## Autonomous Program Structure

**Third Year B. Tech. Sixth Semester**  
(Instrumentation and Control Engineering)  
**Academic Year: 2022-2023 Onwards**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Teaching Scheme Hours /Week</th>
<th>Examination Scheme</th>
<th>Marks</th>
<th>Credit</th>
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<td>Lecture</td>
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<td>Practical</td>
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**Programme Elective-III**  
20PEIN601A Building Automation  
20PEIN601B Embedded Product Design  
20PEIN601C MEMS

**Programme Elective-III Lab**  
20PEIN601LA Building Automation  
20PEIN601LB Embedded Product Design  
20PEIN601LC MEMS
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20IN601 Process Instrumentation and Control

Teaching Scheme:  
Lectures: 3 Hrs/week  
Tutorial: 1 Hr/week  

Examination Scheme:  
In Semester: 50 Marks  
End Semester: 50 Marks  
Credit: 4  

Prerequisites: Principle and applications of various Sensors and Transducers, Basics of control systems, Principle of actuators and final control element and their applications.  

Course Objectives:  
1. To understand the principles of multi-loop controllers and nonlinear systems.  
2. To equip students with knowledge of multi variable control, interaction, the pairing, decoupling and design of controllers for interacting multi variable systems.  
3. Explain the control loops related to heat exchanger, Boiler, distillation column, reactor, pumps and compressors  

Course outcomes: the students will be able to  
1. Identify the characteristics of given process.  
2. Compare the features of different control strategies.  
3. Select appropriate control strategy for given application.  
4. Develop the instrumentation and control loops for various processes.  

Unit 1: Multi-Loop Control & Nonlinear Systems (09)  
SLPC and MLPC features, Feedback, feed forward control, cascade control, ratio control, selective control, split-range control  
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 2: Multivariable Control (09)  
Concept of Multivariable Control: Interactions and its effects, Modelling and transfer functions, Influence of Interaction on the possibility of feedback control, important effects on Multivariable system behaviour 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 3: Heat exchanger and Boiler controls (08)  
Types, gain and time constants, degrees of freedom. Basic controls in Heat exchangers, Steam Heaters, Condensers, fired heaters and vaporizers. Advanced Control Override, Feed forward Control.
Types, Components, Boiler controls like Drum level control (1,2,3,5 element), Air to fuel ratio control, Combustion controls, Steam temperature and pressure control, Safety interlocks, Burner management system, startup and shutdown procedures, boiler safety standards

Unit 4: Distillation Column control (08)
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 vapour flow, concentration lag, predicting the behaviour of control system

Unit 5: Reactor and pumps and compressor control (08)
Types of reactions and reactors, factors governing the conduct of reaction, stability of reactors, time constant, effects of lag, flow control, temperature control, pH control, end point detection of continuous and batch reactors. Sequential & logic control in batch process, batch production management.
Pumps: Types, Basic Controls, Multi pump system controls. Compressors: Types, Basic Controls.

Text Books:
1. Process Control Systems - F.G. Shinskey, TMH.
3. Optimization of Industrial Unit Processes - Bela G. Liptak

Reference Books:
1. Boiler Control Systems: David Lindsey, Mc GRAW-HILL

Tutorials:
Minimum 8 assignments based on the theory syllabus
20IN602 Industrial Automation

**Teaching Scheme:**
Lectures: 3 Hrs/Week

**Examination Scheme:**
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

**Prerequisites:** Basics of Process Loop Components

**Course Objectives:**
1. Understand the basic concepts of automation and its requirements.
2. To develop an automation project and its documentation.
3. To learn and apply standards and recommended practices to automation.
4. To understand the activities followed in automation projects.

**Course Outcomes:** the students will be able to
1. Compare to select the different automation tools used in the process industry.
2. Identify suitable communication protocol for the required automation system.
3. Develop PLC/ DCS logic for automation of given application.
4. Analyse the safety systems in process industry.

**Unit 1: Introduction to Industrial Automation** (08)
Introduction to industrial automation (Automation Pyramid according to industry 4),
Introduction to automation tools (PLC, HMI, SCADA, DCS, Robotics and Drives),
Introduction to automation tools performance criteria, Development of URS (User Requirement Specification) for automation and FDS (Functional Design Specification) for automation tools.

**Unit 2: Components and Hardware** (07)
Controllers: PLC, DCS, Embedded controllers; Operator Interfaces: Text based interfaces, graphical interfaces, Touch screens; Sensors: Discrete devices (sourcing and sinking concept, limit switches, proximity switches), Analog (pressure, flow, temperature sensing), Special purpose components: Encoders (high speed counter), vision sensors, bar code, RFID; Contactors, Starters, Circuit breakers, fuses, terminal blocks; Actuators and motion control: Pneumatic and hydraulic actuators, motors. Wiring of discrete, analog input and output devices.

**Unit 3: Industrial Protocols** (08)
Definition of protocols, Introduction to OSI model, Communication standards (RS232, RS485), Modbus (ASCII/RTU), Foundation fieldbus (H1/HSE), Profinet, Profibus, Industrial Ethernet, CAN, DeviceNet, ControlNet and HART protocols, Introduction to third party interface. Comparison between the protocols.


Unit 4: PLC Based Automation (07)
IEC 61131-3 standard, Logic development(Timer, Counter, Compare, Math, Conversion and Move instructions) Analog control loop (PID) configuration in PLC, PLC to PLC communication, PLC to HMI communication, PLC to other devices communication programs(servo motor and stepper motor logic in PLC)

Unit 5: Distributed Control System (06)
DCS introduction, Architecture of different makes: comparison and specification, Configuration of discrete and analog IO’s and programming, Development and configuration of user interface, alarm management, diagnosis, security and user access management.

Unit 6: Process Safety and Safety Management System (06)
Introduction to process safety, hazardous area classification, process hazard analysis, safety integrity levels (SIL), Introduction to IEC61511 standard, SIS application for safety system.

Text Books:

Reference Books:
1. Samuel Herb, “Understanding Distributed Process Systems for Control”, ISA.
2. Webb & Reis, “Programmable Logic Controllers: Principles and Applications”, PHI.
20IN603 System Engineering and Management

Teaching Scheme:
Lectures: 3hrs/week
Tutorial: 1 Hr/week

Examination Scheme:
In Semester: 50 Marks
End Semester: 50 Mark
Credit: 4

Prerequisites: -

Course Objectives:
1. To Know the basic concepts of Project Engineering and Management.
2. To Understand various engineering documents.
3. To interpret and apply national and international standards, and recommended practices.
4. To Know the activities followed in instrumentation projects.

Course Outcomes: the students should be able to
1. Develop documentation for, work distribution, team, planning and scheduling for any project.
2. Apply national and international standards, and recommended practices.
3. Develop instrumentation detailed engineering documents as per required standards.
4. Develop testing and commissioning documentation.

Unit 1: Basic Concept of Project Management (08)
Definition, Types and Life cycle phases of project, Basics of Project management, Project Planning, Scheduling, Tools and techniques of project management.

Unit 2: Instrumentation Documentation and its Related Standards (07)
Detailed discussion of ISA standards, FEED documents (PFD, Material balance, P&ID etc.) and DED documents (Process data sheets, instrument index, instrument specification sheet, calculation sheets like valve sizing, thermowell design, orifice design etc.).

Unit 3: Panels and Wiring Documentation (08)

Unit 4: EPC Contracting and Procurement Activities (07)
Introduction to EPC contracting, Vendor registration, requirements for qualification documents. Tendering and bidding process, requirement and qualification documents, Bid evaluation (Role and knowledge required as an instrumentation engineer), Purchase orders etc..

Unit 5: Installation (06)
Understand, design and develop instrument Installation sketches for various instruments (Hook up drawings like Thermowell, Flow transmitter, Differential pressure transmitter, orifice, pitot tube, rotameter, DPT type level transmitter installation specification etc.)
Unit 6: Commissioning and testing (06)
Inspection and Testing: Factory Acceptance Test (FAT) Team, Planning, documentation, Customer or Site Acceptance Test (CAT or SAT), Team, Planning, documentation. Test and inspection reports. Pre-commissioning planning activities, documents required for Cold Commissioning and hot commissioning, Performance trials and final hand over, Calibration records

Text Books:
1. Applied instrumentation in process industries by Andrew & Williams (Gulf Publishing)
2. Management systems by John Bacon (ISA)

Reference Books:
1. Instrument Installation Project Management (ISA).

Tutorials:
Minimum 8 assignments based on the course contents
20HS601 HS – Management Information System

Teaching Scheme:
Lectures: 3 Hr/Week

Examination Scheme:
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisites:

Course Objectives:
1. To introduce the students to the Management Information Systems
2. Its application in organizations and related technology
3. The course would expose the students to the managerial issues relating to information systems.
4. Help them identify and evaluate various options in Management Information Systems.

Course Outcomes: the students will be able to
1. Identify the functionalities and use of Management information system in industry.
2. Analyse various factors of Management Information System in organization e.g. sales, profit, digital marketing.
3. Develop various information system like ERP, CRM, data warehouse, etc.
4. Analyse various parameters of technology solutions in any organization.

Unit 1: Introduction to Management Information Systems (07)
Need, Purpose and Objectives - Contemporary Approaches to MIS, architecture of MIS, MIS as an instrument for the organizational change. Organizational levels, functional area. Automation pyramid, MIS in level 5 of industry 4.0.

Unit 2: Information System in Business (08)
Data and Information: Introduction, data and information- measuring data, information as a resource, information in organisational functions, types of information technology, types of information systems- transaction processing systems-management information systems

Unit 3: Management Information Systems, Technology, and Strategy (08)
Role of Information Technology in Organization, Plant Operation management and digitization. Information System and Strategy; Strategic Analysis and management. The Information Centre, Plant Operation management and digitization.

Unit 4: Systems Analysis and Design (07)

Unit 5: Decision Support Systems (06)
Unit 6: SCM, CRM, EIS and International Systems (06)

Text Books:

Reference Books:
1. Decision Support Systems and Intelligent Systems, Turban and Aronson, Pearson Education Asia
Teaching Scheme:
Lectures: 3 Hrs/Week

Examination Scheme:
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisites: Basics of Electronics and Instrumentation

Course Objectives:
1. Enable students to understand basic concept of building automation
2. Learn to create safe, secure, comfortable, healthy, and sustainable environment in buildings
3. Learn to bring energy efficiency in building systems

Course Outcomes: the students will be able to
1. Delineate various HVAC system, fire and security system components and systems.
2. Investigate the system requirements to select HVAC system, fire and security system components.
3. Develop the HVAC air systems and water system operations and control philosophies.

Unit 1: Introduction to Building Automation Systems (08)
Intelligent buildings, its’s architecture and structure - Evolution of intelligent buildings. Facilities management vs. intelligent buildings, Lifecycle of building. BAS System Hierarchy – Field level components, Direct Digital Control (DDC), Supervisory Controller, Server, Operator Workstation (OWS). Different systems in BAS which includes HVAC, security, fire, lighting systems. Importance of each system in BAS. Process of BAS design, Role of different stakeholders (Architect, contractor, consultant, application engineer and engineer) in BAS system design. BAS communication protocols and addressing concepts – BACnet and LON

Unit 2: Comfort parameters and measurement in BAS system (08)
Comfort parameters for human being - temperature, humidity, flow, pressure, clean air: Working Principle, Characteristics of different types of temperature sensors - RTD, Thermistor, Thermocouple, Bimetallic strip; Humidity, Specific Humidity, Relative Humidity, Dew point, Saturation point; Dry bulb & Wet bulb temperature, Working principle of Psychrometer; Pressure and Flow measurements in HVAC for air-side and water-side applications; Measurement of CO2 level in air, Air filtration techniques, ozonisation and UV; Other Parameters affecting building operation - Building load for Chilled water and hot water system, Working principal of BTU meter, BTU meter mounting.

Unit 3: HVAC Water Systems (07)
Chilled Water Systems: Concept of refrigeration cycle. Working, mechanical configuration of different types of components used in refrigeration cycle - evaporator, condenser, compressor, expansion valve. Difference between air-cooled chiller and water-cooled chiller. Working and mechanical configuration of different types of cooling towers. Concept and working of heat pump. Design, working of different types of chilled water system - single chiller system, series
chiller system, parallel chiller system. Working of different components of chilled water system - decoupler line, bypass line, primary circuit, secondary circuit, and condenser pumps. Hot Water Systems: Working and design of different types of boilers- fire tube, water tube, packaged boiler. Working and design of different types of heat exchanger. Design of different types of hot water system- with boilers, heat exchanger with steam input, heat exchanger with hot water input. Concept of geothermal system - Variable frequency drives: Use of VFD’s for Pumps and Fans. Purpose and application of VFD.

Unit 4: HVAC Air Systems
Air Handling Units and Terminal units - Concept of Air handling unit. Design, working of different components in AHU - damper, filter, cooling coil, heating coil, fan, heat recovery wheel, humidifier. Design and working of different types of AHU with combination of - 100% outdoor air, mixed air, constant volume, variable volume, dual duct, single duct. Operation of different modes in AHU - cooling, heating, humidification, dehumidification, static pressure control, volume matching, economizer mode. Heat recovery techniques - plate heat exchanger, heat recovery wheel and glycol heat recovery loop. Concept of Variable Air Volume (VAV) system - Design, working, use of different types of VAV- CAV, cooling only, with reheat, supply-exhaust VAV for critical areas (hospital and labs)

Unit 5: Introduction to Fire Alarm System & Fire Detection

Unit 6: Introduction to Building Security – Access Control & CCTV

Text Books:
3. Benantar M., Access Control System
6. James E. Brumbaugh “HVAC Fundamentals”, volume 1 to 3
7. “Basics of Air Conditioning” ISHRAE, Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0004 for online shopping)

**Reference Books:**
1. “All About AHU’s”, ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0005 for online shopping)
2. “Chillers Basics”, ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers
   (product code: B0009 for online shopping)
20PEIN601B Embedded Product Design

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisites: Embedded system design, Knowledge of Assembly and C programming, Electronic instrumentation and system design

Course Objectives:
1. To give knowledge of interfacing analog and digital input devices to microcontrollers.
2. To give knowledge of interfacing analog and digital output devices to microcontrollers.
3. To implement different power optimization techniques for low power systems.
4. To give an overview of product design with case study.

Course Outcomes: the students will be able to
1. Apply different methodologies to interface different sensors and devices to microcontrollers.
2. Apply different methodologies to interface different actuators to microcontrollers.
3. Explore and select proper power optimization techniques.
4. Design embedded system for various applications.

Unit 1: Programming and interfacing analogue input devices (07)
Load cell, Temperature sensor, 2-wire transmitters, potentiometric sensors, LVDT, Linear opto IL300

Unit 2: Programming and interfacing analogue output devices (08)
Linear opto IL300, PWM based DAC, serial DAC, Voltage to current converter, Lamp/indicator, miniature DC motor,

Unit 3: Programming and interfacing digital input devices (08)
Keyboard, Proximity switch, incremental Encoders, Ultrasonic sensors, serial ADC, RTC-1307, Optocoupler MCT2E

Unit 4: Programming and interfacing digital output devices (08)
Alpha-numeric LCD, 7-Segment LED display, serial memories, Optocoupler MCT2E, printer, Stepper motor, relays (SSR and Electro-mechanical)

Unit 5: Power efficient system and communication design (06)
Design considerations for battery powered systems, communication based on RS-232, RS-485, Bluetooth, USB drives
Unit 6: Small system design with case study

Embedded system design for Temperature data logger, Burglar alarm, Fire alarm, WSN based system, RFID based access control

Text Books:
3. AVR microcontroller & Embedded System by A. Mazidi, Prentice Hall

Reference Books:
1. Internet resources for AVR:
4. Datasheets of ATmega 8535, ATtiny2313
5. Datasheets of IL300, RTC1307, MCT2E, serial ADCs, DACs
20PEIN601C MEMS

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisites: Conventional sensors and materials, application of sensors

Course Objectives:
1. To introduce emerging MEMS field and importance of micro scaling to students
2. To provide knowledge of advanced materials, sensors and actuators
3. To learn advance micro fabrication techniques
4. To know advancement in instrumentation field of bio, automotive, aerospace field

Course Outcomes: the students will be able to
1. Compare smart material based on their characteristics.
2. Select the appropriate micro sensor, micro actuator and type of microfluidic flow for given application.
3. Identify and define various phases of micro scaling and micro fabrication process.
4. Develop applications using MEMS devices.

Unit 1: Introduction to MEMS (06)
Introduction to MEMS, Introduction to micro sensors, Evaluation of MEMS, Application of MEMS

Unit 2: Smart Material (08)
Shape memory Materials, Electrostrictive Materials, Magnetostrictive Materials, Rheological Materials, Electro chromic Materials, Self-healing Material, Conducting polymer

Unit 3: Micro Fabrication (09)
Study of Silicon as a Material for Micromachining, Thin-film Deposition –Evaporation, Sputtering, Chemical Vapor Deposition, Epitaxial Growth of Silicon Thermal Oxidation, Lithography, Doping the Silicon Wafer: Diffusion and Ion, Implantation of Dopants, Etching. Dry Etching, Silicon Micromachining Bulk Micromachining, Surface Micromachining

Unit 4: Micro Sensor and Micro Actuator (07)
Micro sensor - Silicon Capacitive Accelerometer, Conductometric Gas Sensor, Fibre-Optic Sensors, Electrostatic Comb-Drive
Micro Actuator - Magnetic Micro relay, Microsystems at Radio Frequencies, Piezoelectric Inkjet Print Head, Portable Blood Analyzer, Micro mirror Array for Video Projection

Unit 5: Microfluidics (06)
Droplet Microfluidics, Active Flow control, Microvalves, Electrically actuated microvalves, Micromixers, Combinational Mixers, Elastomeric Micromixers. Microfluidic for Flow cytometry, cell sorting, cell trapping, Cell culture in microenvironment.
Unit 6: MEMS – Electronics, Packaging and Applications
Wafer Bonding & Packaging of MEMS Interface Electronics for MEMS

Text Books:
2. Microfluidics and Microfabrication by Suman Chakraborty
3. Foundation of MEMS by Chang Liu
4. An Introduction to MEMS by Nadim Maluf and Kirt Williams

Reference Books:
5. Fundamentals of Micro fabrication, Marc Madou
20OE601C Avionics

Teaching Scheme:  
Lectures: 3 Hrs/week  

Examination Scheme:  
In Semester: 50 Marks  
End Semester: 50 Marks  
Credit: 3

Prerequisites: Basics of Control Systems, Basics of Communication System

Course Objectives:  
1. To integrate the digital electronics with cockpit equipment  
2. To understand the various principles in flight desk and cockpit panels.  
3. To understand the communication techniques used in aircraft.  
4. To explain the modern era of flight control system

Course Outcomes: the students will be able to  
1. Identify the mechanical and electronic hardware required for aircraft.  
2. Compare the communication and navigation techniques used in aircrafts.  
3. Disseminate the autopilot and cockpit display related concepts.  
4. Identify and Compare different actuators in avionics.

Unit 1: Introduction to Avionics (08)  

Unit 2: Digital Avionics Bus Architecture (07)  

Unit 3: Flight Deck and Cockpit (07)  
Control and display technologies CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil cockpit and military cockpit: MFDS, PFDS-HUD, HMD, HMI

Unit 4: Avionics Systems (06)  

Unit 5: On Board Navigation Systems (07)  
Overview of navigational aids, Flight planning, Area navigation, required time of arrival, RNAV architecture , performance aspects, approach and landing challenges, regulatory and safety aspects, black box instrumentation INS, GPS and GNSS characteristics.
Unit 6: Basics of Final Control Element (06)
Basics of pneumatic, hydraulic and electric actuators, Function of DC Servo motor, AC Servo motor function of pneumatic, hydraulic actuators.

Text Books:

Reference Books:
20OE601D Bioinformatics

Teaching Scheme:
Lectures: 3 Hrs/week

Examination Scheme:
In Semester: 50 Marks
End Semester: 50 Marks
Credit: 3

Prerequisites: -

Course Objectives:
1. To understand the basics of bioinformatics and explore various databases used in bioinformatics.
2. To be familiar with a set of well-known supervised, unsupervised learning algorithms used for bioinformatics applications.
3. To understand the concepts and types of Phylogeny.

Course Outcomes: the students will be able
1. Apply basic concepts of bioinformatics to biological data analysis.
2. Classify different types of biological databases.
3. Apply various techniques, algorithms and tools to nucleic acid and protein sequence analysis.
4. Apply various techniques, algorithms and tools to be used for phylogenetic analysis.

Unit 1: Introduction to Bioinformatics (06)
Definition, applications, Protein and DNA structure, Biological Data Acquisition: The form of biological information. Retrieval methods for DNA sequence, protein sequence

Unit 2: Bioinformatics Databases (08)
Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases - primary sequence databases, protein sequence, Information on various databases and bioinformatics tools available. For eg; nucleic acid sequence database (GenBank, EMBL, DDBJ), protein sequence databases (SWISSPROT, TrEMBL, PIR, PPB)

Unit 3: Algorithms for bioinformatics (08)
Introduction to various machine learning techniques and their applications in bioinformatics. Genetic algorithm, Support Vector Machine, Neural Network and their practical applications towards the development of new models, methods and tools for bioinformatics

Unit 4: Sequence Analysis (08)
Various file formats for biomolecular sequences - genbank, fasta, gcg, msf, nbrf-pir, etc Basic concepts of sequence similarity, identity and homology, paralogues. Sequence based database searches - BLAST and FASTA algorithms
Unit 5: Sequence Alignment
Pairwise and Multiple Sequence Alignments (MSA). Basic concept of sequence alignment, Pairwise alignment (Needleman and Wunsch, Smith and Waterman algorithms), MSA (Progressive and Hierarchical algorithms). Their use for analysis of Nucleic acid and protein sequences and interpretation of results

Unit 6: Phylogeny
Phylogeny analysis, definition and description of phylogenetic trees and its types. Various computational methods in phylogenetic and molecular evolutionary analysis

Text Books/Reference Books:
5. Bioinformatics Databases: Design, Implementation, and Usage (Chapman & Hall/ CRC
6. Mathematical Biology & Medicine), by SorinDraghici
7. Data base annotation in molecular biology, principles and practices, Arthur M.Lesk
8. Current topics in computational molecular biology, Tao, Jiang, Ying Xu, Michael Q.Zang
Teaching Scheme: Practical: 2Hrs/Week

Examination Scheme: In Semester: 25 Marks
Practical: 25 Marks
Credit: 1

Course Outcomes: the students will be able to
1. Develop URS and FDS documents for any automation project.
2. Develop PLC/ DCS logic for any given industrial application.
3. Simulate and test the developed logic for the given application.
4. Interface different devices with PLC/ DCS.

List of Practical Assignments:(any 8)
1. Compare the applicability of different automation tools for the given application.
2. Preparing URS and FDS for any automation project.
3. Logic implementation of any automation project in PLC using ladder language.
4. Logic implementation of any automation project in PLC using FBD language.
5. Simulate digital and analog function blocks in DCS.
6. Tune PID controller for any loop using PLC/DCS.
7. Interface PLC and HMI for any automation project through OPC or suitable protocol.
8. Study the interfacing of PLC to PLC and PLC to other devices(Servo motor, stepper motor, printer, etc)
9. Develop Graphical User Interface in DCS for any control loop.
10. Study the application of different safety systems (Case study).

Or similar type of practical assignments based on the course contents
20IN603L System Engineering and Management Lab

Teaching Scheme:
Practical: 2Hrs/Week

Examination Scheme:
In Semester: 25 Marks
Oral: 25 Marks
Credit: 1

Course Outcomes: the students will be able to
1. Develop Project Management documents.
2. Apply national and international standards and recommended practices for project documentation.
3. Create instrumentation detailed engineering documents as per specified standards.
4. Create testing and commissioning documentation.

List of Practical Assignments:
1. Develop documents for SOW/WBS/Organization structure for any I&C Project
2. Interpret the Process flow diagram and Material Balance sheet.
3. Introduction Auto CAD like (smart sketch etc.) software.
4. Develop P&ID for given process
5. Develop Instrument Index sheet, I/O list for given P&ID
6. Develop Specification sheets for given instruments and P&ID
7. Develop GA drawings for a given panel (JB/Electrical/ PLC/DCS).
8. Develop Hook up drawings (Control valve, Thermowell, orifice plate, rotameter etc..)
9. Create Loop Wiring Diagram/Logic diagram
10. Create documents for tests like FAT/SAT or CAT
11. Develop commissioning documents.

Or similar type of practical assignments based on the course contents
Building Automation Lab

Teaching Scheme:  
Practical: 2Hrs/Week

Examination Scheme:  
In Semester: 25 Marks  
Oral: 25 Marks  
Credit: 1

Course Outcomes: the student will be able to,
1. Identify/List the various components of a Building Automation System.
2. Investigate the system requirements of a Building Automation System.
3. Design the various Building Automation System components.
4. Develop the various Building Automation System components.

List of Practical Assignments: (minimum eight)
1. To study Architecture of BMS & IBMS
2. To study Psychrometric chart and various parameters
3. To study different types of Air Handling Units
4. To study various terminal unit systems (CAV, VAV)
5. To study Chilled Water System and loops
6. To study Hot Water System and loops
7. To study FAS loops and classifications
8. To study SLC wiring, loops, classifications
9. To study cause and effect matrix-Fire alarm system
10. To study CCTV System Architecture and types of cameras

Or similar type of practical assignments based on the course contents
20PEIN601LB Embedded Product Design Lab

Teaching Scheme:  
Practical: 2Hrs/Week

Examination Scheme:  
In Semester: 25 Marks
Oral: 25 Marks
Credit: 1

Course Outcomes: the students will be able to
1. Verify and compare the performance of different displays.
2. Design and interface various sensors to embedded controller.
3. Select appropriate output devices for given application.
4. Design and test embedded controller-based systems for industrial application.

List of Practical Assignments: (minimum 5)
1. Interfacing of Keyboard and LCD
2. Interfacing of 2-wire transmitter
3. Design of up-down counter and Interfacing of 7-segment LED display
4. Design and testing of an application based on power down mode of microcontroller
   (Any 1 from)
5. Temperature indicator using LM35
6. Interfacing of proximity switch and relay using MCT2E optocoupler
7. Distance measurement using ultrasonic sensor HC-SR04
   (Any 1 from)
8. Speed control of miniature DC motor
9. Intensity control of Lamp/Power LED
10. Programmable voltage to current converter
   Or similar type of practical assignments based on the course contents
Teaching Scheme: Practical: 2Hrs/Week

Examination Scheme: In Semester: 25 Marks
Oral: 25 Marks
Credit: 1

Course Outcomes: the students will be able to
1. Simulate a sensor design through software like COMSOL.
2. Selection of appropriate sensor and actuator for the specified application.
3. Characterization of simulated sensor design.
4. Design a MEMS system based on the specified application.

List of Practical Assignments:
1. Finite element simulation of MEMS sensor – COMSOL/ANSYS
2. Design of MEMS sensor – system on a chip approach
3. Fabrication of MEMS sensor – resistive/capacitive type
4. Characterization of MEMS sensor – resistive/capacitive type
5. Microfluidics – Design, simulation, fabrication and characterisation
6. Micromixers – Design, simulation, fabrication and characterisation
7. Paper microfluidics – Simulation, fabrication and characterisation

Or similar type of practical assignments based on the course contents
20IN604 Mini Project

Teaching Scheme:
Practical: 2 Hrs/week

Examination Scheme:
In Semester: 25 Marks
Practical: 25 Marks
Credit: 1

Course Outcomes: the students will be able to
1. Identify and define with proper study, problem statement related to industry, healthcare, society, laboratory.
2. Design various stages to solve the identified problem.
3. Implement and test the developed design or system or prototype.
4. Prepare and present technical documentation of the developed system.