**Course Description**

Learners apply CNC principles to select materials, plan machining processes, interpret blueprints, and operate CNC machines. They develop skills in programming, setup, precision machining, and part inspection, ensuring accurate, efficient, and safe CNC production.

**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).

1.3.4. Identify how federal and state consumer protection laws affect products and services.

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 [EEOC]).

**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 5.4 Material Selection:** 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 inputs.

5.4.3 Determine the appropriate material to be used to create a product considering production process factors and category of material (e.g. organic materials, metals, polymers, ceramics and composites).

5.4.4 Evaluate the types and magnitude of stresses and forces.

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

5.4.7 Analyze the strength of a design using a simulation.

5.4.8 Use a material and develop a product.

**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.

5.7.6 Utilize a blueprint to produce a product

**Strand 6 Precision and Advanced Machining**

Learners apply principles of precision machining to measuring work pieces, drawing interpretation, inspection, bench work and layout, power saws, drilling machines, lathes and turning machines, milling machines and grinding machines.

**Outcome 6.1 Subtractive Manufacturing:** Perform subtractive manufacturing using a variety of methods and techniques

**Competencies**

6.1.1 Describe the steps of the subtractive manufacturing (e.g., pre-processing processing and post-processing).

6.1.2 Identify the type of material, tooling, and subtractive method required to meet product specifications

6.1.3 Select appropriate machine, cutting tool, work holding device, speeds, cutting fluids, and end of arm tooling required to produce the part

6.1.4 Configure the equipment.

6.1.5 Prepare work pieces for manufacturing

6.1.6 Manufacture the material utilizing the necessary method, tooling, and material to meet product specifications

6.1.7 Inspect the work to meet requirements.

6.1.8 Perform subtractive manufacturing for rapid prototyping and customization.

**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

**Outcome 6.4 Computer Numerical Control (CNC) Machining:** Apply standard practices of CNC operations and part inspection.

**Competencies**

6.4.1 Identify CNC machine components and controllers.

6.4.2 Plan a CNC production process for jobs in a machining cell.

6.4.3 Create and edit CNC programs (e.g., G-code, [CAM]) for machine operations according to job specifications, dimensions and tolerances

6.4.4 Create a tool setup sheet.

6.4.5 Work from a process sheet and part print.

6.4.6 Set up and operate CNC machines

6.4.7 Monitor the operations of a machining cell and troubleshoot problems that arise.

6.4.8 Verify part quality against job specifications.

**Strand 7 Computer Integrated Manufacturing**

Learners apply the principles of computer integrated manufacturing related to robotics, programmable logic controllers and automated systems.

**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

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

7.3.9 Describe the use of subroutines.

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.

**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.)

**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.

**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

10.1.5 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.

10.1.8 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.

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

**Competencies**

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

10.2.2 Describe how working under the influence of drugs and alcohol increases the risk of accidents, lowers productivity, raises insurance costs and reduces profits.

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.

10.3.4 Report and document unsafe machinery conditions.

10.3.8 Monitor equipment for unsafe conditions.

**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.