**Course Description**

Students will apply the knowledge and skills necessary for installing, maintaining and safely troubleshooting modern industrial machinery. Students will learn about pneumatic, hydraulic, mechanical and electrical systems. They will learn to solve practical maintenance problems, read and interpret drawings and maintenance manuals and understand manufacturing process quality practices. Students will troubleshoot electrical controls, sensors and actuators for automated machinery and manufacturing processes.

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

**Competencies**

2.2.6 Construct and troubleshoot series, parallel and series-parallel circuits.

2.2.7 Analyze wiring schematics and diagrams for accuracy, function, and performance characteristics (e.g., time constants, current flow, impedance, signal timing, etc.)

2.2.15 Troubleshoot and diagnose faults in AC circuits, identifying common issues such as open circuits, short circuits, faulty components (e.g., capacitors, resistors), and wiring issues.

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**

2.3.1 Identify resistor values from color codes or other marks.

2.3.2 Compare resistor compositions and their uses.

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 the 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.

2.4.6 Select and install terminal strip according to wiring diagram and/or schematics.

2.4.8 Use diagnostic tools to troubleshoot circuits effectively (signal generator, oscilloscope, multimeter etc.)

**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.

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

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

**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)

3.2.5 Interpret a basic schematic of a basic hydraulic or pneumatic system identifying the components of that system within the schematic

3.2.6 Calculate pressures, forces, and fluid flow rates in hydraulic and pneumatic systems

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.

3.3.5 Install and align power transmissions systems.

3.3.6 Perform power transmissions systems maintenance.

3.3.7 Monitor power transmissions systems.

3.3.8 Troubleshoots for power transmission systems problems and inefficiencies.

**Outcome 3.4 Pumping Systems:** Install, maintain, and troubleshoot pumps and pumping systems.

**Competencies**

3.4.1 Understand and explain the fundamental principles of pumps and pumping systems.

3.4.2 Identify the major components of pumps and pumping systems.

3.4.3 Interpret a basic schematic of a pumping system identifying the components of that system within the schematic

3.4.7 Align precision and non-precision couplings.

3.4.8 Disassemble and assemble pumping stations.

3.4.9 Troubleshoot pump system failure conditions (e.g., cavitation).

**Strand 5. Design and Development**

Learners apply principles of design and development related to the design process,

sketching and visualization, modeling, drafting, materials and production and process

design.

**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.

5.7.6 Utilize a blueprint to produce a product

**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.

5.8.5 Identify discrepancies or errors in a schematic.

5.8.6 Utilize a schematic to produce a product

5.8.7 Differentiate between different styles and standards in schematics (e.g., international, US)

**Strand 9 Technical Math and Science**

Learners develop a comprehensive understanding of the fundamental principles and applications of technical mathematics and scientific concepts. Learners will perform precise measurements, interpret technical drawings, and apply scientific principles to solve engineering and manufacturing problems.

**Outcome 9.4 Measurement and Interpretation:** Interpret drawings and documentation and perform measurements.

9.4.3 Identify measuring systems and convert between systems.

9.4.4 Identify information and symbols provided in drawings and specifications.

9.4.5 Skill in taking accurate measurements of material properties, components, and finished products using appropriate measuring tools & equipment

9.4.7 Ability to utilize a variety of different measuring instruments

**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**

10.1.1 Knowledge of safety standards and regulations, including Hazard Communication (HAZCOM) and Occupational Safety and Health Administration (OSHA) requirements (e.g., Working at Heights, Confined Space)

10.1.2 Knowledge of risk identification, evaluation, and mitigation strategies

10.1.4 Demonstrate proper use of American National Standards Institute (ANSI) hand signals.

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

10.1.8 Identify the location of emergency flush showers, eyewash fountains, Safety Data Sheets (SDSs), fire alarms and exits.

10.1.9 Respond effectively to manufacturing-related emergencies and adapt response plans.

10.1.10 Identify the components of a hazardous materials safety plan.

10.1.14 Explain the role of third part certification (UL, IE, OSHA, etc.)

10.1.15 Apply information in the National Electrical Code (NEC) and other applicable codes when working on a job

**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.

10.3.5 Safely operate platforms, man lifts and ladders.

10.3.6 Identify tools and equipment requiring safety certification.

10.3.7 Use environmental data systems.

10.3.8 Monitor equipment for unsafe conditions.

10.3.9 Identify the benefits of cross‐training.

10.3.10 Deliver set‐up and operational procedures.

**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.

10.4.3 Maintain inspection processes and records.

10.4.4 Calibrate and adjust manufacturing equipment.

10.4.5 Inspect and correct machine malfunctions.

10.4.6 Perform roughing pump system maintenance using a complex set of equipment specific instructions.

10.4.7 Describe costs and benefits of proactive versus reactive maintenance.

10.4.8 Describe predictive time based, and preventative maintenance schemas.

**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.

10.5.2 Identify maintenance tasks required (e.g., inspecting, grinding, sharpening, dressing, lubricating, cleaning).

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

10.5.4 Develop a preventive maintenance schedule.

10.5.5 Monitor equipment operation based off manufactures SOP

10.5.6 Repair or replace equipment and accessories as needed.