AUTOMATION AND ROBOTICS 48.0500.20

TECHNICAL STANDARDS

An Industry Technical Standards Validation Committee developed and validated these standards on October 1 and November 5, 2020. The Arizona Career and Technical Education Quality Commission, the validating authority for the Arizona Skills Standards Assessment System, endorsed these standards on January 27, 2021.

Note: Arizona's Professional Skills are taught as an integral part of the Automation and Robotics program.

The Technical Skills Assessment for Animation and Robotics is available SY2022-2023.

Note: In this document i.e. explains or clarifies the content and e.g. provides examples of the content that must be taught.

STANDARD 1.0 EXAMINE THE IMPACT OF NEW TECHNOLOGIES ON AUTOMATION AND ROBOTICS

1.1 Describe the principles, processes, and practices of AI (artificial intelligence), ML (machine learning), and RPA (robotic process automation)

1.2 Discuss how the application of AI, MI, and RPA have changed existing business (i.e., enhanced efficiency, increased work performance, reduced human error, simplified interactions, speedier processes, improved customer experience, etc.)

1.3 Give examples of how AI, ML, and RPA are used in services, manufacturing, agriculture, and healthcare [i.e., social media, virtual/personal assistant (Alexa and Siri), financial fraud detection, self-driving cars, medical diagnosis and prediction. etc.]

1.4 Relate the Three Laws of Robotics (Asimov's Laws) to future technology applications

1.5 Discuss ethical challenges associated with AI, ML, and RPA (i.e., privacy, data inaccuracies, future loss of jobs, how machines affect human behavior and interaction, etc.)

STANDARD 2.0 PERFORM ELECTRICAL AND ELECTRONIC TASKS

2.1 Measure and determine voltage, current, resistance, and power in AC and DC circuits (i.e., oscilloscope, volt/ohm, meter, etc.)

2.2 Troubleshoot voltage, current, and power in AC and DC circuits (i.e., fuse, continuity, etc.)

2.3 Identify and troubleshoot components and connections

2.4 Read electrical drawings (i.e., simple starter circuits, PLC output, etc.)

2.5 Explain the role of electronic devise in automation and robotics (i.e., common problems, common scenarios, etc.)

STANDARD 3.0 ANALYZE HYDRAULIC AND PNEUMATIC SYSTEMS

3.1 Describe the relevance of material properties to robotics (e.g., inertia, velocity, mass, density, and strength)

3.2 Examine the performance of hydraulic circuits

3.3 Examine the performance of pneumatic circuits

3.4 Troubleshoot hydraulic and pneumatic circuits (i.e., flow controls, valve functionality, pressure sensors, etc.)

3.5 Describe the fundamentals of vacuum technology

STANDARD 4.0 ANALYZE PROGRAMMABLE LOGIC CONTROLLER (PLC) SYSTEMS

4.1 Explain PLC functionality (i.e., relate schematics to PLC inputs/outputs, program flow, etc.)

4.2 Interpret ladder logic and other commonly used industrial languages

4.3 Develop a flowchart that identifies and solves the automation problem

4.4 Upload/download a logic program into a PLC

4.5 Troubleshoot input/output modules (AC and DC)

STANDARD 5.0 DESCRIBE THE OPERATION AND USE OF VARIOUS FORMS OR ELECTRICAL MOTORS

5.1 Explain the "safety by design" concept to ensure operator and workspace safety

5.2 Explain the operation and use of DC motors in automation controls

5.3 Explain the operation and use of stepper motors in automation scenarios

5.4 Explain the operation and primary use of AC motors in automation assemblies

5.5 Explain the operation, use, and advantages of brushless motors in automation and robotics

5.6 Describe how servos are used in automation and robotics (e.g., robot arms, legs, and steering)

STANDARD 6.0 PERFORM MECHANICAL SYSTEMS LINKAGES TASKS

6.1 Explain gear reduction and install a belt or chain drive

6.2 Explain gear ratio and install a gear train

6.3 Compute mechanical advantage of a belt or chain drive

6.4 Compute mechanical advantage of a gear train

STANDARD 7.0 PERFORM DRAFTING TASKS

7.1 Make freehand sketches (e.g., line weights, hidden lines, center lines, and dimensioning)

7.2 Make CAD representations from freehand sketches

7.3 Determine shapes and sizes of surfaces from alternative views (e.g., orthographic, projection view, first angle projection, and third angle projection)

7.4 Make CAD drawings using geometric construction techniques

7.5 Make dimensional CAD drawings (e.g., 2D and 3D)

7.6 Explain basic knowledge of geometric dimensioning and tolerancing

7.7 Interpret electrical drawings and architectural plans

STANDARD 8.0 IDENTIFY INDUSTRIAL ROBOT TYPES AND THE TASKS THEY PERFORM

8.1 Identify robot types and degrees of freedom (i.e., SCARA, articulated, cartesian, delta, etc.)

8.2 Measure robotic performance against specified criteria

8.3 Interface a robot to real or simulated external equipment

8.4 Simulate a solution

STANDARD 9.0 EXAMINE DATA COMMUNICATION METHODOLOGIES

9.1 Select data communication protocols and associated connectors

9.2 Identify tradeoffs among wired and wireless data communication protocols

9.3 Explain IOT (Internet of Things) and IIOT (Industrial Internet of Things)

STANDARD 10.0 APPLY SENSOR SOLUTIONS

10.1 Select sensors for use in a feedback control loop

10.2 Construct and operate a system with a feedback control loop

10.3 Calibrate sensors

10.4 Gather and statistically analyze performance data on a control loop

10.5 Explain analog to digital and digital to analog converters

STANDARD 11.0 DESCRIBE COMMON MANUFACTURING PROCESSES IN AUTOMATION

11.1 Describe machining processes (i.e., traditional machining, CNC, etc.)

11.2 Describe basic material properties used in manufacturing processes (i.e., aluminum, steel, titanium, etc.)

11.3 Explain the impact of 3D printing on rapid prototyping

11.4 Explain additive manufacturing versus subtractive manufacturing

11.5 Describe basic fabrication principles (i.e., laser, sheet metal, welding, cutting, etc.)

11.6 Describe material handling [i.e., conveyers, bowl feeders, AGV (Automated Guided Vehicle), etc.]

STANDARD 12.0 DEVELOP ROBOTICS APPLICATION SYSTEMS

12.1 Describe robotics operating systems [i.e., ROS (robot operation system), Linux, etc.]

12.2 Identify a problem and develop a flowchart for software development (i.e., Boolean logic, ladder, etc.)

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12.3 Identify peripheral hardware required to complete the task (i.e., vision systems, 3D scanners, end-of-arm tools, force sensing, etc.)

12.4 Develop or reuse software components (i.e., modular software design, etc.)

12.5 Use software tools to develop a robotics application

12.6 Use a simulation to develop and validate a design for a robotics problem

12.7 Use a test-driven development approach

12.8 Demonstrate a methodical approach to process development

12.9 Describe integration technologies (i.e., CNC, AI, RPA, ML, etc.)

12.10 Describe robotics project constraints (i.e., timeline, budget, environment, skill level, etc.)

STANDARD 13.0 DEMONSTRATE SAFE AND PROPER USE OF ELECTRONIC AND OTHER LABORATORY EQUIPMENT, TOOLS, AND MATERIALS

13.1 Explain and apply proper ground requirements

13.2 Specify safety conditions when working with automation and robotics (e.g., arc flash, high voltage, pneumatics, hydraulics, and stored energy)

13.3 Identify and properly use common electrical and electronics hand tools

13.4 Follow laboratory safety rules and procedures

13.5 Describe the concept of “fail safe” and how such components are integrated into robotic systems

13.6 Explain modern safety hardware and circuits (i.e., light curtains, safety fences, safety relays, etc.)