College of Engineering, Pune

(An Autonomous Institute of Govt. of Maharashtra, Permanently Affiliated to S.P. Pune University)

Department of Instrumentation and Control Engineering

Curriculum Structure & Detailed Syllabus (PG Program)

M. Tech (Process Instrumentation)

(Revision: A.Y. 2019-2023, Effective from: A.Y. 2019-20)

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Department Vision:

To lead the field of Instrumentation and Control towards **inclusive excellence**through integration of **teaching and learning**, advancement of the knowledge base by **research, innovations, scholarships** and**services to the society.**

Department Mission:

- **Set-up** a mechanism for creating high quality undergraduate and post graduate programs in Instrumentation and Control Engineering.
- **Adapt** systems and methods for meaningful collaboration with stakeholders.
- **Take-up** socially relevant and nationally important issues and problems as project assignments.
- **Inculcate** creativity, entrepreneurial attitude and values amongst Learners.

Program Education Objectives (PEOs):

Program Educational Objectives for M Tech (Process Instrumentation) are as follows:

- **PEO1:** Practice the knowledge of Instrumentation and Control Engineering and allied /related fields
- **PEO2:** Demonstrate technical, communication skills and team spirit along with leadership qualities to pursue career in broad areas of Instrumentation and Control Engineering, Process Instrumentation
- **PEO3:** Engage in life-long learning through independent study and research
- **PEO4:** Undertake responsibilities for societal, environmental and ethical causes

Program Outcomes (POs):

On successful completion of the Program, engineering graduates will able to:

PO1: Engineering Knowledge of subject: An ability to independently carry out research/investigation and development work to solve practical problems.

PO2: Technical Writing: An ability to write and present a substantial technical report/document.

PO3: Problem Analysis: Students should be able to demonstrate a degree of mastery over thearea as per the specialization of the program. The mastery should be at a level higher than therequirements in the appropriate bachelor program.

PO4: Engineering and Society: Learn and use of sensors, data acquisition systems, actuators, andcontrol methodologies to readily provide innovative solutions to the day-to-day problems in the coreindustry (e.g. processes, power plants, Industrial Automation).

PO5: Leadership: To function efficiently in various capacities as members, leaders, and decisionmakers in multi-disciplinary teams to accomplish projects of different magnitudes.

PO6: Life-long learning: Would have recognized the need for engaging themselves in independent and life-long learning in the broadest context of technological change.

Correlation between the PEOs and the POs

PO→ PEO↓	PO1	PO2	PO3	PO4	PO5	PO6
PEO1	✓		✓	✓		
PEO2		✓		✓	✓	
PEO3	✓					✓
PEO4		✓		✓		

List of Abbreviations

Sr. No.	Abbreviation	Stands for:
1	PSMC	Program Specific Mathematics Course
2	PSBC	Program Specific Bridge Course
3	DEC	Department Elective Course
4	MLC	Mandatory Learning Course
5	PCC	Program Core Course
6	LC	Laboratory Course
7	IOC	Interdisciplinary Open Course
8	LLC	Liberal Learning Course
9	SLC	Self Learning Course
10	SBC	Skill Based Course

Title	No of courses	Credits	% of Credits
Program Core Course (PCC)	6	18	26.4%
Department Elective Course (DEC)	3	09	13.2%
Open Electives (OE)	1	03	4.4%
Major Project: Skill Base Course (SBC)	1	18	26.4%
Any other (MOOC) Self Learning Course (SLC)	2	06	8.8%
Laboratory Course (LC)	6	06	8.8%
Program specific Mathematics course (PSMC)	1	04	5.9%
Program Specific Bridge Course (PSBC)	1	03	4.4%
Liberal Learning Course (LLC)	1	01	1.7%
Total	**22**	**68**	**100%**

CURRICULUM STRUCTURE OF M. TECH. PROCESS INSTRUMENTATION
(Effective from A. Y. 2020-2021)

Semester I

Sr. No.	Course Type/ Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	PSMC/IPI-19001	Computational Methods in Engineering	3	1	0	4
2.	PSBC/IPI-19002	Process Plant Operations	3	0	0	3
3.	DEC IPI(DE)-19001 IPI(DE)-19002 IPI(DE)-19003 IPI(DE)-19004 IPI(DE)-19005	**Department Elective-I** 1. Embedded Systems-I 2. Industrial Internet of Things 3. Flow Engineering 4. Automotive Embedded Product Development **5.** Building Automation	3	0	0	3
4.	MLC/ML-19011	Research Methodology and Intellectual Property Rights	2	0	0	0
5.	MLC/ML-19012	Effective Technical Communication	1	0	0	0
6.	PCC/IPI-19003	Transducers Design	3	0	2	4
7.	PCC/IPI-19004	Instrument Design Engineering	3	0	2	4
8.	PCC/IPI-19005	Modern Control Theory	3	0	2	4
	Total		**21**	**1**	**6**	**22**
	Total Academic Engagement and Credits		**28**			**22**

Semester II

Sr. No.	Course Type/ Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	IOC/ ICE-19001	Interdisciplinary Open Course	3	0	0	3
2.	DEC IPI(DE)-19006 IPI(DE)-19007 IPI(DE)-19008 IPI(DE)-19009	**Department Elective –II** 1. Batch Process control 2. Industrial Automation 3. Advanced Control System 4. Automotive Electronics Hardware Development	3	0	0	3
3.	DEC IPI(DE)-19011 IPI(DE)-19012 IPI(DE)-19013 IPI(DE)-19014 IPI(DE)-19015	**Department Elective –III** 1. Embedded Systems-II 2. Soft Computing 3. Optical Instrumentation 4. Artificial Intelligence and Machine Learning 5. Automotive Electronics Software Development	3	0	0	3
4.	LLC/ LLC-19001	Liberal Learning Course	1	0	0	1
5.	PCC/ IPI-19006	Advanced Process Instrumentation	3	0	2	4
6.	PCC/ IPI-19007	Process Modeling and Optimization	3	0	2	4
7.	PCC/ IPI-19008	Statistical Process Control	3	0	2	4
	Total		**19**	**0**	**6**	**22**
	Total Academic Engagement and Credits		**25**			**22**

Interdisciplinary Open Course: **Smart Sensors** offered to other departments.

Semester-III

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	SBC/IPI-20001	Dissertation Phase – I	0	0	18	9
2.	SLC/IPI(OC)-2001	Massive Open Online Course -I	3	0	0	3
	Total		**3**	**0**	**18**	**12**
	Total Academic Engagement and Credits		**21**			**12**

Semester-IV

Sr. No.	Course Code	Course Name	Teaching Scheme			Credits
			L	T	P	
1.	SBC/IPI-20002	Dissertation Phase – II	0	0	18	9
2.	SLC/IPI(OC)-2002	Massive Open Online Course -II	3	0	0	3
	Total		**3**	**0**	**18**	**12**
	Total Academic Engagement and Credits		**21**			**12**

IPI-19001 Computational Methods in Engineering

Teaching Scheme:
Lectures: 3 hours / week

Examination Scheme:
Test 1: 20 Marks
Test 2: 20 Marks
End-Sem Exam: 60 Marks:

Course Outcomes

1. Appreciation of the need for numerical methods. [PEO1],[PO3].
2. Develop the numerical skills for analyzing engineering problems. [PEO3],[PO3].
3. Understand and evaluate numerical methods for solving (i) Equations (ii) Linear systems of equations (iii) integration, and (IV) ODE's & PDE's. [PEO1],[PO4].
4. To use numerical methods to solve engineering problems through solutions of differential equations [PEO1],[PO4].

Course Contents

Roots of Equations: bracketing methods, open methods and case studies.

Linear Algebraic Equations: Gauss Elimination, LU decomposition and matrix inversion, special matrices and Gauss-Seidel method, case studies.

Numerical Differentiation and Integration: Newton-Cotes integration formulas, integration of equations, numerical differentiation, case studies.

Ordinary Differential Equations:Runge-Kutta methods, stiffness and multistep methods, boundary value and Eigen value problems, case studies.

Partial Differential Equations: Finite difference methods for elliptic and parabolic equations, case studies.

Reference Books

- Advanced Engineering Mathematics by Erwin Kreyszig, John Wiley & Sons, Inc., 8thedition 2010.
- Higher Engineering Mathematics by H K Dass, S Chand & Co. Ltd.,15th edition2006.
- Higher Engineering Mathematics by Dr B S Grewal, Khanna Publication, 40th edition2007.
- Introductory methods in Numerical Analysis by S. S. Sastry,PHI,LatestEdition.
- AppliedNumericalMethodsusingMATLABforEngineersandScientistsbyStevenC.Chapra McGraw-Hill (Indian edition), 3rd edition2012.

[IPI-19002] Process Plant Operation

Teaching Scheme:
Lectures: 3 hours / week

Examination Scheme:
Test 1: 20 Marks
Test 2: 20 Marks
End-Sem Exam: 60 Marks

Course Outcomes

1. Knowledge of unit operations and effect of other parameters [PEO1],[PO1]
2. Apply instrumentation basics to the unit operations [PEO2], [PO3]
3. Discuss different control strategies for controlling these unit operations for energy efficiency [PEO2],[PO4]
4. Propose the unit operation sequence and equipment required in different industries[PEO4],[PO4]

Course Contents

Unit operations and unit processes, Different physical and chemical laws in reference to different unit operations. Basic concepts of corrosion and protection from corrosion. Fluid transportation operations and equipment like pumps, compressors, fans, blowers and its specifications and working, selection of criteria, material. Heat transfer Operations and equipment like heat exchangers, boilers, condensers, evaporators, cooling towers and its and its specifications and working, selection of criteria, material. Study of different types of reactors. Mass transfer Operations and equipment like distillation, extraction, drying, humidification, dehumidification, absorption, filtration, sedimentation and its specifications and working, selection of criteria, material.Size reduction and mechanical separation operations like crushing and grinding, size separation and screening. Selection criteria and considerations for equipment used for size reduction and mechanical separation, forth floatation, hydro cyclones, jigging and concentration equipment. Applications of unit operations used in different industries like food, pharma, paper, sugar, cement, fertilizer, Petrochemical industry with help of process flow diagram.

Reference Books:

- Warren L. McCabe, Julian C. Smith, Peter Harroitt "Unit Operation in Chemical Engineering" McGraw Hill. Fifth ed., 2005.
- Bela G Liptak, "Instrument Engineers Handbook: Process Control" Pearson Education, Third ed., 1985.

[IPI (DE)-19001]Embedded Systems-I

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
Test 1: 20 Marks
Test 2: 20 Marks
End-Sem Exam: 60 Marks

Course Outcomes

1. To understand the scientific principles and concepts behind small scale embedded systems. [PEO1],[PO1].
2. To have a direct hands-on experience on both hardware and software elements commonly used in small scale embedded system design. [PEO2],[PO4].
3. To have knowledge of hardware/software co-design.[PEO2],[PO3].
4. Understanding the applications and role of microcontrollers for embedded systems design.[PEO3],[PO6].

Course Contents

Embedded Systems: Definition, classification, examples and broad overview. Embedded system design criterions, architectural design aspects, embedded programming and tools for building embedded systems, memory types- organization and interfacing.

Small scale embedded system design: Architecture of small scale microcontroller (PIC18F4550), I/O programming, Interrupt driven programming, digital and analog sensor interfacing, actuator interfacing,

Programming with: Timers, Counters, PWM, Enhanced PWM, CCP Module, On chip communication protocols: UART and USART (I2C, SPI).

Case studies and applications: DC Motor control, Control of conveyer belt, etc.

Reference Books:

- Mazidi, PIC Microcontroller and Embedded Systems: Using Assembly and C for PIC 18 series, Pearson, January 2008 edition
- John B. Peatman-- Design with PIC Microcontrollers, Pearson, 2009 Edition
- Raj Kamal, —Embedded Systems – Architecture: Programming and Design, Tata McGraw-Hill Education, 3rd ed.,2003
- Frank Vahid, Tony Givargis-- "Embedded System Design: A Unified Hardware/Software Introduction", John Wiley & Sons Inc., 2002.

[IPI(DE)-19002] Industrial Internet of Things

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. Understand, design and develop the real life IoT applications using off the shelf hardware and software. [PEO4],[PO4].
2. Knowledge of Key components in the field of IIoT, Architectures and its pros and cons [PEO1],[PO1].
3. Interpret the various IoT Layers and their relative importance in Business Models. [PEO3],[PO6].
4. Use various IoT platforms and security for solving social and industrial problems.[PEO4],[PO4].

Course Contents

Introduction to IIoT&IIoT Architectures, Overview of Components of IIoT – Sensors, Networks, Characteristic of IIoT System, Architectures for IIoT, Types of Architectures, Components of IIoT – Field Devices (Sensors /Actuators) & Field Networks - Sensors, Applicability of Sensors in different Industries, Design of sensors, Special requirements for IIoT sensors, Sensor architecture, Actuators basics, Types of Actuators, Introduction to wired and wireless technologies, Topologies of Networks, Overview of Protocols such as ZIGBEE, ZWAVE, MBUS, etc. Different IIoT networks & connectivity, Modes of communications, Overview of various IIoT protocols like - COAP, 6LoWPAN, LWM2M, MQTT, AMPQ etc., Comparison of Industrial devices vs. Prototype devices (Arduino, Mega, Pi, Galileo), Software Architecture of Edge/FOG devices. IOT Platform Architecture, Overview & Understanding of of COTS cloud platforms like Predix, Watson, Thingworks, Azure etc. , Basic understanding of various business models like SaaS, PaaS&IaaS and pros & cons

IoT Privacy, Security & Governance - Security Basics - Risk, Threat & Vulnerability, Risk Assessment, IIoT Security Framework based on IIC , Basic understanding of various IIoT security standards like NIST 82, IEC 62443, NERC, NIC etc., Hardware based Security, Overview of Data analytics, Cloud services, IIoT Use cases& Recent Trends in IOT - Data Analytics Basics, various techniques – Machine Learning , Deep learning, AI, Overview of IOT Cloud Services, classification and machine learning algorithms extract useful information from aggregated data, Recent Trends in IIOTs

Reference Books:

- Industrial Internet Vocabulary - IIC
- The Industrial Internet of Things Volume G1: Reference Architecture – IIC
- Industrial Internet of Things Volume G4: Security Framework – IIC
- The Industrial Internet of Things, Volume B01: Business Strategy and Innovation Framework – IIC
- Industrial Analytics: The Engine Driving the IIoT Revolution
- Karen Rose, Scott Eldridge, Lyman Chapin, "The Internet of Things: An Overview Understanding the Issues and Challenges of a More Connected World" Internet Society
- Bahga – Madisetti, "Internet of things Book – A hands on Approach"
- Olivier Hersent, "The Internet of Things: Key Applications and Protocols", 2nd Edition

- Alasdair Gilchrist, "Industry 4.0: The Industrial Internet of Things", 1st ed. Edition
- Industrial Automation and Control System Security Principles: Protecting the Critical
- Ronald L. Krutz, PhD, PE, "Infrastructure", Second Edition

[IPI(DE)-19003] Flow Engineering

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. Identify the required data for sizing and selecting flow meters and control valves [PEO1], [PO3].
2. Select proper size of flow meters and control valves as per the industrial requirements [PEO1],[PO4].
3. Examine behavior of flow metering and control valve sizing in fluid transportation system. [PEO1],[PO1].
4. Plan and prepare fluid transportation system in the process industries as per standard specifications.[PEO2],[PO5].

Course Contents

Fluid Properties, Phase Diagram, Density, Viscosity, Compressibility, Gas Mixtures, wet gas isentropic exponent, Measurement units and conversions, Flow calibration Standards, Calibration, Cross Correlation, Accuracy and turndown, Influence quantities, Process parameters, installation issues, laminar and turbulent flow, Flow straighteners and conditioners, Flow meter selection, sizing of orifice plates, venturi and nozzles, Their geometries, applications, R.O. plates, Fixed geometry flow Meters like annubar, US flow meters, magnetic flow meters, Turbine and PD meters, Installation of flow meters, critical flow, multiphase flow meters, multiphase flow patterns, Definitions and terminology used for control valves,Sizing for liquid flow, sizing for compressible fluids flow, Flow capacity tests, inherent flow characteristics,F to F dimensions, inspection and testing, marking, positioners, Data sheets, Cavitation and flashing, incipient cavitation, hydrodynamic noise, Aerodynamic noise, Severe service valves, Pressure Regulators, custody transfer

Industry Standards:

1. ISO 6817: Measurement of Conductive liquid flow in closed conduits-method using electromagnetic flowmeter
2. ISO 5167 part 1 to 4 – Measurement of fluid flow by means of pressure differential devices inserted in circular cross section conduits running full
3. ISO 9300: Measurement of gas flow by means of critical flow venturi nozzles
4. ISO 9951:1993: Measurement of gas flow in closed conduits-Turbine meters
5. IEC 60534 Part 1 to 8 – Industrial Process Control Valves
6. ISA – ANSI/ISA 75.01.01 – Flow Equations for Sizing Control Valves
7. ISO 9300: Measurement of gas flow by means of critical flow venturi nozzles
8. ISO 9951:1993: Measurement of gas flow in closed conduits-Turbine meters

Reference Books:

- Flow Measurement Engineering Handbook – R.W. Miller.
- Flow Measurement Handbook – Roger C. Baker
- Instrument Engineers Handbook – BelaLiptak

[IPI(DE)-19004] Automotive Embedded Product Development

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 30 marks each, End-Sem Exam - 40

Course Outcomes

1. Acquire knowledge of automotive embedded product development and illustrate their operation. [PEO1],[PO4]
2. Design and assemble automotive embedded products in appropriate project planning and scheduling. [PEO1],[PO3]
3. Apply processes, methods and tools to demonstrate learning. [PEO4],[PO4]
4. Develop, evaluate, and distribute stand-alone automotive applications. [PEO1],[PO3]

Course Contents

Automotive system overview & product development: Major Automotive trends (e-mobility, Autonomous Driving, Comfort & Connected Cars), Vehicle EE architecture, Products. Integration of Mechanical, Software, Hardware domains and their interdependences, Design for xAbilities(manufacturability, testability, serviceability, maintainability), Overview of Design guidelines.
Process, methods &tools: Requirement Engineering and version control tools: DOORs, PTC, V model, Product Engineering Process, Automotive Spice, TS 16949, Key Performance Indicators for development.
Product reliability, safety &quality:DFMEA, PFMEA, Warranty, Design Validations, Process Validations, Customer Line Return, Non-Quality Expenses, First Pass Yield, Statistical tools, ASIL levels, Safety Goals, Safety Measures, HARA, FMEDA, ISO 26262.
Project Management &Organization: Matrix Organization, Line responsibilities, Functional responsibility, Team work, Leadership, Scope management, Scheduling, Cost, Monitoring & Tracking, Engineering Change Management, Milestones.

[IPI(DE)-19005] Building Automation

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. Understand the architecture of BMS system. [PEO1],[PO1].
2. Discuss different components of HVAC, Fire & Alarm and Access Control system [PEO2],[PO4].
3. Discuss and implement new control strategies for HVAC systems for Energy Management [PEO3],[PO6].
4. Familiar with protocols and other systems used in BMS [PEO2],[PO3].

Course Contents

Introduction to intelligent buildings and Building automation systems, intelligent building, intelligent architecture and structure, Facilities management vs. intelligent buildings, Lifecycle of building. HVAC Basic Concepts such as Air handling unit-Design, working of different Operation of different modes. Variable Air Volume (VAV) system- unit heater, Fan coil unit and unit ventilator. Chilled water system and different types of components used in refrigeration cycle- evaporator, condenser, compressor, expansion valve. Hot water systems and different types of hot water system- with boilers, heat exchanger with steam input, heat exchanger, Sequencing of Boiler Plant. Access Control- Physical security system with components, RFID enabled access control with components. Computer system access control. Fire &Alarm System- Sensors to actuators and safety with standards. BMS Protocols - Open Protocols -BACnet, LON, Profibus, Modbus, M-bus, Proprietary Protocols- N2, CBUS, Introduction to wireless – Wireless filed devices, controllers, routers, coordinators. Energy Management System , Concept of Green

Reference Books:

- Roger W. Haines "HVAC Systems Design Handbook", Fifth Edition
- James E. Brumbaugh "HVAC Fundamentals", volume 1 to 3
- "Basics of Air Conditioning" ISHRAE, Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0004 for online shopping)
- "All About AHU's", ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0005 for online shopping)
- "Chillers Basics", ISHRAE. Indian Society of Heating

[ML-19011] Research Methodology and Intellectual Property Rights

Teaching Scheme:
Lectures: 2hrs/week

Examination Scheme:
Continuous evaluation
Assignments/Presentation/Quiz/Test

Course Outcomes

1. Define research problem formulation and approaches of investigation of solutions for research problems. [PEO1],[PO4].
2. Learn and use ethical practices to be followed in research and apply research methodology in case studies and acquire skills required for presentation of research outcomes. [PEO2],[PO2].
3. Analyze IPR is regarded as a source of national wealth and mark of an economic leadership in context of global market scenario. [PEO2],[PO5].
4. Summarize that it is an incentive for further research work and investment in R & D, leading to creation of new and better products and generation of economic and social benefits. [PEO3],[PO6].

Course Contents

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.Effective literature studies approaches, analysis, Use Design of Experiments /Taguchi Method to plan a set of experiments or simulationsor build prototype, Analyze your results and draw conclusions or Build Prototype, Test and Redesign, Plagiarism, Research ethics, Effective technical writing, how to write report, Paper.Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee. Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives and Importance of understanding Intellectual Property Rights. Understanding the types of Intellectual Property Rights: -Patents-Indian Patent Office and its Administration, Administration of Patent System – Patenting under Indian Patent Act, Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non-Provisional Patent Application and Specification, Plant Patenting, Idea Patenting, Integrated Circuits, Industrial Designs, Trademarks (Registered and unregistered trademarks), Copyrights, Traditional Knowledge, Geographical Indications, Trade Secrets, Case StudiesNew Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development, International Scenario: WIPO, TRIPs, Patenting under PCT

Reference Books:

- Aswani Kumar Bansal: Law of Trademarks in India
- B L Wadehra : Law Relating to Patents, Trademarks, Copyright,Designs and Geographical Indications.
- G.V.G Krishnamurthy: The Law of Trademarks, Copyright, Patents andDesign.
- SatyawratPonkse: The Management of Intellectual Property.
- S K Roy Chaudhary & H K Saharay : The Law of Trademarks, Copyright, Patents

- Intellectual Property Rights under WTO by T. Ramappa, S. Chand.
- Manual of Patent Office Practice and Procedure
- WIPO : WIPO Guide To Using Patent Information
- Resisting Intellectual Property by Halbert ,Taylor& Francis
- Industrial Design by Mayall, Mc Graw Hill
- Product Design by Niebel, Mc Graw Hill
- Introduction to Design by Asimov, Prentice Hall
- Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemle

[ML-19012] MLC-Effective Technical Communication

Teaching Scheme:
Lectures: 1hr / week

Evaluation Scheme:
100M: 4 Assignments (25M each)

Course Outcomes

1. Produce effective dialogue for business related situations [PEO2],[PO5]
2. Use listening, speaking, reading and writing skills for communication purposes and attempt tasks by using functional grammar and vocabulary effectively [PEO2],[PO2]
3. Analyze critically different concepts / principles of communication skills [PEO3],[PO6]
4. Appreciate, analyze, evaluate business reports and research papers [PEO2],[PO2]

Course Contents

Fundamentals of Communication: 7 Cs of communication, common errors in English, enriching vocabulary, styles and registers

Aural-Oral Communication: The art of listening, stress and intonation, group discussion, oral presentation skills

Reading and Writing: Types of reading, effective writing, business correspondence, interpretation of technical reports and research papers

Reference Books:

- Raman Sharma, "Technical Communication", Oxford University Press.
- Raymond Murphy "Essential English Grammar" (Elementary & Intermediate) Cambridge University Press.
- Mark Hancock "English Pronunciation in Use" Cambridge University Press.
- Shirley Taylor, "Model Business Letters, Emails and Other Business Documents" (seventh edition), Prentise Hall
- Thomas Huckin, Leslie Olsen "Technical writing and Professional Communications for Non-native speakers of English", McGraw Hill.

[IPI-19003] Transducers Design

Teaching Scheme:
Lectures: 3 hrs/week
Course Project:2hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. To recall the basic concepts, construction and working principle of various type of transducers/sensor to measure physical quantities. [PEO2],[PO4].
2. Design the transducer for a specific application based on the data provided by the process engineer. [PEO1],[PO1].
3. Develop a soft model of the sensors with variables, which will most affect the performance.[PEO1],[PO4].
4. Design a type testing and calibration system for the designed transducer. [PEO1],[PO3].

Course Contents

Review of transducers for various parameters like temperature, pressure, flow, level, humidity, acceleration, vibration, density etc. Design considerations and selection criterion as per standards, Sensor fabrication techniques, process details, and latest trends in sensor fabrication, fiber optics sensors, electromechanical sensors, Solid state chemical sensors, Bio-sensors, Piezo-resistive sensors, characterization of sensors, effect of sensors on process identification, signal conditioning techniques.
Modeling methods for transducer design, developing first principle model, and empirical model based on the data, describe effect of variables which are related to manufacturing tolerances and environmental effects.Standards for testing the transducers and calibration procedure and documentation for the calibration process.

Reference Books:

- Chapman, P., "Smart Sensors", ISA Publications, 1995.
- ISA–S37.1–1975 (Reaffirmed 1982), "Electrical Transducer Nomenclature and Terminology,"
- Instrument Society of America, 1975.
- SabrieSoloman, "Sensors Handbook", McGraw-Hill, 1999.
- Brayan Eggins, "Chemical Sensors and Biosensors" John Wiley& Sons, 2003.
- Eric Udd , "Fiber optics sensors",Wliey,1991.

[IPI-19004] Instrument Design Engineering

Teaching Scheme:
Lectures: 3 hrs/week
Course Project:2 hrs/week

Examination Scheme:
Test 1: 20 Marks
Test 2: 20 Marks
End-Sem Exam: 60 Marks

Course Outcomes

1. Analyze and justify the requirement of Instrument and systems. [PEO1],[PO1]
2. Design various electronic circuits and measurement systems, noises identification and appropriate elimination methods related to instrument and system. [PEO1],[PO3]
3. Select, design appropriate enclosure, cables, PCB. [PEO1],[PO3]
4. Estimate, analyze, improve the reliability of instrument and system. [PEO1],[PO4]

Course Contents

Electromagnetic Compatibility: Noise, Interference, Noise Coupling, cabling, grounding, ground loops, balancing and filtering Shielding: Near field, far field, absorption losses, and reflection losses Contact **Protections:** Arc discharge, Glow discharge, intrinsic noise sources, active device noise, and digital circuit grounding.

EMC Applications: Digital circuit power distribution, Digital circuit radiations, Conducted emissions, RF and transient immunity, electrostatic discharge, PCB layout and design, EMC measurements. Standards, reliability, automated test equipment.

Reference Books:

- Henry W Ott, "Electromagnetic Compatibility Engineering", John Wiley and Sons Inc. Publication, 2009 W. C. Bossshart , "PCB Design and Technology" Tata McGraw Hill, 1987
- Clyde F. Coombs, "Electronic Instrument Handbook", McGraw Hill, Third Edition, 2005

[IPI-19005] Modern Control Theory

Teaching Scheme:
Lectures: 3 hrs/week
Course Project:2 hrs/week

Examination Scheme:
Test 1: 20 Marks
Test 2: 20 Marks
End-Sem Exam: 60 Marks

Course Outcomes

1. An ability to design a continuous state feedback controller and observer in state space. [PEO1],[PO4]
2. An ability to design discrete state feedback controller and observer for the continuous system. [PEO1],[PO4]
3. To carry out analysis of multivariable systems using the concept of controllability, observability and stability. [PEO1],[PO3]
4. Ability to design compensators in continuous and discrete domain [PEO1],[[PO3]

Course Contents

State variable representation of linear and nonlinear systems, comparison with transfer function representation, standard forms of representation.

Time and frequency domain specifications, Pole placement by state feedback, controllability and observability, design of observers, separation principle. Controller design using transfer function approach.

Introduction to discrete time control, z transforms, difference equations, analysis of discrete time systems, controller design in discrete domain

Reference Books:

- H. Nijmeijer and AVD Schaft, "Nonlinear Dynamical Control Systems", Springer Verlag, New York, 1990.
- JJE Slotine and W. Li, "Applied Nonlinear Control", Prentice Hall, New Jersey, 1991.
- B. Friedland, "Advanced Control System Design", Prentice Hall, New Jersey, 1996.
- HK Khalil, "Nonlinear Systems", Prentice Hall, New Jersey, 2002.

Semester II

[IOC/ ICE-19001] Smart Sensors

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. Understand the concept of smart sensor. [PEO1],[PO1].
2. Select and analyze the behavior of smart sensor for a given application. [PEO1],[PO3].
3. Simulate, synthesize, and layout a complete sensor or sensor system. [PEO3],[PO4].
4. Design smart sensor and auto-calibration system for measurement of physical parameters. [PEO1],[PO3].

Course Contents

Introduction to smart sensors and emerging trends, measurement techniques, static & dynamic characteristics, Review of Fundamentals of sensors, Review of transducers for various parameters like temperature, pressure, flow, level, humidity, acceleration, Sensors fabrication, Design considerations and selection criterion as per standards, Sensor fabrication techniques, Theory and classifications of chemical sensors, fiber optic sensors, gas sensors, Data Acquisition techniques and Interface electronics, concept of intelligent instrumentation, case studies

Reference Books:

- Sensors and Transducers, D. Patranabis, Second Edition Prentice Hall of India Pvt. Ltd. New Delhi, 2006
- Fiber optics Communication and other applications, Henry Zanger, Cynthia Zanger, Macmillan publishing company, New York, 1991
- Transducers and Instrumentation, D.V.S.Murty, Second edition, PHI publication, Second edition, 2010.
- Handbook of modern sensors: physics, designs, and applications, Jacob Fraden, Third edition.
- Sensors Handbook, SabrieSoloman, McGraw-Hill , 1999
- Smart Sensors, Chapman, P., ISA Publications,1995

[IPI(DE)-19006] Batch Process Control

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. Study different standards required for batch process control. [PEO1],[PO1]
2. Identify and understand different module and components in batch Standards. [PEO2],[PO3]
3. Discuss different configuration of batch system to enhance the availability of process. [PEO4],[PO4]
4. Implement the standards for different batch processes with latest technology. [PEO2],[PO6]

Course Contents

Introduction to Batch Control System, Batch Control system terminology, Characteristics of Batch Processes, Hierarchical Batch Model, Control structure for batch systems. International Standards and Practices such as S 88, S 95, USA FDA regulation, 21CFR 11, etc. regulatory and discrete systems, Batch control design, system hardware and software, Batch control system specifications and implementation, Information/display requirements, cost justification and benefits, data management. Case study of batch control system implementation for applications in food and beverages, pharmaceuticals, etc.

Reference Books:

- T. G. Fisher, "Batch Control System", ISA series, 2nd Edition, 2010.
- Gregory K. Macmillan, Process/ Industrial Instruments and Controls Handbook, MCGrawHill

[IPI(DE)-19008] Industrial Automation

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. Apply the knowledge of automation in the field of industrial process control. [PEO1],[PO1].
2. Design the plant-wide architecture of the control system for a process industry. [PEO1],[PO3].
3. Develop network architecture and detailed specifications of network components. [PEO3],[PO4].
4. Solve engineering solution for fast growing industrial sector with reliable atomized system using PLC and DCS system. [PEO3],[PO4].

Course Contents

Different types of processes. Typical examples of continuous, batch, discrete and hybrid processes. Study of Process flow, detailed P&ID, Critical loops, Safety and Alarms, Reliability and Fail-safe operation requirements, efficient running and adhering to standards.

Role of automation in industries, Benefits of automation. Distributed Control Systems (DCS) system architecture, system elements, data communication links, DCS Engineering and Design, detailed engineering, specifications, configuration and programming, functions including database management, reporting, Sequential event recording 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. Selection and control of different process with advanced tools available with DCS, SCADA and PLCs. Discussion about hybrid control system. HART, Foundation fieldbus, Profibus protocol introduction, frame structure, programming, implementation examples, Benefits, Advantages and Limitations. Comparison with other fieldbus standards including device net, Profibus, Controlnet, CAN, Industrial Ethernet etc. Test and validation of system architecture, safety plans, and Safety Instrumented Systems (SIS).

Reference Books:

- Popovic and Bhatkar , " Distributed Computer Control For Industrial Automation" , Taylor & Francis group, 2011.
- Webb and Reis, "Programmable Logic Controllers: Principles and Applications", PHI, 2009.
- S.K.Singh, "Computer Aided Process Control", PHI, 2009.

[IPI(DE)-19009] Advanced Control System

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. Ability to design robust controller using SMC. [PEO1],[PO4].
2. Ability to design discrete controller using IDC and observer design. [PEO1],[PO4].
3. Understand and implement robust control laws for nonlinear\linear process models. [PEO1],[PO1].
4. To carry out analysis of nonlinear\linear systems using concept of finite-time reachability and stability. [PEO1],[PO3].

Course Contents

Introduction to uncertain systems, Nonlinear systems, Feedback linearization. Lyapunov stability theory. Design of controllers for nonlinear systems.

Sliding mode control, chatter control, reaching phase elimination, invariance and matching conditions. Control of mismatched systems: Back- stepping technique, co-ordinate transformation, special sliding surfaces.

Model following. Discrete sliding mode control. Unified sliding mode control.Methods of uncertainty estimation. Adaptive sliding mode control, time delay control, inertial delaycontrol, disturbance observers. State observers. Simultaneous state and uncertainty observers. Some case studies.

Reference Books:

- C. Edwards and S.K. Spurgeon, "Sliding Mode Control: Theory and Applications", Taylor & Francis, 1998.
- G. Bartolini, L.Fridman, A. Pisano and E. Usai (Ed.), "Modern sliding mode control theory", Springer, 2008.
- J.J.E Slotine and W. Li, "Applied nonlinear control", Prentice Hall, 1991.

[IPI(DE)-19010] Automotive Electronics Hardware Design

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 30 marks each, End-Sem Exam - 40

Course Outcomes

1. Acquire automotive specific hardware design skills. [PEO1],[PO4].
2. Understand concepts such as DFM, DFT, EMC, DFMEA. [PEO1],[PO1].
3. Apply processes, methods and tools to demonstrate design skills. [PEO4],[PO4].
4. Develop, evaluate, and deal with stand-alone automotive electronic hardware module. [PEO1],[PO3].

Course Contents

Low Power Domain: 16/32 bit controllers, Hardware-Software Interfaces, communication interfaces-CAN, LIN, SPI, wireless interfaces-Bluetooth, ISM band applications, I/O interfaces-digital, analog signal conditioning, switches, relays, high side, low side drivers, Introduction to design tools (Microcap, Cadence Concept HDL and Allegro).

High Power Domain: Selection of power switching devices-MOSFETs/ IGBTs/ SiC/GaNFETs, Gate driver design, power loss calculations, thermal management, Design considerations for High Voltage applications.

Electromagnetic Compatibility: Introduction to various regulatory requirements and International electrical and EMC standards, understanding origin of pulses, disturbances, circuit and PCB layout design techniques to meet EMC.

Design for Manufacturability and Testability: PCB layout considerations, Manufacturing interfaces and process flow, ICT, AOI and EOL testing.

[IPI(DE)-19011] Embedded Systems-II

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. Understanding the RISC architecture of processors, its features and applications. [PEO1],[PO1].
2. Hands on usage of IDE of processors and algorithm development. [PEO2],[PO4]
3. To understand the concept of OS, embedded OS, and applications perspectives. [PEO3],[PO6]
4. Study, design, analyze and prototype high-end embedded systems. [PEO2],[PO3].

Course Contents

ARM-Cortex M series architecture: Embedded systems, classification, ARM 32-bit microcontroller Tiva, architecture—technology overview, Architectural Features of ARM Cortex M series: Tiva Block Diagram, CPU modes, register organization, ROM, RAM, timers, data and address bus, Memory and I/O interfacing concepts, memory mapped I/O. CISC Vs RISC design philosophy, pipelining, exceptions and its handling, memory, I/O‘s and addressing modes.

Peripherals: Interfacing of peripherals using Tiva: LED and sensors, ADC, Timer, PWM, UART, SPI, I2C.

Operating system based development: Operating systems fundamentals, operating system services, memory management, process management, device management, file management, Operating system services- program execution, I/O operation, file manipulation, communication, Operating system properties- multitasking, parallel programming, interactivity, scheduling and scheduling algorithms.

Linux: An overview of Red Hat Linux, installing Ubuntu, Linux commands, shell scrip programming, embedded Linux.

Development Tools (Open Source): GNU tools, text editors-vi, nano, pico,etc. IDE-Eclipse, code lite, compilers-gcc, g++, debuggers, cross-compilers, gcc- arm specific tool chains and in line assembly, Writing and compiling C/C++ programs, cross-compilation for ARM development board, Basics of make file, static and dynamic libraries.

Kernel programming: Kernel, basic functionalities of kernel, kernel module programming, Linux kernel sources, kernel configuration, booting kernel, kernel booting parameters, root file system,bootloader,U-boot,portingLinuxonARMboard,devicedriverprogramming, architecture, I/O communication, writing simple character device driver.

Reference Books:

- MichaelBeck, —Linuxkernelprogramming, Addison-WesleyProfessional,3rded. 2002.
- Embedded Systems: Real-Time Interfacing to ARM Cortex-M Microcontrollers, 2014, Jonathan W Valvano Create space publications ISBN: 978-1463590154.
- Sloss Andrew N, Symes Dominic, Wright Chris, —ARM System Developer's Guide: Designing and Optimizing‖, Morgan Kaufman Publication,2004
- Embedded Systems: Introduction to ARM Cortex - M Microcontrollers, 5th edition Jonathan W Valvano, Create space publications ISBN-13: 978-1477508992

[IPI(DE)-19012] Soft Computing

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. Able to define the expert system architecture and soft computing techniques. [PEO1],[PO1].
2. Recognize the feasibility of applying appropriate soft computing techniques for a given real world problem. [PEO1],[PO3]
3. Examine the solution of problem based on of the basics of learning and training algorithms. [PEO4],[PO4]
4. Develop engineering applications using neural network, fuzzy logic, genetic algorithm and hybrid system.[PEO3],[PO6]

Course Contents

Artificial Intelligence: a Brief Review, Pitfalls of Traditional AI, Need for Computational Intelligence, Importance of Tolerance of Imprecision and Uncertainty, Constituent Techniques, Overview of Artificial Neural Networks, Fuzzy Logic, Evolutionary Computation.

Neural Network: Biological and Artificial Neuron, Neural Networks, Supervised and Unsupervised Learning. Single Layer Perceptron, Multilayer Perceptron, Backpropagation Learning, Neural Networks as Associative Memories, Hopfield Networks, Bidirectional Associative Memory, Topologically Organized Neural Networks, Competitive Learning, Kohonen Maps.

Fuzzy Logic: Fuzzy Sets, Properties, Membership Functions, Fuzzy Operations, Fuzzy Inference System, Fuzzification and defuzzifications module, Scaling factors, Fuzzy controllers.

Genetic Algorithms: Introduction and concept, Coding, Reproduction, Cross Applications, Swarm intelligence, and their applications.

Evolutionary Computation: Overview of other Bio-inspired Algorithms - Swarm Intelligence Algorithms, Particle Swarm optimization, Ant Colony optimization, Grey-Wolf optimization, Hybrid systems: Neuro-fuzzy, Genetic-neuro, Genetic-fuzzy.

Reference books:

1. Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications, by S. Rajasekaran and G. A. VijayalakshmiPai, 2nd Edition, PHI Learning, 2003.
2. Soft Computing: Neuro-Fuzzy and Genetic Algorithms by Samir Roy and Udit Chakraborty, 1st Edition, Pearson, 2006.
3. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, 3rdedition ,Prentice-Hall International, 2000.
4. Introduction to Artificial Systems by J. M. Zurada, 5th Edition, Jaico Publishing House, 2004.

5. An Introduction to Neural Networks by James A. Anderson, 2nd edition , Prentice Hall of India, New Delhi, 1999.
6. An Introduction to Fuzzy Control by D. Drainkov, H. Hellendoorn and M. Reinfrank,, 6th edition , Springer-Verlag Berlin Heidelberg Publisher, 2008.
7. Fuzzy Logic with Engineering Applications by T. J. Ross, 3rd edition, MIT Press, Inc 2011.
8. Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence by Kosko Bart, Prentice Hall of India, New Delhi, 2001.
9. An Introduction to Genetic Algorithms by Melanie Mitchell, 2nd Edition, MIT Press, 1999.

[IPI(DE)-19013] Optical Instrumentation

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. Able to explain the basic concepts of opto-electronic modules. [PEO1],[PO1].
2. Apply LASER and Optical fiber for various physical parameter measurements. [PEO1],[PO4]
3. Analyzing the optical sensor technology on various parameters of measurements. [PEO2],[PO4]
4. Describe selection of the appropriate optical fiber sensors for industrial applications. [PEO3],[PO1]

Course Contents

Optical fiber waveguide: Ray theory of transmission, total internal reflection, and electromagnetic mode theory of optical propagation, cylindrical fiber, classification of fibers, manufacturing of optical fiber.

Transmission characteristics of optical fiber: Attenuation, material absorption losses, scattering losses, nonlinear and linear scattering, fiber bend loss, dispersion, intermodal dispersion, dispersion modified single mode fiber, dispersion flattened fibers, polarization, nonlinear phenomena.

Optical sources and detectors: Optical emission from semiconductor, semiconductor LASER, non-semiconductor LASER, LED as an optical source, optical detector principles, absorption, quantum efficiency, responsively, photo diodes, modulation.

Optical fiber sensors: Introduction to fiber optics sensors, sensors based on intensity modulation, application of optical fiber for displacement, strain, stress and pressure measurement. Active multimode FO sensors, micro-bend optical fiber sensors, current sensors, phase modulated, polarization modulated optical fiber sensors, fiber optic gyroscope.

LASER applications: Introduction, application of LASER in biomedical instrumentation, LASER interferometry, performance parameters, LASER telemeters, measurement of distance, LIDAR, holography: basic principle of holography, measurement of strain, stress, bending moments and vibrations using hologram.

Optical amplification and integrated optics: Optical amplifiers, integrated optics integrated optical devices: beam splitters, directional couplers, modulators, switches, optoelectronics integration and differentiation, analog arithmetic operations, digital optics.

Reference Books:

- Jose Miguel Lopez, "Optical fiber sensing technology", John Wiley & Sons, 2002
- AjoyGhatak, "Optics", Tata Mc- Graw Hill Publishing, 5th ed., 2012
- Joseph T Verdeyen, "LASER Electronics", Prentice Hall of India, 3rd ed., 2003
- John M. Senior, "Optical fiber Communications Principles and Practice", PHI publication, 2nd ed., 2008

[IPI(DE)-19014] Artificial Intelligence and Machine Learning

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course outcomes

1. Understand Artificial Intelligence and its approaches. [PEO1][PO1].
2. Solving some problems using supervised, unsupervised and semi supervised machine learning algorithm.[PEO1],[PO4]
3. Study of probabilistic analysis, parametric and non-parametric algorithms. [PEO1],[PO1].
4. Estimation of Maximum Likelihood, losses and risks for classifications problems. [PEO1],[PO3]

Course Contents:

Artificial Intelligence - Introduction, Intelligent Agents, Problem-solving, Solving Problems by Searching, Informed Search and Exploration, Constraint Satisfaction Problems, Adversarial Search, Knowledge and reasoning, Logical Agents, First-Order Logic, Inference in First-Order Logic, Knowledge Representation. Planning, Planning and Acting in the Real World, Uncertain knowledge and reasoning, Uncertainty, Probabilistic Reasoning, Probabilistic Reasoning over Time, Making Simple Decisions, Making Complex Decisions. Introduction to Machine Learning: What is machine learning, Applications of ML, Design Perspective and Issues in ML, Supervised, Unsupervised, Semi-supervised learning with applications and issues, Input : Concepts, instances and attributes, Output: Knowledge Representation: Decision tables, Decision trees, Decision rules, Rules involving relations, Instance-based representation, Data Pre-processing-data cleaning, data integration and transformation, data reduction, data discretization and concept hierarchy generation. Introduction to Classification, issues regarding classification, Classification:Model(or hypothesis) representation, decision boundary, cost function, gradient descent, regularization. Diagnostic: debugging a learning algorithm, evaluating a hypothesis (Modelselection), training/validating/testing procedures, diagnosing bias versus variance and vice versa, regularization and bias/variance, learning curves. Accuracy and Error measures: classifier accuracy measures, predictor error measure, evaluating the accuracy of a classifier or predictor, Confusion metric, precision, recall, tradeoff between both, accuracy. Decision Tree : representation, hypothesis, issues in Decision Tree Learning, Pruning, Rule extraction from Tree, Learning rules from Data, Probabilistic classifier: Bayes rule, Maximum Likelihood Estimation, case Study, Clustering :Unsupervised learning technique, Similarity and Distance Measures, k-means and k-medoids algorithm, optimization objective, random initialization, choosing value of k, EM algorithm. Framework for machine learning applications, human-computer interaction, Case studies in the domain of Measurement, Analysis and Control, etc.

Reference Books:

- Stuart J. Russell and Peter Norvig, "Artificial Intelligence A Modern Approach," 3rd edition, Prentice Hall
- Tom Mitchell, "Machine Learning", McGraw-Hill, 1997
- EthemAlpaydin, "Introduction to Machine Learning", PHI, 2005
- Bishop, C., "Pattern Recognition and Machine Learning:," Berlin: Springer-Verlag, 2006

- K.P. Soman, R. Longonathan and V. Vijay, "Machine Learning with SVM and Other Kernel Methods", PHI
- Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer 2006.
- Tom M. Mitchell , "Machine Learning", McGraw-Hill, 1997
- The Elements of Statistical Learning - by T. Hastie, R. Tibshirani, and J. Friedman, 2009

[IPI(DE)-19015] Automotive Electronics Software Development

Teaching Scheme:
Lectures: 3 hrs/week

Examination Scheme:
T1, T2 – 30 marks each, End-Sem Exam - 40

Course Outcomes

1. Acquire automotive specific software design skills. [PEO1],[PO4].
2. Understand concepts such as AUTOSAR, MATLAB, Communication Protocol. [PEO1],[PO1].
3. Apply processes, methods and tools to demonstrate design skills. [PEO4],[PO4].
4. Develop, evaluate, and deal with stand-alone automotive electronic software module. [PEO1],[PO3].

Course Contents

Software Architecture: Classical architecture, Layered Architecture (AUTOSAR), All layer information (e.g. RTE, BSW, Application) Tool: Davinci developer, configurator, Raphsody.

Communication Protocols: Communication Protocol, CAN, LIN, Automotive Ethernet, RF, Bluetooth, Wi-Fi, Diagnostic Protocol: UDS, Tools: CANoe, Vehicle spy, CAPEL ,TAE scripting.

Model Based Development: Model Based Development: Algorithm/application development using Simulink, stateflow, code generator.

Embedded C: Concepts of C (structure, union, pointer, bitwise operator), Logic building according to requirement, MISRA C guidelines.

Software Testing: Unit testing, Model in loop(MIL) testing, module testing, integration testing, software in loop(SIL) testing, Hardware in Loop (HIL) testing,. Tools: Tessy, PolySpace, TPT, Winidea, QAC, HIL Test Setup.

[LLC-19001] Liberal Learning Course

Teaching scheme:
Lectures: 3 hrs./week

Examination Scheme:
T1, T2 – 20 marks each,
End-Sem Exam – 60

Course Outcomes:

1. Ability to exhibit self-learning capabilities and its use in effective communication. [PEO2], [PO5].
2. An ability to inculcate impact of various areas to relate with society at large.[PEO4], [PO6].
3. Demonstrate the familiarity with one or more multi-disciplinary areas of their choice. [PEO2], [PO5].
4. Communicate effectively, through written and oral communication and through other forms as appropriate. [PEO2], [PO5].

Course Contents:

Identification of topic and resources, scope, and synthesize viewpoints for the areas such as performing arts, basic Sciences, business, philosophy, sports and athletics, defense studies and education.

[IPI-19006] Advanced Process Instrumentation

Teaching Scheme:
Lectures: 3 hrs/week
Course Project:2hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. Know the application of different transducers, calculation of errors in measurement and computer process control systems.[PEO1],[PO4].
2. To analyze various process characteristics and dynamics. [PEO2],[PO4].
3. To implement various control configurations for industrial processes using advanced process control techniques. [PEO1],[PO3].
4. Develop the advanced control techniques, system identification and process modelling. [PEO1],[PO3].

Course Contents

Review of process characteristics and process analysis, different control strategies for various processes. Process identification methods, Analysis and control of some common processes like Distillation column, Boilers, Heat Exchangers, Spray Dryer and evaporator, Types of models and modeling methods, process dynamics and design, advanced and intelligent control strategies and their applications, RGA, Introduction to interaction and decoupling.

Reference Books:

- S K Singh, "Process Control Concepts, Dynamics and Applications", PHI Publications, 2009
- Andrews and Williams, "Principles of Applied instrumentation", Vol. I, II, III, IV, Gulf Publications company
- F. G. Shinsky, "Process Control System," Mc Graw Hills, 1996.
- B.G. Liptak , "Process Control", Chilton Publications, Fourth edition, 2009.
- Design and Application of Process Control Systems, ISA

[IPI-19007] Process Modeling and Optimization

Teaching Scheme:
Lectures: 3 hrs/week
Course Project:2hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. Understanding of process model design using first principles, conversation principles and process data. [PEO1],[PO1]
2. Have an understanding of computational techniques to solve the process models. [PEO1],[PO4].
3. To solve and analyze optimization problem formulations. [PEO2],[PO4].
4. Get familiar with analytical techniques used to solve single objective, unconstrained and constrained optimization problems. [PEO1],[PO3]

Course Contents

Introduction of Mathematical Modeling: Definition of process Model, Physical and Mathematical modeling, deterministic and stochastic models, need of models and their classifications, model building, black-box model. Classification of mathematical models, use of mathematical models, principles of formulation, fundamental laws, continuity equations, energy equations, transport equations, equations of state, equilibrium, kinetics. **Case study:** CSTR Model, boiler-heat exchanger model.

Model Solving: Solving non-linear simultaneous equations using Newton's Method. Ordinary differential equations and differential algebraic equations and solving ODE's and DAE's, partial differential equations, solution of PDE's by finite difference methods. Introduction to various simulation software and solvers.

Optimization Fundamentals: Optimization problems, objective function, constraint and unconstraint surfaces, classification of optimization problems. Convexity and concavity of functions having one and two variables.

Unconstrained Optimization: Optimization of a function with one and multiple variables, gradient vectors, subject to equality constraints and Lagrangian multipliers, Hessian matrix formulation, necessary and sufficient conditions of optimality (KKT) conditions. First derivative method, Newton's and quasi-Newton's method, conjugate gradient method of unconstrained optimization problems.

Linear Programming: Standard form of linear programming problem, canonical form of LP problem, Simplex method, simplex algorithm, construction of simplex tableau, minimization versus maximization problem.

Constrained optimization: formulation of equality constraint and inequality constraint optimization problems, KKT conditions, Lagrangian methods, NLP and solution of NLP by sequential quadratic programming (SQP) methods.

Reference Books:

- Luyben W. L., "Process Modeling Simulation and Control for Chemical Engineers", 2nd Ed., McGraw Hill
- Edger, Himmelblau, Lasdon, Optimization of Chemical Processes,McGraw-Hill International, Edition.

- S.S. Rao, "Engineering Optimization: Theory and Practice", New Age International P)Ltd., New Delhi.
- K. Deb, "Optimization for Engineering Design-Algorithms and Examples", Prentice-Hall of India Pvt. Ltd., New Delhi, 1995.
- Denn M. M., "Process Modeling", Longman, 1986
- B Wayne Bequette, Process Dynamics: Modelling, Analysis and Simulation, Prentice Hall International Inc.

[IPI-19008] Statistical Process Control

Teaching Scheme:
Lectures: 3 hrs/week
Course Project:2hrs/week

Examination Scheme:
T1, T2 – 20 marks each, End-Sem Exam - 60

Course Outcomes

1. Understand the philosophy and basic concepts of quality improvement as regards to process plant environment. [PEO1],[PO1]
2. Demonstrate the ability to use the methods of statistical process control. [PEO1],[PO4]
3. Demonstrate the ability to design use and interpret control charts for variables. [PEO1], [PO3]
4. Performance analysis of process capability and measurement system capability. [PEO2],[PO4].

Course Contents

Quality Improvement in the modern business environment, The DMAIC Process, methods and Philosophy of Statistical Process, Control Charts for Variables, Control Charts for Attributes, Process and Measurement System Capability Analysis, Exponentially Weighted Moving Average and Moving Average Control Charts, Introduction to basic concepts of quality improvement, management and quality control, An overview of Statistical Quality Control methods, Six-Sigma Process and the DMAIC Roadmap (and requisite tool usage), Practical Industry Quality examples and outcomes, Root cause problem identification, analyses and resolution, Statistical Process Control and Capability Analyses (Control Charting, Capability, etc.)
SPC-The Magnificent Seven, Applications of SPC, Control Charts for Variables, Control Chart for Individual Units, Applications for Variables Control Charts, Control Charts for Attributes, Choice between Attributes and Variables, Control Charts, Process Capability Analysis, Process Capability Ratios, Process Capability Analysis, Exponentially Weighted Moving Average Control Chart

Reference Books:

- Introduction to Statistical Quality Control, by D. C. Montgomery, 7th edition, 2009. Wiley, ISBN: 9780470169926.
- Montgomery, Douglas C. (2009). Introduction to Statistical Quality Control, Sixth Edition. John Wiley and Sons, Inc. (ISBN: 978-0-470-16992-6).

Semester-III

[IPI-20001] Dissertation Phase I

Teaching Scheme:
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Examination Scheme:
Marks: 100 each for phase I and II

Course Outcomes

1. Ability to synthesize knowledge and skills previously gained and applied to an in depth study and execution of new technical problem. [PEO1][PO1]
2. Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design and justify their design. [PEO3][PO6]
3. Ability to present the findings of their technical solution in a written report. [PEO2],[PO2].
4. Demonstrate an ability to present and defend their research work to a panel of experts. [PEO1],[PO3].

Course Contents

The dissertation / project topic should be selected / chosen 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 dissertation should have the following:

1. Relevance to social needs of society
2. Relevance to value addition to existing facilities in the institute
3. Relevance to industry need /requirement
4. Problems of national importance
5. Research and development in various domain

The student should complete the following:

1. Literature survey
2. Problem Definition
3. Motivation for study and Objectives
4. Preliminary design / feasibility / modular approaches
5. Implementation and Verification
6. Report and presentation

Semester-IV

[IPI-20002] Dissertation Phase II

Teaching Scheme:
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Examination Scheme:
Marks: 100 each for phase I and II

Course Outcomes

1. Ability to synthesize knowledge and skills previously gained and applied to an in depth study and execution of new technical problem. [PEO1][PO1]
2. Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design and justify their design. [PEO3][PO6]
3. Ability to present the findings of their technical solution in a written report. [PEO2],[PO2].
4. Demonstrate an ability to present and defend their research work to a panel of experts. [PEO1],[PO3].

Course Contents

The dissertation stage II is based on a report prepared by the students on dissertation allotted to them.

It may be based on:

1. Entirely on study and analysis of typical Instrumentation and Control system, Biomedical Instrumentation / devices / instruments / related topic
2. Experimental verification / Proof of concept
3. Design, fabrication, testing, and calibration of an instrumentation system.
4. The viva-voce examination will be based on the above report and work.