Introduction to Industrial Instrumentation and Control

Industrial instrumentation and control systems are essential for accurate and efficient management of industrial processes. These systems involve the use of various instruments and devices to measure and control process variables such as temperature, pressure, flow, and level. Control systems, which utilize feedback loops and sophisticated strategies, are key to maintaining the desired operational conditions within these processes.

This course provides a thorough overview of industrial instrumentation and the control systems integral to industrial operations. It offers a hands-on learning experience, allowing participants to develop the skills needed to address complex measurement and control challenges. The course emphasizes practical techniques for designing, developing, testing, and evaluating instrumentation systems.

Target Audience

- Plant management personnel
- Engineers from all disciplines
- Process control technicians
- Instrumentation artisans
- Supervisors and team leaders
- Project personnel
- Those involved in selecting instrumentation equipment
- Safety department representatives
- Purchasing department representatives
- Anyone with a keen interest in industrial instrumentation

Learning Objectives

Upon completion of this course, participants will be able to:

- Understand the principles and practices of various sensors and transducers.
- Engage in hands-on activities to design, build, and test typical sensors with corresponding signal conditioning circuits.
- Familiarize themselves with various measurement techniques.
- Grasp the concepts of process control and comprehend the characteristics of process variables being measured.
- Share experiences and insights with peers through group discussions.
- Gain proficiency in PID control and develop the ability to tune process control systems.
- Apply the learned principles to address unique measurement challenges in their work environments.
- Evaluate and select the most suitable sensor technologies for specific instrumentation systems.
- Design, build, and test instrumentation systems based on provided specifications.

- Identify key components and features of process control systems.
- Calibrate and signal condition systems to capture accurate measurements.

Targeted Competencies

By the end of this course, participants will be equipped to:

- Understand instrumentation systems and process variables.
- Master temperature, strain, pressure, and flow measurement techniques.
- Investigate ultrasonic methods for non-invasive process measurement.
- Design, build, calibrate, and signal condition sensor applications.

Course Content

Unit 1: Introduction to Sensors, Transducers, and Instrumentation Systems

- Overview of the course schedule and structure.
- Introduction to sensors, transducers, and instrumentation systems.
- Key terminology: maximum error, hysteresis, repeatability, sensitivity, resolution, span, response time.
- Understanding process variables: mass flow, volumetric flow, pressure, viscosity, turbidity.

Unit 2: Strain, Pressure, and Flow Measurement

- Principles of strain measurement: tension, compression, stress, strain, and Young’s modulus.
- Gauge types and configurations.
- Pressure measurement principles and types: diaphragms, bellows, capacitive devices, and fiber optic pressure techniques.
- Flow measurement techniques: Coriolis flowmeter, differential pressure flowmeters, orifice plates, Venturi tubes, flow nozzles, electromagnetic flowmeters.

Unit 3: Temperature, Level, and Non-Invasive Ultrasonic Measurement Techniques

- Temperature measurement scales and principles.
- Temperature sensing devices: Resistance Temperature Detectors (RTDs), thermistors, thermocouples, and radiation pyrometers.
- Level measurement techniques: single-point and continuous level measurement, ultrasonic, capacitive, and pressure-based methods.
- Non-invasive ultrasonic techniques: Doppler shift and transit-time methods for flow measurement.

Unit 4: Introduction to Process Control Engineering

- Key control strategies and components.
- Block diagram representation of control systems.
- Open and closed-loop systems, negative feedback.
- Transfer functions and their application in control systems.

- On/off control, proportional control, integral action, derivative action, and PID control.

Unit 5: Tuning PID Controllers

- Understanding system stability and response.
- Tools for tuning PID controllers: Bode plots, Nyquist plots.
- Methods of setting controllers: open-loop reaction curve (Ziegler-Nichols) and closed-loop continuous cycling (Ziegler-Nichols).
- Fine-tuning PID controllers for optimal performance.

This course combines theoretical knowledge with practical skills, empowering participants to apply the learned principles effectively in industrial settings. Upon completion, they will be prepared to take on complex instrumentation and control challenges across a wide range of industries.