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| A picture containing emblem, logo, symbol, trademark  Description automatically generated **AUTOMATION AND ROBOTICS 14.4201.00****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 |

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| 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.) |
| 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.) |