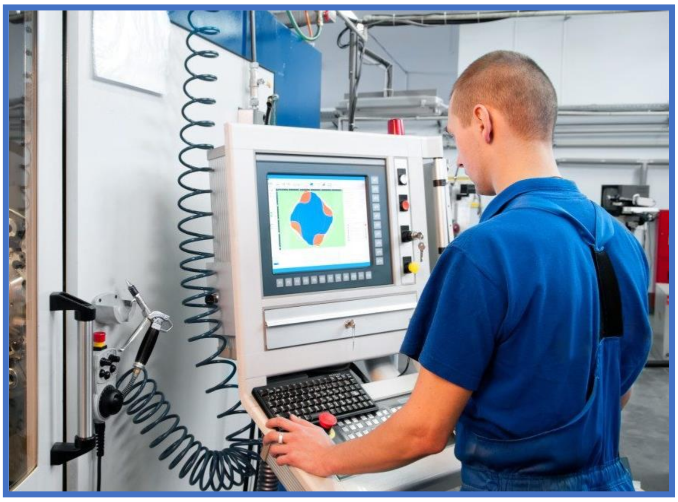
COURSE OVERVIEW IE0662
Basics of Control and Automation (E-Learning Module)



Course Title
Basics of Control and Automation (E-Learning Module)

Course Reference
IE0662

Course Format & Compatibility
SCORM 1.2. Compatible with IE11, MS-Edge, Google Chrome, Windows, Linux, Unix, Android, IOS, iPadOS, macOS, iPhone, iPad & HarmonyOS (Huawei)

Course Duration
30 online contact hours (3.0 CEUs/30 PDHs)

Course Description

This E-learning course is designed to provide participants with a basic overview of control and automation. It covers the fundamentals of instrumentation and the terminology for home heating control; the motivation for automatic process control; the fundamentals of instrumentation and process control; the modes of closed loop control; the manual control, on-off control, PID control, time proportion control and cascade control; the basic elements of process control and the dynamic process behavior; and the graphical modelling of dynamic process data, process and controller action.

During this course, participants will learn the standard instrumentation signals, pneumatic scaling and current loop scaling; the digital communications, configuration, signal conditioning and self-diagnosis; the instrument properties that affect a process covering range and span, measurement resolution, accuracy, precision and instrument dynamics; the range and span, measurement resolution, accuracy, precision and instrument dynamics; the input aliasing and correct sampling frequency and the correct sampling interval; the instrument noise and temperature; the thermocouples, thermocouple junctions, linearization, gain, types and etc.; the pressure absolute, gauge and differential; and the common level sensing technologies-non-contract.

Course Objectives

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

- Apply and gain a basic knowledge on control and automation
- Discuss the fundamentals of instrumentation including the terminology for home heating control
- Explain the motivation for automatic process control and recognize the terminology for home heating control
- Describe the fundamentals of instrumentation and process control and identify the modes of closed loop control
- Employ manual control, on-off control, PID control, time proportion control and cascade control
- Identify the basic elements of process control and the dynamic process behavior
- Describe graphical modelling of dynamic process data, process and controller action
- Recognize the standard instrumentation signals, pneumatic scaling and current loop scaling
- Employ digital communications, configuration, signal conditioning and self-diagnosis
- Determine instrument properties that affect a process covering range and span, measurement resolution, accuracy, precision and instrument dynamics
- Discuss input aliasing and correct sampling frequency as well as determine the correct sampling interval
- Identify instrument noise and temperature including thermocouples, thermocouple junctions, linearization, gain, types and etc.
- Define pressure and describe pressure absolute, gauge and differential
- Recognize common level sensing technologies-non-contract comprising of ultrasonic, radar/microwave, nuclear level measurement, hydrostatic pressure, RF/capacitance and guided wave radar

Who Should Attend

This course provides a basic overview of all significant aspects and considerations of control and automation for engineering managers, instrumentation and control engineers, process control and automation engineers, design engineers and consulting engineers, process control engineers, electrical engineers, management, engineering and supervision staff who are responsible on PLC, superintendents, supervisors, DCS, SCADA and PLC personnel, process control staff, trades staff working with or near PLC's and other technical staff.

Course Certificate(s)
Internationally recognized certificates will be issued to all participants of the course.

Certificate Accreditations
Certificates are accredited by the following international accreditation organizations: -

- USA International Association for Continuing Education and Training (IACET)

  Haward Technology is an Authorized Training Provider by the International Association for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 1-2013 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 1-2013 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Association for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Training Methodology

This Trainee-centered course includes the following training methodologies:-

- Talking presentation Slides (ppt with audio)
- Simulation & Animation
- Exercises
- Videos
- Case Studies
- Gamification (learning through games)
- Quizzes, Pre-test & Post-test

Every section/module of the course ends up with a Quiz which must be passed by the trainee in order to move to the next section/module. A Post-test at the end of the course must be passed in order to get the online accredited certificate.

Course Fee

As per proposal

Course Contents

- Fundamentals of Instrumentation & Process Control
- Introduction to Process Control
- Motivation for Automatic Process Control
- “Loose” Control Costs Money
- “Tight” Control is More Profitable
- Terminology for Home Heating Control
- What is Process Control
- What is a Process
- Process control
- What is Open Loop Control
- What is Closed Loop Control
- What are the Modes of Closed Loop Control
- Manual Control
- On-Off Control
- PID Control
- Time Proportion Control
- Cascade Control
- Basic Elements of Process Control

- Understanding Dynamic Process Behavior
- Dynamic Process Behavior and Controller Tuning
- Graphical Modeling of Dynamic Process Data
- Modeling Dynamic Process Behavior
- The FOPDT Model is All Important
- Step Test Data and Dynamic Process Modeling
- Process Gain (Kp) from Step Test Data
- Process Gain (Kp) for Gravity-Drained Tanks
- Additional Notes on Process Gain Measuring the Process Gain
- Additional Notes on Process Gain Converting Units of Process Gain
- Additional Notes on Process Gain Values for Process Gain
- Process Time Constant (   ) from Step Test Data
- Time Constant (   ) for Gravity-Drained Tanks
- Process Dead-Time (Ѳp) from Step Test Data
- Dead-Time (Ѳp) is the Killer of Control
- Process Dead-Time (Ѳp) from Step Test Data
- Dead-Time (Ѳp) for Gravity Drained Tanks
- The FOPDT Model Parameters
- In Summary
- Processes have Time Varying Behavior
- Processes have Nonlinear Behavior
- What is a Nonlinear Process
- What is a Nonlinear Process Dealing with Nonlinearity – Set Point Response
- What is a Nonlinear Process Dealing with Nonlinearity
- What is Process Action
- Process and Controller Action
- Introduction to Instrumentation
- What are Sensors and Transducers
- What are Standard Instrumentation Signals- Pneumatic
- What are Standard Instrumentation Signals- Pneumatic Scaling
- What are Standard Instrumentation Signals- Current Loop
- What are Standard Instrumentation Signals- Current Loop Scaling
- What are Standard Instrumentation Signals- 0 to 10 Volt
- What are Smart Transmitters

- What are Smart Transmitters- Digital Communications
- What are Smart Transmitters- Configuration, Signal Conditioning, Self-Diagnosis
- What Instrument Properties Affect a Process
- What Instrument Properties Affect a Process- Range and Span
- What Instrument Properties Affect a Process- Measurement Resolution
- What Instrument Properties Affect a Process- Accuracy
- What Instrument Properties Affect a Process- Precision
- What Instrument Properties Affect a Process- Accuracy vs. Precision
- What Instrument Properties Affect a Process- Instrumentation Dynamics: Gain and Dead Time
- What Instrument Properties Affect a Process- Instrumentation Dynamics: Time Constant
- What is Input Aliasing
- What is Input Aliasing- Correct Sampling Frequency
- What is Input Aliasing- Determining the Correct Sampling Interval
- What is Instrument Noise
- What is Instrument Noise- Sources?
- What is Instrument Noise- Effects of Noise
- What is Instrument Noise- Low Pass Filter
- What is Instrument Noise- Selecting a Low Pass Filter
- What is Temperature
- What is Temperature- Unit Conversion
- What Temperature Instruments Do We Use
- What Temperature Instruments Do We Use- Thermocouples
- What Temperature Instruments Do We Use- Thermocouple Junctions
- What Temperature Instruments Do We Use- Thermocouple Linearization
- What Temperature Instruments Do We Use- Thermocouple Gain
- What Temperature Instruments Do We Use- Thermocouple Types
- What Temperature Instruments Do We Use- RTDs
- What Temperature Instruments Do We Use- RTDs: Importance of α
- What Temperature Instruments Do We Use- RTD Lead Wire Resistance
- What Temperature Instruments Do We Use- RTD Self Heating Effect
- What Temperature Instruments Do We Use- Thermistors
- What Temperature Instruments Do We Use- Infrared
- What Temperature Instruments Do We Use- Infrared Emittance

- What Temperature Instruments Do We Use- Infrared Field of View
- What Temperature Instruments Do We Use- Infrared Spectral Response
- What is Pressure
- What is Pressure Absolute, Gauge and Differential
- Common Level Sensing Technologies
- Common Level Sensing Technologies - Non-Contact: Ultrasonic
- Common Level Sensing Technologies - Non-Contact: Radar/Microwave
- Common Level Sensing Technologies- Non-Contact: Nuclear Level Measurement
- Common Level Sensing Technologies- Contact: Hydrostatic Pressure
- Common Level Sensing Technologies- Contact: RF/Capacitance
- Common Level Sensing Technologies- Contact: Guided Wave Radar
- What is Flow
- Factors Affecting Flow Measurement
- Factors Affecting Flow Measurement- Viscosity
- Factors Affecting Flow Measurement- Viscosity Conversion Chart
- Factors Affecting Flow Measurement- Viscosity of Common Fluids
- Factors Affecting Flow Measurement- Viscosity
- Factors Affecting Flow Measurement- Fluid Type
- Factors Affecting Flow Measurement- Reynolds Number
- Factors Affecting Flow Measurement- Laminar Flow
- Factors Affecting Flow Measurement- Turbulent Flow
- Factors Affecting Flow Measurement- Transitional Flow
- Factors Affecting Flow Measurement- Reynolds Number
- Factors Affecting Flow Measurement- Flow Irregularities
- Common Flowmeter Technologies
- Common Flowmeter Technologies- Volumetric Flow
- Common Flowmeter Technologies- Volumetric Flow: Positive Displacement
- Common Flowmeter Technologies- Volumetric Flow: Magnetic
- Common Flowmeter Technologies- Volumetric Flow: Orifice Plates
- Common Flowmeter Technologies- Mass Flow
- Common Flowmeter Technologies- Mass Flow: Coriolis
- Common Flowmeter Technologies- Flowmeter Turndown
- Common Flowmeter Technologies-Installation and Calibration

- Introduction to Final Control Elements
- What is a Control Valve
- What is a Control Valve- Shut-Off Service
- What is a Control Valve- Divert Service
- What is a Control Valve- Throttling Service
- What is an Actuator
- Additional Photos of Actuators
- What is a Positioner
- What is Cv
- What are Valve Characteristics
- What are Valve Characteristics- Inherent Characteristics
- What are Valve Characteristics- Inherent Characteristics: Rangeability
- What are Valve Characteristics- Inherent Characteristics: Gain
- What are Valve Characteristics- Inherent Characteristics: Equal % Valves
- What are Valve Characteristics- Inherent Characteristics: Linear Valves
- What are Valve Characteristics- Inherent Characteristics: Quick Opening
- What are Valve Characteristics- Installed Characteristics
- What is Valve Deadband
- What is Valve Deadband- Testing for Deadband
- What is Valve Deadband- Effects of Deadband
- What is Stiction
- What is Stiction- Testing for Stiction
- What is Stiction- Effects of Stiction
- What are the Types of Valves- Linear Motion
- What are the Types of Valves- Linear Motion: Globe Valves
- What are the Types of Valves- Linear motion: Gate Valves
- What are the Types of Valves- Linear Motion: Diaphragm Valves
- What are the Types of Valves- Linear Motion: Pinch Valves
- What are the Types of Valves- Rotary Motion
- What are the Types of Valves- Rotary Motion: Ball Valve
- What are the Types of Valves- Rotary Motion: Butterfly Valve
- What are the Types of Valves- Rotary Motion: Plug Valve
- What is a Centrifugal Pump
- What is Pump Head

- Why Do We Use Pump Head and not PSI
- What is a Pump Curve
- What is a System Curve
- What is the System Operating Point
- What is the System Operating Point- Throttling Valves
- What is the System Operating Point- Variable Speed Drives: Affinity Laws
- Speed Capacity Relationship
- Speed Head Relationship
- Speed Horsepower Relationship
- What is the System Operating Point- Variable Speed Drives: Shifting the Pump Curve
- What is a Positive Displacement Pump
- How Does a PD Pump Differ from a Centrifugal Pump
- Pump Curve
- Changing the System Operating Point
- Positive Displacement Pump- Variable Speed Drives: Affinity Laws
- Speed Capacity Relationship
- Speed Horsepower Relationship
- Good Practice and Troubleshooting- The Method
- Good Practice and Troubleshooting- Common Valve Problems
- Good Practice and Troubleshooting- Common Sensor Problems
- Smart Transmitters
- Temperature Sensors
- Pressure Sensors
- Flow Sensors
- Good Practice and Troubleshooting
- Common Controller Problems
- Good Practice and Troubleshooting
- Common Process Problems
- Programmable Logic Controller (PLC).
- Description
- Introduction To PLCS
- Advantages of PLCs
- PLC Origin

- Historical Background
- Programmable Controller Development
- Programmable Logic Controllers (Definition according to NEMA standard ICS3-1978)
- Leading Brands Of PLC
- Areas of Application
- PLC Size
- Tank Used to Mix Two Liquids
- Major Components of a Common PLC
- Processor
- Programming Device
- I/O Module
- DC Input Module
- AC Input Module
- Figure 3.1a 3-input circuit diagram
- Input connection
- I/O Module- DC / AC Output Module
- I/O Circuits- Different Types Of I/O Circuits
- Allen Bradley 1746-1A16
- Ladder Program
- Discrete Input
- Analog Input
- Digital Output
- Analog Output
- Processor
- Memory Map Organization
- Memory Designs
- Volatile
- Non-Volatile
- ROM, Read Only Memory
- PROM, Programmable Read Only Memory
- EPROM, Erasable Programmable Read Only Memory
- EEPROM, Electrically Erasable Programmable Read Only Memory
- PLC Operation

- Basic Function of a Typical PLC
- PHASE 1 – Input Status scan
- PHASE 2– Logic Solve/Program Execution
- PHASE 3– Logic Solve/Program Execution
- PHASE 4 - Output Status Scan
- PLC Communications
- Common Uses of PLC Communications Ports
- Serial Communications
- RS 232
- Local Area Network (LAN)
- RS 422 / RS 485
- Programmable Controllers and Networks
- Specifications
- Selecting a PLC
- A Detailed Design Process
- Specifications
- Output-Port Power Ratings
- Scan Time
- Memory Capacity
- PLC Status Indicators
- Troubleshooting
- List of items required when working with PLCs
- Examples of PLC Programming Software
- Programming
- Coils
- Boxes
- And Operation
- Or Operation
- Not Operation
- Device Management Protocols
- 4–20 mA Process Control Loops
- 4–20 mA Process Control Loops
- Control Loops
- Pneumatic Control Loop

- Electronic Control Loop
- 4-20mA Current Loop for flow transmitter and Control Valve Positioner
- History of Control Signals
- The HART Protocol, Current Loop and the Classical Solution for Analog Values
- Field Device: Example Differential Pressure Transducer
- 4-20 mA loop - the Conventional, Analog Standard (Recall)
- HART- Data over 4.20 mA loops
- HART – Principle
- Installation
- The Round card
- HART – Protocol
- HART – Commands
- HART commands summary
- Device Description
- Device access
- Device Description Language
- Device Description usage
- Assessment
- Industrial Control Systems
- Automation Defined
- Program of Instructions
- Work Cycle Program
- Control System
- Control Architecture
- Automatic Control - Level 0 and 1
- Sensors – Level 0
- Actuators – Level 0
- Advanced Automation Functions
- Safety Monitoring
- Maintenance and Repair Diagnostics
- Error Detection and Recovery
- Industrial Control Systems
- Process vs. Discrete Industries
- Variables and Parameters

- Types of Control
- Types of Continuous Process Control
- Regulatory Control
- Feedforward Control
- Feedforward Control - Combined with Feedback Control
- Steady-State Optimization
- Steady State (Open-Loop) Optimal Control
- Adaptive Control
- Adaptive Control Operates in a- Time-Varying Environment
- Three Functions in Adaptive Control
- Adaptive Control System
- On-Line Search Strategies
- Distributed Control System DCS
- DCS Overview
- DCS
- Why DCS System is required?
- What does DCS System consists of?
- How does it work?
- How Process Control Loop Works
- The Basic Plant areas classified as follows
- D C S - Components and Inter faces
- Components of DCS
- Operator console
- Engineering Console
- History Module
- Data Historian
- Control Modules
- I / O
- Interface DCS: Human – Machine Interface
- Human – Machine Interface
- Engineering Interface
- Interface to Other Systems
- Computer Interface Supervisory
- Control Sub-system Interface

- Process Interface
- D C S - Communication Facilities, Requirements, Architecture Model
- Communication System Requirements
- DCS Communication Architecture
- Channel Structure
- Levels of Subnetworks
- DCS System Layout and its Different Parts
- DCS System Layout
- DCS System – Level 0
- DCS System – Level 1
- DCS System – Level 2
- DCS System – Level 3
- System Cabinets
- Marshalling Cabinets
- Operator WorkStation
- Figure: DCS TDC2000 Operator Workstation (old model)
- DCS TDC3000 Operator Workstation
- Engineering WorkStation
- Switch
- Communication Media and Protocols
- Types of System Architecture used in Industrial Automation
- Architecture #1
- Architecture #2- Access to the Local System via Remote Display
- Architecture #3- Transfer of Data to Enterprise Level
- Architecture #4-Access from Level 4 and above to DMZ Portal for view only
- Architecture #5- Access from an External Monitoring Center to Level 2 for view only
- Architecture #6- Remote Access from Level 4 and above for Read and Write access
- File Transfer
- Recommended System Architectures
- Example of Hybrid Architecture Implementation
- What is SCADA ? How does SCADA Works ?
- What is SCADA ?
- SCADA

- SCADA Systems Concepts
- Data acquisition
- SCADA
- Human Machine Interface
- SCADA Hardware
- Remote Terminal Unit (RTU)
- Supervisory Station
- SCADA Operational Philosophy
- Communication Methods and Infrastructure
- SCADA Architectures
- Monolithic: The First Generation
- Distributed: The Second Generation
- Networked: The Third Generation
- SCADA Security Issues
- Applications of Scada:
- Application in Power Plants:
- Application in Oil & Gas Plants:
- Applications in Pipelines
- Applications in Power Transmission
- Applications in Irrigation Systems
- Know, read & understand your Piping & Instrumentation Diagrams (P&ID's)
- What is Piping and Instrumentation Diagram (P&ID)?
- Contents and function
- List of P&ID items
- Piping and Instrumentation Diagram Example
- Anatomy of a Drawing
- The Title Block
- Second Area of the Title Block
- Third Area of the Title Block
- Categories of Drawings
- Figure 6: Example P&ID
- Figure 1: Valve Symbols
- Figure 2: Valve Actuator Symbols
- Figure 3: Remotely Controlled Valve

- Figure 4: Level Control Valve
- Figure 5: Control Valves with Valve Positioners
- Figure 6: Control Valve Designations
- Figure 7: Piping Symbols
- Figure 8: Piping Symbols
- Figure 9: Sensing Device Symbols
- Figure 10: Transmitters and Instruments
- Figure 11: Indicators and Recorders
- Figure 12: Controllers
- Figure 13: Signal Conditioners
- Figure 14: Instrumentation System Examples
- Figure 15: Symbols for Major Components
- Figure 16: Miscellaneous Symbols
- Figure 17: Valve Status Symbols
- P&ID Guidelines for Pumps
- P&ID Guidelines for Control Valves
- P&ID Guidelines for Storage Tanks
- P&ID Guidelines for Centrifugal Compressor Systems
- Figure 18: Exercise P&ID
- Exercises: Identify Instruments in Piping and instrumentation Diagram
- Identify Process Variables in P&ID
- Instrumentation Diagrams Multiple Choice Questions
- Question 2
- Question 3
- Question 4
- Question 5
- Question 6
- Question 7
- Question 8
- Question 9
- Question 10