electro-static precipitator, soot blower, economizer, de aerator, super heater, chemical dosing systems, air pre-heater, coal and ash handling systems, fuel storage and distribution, Bag House Filters.

Unit 4  
(07)
Turbine instrumentation and control, start-up and shut-down, thermal stress control, condition monitoring & power distribution instrumentation. Synchronous, Induction generators

Unit 5  
(07)

Unit 6  
(07)
Power Generation using non-conventional energy sources viz. Wind Power, solar Power,
Diesel Generator Controls.

Text Books
- Energy Technology Handbook by Considine D.M., MGH
- Process Control by B.G. Liptak
- Solar Energy Technology Vol. I & II by Dickson & Chereminoff (Dekker)
- Efficient Boiler Operation source book by Payane & Thompson

Reference Books
- Computer Based Industrial control by Krishna Kant, PHI.
- Distributed Computer Control for industrial Automation by Bhatkar, CRC press.

IE 405 1 DIGITAL CONTROL

Teaching Scheme

Lectures : 3 hrs/week

Examination Scheme

Mid-Sem - 30
Assignments, Quiz - 20
End-Sem Exam - 50

Unit 1 (07)
Configuration of basic digital control system, discrete transfer function, discrete model sampled data systems using z-transform, transfer function model, signal analysis and dynamic response, zero-order hold equivalent, introduction to first-order-hold equivalent, transformation between ‘s’, ‘z’, ‘w’ plane, Stability analysis and Jury’s stability criterion.

Unit 2 (08)
Design using transform techniques: Root locus and frequency domain analysis compensator design.

Unit 3 (08)
Control system analysis using state variable method, vector and matrices, state variable representation, conversion of state variable to transfer function and vice versa, conversion of transfer function to canonical state variable models, realization using companion-I and II, Jordan canonical form, solution of state equations.

Unit 4 (07)
Design using state-space methods: controllability and observability, control law design, pole placement, pole placement design using computer aided control system design (CACSD), observer design.

Unit 5 (06)
Stability improvement by state feedback, digital controller for deadbeat performance.

Unit 6 (06)
Case study: Design of different digital control system design with CACSD.
Text Books
- K. Ogata; Discrete Control Systems, PH, 2nd ed.

Reference Books
- Digital Control Systems vol. I & II - Isermann, Narosa publications
- Designing Linear and Non linear Control Systems with MATLAB- K. Ogata, PHI, MATLAB curriculum series

IE 405 - 2 AUTOMOTIVE INSTRUMENTATION

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
Mid-Sem - 30
Assignments, Quiz -20
End-Sem Exam - 50

Unit 1

(05)

Current trends in automobiles with emphasis on increasing role of electronics and software. Overview of generic automotive control ECU functioning. Overview of typical automotive subsystems and components.

Unit 2

(05)

Engine Management Systems: Basic sensor arrangement, types of sensors such as oxygen sensors, crank angle position sensors, Fuel metering/ vehicle speed sensors, Flow sensor, temperature, air mass flow sensors, Throttle position sensor, solenoids etc. Algorithms for engine control including open loop and closed loop control system, electronic ignition, EGR for exhaust emission control.

Unit 3

(05)

Vehicle Power Train and Motion Control: Electronic Transmission Control, Adaptive Power Steering, Adaptive cruise control Safety and comfort systems Anti-lock braking, Traction Control and Electronic Stability, Active suspension control.

Unit 4

(07)

Body electronics including lighting control, remote keyless entry, immobilizers etc. Electronic instrument clusters and dashboard electronics. Aspects of hardware design for automotive including electro-magnetic interference suppression, Electromagnetic compatibility etc.

Unit 5

(07)
Automotive Standards and Protocols: Automotive standards like CAN protocol, Lin Protocol, Flex Ray, OBD-II etc. Automotive standards like MISRA.

**Unit 6**

Hardware in loop testing of automotive ECU using available software/hardware platform. Simulation of engine control, adaptive cruise control etc.

**Text Books**


**Reference Books**


### IE 406  PROCESS INSTRUMENTATION LABORATORY

**Teaching Scheme**

| Practical: 2 hrs/week |

**Examination Scheme**

| Practical: 50 |

**List of Experiments:**

1. Study & analysis of flow, pressure, and level control loop (Analysis includes process parameters such as type of process, dead time, capacity etc.)
2. Implementation of cascade controller.
3. Design & implementation of feed-forward controller.
4. Design of orifice plates as per BS1042 / ISO 5167
5. Control loop design for Power, Water and Waste Water Treatment, Food and Beverages (any one)
6. Control loop design for Cement, Pharmaceuticals, Automobile and Building Automation (any one)
7. Designing of control valve for liquid/gas/vapor applications.
8. Design of pneumatic or electric actuator.

### IE 407  PROJECT ENGINEERING AND MANAGEMENT LABORATORY

**Teaching Scheme**

| Practical: 4 hrs/week |

**Examination Scheme**

| Oral: 50 |
List of Experiments:
Preparation of project document of typical process:
1. Study of standards & Symbols
2. Study of Specification sheets
3. P&I diagram of typical process.
4. Wiring diagram.
5. Cable scheduling.
6. GA & Mimic diagram of control panel.
7. Control diagrams of typical process unit. (e.g. boiler, heat exchanger, distillation column etc)
8. Experiments on engineering software packages & management software’s.
9. Preparation of Inquiry, Quotation, Comparative statement, Purchase orders, SAT, FAT & CAT. Inspection reports for control panel or transmitter control valve/ recorder.

IE 408 - 1 MEDICAL INSTRUMENTATION LABORATORY

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Practical: 50

List of Experiments:
1. Design and Implementation of ECG and EEG Simulator.
2. Design and Implementation of ECG amplifier.
3. Design and Implementation of EEG amplifier.
4. Design and implementation of Instrumentation amplifier.
5. Design and implementation of Heart Rate Meter.
6. Design and implementation of Digital BP meter.
7. To study various blood Pressure Measurement techniques.
8. To calibrate the Blood Pressure apparatus.
9. To study the ultrasonic Blood Flow meter.
10. To study the ECG Recorder and determine its time constants. Also study the design aspects of ECG Recorder.
11. To design and implement the pacemaker simulator. Also study the design aspects of Pacemaker.
12. To design and implement the Defibrillator Simulator. Also study the design aspects of Defibrillator.
13. To study EMG machine
14. To study the PC Based ECG and EEG analysis System.

IE 408 - 2 POWER PLANT INSTRUMENTATION LABORATORY

Teaching Scheme
Practical: 2 hrs/week

Examination Scheme
Oral: 50
**List of Experiments:**

1. Study of Hydro-electric power plant.
2. Study of electrical sub-station.
3. Study of thermal power plant.
4. Study of Nuclear power plant.
5. Study of solar power plant.
7. Design and development of interlocks and safety system for thermal power plants.
8. Design of boiler automation using DCS and PLC.

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**IE 409 - 1 DIGITAL CONTROL LABORATORY**

**Teaching Scheme**

Practical : 2 hrs/week

**Examination Scheme**

Practical: 50

**List of Experiments:**

All experiments are to be design with CACSD

1. Analysis of continuous and discrete control system.
2. Study of Jury’s stability criterion and analysis.
3. Digital controller design with root locus techniques.
4. Digital lead controller design with frequency domain techniques.
5. Digital lag controller design with frequency domain techniques.
6. Digital controller design with pole placement method.
7. Observer design.
8. Simulation of any digital control system based on unit 6.

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**IE 409 - 2 AUTOMOTIVE INSTRUMENTATION LABORATORY**

**Teaching Scheme**

Practical : 2 hrs/week

**Examination Scheme**

Practical: 50

**List of Experiments:**

Study of two stroke and four strike engine

1. Study of different ECU (Fuel Injection system, ABS, Battery management)
2. Design and development of firing angle detection system
3. Design and development of digital speedometer
4. Study and designing of fuel ratio monitoring system
5. Study and designing of fuel indication system
6. Study and development of algorithm for ABS
7. Study and development of control algorithm (Fuzzy or PID) for fuel injection system or electronic steering.
**IE 410 SEMINAR**

**Teaching Scheme**
Practical: 2 hrs/week

**Examination Scheme**
Term work: 50

The Term-work will consist of report prepared by every student on the seminar topic allotted to them and power point presentation. The student is expected to submit the seminar report in standard format.

**IE 411 PROJECT DESIGN**

**Teaching Scheme**
Practical: 2 hrs/week

**Examination Scheme**
Term work: 100

**Prerequisite:**
Students have to finalize their project title based on Industrial Assignments.

The projects selected should be such so as to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The term work will consist of a report prepared by the student on the project allotted to them. It may be based (i) Entirely on study and analysis of a typical Instrumentation and Control System, (ii) Experimental verification, or (iii) Design, fabrication, testing and calibration of an Instrumentation system. The students are required to submit the report based on project work done.

**IE 412 PROCESS MODELING AND OPTIMIZATION**

**Teaching Scheme**
Lectures: 3 hrs/week

**Examination Scheme**
Mid-Sem - 30
Assignments, Quiz - 20
End-Sem Exam - 50

**Unit 1**

**Unit 2**
Kinetics & Reactors: rate equations for simple first, second & third reactions, in batch reactors, their integrated forms in convention & concentration units, their integrated forms simulations, consecutive, chain & complex order, systems. Effect of different feed
concentration. Reactors - batch, semi batch, continuous stirred flow & recycle. Types of simple first & second order reactions, steady state unsteady state reactors, Batch CSTR and PFR reactors in series and in parallel for different reactor combinations. Temperature control in flow and non-flow reactors and isothermal and adiabatic reactors.

Unit 3
Equipment cost, operational and capitalized costs, time, value of money, profitability, Application of these concepts to thermal insulation, rate of production, cyclic and semi cyclic operations like plate and frame filter press, continuous filtration, distillation, evaporators, modeling of heat exchanger, compressor. Process identification: Purpose, time domain fitting of step test data, sine wave testing, pulse testing, step testing and on-line identification.

Unit 4
Optimization techniques and applications: Single and multivariable optimization, line programming, sequential quadratic programming and reduce gradient optimization techniques and application. Introduction to geometric programming and dynamic programming.

Unit 5
Intelligent/Advanced Process Controllers: Model Based controllers (self-tuning & Model reference Adaptive Controller), Optimal Controller using Kaman filter, Model Predictive Controller,

Unit 6
Expert systems & expert controllers (AI based), Fuzzy Controllers, Artificial Neural networks & ANN Controller, Neuro-Fuzzy Control System, Neuro-MPC.

Text Books
- Azriel Rosenfeld, Avinash C. Kak; Digital picture processing, CRC.
- Rafael C. Gonzalez, Richard E. Woods; Digital image processing, PHI.

Reference Books
- F. G. Shinskey; Process Control Systems (TMH).
- B. G. Liptak; Process Control.
- Krishna Kant; Computer based Industrial control (PHI).
- G. Stephanopulous; Chemical Process Control, PHI.
- W.L. Luyben; Process modeling; simulation & control for chemical engineers, McGraw Hill.
- Edagar & Himmelblau; Optimization of Chemical process, McGraw Hill.
- J. Malley; Practical Process Instrumentation & Control, PHI.
- Deo Narsingh; System simulation with digital Computer, TMH.

IE 413 OPERATING SYSTEMS AND NETWORKING
Teaching Scheme

Lectures: 3 hrs/week

Examination Scheme

Mid-Sem - 30
Assignments, Quiz - 20
End-Sem Exam - 50

Unit 1

Introduction to the principles of operating systems and concurrent programming. Operating system services, file systems and organization, resource management, synchronization. Memory management, I/O subsystem. The concept of a process; process cooperation and interference. Introduction to networks, and protection and security.

Unit 2


Unit 3

Introduction to Real-Time /Embedded Operating Systems. Real Time Scheduling, Performance Metrics of RTOS, Linux & RTLinux Internals, Programming in Linux & RTLinux, Configuring & Compiling RTLinux, Overview of other RTOS/EOS.

Unit 4

Introduction to computer networks and transmission media: Types of networks, topologies, centralized and distributed networks, Overview of wireless networks, Internet, Design Issues, Layered architecture, Protocols. Overview of network models - ISO OSI and TCP/IP. Physical Layer: Max data rate of Channel, Transmission media-guided and unguided and their types with specifications; Modems and Protocols used; Multiplexing techniques; Circuit switching, Message Switching, Packet switching networks; Cable TV and Internet over Cable.

Unit 5

Data link layer (LLC and MAC sub layer): Framing, Error control, Flow control, Simplex Stop and Wait Protocol, Sliding Window Protocols, Data Link layer in Internet, HDLC, PPP, SLIP, Static and Dynamic Channel Allocation in LAN, CSMA/CD Protocols, Collision free protocols, WDMA protocol, IEEE 802 standards for Ethernet, token bus and token ring, DQDB. Bridges, High speed LANs (Fast Ethernet, gigabit Ethernet and FDDI)
Unit 6

Network Layer and Transport Layer:- Virtual Circuits and Datagram networks, Circuit switching and Packet Switching, Routing Algorithms, Routers and Routing Protocols, Congestion Control and Algorithm (Issues like delay, load, throughput, jitter etc), IP layer of TCP/IP, ICMP, ARP, RARP, Transport layer services and principles, Connectionless v/s connection oriented services, UDP and TCP, Quality of Service, Introduction to sockets and socket programming. Application Layer:- Introduction to Cryptography, Secret key and public key algorithm, Security issues for Intranet and Internet, DNS (Domain name System), Electronic mail, World wide Web, FTP, Telnet, SNMP.

Text Books
• [T Vishwanathan] Telecommunication switching systems and Networks; PHI
• [Andrew Tanenbaum] Computer networks, Prentice Hall

Reference Books
• [Kurose/Ross] Computer Networking: A Top-Down Approach Featuring the Internet, Addison-Wesley
• [D. Comer] Computer Networks and Internet/ TCP-IP.

IE 414 - 1 CLINICAL ENGINEERING

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
Mid-Sem - 30
Assignments, Quiz -20
End-Sem Exam- 50

Unit 1
Respiratory Instrumentation

Natural process of Breathing, O₂ and CO₂ transport, regulation of breathing, Spirometer, airflow measurement, Oxygenators-Bubble type, membrane type, Gas analyzers, Ventilators.

Unit 2
Clinical Lab Instrumentation

Operation Room Instrumentation

Electrosurgical Unit, Anesthesia machine, Operation table, Autoclave Elements of Intensive care unit, Bedside monitor, Drug delivery system, Lithotripsy, ICU Layout. Introduction to telemetry and telemedicine.

Unit 4
Electrical Safety

Significance of electrical danger, Physiological effects of electrical current, ground shock hazards, methods of accident prevention, Safety standards.

Unit 5
Concept of Rehabilitation Engineering

Orthotics and Prosthetic devices, overview of various orthotics and prosthetic devices materials, Wheelchair – Types, Materials used in wheelchair, Joysticks used in wheelchair.

Artificial Organ – e.g. Artificial Kidney, dialysis system.

Unit 6
Imaging systems

X-rays, Image intensifiers, CT scanner, Ultrasound scanner, nuclear methods, Thermography, MRI.

Text Books
• Medical Instrumentation Application and Design by John G. Webster, John Wiley & Sons Pvt. Ltd.
• Biomedical Instrumentation by Dr. M. Arumugam, Anuradha Publishers, 1992.
• Biomedical Instrumentation and Measurements by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, Pearson Education.
• Handbook of Biomedical Instrumentation by R. S. Khandpur, TMH.
• Medicine and Clinical Engineering by Jacobsons and Webster, PHI.

Reference Books
• Human Physiology – The Mechanism of Body Functions by Vander, Shermen, TMH
Teaching Scheme
Lectures: 3 hrs/week

Biomedical Digital Signal Processing by Tompkins, PHI

Examination Scheme
Mid-Sem – 30
Assignments, Quiz -20
End-Sem Exam- 50

Unit 1 (07)
Introduction to Batch Control System, Batch Control system terminology, Characteristics of Batch Processes, Hierarchical Batch Model, Control structure for batch systems.

Unit 2 (07)
Role of standards in batch control systems, study of International Standards and Practices such as S 88, S 95, USA FDA regulation, 21CFR 11, etc. General control requirements, safety interlocking.

Unit 3 (07)
Discrete and regulatory control of batch processes, sequential control of batch processes, batch management and recipe management, and production scheduling.

Unit 4 (07)
Batch control system design, system requirements, system hardware/reliability requirement.

Unit 5 (07)
Batch control system specifications and implementation, Information/display requirements, cost justification and benefits, data management.

Unit 6 (07)
Case study of batch control system implementation for applications in food and
beverages, pharmaceuticals, etc.

Reference Books
• Batch Control System by T.G.Fisher, ISA series

IE 415 - 1 ROBOTICS

Teaching Scheme
Lectures : 3 hrs/week

Examination Scheme
Mid-Sem - 30
Assignments, Quiz -20
End-Sem Exam - 50

Unit 1
Robot Arm Kinematics and Dynamics The Direct Kinematics Problem, The inverse Kinematics Solution, lagrange-Eular Formulation, Newton-Euler Formation, Generalized D’Alembert Equations of Motion.

Unit 2
Planning of manipulator Trajectories, General Considerations on Trajectory Planning, Joint-interpolated Trajectories, Planning of Manipulator Cartesian path Trajectories.

Unit 3
Control of Robot Manipulators: Control of the Puma Robot Arm, Computed Torque technique, Near-Minimum-Time Control, Nonlinear Decoupled Feedback Control, Resolved Motion Control, Adaptive Control.

Unit 4
Sensing, Range Sensing, Proximity Sensing, Touch Sensors, Force and Torque Sensing.

Unit 5

Unit 6
Higher - Level Vision
Segmentation, Description, Segmentation and Description of Three-Dimensional Structures, Recognition, Interpretation, Concluding Remarks, References, Problems.
Text Books
• KS. Fu, R.C. Gonzalez, C.S.G. Lee; Robotics, McGraw – Hill.

Reference Books
• John J. Craig, Introduction to Robotics, Pearson Education.
• Richard D. Klafter, Michael Negin; Robotic Engineering An Integrated Approach, PHI.

IE 415 – 2 BUILDING AUTOMATION

Teaching Scheme
Examination Scheme
Lectures : 3 hrs/week
Mid-Sem – 30
Assignments, Quiz -20
End-Sem Exam- 50

Unit 1
Introduction
Introduction, concept and application of Building Management System and Automation. Requirements and design considerations and its effect on functional efficiency of building automation system.

Unit 2
HVAC system
Different components of HVAC system like heating, cooling system, chillers, AHUs, compressors and filter units and their types. Design issues in consideration with respect to efficiency and economics. Concept of district cooling.

Unit 3
Access Control & Security System
Concept of automation in access control system for safety. Manual security system. RFID enabled access control with components like active, passive cards, controllers, antennas.

Unit 4
Fire & Alarm System
Different fire sensors, smoke detectors and their types. CO and CO2 sensors. Fire control panels. Design considerations for the FA system. Concept of IP enabled Fire & Alarm system.

Unit 5
CCTV System & Energy Management System
Components of CCTV system like cameras, types of lenses, typical types of cables, controlling system. Concept of energy management system, occupancy sensors, fans & lighting controller.
Unit 6

PA System & EPBX System

Components of Public Access System like speakers, Indicators, control panels, switches. Design aspects of PA system. Design consideration of EPBX system and its components. Integration of all the above systems to design a total building management system.

Text Books and Reference Books

- Barney Capehart, ‘Web Based Enterprise Energy and Building Automation Systems’, C.E.M, Editor
- Paul Ehrlich, ‘What is an Intelligent Building?’, Building Intelligence Group

IE 416 PROCESS MODELING AND OPTIMIZATION LABORATORY

Teaching Scheme

Practical: 2 hrs/week

Examination Scheme

Oral: 50

List of Experiments:

1. Mathematical modeling and simulation of single tank process.
2. Mathematical modeling and simulation of interacting tank process.
3. Mathematical modeling and simulation of non-self regulating system.
4. Mathematical modeling of stirred tank heated system.
5. Model identification of level loop.
8. Study of advance control techniques.

IE 417 - 1 CLINICAL ENGINEERING LABORATORY

Teaching Scheme

Practical: 2 hrs/week

Examination Scheme

Oral: 50
**List of Experiments:**
1. To design and implement the Nerve Stimulator.
2. To study the design aspects and functioning of pulse oxymeter.
3. Design and implementation of Telemetry.
4. Design and implementation of Apnea monitor.
5. To study Hemoglobin meter.
6. To design and implement Respiration Rate Meter.
7. To study the Pulmonary Function Analyzer.
8. To study the artificial Kidney.
9. To study the ESU.
10. To study the ultrasonic therapy unit.

**IE 417 - 2 BATCH PROCESS CONTROL LABORATORY**

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<th>Teaching Scheme</th>
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<td>Practical : 2 hrs/week</td>
<td>Oral: 50</td>
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**List of Experiments:**
3. Design batch control system for continuous stirred Tank Reactor (CSTR).
4. Development of information display system for batch process.
5. Development of logic diagram using function block diagram (FBD) for CSTR.
6. Case study for development of batch control system for Dairy.
7. Case study for development of batch control system for Food Processing Plant.
8. Case study for development of batch control system for Pharmaceuticals

**IE 418 - 1 ROBOTICS LABORATORY**

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<th>Teaching Scheme</th>
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<td>Practical : 2 hrs/week</td>
<td>Oral: 50</td>
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**List of Experiments:**
1. Study Experiment of working of Industrial Robot for understanding Manipulator Mechanism Design, Programming, Controls, etc.
2. To obtain the characteristics of a Hall Effect transducer
3. Characteristics of Reflective Opto-Electronic Transducers and Gray Code Disc
4. Characteristics of D.C. Motor
5. To study the characteristics of a Tacho-Generator
6. Simulation of robotic system using suitable software
7. Short Seminar on Recent Updates in the fields of Robotics and Mechatronics.
**IE 418 - 2 BUILDING AUTOMATION LABORATORY**

<table>
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<th>Teaching Scheme</th>
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<td>Practical : 2 hrs/week</td>
<td>Oral: 50</td>
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**List of Experiments:**

1. Design of HAVC system.
2. Design of Access Control System.
3. Design CCTV System.
5. Design of FA System.
6. Design of PA System.
7. Design of EPBX System.
8. Visit report.

**IE 419 PROJECT DESIGN**

<table>
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<th>Teaching Scheme</th>
<th>Examination Scheme</th>
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<tr>
<td>Practical : 6 hrs/week</td>
<td>Term work: 200</td>
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<td>Oral: 100</td>
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Prerequisite:
Course IE 411 Project Design.
The projects selected should be such so as to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The term work will consist of a report prepared by the student on the project allotted to them. It may be based (i) Entirely on study and analysis of a typical Instrumentation and Control System, (ii) Experimental verification, or (iii) Design, fabrication, testing and calibration of an Instrumentation system. The oral Examination will be based on the above report and work.