Instructional Framework

Automation and Robotics

14.4201.00

This Instructional Framework identifies, explains, and expands the content of the standards/measurement criteria, and, as well, guides the development of multiple-choice items for the Technical Skills Assessment. This document corresponds with the Technical Standards reviewed on July 13, 2025.

Domain 1: Industrial Applications **Instructional Time: 25 - 35%**	
STANDARD 3.0 USE SCHEMATICS, TECHNICAL DRAWINGS, MATHEMATICAL PROCESSES, AND MEASUREMENT TECHNIQUES	
3.1 Describe different types of visual representations used to convey information about systems or processes (e.g., schematics, blueprints, and technical drawings)	• Electrical, pneumatic, and hydraulic symbols • Electrical, pneumatic, and hydraulic circuits • PLC input and output • Intro to design process
3.2 Interpret dimensions, symbols, legends, scales, and directions on schematics, blueprints, and technical drawings	• Electrical, pneumatic, and hydraulic symbols • Electrical, pneumatic, and hydraulic circuits • PLC input and output
3.3 Explain tolerance on blueprints, technical drawings, and graphic representations used to express problems	• Mathematical symbols • Absolute value
3.4 Demonstrate drawing and visualization skills including the use of computer-aided design (CAD) tools and electrical drawings [i.e., simple starter circuits, programmable logic controller (PLC) output, etc.]	• Sketching • Modeling • Simulation
3.5 Solve basic mathematical equations and identify the relationship/dependency of variables within the equation	• Math skill integration • Create and/or interpret graphs • Select and utilize appropriate formulas • Basic algebra
3.6 Explain the functions of common electrical measurement tools (i.e., voltmeter, ohmmeter, ammeter, etc.)	• Testing or verification • Multimeter
3.7 Use the appropriate measurement technique for a specific measurement (e.g., consider size, what's being measured, and level of precision)	• Testing or verification • Modeling • Simulation • Electrical, pneumatic, and hydraulic measurements

	● Vacuum
3.8 Describe dimensioning, tolerancing and quality control	● Quality assurance ● Testing or verification ○ Non-destructive testing
3.9 Differentiate among theoretical, simulation, and real-world scenarios and tests	● Modeling ● Prototyping ● Criteria and constraints
STANDARD 11.0 PERFORM DRAFTING TASKS USING COMPUTER-AIDED DRAFTING (CAD)	
11.1 Make freehand sketches (e.g., line weights, hidden lines, center lines, and dimensioning) and translate them to create a CAD drawing	● Views ○ Top ○ Side ○ Front ○ Isometric ○ Orthographic ● Sketching vs. Computer-Aided Drafting (CAD) ● Modeling ● Design process ● Parts and assemblies ● American National Standards Institute (ANSI)
11.2 Explain and use geometric dimensioning in a CAD drawing	● Size, shape, orientation, and location ● Scaling ● Points of view ● Measurement ● Tolerancing ○ Margins of error ● Variance ● Form ● Profile ● Run out
11.3 Determine shapes and sizes of surfaces from alternative views (e.g., orthographic, projection view, first angle projection, and third angle projection)	● Design process ● Size, shape, orientation, and location ● Application
11.4 Apply 2D sketching techniques in CAD then convert to 3D part	● Modeling ● Prototyping ● File conversion ○ STL (3D printer file)

	○ OBJ (3D file format) ○ GCO (CNC), etc.
11.5 Create a 4-view drawing from a 3D part using dimensional standards(e.g., ANSI and include title blocks)	● Size, shape, orientation, location ● Multiview ○ Front ○ Top ○ Right ○ Isometric ● Symbols and formatting
11.6 Create a CAD drawing and schematic of a working robotic workcell	● Model ● Simulation ● Design process ● Workcell layout
STANDARD 12.0 EXAMINE TYPES AND TASKS PERFORMED BY ROBOTIC SYSTEMS	
12.1 Describe common robot types used in industry and classify them based on their structure and degrees of freedom (e.g. SCARA, Articulated, Cartesian, and Delta Robots)	● Constraints and criteria ● Collaborative robotics (Co-bot) ● Robot selection
12.2 Differentiate robotics programming languages, open-source vs proprietary	● Pseudocode/Algorithms ● Robot C/C++ ● Python/MATLAB ● PLC ● Java
12.3 Determine factors that influence robotic performance and how criteria such as speed, accuracy, and payload are used to evaluate suitability for tasks	● Constraints and criteria ● Design process ● Flowchart ● Workcell layout ● Robotic movement parameters ● Safety zones
12.4 Describe how robots are connected to external systems such as sensors, conveyors, or controllers	● Mechatronics ● PLC ○ Analog vs. digital ○ Central Processing Unit (CPU) ○ SCADA ○ Human Machine Interface (HMIs) ● Wired vs. wireless connection ○ Serial

	○ Internet of Things (IoT)
12.5 Use simulation tools to model robotic tasks, verify sequences, and improve design decisions in automation workflows	● Prototype ● Design process ● Flowchart ● Constraints and criteria
12.6 Explain how end effectors (e.g., grippers, tools, and sensors) interact with the environment to perform tasks	● Types ○ Mechanical ○ Vacuum ○ Pneumatic ○ Magnetic ○ Electrical ○ Hydraulic ○ Adaptive ○ Soft, etc. ● Task-specific ● Pick and place tasks ● Safety and efficiency
STANDARD 15.0 EXAMINE COMMON MANUFACTURING PROCESSES IN AUTOMATION	
15.1 Describe machining processes [i.e., traditional machining, Computer Numerical Control (CNC), etc.]	● Traditional machining ○ Milling ○ Lathing ○ Drilling ● CAM ○ G-code
15.2 Explain how robotic systems enhance and improve the efficiency of machining processes	● Additive and subtractive ● Prototyping ● Design process ● Flowchart ● Constraints and criteria
15.3 Describe basic material properties used in manufacturing processes (i.e., aluminum, steel, titanium, silicon, copper, germanium, composites, etc.)	● Wood ● Plastic ● Silicates ● Rubber, etc. ● Sustainability

15.4 Demonstrate the steps in the CNC process [e.g., design the part, generate a CNC program (G-code), set up the machine, and execute the machining operations]	● Flowchart ● Algorithm
15.5 Explain the benefit of 3D printing used by manufacturing companies (e.g., can quickly build prototypes for testing and quality assurance)	● Rapid prototyping ● Modeling ● Scaling ● Material application ● Cost effective
15.6 Demonstrate the basis steps of 3D printing (e.g., modeling, printing, and finishing)	● CAD ● Sketching ● Slicing ● Rafting and supports ● Filetypes ● Filament type
15.7 Explain additive versus subtractive manufacturing and when each process is beneficial	● Define the types ● Design process ● Criteria and constraints ● Pros and cons of each approach ○ Cost ○ Material ○ Waste ○ Speed/efficiency
15.8 Describe basic fabrication principles and how they are applied (i.e., laser, water jet, plasma, welding, cutting, etc.)	● Injector molding ● Manufacturing vs. fabrication
15.9 Explain material handling and related safety protocols [i.e., conveyers, bowl feeders, manufacturing, microchip industry, Automated Guided Vehicle (AGV), etc.]	● International Organization for Standardization (ISO) ● National Industry Regulations ○ Occupational Safety and Health Administration (OSHA) ○ National Institute for Occupational Safety and Health (NIOSH) ● State and Regional Regulations ● Standard Operating Procedures (SOP)
STANDARD 16.0 DESIGN AN AUTOMATION SYSTEM	
16.1 Recognize automation system constraints (i.e., timeline, budget, environment, skill level, etc.)	● Criteria ● Flowchart ● Design process

16.2 Develop a process flowchart for an automation system (i.e., steps and tasks, decisions and directions, input / output, etc.)	• Boolean logic • Ladder logic • Symbol identification
16.3 Identify peripheral equipment and related software to complete specific tasks (i.e., robotic system, rotary table, conveyor, sensors, PLCs, end effectors, actuators, quality control camera, etc.)	• Vision systems • 3D scanners • End-of-arm tools • Force sensing, etc.
16.4 Use a simulation to develop and validate a design for an automation system utilizing program subroutines, variables and appropriate remarks	• Prototype • Design process • Criteria and constraints • Flowchart
16.5 Integrate and build an automation system using peripheral equipment and related software to complete a specific task	• Design process • Criteria and constraints • Workflow • Workcell • Computer system • Environmental/workplace safety • HMI
16.6 Test and improve the automation system based on the objectives, test cases, and right tools	• Criteria and constraints • Design process • Test verification • Data analysis • Quality control and assurance • Monitoring • Troubleshooting

Domain 2: Electrical Applications
Instructional Time: 25 - 30%

STANDARD 4.0 ANALYZE AND APPLY FOUNDATIONAL CONCEPTS OR ELECTRICAL AND ELECTRONIC CIRCUITS

4.1 Distinguish between electrical and electronic circuits and explain their role in modern automation systems across industries (i.e., manufacturing, energy, transportation, and robotics)	• AC/DC • Motor type • Blueprints and schematics • Scale

4.2 Explain common electrical components (e.g., resistors, transistors, capacitors, inductors, and diodes)	● Circuits
4.3 Explain fundamental quantities in a charge and measurement system performance [e.g., charge (coulomb), current (ampere), voltage (volt), power (watt)l, and energy (joule), with frequency measured in hertz]	● SI vs. Imperial ● Tools ● Resistance (ohms) ● Symbols ● Voltage (watts)
4.4 Explain key units and their relevance in circuits [e.g., ampere (A), for current, volt (V) for voltage, watt (W) for power, and coulomb (C) for electrical change; also, hertz (Hz) for frequency, farad (F) for capacitance, henry (H) for inductance, and siemens (S) for conductance]	● Tools ○ Multimeter ● Symbols
4.5 Use ammeters and voltmeters to measure voltage and amperage	● Multimeter
4.6 Define, calculate, and apply Ohm's law and Kirchhoff's law of energy and power	● Resistance ● Power ● Energy ● Conservation of charge ○ Kirchhoff's law ● Conservation of energy ○ Ohm's law ○ Kirchhoff's law
4.7 Distinguish between AC and DC circuits including series and parallel circuits	● Energy source ● Schematic
4.8 Describe types of electronic circuits and their function [e.g., permanent live (PL) which involves resistor and inductor; RC (resistor-capacitor) circuits which involve a resistor and capacitor; and Full Load Current (FLC) circuits which involve a resistor, inductor, and capacitor]	● Applications ● Constraints and criteria ● Transformer ● Transducer ● Integration
4.9 Analyze frequency oscillators (e.g., electronic circuits that generate periodic signals such as sine waves or square waves from a DC source, and how they are used for a wide range of applications, including clock generation, signal generation, and frequency control in devices such as computers, and radios	● Oscilloscope ● Data and graphical analysis
4.10 Describe the role of integrated circuits in powering control systems, sensors, and smart devices across industrial sectors (e.g., miniaturizing	● IoT ● Artificial Intelligence (AI)

electronic circuits onto a small semiconductor chip, typically silicon, and enabling complex functionalities in a compact space)	• Constraints and criteria
4.11 Analyze the difference between signal processing analog and digital circuit (i.e., electronic circuits designed to analyze, modify, and synthesize signals, which can be audio, video, sensor data, or other forms of information, etc.)	• Data and graphical analysis • Wavelengths • Electromagnetic spectrum • Continuous vs. discrete • Sound vs. light • Short vs. long transmission
STANDARD 5.0 IMPLEMENT AND TEST CONTROL CIRCUITS USING DIODES AND SEMICONDUCTOR COMPONENTS	
5.1 Explain what a diode is and its function in an electronic control circuit (e.g., a type of semiconductor device that allows current to flow primarily in one direction, acting as a one-way switch for electricity)	• Modeling • Symbols • Microcontrollers
5.2 Describe insulators, conductors, N- and P-types, diodes, semiconductors, and transistors and the effect temperature has on these materials	• Materials tolerance • Modeling • Doping
5.3 Explain the operation of thyristors and relays in a control circuit	• Modeling • Simulation • Input/output
5.4 Illustrate and explain electron and hole currents in semiconductor materials and how they relate to the function of diodes and transistors	• Modeling • Simulation
5.5 Describe and calculate decibel gain and loss of amplifiers and power gain	• Data and graphical analysis
5.6 Calculate transistor biasing currents including cutoff, saturation, active states, and linear region	• Modeling • Simulation • Data and graphical analysis
5.7 Build a basic transistor circuit and diode circuit using an oscilloscope and digital multimeter (DMM)	• Modeling • Microcontroller • Data and graphical analysis • Design process
5.8 Explain the importance of impedance matching and its impact on signal clarity in electronic control systems	• Troubleshooting • Data and graphical analysis
5.9 Investigate cascade amplifiers and calculate voltage gain	• Data and graphical analysis • Test verification

	● Oscilloscope ● Multimeter
5.10 Identify and troubleshoot circuits for component-level defects using diagnostic tools (i.e., voltage meters, oscilloscope, etc.)	● Data and graphical analysis ● Quality control and assurance ● Fault testing
STANDARD 6.0 BUILD, MEASURE, AND TEST ELECTRICAL AND ELECTRONIC CIRCUITS	
6.1 Determine voltage, current, resistance, and power in AC and DC circuits (i.e., oscilloscope, volt/ohm, meter, etc.)	● Ohm's law ● Multimeter ● Formula application
6.2 Build DC series, parallel, and series parallel circuits and verify circuit behavior by taking measurements	● Test verification ● Modeling ● Multimeter ● Ammeter ● Symbols
6.3 Assemble RC, RL, and RLC circuits	● Symbols ● Modeling ● Design process ● Troubleshooting ● Schematics
6.4 Explain transformer operations and its application within automation and robotics	● Circuits ○ Step up ○ Step down ○ Isolation ○ Autotransformer ● Constraints and criteria
6.5 Explain power supply operations and its application within automation and robotics	● Criteria and constraints ● Safety
6.6 Analyze magnetic circuit performance using magnetic quantities and units	● Motor integration ○ Brush motor ○ Stepper motor, etc. ● Material selection ● Temperature ● Magnetic field strength (ampere per meter)

6.7 Troubleshoot voltage, current, and power in AC and DC circuits	• Fuse • Continuity • Circuit breaker • SOPs • Testing verification • Multimeter • Ammeter
6.8 Identify and troubleshoot components and connections using diagnostic tools (i.e., signal probes, voltage meters, oscilloscope, etc.)	• Multimeter • Data and graphical analysis • Measurement tool selection • SOPs

Domain 3: Mechanical Properties **Instructional Time: 20 - 25%**	
STANDARD 7.0 ANALYZE FLUID POWER SYSTEMS INCLUDING HYDRAULICS AND PNEUMATICS	
7.1 Differentiate between hydraulic and pneumatic systems and explain where and how they are used in industry (i.e., pressure differences, power, inertia, strength, mass, density, etc.)	• Newton's Laws of Motion • Viscosity • Fluid dynamics
7.2 Describe the benefits of integrating hydraulic and pneumatic systems with robotic systems	• Constraints and criteria
7.3 Explain the principles of fluid power systems behavior (i.e., water cannot be compressed)	• Fluid dynamics
7.4 Follow safety protocols for fluid and air power systems	• SOPs
7.5 Operate and observe simulated industrial grade pneumatic and electro-pneumatic devices and circuits (i.e., change physical parameters and observe system responses, etc.)	• Modeling
7.6 Describe the fundamental uses of vacuum technology (i.e., cleaning and packaging to semiconductor manufacturing and scientific research, etc.)	• Constraints and criteria • Modeling • Pump types • Vacuum measurement tools
7.7 Identify power supplies for different fluid power systems	• PLC • Fixed and variable displaced pump systems

7.8 Build and examine the performance of a hydraulic circuit	● Pressure (PSI) ● Design process ● Modeling ● Troubleshooting ● Data analysis ● Venturi effect
7.9 Build and examine the performance of a pneumatic circuit	● Pressure (PSI) ● Design process ● Modeling ● Troubleshooting ● Data analysis ● Venturi effect
7.10 Troubleshoot hydraulic and pneumatic circuits (i.e., flow controls, valve functionality, pressure sensors, etc.)	● Hoses ● Safety ○ Release/relief valve, etc. ● Hydraulic and pneumatic diagrams and schematics ● SOPs ● Data analysis
STANDARD 9.0 DESCRIBE THE OPERATION AND USE OF VARIOUS ELECTRICAL MOTORS	
9.1 Explain the “safety by design” concept to ensure operator and workspace safety	● Hazards ○ Identify ○ Pinch point ○ Reduce/eliminate, etc. ● Prevention through design ● OSHA ● NIOSH ● SOPs
9.2 Identify how motors are controlled [i.e., capacitor (CAP) start, variable, frequency drives, start stops, etc.]	● Motor types ○ Brushed ○ Brushless ○ Stepper ○ AC Induction ○ Servo, etc. ● Programming and sensors ● Power source ● HMI

9.3 Explain the operation and use of DC motors in automation controls	● HMI ● PLC ● Motor types ○ Brushed ○ Brushless ○ Stepper ○ Servo, etc.
9.4 Explain the operation and use of stepper motors in automation scenarios	● HMI ● PLC
9.5 Explain the different types of AC motors and when they should be used in automation assemblies (e.g., three phase, single phase, and split phase)	● Pumps ● Blowers ● Conveyors ● Constraints and criteria
9.6 Explain the operation, use, and advantages of brushless motors in automation and robotics	● Actuation applications ● Efficiency ● Constraints and criteria
9.7 Describe how servos are used in automation and robotics (e.g., robot arms, legs, and steering)	● Degrees of freedom ● Constraints and criteria
9.8 Describe the use of electrical generators (AC and DC generators)	● Power type ● Power needs ○ Watts ○ Volts ● Constraints and criteria
STANDARD 10.0 PERFORM MECHANICAL SYSTEMS LINKAGES TASKS	
10.1 Explain the difference between the gear reduction and gear ratio	● Belt, chains, gear to gear ● Changing gears/sprocket/pulleys ● Changing size ● Compound gears ● Gear box ● Bevel gears ● Worm gears ● Universal joints
10.2 Install, troubleshoot, and test a belt system	● Mechanical advantage ● Types of belts

	● Safety ● Deflection ● Tachometer ● Alignment ● Oscillation and reciprocation
10.3 Install, troubleshoot, and test a chain drive system	● Mechanical advantage ● Types of chains ● Safety ● Deflection ● Tachometer ● Alignment ● Oscillation and reciprocation
10.4 Install, troubleshoot, and test a gear train system	● Mechanical advantage ● Gear selection ● Changing size ● Compound gears ● Safety ● Deflection ● Tachometer ● Alignment ● Motion direction changes ● Oscillation and reciprocation
10.5 Calculate revolutions per minute (RPM) output based on RPM input	● Gear ratio ● Torque ● Speed ● Drive ratio ● Tachometer ● Data analysis ● Appropriate formulas application
10.6 Calculate the gear ratio of a gear train system	● Gear ratio ● Torque ● Speed ● Drive ratio ● Tachometer ● Data analysis ● Appropriate formulas application

10.7 Explain the importance of vibration analysis and describe how it affects mechanical systems	● Oscillation and reciprocation ● Efficiency ● Rotation

Domain 4: Automation & Programming **Instructional Time: 10 - 15%**	
STANDARD 8.0 PROGRAM AND TEST PLC (PROGRAMMABLE LOGIC CONTROLLER) SYSTEMS	
8.1 Explain PLC functionality (i.e., relate schematics to PLC inputs/outputs, program flow, etc.)	● Flow chart ● Symbols and abbreviations ● Programing languages ○ Ladder logic ○ Function block diagrams ○ Structured text ○ Instructional list ○ Sequential function
8.2 Interpret and apply ladder logic and other commonly used industrial languages	● Symbols and abbreviations ● Flow chart ● Criteria and constraints
8.3 Develop a flowchart that identifies and solves an automation problem	● Design process ● Troubleshooting ● Schematics
8.4 Upload and download an existing logic program to and from a PLC	● Troubleshooting ● Simulator
8.5 Diagnose and troubleshoot problems within PLC input and output modules (AC and DC)	● Modeling ● Simulation ● Schematics ● Testing ● Programming languages ○ Proper formatting
8.6 Write and apply a PLC program using ladder logic	● Troubleshooting ● Design process ● Simulation ● Testing verification ● Programming languages

	• Algorithms and pseudocode • Flowchart
STANDARD 13.0 EXAMINE DATA COMMUNICATIONS METHODOLOGIES	
13.1 Select data communication protocols and associated connectors (i.e., TCP/IP for the internet, USB for peripherals, and I2C for embedded systems)	• Criteria and constraints • Programming languages • Wired and wireless • Peripherals • Cybersecurity
13.2 Compare and contrast wired and wireless data communication protocols to understand tradeoffs (benefits and shortfalls)	• Cybersecurity • Ease of access • Cost • Distance • Data storage
13.3 Explain Internet of Things (IoT) and Industrial Internet of Things (IIoT) in relation to robotic systems	• Constraints and criteria • Cybersecurity • Machine to Machine (M2M) • Data storage • Data analysis
13.4 Identify cybersecurity systems used in robotics (i.e., protecting computer systems and data from digital attacks and threats)	• Firewall • Encryption • Access protocols • Authentication • Network security • VPN • Risk management
13.5 Identify cybersecurity concerns within robotic systems (i.e., data breaches, malware and system manipulations, ransomware, social engineering, etc.)	• Unauthorized access • Virus • System updates • Supply chain attacks • Data theft/manipulation • Out of date/off the market equipment • Risk management • HMI
STANDARD 14.0 UTILIZE SENSOR SOLUTIONS	
14.1 Select sensors for use in a feedback control loop	• Constraints and criteria

14.2 Construct and operate a system with a feedback control loop	● Design process ● Modeling ● Constraints and criteria ● Troubleshooting ● Flowchart ● Sensors ● Measurement tool selection ● Data analysis
14.3 Calibrate and align sensors to their application	● Troubleshooting ● Measurement tool selection ● Data analysis
14.4 Gather statistical data and analyze performance on a control loop (Proportional Integral Derivative PID)	● Data analysis ● Measurement tool selection
14.5 Explain analog to digital and digital to analog conversions and how these relate to cybersecurity concerns	● Encryption ● Authentication ● Continuous vs. discrete ● Wired vs. wireless communications ● Troubleshooting
14.6 Compare and contrast common sensors used in robotics systems (i.e., flow, vision, level, temperature, force and torque, metallic, proximity, pressure, etc.)	● Constraints and criteria ● Troubleshooting ● Cost/benefit analysis ● Data type selection
14.7 Explain how a smart sensor system uses and collects data in an automation system	● IoT ● Industrial Internet of Things (IIoT) ● HMI ● AI ● Machine Learning (ML) ● Cybersecurity ● Industry 4.0

Domain 5: Knowledge and Safety **Instructional Time: 5 - 10%**	
STANDARD 1.0 EXAMINE THE INTERCONNECTION OF AUTOMATION AND ROBOTICS AND THE IMPACT OF NEW TECHNOLOGIES ON BOTH	
1.1 Explain how the manufacturing industry uses automation and robotics to perform routine tasks such as welding, material handling, and assembly (e.g., automation uses software, machines, or other technology to carry out tasks; robotics combines engineering and computer science to design and build robots to perform tasks)	● AI ● Safety ● Benefits and challenges/lean manufacturing ○ 5S (Sort, Set in order, Shine, Standardize, Sustain) ○ 3D (Dirty, Dangerous, Dull) ● IoT ● Configuration ● Data integration ● Industry 4.0
1.2 Describe artificial intelligence (AI), machine learning (ML), and robotic process automation (RPA) and their results on manufacturing (i.e., to enable machines to learn, adapt, and perform complex tasks leading to increased efficiency, precision, and safety; to predict maintenance and quality control; to streamline workflow and enhance production; to improve data collection and analysis; etc.)	● Increased work performance ● Reduced human error ● Stakeholder considerations
1.3 Discuss challenges associated with AI, ML, RPA (e.g., limited talent, personnel training, keeping up with advancements, ability to manage and troubleshoot tasks, and such issues as privacy, data inaccuracies, ethical considerations, and safety concerns)	● Job and skill changes ● How machines affect human behavior and interaction
1.4 Identify skills needed by automation and robotics technicians (i.e., ability to visually inspect, test, and assemble components using approved procedures; experience with and ability to use computers to perform tests and diagnostics, download information, analyze data acquisition, and record data; ability to use hand tools, machine tools, and various equipment; ability to solve problems, organize work, and communicate with others, etc.)	● Troubleshooting ● Continual training ● Industry certification
1.5 Discuss education and training programs for individuals interested in a career in automation and robotics (e.g., completion of the automation robotics or engineering CTE program; apprenticeship in automation engineering; on-the-job training emphasizing hands-on experience with automation systems, programming, and maintenance; and/or further	● Industry certification ● Career path ● Post-secondary degrees

training in community college or university in areas such as mechanical or electrical engineering, computer science, or robotics)	
STANDARD 2.0 MAINTAIN A SAFE WORK ENVIRONMENT	
2.1 Comply with Occupational Safety and Health Administration (OSHA) health and safety standards [i.e., safe work attire and personal protective equipment (PPE), fall protection requirements, lifting procedures, fire protection plan, emergency plan, Safety Data Sheets, etc.)	● OSHA certification
2.2 Identify and describe key elements of safe work conditions with automation and robotics (i.e., physical barriers and work zone safety, detection sensors, emergency stop buttons, visual and audible warning systems, lockout/tagout procedures, compliance with standards ANSI/RIA R15.06 for industrial robots, ergonomics, etc.)	● Arc flash ● High voltage ● Stored energy ● Light curtains ● Safety fences ● Safety relays, etc.
2.3 Identify and describe key elements of safe work conditions in the electronic technology environment [i.e., electrical safety (power down equipment before working on it, use insulated tools and equipment, use grounding procedures for sensitive components, avoid working on wet environments); chemical safety (proper ventilation, labeled chemicals, appropriate handling and disposal procedures); clear room protocols and procedures, etc.]	● OSHA 10 ● NIOSH ● Emergency Planning and Community Right to Know Act (EPCRA) ● Regional and state regulations ● Common electrical and electronics hand tools ● Proper tool use
2.4 Explain the “fail safe” component integrated in robotic and automated systems (i.e., emergency shutdowns, interlocks, and sensor-based stops, etc.)	● Workcell ● Work zone
2.5 Utilize drawings, instrument data, prints, and manufacturer’s recommendations to install, repair, and store tools and equipment	● SOPs ● Troubleshooting
2.6 Follow good housekeeping procedures (e.g., follow clean work area protocols, eliminate potential hazards, perform safety checks, document equipment repairs and maintenance activity, and report injuries, incidents, and near misses)	● 5S ● SOPs