COURSE OVERVIEW IE0136
Control Loops
(E-Learning Module)

Course Title
Control Loops (E-Learning Module)

Course Reference
IE0136

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)

3.0 CEUs (30 PDHs) AWARD

Course Description

This E-learning course is designed to provide participants with a detailed and up-to-date overview of control loops. It covers the process controller, control loop and valve tuning including control fundamental and process control terminology; the control principle, basic control loop, advance control loop and feed forwarded control loop; the control algorithm, control system, valve types, control valve types and control valve selection; the selection guidelines, application comparisons, process control methods, reset action and trial-and-error tuning; and the Zigler-Nichols tuning methods, Zigler-Nichols reactive curve method and Ziegler & Nichols tuning reaction curve using point of inflection.

Further, the course will also discuss the steps of open loop tuning, continuous cycling method, direct synthesis method, direct synthesis tuning calculations and advanced control techniques; the cascade control, feedforward control, ratio control, adaptive control, selection of flow characteristic and valve engineering liquid and flashing sizing; the recovery coefficient, physical constants of hydrocarbons and pressure-temperature ratings for standard class valves; and the fisher controls, shutoff methods, seat leakage classifications, valve selection process and advance valve sizing.

During this course, participants will learn the control valve seat leakage classifications, cavitation and flashing, noise prediction and control and self (auto) tuning operation; the main components of self-tuning, practical limitations in tuning of a control loop and control valve actuators and accessories; and the field calibration checks of valves, actuator selection, principle of operation, direct action operation and reverse action operation.

Course Objectives

After completing the course, the employee will be able to:-

- Apply and gain a comprehensive knowledge on control loops
- Discuss process controller, control loop and valve tuning including control fundamental and process control terminology
- Explain control principle, basic control loop, advance control loop and feed forwarded control loop
- Recognize control algorithm, control system, valve types, control valve types and control valve selection
- Carryout selection guidelines, application comparisons, process control methods, reset action and trial-and-error tuning
- Apply Zigler-Nichols tuning methods, Zigler-Nichols reactive curve method and Ziegler & Nichols tuning reaction curve using point of inflection
- Illustrate the steps of open loop tuning, continuous cycling method, direct synthesis method, direct synthesis tuning calculations and advanced control techniques
- Employ cascade control, feedforward control, ratio control, adaptive control, selection of flow characteristic and valve engineering liquid and flashing sizing
- Identify recovery coefficient, physical constants of hydrocarbons and pressure-temperature ratings for standard class valves
- Perform fisher controls, shutoff methods, seat leakage classifications, valve selection process and advance valve sizing
- Apply control valve seat leakage classifications, cavitation and flashing, noise prediction and control and self (auto) tuning operation
- Identify the main components of self-tuning, practical limitations in tuning of a control loop and control valve actuators and accessories
- Illustrate field calibration checks of valves, actuator selection, principle of operation, direct action operation and reverse action operation

Who Should Attend

This course provides an overview of all significant aspects and considerations of control loops for engineers and other technical staff who are willing to learn more about single loop controllers, PID and tuning.

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.

Course Fee

As per proposal

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 Contents

- Process Controller, Control Loop & Valve Tuning
- Control Fundamental
- Process Control Terminology
- Control Principle
- Basic Control Loop
- Advance Control Loop
- Feed Forwarded Control loop
- Example of Ratio control
- Control Algorithm
- Control System
- Look At How The Control Migrate
- Course Recap
- Review questions
- Valve Types
- Control Valves
- Control Valve Types
- Globe Valves

- Different Types of Global Value
- Rotary Motion Control Valves
- Control Valve End Connections
- Valve Body Bonnets
- Actuators
- Course Recap
- Review questions
- Control Valve Types
- Rotary Valves
- Butterfly Valves
- Control Valve Types
- Eccentric Disk Valves
- Eccentric Rotary Plug Valves
- Control Valve Types
- Ball Valves
- Plug Valves
- Linear Valves
- Globe Valves
- Control Valve Selection
- Price Comparison
- Control Valve Types
- Selection Guidelines
- Application Comparisons
- Review questions
- Process Control Methods
- Open-Loop Control
- Closed-Loop Control
- Process Behavior
- Process Behavior Example
- Single-Variable Control Loop

- Response Time of the Instrument
- Time Lag
- Selecting a Controller
- On-Off Control
- Continuous Control
- Amplitude Proportional
- Proportional Band
- Integral Control
- Reset Action
- Derivative Mode
- P & I & D relation ship
- Control Mode Summary
- Tuning the Controller
- Trial-and-Error Tuning
- Zigler-Nichols Tuning Methods
- Zigler-Nicoles Reactive Curve Method
- Ziegler & Nichols Tuning Reaction Curve using Point of)Inflection (POI
- Steps of Open Loop Tuning (Reaction Curve) using POI
- Continuous Cycling Method
- Direct Synthesis Method
- Direct Synthesis Tuning Calculations
- Advanced Control Techniques
- Cascade Control
- Feedforward Control
- Ratio Control
- Adaptive Control
- Course Recap
- Review questions
- Control Valve Flow Characteristics
- Selection of Flow Characteristic

- Valve Engineering Liquid and Flashing Sizing
- Recovery Coefficient
- Physical Constants of Hydrocarbons
- Pressure-Temperature ratings for Standard Class Valves
- Fisher Controls
- Shutoff Methods
- Seat Leakage Classifications
- Valve Selection Process
- Advance Valve Sizing
- Valve Sizing
- Characterization of Cage-Guided Valve Bodies
- Valve Plug Guiding
- Restricted-Capacity Control Valve Trim
- Control Valve Seat Leakage Classifications
- Review questions
- Cavitations & Flashing
- Choked Flow Causes Flashing and Cavitation
- Valve Selection for Flashing Service
- Valve Selection for Cavitation Service
- Noise Prediction
- Noise Control
- Noise Summary
- Noise Prediction {conclusion}
- Review questions
- Different Tuning Rules Available
- Tuning for NO Overshoot on Start-up
- Formula for NO Overshoot on Start-up
- Short Cut Open Loop Method
- Simplified Lambda Tuning
- On-line Trial Tuning

- Cohen Coon Tuning Rule
- This from Zigler -Nicols Curve its here just for ↓RR value
- Cohen Coon Tuning Rule
- Controllability of Process
- A Few General Suggestions
- A Few Suggestions
- Some Rules of Thumb
- Review questions
- Fundamentals of Control Systems
- Terminology in Control
- ON/OFF Control
- Response of a Two Position Controller
- ON-OFF Control
- Modulating Control
- Cascade Control
- Ratio Control
- Open Loop and Closed Loop Control
- Open Loop Control
- Simple Process Block
- Open Loop Control
- Open Loop Example
- Feedforward Control
- Feedforward Block Diagram
- Feedforward Control Example
- Feed Heater Example - Analyse Components
- Closed Loop Control
- Closed Loop Block Diagram
- Disadvantage of Feedback Control
- Modes of Feedback Control
- Closed Loop PID has 3 Modes

- Basic Error Assessment
- Proportional Control
- Proportional Action (Closed Loop)
- Proportional Formulas
- Proportional Band
- Ranges of Proportional Bands
- Integral Action to Reduce Offset
- Phase Shift of Integration Action
- Integral Relationships
- Integral Action in Practice
- Proportional and Integral Control (Closed Loop)
- Integral has a Phase Lag
- Integral Lag Needs Compensation
- Derivative Control
- Derivation Control Formula
- Derivative Relationships
- Derivative Control has No Functionality
- Derivative has a Phase Lead
- Combined PID Control
- Principles of PID Application
- Diagram of a Ideal PID Controller
- Reverse or Direct Acting Controllers
- Direct and Reverse Controllers
- Manual Feedback Control
- Stability & Control Modes of Closed Loops
- Principle Of Closed Loop Control
- Stability Criteria
- Mathematical Criteria for Stability
- Increasing Instability With a Phase Shift
- Considerations for Critical Frequency

- Integral Action to Reduce Offset
- Process Response Curve
- Sample and Hold Algorithms
- Step Change of Input Value
- Industrial Control in Practice
- Feed Heater - PV, MV
- Objectives of Feed Heater Control
- Major Disturbances - Feed Heater
- Section Divider
- Proportional Control Basics
- Proportional Band (PB) vs Gain (K)
- Review questions
- Auto Tuning and Self Tuning Controllers
- The Need for Adaptive Control
- Gain Scheduling Controller
- Self (Auto) Tuning operation
- Main Components of Self Tuning
- Review questions
- Good Practice and Troubleshooting in Tuning
- Control Objective
- Flow Control
- Pressure and Level Control
- Tight Control
- Average Control
- Intermediate Level Control
- Temperature Control
- Composition Control
- Cascade Control Tuning
- Troubleshooting and Diagnostics
- Practical Limitations in Tuning of a Control Loop

- Course Recap
- Review questions
- Control Valve Actuators and Accessories
- Types of Actuators
- Pneumatic Actuators
- Diaphragm and Spring Actuators
- Piston Actuators
- Electric Actuators
- Hydraulic and Electrohydraulic Actuators
- Actuator Sizing
- Actuator Force Balance
- Actuator Stiffness
- Bench Set
- Bench Range
- Field Calibration Checks of Valves
- Actuator Selection
- Fail Position
- Pneumatic Actuators
- main disadvantages
- Electric, Hydraulic, and Electrohydraulic Actuators
- main disadvantages
- Control Valve Actuator Accessories
- Hand Wheels
- Limit Switches
- Solenoid Valve Manifold
- Valve Positioner
- Electrical Signals
- Electro-Pneumatic Transducers
- Electro-Pneumatic Valve Positioners
- Electric Motor Actuators

- Booster Relays
- Type of booster relay
- Features of Volume Boosters
- Sectional View Of A Volume Booster
- Principle Of Operation
- Amplifying And Reducing Relays
- Direct Action Operation
- Reverse Action Operation
- High and Low Pressure Selectors and Limiters
- Other Valve Accessories
- Positioners
- Limit Switches
- Solenoid Valve Manifold
- Supply Pressure Regulator
- Pneumatic Lock-Up Systems
- Fail-Safe Systems for Piston Actuators
- Electro-Pneumatic Transducers
- Electro-Pneumatic Valve Positioners
- Diagnostics
- Course Recap
- Review questions