**Course Description**

Students develop skills in automating manufacturing processes through the integration of robotics, programmable logic controllers (PLCs), and control systems. They design, program, and troubleshoot automated work cells using schematics, blueprints, and simulation software. Emphasis is placed on optimizing robotic operations, configuring sensors and actuators, and improving system efficiency. Learners apply automation tools to streamline production, monitor data for continuous improvement, and ensure safe, high-performance manufacturing environments.

**Strand 1. Business Operations/21st Century Skills**

Learners apply principles of economics, business management, marketing and employability in an entrepreneur, manager and employee role to the leadership, planning, developing and analyzing of business enterprises related to the career field.

**Outcome 1.1. Employability Skills:** Develop career awareness and employability skills (e.g. face-to-face, online) needed for gaining and maintaining employment in diverse business settings.

**Competencies**

1.1.1. Identify the knowledge, skills, and abilities necessary to succeed in careers.

1.1.2. Identify the scope of career opportunities and the requirements for education, training, certification, licensure, and experience.

1.1.3. Develop a career plan that reflects career interests, pathways, and secondary and postsecondary options.

1.1.4. Describe the role and function of professional organizations, industry associations, and organized labor and use networking techniques to develop and maintain professional relationships.

1.1.5. Develop strategies for self-promotion in the hiring process (e.g. filling out job applications, résumé writing, interviewing skills, portfolio development).

1.1.6. Explain the importance of work ethic, accountability, and responsibility and demonstrate associated behaviors in fulfilling personal, community, and workplace roles.

1.1.7. Apply problem-solving and critical-thinking skills to work-related issues when making decisions and formulating solutions.

1.1.8. Identify the correlation between emotions, behavior, and appearance and manage those to establish and maintain professionalism.

1.1.9. Give and receive constructive feedback to improve work habits.

1.1.10. Adapt personal coping skills to adjust to taxing workplace demands.

1.1.11. Recognize different cultural beliefs and practices in the workplace and demonstrate respect for them.

**Outcome 1.3. Business Ethics and Law:** Analyze how professional, ethical, and legal behavior contributes to continuous improvement in organizational performance and regulatory compliance.

**Competencies**

1.3.1. Analyze how regulatory compliance affects business operations and organizational performance.

1.3.2. Follow protocols and practices necessary to maintain a clean, safe, and healthy work environment.

1.3.3. Use ethical character traits consistent with workplace standards (e.g. honesty, personal integrity, compassion, justice).

1.3.5. Access and implement safety compliance measures (e.g. quality assurance information, safety data sheets [SDSs], product safety data sheets [PSDSs], U.S. Environmental Protection Agency [EPA], United States Occupational Safety and Health Administration [OSHA]) that contribute to the continuous improvement of the organization.

1.3.7. Identify the labor laws that affect employment and the consequences of noncompliance for both employee and employer (e.g. harassment, labor, employment, employment interview, testing, minor labor laws, Americans with Disabilities Act, Fair Labor Standards Acts, Equal Employment Opportunity Commission).

1.3.8. Verify compliance with computer, copyright, and intellectual property laws and regulations.

1.3.9. Identify potential conflicts of interest (e.g. personal gain, project bidding) between personal, organizational, and professional ethical standards.

**Strand 5 Design and Development:** Learners apply principles of the engineering design process, using sketching and drawing, computer-aided drafting and modeling, production and process design, and print interpretation. They gain essential knowledge and skills in analyzing and solving design problems, creating and interpreting technical drawings and models, selecting appropriate materials, and planning and evaluating production processes.

**Outcome 5.6 Layout and Planning:** Plan a machining process.

**Competencies**

5.6.2 Determine process steps (e.g., cut, drill, turn, mill, grind, heat treat).

5.6.3 Plan individual process steps based on industry standards (e.g., manufacturers' specifications, machining standards).

**Outcome 5.7 Blueprint Interpretation:** Read, interpret, and utilize blueprints to produce accurate products.

**Competencies**

5.7.1 Identify and interpret standard symbols used in blueprints.

5.7.2 Demonstrate the ability to read and convert measurements from scaled drawings.

5.7.3 Differentiate between various line types (e.g., solid, dashed) and their meanings in a blueprint.

5.7.4 Analyze and interpret dimensions, tolerances, and annotations effectively.

5.7.5 Utilize reference notes and legends to clarify details and specifications in blueprints.

**Outcome 5.8 Schematic Interpretation:** Read, interpret, and utilize schematics to produce accurate products.

**Competencies**

5.8.1 Identify and interpret standard symbols used in schematics.

5.8.2 Recognize and label key components and systems within a schematic

5.8.3 Trace the flow of systems of schematic diagrams.

5.8.4 Utilize reference notes and legends to clarify details and specifications of schematics.

**Strand 7 Computer Integrated Manufacturing:** Learners apply the principles of computer integrated manufacturing related to robotics, programmable logic controllers and automated systems.

**Outcome 7.1 Robotic Fundamentals:** Apply robotics fundamentals.

**Competencies**

7.1.1 Identify the components of a robot system and explain their roles in the robot's operation cycle.

7.1.2 Understand applications of robot components and controllers. (e.g. sensors, motors, actuators, endo factor etc.)

7.1.3 Select the type of industrial robot to meet specific applications.

7.1.4 Use job specifications to create programs for robot operations, sensors and feeder systems.

7.1.5 Plan, program and test a robot using teach pendant and simulation software.

7.1.6 Identify the robot's payload and identify the concepts of payload weight and moment of inertia to select an appropriate robot.

7.1.7 Use robot speed specifications to calculate estimated cycle times for sample tasks.

7.1.8 Direct robot to home position using absolute and incremental coordinates.

7.1.9 Compare robotic applications and processes (e.g., palletizing, vision, pick and place, welding).

7.1.10 Identify the robot's work envelope and apply the concepts of reach and articulation to evaluate whether a robot is suited to an application.

7.1.11 Analyze the performance and troubleshoot the operation of a robot.

**Outcome 7.2 Robotic Operation:** Plan and operate robotic production processes.

**Competencies**

7.2.3 Use coordinates or motion functions to execute robotic processes.

7.2.4 Analyze alarm and event data, investigate anomalies, and take appropriate action to resolve issues

7.2.5 Select, display, and run a robotic program.

7.2.6 Modify command positions (i.e., touching-up points).

7.2.7 Explain both motion and non-motion instructions (i.e., control instructions, arithmetic instructions, and input/output instructions).

7.2.8 Identify robotic applications and processes (e.g., pick and place, welding).

7.2.10 Explain how payload requirements impact robot operation

7.2.11 Describe Cartesian space, the Right-Hand rule and how locations are represented in three-dimensional space.

7.2.12 Determine home position using absolute and incremental coordinates (e.g., fixed and floating zero).

7.2.15 Determine application suitability using work envelop, reach and articulation.

7.2.16 Explain methods of establishing a Tool-Center Point (TCP) or Tool-Control Point (TCP)

7.2.17 Identify and explain the function of robotic hardware (switches, sensors, proximity sensors)

**Outcome 7.3 Industrial Robotic Programming:** Write, edit and test robotic programming.

**Competencies**

7.3.1 Create, modify, and test robotic programs (e.g., second home, toolpath, non-motion commands).

7.3.2 Program macro and micro instructions, conditional statements, and arithmetic variables and instructions.

7.3.3 Program, monitor and operate inputs and outputs.

7.3.4 Create and set up tool and user frames to define reference points for robot end effectors and coordinate systems

7.3.5 Create and manage payload schedules, configuring and optimizing robots to handle varying weights, materials, and conditions.

7.3.6 Create and configure global and local positions for robotic systems by defining and adjusting coordinates creating precise robotic movements.

7.3.7 Configure and integrate I/O systems in robotic applications by setting up devices like sensors and actuators to ensure communication with external automation systems (PLCs).

7.3.14 Perform a robotic simulation to verify reach, cycle time, interference and work cell layout.

**Outcome 7.4 Programmable Logic Controllers (PLCs):** Program, install, and monitor digital computers used for automation of electromechanical processes to perform tasks.

**Competencies**

7.4.1 Describe the use of Programmable Logic Circuits (PLC) in manufacturing automation.

7.4.2 Identify programmable logic controller (PLC) hardware components, including relays, relay ladder logic, input/output modules, and communication interfaces

7.4.3 Design a programmable logic controller (PLC) program incorporating timers, counters, sequencers, comparators, and block transfers.

7.4.4 Demonstrate an understanding of number systems used in Programmable Logic Controllers (PLCs) binary, octal, decimal, and hexadecimal systems).

7.4.5 Develop, apply and execute a ladder logic program.

7.4.6 Design a motor control program using manual and automatic modes.

7.4.7 Monitor and troubleshoot a network and hardwired system with a programmable logic controller (PLC).

7.4.8 Monitor and troubleshoot programmable logic controller (PLC) operation (e.g., I/O forcing)

7.4.9 Install and maintain programmable logic controllers (PLCs).

7.4.10 Explain the operation and design of various control relays

7.4.11 Identify and explain the purpose of three sections found in a PLC

7.4.12 Identify different output devices for a PLC and how they are controlled (e.g., lights, motors, solenoids etc.)

7.4.13 Identify different input devices for a PLC and how they are controlled (e.g., photoelectric, proximity, switches, push buttons, etc.)

7.4.14 Demonstrate and execute data transfers in PLC networks.

**Outcome 7.5 Automation:** Conceptualize the use of automation in manufacturing and apply this technique to a production process

**Competencies**

7.5.1 Describe key concepts of automation and its importance in advanced manufacturing

7.5.2 Identify various automation tools and techniques and explain their functions (e.g., robots, sensors, controls etc.)

7.5.3 Identify the PLC of an automated system and explain its importance to the cell

7.5.4 Collect data from an automated system to identify continuous improvement opportunities

7.5.5 Analyze data gathered from an automated system to identify continuous improvement opportunities

7.5.6 Apply continuous improvement techniques to enhance the manufacturing process

7.5.7 Diagnose and troubleshoot errors within an automated system

7.5.8 Identify processes in the production that can be automated

**Strand 10 Maintenance and Safety:** Learners apply principles of protection, prevention and mitigation to create and maintain safe working conditions at manufacturing sites. Knowledge and skills may be applied in all aspects of personal and site safety, including handling materials, using tools and equipment, working with and around electricity and using personal protective equipment.

**Outcome 10.1 Site Safety:** Handle materials, prevent accidents and mitigate hazards.

**Competencies**

10.1.2 Knowledge of risk identification, evaluation, and mitigation strategies

10.1.6 Identify and eliminate worksite clutter in accordance with standards for cleanliness and safety.

10.1.12 Set up for ergonomic workflow.

**Outcome 10.2 Personal Safety:** Practice personal safety.

**Competencies**

10.2.5 Identify, inspect and use safety equipment appropriate for a task.

10.2.6 Use safe practices when working with electrical, mechanical, or other equipment.

**Outcome 10.3 Industrial Maintenance Safety:** Plan, develop and ensure industrial maintenance safety.

**Competencies**

10.3.1 Safely operate machinery and equipment.

10.3.2 Follow equipment shutdown procedures.

10.3.8 Monitor equipment for unsafe conditions.

**Outcome 10.4 Industrial Maintenance Installation and Repair:** Inspect, maintain and repair industrial equipment.

**Competencies**

10.4.1 Identify installation techniques using manuals, checklists, and regulations.

10.4.2 Identify equipment alarms.

10.4.4 Calibrate and adjust manufacturing equipment.

10.4.5 Inspect and correct machine malfunctions.

**Outcome 10.5 Machine Maintenance:** Maintain tools and equipment in working condition.

**Competencies**

10.5.1 Identify equipment maintenance requirements in the equipment manufacturer's documentation.

10.5.3 Calibrate instruments accurately, following calibration procedures, and documenting calibration records

10.5.5 Monitor equipment operation based off manufactures SOP

10.5.6 Repair or replace equipment and accessories as needed.