CareerClusters™ PATHWAYS TO COLLEGE & CAREER READINESS
Manufacturing

Learning that works for Colorado CTE®

Colorado CTE Course – Scope and Sequence

Course Name	**Introduction to Welding**		**Course Details** **Course = 0.50 Carnegie Unit Credit**	**Credit = 1.0** **Prerequisite: None** **Instructor Credentials Required: CTE Manufacturing Production**	
Course Description	This introductory welding class teaches students the basics of Oxy-Acetylene welding and cutting, Wire Feed/Mig welding, SMAW (stick arc welding) and Plasma cutting. It also covers general and welding safety as well as general metal working procedures.				
Note:	This is a suggested scope and sequence for the course content. The content will work with any textbook or instructional resource. If locally adapted, make sure all essential knowledge and skills are covered.				
SCED Identification #	13207	Schedule calculation based on 60 calendar days of a 90-day semester. Scope and sequence allows for additional time for guest speakers, student presentations, field trips, remediation, or other content topics.			
All courses taught in an approved CTE program must include Essential Skills embedded into the course content. The Essential Skills Framework for this course can be found at **https://www.cde.state.co.us/standardsandinstruction/essentialskills**					
Instructional Unit Topic	Suggested Length of Instruction	CTE or Academic Standard Alignment	Competency / Performance Indicator	Outcome / Measurement	CTSO Integration
Careers in Welding		Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans.	Student demonstrates ability to use multiple sources of information to manage the career planning process. Student is expected to: (A) identify personal interests, aptitudes, information, and skills necessary for informed career decision making; (B) research the scope of career opportunities available and the requirements for education, training, certification, and licensure;	Research the postsecondary institutions (colleges of applied technology, community colleges, and four-year universities) in Colorado and other states that offer programs leading to careers in welding technology. Write an informative paper or develop an infographic identifying admissions criteria, the postsecondary programs of study, and the secondary courses that will prepare individuals to be successful in a postsecondary program. Locate and assess the American Welding Society website and analyze its	SkillsUSA Personal Skills SkillsUSA 4 Pillars FFA Updates to Student ICAP

			(C) understand economic, social, and personal influences on the career planning process.	structure, policies, and requirements for the AWS Entry Welder qualification and certification. Explain a welder certification document, what steps are required to obtain the certification, and how to prepare for the examination.	
Safety		Interpret policies, procedures, and regulations for the workplace environment, including employer and employee responsibilities.	Comply with standard industry and classroom safety requirements. Student is expected to: (A) Locate, and adhere to, Material Safety Data Sheet (MSDS) instructions; (B) Apply Personal Protective Equipment (PPE) precautions; (C) use health and safety practices for storing, cleaning, and maintaining tools, equipment, and supplies; (D) be informed of laws/acts pertaining to the Occupational Safety and Health Administration (OSHA).	Identify and explain the intended use of safety equipment available in the classroom. For example, demonstrate how to properly inspect, use, store, and maintain safe operating procedures with tools and equipment. Create an infographic that distinguishes between rules and explain why certain rules apply. Complete safety test with 100 percent accuracy. Accurately read, interpret, and demonstrate adherence to safety rules, including rules published by the (1) American Welding Society, (2) rules pertaining to electrical safety, (3) Occupational Safety and Health Administration (OSHA) guidelines, (4) American Society for Testing Materials; ANSI Z49.1: Safety and Welding, Cutting, and Allied Processes, and (5) state and national code requirements.	

Materials and Metals		Understand and demonstrate how materials can be processed through the use of welding tools and equipment.	Understand the properties of materials commonly found in the metal working industry. Student is expected to: (A) list basic metal used in the industry and state their physical and chemical characteristics; (B) describe impact of heat on metal and the resulting chemical and physical changes; (C) describe ways to identify and test metal; and (D) investigate the thermal properties of metals and their effects on welding processes.	Compare and contrast the physical qualities of various industrial materials and how these qualities affect the ability of the materials to be processed to produce useful welded parts and products. Create a report summarizing your research. Compare and contrast existing material bonding methods with future innovative bonding processes. Research the following mechanical properties of metals and their importance in the welding process. a. Tensile b. Strength Page 4 c. Hardness d. Elasticity e. Ductility f. Toughness g. Brittleness Create a chart or table that compares and contrasts the meaning of these properties. Explain the changes in the mechanical properties of weldments that occur during the welding process. Describe and demonstrate techniques to mitigate the effects of thermal expansion and contraction that occur during the welding process. During the demonstrations, observe and record the changes that occur in the mechanical properties of weld and parent metals caused by	

				heating and cooling. Write a report summarizing and explaining the findings. Justify all explanations with supporting evidence gathered from observations and welding principles. Design an experiment to test and compare the effect that thermal conductivity and specific heat have on various metals such as steel and aluminum. Record all observations and write a report to present the test results in an electronic format, integrating quantitative and visual information. The report should include, but should not be limited to, explaining the effect of thermal conductivity on the heating and cooling rates observed during the welding process, as well as the effect of specific heat on heat rates required for welding.	
Layout and Measurement		Interpret and demonstrate the planning and layout operations used in the welding processes.	Understand how layout and measurements are applied in welding occupations. Student is expected to: (A) use current information technology ideation and design process systems in the	Identify and demonstrate proper use of the following typical measuring tools: a. Tape rule b. Machinist's rule c. Bench rule d. Caliper e. Divider f. Depth gage g. Micrometer h. Square i. Protractor j. Combination set	

			manufacturing of welded parts and products; (B) explain why proper layout is a critical skill for welding professionals; (C) demonstrate basic measuring techniques and tools; (D) identify, sketch, and explain the five basic weld joint designs (e.g., butt, lap, tee, outside corner, and edge); and (E) demonstrate joint preparation methods and explain how to identify joint specifications.	Determine when it is appropriate to use linear distance, diameter, and angle measuring tools, and record accurate and repeatable measurements, attending to appropriate units and quantities. Explain why proper layout is a critical skill for welding professionals.	
Blueprint Reading		Interpret scaled welding blueprints; gather design and materials information; perform calculations; and use the detail to plan, lay out, and produce parts or finished products.	Interpret welding-specific drawings and welding symbol information. Student is expected to: (A) differentiating between drawings and blueprints, examine parts to determine the application of symbols from drawings, sketches, and blueprints. (B) analyze welding symbols on drawings, specifications, and welding procedure specifications. (C) critique the design parameters across welding processes to produce a welded part or product.	Examine given shop and assembly drawings for a weldment composed of five to ten components. Interpret the dimensions and write a plan describing the materials and tools needed to complete the assignment. Make the required cuts and execute the plan.	

Equipment Set Up & Oxy-fuel		Explore and understand various welding systems that require standard hand and machine tools.	Use standard and new emerging welding tools and equipment for the purpose of completing a finished product that meets the standards of the AWS or a similar industry standard. Student is expected to: (A) identify and explain the equipment, equipment setup, and techniques that apply to the following thermal cutting operations: a. Oxyfuel cutting b. Plasma-arc cutting c. Air carbon arc cutting d. Sawing e. Shearing f. Punching (B) select and use appropriate welding tools, equipment, and inspection devices to manufacture parts or products; and (C) introduce joint preparation methods and explain how to identify joint specifications.	Perform straight, shaped, and beveled cutting operations using both manual and machine-guided techniques. Properly use weld-washing techniques and visually examine cut surfaces for meeting the given specifications.	
SMAW Process		Apply knowledge of SMAW process of welding. Interpret and explain terminology and practices specific to the Manufacturing and Product Design sector.	Understand the Shield Metal Arc Welding process as it applies to the welding profession. Student is expected to: (A) demonstrate how to make single- and multiple-pass fillet welds	Safely set up equipment for shielded metal arc welding (SMAW). Identify and explain the equipment, equipment setup, and the electrical current used in the welding process. Drawing on multiple resources, compare and	

			and groove welds in the following positions: • Flat • Horizontal • Vertical • Overhead (B) apply knowledge to properly demonstrate the ability to review a welding procedure specification and conduct a welding procedure test. Steps must include: a. Properly setting up welding equipment for the process being tested b. Properly select base material and filler metal (gas shielding if required) c. Gathering equipment needed to capture welding variables d. Properly set up test coupon (per code, or as performed in production) e. Properly document data as coupon is being welded f. Performing visual inspection g. Performing destructive testing h. Completing the Welding Procedure Specification document	contrast SMAW with other welding and cutting processes such as oxyfuel gas welding (OFW), gas metal arc welding (GMAW), flux-cored arc welding (FCAW), and gas tungsten arc welding (GTAW). Write a brief informative paper discussing the distinguishing characteristics and primary advantages of each	
Welding Information Resources		Use existing and emerging technology, to investigate, research, and produce	Use information and communication technologies to	Research the American Welding Society (AWS) filler metal classification system	

		products and services, including new information, as required in the Manufacturing and Product Design sector workplace environment. Select and apply informational resources appropriate to the industry.	synthesize, summarize, compare, and contrast information from multiple sources. Student is expected to: (A) Use and apply American Welding Society (AWS) resources appropriately; and (B) locate and use manufacturing resources appropriately.	and write a paper explaining the system, briefly discussing the multiple factors that affect electrode selection for shielded metal arc welding (SMAW). Using various electrodes, demonstrate how to make pad beads on plain carbon steel in the following positions. a. Flat b. Horizontal c. Vertical d. Overhead Summarize the demonstration results of using various electrodes and explain the findings using supporting evidence from the AWS metal classification system.	
Quality control		Understand the purposes and processes of inspection and quality control in machining and forming processes.	Understand and defend the reasons for inspection and quality control in the manufacturing of machined and formed parts. Student is expected to: (A) explain the importance of the American Welding Society (AWS) Specification for Welding Procedure and Performance Qualification (AWS B2.1/B2.1M); (B) Identify and explain weld imperfections and their causes;	Drawing upon multiple resources, research and write a text explaining the relationship between discontinuities and defects. Describe various examples of defects found in welded products. Also identify and explain both destructive and nondestructive tests used as quality control techniques to prevent manufacturing defects in welding. Compare and contrast these techniques and provide specific examples when they are most appropriately used. Cite evidence to justify the examples.	

			(C) investigate procedure qualification variables associated with the following elements and their effects on welding processes: • Joint Design • Base Metal • Filler Metal • Position • Preheat and Interpass • Heat Treatment • Shielding Gas • Electrical (D) understand the relationship between specification and tolerance in welding; (E) describe techniques to mitigate the effects of variables that can occur during the welding process; (F) identify and explain destructive and nondestructive examination practices.	Using the American Welding Society (AWS) Specification for Welding Procedure and Performance Qualification (AWS B2.1/B2.1M), define the following elements: a. Joint Design b. Base Metal c. Filler Metal d. Position e. Preheat and Interpass f. Heat Treatment g. Shielding Gas h. Electrical. Research or conduct an experiment on how to mitigate the effects of the above elements during the welding process and write a report summarizing and explaining the findings. Justify all explanations with supporting evidence gathered from observations and welding principles. Read and interpret an example of a welding procedure specification and observe demonstrations of qualified welders to understand the proper procedures involved in conducting a welding procedure test. Create a training document to instruct a new welder on how to properly use the welding procedure specification to help successfully conduct a welding procedure test. Include the following: a. Code Requirements b. Materials c.	

				Documentation d. Destructive Testing e. Inspection and evaluation	