**Course Description**

Learners explore the fundamentals of industrial robots, including their design, operation, and applications in manufacturing and automation. The course covers robot types, kinematics, sensors, actuators, programming, and safety protocols. Emphasis is placed on integrating robots into production systems for tasks such as assembly, welding, material handling, and inspection, alongside troubleshooting and maintenance practices.

**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.

**Outcome 1.4. Knowledge Management and Information Technology:** Demonstrate current and emerging strategies and technologies used to collect, analyze, record and share information in business operations.

**Competencies**

1.4.2. Select and use software applications to locate, record, analyze and present information (e.g. word processing, e‐mail, spreadsheet, databases, presentation, Internet search engines).

1.4.3. Verify compliance with security rules, regulations and codes (e.g. property, privacy, access, accuracy issues, client and patient record confidentiality) pertaining to technology specific to the industry pathway.

**Strand 2. Electrical/Electronics**

Learners apply principles of electricity and electronics related to electronic theory, alternating and direct current, electronic components, electronic skills, digital electronics and power supplies. Knowledge and skills may be applied to fundamentals of electricity, analyzing and evaluating circuits, assembling components into electrical circuits, creating circuits to perform tasks and operations, wiring components to construct a communications system and providing power to an electrical system.

**Outcome 2.1 Electrical and Electronic Theory:** Explain electrical and electronic principles and theory.

**Competencies**

2.1.4 Compare alternating current (AC) and direct current (DC).

2.1.5 Define the units of measurement for voltage, current, power and resistance.

2.1.6 Describe the relationships between voltage, current, resistance and power in circuits.

**Outcome 2.2 Circuits:** Construct and analyze alternating current (AC) and direct current (DC) circuits.

**Competencies**

2.2.16 Explain the role of AC circuits in real-world applications (power supplies, audio amplification, motor control etc.)

2.2.17 Explain the role of DC Circuits in real-world applications (XXX)

**Outcome 2.3 Electronic Components:** Describe the functions and purposes of electronic components.

**Competencies**

2.3.3 Identify symbols for electronic components.

**Outcome 2.4 Electronic Connections:** Connect individual components into an electrical circuit.

**Competencies**

2.4.1 Define the purpose of a connection and the differences between a good and bad connection.

2.4.2 Describe methods of electrical connections and the purpose for each method.

2.4.3 Select type of electrical connection for electrical components.

2.4.4 Protect circuit boards from electrostatic discharge (ESD).

2.4.5 Combine components per wiring schematics, block diagrams, and flow charts.

**Outcome 2.6 Cabling and Wiring:** Connect components to construct low-voltage, data and communication systems using coaxial or fiber optic cables and twisted pair or balanced wires.

**Competencies**

2.6.1 Describe the types, purpose, and characteristics of cables and wires and their purpose

2.6.2 Select methods for splicing and terminating cables and wires (e.g., terminal strips, and crimp connectors).

2.6.3 Splice and terminate cables and wires.

2.6.4 Test cables and wires.

**Outcome 2.7 Power Supplies:** Provide power to electrical circuits.

**Competencies**

2.7.1 Identify the differences between transformer-powered supplies and line-connected supplies.

2.7.2 Select and install filters.

2.7.3 Construct and install regulated power supplies.

2.7.4 Select and install fuses and circuit breakers.

**Strand 3. Mechanical Systems**

Learners apply principles of motors and power, hydraulics and pneumatics, mechanical drives, pumping systems, and cleanroom vacuum systems. They gain essential knowledge and skills in installing, maintaining, and troubleshooting various mechanical systems used in engineering and manufacturing.

**Outcome 3.1 Motors and Power:** Install motors, variable-frequency drives (VFD), and power wiring.

**Competencies**

3.1.1 Identify types and components of single phase and three phase motors.

3.1.2 Interpret motor nameplate information and motor specifications.

3.1.3 Calculate motor loads.

3.1.4 Determine motor rotation needed for the installed load and explain the process for reversing rotation (i.e., three phase and single phase).

3.1.5 Interpret schematics and control diagrams for building a motor circuit.

3.1.6 Wire single phase and three phase circuits and install motor control devices (e.g., contactors, starters, variable-frequency drive (VFD) and motor speed controls).

3.1.7 Explain the starting sequence of motor components within a given circuit.

3.1.8 Troubleshoot and repair motor starting systems to verify operation according to schematics and control diagrams.

3.1.9 Describe how programmable controllers can be used to control single speed motors and variable speed motor applications.

**Outcome 3.2 Hydraulics and Pneumatics Systems:** Install, maintain, and Hydraulic and Pneumatic systems

**Competencies**

3.2.1 Understand and explain the fundamental principles of hydraulics and pneumatics system (e.g., Pressure, Flow, and Force)

3.2.2 Identify the major components of hydraulics and pneumatics systems (e.g., pumps, cylinders, valves, and compressors)

3.2.3 Describe the properties of fluids used in hydraulics systems including viscosity, density, and compressibility.

3.2.4 Describe the properties of gases used in pneumatic systems including viscosity, density, and compressibility.

3.2.8 Identify present applications of hydraulic and pneumatic systems in industry.

3.2.9 Troubleshoot common issues in hydraulic and pneumatic systems (e.g., leaks, pressure drops, and component failures)

**Outcome 3.3 Mechanical Drives Systems:** Install, maintain, and monitor mechanical drives systems.

**Competencies**

3.3.1 Compare types of gears, couplings, belts and chains and describe their uses.

3.3.2 Perform shaft alignment on rotating equipment.

3.3.3 Select bearings for specific applications.

3.3.4 Calculate or obtain speed and torque ratios for belt and chain drives per design specifications.

**Strand 6 Precision and Advanced Machining**

Learners apply principles of subtractive and additive manufacturing, tooling, CNC machining, and semiconductor manufacturing. They gain essential knowledge and skills in performing various manufacturing processes, selecting and configuring appropriate tools and equipment, and understanding advanced manufacturing production technologies.

**Outcome 6.3 Tooling:** Identify necessary and appropriate tooling to be used in production

**Competencies**

6.3.1 Classify various types of end-of-arm tooling used in machining. (i.e.: Grippers, Vacuums etc.)

6.3.2 Identify various types of materials used to create end-of-arm tools

6.3.3 Describe the functionality and purpose of the end-of-arm tool

6.3.4 Select an appropriate end-of-arm tool based off job specifications and material requirement

6.3.5 Design custom end-of-arm tool to meet operational and job requirements

6.3.6 Perform setup and integration of end-of-arm tool

6.3.7 Evaluate the effectiveness of end-of-arm tool

**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**

7.2.1 Perform controller startup and shutdown.

7.2.2 Operate a teach pendant and pendant menu.

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).

7.2.9 Describe common end of arm tooling.

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).

7.2.13 Analyze the information contained in positional data.

7.2.14 Perform robot I/O analysis and manipulation.

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).

7.3.8 Calibrate and modify tool control point Tool Center Point (TCP).

7.3.9 Describe the use of subroutines.

7.3.10 Perform data manipulation (e.g., counters, data tables, data registers).

7.3.11 Describe the various file types used for import/export of data.

7.3.12 Upload and download data between robotic simulation and a real robot.

7.3.13 Compare the differences between programming in robotic simulation and programming a physical robot.

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

**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

7.5.8 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**

10.1.5 Identify source of electrical and mechanical hazards and use shut-down and established lock out/tag-out procedures.

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

**Competencies**

10.2.3 Select, use, store, maintain and dispose of personal protective equipment (PPE) appropriate to job tasks, conditions and materials.

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.

10.2.8 Safely operate manual, electrical‐powered and pneumatic tools.

**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.

10.3.3 Perform leak checks on equipment.

10.3.4 Report and document unsafe machinery conditions.