Introduction to Industrial Instrumentation and Control:
In industrial settings, industrial instrumentation and control are essential for ensuring accurate and efficient measurement and regulation of processes. Industrial instrumentation involves the use of devices and instruments to monitor and manage process variables, such as temperature, pressure, flow, and level. Control systems play a crucial role in maintaining desired process conditions by using feedback mechanisms and advanced control strategies.

This industrial instrumentation and control systems course provides a thorough overview of both industrial instrumentation and modern control systems, emphasizing their importance in industrial operations. Participants will explore fundamental concepts, learn practical applications, and gain the skills required to solve complex measurement and control challenges. Hands-on exercises enable participants to design, develop, build, test, and evaluate instrumentation systems.

Targeted Groups:

- Plant management personnel
- Engineers from all disciplines
- Process control technicians
- Instrumentation artisans
- Supervisors
- Individuals involved in projects
- Professionals responsible for instrumentation equipment selection
- Representatives from safety departments
- Representatives from purchasing departments
- Anyone with an interest in industrial instrumentation

Course Objectives:
By the end of this course, participants will be able to:

- Understand the principles and operation of various sensors and transducers
- Use hands-on exercises to explore instrumentation system design, construction, and testing of sensors with signal conditioning circuits
- Become proficient in a range of measurement techniques
- Understand process control concepts and the characteristics of process variables
- Share experiences and knowledge with other participants to broaden collective understanding
- Gain knowledge of proportional-integral-derivative control and develop skills to tune process control systems
- Apply learned principles to solve novel measurement challenges in the workplace

- Evaluate and select the most suitable sensor technology for a given instrumentation system
- Design, construct, and test instrumentation systems according to specifications
- Identify components and features of process control systems
- Calibrate and condition signals for systems and accurately measure variables

Targeted Competencies:
Upon completion, participants will enhance their ability to:

- Understand instrumentation systems and process variables
- Perform temperature measurement
- Conduct strain measurement
- Investigate pressure and flow measurement techniques
- Apply ultrasonic methods for non-invasive process measurement
- Design, build, calibrate, and signal condition sensors in practical exercises

Course Content:

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

- Course structure and schedule
- Overview of sensors, transducers, and instrumentation systems
- Key terms and definitions including maximum error, hysteresis, repeatability, sensitivity, resolution, span, and response time
- Understanding process variables such as mass flow, volumetric flow rate, pressure, viscosity, and turbidity

Unit 2: Strain, Pressure, and Flow Measurement

- Principles of strain measurement, including tension, compression, stress, strain, and Young's modulus
- Principles, applications, and installation of strain gauges
- Pressure measurement principles and devices, including diaphragms, bellows, capacitive devices, and fiber optic systems
- Flow measurement principles, including Reynolds number, and operation of Coriolis flowmeters, differential pressure flowmeters, orifice plates, Venturi tubes, flow nozzles, Dall flow tubes, and electromagnetic flowmeters

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

- Temperature scales and measurement methods using resistance temperature detectors, thermistors, thermocouples, and radiation pyrometers
- Principles of single-point and continuous level measurement
- Direct and indirect level measurement techniques, including ultrasonic, capacitive, and pressure methods
- Ultrasonic measurement techniques for non-invasive applications, including Doppler shift and transit-time methods
- Ultrasonic flowmeters

Unit 4: Introduction to Process Control Engineering

- Control strategies and block diagram representations
- Control components, servomechanisms, and regulators
- Open-loop and closed-loop systems with negative feedback
- Transfer functions for first- and second-order systems
- Control actions, including on/off, two-step, proportional, integral, derivative, and proportional-integral-derivative control
- Concepts of proportional band, proportional gain, proportional offset, integral action, integral windup, and derivative action

Unit 5: Tuning Proportional-Integral-Derivative Controllers

- System stability and response
- Bode and Nyquist plots
- Addressing load disturbances and offsets
- Empirical methods for setting controllers
- Open-loop reaction curve method and closed-loop continuous cycling method for tuning
- Fine-tuning proportional-integral-derivative controllers for optimal system performance