**Course Description**

Students will use fundamental welding principles involving shielded metal arc, oxyacetylene, gas tungsten and gas metal arc welding in the flat, horizontal and vertical positions. An emphasis is given to electrode selection, equipment setup, operating procedures, welding inspection and testing. Students will learn joint designs and layout and will be introduced to welding codes and standards. Additional topics include employability skills and an emphasis will be given to personal safety.

**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, resume 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.

1.1.12. Identify healthy lifestyles that reduce the risk of chronic disease, unsafe habits and abusive behavior.

**Outcome 1.2. Leadership and Communications:** Process, maintain, evaluate and disseminate information in a business. Develop leadership and team building to promote collaboration.

**Competencies**

1.2.1. Extract relevant, valid information from materials and cite sources of information (e.g. medical reports, fitness assessment, medical test results).

1.2.2. Deliver formal and informal presentations.

1.2.3. Identify and use verbal, nonverbal and active listening skills to communicate effectively.

1.2.4. Use negotiation and conflict‐resolution skills to reach solutions.

1.2.5. Communicate information for an intended audience and purpose.

1.2.6. Use proper grammar and expression in all aspects of communication.

1.2.7. Use problem‐solving and consensus‐building techniques to draw conclusions and determine next steps.

1.2.8. Identify the strengths, weaknesses and characteristics of leadership styles that influence internal and external workplace relationships.

1.2.9. Identify advantages and disadvantages involving digital and/or electronic communications (e.g. common content for large audience, control of tone, speed, cost, lack of non-verbal cues, potential for forwarding information, longevity).

1.2.10. Use interpersonal skills to provide group leadership, promote collaboration and work in a team.

1.2.11. Write professional correspondence, documents, job applications and resumes.

1.2.12. Use technical writing skills to complete forms and create reports.

1.2.13. Identify stakeholders and solicit their opinions.

1.2.14. Use motivational strategies to accomplish goals.

**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**

1.3.2. 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], United States 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 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. Physics of Welding:** Apply the physics of arc welding to the process of joining metal.

**Competencies**

4.1.1. Explain how the welding arc produces a weld.

4.1.2. Identify the factors that affect heat transfer.

4.1.3. Identify the factors that affect melting.

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

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

4.1.6. Identify how metal transfers in different welding processes (i.e. short circuit, globular, spray transfer, pulsed spray transfer).

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

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

4.1.9. Describe types of transfer modes.

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

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

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

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

4.1.14. Describe how polarity affects the arc welding process.

4.1.15. Explain the effects of high frequency when welding aluminum with the gas tungsten arc welding (GTAW) process.

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

**Outcome 4.2. Metallurgy of Welding:** Apply the metallurgy of welding to the processes of joining metal.

**Competencies**

4.2.1. Explain phases of matter and phase changes during solidification.

4.2.2. Explain how the common crystal structure in metallic materials affects welds.

4.2.4. Explain the types of weld imperfections and their effects on material properties.

**Outcome 4.3. Arc Welding Processes:** Perform types of welds in the six positions using arc welding processes.

**Competencies**

4.3.1. Identify types of ferrous and nonferrous materials to be joined.

4.3.2. Select the types of weld required for product specifications.

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

4.3.4. Select an arc welding process based on product specifications.

4.3.5. Join materials using the shielded metal arc welding (SMAW) process.

4.3.6. Join materials using the gas metal arc welding (GMAW) process.

4.3.7. Join materials using the flux core arc welding (FCAW) process.

4.3.9. Join materials using the gas tungsten arc welding (GTAW) process.

4.3.10. Join materials using the arc stud welding process.

**Outcome 4.4. Non‐Arc Material Joining Processes:** Perform types of non-arc material joining processes in the six positions.

**Competencies**

4.4.1. Identify types of ferrous and nonferrous metals and plastics to be joined.

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

4.4.5. Join materials using the oxy‐fuel gas welding process.

4.4.10. Join materials using the brazing and soldering processes.

**Outcome 4.5. Testing and Inspection:** Test and inspect joints and weld structures.

**Competencies**

4.5.1. Identify the factors considered in weld quality.

4.5.2. Conduct a visual defect examination.

4.5.3. Conduct destructive weldment testing.

**Outcome 4.6. Cutting Processes:** Cut materials using cutting processes.

**Competencies**

4.6.1. Identify types of materials to be cut.

4.6.2. Identify the characteristics of the cut (e.g. bevels, miters, angles) and finish (e.g. machined, grind, rolled).

4.6.3. Select a cutting process based on product specifications.

4.6.4. Cut metals using the plasma arc cutting (PAC) process.

4.6.6. Cut metals using manual and machine‐guided oxy‐fuel processes.

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

**Competencies**

6.1.3. Identify measuring systems and convert between systems.

6.1.4. Identify information and symbols provided in drawings and specifications.

6.1.5. Measure and inspect work pieces according to product specifications.

**Outcome 6.2. Layout and Planning:** Plan a machining process.

**Competencies**

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

6.2.2. Determine process steps (e.g. cut, drill, turn, mill, grind, heat treat).

6.2.3. Plan individual process steps based on industry standards (e.g. manufacturers’ specifications, machining standards).

6.2.4. Schedule machining equipment as required.

**Outcome 6.3. Cutting:** Cut materials.

**Competencies**

6.3.1. Identify the type of material and cuts required in product specifications.

6.3.4. Prepare work pieces for cutting.

6.3.5. Cut the materials.

6.3.6. Inspect the work to meet requirements.

**Outcome 6.8. Maintenance:** Maintain tools and equipment in working condition.

**Competencies**

6.8.1. Identify equipment maintenance requirements in the equipment manufacturer’s documentation.

6.8.4. Develop a preventive maintenance schedule.

6.8.5. Monitor equipment performance during use.

6.8.6. Repair or replace equipment and accessories as needed.

**Strand 7. Industrial 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 7.1. Site Safety:** Handle materials, prevent accidents and mitigate hazards.

**Competencies**

7.1.1. Use Occupational Safety and Health Administration (OSHA)‐defined procedures for identifying employer and employee responsibilities, working in confined spaces, managing worker safety programs, using ground fault circuit interrupters (GFCIs), maintaining clearance and boundaries and labeling.

7.1.2. Identify and rectify or mitigate hazards associated with walking surfaces, working surfaces and lighting.

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

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

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

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

7.1.10. Select and operate fire extinguishers based on the class of fire.

7.1.11. Identify the components of a hazardous materials safety plan.

7.1.12. Create a hazardous materials safety plan.

7.1.13. Set up for ergonomic workflow.

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

**Outcome 7.2. Personal Safety:** Practice personal safety.

**Competencies**

7.2.1. Interpret personal safety rights according to the employee Right to Know plan.

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

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

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

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

7.2.6. Use safe practices when working with electrical, mechanical or other equipment.