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

Honor Program (Industrial Measurement and Automation) (Instrumentation and Control Engineering)

2023 Pattern [R0]

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Autonomous Program Structure
B. Tech in Instrumentation and Control
With Honors Degree Programme in
Industrial Measurement and Automation
Academic Year: 2025-2026 onwards

Sr. No.	Course Code	Course Title	Teaching Scheme (Hours/week)			Credits	Examination Scheme			Total Marks
			L	T	P		ISE	ESE	Pr/Or	
1	23HIA501	Transducer Design	3	1	0	4	50	50	0	100
2	23HIA501L	Transducer Design Lab	0	0	2	1	25	0	25	50
3	23HIA601	Industrial Digital Transformation	3	1	0	4	50	50	0	100
4	23HIA602	Industrial Predictive Maintenance	3	0	0	3	50	50	0	100
5	23HIA602L	Industrial Predictive Maintenance Lab	0	0	2	1	25	0	25	50
6	23HIA801	Batch Automation	3	1	0	4	50	50	0	100
7	23HIA801L	Batch Automation Lab	0	0	2	1	25	0	25	50
		Total =	**12**	**3**	**6**	**18**	**275**	**200**	**75**	**550**

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

Instrumentation and Control Department

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

APPROVED BY
Chairman Academic Council
MKSSS's Cummins College of Engineering
For Women, Pune-411052

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23HIA501: Transducer Design

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

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

Prerequisites: -

Course Objectives:
1. Understand the design considerations of transducers for typical application
2. Explain signal conditioning and interface circuits
3. Design complete measurement system for given application

Course Outcomes:
1. Select appropriate transducers for specific application
2. Design signal conditioning for given range and application
3. Analyze the performance of the designed system in relation to various testing and calibration parameters.
4. Design transducer system for given problem statement

Unit I: Design Considerations for Various Transducers
Review of various measurement principles, selection and design considerations of various resistive, inductive, capacitive, piezoelectric and optical transducers

Unit II: Transducer Signal Conditioning and Interfacing Circuits
Signal Conditioning used in various electromechanical transducers and sensing applications and their design for some typical applications. Transducer Interface Circuits like Voltage, Current, and Frequency-to-Voltage Converters. Power supply considerations and regulation for transducers

Unit III: Calibration and Testing of Transducers
Importance of calibration in measurement systems, Calibration Techniques, Calibration procedures for different types of transducers, standards and reference devices used. Performance Testing and Characterization of transducers under varying environmental conditions. (temperature, humidity, vibration). Methods for assessing accuracy, precision, and linearity, Error analysis and compensation methods. Environmental and mechanical testing

Unit IV: Emerging Trends and Innovations in Transducer Design
Smart sensors and sensor networks, Wireless sensors and IoT applications. Future Trends: AI/ML for sensor data analysis and sensor fusion. Bio-compatible and flexible transducers. Emerging applications: Wearable, environmental monitoring, automotive systems

Unit V: Design Applications and Case Studies:
Transducer designing for typical applications in Environmental and Industrial Monitoring (e.g., gas sensors, pressure transducers, and environmental impact monitoring). Automotive and Aerospace Transducers (sensors for vehicle dynamics, air quality, and flight systems). Transducers in defence sectors and similar more applications.

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Text Books:
1. "Transducers and Instrumentation" by D. V. S. Murthy, Prentice Hall, 1st Edition, 2007.
2. "Signal Conditioning for Transducers" by David A. Bell, Oxford University Press, 1st Edition, 2007.

Reference Books:
1. "Measurement Systems: Application and Design" by Ernest O. Doebelin, McGraw-Hill Education, 5th Edition, 2004
2. Precision Measurement and Calibration" by T. L. H. Han, Wiley-Interscience, 1st Edition, 1998.
3. "Transducers and Interfacing: Principles and Applications" by David G. Luenberger, Oxford University Press, 1st Edition, 1988.

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23HIA501L: Transducer Design 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. Select appropriate signal conditioning blocks for given application
2. Design appropriate signal conditioning circuits based on system requirements
3. Implement calibration and test procedures for the designed system
4. Develop the transducer design solution for given problem statement

Lab Assignments:
1. Implement measuring (signal conditioning) circuit for parameters like: Temperature, flow, level
2. Design a process converter for: I to V,V to I, F toV
3. Calibration and error analysis of transducers
4. Testing Transducers under Varying Environmental Conditions
5. Design a temperature, level, flow indicator
6. Design of a Wireless Sensor Node for IoT Applications
7. Design of Gas Sensor for Environmental Monitoring

Or similar type of practical assignments based on the course contents

Note: Every mentioned assignment would require more than 01 practical turn.

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23HIA601 Industrial Digital Transformation

Teaching Scheme

Theory : 3 Hrs/week

Tutorial: 1 Hr/week

Examination Scheme

In semester: 50 Marks

End semester: 50 Marks

Credits: 4

Prerequisites: Concepts of IoT and IIoT, Communication Protocols

Course Objectives:
1. To explain the scope, principles and frameworks used in industrial digital transformation.
2. To help students understand key enabling technologies used in digital transformation.
3. To introduce advanced and emerging technologies that support modern industrial systems.
4. To develop the ability to study and analyse real industrial digital transformation case studies.

Course Outcomes: The students will be able to
1. Explain the frameworks that guide industrial digital transformation.
2. Comprehend the fundamentals of enabling technologies supporting digital transformation
3. Apply suitable technology for digital transformation across industrial systems.
4. Analyse real-world examples of digital transformation incorporating sustainable approaches.

Unit I: Introduction to Industrial Digital Transformation
Introduction, Definition, Scope, impact, challenges and opportunities, Frameworks like RAMI 4.0 (Reference Architectural Model for Industry 4.0), TOGAF and enterprise architecture in digital transformation,

Unit II: Business Drivers for Industrial Digital Transformation
Business process, Business Model, Strategic Roadmap for Digital Transformation, Smart manufacturing and Digital Supply chain management concepts, Major challenges in industrial
Companies, Overcoming the challenges

Unit III: Enabling technologies for digital transformation-I
Introduction, Features, Specifications, tools and technology, development stages, challenges and applications of CPS, M2M, OPC- UA, IIoT in digital transformation.

Unit IV: Enabling technologies for digital transformation-II
Introduction, Features, Specifications, tools and technology, development stages, challenges and applications of Next-Gen HMI Systems, Additive manufacturing(3D printing), Robots, Cobots in digital transformation.

Unit V: Emerging Technologies in Industrial Transformation
Introduction, Features, Specifications, tools and technology, challenges and applications of 5G Networks, Quantum Computing, Autonomous vehicles (Delivery Robots, Drones, UAVs

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or similar) (Case Studies: Tesla, Waymo, Airbus Autonomous Systems or similar) and Blockchain for Industrial Applications (for supply chain transparency, asset tracking, smart contracts or similar)

Unit VI: Case Studies and Real-World Examples
Challenges and approaches for digital transformation in small, medium and large enterprises in industrial sectors like Food industry, Power Plants, Healthcare, Inventory Management & Quality Control, Oil and gas, chemical. Case studies of digital transformation for a sustainable approach.

Books:
1. Gilchrist, A. *Industry 4.0: Managing the Digital Transformation.* Springer, 2016.

2. Schwab, K. *The Fourth Industrial Revolution.* World Economic Forum, 2016.

3. Ustundag, A., & Cevikcan, E. *Industry 4.0: Managing the Digital Transformation.* Springer, 2018.

4. Lang, V. *Digital Fluency: Understanding the Basics of Artificial Intelligence, Blockchain Technology, Quantum Computing, and Their Applications for Digital Transformation.* Springer, 2021.

5. Nath, S. V., Dunkin, A., Chowdhary, M., & Patel, N. *Industrial Digital Transformation: Accelerate Digital Transformation with Business Optimization, AI, and Industry 4.0.* Packt Publishing, 2021.

6. Sharma, A., Jangir, S. K., Kumar, M., Choubey, D. K., Shrivastava, T., & Balamurugan, S. *Industrial Internet of Things: Technologies and Research Directions.* CRC Press, 2024

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23HIA602 Industrial Predictive Maintenance

Teaching Scheme
Lecture: 3 Hrs/Week

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

Prerequisites: -

Course Objectives: To
1. Understand the concept and role of predictive monitoring in risk management.
2. Assess the potential impact of identified hazards on operations, safety, environment and efficiency.
3. Understand and construct reliability matrices for system analysis.
4. Use diagnostic techniques and tools to analyse and interpret machine health data.

Course Outcomes:
1. Recognise different types of industrial hazards and their potential impact on operations.
2. Select various predictive monitoring strategies to minimise risk and hazard.
3. Apply various reliability techniques to improve system performance.
4. Analyse real-world case studies for health diagnosis of industrial machines.

Unit I: Introduction to Predictive Monitoring
Definition, Need of Monitoring, Monitoring Criteria, Preventive Control Strategies.

Unit II: Maintenance
Need of Maintenance, Maintenance Philosophy, Types of Maintenance - Breakdown Maintenance, Preventive/Time Based Maintenance, Condition Based Maintenance, Opportunity Maintenance, Predictive Maintenance, Prescriptive Maintenance

Unit III: Reliability
Definition and Importance of Reliability, Types of Reliability, Reliability Matrix, Reliability Block Diagram, Fault Tree Analysis, Root Cause Analysis, Risk Priority Number, Failure Mode and Effects Analysis.

Unit IV: Health of Machines
Machine Parameter Monitoring for OEE, Performance and Auxiliary Variables, Vibration Parameters, Time and Frequency Domain Signals, Vibration Identification and Diagnostic Tables, Vibration Standards, Vibration Monitoring Instruments.
Temperature Monitoring, Thermography, Thermo-Paints.
Noise-Sound Monitoring, Ultrasound Monitoring, Sound Level Data Processing.

Unit V: Applications of Predictive Maintenance
Predictive Maintenance of Pumps, Control Valves, Actuators, Boiler Maintenance Safety and Efficiency, Steam Trap Monitoring, Leak Detection using Ultrasonic Technology, etc.

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Books:

1. "The Certified Maintenance & Reliability Professional Handbook" by William C. Blumenfeld
2. ISO 9001:2015 Quality Management Systems
3. ISO 55000: Asset Management
4. Patrick O'Connor, Practical Reliability Engineering, Wiley
5. L.S. Srinath, Reliability Engineering, East-West Press
6. R. Keith Mobley, An Introduction to Predictive Maintenance, Elsevier
7. William R. Thomson, Vibration Monitoring of Rotating Machinery, Wiley
8. M. Modarres, "Reliability Engineering and Risk Analysis – A Practical Guide".
9. Case studies from manufacturers, healthcare systems, and regulatory bodies.
10. Industry reports and white papers on process control systems.

23HIA602L Industrial Predictive Maintenance Lab

Teaching Scheme
Practical: 2 Hrs/Week

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

Course Outcomes: Students will be able to

1. Apply diagnostic tools to acquired industrial process parameters.
2. Interpret data to predict equipment failures.
3. Recommend preventive maintenance strategies based on industry best practices and standards.
4. Implement condition monitoring techniques to improve system reliability and efficiency.

List of Practical Titles:

1. Study of Hazard Identification & Risk Assessment – Safety-related Logic development
2. Reliability Analysis Using MTTR and MTBF Metrics
3. Machine Health Monitoring Using Vibration Analysis
4. Machine Health Monitoring using Temperature Analysis or Infrared Thermography
5. Machine Health Monitoring using Noise-Sound Analysis or Acoustic Sensors
6. SCADA System for Machine Health Monitoring
7. Leak/Flaw Detection using Ultrasonic Technology or Pressure Sensors
8. Oil Analysis for Equipment Health Monitoring

Or similar type of practical assignments based on the course contents