**Course Description:**

Learners develop practical knowledge and skills related to manufacturing processes, production planning, quality control, and workplace safety. The course emphasizes understanding various manufacturing methods, equipment operation, and the coordination of resources to efficiently produce goods. Students gain hands-on experience in monitoring production lines, maintaining equipment, and implementing continuous improvement 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).

**Outcome 1.8 Operations Management:** Plan, organize and monitor an organization or department to maximize contribution to organizational goals and objectives.

**Competencies**

1.8.5 Use inventory and control systems to purchase materials, supplies and equipment (e.g., Last In, First Out [LIFO]; First In, First Out [FIFO]; Just in Time [JIT]; LEAN).

1.8.6 Identify the advantages and disadvantages of carrying cost and Just-in-Time (JIT) production systems and the effects of maintaining inventory (e.g., perishable, shrinkage, insurance) on profitability.

1.8.8 Identify routine activities for maintaining business facilities and equipment.

**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.

**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

**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

**Strand 4 Materials Joining**

Learners apply principles of physics and metallurgy to join materials and test joints. Knowledge and skills may be applied to arc welding processes, non‐arc welding processes, testing and inspection and thermal cutting.

**Outcome 4.3 Non-Arc Material Joining Processes:** Perform types of non-arc material joining processes in the six positions.

**Competencies**

4.3.1 Select the types of material joining required for product specifications.

4.3.2 Select non-arc welding processes based on product specifications.

4.3.8 Describe the high energy density fusion welding processes.

4.3.9 Describe the process for joining plastics and the techniques used.

**Outcome 4.6 Fabrication:** Fabricate parts and weldment using fabrication equipment and tools.

**Competencies**

4.6.7 Identify various methods of fastening materials.

**Strand 5. Pre‐Engineering: 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 5.4. Materials:** Select materials for design projects and components.

**Competencies**

5.4.1. Compare advantages of materials used in manufacturing based on physical properties.

5.4.2. Identify the production processes used to create materials.

5.4.3. Determine the production processes used to create products from categories of materials (e.g. organic materials, metals, polymers, ceramics and composites).

5.4.6. Select materials for a given application based on specified criteria (e.g. cost, availability, manufacturability).

**Outcome 5.5 Production and Process Design:** Identify and evaluate production and process design.

**Competencies**

5.5.3 Use process planning and improvement tools (e.g., flowcharts, diagrams, design for manufacturability [DFM]).

5.5.4 Identify the planning and process procedures for production (e.g., corrective preventive actions, audit documentation, Process Failure Mode Effect Analysis [PFMEA]).

5.5.5 Determine critical characteristics and establish quality controls.

5.5.6 Employ project scheduling techniques (e.g., critical path methodology [CPM], project evaluation and review technique [PERT]).

5.5.7 Identify criteria and constraints and determine how those will affect the design of the production process.

5.5.8 Estimate time, tooling, product packaging and material costs.

5.5.9 Monitor performance and compared to time, tool and material cost estimates.

5.5.10 Adjust the production as necessary to respond to variations in the manufacturing process.

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

**Competencies**

5.6.1 Determine product requirements, dimensions and tolerances from drawing and specifications.

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).

5.6.4 Schedule for machining equipment as required.

5.6.5 Determine the appropriate manufacturing technique that should be utilized when creating the product

**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.

5.8.5 Identify discrepancies or errors in a schematic.

**Strand 9 Technical Math and Science**

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 9.1** **Physics of Engineering:** Learn the fundamentals of physics as it relates to engineering.

**Competencies**

9.1.5 Perform operations on whole numbers, fractions and mixed numbers.

9.1.6 Analyze measurements and perform technical calculations.

9.1.16 Use facility drawings to locate equipment.

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

**Competencies:**

9.4.1 Identify measuring tools and gradations used in precision machining and their purposes.

9.4.2 Identify typical measurements in precision machining (e.g., angles, diameter, hardness).

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

9.4.6 Evaluate the influence environmental factors can have on a part (e.g., temperature)

9.4.7 Ability to utilize a variety of different measuring instruments

9.4.8 Identify advanced measuring techniques and understand how they are being used to measure work pieces (Probing, Scanning etc.)

**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

10.1.3 Apply inspection, rejection criteria, hitch configurations and load-handling practices to slings and rigging hardware.

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.

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

10.1.7 Identify procedures for the handling, storage and disposal of hazardous materials.

10.1.8 Identify the location of emergency equipment (eyewash fountains, Safety Data Sheets (SDSs), fire alarms, fire extinguishers, etc.) and utilize them when necessary.

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.

10.1.12 Set up for ergonomic workflow.

10.1.13 Describe the interactions of incompatible substances when measuring and mixing chemicals.

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

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

**Competencies**

10.2.1 Interpret personal safety rights according to the Employee Right to Know plan.

10.2.4 Identify workplace risk factors associated with lifting, operating and moving heavy objects and establish an ergonomics process.

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

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

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.