Cummins College of Engineering for Women

(An autonomous institute affiliated to Savitribai Phule pune university)

Karve Nagar, Pune - 411 052.

Vision

To be globally renowned engineering institute for imparting holistic education and developing professional women leaders in engineering and technology

Structure and Syllabus

of

T. Y. BTech

(Instrumentation and Control Engineering)

2023 Pattern [R0]

List of Abbreviations

Abbreviation	Title
PC	Programme Core Course
BSC	Basic Science Course
ESC	Engineering Science Course
PE	Programme Elective Course
OE	Open Elective
VSEC	Vocational and Skill Enhancement Course
CC	Co-curricular Courses / Liberal Learning Course
IKS	Indian Knowledge System
VEC	Value Education Course
RM	Research Methodology
INTR	Internship
PROJ	Project
CEP	Community Engagement Project
Mm	Multidisciplinary Minor
AEC	Ability Enhancement course

Curriculum for UG Degree Course in BTech. Instrumentation and Control Engineering
(Academic Year: 2025-26 Onwards)
Third Year | Semester-V

Sr. No.	Course Code	Course Title	Teaching Scheme (Hours/week)			Credits	Examination Scheme			Total Marks
			L	T	P		ISE	ESE	Pr/Or	
1	23PCIN501	Process Loop Components	3	0	0	3	50	50	0	100
2	23PCIN502	Internet of Things	3	0	0	3	50	50	0	100
3	23PCIN503	Digital Signal Processing	3	1	0	4	50	50	0	100
4	23PCIN504	Analytical Instrumentation	2	0	0	2	25	25	0	50
5	23PEIN501	Programme Elective-I	3	0	0	3	50	50	0	100
6	23MmIN501	Data Science in Sustainability	3	0	0	3	50	50	0	100
7	23PCIN501L	Process Loop Components Lab	0	0	2	1	25	0	25	50
8	23PCIN502L	Internet of Things Lab	0	0	2	1	25	0	25	50
9	23PEIN501L	Programme Elective-I Lab	0	0	2	1	25	0	25	50
10	23MmIN501L	Data Science in Sustainability Lab	0	0	2	1	25	0	25	50
Total =			**17**	**1**	**8**	**22**	**375**	**275**	**100**	**750**

L=Lecture, T=Tutorial, P= Practical, Cr= Credits, ISE =In Semester Evaluation, ESE =End Semester Examination, Pr/Or = Practical/Oral

23PEIN501: Programme Elective-I

A. Modern Control Theory
B. Biomedical Instrumentation
C. Advanced Microcontrollers
D. Introduction to Hydraulic Systems

23PEIN501L: Programme Elective-I Lab

A. Modern Control Theory
B. Biomedical Instrumentation
C. Advanced Microcontrollers
D. Introduction to Hydraulic Systems

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Secretary Academic Council
MKSSS's Cummins College of Engineering
For Women, Pune-411052

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23PCIN501 Process Loop Components

Teaching Scheme
Lecture: 03 Hrs/week

Examination Scheme
In semester: 50 marks
End semester: 50 marks
Credits : 3

Prerequisite: Sensors and transducers, pneumatic flapper nozzle system, op amp circuits

Course Objectives:

1. To understand the different types of systems and basics of process control.
2. To explain the need, construction, working, types of process control components
3. Develop process control circuits/loops for various applications using standard symbols and notations

Course Outcomes:

1. Delineate the working of different process control components.
2. Compare to select different process control components for various applications.
3. Analyze the performance of the process control components with respect to calibration, configuration, tuning.
4. Develop process control circuits/loops for various industrial applications using standard symbols and notations.

Unit I: Types of systems and process control components

Introduction to different types of systems, process control components related to different types of systems like switches, contactors, miniature circuit breaker, relays, actuators, FRL, Relief/safety valve, DCV, NRV etc, and applications. Circuits using process control components. Hazardous area classification

Unit II: Process Control Fundamentals

Elements of process control loop, Types of process variables, Representation of process loop components using standard symbols (basics with reference to control loop), P & ID for temperature, flow, level, pressure process loops, Process Characteristics like process load, plant lags, dead time, capacity and regulation. Auxiliary components like alarm annunciators.

Unit III: Transmitters and Converters

Need of transmitter (concept of field area & control room area) ,Need for standardization of signals, Current, voltage, and pneumatic signal standards, Concept of live & dead zero, Types of transmitters (Two and four wire transmitters), Types, mounting (Installation), manifold,

calibration setup, of electronic Differential Pressure Transmitter (DPT). DPT for Level measurement, zero elevation, zero suppression, Square root extractor, Block schematic and calibration of Smart transmitter, Comparison of SMART with conventional transmitter, Difference between converter and transmitter, Converters like Current to pressure converter and Pressure to current converter.

Unit IV: Controllers

Discontinuous (Two position, time-proportional), Continuous controllers (Proportional, Integral, Derivative, Proportional-Integral, Proportional- Derivative, Proportional-Integral-Derivative (PID), Reset windup, Anti reset windup, Rate before reset, Bump less transfer, Effect of process characteristics on PID combination, Tuning of controllers, Block schematic and face plate of digital controllers, Position and Velocity algorithms. Introduction to discrete process controller.

Unit V: Control valve

Parts of pneumatic control valve, Control valve terminologies, Inherent and Installed control valve characteristics, types of control valves, Control valve selection criteria, Control valve accessories, types of actuators, Introduction to Control valve sizing and cavitation and flashing

Text Books:

1. Petruzella, “Industrial Electronics”, McGraw-Hill
2. Andrew Parr, “Hydraulics and pneumatics: A Technician's and Engineer's guide”, Butterworth Heinemann Ltd
3. C. D. Johnson, “Process control and Instrument technology”, Tata McGraw Hill Publications
4. B. G. Liptak, “Process Control", Instrument Engineering Handbook CRC Press.
5. N.A. Anderson, Boca Ratan, “Instrumentation for Process measurement and control” CRC Press, Third ed., 1980.

Reference Books:

1. Armando B. Corripio,“Tuning of industrial control systems”, ISA.
2. James W. Hutchinson, “Control valve Handbook”, ISA
3. E. B. Jones, “Instrument Technology”, Butterworth’s, Forth ed., 1985
4. William Andrews, “Applied Instrumentation in Process Industries”, Gulf, Second ed.,

23PCIN502 Internet of Things

Teaching Scheme
Theory : 3 Hrs/week

Examination Scheme
In semester: 50 Marks
End semester: 50 Marks
Credits: 3

Prerequisites: Basics of sensors and actuators, networks, logic building ability

Course Objectives:

1. To understand building blocks and components of IIoT
2. To understand technologies used in IIoT
3. To understand the role of platforms and big data in IIoT

Course Outcomes: Students will be able to

1. Explain the fundamental concepts of IoT and related technologies.
2. Compare to select different IoT technologies for the given application.
3. Design systems using IoT technologies for given scenarios.
4. Analyze real-world case studies in various domains of the industry to identify IoT implementation challenges and solutions.

Unit I : Introduction to IoT

IoT Basics, Components, architecture, building block, categories, gateways, associated technologies, challenges, considerations, scalability.
Study of Raspberry Pi/ Arduino/ equivalent for integration of sensors/ actuators/ devices in IoT based systems.
Study of boards like NVIDIA Jetson built for embedded AI and IoT, and system design examples for real life applications.
Power management in IoT devices/ nodes.

Unit II: Connectivity Technologies: wireless sensor technologies

Introduction, Features, Specifications, challenges and applications of technologies like IEEE802.15.4, 6LoWPAN, Zigbee, Zwave, Radio Frequency Identification (RFID), Near Field Communication (NFC), Bluetooth and Bluetooth Low Energy (BLE), Wireless Highway Addressable Remote Transducer (HART) and ISA100.11A
Case studies from various domains of the industry.

Unit III: Networking and Communication Protocols:

Introduction, Features, Specifications, technology, challenges and applications of Message Queuing Telemetry Transport (MQTT), Constrained Application Protocol (CoAP), Advanced

Message Queueing Protocol (AMQP), Extensible Messaging and Presence Protocol (XMPP), Long Range (LoRA), Sigfox or similar. Case studies from various domains of the industry.

Unit IV: Technologies and Platforms:

Digital Twins, Augmented Reality, Virtual Reality: Introduction, Features, Specifications, tools and technology, development stages, challenges and applications in various sectors

Platforms: Definition, need, functions, types, challenges, architectures, security mechanism and case studies from various industrial sectors of platforms like e.g., AWS IoT, Azure IoT, Google Cloud IoT, Blynk, ThingSpeak

Unit V: IoT Enabling Technologies:

Introduction, Features, Specifications, technology, challenges and applications of Wireless Sensor Networks (WSN), Low Power Wifi technology, NB-IoT, Global System for Mobile Communications (GSM), Introduction to Cloud, Edge and Fog computing, Introduction to Big Data Analytics, Introduction to Cybersecurity

Unit VI: Introduction to Industrial IoT

IIoT-Introduction, Business Model and Reference Architectures, associated technologies

Industry 4.0: Globalization and Emerging Issues, LEAN Production Systems, Smart factories, Smart and Connected Business Perspective. Basic understanding of Manufacturing Execution Systems (MES) / Manufacturing Operations Managements Systems (MOMS), Definitions and roles of OT and IT, Importance and objectives of OT-IT integration.

Text Books:

1. Pethuru Raj and Anupama C. Raman, “The Internet of Things: Enabling Technologies, Platforms, and Use Cases”, by CRC Press.
2. Arshdeep Bahga and Vijay Madisetti, “Internet of Things: A Hands-on Approach”, Universities Press.
3. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving”.
4. Dieter Uckelmann, Mark Harrison, Florian, “Architecting the Internet of Things”, Springer.
5. “The Internet of Things: Key Applications and Protocols”, by, Wiley
6. Olivier Hersent, David Boswarthick, Elloumi, Daniel Kellmereit, Daniel Obodovski, “The Silent Intelligence: The Internet of Things”, Publisher: Lightning Source Inc; 1 st Edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978- 0989973700.
7. Pascal Ackerman, “Industrial Cybersecurity: Efficiently Secure Critical Infrastructure Systems”, Packt Publication, 2017

23PCIN503 Digital Signal Processing

Teaching Scheme
Lecture : 3 Hrs/week
Tutorials: 1 Hr/week

Examination Scheme
In semester: 50 marks
End semester : 50 marks
Credits : 4

Prerequisite:
Linear Algebra, Complex numbers, basics of ZT and DFT

Course Objectives:

1. To understand the concept of digital different types of signals and systems.
2. To learn the use of various transforms for different applications.
3. To understand designing steps of various types of digital filters for given applications.

Course Outcomes: After the successful completion of the course the students will be able to

1. Classify various types of signals and systems based on their properties and behavior.
2. Analyze signals in both time and frequency domains using appropriate mathematical tools.
3. Apply discrete transforms to characterize and solve responses of discrete-time systems.
4. Design digital filters and systems to address real-world signal processing applications.

Unit I: Introduction to Signals and Systems

Introduction to Signals, Classification of Signals, Continuous Time and Discrete Time Signals, Step and Impulse Functions, Transformation of Independent Variable and Dependent Variable. Introduction to Systems, Classification of Systems, Properties of Systems

Unit II: Analysis of Discrete LTI Systems

Introduction to Convolution, Convolution Sum, Linear and Circular Convolution, Sampling theorem, reconstruction, aliasing, sampling in the frequency domain, sampling of discrete time signals, autocorrelation, cross correlation, decimation and interpolation

Unit III: Discrete Transform Applications

Application of Z-Transform: System stability analysis using poles and zeros, Realization of discrete-time systems using Z-transform.
Applications of DFT, DTFT and FFT in Signal Analysis : Energy and spectral analysis

Unit IV: Design of Digital Filters: FIR

FIR Filters: Concept of analog filter design, Ideal filter requirements, Gibbs phenomenon, windowing techniques, characteristics and comparison of different window functions, Design of linear phase FIR filter using windows and frequency sampling method. Magnitude and Phase response of Digital filters, Frequency response of Linear phase FIR filters

Unit V : Design of Digital Filters: IIR

IIR Filters: IIR filter design by approximation of derivatives, IIR filter design by impulse invariance method, Bilinear transformation method, warping effect. Butterworth filter design, Characteristics of Butterworth filters

Unit VI: DSP Practical Application:

DSP in audio and speech processing, Biomedical signal processing, Industrial applications and other similar applications.

Text Books:

1. Nagoor Kani, Digital Signal Processing, Tata McGraw-Hill Education
2. Salivahanan, A Vallaraj, C. Gnanapriya, “Digital Signal Processing”, Tata McGraw-Hill Publishing Company Limited.
3. P. Ramesh Babu, “Digital Signal Processing”, Sci-Tech Publications
4. S. K. Mitra, “Digital Signal Processing-A Computer Based Approach”, MGH

Reference Books:

1. J. G. Proakis and D. J. Manolakis, “Digital Signal Processing: Principles, Algorithms and Applications”, PHI, 2000.
2. V. Oppenheim and R. W. Schafer, “Discrete Time Signal Processing”, Pearson Education.
3. Rabiner, Gold, “Theory and Applications of Digital Signal Processing”, TMH.
4. E. C. Ifeachor and B. W. Jervis, “Digital Signal Processing-A practical Approach”, Addison-Wesley publication
5. Steven W. Smith, “The scientist and engineer's guide to digital signal processing” California Technical Publishing, USA.

23PCIN504 Analytical Instrumentation

Teaching Scheme
Lecture: 2 Hrs/week

Examination Scheme
In semester: 25 marks
End semester: 25 marks
Credits: 2

Course Objectives:

1. To learn the role of analytical instrumentation in process control
2. To describe various chemical analysis techniques in process industry
3. To explain the principles, instrumentation of various chemical analysis methods

Course Outcomes:

1. Identify the necessity of instrumentation related to qualitative analysis
2. Select the required instruments for qualitative analysis.
3. Apply standard norms for qualitative analysis required in processes
4. Analyze the given application to suggest appropriate analytical techniques in real-world process

Unit I: Introduction to Analytical Instrumentation in Process Industries

Overview of Analytical Instrumentation: Role in process control, monitoring, and quality assurance, Regulatory Standards and Instrumentation Compliance: Key Analytical Techniques. Overview of environmental regulations and how analytical instruments help meet standards.
Various techniques like Process Analytical Technology, Spectroscopic, chromatographic, electrochemical, and mass spectrometric techniques, Nuclear Magnetic Resonance, Colorimeter, Near Infra-Red, FTIR used in qualitative analysis

Unit II: Spectroscopic Techniques in Process Industries

UV-Visible Spectroscopy, Raman Spectroscopy, Infrared Spectroscopy (FTIR) and
Near-Infrared (NIR) Spectroscopy: Principles, instrumentation, and its role in chemical process analysis and product quality control.

Unit III: Chromatography and Mass Spectrometry in Process Industries

Gas Chromatography (GC): Principles, applications in process analysis,
Liquid Chromatography (HPLC): Separation techniques, applications
Mass Spectrometry (MS): Principles of MS, applications in trace chemical analysis and process monitoring.

Coupled Techniques (GC-MS, LC-MS): Integration of chromatography with mass spectrometry for complex mixture analysis.

Unit IV: Case Studies and Industry Applications

Various applications like Effluent Treatment Analysis, Flue Gas Monitoring, Distillation Product Analysis, Real-Time Environmental Monitoring Systems, Pharmaceutical Manufacturing, Food and Beverage Industry Quality Control

Text Books

1. Willard, Merritt, John AurieDean, “Instrumental Methods of Analysis”, CBS Publishers & Distributors, New Delhi, Seventh ed., 1988.
2. R. S. Khandpur, “Handbook of Analytical Instruments”, Tata McGraw–Hill Publications, Second ed., 2006.

Reference Books

1. Bela G Liptak, “Analytical Instrumentation Handbook”, Chilton, Second ed., 1994.
2. Leslie S Ettre, Albert Zlatkis, “The Practice of Gas Chromatography”, John Wiley and son’s publication, First ed., 1967.
3. Skoog, Holler, Nieman, “Principles of Instrumental Analysis”, Thomson bookscole publications, Sixth ed., 2006

23PEIN501A Modern Control Theory

Teaching Scheme:
Lectures: 3hrs/week

Examination Scheme:
In semester: 50 Marks
End semester: 50 Marks
Credits: 3

Prerequisite: Basics of Automatic Control Systems

Course Objectives: To
1. Learn Modern Control Techniques and Control Actions.
2. Learn Tuning and Designing of PID Controllers.
3. Learn Control System Analysis with Modem Control Theory
4. Learn Control system design with Modem Control Theory

Course Outcomes: Students will be able to
1. Identify system requirements in time and frequency domain for continuous and discrete time systems
2. Select suitable control action and its tuning method for the given application.
3. Design controller using appropriate methods for the given application.
4. Analyze the performance of the given control system.

UNIT I: Introduction to Modern Control
Introduction to Modem Control Techniques, Classical Control Vs Modern Control, Need to Modern Control Techniques, Advantages and Limitations of Modern Control Techniques, Basic Representation of Modern Control.

UNIT II: Basics of Control actions and Controller tuning
Control actions: ON/OFF, Proportion, Proportional + Integral, Proportional plus integral plus derivative. PID Controller tuning methods.

UNIT III: Controller Design analytical approach
Design of PI/PD/PID using root locus / Bode plot approaches, Direct synthesis of controller, controller design for systems with and without dead time through controller synthesis formula.

UNIT IV: Analysis of control system in state space
State transition matrix, concept of controllability: definition, derivation for the necessary and sufficiency condition for complete state controllability, controllability matrix, concept of

observability: definition, derivation for the necessary and sufficient condition for complete state observability, observability matrix.

UNIT V: Design concepts in State Space

State variable feedback, control system design via pole placement, State observer, quadratic optimal control systems, design of optimal state regulator using reduced matrix Riccati equation. concept of performance indices.

UNIT VI: Fundamentals of Digital Control

Introduction to Digital Control, Analog Control Vs Digital Control, Need of Digital Control, Advantages of and Limitations of Digital Control, Sample and Hold, Nyquist Theorem, Interpolation and Extrapolation.

Text Books:

1. B. C. Kuo, “Digital Control Systems”, John Wiley and Sons, 2003.
2. K. Ogata, “Modern Control Engineering”, 4th Edition, Pearson Education.
3. D. Roy Choudhaury, “Control System Engineering”, PHI.
4. Samarjit Ghosh, “Control Systems Theory and Applications”, Pearson Education.
5. Norman Nise, “Control System Engineering”, 3rd Edition, John Wiely and Sons.

Reference Books:

1. Katsuhiko Ogata, “Modern Control Engineering”, PHI, 3rd Edition, 1998.
2. R.C. Dorf & R.H. Bishop, “Modern Control System”, 11th Edition, Pearson Education.
3. Graham C Goodwin, Stefan F. Graebe, Mario E. Salgado, “Control System Design”, PHI.
4. Christopher T. Kilian, “Modern Control Technology Components & Systems”, 3rd Edition, Cengage Learning.
5. R. T. Stefani, B. Shahian, C. J. Savant and G. H. Hostetter, “Design of Feedback Control Systems”, Oxford University Press.

23PEIN501B Biomedical Instrumentation

Teaching Scheme
Lecture: 3 Hrs/week

Examination Scheme
In semester: 50 marks
End semester: 50 marks
Credits: 3

Prerequisite: : Human Anatomy and Physiology

Course Objectives:
1. To study the characteristics of signals generated during the functioning of the organ.
2. To study instrumentation required for all types of spectroscopy

Course Outcomes:
1 Identify the bio-signals generated during the functioning of various organs.
2. Apply various measurement techniques for various non-electrical physiological parameters
3.Analyse the various biosignals
4 Design signal conditioning circuits for biosignals

Unit I: Action potential measurement
Generation and Conduction of Bio potential, Homeostasis, Sensors: Study of Bio transducers, Biochemical Sensors (Glucose, pH, Po2,Pco2), Electrode as sensor, Types of electrodes, Electrode circuit model, bioamplifiers.

Unit II: Cardiovascular and Musculo-Skeletal System
Function of heart as Pump, electro conduction system, Basics of ECG, Einthoven triangle, 12 lead Configuration & Electrocardiograph, Types of ECG monitors, Analysis of ECG signal., Phonocardiography, Plethysmography Pulse transit time, Pulse wave Velocity.
Structure of Skeletal Muscle, EMG Signal, Electromyography

Unit III :Nervous and Sensory System
Structure of neuron, Types of EEG electrode .EEG basics. 10-20 electrode system, Electroencephalogram, EEG machine Block diagram, types of EEG machine, EEG bands.
Special sensors: tongue-test, nose-smell, skin-touch, temperature regulation

Unit IV: Physiological Parameter measurement
Temperature, respiration rate and pulse rate measurements. Blood Pressure: indirect methods - auscultatory method, oscillometric method, direct methods: electronic manometer, Pressure amplifiers - systolic, diastolic, mean detector circuit. Blood flow and cardiac output

measurement: Indicator dilution, thermal dilution and dye dilution method, Electromagnetic and ultrasound blood flow measurement.

Unit V: Respiratory and Renal Systems

Respiratory system: Pulmonary function test: lungs volume and capacities, Artificial respiration, Spirometers, ventilators. Basics of Kidney Functioning, artificial kidney and types of dialysis.

Unit VI: Bioelectric Signal Conditioning Techniques

S/N Ratio, Filters like Notch, Band pass, Instrumentation Amplifier, Isolation Amplifier, Transient Protection, Electrical Safety: Significance of Electrical Danger, Physiological Effect of Current,Micro-shock and Macro-shock.

Text Books:

1. Introduction to Biomedical Equipment Technology By Carr& Brown
2. Biomedical Instrumentation and Measurements By Cromwell, 2nd edition, Pearson Education.
3. Handbook of Biomedical Instrumentation By R. S. Khandpur, TMH
4. Khandpur R. S., Handbook of Analytical Instruments, Tata McGraw–Hill Publications, 3rd ed.

23PEIN501C Advanced Microcontrollers

Teaching Scheme
Lectures: 3 Hrs/week

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

Prerequisites:
1. Concepts of Microprocessors and Microcontrollers
2. Logic building concepts and programming microcontrollers in C

Course Objectives:
1. To introduce the architecture and features of high-capacity microcontrollers
2. To provide an understanding of integrated peripherals and its configuration
3. To design system for specified application

Course Outcomes: the students will be able to
1. Comprehend the architecture and features of advance microcontroller
2. Select appropriate features of advanced microcontroller for given application.
3. Develop configuration of integrated peripherals.
4. Design system for given application using microcontrollers.

Unit I: Introduction to ARM Cortex
Architecture, Block Diagram, Programmer's Model, Registers and Memory Management, CPU operating modes, Pipeline, Thumb instructions set, Reset circuit and Sequence. Comparison with features of 64 bit microcontrollers.
Development Tools, Tool chains, Libraries and Software for programming.

Unit II: The ARM Cortex Processor
Buses, System Timing, Interrupt handling and NVIC, Power management, Clock, comparison with ARM7 and ARM10

Unit III: Introduction to STM32 microcontrollers
Overview and Features of STM32 Microcontrollers, Peripheral mapping, Development tools, Advantages, Drawbacks and Subfamilies, reset sources and power optimization techniques

Unit IV: Integrated Peripherals of STM32 microcontrollers-I

General Purpose I/O, External Interrupts, ADC (Analog to Digital Converter) and Timers, DMA (Direct Memory Access)

Unit V: Integrated Peripherals of STM32 microcontrollers-II

Features, Operation, Programming and Configuring serial and wireless interfaces SPI(Serial Peripheral Interface), I2C (Inter Integrated Circuits), USART(Universal Synchronous/Asynchronous Receiver/Transmitter), CAN(Controlled Area Network) and USB(Universal Serial Bus), Bluetooth, Wifi, LoRa(Long Range)

Unit VI: Small System Design with STM32 microcontrollers

System design for specified applications like motor control for industrial automation, IoT applications, embedded system based prototypes or similar.

RTOS- features, case studies and applications

Reference Books:

1. Discovering the STM32 Microcontroller, Geoffrey Brown
2. The Insider's Guide To The STM32 ARM Based Microcontroller, Trevor Martin, Published by Hitex (UK) Ltd.
3. Mastering STM32, Carmine Noviello, Lean Publishing, 2016
4. The Definitive Guide to ARM Cortex®-M0 and Cortex-M0+ Processors, Joseph Yiu, Second Edition, Elsevier

23PEIN501D Introduction to Hydraulic Systems

Teaching Scheme
Lectures: 3 Hrs/week

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

Prerequisites: -

Course Objectives:
1. To provide foundational knowledge of fluid power systems, hydraulic fluids, and their properties, enabling students to explain their role in hydraulic applications.
2. To develop analytical skills for evaluating the working principles and performance of hydraulic actuators and motors in real-world systems.
3. To familiarize students with the construction, operation, and industrial applications of hydraulic control valves, including proportional and servo valves.
4. To equip learners with the ability to critically evaluate the design, selection, and operational parameters of hydraulic pumps, pipes, and fittings.
5. To enable students to design and integrate simple hydraulic systems using accumulators, filters, and coolers while demonstrating hands-on component functionality.

Course Outcomes:
1. Explain fluid power fundamentals, hydraulic fluid properties, and the merits/demerits of hydraulic systems.
2. Analyze the working principles and performance characteristics of hydraulic actuators and motors.
3. Describe the construction, operation, and applications of hydraulic control valves, including proportional and servo valves.
4. Evaluate the design, selection, and operation of hydraulic pumps, pipes, and fittings based on system requirements.
5. Design a simple hydraulic system using accumulators, filters, and coolers while demonstrating the integration of key components.

Unit I: Introduction to fluid power:
Evolution of fluid power systems, components of fluid power, introduction to work and power in hydraulics. Hydraulic fluids: purpose of the fluid, compressible and incompressible fluids, Fluid properties, SAE grades and ISO viscosity numbers, selection of fluid, sources of fluids and additives, Analogies with electrical components, Merits and Demerits of fluid power systems

Unit II: Actuators and Motors
Introduction to Hydraulic Actuators, Linear actuators, Rotary actuators, Performance characteristics of hydraulic actuators

Unit III: Hydraulic Valves
Introduction, Construction and application of control valves, proportional valves, and servo valves.

Unit IV: Hydraulic Pumps and Fittings
Introduction, construction, operation, and application of hydraulic pumps. Fluid conductors, material considerations, installation recommendations, compatibility of hydraulic fluids with hose material, design parameters (cover, tube & reinforcement) and manufacturing processes, governing standards (performance & reliability test for hoses). Determining pipe size requirements, velocity in pipes.

Unit V: System accessories and design of simple hydraulic systems
Introduction to hydraulic accessories such as hydraulic accumulators, hydraulic reservoirs, Filters and Coolers, Performance analysis of hydraulic accumulators and hydraulic reservoirs Build a simple hydraulic system to protect and control the system. Demonstrate and use valves, actuators, pumps and motors in simple hydraulic systems.

Books:
1. Peter Rohner, “Industrial Hydraulic Control”, 4th Edition
2. Andrew Parr, “Hydraulics and Pneumatics”
3. Peter Chappel, “Principles of Hydraulic Systems Design”

23MmIN501: Data Science in Sustainability

Teaching Scheme
Theory : 3 Hrs/week

Examination Scheme
In semester: 50 Marks
End semester: 50 Marks
Credits: 3

Prerequisites: -

Course Objectives:

1. Apply data science techniques to sustainability challenges in environmental, social, and economic contexts relevant to instrumentation and control engineering.
2. Develop skills in data acquisition, preprocessing, and analysis using tools such as Python, R, and sensor-based data platforms to monitor, model, and optimize sustainable systems and processes.
3. Use AI tools and statistics to assess sustainable technologies and control systems in energy, waste, water, and smart manufacturing.

Course Outcomes:

1. Identify the role of data science in promoting sustainable practices across different fields.
2. Apply data collection and preprocessing techniques to gather, clean, and prepare sustainability-related datasets from various sources.
3. Apply suitable tools for effective visualizations of sustainability data.
4. Analyze real-world case studies of data science applications in sustainability across industries.

Unit I: Introduction to Data Science in Sustainability
Role of Data Science in Sustainability, Circular economy
Sustainable Development Goals (SDGs) and Data-Driven Decision Making
Overview of Environmental, Social, and Governance (ESG) Data, BRSR
Case Studies like Smart Cities, Renewable Energy Forecasting, Carbon Footprint Tracking

Unit II: Data Collection and Processing for Sustainability
Sources of Sustainability Data: IoT Sensors, Remote Sensing, Open Datasets
Data Acquisition from Smart Meters and Environmental Sensors
Data Cleaning, Preprocessing, and Handling Missing Data
Data Storage: Cloud & Edge Computing for Sustainable Applications

Ethics of data collection and sharing in sustainability.
Open datasets for sustainability like Climate, energy, biodiversity, and water resources data.

Unit III: Data Analytics and Visualization for Sustainability
Statistical Analysis of Sustainability Data
Time Series Analysis for Environmental Monitoring
Study of Data Visualization Tools and its comparison
Visualizing sustainability data: charts, graphs, temporal trends, and heatmaps
Data storytelling for sustainability: dashboards, interactive visualizations for Air Quality Index (AQI)/ Energy Consumption Data Analysis or relevant dataset.

Unit IV: Sustainable System Analysis
Systems thinking & sustainability frameworks
Key sustainability metrics (carbon footprint, energy efficiency, circularity)
Role of instrumentation & control in sustainable systems
Principles of Life Cycle Assessment (goal, scope, inventory, impact assessment, interpretation)
Overview of data-driven sustainability assessment for sustainable systems.

Unit V: Case Studies
Real-World Applications of Data Science in Sustainability
Policy and Ethical Considerations in Sustainability Analytics
Industry Collaboration & Research Trends in Sustainable Data Science

Text Books:

1. Introduction to Sustainable Engineering by R.L.Rag & Lekshmi D Ramesh [2nd Edition - PHI]
2. Sustainable Engineering by David T. Allen and David R. Shonnard [Pearson]
3. Data Science fundamentals and Practical Approaches by Dr. Gypsy Nandi and Dr. Rupam Kumar Sharma [BPB]

Reference books and Resources:

1. Data Science Applied to Sustainability Analysis by Jennifer B. Dunn and Prasanna Balaprakash.[1st edition Elsevier Science Ltd]
2. Navigating Sustainability Data by Sherry Madera [1st Edition Atlantic Books]
3. Relevant research papers, datasets, and case studies from international sustainability projects.

23PCIN501L Process Loop Components Lab

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme
In semester : 25 marks
Practical: 25 marks
Credits: 1

Course Outcomes:

1. Calibrate various process control components like transmitter, converter etc by selecting proper test and measuring instruments
2. Find the characteristics of various process control components like transmitter, converter, control valve etc.
3. Configure, tune and test various process control components like pressure switch, transmitter, controller, control valve etc by proper analysis of given application
4. Develop and implement control circuits for the given application

List of Practical Assignments: (Minimum 8)

1. Testing of various pneumatic and hydraulic components.
2. Identify the sequence of the given Alarm Annunciator and testing of Alarm annunciator using pressure switch
3. Calibration & plotting the characteristics of Temperature Transmitter
4. Calibration of Current to pneumatic Converter
5. Plot the characteristics of square root extractor
6. Calibration of Differential Pressure transmitter
7. Calibration of SMART differential pressure transmitter and Flow measurement using SMART differential pressure transmitter
8. Plot the step response of electronic controllers
9. Control of single capacity process
10. Implementation of logic circuits
11. Plotting control valve characteristics
12. Open ended assignment

Or similar type of practical assignments based on the course contents

23PCIN502L Internet of Things Lab

Teaching Scheme
Practical : 2 Hrs/week

Examination Scheme
In semester: 25 Marks
Oral: 25 Marks
Credits: 1

Course Outcomes:

1. Configure IoT devices for given applications.
2. Implement wireless communication technologies for IoT-based data transmission systems.
3. Connect IoT devices with cloud platforms for remote control, data management, and real-time monitoring.
4. Develop IoT enabled solutions for a given problem statement.

List of Practicals

1. Sensor interface to Node MCU/Arduino / Raspberry Pi for IoT applications
2. Connecting, Interacting, and Programming with Cloud Services
3. Controlling and configuring control elements with Node MCU /Arduino / Raspberry Pi
4. Implement an IoT Data Transmission system using MQTT Protocol.
5. Implementing Wireless Communication Using LoRa Technology
6. Study of Augmented Reality and Virtual Reality systems
7. Connect and Control Devices Using a Registration Server of Cisco Packet Tracer
8. Home Automation using Cisco Packet Tracer
9. Mini Project

Or similar type of practical assignments based on the course contents

23PEIN501LA Modern Control Theory Lab

Teaching Scheme:
Practical: 2hrs/week

Examination Scheme:
InSem: 25 Marks
Oral: 25 Marks
Credits: 1

Course Outcomes: Students will be able to
1. Analyze the effects of various control actions on the performance of systems.
2. Implement PID controller tuning methods for various applications.
3. Design suitable controllers for a system with the given specifications
4. Evaluate the stability of MIMO systems.

List of Practical Titles:

Group A:

1. Effect of Addition of Pole and Zero on Transient and Steady State Performance of System.
2. Analysis of Effect of Proportional, Integral and Derivative Control Action.
3. Tuning of PID Controller: Open Loop Methods
4. Tuning of PID Controller: Closed Loop Methods
5. Design of P/PI/PID Controller using Root Locus Approach Approach.
6. Design of P/ PI/PID Controller using Frequency Response Approach.
7. Design of Controller using Direct synthesis Approach for System with and without Dead Time.

Group B:

8. Analyse the given system for State Controllability.
9. Analyse the given system for State Observability.
10. Design State Feedback Controller using Pole Placement Technique.
11. Evaluate Full Order State Observer.
12. Design of Optimal State Regulator for Minimising Performance Index.
13. Formation of a Control System in Discrete Domain.
14. Explore Interpolation and Extrapolation.

Note: Any 4 practicals from group A and B

Or similar type of practical assignments based on the course contents

23PEIN501LB Biomedical Instrumentation Lab

Teaching Scheme:
Practical: 2hrs/week

Examination Scheme:
In semester: 25 Marks
Oral: 25 Marks
Credits: 1

Course Outcomes: Students will be able to
1. To record bio-signals using various instruments
2. Analyse the bio-signals acquired by biomedical instruments.
3 Design biosignals signal conditioning Circuits
4. Develop a biosignal recording system for the given application

List of Practical Titles:
1. To Study principles and design concepts of biosensors and their applications in the biomedical field.
2. Measurement of Blood Pressure .
3. Recording and analysis of ECG Signal ..
4. Recording and analysis of EEG Signal ..
5. To record various lung capacities of the Respiratory system using Power lab.
6. To record/monitor heart sounds using Power lab
8. To design and implement the photo-plethysmography Sensor for Pulse Rate Measurement.
9. Design Notch Filter
10. Design Heart rate meter
11. Design ECG/EEG amplifier.

Or similar type of practical assignments based on the course contents

23PEIN501LC Advanced Microcontrollers Lab

Teaching Scheme
Practical: 2 Hrs/Week

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

Course Outcomes: The students will be able to

1. Apply programming techniques for ARM cortex and STM32 microcontrollers
2. Configure different peripherals of STM32 microcontrollers in appropriate modes
3. Analyze the performance of peripherals and communication interfaces in STM32
4. Develop microcontroller based system for given problem statement

List of Practical Assignments:

Part A: (any 6)

1. Introduction and familiarization with programming environment
2. Wave generation using ARM
3. Port configuration and programming for input/ output devices
4. Display interfacing and Programming
5. Waveform generation using timers
6. Analog input measurement using ADC
7. Serial communication interface configuration and programming
8. Wireless communication interface configuring and programming

Part B:

System development using STM32 microcontroller for given problem statement

Or similar type of practical assignments based on the course contents

23PEIN501LD Introduction to Hydraulic Systems Lab

Teaching Scheme
Practical: 2 Hrs/Week

Examination Scheme
In Semester: 25 marks
Oral: 25 Marks
Credits: 1

Course Outcomes: The students will be able to
1. Assemble and test basic hydraulic circuits (double-acting cylinder, hydraulic motor) and pneumatic circuits (single/double-acting cylinders) to demonstrate understanding of fluid power principles.
2. Troubleshoot and optimize hydraulic systems by implementing speed control circuits and metering methods (meter-in/meter-out).
3. Design and validate advanced hydraulic circuits (counter-balancing, regenerative, sequencing) to solve industrial automation challenges.
4. Operate and integrate directional control valves, solenoid valves, and limit switches to create multi-actuation systems.
5. Synthesize an automated hydraulic system using programmable controls (e.g., cam-operated valves, solenoid valves) for industrial applications.

List of Practical Assignments:
1. Study of Construction and working Hydraulic pumps
2. Study of Hydraulic valves.
3. Study of solenoid valves, limit switches. Pressure, flow control valve
4. Basic hydraulic circuit for the working of double acting cylinder and a hydraulic motor.
5. Basic pneumatic circuit for the working of single and double acting cylinder.
6. Speed control circuits. Different Metering methods Inlet & outlet flow control (meter-in & meter-out circuit)
7. Circuits for the Use of different direction control valves and valve actuation in single and double acting cylinder, and multi actuation circuit.
8. Hydraulic Counter-balancing circuit.
9. Hydraulic Regenerative circuit.
10. Hydraulic Sequencing circuit.
11. Design circuit with cam operated pilot valves operating a pilot operated 4way direction control Valve or proximity/ limit switches, solenoid operated 4way direction control valve for Auto reversing circuit.

Or similar type of practical assignments based on the course contents

23MmIN501L: Data Science in Sustainability Lab

Teaching Scheme
Practical: 2 Hrs/week

Examination Scheme
In semester: 25 Marks
Oral: 25 Marks
Credits: 1

Course Outcomes:

1. Identify the role of data science in promoting sustainable practices across different fields.
2. Apply techniques for cleaning and preprocessing of open source datasets related to sustainability.
3. Develop insightful visualizations using suitable tools to effectively communicate trends and insights.
4. Analyse the developed sustainable solution using suitable tools.

List of practicals:

1. Collect real-time environmental data.
2. Identify SDG indicators for the collected data
3. Clean a public climate dataset for further analysis.
4. Apply various data preprocess methods to the provided environmental data.
5. Create effective visualizations for smart waste management systems.
6. Compare various graphical methods for visualization for a given dataset.
7. Time-Series Analysis of Renewable Energy Generation
8. Carbon Footprint Estimation using Data Science
9. Open-ended assignment

Or similar type of practical assignments based on the course contents