



Level One

MODULE 12101-01 - HAND TOOLS FOR INSTRUMENTATION

1. Identify hand tools used in instrumentation.
2. Select the proper hand tool for a job.
3. Inspect the condition of tools.
4. Properly maintain hand tools.
5. Use hand tools safely.
6. Assemble and safely operate oxyacetylene cutting equipment.

MODULE 12102-01 – ELECTRICAL SAFETY

1. Demonstrate safe working procedures in a construction environment.
2. Explain the purpose of OSHA and how it promotes safety on the job.
3. Identify electrical hazards and how to avoid or minimize them in the workplace.
4. Explain safety issues concerning lockout/tagout procedures, personal protection using assured grounding and isolation programs, confined space entry, respiratory protection, and fall protection systems.

MODULE 12103-01 - POWER TOOLS FOR INSTRUMENTATION

1. Identify power tools used in instrumentation.
2. Select the proper power tool for a job.
3. Inspect the condition of the power tool.
4. Properly maintain power tools.
5. Use power tools safely.

MODULE 12104-01 - ELECTRICAL SYSTEMS FOR INSTRUMENTATION

1. Define the following terms:
 - Alternating current (AC)
 - Capacitance
 - Conductor
 - Current
 - Direct current (DC)
 - Electrical circuit
 - Inductance
 - Insulator
 - Ohm's law
 - Resistance
 - Voltage
2. State the two requirements for current flow in a circuit.
3. Use a multimeter and clamp-on ammeter to measure voltage, current, and resistance in a circuit.
4. State Ohm's law in equation form.
5. Use Ohm's law to calculate individual component values and total values for I, E, R, and P in a simple DC series circuit, given any two of the following properties: resistance, current, and voltage.
6. Demonstrate a knowledge of safety considerations when working with electricity.
7. Calculate the value and determine the tolerance of a resistor.
8. Identify correct wire sizes used for different instrumentation applications.
9. Identify various types of electrical fittings used for different instrumentation applications.

MODULE 12105-01 - METALLURGY FOR INSTRUMENTATION

1. Define metallurgy.
2. Identify types of common metals.
3. Describe uses and applications of metals in instrumentation.

MODULE 12106-01 - FASTENERS

1. Identify and explain the use of threaded fasteners.
2. Identify and explain the use of non-threaded fasteners.
3. Describe various types of fasteners.
4. Demonstrate the correct applications for fasteners.
5. Install fasteners.

MODULE 12107-01 - INSTRUMENT DRAWINGS AND DOCUMENTS, PART ONE

1. Identify and describe standard Instrument Society of America (ISA) instrument symbols and abbreviations.
2. Read and interpret instrument indexes.
3. Read and interpret general instrument specifications.
4. Read and interpret general notes and details included on instrument drawings and documents.
5. Read and interpret installation detail drawings.
6. Read and interpret location drawings.

MODULE 12108-01 – GASKETS AND PACKING

1. Identify the different types of gaskets and gasket material.
2. Identify the different types of packing.
3. Describe uses of packing.
4. Describe uses of O-rings.
5. Describe uses of gaskets.
6. Fabricate gaskets.

MODULE 12109-01 - LUBRICANTS, SEALANTS, AND CLEANERS

1. Identify and select the appropriate lubricants for use in specific applications.
2. Identify and select the appropriate sealants for use in specific applications.
3. Identify and select the appropriate cleaners for specific applications.
4. Describe the differences between lubricants, sealants, and cleaners.
5. Describe proper applications of lubricants, sealants, and cleaners.
6. Properly handle and store lubricants, sealants, and cleaners.
7. Explain Material Safety Data Sheets (MSDSs).

MODULE 12110-01 - FLOW, PRESSURE, LEVEL, AND TEMPERATURE

1. Identify and describe characteristics of flow measurement.
2. Identify and describe characteristics of pressure measurement.
3. Identify and describe characteristics of temperature measurement.
4. Identify and describe characteristics of level measurement.

MODULE 12111-01 - TUBING

1. Identify the different kinds of tubing and describe the properties and common uses for each kind.
2. Explain the purpose for tubing standards and specifications.
3. Properly handle and store tubing.
4. Cut tubing using the proper tools, cutting methods, and safety procedures.
5. Bend tubing using the proper tools, bending methods, and safety procedures.
6. Identify and select proper tubing fittings for selected instrumentation applications.
7. Flare tubing using the proper tools, flaring methods, and safety procedures.

MODULE 12112-01 - PIPING – 2 INCHES AND UNDER

1. Identify the different kinds of welded and seamless piping and give their process applications.
2. Discuss national tubing standards.
3. Store and handle pipe properly to prevent damage and/or contamination to the pipe or personal injury.
4. Use proper procedures for cutting piping.
5. Use proper procedures for threading piping.
6. Identify and select appropriate fittings for selected piping applications.

MODULE 12113-01 - HOSES

1. Identify various types of hoses and fittings.
2. Select appropriate types and sizes of hoses and fittings for selected applications.
3. Recognize standards and codes used to identify hoses and fittings.
4. Store and handle hose properly to prevent damage and/or contamination to the hose or personal injury.
5. Install a reusable fitting on a hose.

Level Two

MODULE 12201-03 - CRAFT-RELATED MATHEMATICS

1. Identify similar units of measurement in both the English and metric systems and identify which units are larger.
2. Convert measured values in the English system, using common conversion factor tables, to equivalent metric values.
3. Use a handheld calculator to perform the basic mathematical operations necessary in instrumentation.
4. Use a handheld calculator to square numbers and find the square root of numbers.
5. Perform the mathematical conversions necessary for instrumentation measurements.

MODULE 12202-03 - INSTRUMENT DRAWINGS AND DOCUMENTS, PART TWO

1. Identify common types of electrical and instrumentation diagrams and drawings.
2. Read and interpret electrical diagrams used in instrumentation work:
 - Wiring diagrams
 - Ladder diagrams
 - One-line diagrams
 - Motor controller diagrams
3. Read and interpret instrumentation diagrams:
 - P&ID diagrams
 - Loop diagrams
 - Raceway diagrams
4. Draw a loop diagram for a given instrumentation loop.

MODULE 12203-03 - PRINCIPLES OF WELDING FOR INSTRUMENTATION

1. Define stick and orbital tube welding principles, procedures and applications.
2. Identify TIG and MIG welding principles, procedures, and applications.
3. Identify brazing principles, procedures, and applications.
4. Identify types of fittings that are welded.
5. Identify and demonstrate proper use of personal protective equipment.

MODULE 12204-03 - PROCESS CONTROL THEORY

1. Define process measurement and control.
2. Explain process characteristics that demand process control.
3. Describe the elements of an instrumentation channel, including:
 - Detector (sensor)
 - Transducer
 - Amplifier or signal conditioner
 - Transmitter
 - Controller
 - Final element (control valve)
4. Define and describe process control loop types, including:
 - Feedforward
 - Feedback
 - Cascade
 - Ratio
5. Define and describe process controller modes, including:
 - On-off control (two-position control)
 - Modulating control
 - Proportional (P)
 - Integral (I)
 - Derivative (D)
 - Proportional plus integral (PI)
 - Proportional plus derivative (PD)
 - Proportional plus integral plus derivative (PID)
6. Discuss various types of process control applications and loops.

MODULE 12205-03 – DETECTORS, SECONDARY ELEMENTS, TRANSDUCERS, & TRANSMITTERS

1. Identify the following primary elements (detectors) and describe their operation:
 - Orifice plate
 - Pitot tube
 - Bimetallic strip device
 - Thermocouple
2. Identify the following secondary elements and describe their operation:
 - Bourdon tube
 - Diaphragm device
 - Pressure capsule
 - Bellows device
3. Define an I/P and a P/I transducer and describe their operation.
4. Describe the operation of a strain gauge.
5. Identify a pneumatic DP transmitter and an electronic DP transmitter and describe their operation.
6. Identify the following primary components in a DP cell transmitter:
 - Process measuring section (hi and lo sides)
 - Force bar section
 - Flapper-nozzle (pneumatic only)
 - Pneumatic relay (pneumatic only)
 - Input/output sections (pneumatic and electronic)
7. Draw a one-line diagram including a measuring element, transducer, and transmitter.

MODULE 12206-03 - CONTROLLERS, RECORDERS, AND INDICATORS

1. Describe the operation of a controller.
2. Describe the operation of a recorder.
3. Describe the operation of an indicator.
4. Using samples, pictures, or specification sheets, identify common types of controllers, recorders, and indicators.
5. Identify the common parts of a pneumatic controller.
6. Describe the functions of an electronic controller.
7. Identify the common parts of an electronic controller.
8. Identify the three main sections of a recorder.
9. Connect and use a short recorder.

MODULE 12207-03 - CONTROL VALVES, ACTUATORS, AND POSITIONERS

1. Describe the construction principles of operation of various control valves.
2. Describe the construction principles of operation of various actuators.
3. Describe the principles of operation of various positioners.
4. Describe the variables measured and used as inputs for various types of positioners.
5. Discuss valve selection criteria and identify various control valves, actuators, and positioners using specification sheets, pictures, or samples.

MODULE 12208-03 - RELAYS AND TIMERS

1. Describe the basic functions of relays.
2. Describe and identify electromechanical relays and explain how they operate.
3. Install and connect relays in sockets.
4. Describe and identify solid state relays and explain how they operate.
5. Describe and identify pneumatic relays and repeaters. Explain how these operate.
6. Describe and identify hydraulic relays and explain how they operate.
7. Describe and identify timers and time delay relays, including:
 - Dashpot
 - Synchronous time clock
 - Solid state
8. Describe the operation of a volume booster.
9. Install various types of timers.

MODULE 12209-03 - SWITCHES AND PHOTOELECTRIC DEVICES

1. State the purpose of a switch.
2. Identify commonly used switches.
3. Describe the operation of various types of switches.
4. Classify switches, using wiring symbols, according to the number of poles and the number of throws.
5. State the purpose of an SCR.
6. Describe the operation of photoelectric devices.
7. Identify commonly used photoelectric devices.
8. State the electrical characteristics of a solar cell.

MODULE 12210-03 - FILTERS, REGULATORS, AND DRYERS

1. Define and discuss principles of operation of various filters.
2. Define and discuss principles of operation of various regulators.
3. Define and discuss principles of operation of dryers.
4. Define and discuss variables measured and used as inputs to various types of regulators.
5. Discuss selection criteria, and identify various filters, regulators, and dryers using specification sheets, pictures, and samples.

MODULE 12211-03 - ANALYZERS AND MONITORS

1. Describe the purpose of the periodic table.
2. Describe the scale used for measuring pH.
3. Define conductivity, and describe the method used to measure conductivity.
4. Define specific gravity, and list two methods used for measuring specific gravity.
5. Define viscosity, and list two methods used for measuring viscosity.
6. Describe the purpose of gas chromatography.
7. Describe the purpose of thermal conductivity gas analysis.
8. List two methods commonly used for measuring hydrocarbons.

MODULE 12212-03 - PANEL-MOUNTED INSTRUMENTS

1. Identify panel-mounted instruments from piping and instrumentation drawings.
2. Lay out panel-mounted devices for installation.
3. Install various panel-mounted instruments.

MODULE 12213-03 – INSTALLING FIELD-MOUNTED INSTRUMENTS

1. Identify and describe various methods used in installing instruments in the field, including these:
 - Stand mount
 - In-line mount
 - Structure mount
 - Strap mount
 - Insertion mount
2. Determine and select the proper method of installation and location based on the instrument, environment and situation.
3. Plan and prepare support components for field-mounted instruments.
4. Install and describe the purpose of various valve manifold assemblies associated with the installation of field-mounted instruments.

MODULE 12214-03 – RACEWAYS FOR INSTRUMENTATION

1. Identify various types of metallic conduit and fittings and state their uses.
2. Identify types of nonmetallic conduit and fittings and state their uses.
3. Identify raceway supports and their uses.
4. Prepare various types of conduit for installation.
5. Describe wireways and cable trays and their associated fittings.

Level Three

MODULE 12301-03 – INSTRUMENT FITTER’S MATH

1. Identify a right triangle and the angles in a right triangle.
2. Calculate the unknown side length in a right triangle when the two other side lengths are known.
3. Find the sine, cosine, or tangent in decimal form of any right triangle when side lengths are known, using either longhand math or a standard calculator.
4. Find the length of an unknown side in a right triangle when one other side length and the associated angle are known, using the proper calculator.
5. Find the angle in a right triangle when two associated sides are known, using the proper calculator.
6. Apply fitter’s math to tubing and conduit installations.

MODULE 12302-03 – LAYOUT AND INSTALLATION OF TUBING AND PIPING SYSTEMS

1. Using prints, specifications and visual inspections, determine the scope of the layout procedure.
2. Determine the proper methods for routing piping or tubing.
3. Apply fitter’s math to measure and bend piping or tubing.
4. Cut piping or tubing.
5. Apply the appropriate calculations and bender to accurately bend piping or tubing to the proper angle in an offset.
6. Identify and state the usage of various piping and tubing supports.
7. Install various piping and tubing supports.
8. Identify and state the usage of various piping and tubing fittings, including:
 - Flare tubing fittings
 - Compression tubing fittings
 - Threaded pipe fittings
 - Pipe flanges

MODULE 12303-03 – CLEAN, PURGE, AND TEST TUBING AND PIPING SYSTEMS

1. Identify cleaning, flushing, and purging procedures.
2. Describe the general cleaning and purging requirements for piping and tubing.
3. Perform the appropriate cleaning and flushing methods until required cleanliness has been achieved.
4. Describe and select pressure and leak testing methods for piping/tubing systems.
5. Identify precautions associated with testing piping/tubing systems.
6. Perform pressure leak tests per approved procedures.
7. Prepare required test documentation.

MODULE 12304-03 – RECEIVE, INSPECT, HANDLE AND STORE INSTRUMENTATION

1. Inspect a carton or container for physical damage.
2. Identify special handling requirements for a carton or container.
3. Describe the safety requirements for lifting.
4. Inspect received items for damage and complete required paperwork.
5. Compare received instrumentation to instrument data sheet specifications.
6. Describe considerations for storage of instruments or components.

MODULE 12305-03 – INSTRUMENTATION THEORY

1. Explain the basic characteristics of series circuits, parallel circuits, and series-parallel circuits.
2. Analyze series, parallel, and series-parallel circuits.
3. Find the total resistance in series, parallel, and series-parallel circuits.
4. Determine the frequency and period for a given AC sine wave.
5. Calculate the peak, effective (rms), and average voltage or current values for an AC sine wave.
6. Describe the voltage and current phase relationship in a resistive AC circuit.
7. Define inductive reactance and state how it is affected by frequency.
8. Define capacitive reactance and state how it is affected by frequency.
9. Explain the terms true power, apparent power, reactive power, and power factor.
10. Explain why a 4–20mA signal is typically transmitted in a loop instead of a 1–5V signal.
11. Describe the characteristics of a digital signal.
12. Calculate the unknown resistance value in a resistance temperature detector (RTD) bridge circuit.

MODULE 12306-03 – GROUNDING AND SHIELDING OF INSTRUMENTATION WIRING

1. Define electrical system grounding.
2. List the reasons electrical systems are grounded.
3. Describe methods used to ground electrical systems.
4. Define noise in instrumentation systems.
5. Describe types of noise in instrumentation systems.
6. Identify sources of noise in instrumentation systems.
7. Apply shielding methods to reduce noise.

MODULE 12307-03 – TERMINATING CONDUCTORS

1. Identify types of low-voltage and fiber-optic cable.
2. Install and terminate various types of crimp connectors.
3. Terminate shielded cable to provide maximum EMI protection.
4. Install and terminate coaxial cable connectors.
5. Describe fiber-optic splices and terminations.
6. Perform continuity checks on cable installations.
7. Explain causes of cable failure.

MODULE 12308-03 – PROTECTIVE MEASURES FOR INSTRUMENTATION

1. Identify applications that require heat tracing.
2. Describe the elements of a heat tracing system, including:
 - Power distribution
 - Cables
 - Controls
 - Monitoring
3. Install heat tracing systems.
4. Explain steam tracing.
5. Describe types of chemical protection, their purposes, and specific applications.
6. Identify and install types of piping and device insulation.
7. Perform blowdown on instrument air and signal lines.

Level Four

MODULE 12401-03 - DIGITAL LOGIC CIRCUITS

1. Identify the different gates and circuits in digital logic.
2. Describe the truth tables and timing diagrams for various digital gates.
3. Describe the operation of different digital flip-flops.
4. Describe the operation of shift registers.
5. Describe the operation of counters.
6. State the purpose of the American National Standards Institute (ANSI) Q90–Q93 standards.

MODULE 12402-03 - INSTRUMENT CALIBRATION AND CONFIGURATION

1. Define calibration.
2. Discuss the three-point and five-point methods of calibration.
3. Calibrate the following pneumatic instruments using the proper equipment:
 - Differential pressure transmitters
 - Temperature transmitters
4. Calibrate the following 4–20mA instruments using the proper calibration equipment:
 - Differential pressure transmitters
 - Temperature transmitters
5. Define smart instruments.
6. Identify a HART® communicator.
7. Calibrate a smart transmitter using a HART® communicator.
8. Calibrate a transducer.
9. Calibrate the following valve positioners:
 - Pneumatic positioner
 - Electro-pneumatic positioner
 - Smart positioner (digital valve controller)

MODULE 12403-03 - PERFORMING LOOP CHECKS

1. Verify mechanical installation.
2. Verify correct tag numbers according to loop sheets.
3. Perform continuity checks on both electrical and pneumatic loops.
4. Prove a loop.

MODULE 12404-03 - TROUBLESHOOTING AND COMMISSIONING A LOOP

1. Practice universal and methodical troubleshooting techniques in loop tuning.
2. Troubleshoot an oscillating process.
3. Troubleshoot a newly installed control loop.
4. Practice safety procedures when troubleshooting a loop.
5. Commission a loop.

MODULE 12405-03 - TUNING LOOPS

1. Describe the function and applications of various PID controllers.
2. Apply the appropriate equations and perform closed loop tuning.
3. Perform open loop tuning.
4. Perform visual loop tuning.

MODULE 12406-03 - PROGRAMMABLE LOGIC CONTROLLERS

1. Describe the function and purpose of a programmable logic controller (PLC).
2. Compare hardwired and PLC systems.
3. Count and convert between number systems.
4. Explain the purpose of binary codes.
5. Describe the purpose of the various power supplies used within a PLC.
6. Explain the general function of an input/output (I/O) module, including the following types:
 - Discrete
 - Numerical data
 - Special
 - Remote
7. Explain the power supply and ground connections to I/O modules.
8. State the function of the PLC processor module.
9. Explain the interrelations between the various microprocessor components.
10. State the characteristics of various types of memory.
11. Describe the characteristics and features of a PLC processor module.
12. Explain the purpose of PLC software and firmware.
13. Describe the features and the differences between PLC programming languages.
14. Describe the features of relay ladder logic instruction categories.
15. Explain the principles used to correlate PLC hardware components to software instructions.
16. Program and install a PLC.

MODULE 12407-03 - DISTRIBUTED CONTROL SYSTEMS

1. Define a distributed control system (DCS).
2. Identify the typical components associated with a DCS.
3. Identify the various network configurations used with a DCS.
4. Describe uses for a DCS.
5. Explain how an instrument technician interfaces with a DCS.

MODULE 12408-03 - ANALYZERS

1. Define the following properties in a process or environment, and identify methods used to analyze them:
 - Density
 - Specific gravity
 - Viscosity
 - Turbidity
 - Flash point
 - Oxidation-reduction potential (ORP)
 - pH
 - Conductivity of a liquid
 - Oxygen (O₂)
 - Carbon monoxide (CO)
 - Carbon dioxide (CO₂)
 - Hydrogen sulfide (H₂S)
 - Total hydrocarbon content
 - Particulates in a clean room
2. Describe chromatography and its uses.
3. Describe ultraviolet analyzers and their uses.
4. Describe infrared analyzers and their uses.