Training Course on Advanced Process Control and Instrumentation

Professional Development Training Course Outline

Category	Engineering	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

Introduction

Training Course on Advanced Process Control and Instrumentation delves into the cutting-edge realm of Advanced Process Control (APC) and Industrial Instrumentation, equipping professionals with the expertise to optimize industrial operations in today's Industry 4.0 landscape. Participants will gain a comprehensive understanding of smart instrumentation, real-time data analytics, and process optimization techniques to enhance efficiency, reduce costs, and ensure robust, safe, and sustainable production environments. Through practical case studies and hands-on exercises, this program bridges theoretical knowledge with real-world applications, fostering skills crucial for digital transformation and operational excellence.

In an era of rapid technological advancement, mastering predictive maintenance, IoT integration, and cybersecurity in industrial control systems is paramount. This course is meticulously designed to empower engineers and technicians with the ability to implement sophisticated control strategies, leverage AI and machine learning for enhanced performance, and navigate the complexities of modern Distributed Control Systems (DCS) and SCADA. Graduates will be prepared to drive innovation, improve product quality, and contribute significantly to their organizations' competitive edge through intelligent automation and operational technology (OT) mastery.

Programme Curriculum

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Course Objectives

1. Analyze and optimize complex industrial processes using Advanced Process Control (APC) methodologies.
2. Design, implement, and tune multivariable control systems for enhanced performance.
3. Evaluate and select appropriate smart instrumentation for various process measurements.
4. Apply real-time data analytics and predictive modeling for proactive decision-making.
5. Integrate Internet of Things (IoT) devices within industrial control architectures.
6. Understand and mitigate cybersecurity threats in Industrial Control Systems (ICS) and OT environments.
7. Implement predictive maintenance strategies for instrumentation and control assets.
8. Utilize machine learning and AI algorithms for process optimization and anomaly detection.
9. Configure and troubleshoot Distributed Control Systems (DCS) and SCADA platforms.
10. Develop strategies for energy efficiency and sustainability through optimized control.
11. Improve operational reliability and reduce unplanned downtime through advanced techniques.
12. Ensure process safety and compliance with relevant industry standards and regulations.
13. Drive digital transformation initiatives within their organizations' industrial operations.

Organizational Benefits

1. Increased Operational Efficiency: Streamlined processes and reduced waste.
2. Enhanced Product Quality: Consistent output and reduced variability.
3. Significant Cost Reduction: Optimized resource utilization and minimized energy consumption.
4. Improved Asset Utilization: Maximized equipment productivity and extended lifespan.
5. Reduced Unplanned Downtime: Proactive maintenance and early fault detection.
6. Enhanced Safety and Reliability: Operation within safe limits and reduced human intervention.
7. Faster Response to Disturbances: Agile and adaptive control systems.
8. Data-Driven Decision Making: Insights from real-time data and advanced analytics.
9. Competitive Advantage: Adoption of cutting-edge technologies and best practices.

10. Skilled Workforce: Empowered employees proficient in modern industrial automation.

Target Participants

- Process Engineers
- Instrumentation & Control Technicians
- Automation Engineers
- Maintenance Managers
- Control System Engineers
- SCADA/PLC Programmers
- Operations Managers
- Technical Operators
- Reliability Engineers
- Chemical Engineers
- Mechanical Engineers
- Electrical Engineers

Course Outline

Module 1: Foundations of Industrial Process Control

- **Concepts of Process Variables & Control Loops:** Understanding PV, SP, MV, feedback, and feedforward control.
- **PID Control Optimization:** Advanced tuning techniques, auto-tuning, and robust PID design.
- **Process Dynamics and Modeling:** First-order, second-order systems, dead time, and process identification.
- **Control System Architectures:** Overview of PLC, DCS, SCADA, and hybrid systems.
- **Case Study:** Optimizing temperature control in a chemical reactor using advanced PID tuning.

Module 2: Advanced Control Strategies

- **Model Predictive Control (MPC):** Principles, benefits, and applications in multivariable processes.
- **Adaptive Control:** Self-tuning and gain scheduling for changing process conditions.
- **Cascade and Ratio Control:** Design and implementation for improved disturbance rejection.
- **Override and Inferential Control:** Techniques for constraint handling and unmeasurable variables.
- **Case Study:** Implementing MPC for refinery distillation column optimization.

Module 3: Smart Instrumentation and Sensors

- **Advanced Sensor Technologies:** Smart sensors, wireless instrumentation, and IIoT devices.
- **Calibration and Validation:** Best practices for accurate and reliable measurements.
- **Fieldbus Communication Protocols:** HART, Foundation Fieldbus, Profibus, and industrial Ethernet.
- **Analytical Instrumentation:** pH, conductivity, gas chromatographs, and spectroscopy.
- **Case Study:** Integrating wireless temperature sensors for remote monitoring and predictive insights.

Module 4: Data Acquisition and Real-Time Systems

- **SCADA Systems Design & Implementation:** HMI development, alarming, and data logging.
- **Distributed Control Systems (DCS):** Configuration, programming, and integration with plant operations.
- **Data Historians and Management:** Storing and retrieving large volumes of process data.
- **Real-time Operating Systems (RTOS) in Control:** Ensuring timely and deterministic control.
- **Case Study:** Developing a SCADA system for a water treatment plant with real-time data visualization.

Module 5: Process Optimization Techniques

- **Statistical Process Control (SPC):** Monitoring process variability and identifying deviations.
- **Lean Manufacturing Principles:** Eliminating waste and improving flow in industrial processes.
- **Six Sigma Methodologies:** DMAIC cycle for process improvement and defect reduction.
- **Energy Optimization:** Strategies for reducing energy consumption in industrial facilities.
- **Case Study:** Applying Lean Six Sigma to reduce variability in a pharmaceutical manufacturing process.

Module 6: Industrial Data Analytics

- **Big Data in Process Control:** Handling and analyzing vast datasets from industrial operations.
- **Data Preprocessing and Feature Engineering:** Preparing data for analytical models.
- **Descriptive and Diagnostic Analytics:** Understanding past performance and root causes.
- **Introduction to Data Visualization:** Tools and techniques for presenting process insights.
- **Case Study:** Analyzing historical data to identify critical parameters affecting product quality.

Module 7: Predictive Maintenance for Instrumentation

- **Condition Monitoring Techniques:** Vibration analysis, thermography, and acoustic monitoring.
- **Sensor-based Diagnostics:** Using instrument data for proactive fault detection.
- **Reliability-Centered Maintenance (RCM) Principles:** Optimizing maintenance strategies.
- **Prognostics and Health Management (PHM):** Predicting remaining useful life of equipment.
- **Case Study:** Implementing a predictive maintenance program for critical control valves.

Module 8: Introduction to Industrial IoT (IIoT)

- **IIoT Architectures and Components:** Edge computing, cloud platforms, and connectivity.
- **Data Security in IIoT:** Protecting sensitive industrial data.
- **Edge Analytics:** Processing data closer to the source for faster insights.
- **IIoT Platforms and Applications:** Leveraging platforms like Azure IoT, AWS IoT.
- **Case Study:** Deploying IIoT sensors for remote asset monitoring in an oil and gas pipeline.

Module 9: Cybersecurity in Industrial Control Systems (ICS)

- **Threat Landscape for ICS/OT:** Understanding common attacks and vulnerabilities.

- **Purdue Model and Network Segmentation:** Designing secure industrial networks.
- **Risk Assessment and Mitigation Strategies:** Identifying and addressing cybersecurity risks.
- **Security Best Practices for PLCs and DCS:** Hardening control systems.
- **Case Study:** Developing an incident response plan for a cyber-attack on a power grid control system.

Module 10: Artificial Intelligence & Machine Learning in APC

- **Fundamentals of AI and ML for Control:** Supervised, unsupervised, and reinforcement learning.
- **Neural Networks for Process Modeling:** Developing data-driven models of industrial processes.
- **Reinforcement Learning for Optimal Control:** Training agents to make control decisions.
- **Anomaly Detection in Process Data:** Identifying unusual patterns and potential failures.
- **Case Study:** Using a machine learning model to predict equipment failure in a rotating machinery.

Module 11: Virtualization and Digital Twins in Industry

- **Virtualization for Control Systems:** Deploying control software on virtual machines.
- **Concept of Digital Twin:** Creating virtual replicas of physical assets and processes.
- **Benefits of Digital Twins in APC:** Simulation, optimization, and predictive insights.
- **Digital Twin Implementation Strategies:** Data integration and model creation.
- **Case Study:** Developing a digital twin of a manufacturing plant for real-time performance monitoring and optimization.

Module 12: Advanced Process Control Software & Tools

- **Simulation Software for Process Control:** Aspen HYSYS Dynamics, MATLAB/Simulink.
- **Optimization Software Packages:** GAMS, AIMMS, and specialized APC software.
- **Data Analysis Tools:** Python (Pandas, NumPy), R, and specialized industrial analytics platforms.
- **Control System Programming Environments:** IEC 61131-3 languages, ladder logic, function blocks.
- **Case Study:** Using simulation software to test and validate a new control strategy before deployment.

Module 13: Industrial Network & Communication Protocols

- **Industrial Ethernet (Profinet, EtherNet/IP):** High-speed and real-time communication.
- **OPC UA (Open Platform Communications Unified Architecture):** Interoperability and data exchange.
- **Wireless Communication in Industry:** Wi-Fi, Bluetooth, and cellular technologies for remote assets.
- **Network Diagnostics and Troubleshooting:** Identifying and resolving communication issues.
- **Case Study:** Designing a robust industrial network architecture for a smart factory.

Module 14: Safety Instrumented Systems (SIS)

- **Functional Safety Concepts:** Understanding SIL levels and safety lifecycles.
- **Design and Implementation of SIS:** Sensors, logic solvers, and final elements.
- Upcoming Scheduled Sessions

Start Date	End Date	Location	Price
23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

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