**Course Description**

Learners develop skills in welding processes, metallurgy, joint design, and weld testing. They apply principles of arc and non-arc welding, select appropriate materials and parameters, and evaluate weld quality using industry standards.

**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 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 4.1 Metallurgy of Welding:** Apply the metallurgy of welding to the processes of joining metal.

**Competencies**

4.1.1 Explain the difference between ferrous and nonferrous alloys

4.1.2 Identify and explain the differences between various metals

4.1.3 Identify different hardness of material (Carbon content) (Mild steel vs hard steel)

4.1.4 Explain how carbon content impacts steel

4.1.5 Describe how pre and post heat treatments affect weld quality

4.1.6 Describe the conductivity & thermal conductivity of different metals

4.1.7 Understand the process of hard facing and the benefits to weld durability through the process

4.1.8 Determine materials weldability and the appropriate techniques that can be used

4.1.9 Knowledge of welding dissimilar metals and the processes used to achieve this

**Outcome 4.2 Arc Welding Processes:** Perform types of welds in the six positions using arc welding processes.

**Competencies**

4.2.1 Identify and select different types of joints for product specifications

4.2.2 Select the types of welds required for product specifications.

4.2.3 Explain electrode and filler metal classification systems and procedures for handling and storing.

4.2.4 Select an arc welding process based on product specifications.

4.2.11 Identify and position the weldment in the correct position and know what those positions are.

4.2.12 Set the appropriate parameters of the machine according to weld requirements

**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.

4.3.5 Describe the types and applications of solid-state bonding processes.

4.3.6 Describe the ultrasonic welding process.

4.3.7 Describe the friction stir process.

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 4.4 Testing and Inspection:** Test and inspect joints and weld structures.

**Competencies**

4.4.1 Identify the factors considered in weld quality.

4.4.2 Conduct a visual defect examination.

4.4.3 Conduct destructive weldment testing.

4.4.8 Analyze weld structure test results to determine weld quality.

4.4.9 Describe emerging non-destructive examination process related to quality testing.

4.4.10 Differentiate between destructive and non-destructive welding examiniations

4.4.11 Identify the and explain different discontinuity of welds and the issues they can cause

4.4.12 Identify and explain different welding defects and the issues they can cause

4.4.13 Describe the various tools that are needed for visual inspection and examination

4.4.14 Explain what tensil stregnth is and how you can test for it.

4.4.15 Conduct a spark test and interpret the results to identify the metal

**Outcome 4.7 Certification of Welding:** Learners demonstrate a knowledge of welding certifications and licenses to be successful in the field.

**Competencies**

4.7.1 Identify welding codes and standards and their importance to the workplace

4.7.2 Differentiate between welding codes and standards

4.7.3 Compare the different codes provided by the welding industry (Ex. API, ASME, AWS).

4.7.4 Understand the necessary skills in order to achieve different welding qualifications and certifications

4.7.5 Differentiate between welding qualifications and welding certifications

4.7.6 Describe the necessary experience to become a CWI

4.7.7 Describe the certifications and qualifications to work in a variety of industries

4.7.8 Perform qualification or certification exam based on code specifications

**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

**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 9.3 Physics of Welding:** Apply the physics of arc welding to the process of joining metal.

**Competencies**

9.3.1 Explain how the welding arc produces a weld.

9.3.2 Identify the factors that affect heat transfer.

9.3.3 Identify the factors that affect melting.

9.3.4 Describe the effects of arc length and shielding gases on the arc.

9.3.5 Identify key variables that determine the type of metal transfers.

9.3.6 Explain the characteristics of different transfer modes (i.e., short circuit, globular, spray transfer, pulsed spray transfer).

9.3.7 Describe the relationship between wire feed speed, current and voltage.

9.3.8 Describe the effects of wire size and type on deposition rate and current ranges.

9.3.9 Identify the characteristics of a stable arc, arc voltage and arc length.

9.3.10 Describe the relationship of current and voltage as it applies to constant voltage power sources.

9.3.11 Explain conditions when arc blow occurs and how to reduce arc blow.

9.3.12 Describe how polarity affects the arc welding process.

9.3.14 Compare transformers, rectifiers and inverters in relation to the arc welding process.

**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

10.1.6 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.

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.

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

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.

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.

10.3.8 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.