



COURSE OVERVIEW IE0583
Basics of Instrumentation and Measurement
(E-Learning Module)

Course Title

Basics of Instrumentation and Measurement
(E-Learning Module)

Course Reference

IE0583

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 instrumentation and measurement. It covers the basic measurement, range of operations, performance terms, hysteresis, linearity and repeatability; the instrument symbols, instrument installation-guidelines, elements of a process control system, transmitters and controller; the final control element, basic control concepts – variables, controlled and manipulated quantities and elements of a process control system; and the process, measurement, evaluation, control element, manual control and feedback control.



Further, the course will also discuss the general requirements of a control system, cyclic response to a process disturbance and evaluation of control loop response; the ultimate gain and period; the modes of control - tuning methods, ratio control and cascade control; the flow control, level and pressure control and temperature control; the various type of control valves; the butterfly valve body assembly, flashing and cavitation; the valve flow characteristics, linear characteristics, valve accessories and principles of flow measurement; the flow measurement, liquid flow measurement, gas flow measurement, steam flow measurement and flowmeter classification; the type of flowmeters, volumetric, basis of operation and selection and sizing; and the installation techniques, temperature rise method and temperature measurement.



Course Objectives

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

- Apply and gain a basic knowledge on instrumentation and measurement
- Define basic measurement and discuss the range of operations, performance terms, hysteresis, linearity and repeatability
- Identify instrument symbols, instrument installation-guidelines, elements of a process control system, transmitters and controller
- Recognize the final control element, basic control concepts – variables, controlled and manipulated quantities and elements of a process control system
- Carryout process, measurement, evaluation, control element, manual control and feedback control
- Discuss the general requirements of a control system, cyclic response to a process disturbance and evaluation of control loop response
- Determine the ultimate gain and period and apply modes of control - tuning methods, ratio control and cascade control
- Illustrate flow control, level & pressure control and temperature control
- Recognize the various type of control valves and perform butterfly valve body assembly, flashing and cavitation
- Describe valve flow characteristics, linear characteristics, valve accessories and principles of flow measurement
- Apply flow measurement, liquid flow measurement, gas flow measurement, steam flow measurement and flowmeter classification
- Recognize the type of flowmeters, volumetric, basis of operation and selection and sizing
- Employ installation techniques, temperature rise method, temperature measurement, typical thermal well installation and typical applications
- Carryout level measurement, continuous measurement, point detection, application limitations and gauging rod method
- Recognize, buoyancy tape systems, typical applications, ultrasonic measurement and radar measurement
- Identify the main types of antenna, magnetic gauges, radiation level measurement and conductive level detectors
- Apply selection and sizing, installation techniques, typical applications, pressure measurement, installation considerations, selection guidelines, sensor characterization and smart technology

Who Should Attend

This course provides an overview of all significant aspects and considerations of instrumentation and measurement for senior engineers, operation engineers, operational and maintenance staff.

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 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

Course Contents

- Theory and Application - Basic Measurement Definitions
- Quiz
- Accuracy
- Range of Operations
- Budget
- Performance Terms
- Hysteresis
- Linearity
- Repeatability
- Response
- Instrument Symbols
- Instrument Installation-Guidelines
- Control history
- Basic control theory - Elements of a Process Control System
- Transmitters
- Controller
- Final Control Element
- Basic Control Concepts – Variables
- Variables Involved



- Controlled Quantities
- Manipulated Quantities
- Disturbances
- Manipulated Variable
- Basic Elements
- Elements of a Process Control System
- Example of Process Level Control
- Four Elements of a Control System
- Process
- Measurement
- Evaluation
- Control Element
- A Typical Home Heating System
- Manual Control
- Typical Manual Control
- Feedback Control
- Feedback Loop
- Feedback Control Concept
- Advantages of Feedback Control
- Traditional Single Loop Controller
- Basic Control Concepts
- Quiz
- System Responses
- General Requirements of a Control System
- Cyclic Response to a Process Disturbance
- Damped Response to a Process Disturbance
- Evaluation of Control Loop Response
- On – Off Control
- On – Off Temperature Control
- System responses
- Modes of Control - Stability
- Stability of the feedback loop





- Response of Unstable Feedback Control Loop
- Modes of Control - Ultimate Gain
- Determining the ultimate gain and period
- Modes of Control - Tuning Methods
- Tuning for quarter decay response
- Quarter Decay Responses to Disturbance or Set Point
- Modes of Control - Ratio Control
- Ratio Control
- Ratio Control of Heat Exchanger
- Ratio Control by Feedback Control of the Calculatoratio
- Modes of Control - Cascade Control
- Cascade Control
- A Typical Cascade Control Loop Control
- Feed Heater Control –Single Loop Control
- Two Controller Basic Cascade Control
- Principles
- Advantages
- Disadvantages
- Modes of Control - Application examples
- Application examples
- Flow control
- A Typical Flow Loop
- level & pressure control
- Temperature control
- Temperature Control of a Process Furnace
- Control Valves
- Quiz
- Type of Control Valves
- CV of a Control Valve
- Butterfly Valve Body Assembly
- Flashing and Cavitation
- Valve Plugs According to Flow Characteristics





- Valve Flow Characteristics
- Linear Characteristics
- Valve Accessories
- Measurements
- Flow Measurement
- Principles of Flow Measurement
- Types of flow
- Viscosity
- Dynamic Viscosity
- Kinematic Viscosity
- Density
- Specific gravity
- Rangeability
- Velocity
- Flow Measurement
- Liquid Flow Measurement
- Gas Flow Measurement
- Steam Flow Measurement
- Flow Rate
- Volume Flow Rate
- Mass Flow Rate
- Flowmeter classification
- Transit Time Flowmeter
- Doppler Flowmeter
- Clamp-on ultrasonic flowmeter
- Type of flowmeters
- Type A – Volumetric
- Positive Displacement
- Positive Displacement Flowmeter
- Type of flowmeters
- Turbine Flowmeter
- Variable Area Flowmeters



- Thermal Mass Flowmeter
- Flow Measurement
- Oscillatory flow measurement
- Turbine Flowmeters
- Basis of Operation
- Selection and Sizing
- Vortex Flowmeters
- Secondary Element
- Advantages
- Disadvantages
- Installation considerations
- General
- Installation Techniques
- Installation considerations
- Flow meter remains full
- Straight pipe-run arrangements
- Future technologies
- Thermal Type Flowmeters
- Thermal Type Flowmeters
- Constant Current
- Constant temperature
- Principle of Temperature Rise Method
- Insertion Type
- Temperature Measurement
- Quiz
- principles
- Resistive Temperature Devices (RTD)
- Overview
- Typical RTD and Thermowell Construction
- Fluid-expansion Devices
- Field-Mounted Thermometers
- Thermocouples



- Installation Techniques
- Application Details
- Typical Thermal Well Installation
- Typical Applications
- Advantages
- Disadvantages
- Summary
- Level Measurement
- Main types
- Continuous Measurement
- Point Detection
- Simple sight glasses
- Advantages
- Disadvantages
- Application Limitations
- Gauging rod method
- Advantages
- Disadvantages
- Buoyancy tape systems
- There are two main systems
- Float and Tape Systems
- Disadvantages
- Typical Applications
- Ultrasonic measurement
- Radar measurement
- Main types of antenna
- Magnetic Gauges
- Radiation level measurement
- Basic Principles
- Conductive
- Conductive Level Detectors
- Advantages



- Disadvantages
- Capacitive Level Measurement
- Selection and Sizing
- Installation Techniques
- Typical Applications
- Level Measurement - Installation considerations
- Atmospheric Vessels
- Pressurized Vessels
- Future technologies
- Pressure Measurement
- Quiz
- Basic principles
- Pressure Sources
- Static Pressure
- Dynamic Pressure
- Pressure Variations
- Pressure Transducers - Mechanical
- Spring & Bellows Elements
- Diaphragm, Bellows and Piston
- Low Pressure Spring Bellows Element
- Advantages - Spring/Bellows
- Disadvantages - Spring/Bellows
- Application Limitations
- Manometer
- Pressure Transducers & Elements (Electrical)
- Strain Gauges
- Wheatstone circuit for strain gauges
- Typical Application - Force
- Advantages
- Disadvantages
- Piezoelectric
- Advantages

- Disadvantages
- Capacitance
- Illustration of a capacitance D.P. meter body
- Diagram of a capacitance D.P. meter body
- Advantages
- Disadvantages
- Installation considerations
- Sensor Construction
- Temperature Effects
- Selection guidelines
- Future technologies
- Sensor Characterisation
- Smart Technology