SAVITRIBAI PHULE PUNE UNIVERSITY

Syllabus

B. E. Instrumentation & Control

(2015 Course- Credit Based)

Board of Studies

Instrumentation & Control Engineering

(w.e.f. June- 2018)

Savitribai Phule Pune University

Structure for B. E. Instrumentation and Control - 2015 course (Credit Based)

SEMESTER- I

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME						Credits	
				Paper						Theory	PR/OR/TW
		TH	PR	In Semester Assessment	End semester Assessment	PR	TW	Oral	Total		
406261	Process Dynamics and Control	4	2	30	70	50	-	-	150	4	1
406262	Project Engineering and Management	3	2	30	70	-	-	50	150	3	1
406263	Computer Techniques and Applications	3	2	30	70	-	50	-	150	3	1
406264	Elective- I	3	2	30	70	-	-	50	150	3	1
406265	Elective- II	3	-	30	70	-	-	-	100	3	-
406266	Project Stage- I	-	2	-	-	-	50	-	50	-	2
406267	Audit Course- 5	-	-	-	-	-	-	-	-	-	-
Total		16	10	150	350	50	100	100	750	22	

SEMESTER- II

CODE	SUBJECT	TEACHING SCHEME		EXAMINATION SCHEME						Credits	
				Paper						Theory	PR/OR/TW
		TH	PR	In Semester Assessment	End semester Assessment	PR	TW	Oral	Total		
406268	Process Instrumentation	3	2	30	70	-	-	50	150	3	1
406269	Industrial Automation	3	2	30	70	-	-	50	150	3	1
406270	Elective- III	3	2	30	70	-	-	50	150	3	1
406271	Elective- IV	3	-	30	70	-	-	-	100	3	-
406272	Project Stage- II	-	6	-	-	-	100	50	150	-	4 (TW) + 2 (OR) = 6
406273	Online Certification Course	-	2	-	-	-	50	-	50	-	1
406274	Audit Course- 6	-	-	-	-	-	-	-	-	-	-
Total		12	14	120	280	-	150	200	750	22	

Elective- I (406264)	Elective- II (406265)	Elective- III (406270)	Elective- IV (406271)
Industrial Internet of Things	Smart and Wireless Instrumentation	Building Automation	Reliability Engineering
Electrical Drives	Instrumentation and Control for Power Plants	Robotics and Automation	Renewable Energy Systems
Advanced Digital Signal Processing	Automotive Instrumentation	Environmental Instrumentation	Instrumentation in Agriculture and Food Industries.
Advanced Bio- Medical Instrumentation	Opto- Electronics Instrumentation	Digital Image Processing	Smart Material and Systems
Digital Control Systems	Soft Computing	Process Modelling and Optimization	Open Elective

SEMESTER- I

406261: Process Dynamics and Control

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 4 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 4
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Practical: 1
	End Semester Assessment: 70 Marks.	
	Practical : 50 Marks	

Prerequisite: 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 basic principles & importance of process control, classification of process variables and to provide the knowledge of process modeling & dynamics.
2. To equip students with knowledge of dynamic behaviour of first order and second order processes. Analyzing closed-loop control systems for stability and steady-state performance.
3. To understand the principle and design of feedback, multi-loop controllers, model based controllers and their applications.
4. To equip students with knowledge of multivariable control, interaction, the pairing, decoupling and design of controllers for interacting multivariable systems.

Course outcomes:

1. To derive, develop and analysis of mathematical model using fundamental laws and performing experimentation on prototype type laboratory setups.
2. Analysis of temperature, pressure, flow and level loops.
3. To design, simulation and analysis of feedback, multi-loop and model based controllers.
4. Ability to understand the effect of interaction, pairing of variables, design of decoupler and controller for multivariable systems.

Unit I: Introduction to Process Control (6)

Process control introduction, objectives and benefits, Characteristics of processes, Dead time, Single /multi- capacity, self- Regulating /non self-regulating, Interacting / non-interacting, Linear/nonlinear, and Selection of control action for them.

Necessity of process modelling, degree of freedom, Mathematical modelling of simple processes like Surge tank level, stirred tank reactor etc.

Unit II: Process Dynamics and analysis of control loops (6)

Dynamic behaviour of first order and second order systems, Pole- Zero effect on process response, Development of empirical model using Step and PRBS inputs , Approximation of higher order models, Analysis of Flow Control, Pressure Control, Liquid level Control, Temperature control, Steady state gain, Process gain, Valve gain, Process time constant, Variable time Constant, Transmitter gain.

Unit III: Feedback Control (8)
Block Diagram, Elements of the feedback Loop, Response for Set- point and Disturbances inputs, PID Controller Algorithms, Stability, Control Performance Measures, Tuning and Fine tuning of controllers for Good Control Performance, Correlations for tuning Constants, Practical Application of Feedback Control: Equipment Specification, Input Processing, Feedback Control Algorithm, Output Processing.

Unit IV: Multi-Loop Control (7)
SLPC and MLPC features, faceplate, functions and their comparison.
Basic principles, Design Criteria, Performance, Controller Algorithm and Tuning, Implementation issues of- Cascade control, feed forward control, feedback, feed-forward Control, Ratio control, Selective Control, Split range control, Inferential Control.

Unit V: Multivariable Control (8)
Concept of Multivariable Control: Interactions and its effects, block representation and transfer function matrix of two input two output systems, Pairing of controlled and manipulated variables-Relative Gain Array, Singular Value Analysis, effect of Interaction on stability. Decoupler, and decoupler design: ideal decoupler, simplified decoupler and static decoupler. Concept of decentralized control, decentralized control of the coupled tank system.

Unit VI: Advanced Control (7)
Model based controller-design procedure for direct synthesis method, tuning relations based on integral error criteria, Smith predictor, Internal Model control-design procedure for FOPDT, SOPDT and Inverse response processes, Effect of model uncertainty and disturbances, design of improved disturbance rejection, IMC based PID controller design procedure for delay free processes and Introduction to Model predictive control.

List of Experiments :
Students are expected to perform Minimum Eight Experiments: (Using MATLAB, SCILAB etc. wherever required.)

1. Develop a FOPDT/SOPDT empirical model of any process.
2. Effect of control actions on system with dead time and integrating systems
3. Study of Flow loop/Study of Level loop.
4. Study of Temperature loop/ Study of Pressure loop.
5. Finding best tuning values based on any performance criteria.
6. Design and Implementation of Cascade control loop.
7. Study of Ratio control/ Selective control. (Any one)
8. Design and Implementation of Model based controller for FOPDT system.
9. Design and Implementation IMC for FOPDT and SOPDT processes.
10. Design and Implementation of IMC for inverse response processes.
11. Design and Implementation of IMC based PID controller for delay free systems

Text Books:

1. Process Dynamics and Control- Seborg, Wiley
2. Chemical Process Control : George Stephonopolous, PHI.
3. Process Control: Modeling, Design and Simulation : B. Wayne Bequette, PHI.

Reference Books:

1. Process Control- Designing processes and Control Systems for Dynamic Performance: Thomas E Marlin, McGraw-Hill International.
2. Instrument Engineers' Handbook : Process control : B.G. Liptak, Chilton.
3. Process Control Systems-F.G. Shinskey, TMH.

406262: Project Engineering and Management

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	
	Oral : 50 Marks	

Prerequisite: Industrial Organisation and Management

Course Objectives:

1. Apply the basic concepts of industrial organisation and management for instrumentation projects.
2. To understand life cycle phases and activities involve in instrumentation projects.
3. To know the use of various standards in instrumentation projects.
4. To know front end engineering design and its documentation.
5. To learn the detail engineering design and its documentation.

Course Outcomes:

After successful completion of the course the student will be able to

1. Know the role and responsibilities in the project organization structure
2. Know the tools of Project Planning scheduling and planning
3. Apply the Design documents/activities require in different phases of the project.
4. Understand/ apply the standards in the project development
5. Interpret the design information from the documents

Unit I: Introduction to Project Management (6)

Definition and objectives of Project Management, Types and classification of projects, Life cycle phases of the project. Interactions involved in Project and their coordination.
Organization Structure: Role and responsibilities of the project manager, functional team members. Management functions: Defining the scope, team building, controlling, directing.

Unit II: Project Planning and Scheduling (6)

Project Planning: Introduction and basic requirements, establishing project objectives, Statement of work (SOW), project specifications, Work Breakdown structure (WBS).
Project scheduling: Introduction and basic requirements, milestone scheduling, Network scheduling techniques: Network fundamentals, GERT, PERT, CPM, concept of crash time.
Types of estimates, pricing process.

Unit III: Procurement activities (4)

Pre-Qualification Evaluation of Vendor, Vendor registration, Tendering and bidding process and required documents, Bid evaluation, Purchase orders

Unit IV: Instrumentation Preliminary and FEED Project Engineering Documents and Standards (10)

Introduction to ISA standards: ISA S-5.1, 5.2, 5.3, 5.4, 5.5 and S-20.
Preliminary Engineering Documents: PFD, P&ID (ISA S-5.1, 5.3), Process Control Narratives. Front End Engineering and Design (FEED) documents: Plant and piping layouts, Instrument schedule, I/O schedule, Instrument specification sheets (ISA S-20), logic diagram (ISA S-5.2), sizing and calculation documents, Instrument layout, Junction box layout, system Architecture and network layout diagrams, Control room layouts

Unit V: Detail Engineering Design (6)

Cable Engineering: Class of conductors, Types, Specification, Selection, Cable identification schemes, Cable trays. Earthing and Grounding for General and power Signals. Instrument Loop wiring diagrams (ISA S-5.4).
Instrument Hook up, BOM and MBOM. Control room layout, Panel layout and General Arrangement drawings

Unit VI: Construction and Testing Activities (7)

Construction activities: Site conditions and planning, Front availability, Installation and commissioning activities and documents required at this stage.
Types of operating Stations, Control system specifications, Control system graphics (ISA S-5.5), databases, I/O allocation and configuration. Panel testing Procedure and its documentation. Factory Acceptance Test (FAT), Customer Acceptance Test (CAT), Site inspection and testing (SAT), Cold Commissioning and hot commissioning.

List of Experiments :

Students are expected to perform Minimum Eight Experiments :

1. Develop SOW, project specifications and WBS for any instrumentation project.
2. Preparation of Inquiry, Quotation, Comparative statement, Purchase orders.
3. Study of standards and symbols (ANSI / ISA S-5.1).
4. Development of Process & Instrument diagram of typical process.
5. Develop Instrument index sheet for a P&ID developed in experiment 4.
6. Develop specification sheets for transmitters and actuators (ISA S-20 Format).
7. Prepare a loop wiring diagram and Cable schedule.
8. Prepare a Hook up drawings for installation of transmitters and control valve.
9. Develop GA and mimic diagram of a control panel.
10. Prepare documents required for FAT of a control panel.

Text Books:

1. Management systems by John Bacon (ISA).
2. Project Management A System Approach to Planning, Scheduling and Controlling by Harold Kerzner (Van Nostrand Reinhold Publishing).
3. Applied instrumentation in process industries by Andrew & Williams (Gulf Publishing).

Reference Books:

1. Process control Instrument Engineers Handbook by Liptak.
2. Instrument Installation Project Management (ISA).
3. Successful Instrumentation & Control Systems Design, by Michael D. Whitt (ISA).
4. Instrumentation Control Systems Documentation, F.A. Meier and C.A. Meier (ISA).

406263: Computer Techniques and Applications

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Term Work: 1
	End Semester Assessment: 70 Marks.	
	Term Work : 50 Marks	

Prerequisites: Basic computer skills and logic development skills

Course Objectives:

1. To provide better understanding of functions of different operating systems.
2. To provide knowledge of software testing and communication protocols
3. To understand the software development life cycle.

Course Outcomes: Students will be able to

1. To explain the operating system functions in detail.
2. To differentiate real time operating system and operating system.
3. To evaluate the performance of any developed software.
4. To use the proper communication channel and software for transforming and storing the data

Unit I: Operating System Overview

Concepts of Operating System and its services, Types of operating systems
Process Management: Concept, scheduling, operations on process
CPU scheduling: Basic concepts, CPU scheduling algorithms
Deadlocks: Characterization, Handling, Recovery Disk scheduling algorithms

Unit II: Memory and File Management

Memory Management: Address Binding, Overlays, Swapping, Contiguous memory allocation, Paging, Segmentation
Virtual memory: Concept, Demand paging, Prepaging, Page size considerations, Page replacement algorithms, Thrashing
File system management: Concept, file access methods, directory structures, file allocation methods

Unit III: RTOS, Parallel Computers

Real Time & embedded System OS: Concepts, Types, their differences, Handheld Operating Systems. Interrupt Routines in RTOS environment, RTOS Tasks and their Scheduling models, Strategy for synchronization between the processes,
Parallel Computers: Basic concepts, Types of parallelism, Intertask dependencies, classification of parallel computers, vector computers, Array processors, Systolic Arrays
Overview of Information Theory, Data Compression, Huffman Coding, Loss less and lossy compression, Data Encryption and decryption

Unit IV: Communication Protocols

Computer Communication: ISO-OSI Seven Layer model, The TCP/IP reference model Introduction to LAN, LAN topologies, IEEE standards for networking- IEEE 802.3, IEEE 802.4, IEEE 802.5, Circuit switching and Packet switching networks, Features and capabilities of TCP/IP, Industrial Ethernet, Introduction to IEEE 1394, IEEE 488(GPIB), its configuration and advantages.

Unit V: Software Testing

Software Testing: fundamentals, white box, black box testing, control structure testing, specific environment testing, comparison testing, orthogonal testing, strategic approach to testing, unit testing, integrated testing, validation testing, system testing, CASE tools
Software debugging: Standard guidelines, debugging techniques, use of break points, test macros, output files for sampled inputs, instruction set simulation, laboratory tools
Software maintenance: Preventive, Corrective, Adaptive, Enhancement, System Re-engineering

Unit VI: Software Development Life Cycle

Software Development Life Cycle and its models: a. Linear Sequential b. Rapid development c. Incremental d. Component based Software Analysis, Software Design, Software Implementation.

List of Experiments :

Students are expected to perform Minimum Eight Experiments :

1. CPU scheduling algorithms.
2. Program on Huffman Coding.
3. PC to PC Communication.
4. Study of file system management.
5. Generate a test plan format for an application as a case study
6. Theoretical Study of the software testing guidelines.
7. Study of different types of protocols.
8. Study of different software testing tools.
9. Study of Industrial Ethernet.
10. Case study on RTOS.

Text Books:

1. Operating System Concepts by Silberschatz, Galvin, Gagne
2. Parallel Computer architecture and programming by V. Rajaraman, C. SivaRam Murthy, PHI
3. Computer Networks by Andrew Tanenbaum, Prentice Hall.
4. Introduction To Data Compression by Khalid Sayood, Morgan Kaufmann Publishers, Inc.
5. Software Engineering by Ian Somerville, 4th edition, Addison Wesley publication

Reference Books:

1. Computer Architecture and Parallel processing by Kai Hwang, Faye Briggs, McGraw Hill International Editions
2. Computer Networks Protocols, Standards and Interfaces by Uyless Black, PHI
3. High Speed Networks TCP/IP and ATM design principles by William Stallings.
4. Introduction To Data Compression by Khalid Sayood, Morgan Kaufmann Publishers, Inc

406264- Elective- I: A) Industrial Internet of Things

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	
	Oral : 50 Marks	

Course Objective

1. Study of Building blocks of IOT and it's various components
2. Study of protocols in IOT
3. Analyze the security issues in IOT
4. Select proper IOT technology for application.
5. Design simple IOT based application

Course Outcomes:

After successfully completing the course students will be able to:

1. Present a survey on building blocks of IOT.
2. Compare the connectivity technologies and protocols in IOT.
3. Select IOT platform for an application.
4. Discuss Security issues in IOT.
5. Develop Architectural Approach for IOT Empowerment Introduction

Unit I: Introduction (5)

History of IOT, Definition, Architecture. Industry revolutions, Industry Revolution 4.0 – technology, opportunities and challenges, Hardware required: Sensors, Actuators, Routers, Switches, platforms for IOT.

Unit II: IOT Network (6)

Network: OSI model, IP addressing, point to point, point to multi point data transfer, Sub-netting, M2M – Machine to Machine, Web of Things, IOT protocols - M2M Area Network.

Physical Layers - IEEE 802.15.4 - The IEEE 802 Committee Family of Protocols - The Physical Layer- The Media-Access Control Layer - Uses of 802.15.4 - The Future of 802.15.4: 802.15.4e and 802.15.4g. The Layering concepts , IOT Communication Pattern, IOT protocol Architecture, The 6LoWPAN Security aspects in IOT
Wireless communication, Wi-HART protocol, MAP/RAP communication, Hardware requirements

Unit III: IOT Platform (8)

Definition, Roll, Selection: Scalability, Ease of Use, Third party integration, Deployment option, Data Security, Function of IOT platform, Types of platform: Application enablement and development, Network, Data and Subscriber Management, Device Management.

Physical device – Ardino / Raspberry Pi Interfaces, Hardware requirement of Ardino / Pi, Connecting remotely to the Ardino /Raspberry Pi , OSI PI , GPIO Basics, Controlling GPIO

Outputs.

Using a Web Interface– Programming, APIs / Packages, Arduino Interfaces, Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Industry accepted IOT Protocols like MQTT, Limitations.

Unit IV: Resource Management (7)

Clustering, Software Agents, Clustering Principles in an Internet of Things Architecture, Design Guidelines, and Software Agents for Object Representation, Data Synchronization. Identity portrayal, Identity management, various identity management models: Local, Network, Federated and global web identity, user-centric identity management, device centric identity management and hybrid-identity management, Identity and trust. Cloud Computing, Fog Computing

Unit V: Security in IOT (6)

Internet of Things Privacy, Security and Governance Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoT-Data-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach. Data Aggregation for the IoT in Smart Cities, Security.

Unit VI: Case Study & advanced IOT Applications (6)

IOT applications in home- infrastructures, buildings, security, Industries, Home appliances, other IOT electronic equipment. Use of Big Data and Visualization in IOT, Industry 4.0 concepts. Sensors and sensor Node and interfacing using any Embedded target boards (Raspberry Pi / Intel Galileo/ARM Cortex/ Arduino), Introduction to Applications like Steam Trap Monitoring, Pump Health Monitoring, Heat Exchanger Monitoring, CCTV, Location tracking etc. etc.

List of Experiments :

Following practical can be performed on Raspberry Pi &/ Arduino Board

1. Making On and OFF of LED.
2. Interfacing of LCD.
3. Reading and displaying Analogue input voltage.
4. LED intensity variation depending upon potentiometer variation.
5. Speed variation of dc motor.

Any two on application like

1. Interfacing of Raspberry Pi &/ Arduino Board with computer using any protocol.
2. Interfacing of sensor and sending data to mobile as SMS or to computer.

3. Wireless communication between two boards.
4. Sending sensor data to google sheets or any spread sheet. etc

Text Books:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015.
2. Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications.
3. Adrian McEwen , Designing The Internet of Things, Willy Pubication.
4. Raj Kamal, Internet of Things, McGraw Hill Education.
5. Nuno Corriea and Ajay N, Internet of Things with SAP HANA: Build Your IoT Use Case With Raspberry PI, Arduino Uno, HANA XSJS and SAPUI5, publisher UI5 Community Network.
6. Timothy Chou, Precision Internet of Things, Mcgraw Hill Education.

Reference Books:

1. Hakima Chaouchi, " The Internet of Things Connecting Objects to the Web" ISBN : 978-1-84821-140-7, Willy Publications.
2. Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2 nd Edition, Willy Publications.
3. Daniel Kellmereit, Daniel Obodovski, "The Silent Intelligence: The Internet of Things", Publisher: Lightning Source Inc; 1 edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978- 0989973700.
4. Fang Zhaho, Leonidas Guibas, "Wireless Sensor Network: An information processing approach", Elsevier, ISBN: 978-81-8147-642-5.

406264- Elective- I: B) Electrical Drives

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	
	Oral : 50 Marks	

Prerequisite

Basic Electrical Engineering, Drives & Control, Control system Components.

Objective:

1. To understand the basics of electric drives and different types of drives used in industries.
2. Describe the structure of electric drive systems and their role in various applications
3. To operate and maintain solid state drives for speed control of various special electrical machines.

Course Outcome

After learning this course the students should be able to:

1. Select a drive for a particular application based on power rating.
2. Select a drive based on mechanical characteristics for a particular drive application.
3. Operate and maintain solid state drives for speed control of DC and AC machines.
4. Operate and maintain solid state drives for speed control of various special electrical machines

Unit I: Introduction (5)

History of DC Drive -Electronic Control -Solid State Control, State of Art of DC Drive, Block Diagram of Drive - Part of Electrical Drive, Applications in different domains.

Unit II: Basics of Electrical Drives (7)

Terminology used in Drives and controls system, Types of Load-Quadratal diagram of speed, torque characteristics, Types and Characteristics of load torque, Dynamics of motor, load combination, steady state & transient stability of an electrical drive, Determination of moment of inertia.

Unit III: Converters and Control (5)

Phase controlled converters, four quadrant operations, Choppers, AC to DC converters, Inverters and PWM Techniques.

Unit IV: DC Motor Drives (8)

Speed-torque characteristics DC shunt, PMDC and series motors, Block diagram and flow of control signals, Speed and torque control methods, Field weakening control, Selection of Drives for different application and environment, Use of programming software to configure DC Drive, Parameterization of Drive for given assignments.

Unit V: AC Motor Drives (8)

Speed-Torque characteristics of induction motor, V/F control method, Vector control method, Vector control with sensor, Selection of Drives for different application and environment, Synchronous Servo motor and drive-Introduction, Speed and position control methods of servo motor & Servo Drive, Use of programming software to configure AC drive, Parameterization of Drive for given assignments

Unit VI: Applications of Electric Drives (7)

Introduction to Solar and battery powered Drives Siemens-Sinamics V20, Introduction to traction Drives, Servo motor drive requirement – control and implementation traverse application.

List of Experiments :

Students are expected to perform Minimum Eight Experiments :

1. To study the fundamental and block diagram of Electric drive.
2. To study different methods of speed control of D.C. Motor & AC Motor
3. Configuring DC drive & Quick commissioning of DC motor and its optimisation.
4. Configure control of D.C. motor for (a) Current limit control (b) Closed loop torque control(c) Closed loop speed control.
5. Configure braking control of D.C. Motor using 4Q-DC drive.(OFF1,OFF2,OFF3, DBR)
6. To study different methods of Starting of A.C. Motor & Speed Control.
7. To study and configure AC drive for quick commissioning of AC motor with V/F based speed & Vector control method with Its optimisation & observe difference.
8. Configure drive for different DI/DO and AI/AO, & Scaling of AI /AO as per assignment
9. Configure braking control of A.C. Motor using AC drive.(OFF1,OFF2,OFF3, DBR)
10. Configure drive for HVAC temperature control of room using PID control & digital IO's.
11. Configure drive for Staging & de-staging application for multiple pumps to maintain constant pressure in line
12. Configure Servo drive, motor and simulate speed control of Servo motor.
13. Configure Servo drive, motor and simulate position control of Servo motor. (relative & Absolute)

Text Books:

1. Power Electronics by M. H. Rashid 2nd Edition, PHI.
2. Power Electronics by P. C. Sen, THM.
3. G. K. Dubey, Fundamentals of Electrical Drives,Narosa-1995.

Reference Books:

1. R. Krishnan, Electrical Motor drives, PHI.
2. G. K. Dubey, Power Semiconductor controlled drives, Prentice hall-1989.
3. W. Leohnard ,Control of Electric Drives,Springer-2001.

406264- Elective- I: C) Advanced Digital Signal Processing

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	
	Oral : 50 Marks	

Unit I: Multi rate Signal Processing

Multirate digital signal processing: Basic multirate operation (up sampling, down sampling), Efficient structures for decimation and interpolation, Decimation and interpolation with polyphase filters, Noninteger sampling rate conversion , Efficient multirate filtering Applications.

Unit II: Linear Prediction:

Introduction to random signals, discrete time random signals, Innovations representation of a stationary random process, forward and backward linear prediction, solutions of the normal equations.

Unit III: Stochastic Processes and Spectral Estimation

Stochastic Processes: Introduction, WSS signals and linear systems, spectral factorization, models of stochastic processes, vector processes.

Spectral estimation: Periodogramm-based nonparametric methods: Periodogram, Bartlett's method, Welch's method, Blackman-Tukey method . Parametric methods for power spectrum estimation: ARMA modeling, Yule- Walker equation and solution.

Unit IV: Adaptive filtering

Adaptive filtering : Principles of Adaptive filtering , LMS and RMS Algorithms, Applications in noise and echo cancellation, Homomorphic Signal Processing , homomorphic system for convolution, properties of complex-spectrum, Applications of homomorphic deconvolution.

Unit V: Digital Signal Processor:

Digital Signal Processor (Like TMS320C67XX, ADSP-21XX, SHARC) :Introduction to fixed point and floating point DSP processor, Features of DSP processor, architecture of DSP processor, architecture features: computational units, bus architecture memory, data addressing, address generation unit, program control, program sequencer, pipeling, interrupts, features of external interfacing, on-chip peripherals, hardware timers, host interface port, clock generators, SPORT.

Unit VI: Time- Frequency Analysis:

Fourier Transform: Its power and Limitations, Short Time Fourier Transform, The Gabor Transform, Discrete Time Fourier Transform and filter banks, Continuous Wavelet Transform, Discrete Wavelet Transform, Haar Wavelet, Daubechies Wavelet

List of Experiments :

Students are expected to perform Minimum Eight Experiments :

1. Spectrogram analysis of Speech signal uisng STFT,WVD, etc.
2. Interpolation of signal.
3. Decimation of Signal.
4. Power spectrum Estimation: Parametric method.
5. Power spectrum Estimation: non-Parametric method.
6. LMS Adaptive filterring.
7. RMS Adaptive filtering.
8. Homomorphic Signal Processing Application.
9. Linear Convolution using DSP processors.

Text Books:

1. J. Proakis , Charles M. Rader, Fuyun Ling, Christopher L. Nikias, „Advanced Digital Signal Processing‟, (Macmillan Coll Div) (1992)
2. Glenn Zelniker, Fred J. Taylor, „Advanced Digital Signal Processing‟, (CRC Press) (1994)

Reference Books:

1. A.V.Oppenheim and R.W.Schafer, "Discrete time Signal Processing", (Prentice Hall) (1992)
2. Haykins, "Adaptive Filter theory", (Prentice Hall) (1986)
3. Dr. Rulph Chassaing , " Digital Signal Processing and Application with the TMS 320c6713 and TMS 320c6716", Wilay Publication.
4. Raghuveer. M. Rao, Ajit S.Bopardikar, Wavelet Transforms, Introduction to Theory and applications, Pearson Education, Asia, 2000.
5. Introduction to Wavelets and Wavelet Transform: C. S. Burrus, Ramesh and A. Gopinath, Prentice Hall Inc.

406264- Elective- I: D) Advanced Bio- Medical Instrumentation

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	
	Oral : 50 Marks	

Course Objectives:

The students will be able to

1. Interpret technical aspects of medical Instruments.
2. To familiarize the students with concepts related to the operation, analysis and applications of Biomedical Instruments.
3. Understand medical diagnosis and therapy and Solve Engineering Problems related to medical field.
4. To introduce student to advanced biomedical engineering technology and introduce different advanced technologies like rehabilitation used in biomedical Instruments.
5. To understand use of LASER in medical field.

Course outcome:

1. To familiarize students with various medical equipments and their technical aspects.
2. Elucidate cardiovascular system, kidney and related advanced therapy.
3. Measure non-invasive diagnostic parameters.
4. Understand principle and working of various advanced Biomedical Instruments for diagnosis applications.
5. Decide the applications of therapeutic instruments for treatment purpose.
6. Understand applications of imaging instruments and the modalities involved in each technique.

Unit- I:

Life Saving Devices:

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

Diathermy:

Electro surgical Unit, Diathermy: short wave, Microwave, Ultrasound diathermy, Electro surgical Unit.

Unit- II:

Clinical Lab Instrumentation:

Blood and its composition and function, Pulse Oximetry, Blood Cell Counters. Autoanalysers.

Introduction to telemetry & Telemedicine: Introduction to telemedicine, Applications of Telemedicine, telemedicine and internet, future Scope**.**

Unit- III:

Imaging Systems:

X Ray properties, Generation of X-rays, block diagram of X- Ray machine, image intensifier, Drawback of x-ray imaging, CT Scanning, basic CT scanning system, Types of gantries, gray scale [Hounsfield No.], image reconstruction techniques in tomography, image artifacts

Unit- IV:

Computer Assisted Medical Imaging Systems:

Radionuclide Imaging: Rectilinear Scanner, Scintillation Camera, Positron Emission Tomography, Single Photon Emission Computed Tomography , Ultrasound Imaging: Fundamentals of Acoustic propagation, Ultrasonic transducers and frequencies, A, B, M Scan

Unit- V :

Laser applications in Medicine:

Types of Lasers, Properties of Laser, Interaction of Lasers with Tissues -Thermal and Non thermal, Basic Endoscopes system & its characteristics, Laser Applications in ophthalmology- Diabetic Retinopathy , Glaucoma and Retinal hole and detachment treatment , Dermatology- Tattoo, port wine treatment

Unit- VI

Concept of Rehabilitation Engineering:

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

Kidney Instrumentation:

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

List of Experiments :

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

List of equipments

1. Pacemaker & Defibrillator
2. Short Wave Diathermy
3. Endoscope
4. Blood Cell Counters
5. Electrosurgical Unit (Operating Room)
6. X- Ray and CT Imaging Techniques
7. Ultrasound Sound Imaging
8. Dialysis equipment
9. Artificial Kidney: Parallel plate, Hollow fiber, coil Type
10. ECG Telemetry System
11. Rehabilitation equipments
12. Diabetic Retinopathy Treatment using Laser

Text Books:

1. Medicine and Clinical Engineering By Jacobsons & Webster, PHI
2. Introduction To Biomedical Equipment Technology By Carr & Brown
3. Biomedical Instrumentation and Measurements By Cromwell, PHI
4. Handbook of Biomedical Instrumentation By R. S. Khandpur, TMH
5. Computer in Medicine- progress in medical informatics by R. D. Lele, Tata McGRAW HILL
6. The Biomedical Engineering Handbook, Bronzino, IEEE Press
7. Applied Chemical Engineering Feenberg,
8. Principles of Medical Imaging.-By: K. Kirk Shung, Michael B. Smith, Benjamin Tsui.- Pub: Academic Press.
9. Medical Laser Applications -By Carruth
10. Medical Lasers & their safe Use - By Sliney & Trokal

406264- Elective- I: E) Digital Control Systems

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	
	Oral : 50 Marks	

Unit I: Introduction to Discrete Time Control System (DTCS)

Basic building blocks of Discrete Time Control system, Sampling Theorem, Choice of Sampling Rate and Multirate Sampling, Z Transform and Inverse Z Transform for applications for solving Differential Equations, Impulse Sampling, Reconstruction: Data Hold, Mathematical Model of Zero Order Hold

Unit II: Pulse Transfer Function and Digital Controllers.

The Pulse Transfer Function, Pulse Transfer Function of Open Loop and Closed Loop Systems, Pulse Transfer Function of Digital PID Controller, Velocity and Position forms of Digital PID Controller, Realization of Digital Controllers, Deadbeat Response and Ringing of Poles, Design of Deadbeat Controller.

Unit III: Stability Analysis of Discrete Time Control System

Stability regions in S-plane, W-plane and Z-plane and Mapping between the three planes, StabilityTests for Discrete System, Jury Stability Criterion, Bilinear Transformations, Transient and Steady State Response Analysis.

Unit IV: Design of Discrete Time Control System- State Space Approach

Different Canonical forms, Relation between State Equations and Pulse Transfer Function, Solution of Discrete Time State Space Equations, Cayley-Hamilton Theorem, Discretization of Continuous Time State Equation, Pulse Transfer Function Matrix, Eigen Values, Eigen Vectors and Matrix Diagonalization.

Unit V: Pole Placement and Observer Design

Concept of Controllability and Observability, Useful transformations in State Space Analysis and Design, Pole Placement Design by State Feedback, Design of feedback gain matrix using sufficient condition, Ackerman's formula, Direct substitution method, State Observers – Types, Full order and Minimum order state observer design .

Unit VI: Introduction to Optimal Control

Basics of Optimal Control, Performance Indices, Quadratic Optimal Control and Quadratic Performance Index, Steady State Quadratic Optimal Control.

List of Experiments :

Students are expected to perform Minimum Eight Experiments :

1. Find the Response of the Discrete Time Control System for standard inputs.
2. Unit step Response of Discrete Time Control System using Digital PID controller.
3. Design of deadbeat controller for Discrete Time Control System.
4. Determine effect of sampling period on stability of Discrete Time Control System.
5. Conversion of PTF to State space model.
6. Investigation of the controllability and Observability of a system.
7. Design of control system using pole placement technique.
8. Design of full order state observer.
9. Design of a Control System by Optimal Control.
10. Design of Discrete Time Control System based on minimization of quadratic performance index.

Text Books:

1. Discrete Time Control systems by K. Ogata, Prentice Hall, Second Edition,2003.
2. Digital Control and State Variable Methods by M. Gopal, Tata McGraw Hill, 2003.
3. Digital Control by Kannan Moudgalya, John Wiley and Sons, 2007.

Reference Books:

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

406265- Elective- II: A) Smart and Wireless Instrumentation

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
	In semester Assessment: 30 Marks	
	End Semester Assessment: 70 Marks.	

Prerequisites: Sensors and Transducer / Equivalent subject

Course Objectives:

1. To introduce the technologies and applications for the emerging domain of Smart and wireless Instrumentation.
2. To train students to design and development of the various layers in the WSN protocol.
3. To elaborate the various issues related to smart and wireless Instrumentation implementation.
4. To familiarize the students with the hardware and software platforms used in the design of WSN.
5. To elaborate the applications of various smart and wireless systems.

Course Outcomes:

Students will be able to

1. Analyze Smart and Wireless Instrumentation with respect to various performance parameters.
2. Design and develop Applications using WSN (Wireless sensor Network).
3. Demonstration of various Node architectures.
4. Demonstration of Fundamentals of wireless digital communication
5. Analyze the power sources
6. Demonstrate an ability to design strategies as per needs and specifications

Unit I: Introduction (6)

Smart Instrumentation(Materials, automation systems,
ensing and Sensors, Sensor Classifications, Wireless Sensor Networks, History of Wireless Se nsor networks (WSN), Communication in a WSN, important design constraints of a WSN like Energy, Self
Management, Wireless Networking, Decentralized Management, Design Constraints, Securit y etc.

Unit II: Node architecture (6)

The sensing subsystem, Analog to Digital converter, the processor subsystem, architectural overview, microcontroller, digital signal processor, application specific integrated circuit, field programmable gate array (FPGA), comparison, communication interfaces, serial peripheral interface, inter
integrated circuit, the IMote node architecture, The XYZ node architecture, the Hogthrob node architecture.

Unit III: Fundamentals of Wireless Digital Communication (6)

Basic components, source encoding, the efficiency of a source encoder, pulse code modulatio n and delta modulation, channel encoding, types of channels, information transmission over a channel, error recognition and correction, modulation, modulation types, quadratic amplitu de modulation, signal propagation.

Unit IV: Frequency of Wireless Communication (6)

Development of Wireless Sensor Network based on Microcontroller and communication device-Zigbee Communication device.

Unit V: Power sources- Energy Harvesting (6)

Solar and Lead acid batteries-RF Energy /Harvesting-Energy Harvesting from vibration-Thermal Energy Harvesting-Energy Management Techniques Calculation for Battery Selection.

Unit VI: Applications (6)

Structural health monitoring - sensing seismic events, single damage detection using natural frequencies, multiple damage detection using natural frequencies, multiple damage detection
using mode shapes, coherence, piezoelectric effect, traffic control, health care - available sen sors, pipeline monitoring, precision agriculture, active volcano, underground mining.

Text Books:

1. Fundamentals of wireless sensor networks : theory and practice - Waltenegus Dargie, Christian Poellabauer, A John Wiley and Sons, Ltd., Publication.
2. Smart Sensors, Measurement and Instrumentation , Subhas Chandra Mukhopadhyay, Springer Heidelberg, New York, Dordrecht London, 2013.
3. Wireless Sensors and Instruments: Networks, Design and Applications, Halit Eren, CRC Press, Taylor and Francis Group, 2006.

Reference Books:

1. Uvais Qidwai, Smart Instrumentation: A data flow approach to Interfacing“, Chapman & Hall; 1st Edn, December 2013.
2. Wireless Sensor Networks: Architectures and Protocols, Edgar H. Callaway Jr. and Ed gar H. Callaway

406265- Elective- II: B) Instrumentation and Control for Power Plants

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
	In semester Assessment: 30 Marks	
	End Semester Assessment: 70 Marks.	

Course Objectives:

1. To expose the students to the detail process of thermal power plant.
2. To impart knowledge on various measurements and instrumentation involved in thermal power generation.
3. To provide the knowledge on specific measurement techniques and control systems practiced in boiler and turbine units.
4. To impart basic knowledge in nuclear power plant and associated instrumentation.
5. To provide the knowledge on hydroelectric power plant and associated instrumentation.

Unit I:

Introduction to thermal power plant processes – building blocks, Main Equipments: Boiler, Steam turbines, Generator types, Boiler Feed Pump and Condensate Extraction Pump, Deaerators, Function and Description of CW and ACW Systems, Demineralizing Plant's Function and Description, Description of Coal Handling and ASH Handling, Measurements in power plants and sensors used: Measurement of feed water flow, air flow, steam flow and coal flow – drum level measurement – Steam pressure and temperature measurement – Turbine speed and vibration measurement – flue gas analyzer – fuel composition analyzers, flame monitoring.

Unit II:

Boiler control: Steam Pressure Control with Load Index, Air Flow Control, Fuel Flow Control, Coal Mill Control, Furnace Draft Control, Drum-Level and Feedwater Controls, Superheater Temperature Control, Fuel/Air ratio, oxygen, CO and CO2 trimming, combustion efficiency, excess air, parallel and cross limited combustion control. Turbines– Speed and load control – Transient speed rise – automatic load frequency Control – Turbine oil system – Oil cooling system – Turbine run up system, Thermal stress control, Vibration, eccentricity, axial shift , Instrumentation in Generator cooling systems, Generator control system.

Unit III:

Application of DCS in Thermal power plant control-Automation strategy, Automatic boiler control, diagnostic functions and protection, Electro-hydraulic governor system, Automatic startup system, Need of condition monitoring systems, fault tolerant control system in thermal power plants

Unit IV:

Nuclear power plant: Method of power generation, **Basic Physics of Nuclear Reactors,** Atomic Structure, isotopes, Radioactivity, Basics of fission reaction, Moderation, Criticality,

Nuclear Reactor Types, Components of Nuclear Reactor, **Radiation sources and Protection** Safety objectives, Rad-waste management. **Safety Practices in Indian NPPS, r**adiological Protection to workers and public, Dose limits, Health physics

Unit V:

Nuclear power plant instrumentation, P&I diagram of different types of nuclear power plant, nuclear reactor control systems and allied instrumentation, reactor dynamics, excess reactivity, radiations detection instruments, process sensors for nuclear power plants, Spectrum Analyzer,. Safety in nuclear power plant, reliability aspects.

Unit VI:

Hydroelectric power generation: Governing system in hydro power plant, water turbine control, regulation & monitoring of voltage & frequency of output power. Pollution & effluent monitoring & control. Energy Management, electrical sub-station controls, Safty system in hydro power, Distributed control and SCADA solution to improve reliability.

Text Books:

1. Power Plant Instrumentation, K. Krishnaswamy, M. PonniBala, PHI Learning Pvt. Ltd., 2011
2. G.F. Knoll, "Radiation Detection & Measurement", 2nd edition, John Wiley & Sons, 1998.

Reference Books:

1. Process Control, B.G. Liptak
2. Power Plant Engineering, Domkundwar
3. Energy Management Handbook: W.C. Taeruer
4. Pollution: M.N.Rao and H.V. Rao.
5. *Philip Kiameh, Power Plant Instrumentation and Controls, McGraw-Hill Professional, 2014.*
6. Irvin Kaplan, "Nuclear Physics", Narosa, 1987

406265- Elective- II: C) Automotive Instrumentation

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks In semester Assessment: 30 Marks End Semester Assessment: 70 Marks.	Theory: 3

Unit I: Fundamentals of Vehicles (5 Hrs.)

Engine basic concepts (4 stroke), Starting & charging system, Lighting system, Electronic dashboard instruments, onboard diagnostic system, Current trends in modern Automobiles

Unit II: Engine Control System (6 Hrs.)

Introduction to EMS (Engine Management system), ECU (Electronic control unit), Introduction to CRDI (Common rail diesel injection), Contactless Ignition control, Lambda control, idle speed control, Exhaust Emission control.

Unit III: Sensors & Actuators (6 Hrs.)

Basic sensor arrangement, types of sensors, oxygen sensor, cranking position sensor, engine coolant water temperature sensor, engine oil pressure sensor, fuel metering, vehicle speed sensor, detonation sensor, rain gauge sensor, throttle position sensor, stepper motor, relay.

Unit IV: Automotive electronic Control (7 Hrs.)

Principle of electronic braking, tyre pressure system, cruise control circuit, electronic steering control theory, ABS, ASR, and ESP control methods, wiring harshness.

Unit V: Auto body electronic control, Ergonomics & Safety (6 Hrs.)

Introduction to RPAS (Reverse Park Assist System), Automotive central locking & antitheft control system, electronically controlled doors & windows, air bag technology, Lightning system, Battery monitoring & control, FATC (Fully automated Temperature control) in HVAC system.

Unit VI: Latest trends in Automotive Instrumentation (6 Hrs.)

Concepts of hybrid technology, Classification, design & development of Electric vehicles, Introduction to ADAS (Automatic Driver Assist Systems).

Text Books:

1. William B. Riddens, "Understanding Automotive Electronics" , 5th Edition, (Butterworth Heinemann Woburn), (1998).
2. Tom Weather Jr and Cland C. Hunter, "Automotive Computers and Control System" 'Prentice Hall Inc., New Jersey
3. Allan Bonnick, "Automotive Computer Controlled Systems", 2011
4. Young A. P & Griffiths L, "Automobile Electrical and Electronic Equipments", English Languages Book Society & New Press, 1990.
5. Norm Chapman, "Principles of Electricity and electronics for the Automotive Technician", Delmar Cengage Learning, 2008.
6. Rajput R. K, "A textbook of Internal Combustion Engines", 2nd edition, Laxmi

Publications (P) Ltd, 2007
7. Robert N. Brandy, Automotive computer & digital Instrumentation, Prentice Hall Eaglewood Cliff's, New Jersey, 1998.
8. Santini Al, "Automotive Electricity and Electronics", Cengage Learning, 2012.

Reference Books:

1. Jiri Marek, Hans Peter trah, "Sensors Applications, Sensors for Automotive Technology" 1st Edition, Wiley.
2. T. Mellard, Automotive Electronic Systems"1987 by Heinenmann Professional
3. Santini Al, "Automotive Electricity and Electronics", Cengage Learning, 2012
4. George Vachtsevanos, Kimon Valavanis, "Handbook of Unmanned Aerial Vehicles, Springer
5. Iqbal Hussain, "Electric & Hybrid vehicles, design fundamentals, second edition, CRC Press
6. "BOSCH Automotive Handbook", 8th Edition, Bentley publishers, 2011
7. Robert Bosch,"Engine Management", Second Edition, GmbH, 1999

406265- Elective- II: D) Opto- Electronics Instrumentation

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks In semester Assessment: 30 Marks End Semester Assessment: 70 Marks.	Theory: 3

Prerequisite: Sensors and transducers, Applied Physics, Electronic Instrumentation.

Course Objectives:

1. Understand the working of optical fiber as a wave guide and as a sensor.
2. Apply and usage of optical fiber for signal communication and to measure various physical parameters
3. Study LASERs and its applications in the instrumentation field
4. Understand use of various optical measuring instruments
5. Design and perform optical power budget
6. Know optical computing.

Outcomes:

1. Apply optical fiber for various signal transmission.
2. Design, Analyze and perform optical power budget.
3. Apply suitable optical sensor technology on various parameters of measurements.
4. Apply appropriate LASER for various applications.
5. Suggest and apply different technology for signal amplification
6. Use optical measuring instruments.

Unit I: Basics of Optical fiber (7hrs)

Principles of light propagation through a fibre, Ray theory of transmission, total internal reflection, electromagnetic mode theory of optical propagation, cylindrical fiber, classification of fibers and their properties, fibre Connectors and splices –Fibre termination. Overview of optical sources and Optical detectors

Unit II: Characteristics of optical fiber (7hrs)

Manufacturing of optical fiber, Attenuation, material absorption losses, scattering losses, nonlinear and linear scattering, fiber bend loss, dispersion, intermodal dispersion, dispersion modified single mode fiber, and dispersion flattened fibers, polarization, nonlinear phenomena. Concept of design of optical link and Optical link power budget

Unit III: Optical fiber sensors (7hrs)

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.

Unit IV: LASER (7hrs)
Introduction, Fundamental characteristics of lasers – Three level and four level lasers, Properties of laser, Laser modes, Resonator configuration, Q-switching and mode locking, Cavity damping. Types of lasers: Gas lasers, solid lasers, liquid lasers, semiconductor lasers. Application of LASER in biomedical instrumentation and industry in general, LASER interferometry, Holography: basic principle and applications.

Unit V: Optical amplification and integrated optics (7hrs)
Optical amplifiers, integrated optics integrated optical devices: beam splitters, directional couplers, modulators, switches, optoelectronics integration and differentiation, analog arithmetic operations, digital optics.

Unit VI: Optical Measuring instruments and Optical Computing (7hrs)
LED light sources and Tunable laser sources, Fiber optic cable tester, Optical Power meter, Optical Time Domain Refractometer (OTDR), Optical Spectrum Analyzer, Fiber optical Numerical Aperture Measurement, Optical Computing: Concept, gates, memory cell, switch.

Text Books:

1. Optical fiber Communications Principles and Practice- John M. Senior, PHI publication, 2nd ed., 2008
2. Optical fiber sensing technology – Ed. Jose Miguel Lopez-Higuera, John Wiley & Sons, 2002
3. Optoelectronic Devices and Systems- S. C. Gupta, PHI learning Pvt. Ltd EEE (Edition) 2010

Reference Books:

1. LASER Electronics -Joseph T Verdeyen, Prentice Hall of India, 3rded., 2003
2. Integrated Optics-Theory and Technology, R G Hunsperger, Sixth edition, Springer (2009)
3. Sensor Technology- Ed. Jon S. Wilson, Imprint: Newnes, Elesiver, 2004,
4. Optoelectronics - An Introduction – Wilson and Hawkes, Prentice Hall of India, 1998
5. Optical Fiber Sensors, John Dakin and Brian Culshaw, Artech House 1997.
6. Optics- Ajoy Ghatak- Tata Mc- Graw Hill Publishing, 5thed., 2012
7. Optical holography principles techniques and applications- P. Hariharan
8. Optical fiber communications- Gerd Keiser-McGraw Hill, 4th ed.

406265- Elective- II: E) Soft Computing

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks In semester Assessment: 30 Marks End Semester Assessment: 70 Marks.	Theory: 3

Course Objective

1. To create awareness of principle components like fuzzy logic, neural networks which is important from perspective of auto-tuning controllers.
2. Healthy integration of all these techniques has resulted in extending the capabilities of the technologies to more effective and efficient problem solving methodologies.

Course Outcomes

Upon completion of the course, you should be able to:

1. Identify and describe different auto-tuning controller techniques their roles in building intelligent controls.
2. Recognize the feasibility of applying a soft computing methodology for a particular problem
3. Apply fuzzy logic and reasoning to handle uncertainty and solve engineering control problems.
4. Apply neural networks to pattern classification and regression problems.
5. Evaluate and compare solutions by various soft computing approaches for a given problem.

Unit I: Neural Networks-1(Introduction & Architecture) [8 Hours]

Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory.

Unit II: Neural Networks-II (Back propagation networks) [6 Hours]

Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; back propagation learning methods, effect of learning rule co-efficient ;back propagation algorithm, factors affecting backpropagation training, applications.

Unit III: Fuzzy Logic-I (Introduction) [8 Hours]

Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion.

Unit IV: Fuzzy Logic –II (Fuzzy Membership, Rules) [6 Hours]

Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzificataions, Fuzzy Controller, Industrial applications.

Unit V: Fuzzy Logic Based Control: [6 Hours]

Fuzzy Controllers: Preliminaries – Fuzzy sets in commercialproducts – basic construction of fuzzy controller – Analysis of static properties of fuzzycontroller – Analysis of dynamic properties of fuzzy controller – simulation studies –case studies – fuzzy control for smart cars**.**

Unit VI: Neuro – Fuzzy and Fuzzy – Neural Controllers [8 Hours]

Neuro – fuzzy systems: A unifiedapproximate reasoning approach – Construction of rule bases by self-learning: Systemstructure and learning algorithm – A hybrid neural network based Fuzzy controller withself-learning teacher. Fuzzified CMAC and RBF network based self-learning controllers.

Text Books:

1. S. Rajsekaran& G.A. VijayalakshmiPai, "Neural Networks,Fuzzy Logic and Genetic Algorithm:Synthesis and Applications" Prentice Hall of India.
2. Timothy J. Ross, "Fuzzy Logic with Engineering Applications" Wiley India.
3. Kosco B, Neural Networks and Fuzzy Systems: A Dynamic Approach to Machine Intelligence, Prentice Hall of India, New Delhi, 1992.
4. Jacek M. Zuarda, Introduction to Artificial Neural Systems -, Jaico Publishing House, 1997.
5. Klir G.J and Folger T.A, Fuzzy sets, Uncertainty and Information, Prentice Hall of India, New Delhi 1994.

Reference Books:

1. SimanHaykin,"Neural Netowrks"Prentice Hall of India
2. N.P.Padhy,"Artificial Intelligence and Intelligent Systems" Oxford University Press.
3. Kumar Satish, "Neural Networks" Tata Mc Graw Hill
4. Bose and Liang, Artificial Neural Networks, Tata Mc-graw Hill, 1996.
5. Simon Haykin, Neural Networks, ISA, Research Triangle Park, 1995.

406266- Project Stage- I

Teaching Scheme:	Examination Scheme:	Credits:
Practical: 2 Hrs/ Week	Term Work: 50 Marks	Term Work: 2

The term work will consists the comprehensive viva on the project work done in the first semester. The head of the department should constitute the committee of senior faculty members from the department/ institute for this viva examination. The students have to give presentation on the work done and prepare a report.

406267- Audit Course- 5

In addition to credits course, it is recommended that there should be audit course (non-credit course) preferably in each semester from second year. The student will be awarded grade as AP on successful completion of audit course. The student may opt for one of the audit courses per semester, starting in second year first semester. Though not mandatory, such audit courses can help the student to get awareness of different issues which make impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in each semester is provided in curriculum. Each student has to choose one audit course from the list per semester. Evaluation of audit course will be done at institute level. Method of conduction and method of assessment for audit courses is suggested.

The student registered for audit course shall be awarded the grade AP and shall be included such grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself.

(Ref-http://www.unipune.ac.in/Syllabi_PDF/revised-2015/engineering/UG_RULE_REGULATIONS_FOR_CREDIT_SYSTEM-2015_18June.pdf)

Guidelines for Conduction and Assessment (Any one or more of following but not limited to)

- Lectures/ Guest Lectures
- Visits (Social/Field) and reports
- Demonstrations
- Surveys
- Mini Project
- Hands on experience on specific focused topic

Guidelines for Assessment (Any one or more of following but not limited to)

- Written Test
- Demonstrations/ Practical Test
- Presentations
- IPR/Publication
- Report

Students can opt for any other audit course from the list of Audit Course of any branch of engineering.

SEMESTER- II

406268: Process Instrumentation

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	
	Oral : 50 Marks	

Prerequisites: Principle of different controllers and their applications, Principle of various unit operations & unit processes.

Objectives

1. To demonstrate design procedure for control of Heat Exchanger, Boiler, Distillation column control, Dryer, Evaporator, Continuous and batch reactor.
2. To provide students with knowledge about principle and design of controller for pumps and compressors.
3. Use of appropriate software tools (e.g. MATLAB, SCILAB etc. Control Toolbox & Simulink) for design of well-tuned control loops.

Outcomes

1. Analysis and design of controller for safety and process monitoring and understand the need for scaling of instruments.
2. Ability to gain knowledge and analysis of unit processes and unit operations.
3. Ability to understand and analysis how process dynamics and control are related to materials and systems of unit operations.
4. Ability to design appropriate controller, its tuning and analysis for various process control systems.

Unit I: Heat Exchanger (7)

Operation of heat exchanger, controlled and manipulated variables in heat exchanger control problem, Degrees of freedom analysis, instrumentation for feedback, feed-forward, feedback-Feed forward control, cascade control strategies for heat exchanger, PID Tuning methods for heat exchangers. Scaling: types of scaling, examples of scaling

Unit II: Boiler Controls (8)

Operation of boiler, manipulated and controlled variables in boiler control, safety interlocks and burner management system, instrumentation for boiler pressure controls, Air to fuel ratio controls, boiler drum level controls, steam temperature control, optimization of boiler efficiency, Boiler Blow down, Furnace draft, Ratio control, Selective control, Split range control, Adaptive control. PID Tuning methods for boilers.

Unit III: Distillation Controls (8)

Operation of distillation column, manipulated and controlled variables in distillation column control, instrumentation for flow control of distillate, top and bottom composition control, reflux ratio control, pressure control schemes. Degree of freedom analysis. Different methods to control distillation with case study

Unit IV: Dryer Controls and Evaporator (6)
Types and operation of dryers, controlled and manipulated variables in dryer control problem, instrumentation for feedback and feed-forward control of various types of dryers. Types and operation of evaporators, controlled and manipulated variables in evaporator control problem, instrumentation for feedback, feed-forward and cascade control strategies for evaporators.

Unit V: Chemical Reactor Controls (7)
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.

Unit VI: Pumps, Compressors Controls (6)
Pumps: Types, Basic Controls, Multi-pump system controls. Compressors: Types, Basic Controls, Multi-compressor system controls.

List of Experiments :
Students are expected to perform Minimum Eight Experiments on above topics OR :

1. Design of controller for higher-order processes (MATLAB, SCILAB etc.)
2. Design of controllers for multivariable processes (MATLAB, SCILAB etc.)
3. Design of controller for nonlinear systems (MATLAB, SCILAB etc.)
4. Design of controller for chemical reactor /evaporator/dryer MATLAB, SCILAB etc.)
5. Study of boiler controls (Using DCS*)
6. Study of distillation column controls (Using DCS*)
7. Study of pumps and compressor controls (Using DCS*)
8. Process Control Instrumentation – A case study on waste water treatment plant
9. Process Control Instrumentation – A case study on any plant

*- *Optional.*

Text Books:

1. Instrument Engineers' Handbook: Process Control: B.G. Liptak, Chilton.
2. Optimization of Industrial Unit Processes - Bela G. Liptak

Reference Books:

1. Boiler Control Systems: David Lindsey, Mc GRAW-HILL
2. Process Control Systems- F.G.Shinskey, TMH

406269: Industrial Automation

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	
	Oral : 50 Marks	

Course Objectives

1. To make the students understand the fundamentals of automation and various automation systems used in industry such as PLC, DCS, and SCADA.
2. Students should understand the working of these systems and should be able to determine hardware and software requirements of PLC, DCS and SCADA.
3. Students should further understand how to design any application based on these systems.

Course Outcomes

1. Students will understand architecture of PLC, I/O Module, Communication module and Memory Addressing and designing ladder logic for application
2. Students will learn the architecture and programming of DCS.
   Students will understand the need of SIS, risk reduction methods, evaluation of SIL(Safety Integrity Levels)

Unit I: Control Systems and Automation Strategy

Control Systems and Automation Strategy, Evolution of instrumentation and control, Types of industries, Types of automation, Role of automation in industries, Benefits of automation, Automation strategy evolution.

Unit II: Instrumentation Standard Protocols

Instrumentation Standard Protocols: Definition of protocol, Introduction to Open System Interconnection (OSI) model, Communication standard (RS232, RS485), Modbus (ASCII/RTU), Introduction to third party interface, concept of OPC (Object linking and embedding for Process Control), HART Protocol: Introduction, frame structure, programming, implementation examples, benefits, advantages and limitation. Foundation Fieldbus H1: Introduction, frame structure, programming, implementation examples, benefits, advantages and limitation. Comparison of HART, Foundation Fieldbus, Devicenet, Profibus, Controlnet, Industrial Ethernet

Unit III: Programmable logic controllers (PLC)

Introduction, architecture, definition of discrete state process control, PLC Vs PC, PLC Vs DCS, relay diagram, ladder diagram, ladder diagram examples, relay sequencers, timers/counters, high speed counter, PTO, PWM and PID blocks in PLC, PLC design, study of at least one industrial PLC. PLC programming methods as per IEC 61131, PLC applications for batch process using SFC, PLC interface to SCADA/DCS using communication links (RS232, RS485)

Unit IV: Supervisory Control and Data Acquisition (SCADA)
Introduction to (SCADA), Evolution of SCADA, Types of SCADA, Hardware and Software architecture of SCADA System, Objectives of SCADA, Functions of SCADA, SCADA in Process Control, SCADA applications.

Unit V: Distributed Control Systems
Introduction to DCS. Evolution of DCS, DCS flow sheet symbols, architecture of DCS. Controller, Input and output modules, Communication module, data highway, local I/O bus, Workstations, Specifications of DCS. Introduction to database management. Supervisory computer tasks DCS configuration. Supervisory computer functions, Control techniques, DCS & Supervisory computer displays.

Unit VI: Process safety and Safety Management Systems
Process safety and Safety Management Systems Introduction to process safety, ESD systems, safety interlocks, risk terminologies, consequence and risk, risk measurement, Process Hazard Analysis (PHA), Hazard and operability study (HaZOp), Safety Integrity Level (SIL), Introduction to IEC 61511 standard for Functional safety , protection layers, Safety Instrumented System: function, architecture, safety life cycle, Application of safety system

List of Experiments :
Students are expected to perform Minimum Eight Experiments

1. Case study of Industrial DCS trainer.
2. Ladder diagram implementation using combinations of different timers. (Any application)
3. Ladder diagram implementation using combinations of different timers and counters. (Any application)
4. Ladder diagram implementation using HSC/ PTO/PWM. (Any one application
5. Developing and implementing any PID control loop in PLC system.
6. Developing and implementing any closed control loop using SCADA system.
7. Developing and implementing any closed control loop using DCS system
8. Developing and configuring Graphic User Interface (GUI) for any control loop.
9. Configuration of any HART device to PLC and/or DCS system.
10. Configuration of any Foundation Fieldbus device to PLC and /or DCS system.
11. Configure and implement different alarms in PLC and/or DCS system.
12. Configuring and implementing any Advance process control function like MPC/or Fuzzy/or ANN in a DCS system.
13. Design and implementation of ESD system
14. Case study of I/O mapping in PLC/DCS using instrument tag list.

Text Books:

1. Computer Aided Process Control, S. K. Singh, PHI.
2. Programmable Logic Controllers: Principles and Applications, Webb and Reis, PHI.

Reference Books:

1. Distributed Computer Control for Industrial Automation, Poppovik Bhatkar, Dekkar Publications
2. Introduction to Programmable Logic Controllers, Garry Dunning, Thomson Learning.
3. Computer Based Process Control, Krishna Kant, PHI
4. The Management of Control System: Justification and Technical Auditing, N. E. Battikha, ISA.

406270- Elective- III: A) Building Automation

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	
	Oral : 50 Marks	

Course Outcomes

1. Articulate the purpose and operation of HVAC system components, the operation of HVAC systems.
2. Understanding thermal comfort conditions with respect to temperature and humidity and human clothing and activities and its impact on human comfort, productivity, and health.
3. Understanding of the needs and requirements for ventilation and its impact on design and energy and its impact on human comfort, productivity, and health.
4. Understand the way in which a large fire alarm system would be connected and zoned.
5. Understand the fundamental elements that make up an Access Control System.

Unit I: Introduction to Building Automation Systems

- Intelligent building and its architecture
- Evolution of intelligent buildings & Lifecycle of buildings
- Different systems in BAS which includes HVAC, security, fire, lighting systems. Importance of each system in BAS.
- BAS System Hierarchy –Field level components, Direct Digital Control (DDC), Supervisory Controller, Server, Operator Workstation (OWS)
- Different communication protocol and addressing concepts
- Open Protocols -BACnet, LON, Profibus, Modbus, M-bus,
- Proprietary Protocols- N2, CBUS,

Unit II: Comfort parameters and measurement in BAS system

- Comfort parameters for human being- temperature, humidity, flow, pressure, clean air, CO_2%.
- Heat Transfer - Conduction, Convection, Radiation. Specific Heat, Sensitive Heat & Latent Heat, Enthalpy, Entropy
- 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 III: HVAC Air Systems - Air handling unit (AHU) & Terminal Units (VAV)

- 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- humidification, dehumidification, static pressure control, volume matching, warm up mode, night purge mode, cooling, heating, economiser 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, series fan powered, parallel fan powered, pressure dependent, supply-exhaust VAV, and dual duct VAV.

Unit IV: HVAC Water Systems

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, mechanical configuration of different types of cooling towers. Concept and working of Absorption chiller. 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. Concept of free cooling- direct waterside, series waterside, parallel waterside free cooling.

Hot Water Systems:

- Working and design of different types of boilers- fire tube, water tube, packaged boiler.
- Control of boiler- 7 element control, fuel-air ratio control.
- Working and design of different types of heat exchanger.
- Concept of geothermal system, Working, design of different types of hot water system- with boilers, heat exchanger with steam input, heat exchanger with hot water input, geothermal system, solar system and combination of all listed systems.

Unit V: Introduction to Fire Alarm System & Fire Detection

- 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 and Its Requirement and design
- 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 VI: Introduction to Building Security – Access Control & CCTV

- Basic Concepts of Access Control System & it's components
- Benefits of Access Control System & it's 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

List of Experiments :

Students are expected to perform Minimum Eight Experiments

1. To study Architecture of BMS & IBMS
2. To study Psychometric 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

Text Books:

1. HVAC Systems Design Handbook, Fifth Edition by Roger W. Haines
2. HVAC Fundamentals, volume 1 to 3 by James E. Brumbaugh
3. Basics of Air Conditioning by ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0004 for online shopping)

Reference Books:

1. All About AHU's by ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0005 for online shopping)
2. Chillers Basics by ISHRAE. Indian Society of Heating, Refrigerating & Air Conditioning Engineers (product code: B0009 for online shopping)
3. HVAC Handbook Part-1 by Indian Society of Heating, Refrigerating & Air Conditioning Engineers

4. Handbook – Industrial Ventilation Application 2004 by Indian Society of Heating, Refrigerating & Air Conditioning Engineers
5. Fundamentals Of Refrigeration by Indian Society of Heating, Refrigerating & Air Conditioning Engineers
6. Ventilation Handbook by Indian Society of Heating, Refrigerating & Air Conditioning Engineers

406270- Elective- III: B) Robotics and Automation

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	
	Oral : 50 Marks	

Unit I: Robot anatomy & Sensors in Robotics

Definition, law of robotics, History and Terminology of Robotics. Important characteristics of Robots (Cycle time concepts). Specifications of Robot (Drives, joints andlinks, sensors). Robot classifications-Architecture of robotic systems. ROI Robot System Value Calculator (Robotic Industries Association). Transducers and sensors, sensors in robotics, tactile sensors, proximity and range sensors, uses of sensors in robotics

Unit II: Machine Vision

Introduction to machine vision, Low level & High level vision, Sensing & Digitizing, Image processing & analysis, Segmentation, Edge detection, Applications, training the vision system, robotic applications.

Unit III: Kinematics, dynamics and control

Object location, three dimensional transformation matrices, inverse transformation, kinematics and path planning, Jacobian work envelope, manipulator dynamics, dynamic stabilization, position control and force control.

Unit IV: Programming

Methods of robot programming, lead -through programming methods, a robot program as a path in space, motion interpolation, wait, signal and delay commands, branching, capabilities and limitations of lead-through methods

Unit V: Autonomous Mobile Robots: Introduction, Planning & Navigation

Introduction, basic control scheme for mobile robots (basic understanding of perception, localization, cognition path planning, motion control). Planning & Navigation: Introduction, competences for navigation, path planning, obstacle avoidance, navigation architectures.

Unit VI: Robots in Automatic Processing Operations, Assembly & Inspection

Introduction, spot welding, continuous arc welding, sprays coating, other processing operations. Assembly and robotic assembly automation, parts presentation methods, assembly operations, compliance and remote centre compliance (RCC) device, assembly system configurations, adaptable programmable assembly system, designing for robotic assembly, inspection automation.

List of Experiments :

1. Study of different types of robots based on configuration and application.
2. Study of different type of links and joints used in robots
3. Study of components of robots with drive system and end effectors.
4. Determination of maximum and minimum position of links.
5. Verification of transformation (Position and orientation) with respect to gripper and world coordinate system
6. Estimation of accuracy, repeatability and resolution.
7. Robot programming exercises
8. Case study of Industrial Robot.

Text Books:

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta, "Industrial Robotics: Technology, Programming and Applications", 2nd Edition, Tata McGraw Hill, 2012.
2. Roland Siegwart, Illah R. Nourbakhsh, an d Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", 2nd Edition, PHI, 2011.

Reference Books:

1. Ghosh, Control in Robotics and Automation: Sensor Based Integration, Allied Publishers, Chennai, 1998.
2. Asfahl C.R., Robots and manufacturing Automation, John Wiley, USA 1992
3. Robotics and Control, Mittal, Nagrath, Tata Mcgraw-Hill Education
4. Carl D. Crane and Joseph Duffy, Kinematic Analysis of Robot manipulators, Cambridge University press, 2008.
5. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book Co, 1987.

406270- Elective- III: C) Environmental Instrumentation

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	
	Oral : 50 Marks	

Pre-requisite subject: Sensor & Transducers I & II, Instrumental Methods for Chemical Analysis

Course Objectives:

1. To discuss various sources of pollution.
2. To understand various pollutants.
3. To introduce the instrumentation methodologies for environment monitoring.
4. To deal with water quality monitoring and waste water treatment.
5. To discuss the instrumentation required for air pollution monitoring

Program Outcomes: students will be able to:

1. Design instrumentation systems for environment monitoring.
2. Develop methodology for waste water treatment.
3. Measure and analyse air quality and other parameters.
4. Measure and analyse water quality.
5. Provide solution to reduce pollution

Unit I: Introduction

Necessity of instrumentation & control for environment, sensor requirement for environment .

Instrumentation methodologies: Ultraviolet analyzers, total hydrocarbon analyzers using fla me ,ionization detector, Gas chromatography in environmental analysis, photo ionization, po rtable & stationary analytical instruments.

Unit II: Quality of water

Standards of raw & treated water, sources of water & their natural quality, effects of water qu ality.

Water quality parameters: Thermal conductivity, detectors, Opacity monitors, pH analyzers & their application, conductivity analyzers & their application. Water treatment: Requiremen t of water treatment facilities, process design.

Unit III: Sedimentation & Flotation

General equation for settling or rising of discrete particles, hindered settling, effect of temper ature, Viscosity, efficiency of an ideal settling basin , reduction in efficiency due to various ca uses, sludge, storage & removal, design criteria of settling tank, effect of temperature on coag ulation.

Ground water monitoring: Level measurement in ground water monitoring wells, laboratory analysis of ground water samples, instrumentation in ground water monitoring, instrumenta tion in assessment of soil & ground water pollution.

Unit IV: Waste Water and Flow Monitoring System

Automatic waste water sampling, optimum waste water sampling locations, and waste water measurement techniques. Instrumentation set up for waste water treatment plant. Latest methods of waste water treatment plants, Chemical Oxygen Demand (COD), Biochemcal Oxygen Demand (BOD)

Flow monitoring: Non open channel flow measurement, open channel waste water flow measurement. Rain water harvesting: necessity, methods, role of NGOs & municipal cor poration

Unit V: Air Pollution and Sound Monitoring Systems

Definitions, energy environment relationship, importance of air pollution, Air sampling meth ods & equipments, analytical methods for air pollution studies. Control of air pollution. Soun d pollution: basics of sound pollution, its effect to environment. Acoustic noise measurement & monitoring,Environmental Laws

Unit VI: Instruments in Weather station

Instruments in Weather station like Barometer, Rain gauge, Ceilometer etc., Global environmental analysis, Virtual Instruments in Environmental Engineering Laboratory, Rover Environmental Monitoring station (REMS).

List of Experiments : Students are expected to perform Minimum Eight Experiments

1. To study Temperature, Humidity, Environmental parameters in Environment.
2. Analysis of Floating process in water treatment plant.
3. Study of pH in various samples of water.
4. Study of Automation in Water Treatment Plant (WTP) process.
5. Develop a level measurement in ground water monitoring system
6. Implementation of Rain water harvesting system.
7. Study of CO2, Hydrocarbon Environment Air pollution parameters.
8. Development of water purification system.
9. To study Noise Monitoring system.
10. To study and design Sedimentation process.
11. To study Gas Chromatography
12. A case study of Global Environmental analysis.

Text Books:

1. Walter J Weber, "Physici- chemical processes for water quality control", Wiley Inter-science Publications 2012.
2. M N Rao and S K S Rao, " Air pollution", TMH publications 26th reprint 2007.
3. Rao, M. N. and Rao, H. V. N, " Air Pollution", Tata McGraw Hill Publishing Company Limited, New Delhi, 1989, ISBN-13: 978-0074518717
4. Kenneth Wark, Cecil F.Warner,Wayne T.Davis, "Air Pollution: Its Origin and Control" , Pearson; 3 edition (13 November 1997), ISBN-13: 978-0673994165
5. Peany Howard S, Donal R Rowe and George TachoBanoylous Teddy , "Environmental Engineering" . McGraw Hill Education; First edition (1 July 2017), ISBN-13: 978-

9351340263
6. Patrick F. Cunniff, " Environmental Noise Pollution" , John Wiley & Sons Inc (4 May 1977) , ISBN-13: 978-0471189435.
7. Gilber M Masters , "Environmental Engineering and Science" , Pearson Education (1997).

Reference Books:

1. Randy D. Down & Jay H. Lehr, "Environmental Instrumentation & Analysis Handbook", Wiley-Blackwell (7 October 2004), ISBN-13: 978-0471463542

406270- Elective- III: D) Digital Image Processing

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	
	Oral: 50 Marks	

Unit- I: Fundamentals of Digital Image Processing

Digital image representation, fundamental steps in image processing, Elements of digital image processing systems, Image fundamentals: Gray, Color and Black and white. Color image models : RGB, CMY, HIS, etc models. Various Image Format, Sampling and quantization, Relationship between pixels, Statistical parameters (w.r.t. DIP) : Mean, standard deviation, variance, SNR, PSNR etc.

Unit- II: Image Transforms

Basic transformations, Perspective transformation, 2-D Transforms: Fourier transform, Discrete cosine transform, Short time Fourier transform, Gabor transform, Radon transform, SVD, Wavelet Transforms, Hough Transform, Watershed Transform

Unit- III: Image Enhancement

Enhancement by point processing, spatial filtering, enhancement in the frequency domain. Contrast intensification: linear stretching, non-linear stretching, histogram specification, low contrast stretching. Smoothing: Image averaging, mean filter, order statistics filter, edge preserving smoothing. Sharpening: High pass filtering, homomorphic filtering.

Unit- IV : Image Analysis

Segmentation: detection of discontinuities, edge linking and boundary detection, thresholding, region -oriented segmentation Representation and description: Representation schemes, descriptors, regional descriptors, pattern and pattern classes, Introduction Classifiers.

Unit- V : Image Compression

Need, Lossy and lossless compression, Huffman, RLE, LZW, Vector Quantisation, Shift codes, Arithmetic coding, BTC, Transform based compression: JPEG, MPEG, JPEG 2000, etc., properties of image compression schemes**.**

Unit- VI: Applications of DIP

Biometrics, Biomedical, Agricultural, Military, Space, etc.

List of Experiments :

Students are expected to perform Minimum Eight Experiments

1. Study of various image formats and their handling in Matlab.
2. Study of statistical properties mean, standard deviation, variance, etc.

3. Histogram specifications.
4. Gray level transformations such as contrast stretching, negative, power law transformation etc.
5. Spatial Domain filtering- smoothing & sharpening filters.
6. Frequency domail filtering, DFT/IDFT of given image.
7. DCT/IDCT of given image.
8. Edge detection using Sobel, Prewitt and Roberts operators.
9. Image Compression Using any method.
10. Case Study Digital Imaging Device.

Text Books:

1. Gonzalez and Woods, "Digital Image Processing with Matlab", Pearson Education,
2. Arthur Weeks Jr., "Fundamentals of Digital Image Processing", Prentice-Hall International.
3. Madhuri Joshi, "Digital Image Processing", Prentice-Hall International.
4. A. K. Jain, *Fundamentals of Digital Image Processing,* Prentice Hall of India.
5. K. R. Castleman, *Digital Image Processing*, Prentice-Hall International.
6. Pratt William, "Digital Image Processing", John Wiley & Sons

406270- Elective- III: E) Process Modelling and Optimization

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks	Theory: 3
Practical: 2 Hrs/ Week	In semester Assessment: 30 Marks	Oral: 1
	End Semester Assessment: 70 Marks.	
	Oral : 50 Marks	

Unit I: Modeling and Simulations (7)

Introduction, Types of models, modeling of process control systems in time domain and frequency domain, Fitting polynomials in the step test data. Lagrange Interpolation formula, Least square fitting.

Fundamental laws: Continuity equations, Energy Equations, Equations of motion, transport Equations, Equations of state, Equilibrium and Chemical Kinetics.

Process models of some typical systems in differential equations form, , dead time, first and second order models, higher order models, Modeling of first and second order electrical systems, mechanical systems, electromechanically systems and oscillatory systems.

Unit II: Modeling of Mechanical, Chemical systems: (6)

Gravity flow tank, Tanks in series, Tanks in parallel Reaction dynamics, Modeling the chemical

reactions, CSTR models, Plug flow reactor model, modeling of flash drum, distillation columns, evaporators, dryers, heat exchangers.

Unit III: Process Identification: (5)

Identification of physical processes, off-line and on-line identification, Step testing, pulse testing, sine wave testing, ATV identification method, prediction error methods, introduction to numerical algorithm for subspace state space identification, Least square method, Relationships among time, Laplace and frequency domain.

Unit IV: Analysis of multivariable systems. (6)

Open loop and close loop characteristics equations, multivariable Nyquist plot, Loci plot, Niederlinski index, Resiliency, Morari Resiliency Index (MRI), interaction relative gain array (Bristol array) Inverse Nyquist array , robustness Doyle stein criterion, skogestad and morari method .

Unit V: Basic Concepts of Optimization: (5)

Optimization: Concept, need, Essential features of optimization Problem, Concepts of objective functions, Equality and Inequality Constraints, Payback period, Return of Investment, Net present Value, Internal Rate of Return. Classification of optimization problem based on Existence of constrains, Nature of design variables, Physical Structure of the problem, Equation Involved, Permissible values, of design variable, Deterministic Nature of the variables, separability of the variable, Number of objective functions.

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

Unit VI: Optimization Techniques: (9)

Unconstrained Functions One Dimensional: Numerical methods for optimizing a function of one variable , scanning and bracketing procedures, Newton, Quasi-Newton and Secant methods, Multidimensional problem, evaluation of unidimensional search methods.

Unconstrained Multivariable Optimization, Simplex method, Direct Methods, Indirect Methods, Steepest Descent method.

Linear Programming : Basics of Linear Programming, Simplex Algorithm

List of Experiments :

Students are expected to perform Minimum Eight Experiments

1. Analysis of first/second order system by using step and ramp input.
2. Simulation of mathematical modeling of electrical/ mechanical system by first principle.
3. Simulation of mathematical modeling of liquid level system.
4. Study of distillation columns.
5. Study of Heat Exchanger.
6. Identification of second order process by prediction error method and compare it with modeling by first principle.
7. Obtaining unknown parameters of second order process by least square technique.
8. Obtaining Relative gain array of any MIMO physical system.
9. Obtaining inverse Nyquist array of any Physical system.
10. Design of optimal control system by using quadratic approximation.
11. Analysis and comparisons of Quasi-Newton and secant methods.
12. Finding optimal solution using Simplex Method system.

Text Books:

1. W. L. Luyben, Process, Modeling, Simulation and Control for Chemical Engineers• by McGraw Hill, 1973.
2. Thomas Edgar, David Himmelblau, Optimization of Chemical Processes• Second edition, McGraw Hill, 2001.

Reference Books:

1. W. F. Stoecker, Design of Thermal Systems International Education, McGraw hill 1989.
2. J. Malley, Practical Process Instrumentation and Control • McGraw Hill.
3. Deo Narsingh ,System Simulation with digital Computer • Prentice Hall India, New Delhi.
4. Singiresu S.Rao,Engineering Optimization (Therory & Practice),third Edition,New Age International(p) Ltd,Publishers.

406271- Elective- IV: A) Reliability Engineering

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks In semester Assessment: 30 Marks End Semester Assessment: 70 Marks.	Theory: 3

Unit I: SYSTEM RELIABILITY CONCEPTS

Basic Probability Theory, Network Modeling and Reliability Evaluation , Time Dependent Probability, Multi Component & Approximate System Reliability Evaluation

Unit II: LIFE TESTING & RELIABILITY ESTIMATION

Probability Distribution Functions, Interval Estimation, Reliability Life Testing Methods, Baye's testing and Testing Hypotheses, Non - Parametric Methods

Unit III: STATISTICAL QUALITY CONTROL

Quality Control, Control Charts, Acceptance Sampling, Total Quality Management, Tools And Techniques For Tqm

Unit IV: SOFTWARE RELIABILITY

Operational Profile, Software Reliability Concepts, Software Reliability Modeling Survey, Software Metrics for Reliability Assessment, Software Testing and Reliability

Unit V: RELIABILITY IN ENGINEERING DESIGN

Failure Mode and Effect Analysis (FMEA), Fault Tree Analysis (FTA), Product Liability and Planning, Product Development Process

Unit VI: RELIABILITY MANAGEMENT

Objectives of maintenance, types of maintenance, Maintainability, factors affecting maintainability, system down time, availability - inherent, achieved and operational availability (Numerical treatment). Design for maintainability and its considerations, Reliability and costs, Costs of Unreliability, Standards for Reliability - MIL Handbook 217F & Carderock Model. Technology aspects in Reliability Management, BIT (Built in testing).

Text Books:

1. System Reliability Concepts by V. Sankar, Himalaya Publishing House, 2015.
2. Handbook of Software Reliability Engineering Edited by Michael R. Lyu, published by IEEE Computer Society Press and McGraw - Hill Book Company.

Reference Books:

1. Reliability Evaluation of Engineering Systems by Roy Billinton and Ronald N. Allan , Reprinted in India B. S. Publications, 2007.
2. S. K. Sinha, Reliability and Life Testing, Wiley Eastern Ltd.
3. Jain K.C. & Chitale. A.K., Quality Assurance and TQM - Khanna Publisher,
4. Handbook of Software Reliability Engineering Edited by Michael R. Lyu, published by IEEE Computer Society Press and McGraw - Hill Book Company.

5. G. Haribaskaran, Probability, Queuing Theory & Reliability Engineering, Laxmi publications, Second Edition
6. Kapur, — Reliability in engineering Design , Wiley India

406271- Elective- IV: B) Renewable Energy Systems

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks In semester Assessment: 30 Marks End Semester Assessment: 70 Marks.	Theory: 3

Course Objectives:

1. To understand development of sustainable energy recourses.
2. To comprehend utilization of non-conventional technologies.
3. To undertake prospective assignments in relevant fields.

Course Outcomes:

On completion of the course, the students will be able to:

1. Recognize current and possible future role of renewable energy sources.
2. Appraise current technologies of utilizing renewable-energy sources .
3. Assess the potential and economic viability of the utilization of a renewable-energy source.

Unit I: Renewable Energy Sources: (5 Hours)

Introduction to various sources of renewable such as solar, wind, hydro, tidal, geothermal etc. Geographical conditions and availability of energy in various parts of the world. comparison of various renewable energy sources. Efficiency and cost considerations. Installation feasibility and requirements.

Unit II: Solar Photovoltaic Energy: (6 Hours)

Introduction to various types of photovoltaic solar cells such as, crystalline, polycrystalline, amorphous, thin films etc. Efficiency considerations. Structure of solar panels, characteristics, effect of temperature, irradiation and wavelength spectrum. Standard panel ratings, Solar cells, types, construction, characteristics and efficiency. Solar photovoltaic panels construction, characteristics specifications. Effect of temperature, irradiance and shading.

Unit III: Energy storage systems: (7 Hours)

Various types of batteries such as Pb-acid, lithium ion, Ni-MH etc. Their characteristic, specifications and selection. Charging techniques for batteries. Storage media such as fuel cells, fly wheels, super capacitors etc. Their characteristics and applications.

Unit IV: Energy estimation and panel sizing: (8 Hours)

Calculation of energy requirement for various loads, solar panel selection and array design. Series and parallel operation of solar panels. MPPT algorithms, solar panel mounting & tracking. Isolated and non isolated type of solar photovoltaic system, Various types of power converters and their role in solar photovoltaic system. Energy monitoring and metering system.

Unit V: Applications of Renewable Energy: (6 Hours)
Solar water heater, solar cookers. Solar power generation plants. Roof top solar photovoltaic electrical energy systems, solar water pumps, solar electric vehicles and chargers, solar street lamps, Solar powered UPS. Battery charging. Grid tied inverters and specifications.

Unit VI: Wind Energy (8 Hours)
Wind energy conversion technologies, aerodynamics of wind turbine rotor, site selection. Wind resource assessment, various models to predict wind pattern and their analysis, concept of wind farms, various aspects of wind turbine design, hybrid wind energy systems– Wind + diesel power, wind + conventional grid, wind + photovoltaic system etc.

Text Books:

1. Tiwari G N; Solar Energy : Fundamentals, Design, Modelling and Application; Narosa publication.
2. S. Sukhatme, J Nayak; Solar Energy: Principles of Thermal Collection and Storage; 3rd edition, Mc. Graw Hill.
3. Solanki C.S; Solar Photovoltaic Technology and Systems: A Manual for Technicians; 1st edition, PHI.
4. Pramod Jain; Wind Engineering, 2nd edition; Mc.Graw Hill.

Reference Books:

1. Fang Lin Luo, Ye Hong; Renewable Energy Systems: Advanced Conversion Technologies and Applications; 1st edition; CRC Press.
2. D. Yogi Goswami, Frank Kreith; Energy Efficiency and Renewable Energy Handbook; 2nd edition, CRC Press.

406271- Elective- IV: C) Instrumentation in Agriculture and Food Industries

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks In semester Assessment: 30 Marks End Semester Assessment: 70 Marks.	Theory: 3

Course Objectives:

1. Scope of Instrumentation in agriculture field
2. To know difference between continuous and batch process
3. To Know greenhouse automation schemes
4. Understand sensors used in agriculture field.
5. Understand Instrumentation at weather monitoring stations

Program Outcomes: Student should be able to

1. Demonstrate soil properties and sensors used to measure.
2. Demonstrate continuous and batch process.
3. Develop automation scheme for green house.
4. Explain various standards related to food and safety
5. Develop cold storage control strategy .

Unit I: Introduction

Necessity of instrumentation & control for agriculture, engineering properties of soil: fundamental definitions & relationships, index properties of soil, permeability & seepage analysis, shear strength, Mohrs circle of stress, active & passive earth pressures, stability & slopes, Sensors: introduction to sonic anemometers, hygrometers, fine wire thermocouples..

Unit II: Instrumentation in Process industry

Flow diagram of sugar plant & instrumentation set up for it, flow diagram of fermenter & control(batch process),flow diagram of dairy industry & instrumentation set up for it, juice extraction control process & instrumentation set up for it.

Unit III: Instrumentation in Irrigation and Green house System

Irrigation systems: necessity, irrigation methods: overhead, centre pivot, lateral move, micro irrigation systems , soil moisture measurement methods: resistance based method, voltage based method, thermal based method, details of gypsum block, irrigation scheduling, irrigation efficiencies, Application of SCADA for DAM parameters & control. Green houses & instrumentation: ventilation, cooling & heating, wind speed, temperature & humidity, rain gauge carbon dioxide enrichment measurement & control

Unit IV: Instruments in Agriculture

Automation in earth moving equipments & farm equipments, implementation of hydraulic, pneumatic & electronics control circuits in harvesters cotton pickers, tractor etc. classification of pumps: pump characteristics, pump selection & installation. Agrometrological instrumentation weather stations, surface flux measurement, soil water content measurement using time-domain reflectrometery(TDR).

Unit V: Food Processing

Definition, Food quality measurement , food safety and standards bill 2005, central committee for food standards, Agmark, Bureau of Indian Standards, Codex Standards, recommended international code of hygiene for various products, Design consideration: cold storage, atmospheric controller and preservatives; biosensors.

Unit VI: Automation in Food Industry

Application of SCADA & PLC in food packing industry, Trends in modern food processing, Equipments for creating and maintaining controlled atmosphere.

Text Books:

1. D. Patranabis, "Principles of Industrial instrumentation", , TMH (2010), ISBN-13: 978-0070699717
2. Michael. A.M, " Irrigation : Theory and Practice" , Vikas Publishing House Pvt Ltd, Second edition (2008), ISBN-13: 978-8125918677
3. Curtis D. Johnson, " Process control and instrumentation technology", , 8th Edition, 2015 ,Person, ISBN: 9789332549456, 9332549451
4. Akalank Kumar Jain , Vidhi Jain "Food Safety and Standards Act, Rules & Regulations", Akalank Publications; 13th Edition edition (2015), ISBN-13: 978-8176393584
5. Rosana G. Moreira, "Automatic Control for Food Processing Systems (Food Engineering Series)", Springer; 2001 edition (28 February 2001), ISBN-13: 978-0834217812

Reference Books:

1. Bela G. Liptak , "Instrument Engineers' Handbook, Process Control and Optimization", CRC Press; 4 edition (29 September 2005), ISBN-13: 978-0849310812.
2. Robert H. Brown, " CRC Handbook of Engineering in Agriculture, Volume II: Volume 1 (C R C SERIES IN AGRICULTURE)", CRC Press; 1 edition (30 June 1988), ISBN-13: 978-0849338625

406271- Elective- IV: D) Smart Material and Systems

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks In semester Assessment: 30 Marks End Semester Assessment: 70 Marks.	Theory: 3

Prerequisites: Conventional sensors and materials, application of sensors

Course Objectives:

1. To introduce emerging smart material 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:

1. Student will know advance material and material characteristic.
2. They learn working and principle of advance sensors and actuators
3. They learn the importance of micro scaling and the methods of fabrication at microscale.
4 Students understand the practical application of smart, material and sensor in advance engineering field.

Unit I: Introduction Smart Materials (6)

Smart Material Properties, Piezo and Ferroelectric Materials - Piezoelectricity, Piezoresistivity, Ferroelectricity, Dielectric Material-Dielectric Elastomers, Electrostrictive Elastomers

Unit II: Smart Materials and their Applications (6)

Shape memory alloys, Shape Memory Ceramics, Shape memory polymers and their applications. Self-healing material, Conducting polymers, Ionic Polymer Metal Composite actuators

Unit III: Carbon Nanotubes and other smart sensors (6)

Advantages, Typical applications. Fabrication process. SWCNT and MWCNT. Appplication areas of CNT. Principle of operation- Silicon capacitive accelerometer, Piezoresistive pressure Sensor, Conductometric gas Sensor, Fiber-optic sensors. Electrostatic comb-drive.

Unit IV: MEMS actuator and system (6)

Advantages, Typical applications, Commercial product, materials. Fabrication process. Key definitions, Principle of operation-Magnetic microrelay, Microsystems at radio frequencies, Portable blood analyzer, Piezoelectric inkjet print head, Micromirror array for video projection, Micro-PCR Systems

Unit V: Micro fabrication (6)

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 machining

Unit VI: Lab on Chip and Automotive applications of smart sensors (6)

Lab on chip technology and application in research. Automotive applications of smart sensors.

Text Books:

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

Reference Books:

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

406271- Elective- IV: E) Open Elective

Teaching Scheme:	Examination Scheme:	Credits:
Lectures: 3 Hrs/ Week	Paper: (30+70) 100 Marks In semester Assessment: 30 Marks End Semester Assessment: 70 Marks.	Theory: 3

It is expected to offer this elective from other branch with condition that the course contents should not be the same. If the college / Institute wish to start new elective in collaboration with Industry, they are required to approve the elective from university with prior information and permission from BOS Chairman.

406272- Project Stage- II

Teaching Scheme:	Examination Scheme:	Credits:
Practical: 6 Hrs/ Week	Term Work: 100 Marks. Oral: 50 Marks	TW: 4 OR: 2 Total: 6

For the term work the head of the department should constitute the committee of senior faculty Members. A progressive report has to be maintained and should be shown to the external examiner at the time of final exam. The students have to give presentation and a project report has to be prepared. In the project report an evaluation certificate should be there duly signed by external examiner. The oral examination means a comprehensive viva on the project work done.

406273- Online Certification Course

Teaching Scheme:	Examination Scheme:	Credits:
Practical: 2 Hrs/ Week	Term Work: 50 Marks.	Term Work : 1

Course Objectives:

1. To be aware of all the available; national and international online courses.
2. To promote self learning capabilities amongst students.
3. To be able to use various online teaching methodologies like blended classrooms and MOOCs.

Course Outcomes: After completion of this course, students shall be able to:

1. Analyze various online courses offered by MHRD, Government of India and / or other Research Institutes.
2. Select courses based on their interests and course's relevance to their engineering program.
3. Enroll and access courses on MOOCs.
4. Meet the assessment criteria set by the Research Institute or as decided by the Institutional Coordinator for this course.

Selection of Online Courses:

Various self study courses are available online, which can be made available to students in the Institute premises. The suggested platforms are, SWAYAM, NPTEL, LAKSHYA (IIT Bombay), IITBombayX, etc.

Assessment Scheme:

- Continuous Assessment 25 marks: based on regular attainment of the selected online course and timely completion of the assignments.
- End Semester Assessment 25 marks: based on the final assessment criteria selected by the Institute Coordinator.

Execution Steps:

- Students shall check for all the relevant online courses available to them.
- Based on approval of the coordinator, student shall enroll for any Online Course which shall be relevant to the field of Instrumentation & Control.
- The faculty coordinator (one or more) shall keep a track of timely completion of the assignments by students.
- Students shall appear for final assessment designed by the opted Research Institute or by the Coordinator.
- Students shall be evaluated based on their performance during the online course and final assessment.

References:

1. https://onlinecourses.nptel.ac.in/
2. https://www.it.iitb.ac.in/lakshya/home.html
3. iitbombayx.in/home/
4. https://swayam.gov.in/

406274- Audit Course- 6

In addition to credits course, it is recommended that there should be audit course (non-credit course) preferably in each semester from second year. The student will be awarded grade as AP on successful completion of audit course. The student may opt for one of the audit courses per semester, starting in second year first semester. Though not mandatory, such audit courses can help the student to get awareness of different issues which make impact on human lives and enhance their skill sets to improve their employability. List of audit courses offered in each semester is provided in curriculum. Each student has to choose one audit course from the list per semester. Evaluation of audit course will be done at institute level. Method of conduction and method of assessment for audit courses is suggested.

The student registered for audit course shall be awarded the grade AP and shall be included such grade in the Semester grade report for that course, provided student has the minimum attendance as prescribed by the Savitribai Phule Pune University and satisfactory in-semester performance and secured a passing grade in that audit course. No grade points are associated with this 'AP' grade and performance in these courses is not accounted in the calculation of the performance indices SGPA and CGPA. Evaluation of audit course will be done at institute level itself.

(Ref-http://www.unipune.ac.in/Syllabi_PDF/revised-2015/engineering/UG_RULE_REGULATIONS_FOR_CREDIT_SYSTEM-2015_18June.pdf)

Guidelines for Conduction and Assessment (Any one or more of following but not limited to)

- Lectures/ Guest Lectures
- Visits (Social/Field) and reports
- Demonstrations
- Surveys
- Mini Project
- Hands on experience on specific focused topic

Guidelines for Assessment (Any one or more of following but not limited to)

- Written Test
- Demonstrations/ Practical Test
- Presentations
- IPR/Publication
- Report

Students can opt for any other audit course from the list of Audit Course of any branch of engineering.