Autonomous Program Structure
Third Year B. Tech. Sixth Semester
(Instrumentation and Control)
Academic Year: 2022-2023 Onwards

Course Code	Course Title	Teaching Scheme Hours /Week			Examination Scheme				Marks	Credit
		Lecture	Tutorial	Practical	In Semester	End Semester	Oral	Practical		
20IN601	Process Instrumentation and Control	3	1	0	50	50	0	0	100	4
20IN602	Industrial Automation	3	0	0	50	50	0	0	100	3
20IN603	System Engineering and Management	3	1	0	50	50	0	0	100	4
20HS601	Management Information System (MIS)	3	0	0	50	50	0	0	100	3
20PEIN601	Programme Elective-III	3	0	0	50	50	0	0	100	3
20OE601	Open Elective-II	3	0	0	50	50	0	0	100	3
20IN602L	Industrial Automation Lab	0	0	2	25	0	0	25	50	1
20IN603L	System Engineering and Management Lab	0	0	2	25	0	25	0	50	1
20PEIN601L	Programme Elective Lab-III	0	0	2	25	0	25	0	50	1
20IN604	Mini Project	0	0	2	25	0	0	25	50	1
	Total	18	2	8	400	300	50	50	800	24
	Grand Total	28			800				800	24

Programme Elective-III	Programme Elective-III Lab
20PEIN601A Building Automation	20PEIN601LA Building Automation
20PEIN601B Embedded Product Design	20PEIN601LB Embedded Product Design

Department of Instrumentation & Control Engineering

20PEIN601C MEMS   20PEIN601LC MEMS

20OE601 Open Elective-II — Eligible Departments

Sr. No.	Course Code	Course Title	EnTC	Comp	IT	Mech	Instru
1	20OE601A	Automation and Control Engineering	Y	Y	Y	Y	Y
2	20OE601B	Automotive Electronics	Y	Y	Y	Y	Y
3	20OE601C	Avionics	Y	Y	Y	Y	Y
4	20OE601D	Bioinformatics	Y	Y	Y	N	Y
5	20OE601E	Computer Vision	Y	Y	Y	Y	Y
6	20OE601F	Design Thinking	Y	Y	Y	Y	Y
7	20OE601G	e-Business	Y	Y	Y	Y	Y
8	20OE601H	Electric Vehicles	Y	Y	Y	Y	Y
9	20OE601I	Gamification	Y	Y	Y	Y	Y
10	20OE601J	Geographical Information Systems	Y	Y	Y	Y	Y
11	20OE601K	Multimedia Systems	Y	Y	Y	N	Y

20OE601L Open Elective-II Lab — Eligible Departments

Sr. No.	Course Code	Course Title	EnTC	Comp	IT	Mech	Instru
1	20OE601LA	Automation and Control Engineering	Y	Y	Y	Y	Y
2	20OE601LB	Automotive Electronics	Y	Y	Y	Y	Y
3	20OE601LC	Avionics	Y	Y	Y	Y	Y
4	20OE601LD	Bioinformatics	Y	Y	Y	N	Y
5	20OE601LE	Computer Vision	Y	Y	Y	Y	Y
6	20OE601LF	Design Thinking	Y	Y	Y	Y	Y
7	20OE601LG	e-Business	Y	Y	Y	Y	Y
8	20OE601LH	Electric Vehicles	Y	Y	Y	Y	Y
9	20OE601LI	Gamification	Y	Y	Y	Y	Y
10	20OE601LJ	Geographical Information Systems	Y	Y	Y	Y	Y
11	20OE601LK	Multimedia Systems	Y	Y	Y	N	Y

Department of Instrumentation & Control Engineering

APPROVED BY
Secretary Governing Body
MKSSS's Cummins College of Engineering
For Women, Pune-411052
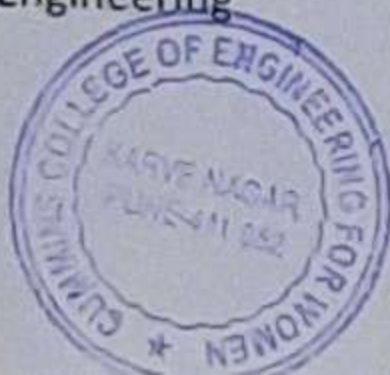
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20IN601 Process Instrumentation and Control

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.
2. Instrument Engineers' Handbook: Process Control: B.G. Liptak, Chilton.
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:	**Examination Scheme:**
Lectures: 3Hrs/Week	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 student will be able to,
1. Classify and compare the different automation tools used in industry.
2. Select suitable communication protocol for the required automation system.
3. Develop the logic and communication for any PLC/DCS system.
4. Discuss various safety methods used in automation industries.

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), Profibus, Profinet, 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:
1. S.K.Singh, "Computer Aided Process Control", PHI.
2. Garry Dunning, "Introduction to Programmable Logic Controllers", Thomson Learning.
3. Krishna Kant, "Computer Based Process Control", PHI.
4. Frank Lamb, "Industrial Automation Hands On", Mc Graw Hill.

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: By the end of the course, 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)
Electrical Panels: Specification, GA drawings, Instrumentation Panels (Instrument panels, Marshalling panels) Terminal Strip reports, Power requirement calculation etc. Instrument Cable: Types, specification, Cable trays, Control room engineering.

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)
3. Process control Instrument Engineers Handbook by Liptak.

Reference Books:

1. Instrument Installation Project Management (ISA).
2. Successful Instrumentation & Control Systems Design, by Michael D. Whitt (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:
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)
Systems Development Life Cycle (SDLC), Alternative System Building Approaches Prototyping, Rapid Development Tools, Agile, CASE Tools, Object Oriented Systems. MIS in renewable energy.

Unit 5: Decision Support Systems (06)

Understanding DSS- MIS and DSS-Decision making-types of decisions, Analytics and Business Intelligence- BI techniques. Group Decision Support Systems, Executive Information Systems, Executive Support Systems, Expert Systems and Knowledge Based Expert Systems, Artificial Intelligence in DSS.

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

Introduction, Supply Chain Management Systems, Customer Relationships Management Systems, Challenges of Enterprise Systems Implementations- Managing the implementation, International Information Systems-Outsourcing and off-shoring.

Text Books:

1. Management Information Systems, Laudon and Laudon, 7th Edition, Pearson Education Asia

2. Management Information Systems, Jawadekar, Tata McGraw Hill

3. Management Information Systems - Sadagopan, Prentice Hall

4. Analysis and Design of Information Systems, Rajaraman, Prentice Hall

Reference Books:

1. Decision Support Systems and Intelligent Systems, Turban and Aronson, Pearson Education Asia

2. Management Information Systems, Schultheiss, Tata McGraw Hill

3. Management Information Systems, Davis and Olson, Tata McGraw Hill 4. Management Information Systems - Jayant Oke

20PEIN601A Building Automation

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/Week	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 student 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
4. Develop the Fire Safety, Security and Access Control Systems.

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 CO_2 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 (07)

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 (06)

What is Fire? Fire alarm System-The History, FAS architecture & operation, Classification of Fire Alarm System, Conventional and Addressable Fire Alarm System, Important Codes-NFPA72, IS 2189, BS 5839, Critical fire & safety parameters in Facility Environment FAS Loops-Classification of Loops and Examples, Power Supply Requirement and its designing parameters. Battery Calculations. Network terminology for Fire Systems, Classification of Cables, Class of Cables, Types, and distance Supported specific to fire alarm system, Working Principles of Fire Alarm devices and its working Application in building safety, Components of fire detection system, SLC wiring and its classification, Concepts of Water leak detection system & Concepts of VESDA (Very early smoke detection system)

Unit 6: Introduction to Building Security – Access Control & CCTV (06)

Basic Concept of Access Control System it's benefits & architecture, Access Control System Devices –Its features and Working principles. Antipassback, Forgiveness, Two-man Rule, Time and Attendance, Guard Tour, Elevator Control, Secure and Non-Secure Concept, Card Technology Overview –Smartcard, Proximity Card, MI fare Cards, System Architecture of Access Control System, Basic of CCTV system, System Architecture of CCTV System,

Types of Camera –Fixed, PTZ, Analog, Digital, Video Analytics, Camera Connectivity, Video Management System: DVR, DVM, NVR

Text Books:

1. Robert Gagnon, Design of Special Hazards and Fire Alarm Systems.
2. Damjanovski, Vlado, CCTV, Butterworth-Heinemann , 3rd ed.
3. Benantar M., Access Control System
4. Montgomery R, Fundamentals of HVAC Control Systems , Elsevier Publications
5. Roger W. Haines "HVAC Systems Design Handbook", Fifth Edition
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)
3. "HVAC Handbook Part-1", Indian Society of Heating, Refrigerating & Air Conditioning Engineers
4. "Handbook – Industrial Ventilation Application", 2004, Indian Society of Heating, Refrigerating & Air Conditioning Engineers

20PEIN601B Embedded Product Design

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/week	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: Students will be able
1. Apply different methodologies to interface different sensors and devices to microcontrollers.
2. To apply different methodologies to interface different actuators to microcontrollers.
3. To explore and select proper power optimization techniques.
4. To design and test performance of a system.

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)
Key board, 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 (05)

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

Text Books:

1. Microcontrollers: Theory & Applications by Dr. A. V. Deshmukh, Tata McGraw Hill, Publications
2. Programming and Customizing the AVR Microcontroller by Dhananjay V. Gadre, Tata McGraw Hill Publishing Company Limited, 2003.
3. AVR microcontroller & Embedded System by A. Mazidi , Prentice Hall

Reference Books:

1. Internet resources for AVR:
2. Atmel AVR Page:. http://www.atmel.com/images/doc2502.pdf
3. http://www.atmel.in/Images/doc0856.pdf
4. Datasheets of ATmega 8535, ATtiny2313
5. Datasheets of IL300, RTC1307, MCT2E, serial ADCs, DACs

20PEIN601C MEMS

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/week	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 student 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   (05)

Wafer Bonding & Packaging of MEMS Interface Electronics for MEMS

Text Books:

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

1. Smart Material Systems and MEMS: Design and Development Methodologies, Vijay, K., Varadan K., Vinoy J. Gopalakrisham S. Willey 2006
2. Smart materials and new technologies, Addington, M. ,Schodek, Daniel L. Architectural Press, 2005.
3. Smart Structure and Materials, Brain Culshaw Artech House – Borton. London 1996
4. Smart Structure analysis and design, Srinivasan A.V., Michael McFarland D., Cambridge University Press, 2001
5. Fundamentals of Micro fabrication, Marc Madou

20OE601C Avionics

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/week	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 student 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. Compare and identify different actuators in avionics.

Unit 1: Introduction to Avionics   (08)
Basics of Avionics-Basics of aircraft- glider – control surfaces- Cockpits instrumentation -Need for Avionics - Integrated Avionics Architecture.

Unit 2: Digital Avionics Bus Architecture   (07)
Avionics Bus architecture–Data buses MIL–RS 232- RS422-RS 485-STD 1553- ARINC 429–ARINC 629- Aircraft system Interface- Network topologies

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)
Communication Systems – Navigation systems – Flight control systems – Radar electronic Warfare – Utility systems Reliability and maintainability Fundamentals- Certification-Military and civil aircrafts.

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:

1. R.P.G. Collinson, "Introduction to Avionics", Chapman & Hall Publications, 1996.
2. N. S. Nagaraja(1996),Elements of electronic navigation, 2 edition, Tata McGraw Hill, New Delhi.

Reference Books:

1. Cary R .Spitzer, "The Avionics Handbook", CRC Press, 2000.
2. Middleton, D.H. "Avionics Systems", Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
3. Spitzer, C.R. "Digital Avionics Systems", Prentice Hall, Englewood Cliffs, N.J., U.S.A., 1987.
4. Brain Kendal, "Manual of Avionics", The English Book House, 3rd Edition, New Delhi, 1993

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: 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 (06)

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 (06)

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

Text Books/Reference Books:

1. Hooman Rashidi, Lukas K. Buehler, 'Bioinformatics Basics: Applications in Biological Science and Medicine' (2nd Edition) (May 2005)
2. Des Higgins (Ed),Willie Taylor (Ed), 'Bioinformatics: Sequence, Structure and Databanks - A practical approach' (1st Edition) (October 2000)
3. N.J. Chikhale and Virendra Gomase, 'Bioinformatics- Theory and Practice' (1st Edition)(July 2007)
4. Bioinformatics: Databases and Systems, by Stanley I. Letovsky
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

20IN602L Industrial Automation Lab

Teaching Scheme:
Practical: 2Hrs/Week

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

Course Outcomes: 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: By the end of the course, students should be able to
1. Develop Project Management documents
2. Apply national and international standards and recommended practices.
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

20PEIN601LA Building Automation Lab

Teaching Scheme: **Examination Scheme:**
Practical: 2Hrs/Week   In Semester: 25 Marks
                                                                              Oral: 25 Marks
                                                                              Credit: 1

Course Outcomes: Student will be able to,
1. Describe 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 student 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

20PEIN601LC MEMS Lab

Teaching Scheme:
Practical: 2Hrs/Week

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

Course Outcomes:
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: 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.