CareerClusters™ PATHWAYS TO COLLEGE & CAREER READINESS
Manufacturing

Learning that works for Colorado CTE®

Colorado CTE Course – Scope and Sequence

Course Name	Welding Technology	Course Details Course = 0.50 Carnegie Unit Credit	Credit= 1.0 Prerequisite: Introduction to Welding CTE Credential: CTE Manufacturing
Course Description	Welding Technology provides the foundational understanding of welding and welding processes. In this course students will learn industry based safety standards and become familiar with the following welding processes; Oxyacetylene welding and torch cutting, plasma cutting, and ARC welding. Students will become familiar with basic blueprint reading, weld symbols, welding-related math, and measurement. As their skill level is developed, small projects will be introduced throughout the year.		
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
Applied Academics for Welding		Understand, interpret, analyze and apply units of measure, mathematics concepts, and science principles in order to solve problems in welding fabrication.	The student applies academic skills to the requirements of welding. The student is expected to: A) demonstrate effective communication skills with individuals from varied cultures such as fellow workers, management, and customers; B) demonstrate mathematical skills to estimate costs;		

			C) demonstrate technical writing skills related to work orders; D) apply accurate readings of measuring devices; E) use appropriate tools to make accurate measurements; F) compute measurements such as area, surface area, volume, and perimeter; G) solve problems using whole numbers, fractions, mixed numbers, and decimals; H) use various methods, including a calculator, to perform computations; I) perform conversions between fractions and decimals; J) perform conversions between standards units and metric units; K) calculate and apply the functions of angles such as using the Pythagorean Theorem; and L) diagram the parts of a circle .		
Workplace Regulations, Safety & Compliance		Apply basic knowledge of using and maintaining professional welding equipment. Identify regulations and safety standards that	The student evaluates the function and application of the tools, equipment, technologies, and materials used in welding. The student is expected to: A) operate welding equipment according to safety standards;	Accurately read, interpret, and demonstrate adherence to safety rules, including rules published by the Occupational Safety and Health Administration (OSHA) guidelines,	

		are implemented within the welding profession. Identify materials and resources commonly used and recycled in welding. Understand the AWS certification requirements.	B) identify and properly dispose of environmentally hazardous materials used in welding; C) explain the importance of recycling materials used in welding; D) choose appropriate personal protective equipment; E) evaluate skills related to health and safety in the workplace as specified by appropriate governmental regulations; and F) Understand the AWS certification process.	American Society for Testing Materials; ANSI Z49.1: Safety and Welding, Cutting, and Allied Processes, And state and national code requirements. Be able to distinguish between rules and explain why certain rules apply. Complete safety test with 100 percent accuracy. 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. Locate and assess the American Welding Society website and analyze its 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.	
Construction Drawings and Standards		Identify and use welding symbols and read detailed drawings. Identify and use the basic weld types, weld joints, and weld positions	The student understands welding joint design, symbols, and welds. The student is expected to: A) demonstrate knowledge of engineering drawings, charts, and diagrams; B) interpret orthographic and isometric views of three-dimensional figures; C) interpret engineering, drawings, charts, and diagrams; D) analyze components of the welding symbol; E) identify types of welding joints; F) identify positions of welding; and G) identify types of welds such as fillet, groove, spot, plug, and flanged. The student analyzes the concepts and intricacies of inspections and related codes. The student is expected to: A) explain weld inspection processes; and B) interpret welding codes	Compare and contrast the architectural scale versus the engineering scale used in mechanical drawings. Describe their distinguishing characteristics. Define a scale and perform conversion calculations of various distances. Building on the knowledge of a two-dimensional drawing, create simple isometric (3-D pictorial) drawings, properly using lines (e.g., object, hidden, center), labels, and dimensioning techniques. Identify, sketch, and explain the five basic weld joint designs (e.g., butt, lap, tee, outside corner, and edge). Find examples of various joint designs applied to structures on or around campus and take pictures to present to classmates.	

				Research the American Welding Society (AWS) Specification for Welding Procedure and Performance Qualification (AWS B2.1/B2.1M) to learn more about Welding Procedure Specifications and the use of the document. Explain the significance of this document and 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	
Metal Properties		Investigate the properties of metals and how the react to heat.	Understand the properties of common metals used in welding procedures. Student is expected to: A) identify common metals and their properties; B) understand the relationship of metals and their welding process specifications; and C) analyze heat and thermal connectivity.	Research the following mechanical properties of metals and their importance in the welding process. a. Tensile b. Strength 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. Investigate the thermal properties of metals and their effects on welding processes. Describe and demonstrate techniques to mitigate the effects of thermal expansion and contraction that occur during the welding process. 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 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.	
Oxyfuel Cutting		Demonstrate the safe setting up and cutting process of oxy-fuel.	The student analyzes oxy-fuel cutting processes on carbon steels. The student is expected to: A) practice safe operating practices; B) perform safe handling of compressed gases; C) identify components of oxy-fuel gas cutting system; D) demonstrate proper set-up procedures for oxy-fuel cutting process; E) identify factors affecting oxy-fuel cutting of base metals;	Identify components of oxy-fuel gas cutting system and demonstrate proper set-up procedures for oxy-fuel cutting process. Perform straight, shaped, and beveled cutting operations using both manual and machine-guided techniques. Properly use weld-washing techniques and visually examine cut	

			F) demonstrate proper cutting techniques such as piercing, straight line, and bevel; G) identify acceptable cuts; and H) evaluate alternative fuel gasses such as propane, propylene, and Chemtane 2®	surfaces for meeting the given specifications. Investigate local welding practices. Analyze the use of alternative fuel gasses within Colorado or your local community.	
Plasma Arc Cutting		Identify and demonstrate setting up plasma arc cutting equipment. Identify, explain, and demonstrate the proper processes, safety procedures, and fume extraction for plasma arc cutting. Demonstrate the skills required to perform various cuts with plasma arc on various materials.	The student analyzes plasma arc cutting on metals. The student is expected to: A) use safe operating practices; B) demonstrate knowledge of the theories of plasma arc cutting; C) apply safe handling of compressed air supply; D) identify components of plasma arc cutting; E) demonstrate correct set-up procedure for plasma arc cutting; F) define cutting terms; and G) perform straight line, piercing, bevels, and shape cuts.	Use plasma arc cutting (PAC), to cut materials for the purpose of completing a finished product that meets the standards of the AWS or a similar industry standard.	
Shielded Metal Arc Welding (SMAW)		Understand the Shielded Metal Arc Welding process (SMAW). Demonstrate knowledge of Shielded Metal Arc Welding (SMAW) including	The student analyzes shielded metal arc welding principles and practices on metals. The student is expected to: A) use safe operating practices; B) analyze welding current relationships such as alternating current and direct current, heat transfer, and polarity;	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.	

		setting up of equipment. Identify and explain the American Welding Society (AWS) classification of wire. Demonstrate the proper AWS codes for fillet weld quality performing fillet welds in the flat, horizontal, vertical, and overhead positions to AWS code.	C) apply shielded metal arc welding principles; D) demonstrate proper set-up procedure for shielded metal arc welding; E) explain the American Welding Society (AWS) identification system for shielded metal arc welding electrodes; F) determine appropriate electrodes for base metal in shielded metal arc welding; and G) perform multi-pass groove welds in all positions according to industry-accepted welding standards.	Drawing on multiple resources, compare and 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. Demonstrate how to make single-and multiple-pass fillet welds and groove welds with backing on plain carbon steel in the following positions. Prior to welding, sketch a cross section, including the dimensions of each weld demonstration. a. Flat b. Horizontal c. Vertical d. Overhead Research the American Welding Society (AWS)	

				filler metal classification system 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 quality control methods and standards used in the welding industry.	Apply knowledge of quality control methods for testing and inspecting welds. Student is expected to: A) identify and explain weld imperfections and their causes; B) identify testing methods used in welding;	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	

			C) read and interpret an example of a welding procedure specification; D) investigate the proper procedures involved in conducting a welding procedure test; and E) analyze and identify the steps to check for distortion, joint misalignment, and poor fit-up before and after welding.	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. Measure and visually inspect welded products for acceptability to American Welding Society QC-10 standards. Record discontinuities and defects, and compare data to given project specifications using class-defined analysis methods. Interpret and communicate results both written and verbally. If necessary, recommend changes that will reduce the number of product defects during the manufacturing process. Investigate procedure qualification variables	

				associated with the joint design, base metal, filler metal, position, preheat and interpass, heat treatment and shielded gas and their effects on welding processes. Describe techniques to mitigate the effects of these variables that can occur during the welding process. Write a report summarizing and explaining the findings. Justify all explanations with supporting evidence gathered from observations and welding principles. Apply knowledge previously learned 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	