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| **AUTOMATION AND ROBOTICS, 48.0500.20** |
| **1.0** | **PERFORM ELECTRICAL AND ELECTRONIC TASKS** |
| 1.1 | Measure voltage, current, resistance, and power in AC and DC circuits using a volt/ohm meter |
| 1.2 | Calculate voltage, current, resistance, and power in AC and DC circuits |
| 1.3 | Test voltage, current, and power in AC and DC circuits using an oscilloscope |
| 1.4 | Troubleshoot voltage, current, and power in AC and DC circuits |
| 1.5 | Troubleshoot components and connections |
| **2.0** | **PERFORM HYDRAULIC AND/OR PNEUMATIC TASKS** |
| 2.1 | Describe how material properties (e.g., mass, density, strength) have applicability to robotics |
| 2.2 | Install linear and rotary actuators |
| 2.3 | Replace linear and rotary actuators |
| 2.4 | Troubleshoot linear and rotary actuators |
| **3.0** | **PERFORM PROGRAMMABLE LOGIC CONTROLLER (PLC) TASKS** |
| 3.1 | Develop and implement ladder logic and relay circuits |
| 3.2 | Upload/download a logic program into a PLC |
| 3.3 | Troubleshoot input/output modules (AC and DC) |
| 3.4 | Troubleshoot PLC system operations |
| **4.0** | **DESCRIBE THE OPERATION AND USE OF VARIOUS FORMS OF ELECTRICAL MOTORS IN ROBOTIC ASSEMBLIES** |
| 4.1 | Explain the “safety by design” concept to ensure operator and workspace safety |
| 4.2 | Explain the operation and use of DC motors in robotic controls |
| 4.3 | Explain the operation and use of stepper motors to control or limit movement of a robotic assembly |
| 4.4 | Explain the operation and primary use of AC motors in robotic assemblies |
| 4.5 | Explain the operation, use, and advantages of brushless motors used in robotics |
| 4.6 | Describe how servos are used in robotics (e.g., robot arms, legs, steering) |

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| **5.0** | **PERFORM MECHANICAL LINKAGES SYSTEM TASKS** |
| 5.1 | Explain gear reduction and install a belt or chain drive |
| 5.2 | Explain gear ratio and install a gear train |
| 5.3 | Compute mechanical advantage of a belt or chain drive |
| 5.4 | Compute mechanical advantage of a gear train |
| **6.0** | **PERFORM DRAFTING TASKS** |
| 6.1 | Make freehand sketches (e.g., line weights, hidden lines, center lines, dimensioning) |
| 6.2 | Make CAD representations from freehand sketcher |
| 6.3 | Determine shapes and sizes of surfaces from alternative views (e.g., orthographic projection view, first angle projection, third angle projection) |
| 6.4 | Make CAD drawings involving geometric construction techniques |
| 6.5 | Make dimensional CAD drawings |
| **7.0** | **PERFORM INDUSTRIAL ROBOTIC TASKS** |
| 7.1 | Measure robotic performance against specified criteria |
| 7.2 | Interface a robot to real or simulated external equipment |
| 7.3 | Identify a robot’s degrees of freedom |
| **8.0** | **PERFORM CNC TASKS** |
| 8.1 | Perform system diagnostic tests on CNC equipment |
| 8.2 | Download CNC programs from a personal computer to a CNC system |
| 8.3 | Troubleshoot CNC equipment |
| 8.4 | Configure software on a personal computer for CNC interfacing |
| 8.5 | Explain the impact of 3D printing on rapid prototyping |
| 8.6 | Explain additive manufacturing versus subtractive manufacturing |
| **9.0** | **DEMONSTRATE AN UNDERSTANDING DATA COMMUNICATIONS METHODOLOGIES** |
| 9.1 | Select data communication protocols and associated connectors |
| 9.2 | Identify tradeoffs among wired and wireless data communication protocols |
| **10.0** | **PERFORM SENSOR AND CONTROL SYSTEMS TASKS** |
| 10.1 | Select actuators and sensors for use in a feedback control loop |
| 10.2 | Construct and operate a system with a feedback control loop |
| 10.3 | Calibrate sensors and actuators |
| 10.4 | Gather and statistically analyze performance data on a control loop |
| 10.5 | Explain analog to digital and digital to analog converters |
| **11.0** | **DEVELOP ROBOTICS SOFTWARE** |
| 11.1 | Develop a flowchart for software development |
| 11.2 | Select a programming language for a robotics application |
| 11.3 | Develop or discover reusable software components |
| 11.4 | Use software components to develop a robotics application |
| 11.5 | Functionally decompose a problem and identify reusable components |
| 11.6 | Describe the use of Boolean logic to analyze a problem |
| **12.0** | **APPLY THE ENGINEERING DESIGN PROCESS TO ROBOTICS DEVELOPMENT** |
| 12.1 | Analyze requirements for a robotics problem |
| 12.2 | Design a solution for a robotics problem |
| 12.3 | Design a flowchart/process map as related to input and output of the design process |
| 12.4 | Use a simulation to develop and validate a design for a robotics problem |
| 12.5 | Use a test driven development approach |
| 12.6 | Demonstrate a methodical approach to process development |
| **13.0** | **EXAMINE THE ETHICAL IMPACT OF ROBOTICS** |
| 13.1 | Identify Isaac Asimov’s three laws of robotics |
| 13.2 | Investigate the societal impact of automation and robotics |
| 13.3 | Investigate the impact of alternative use in robotics |

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| **14.0** | **DEMONSTRATE SAFE AND PROPER USE OF ELECTRONIC AND OTHER LABORATORY EQUIPMENT, TOOLS, AND MATERIALS** |
| 14.1 | Explain and apply proper ground requirements |
| 14.2 | Specify safety conditions when working with automation and robotics |
| 14.3 | Identify and use common electrical and electronics hand tools |
| 14.4 | Follow laboratory safety rules and procedures |
| 14.4 | Describe the concept of “fail safe” and how such components are integrated into robotic systems |