CareerClusters™ PATHWAYS TO COLLEGE & CAREER READINESS
Manufacturing

Learning that works for Colorado CTE®

Colorado CTE Course – Scope and Sequence

Course Name	Metal Fabrication and Machining	Course Details Course = 0.50 Carnegie Unit Credit	Credit = 1.0 Suggested Prerequisites: Principles of Manufacturing
Course Description	Metal Fabrication and Machining provides the knowledge, skills, and certifications required for equal employment opportunities in the metal production industry. This course is designed to teach students industry skills applicable to welding, sheet metal, and machining occupations. Technical Concepts and skills in this course include shielded and gas metal arc welding, hand and power tools common in metal manufacturing, machine tool operation including automated welding machines, lathe and mill machine processes, metallurgy, and sheet metal processes.		
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 #	13203	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
Machining and Metal Fabrication Occupations		Evaluate a wide range of career pathway opportunities within metal fabrication and machining manufacturing.	The student differentiates the technical concepts that form the basic knowledge and skill sets of employees within the metal manufacturing trades. The student is expected to: (A) examine the theory of shielded metal arc welding and gas metal arc welding; (B) examine the sheet metal industry; and (C) understand the relationship of	Students will research, describe, and examine the history of the machining, welding, and sheet metal trade by utilizing technology, collaboration, and other sources. Report on a significant technological advancement and analyze its impact on the industry or profession. Referencing data from U.S. Department of Labor and other sources, articulate a career pathway for the welding, sheet metal, or machining trades; include	ICAP- Develop and revise career plan annually based on workplace awareness and skill attainment.

			international, federal, and state standards and regulations to employers and employees within the metal fabrication trades.	postsecondary training options and write an informative paper or develop an infographic identifying entry requirements for a specific apprenticeship or postsecondary program of study, and the secondary courses that will prepare students to be successful in the program.	
Blueprints and Layout		Read and understand technical drawings, charts, and diagrams common to the metal fabrication occupations. Validate that a provided part meets specifications from its engineering drawing by comparing specifications (geometric dimensioning and tolerancing) and by demonstrating proper technique using appropriate precision measuring tools.	The student applies academic and technical skills to the requirements of metal manufacturing. The student is expected to: (B) interpret engineering drawings, charts, diagrams, and welding symbols; and (C) select algebraic and geometric principles and formulas required for precision measuring operations	Given a specific machining task, select the appropriate tool and accurately measure solid shapes or simple parts. Record the measurements in both English and metric units using the correct number of significant figures. Perform basic mathematical calculations and/or calibrations using tools such as the following: • Micrometers • Verniers • Gages • Dial indicators • Helper measuring tools (e.g., calipers, telescoping gage, small hole gage) Identify and explain the proper use of the following common layout tools used in machining technology. Given a specific machining task, use a multistep layout procedure to	

				locate and mark lines, circles, arcs, and points for drilling holes and making cuts. Such as: • Lines: layout dye, scriber, divider, surface plate, v-blocks, straightedge, squares • Angles: plain protractor, vernier protractor	
Terminology and Technical Applications			The student differentiates the technical concepts that form the knowledge and skills of metal manufacturing. The student is expected to: (A) analyze the resources found in *The Machinery's Handbook* as well as the specifications and codes written by the American Welding Society (AWS), Canadian Welding Bureau (CWB), American National Standards Institute (ANSI), and American Petroleum Institute (API); (B) understand how computerized	Demonstrate technical literacy in the symbols, lines, and figures devised by the American National Standards Institute (ANSI). Distinguish between the past and present metalworking symbols (e.g., counterbore, countersink, and drill) and explain why it is important to be familiar with both. In teams, research the evolution of machining technology, and describe how it has affected the workforce and the manufacturing industry in particular. Report on early machining tools, how power sources changed, basic machine tool operation, non-traditional machining and processes, and automated machining processes. Cite	

			systems increase businesses' effectiveness and completing workplace tasks with accuracy and efficiency; (C) identify and describe trends in the use of emerging technology in the welding industry, including the use of automated welding machines such as numerical control, computer numerical control, and robotics-controlled machines.	evidence to support the information presented. Investigate how the role of a machinist has changed with the evolution of machining technology. Describe the various machining job categories and their characteristics.	
Safety in the Workplace		Incorporate safety procedures when operating tools and equipment. Comply with regulations and applicable codes to establish and manage a legal and safe workplace/jobsite.	The student understands the function and application of the tools, equipment, technologies, and materials used in metal fabrication manufacturing. The student is expected to: (A) practice safe use of equipment; (B) properly dispose of hazardous materials used in metal manufacturing; (C) identify safety hazards on a jobsite and	Demonstrate safe procedures to move materials by planning the movement, properly lifting, stacking, and storing materials, and selecting proper materials-handling equipment. Perform a hazard assessment for a given task or equipment. • Explain the steps necessary to safely perform the task, outlining steps to take	SkillsUSA Workplace skills

			demonstrate practices for safe working; (D) accurately read, interpret, and demonstrate adherence to safety rules, including but not limited to rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements; (E) maintain safety records and demonstrate adherence to industry-standard practices regarding general machine safety, tool safety, equipment safety, electrical safety, and fire safety to protect all personnel and equipment.	in case of an emergency. Locate material safety data sheets (MSDS), explain their function and how to interpret the information presented. Read and discuss information on OSHA, EPA and other safety regulations. Pass safety inspections and comply with regulations at all times	
Tools, Equipment and Materials		Demonstrate understanding of bending, shaping, other metal forming, and fabrication techniques,	The student differentiates the technical concepts that form the knowledge and skills of metal	Identify and explain the parts of an engine lathe and milling machine. Students will perform necessary operations	

		including processes in the metal fabrication industry.	manufacturing. The student is expected to: (A) use hand and power tools and equipment commonly employed in metal manufacturing; (B) use various work mounting procedures on all appropriate machines; (C) operate machine tools such as drill press, lathe, saw, grinders, and milling machines; and (D) examine the nomenclature of abrasive wheels.	in order to use a lathe and mill: • demonstrate lathe procedures such as cutting threads, turning tapers, drilling, reaming, polishing, knurling and boring • demonstrate milling procedures such as milling flat surfaces, bevels, chamfers, grooves, and key-way seats.	
Welding and Cutting Processes		Identify and explain oxy-fuel and plasma arc cutting welding processes. Demonstrate technical practices related to the welding and cutting processes.	The student applies the technical concepts and skills of the welding industry to simulated and actual work situations. The student is expected to: (A) perform cutting processes such as straight cuts, bevel cuts, and hole piercing with oxy-fuel and plasma; (B) use the common types of electrodes with the shield metal arc welding process; (C) practice using gas metal arc welding to weld in multiple positions to produce groove and fillet welds; and	Students will demonstrate the use of elements within a detailed drawing and interpret welding symbols from a detailed drawing. Additionally, students will be able to identify and use the basic weld types, weld joints, and weld positions. Students will demonstrate the safe setting up and disassembly process of oxy-fuel, plasma arc, propane, propylene, and Chemtane 2® equipment. Students will demonstrate lighting, adjusting, and making cuts including straight, bevel, and hole piercing. Report or create an infographic which identifies	

			(D) inspect groove and fillet welds to AWS, CWB, ANSI, and API codes The student differentiates the concepts that form the technical knowledge and skills of sheet metal manufacturing. The student is expected to: (B) analyze the fundamentals of oxy-fuel processes as related to sheet metal; and (C) analyze the fundamentals of shielded metal arc welding and gas metal arc welding as related to sheet metal under various AWS codes	some common hazards in welding and cutting and presents safe practices within the profession.	
Metallurgy		Understand the applications of metallurgy within metal machining and fabrication manufacturing. Identify and measure different types of metals used in sheet metal.	Students will demonstrate the ability to identify and measure different types of metals used in sheet metal. The student is expected to: (A) interpret, engineering drawings, charts, and diagrams as related to the sheet metal industry. Students will identify and demonstrate using various metals in sheet metal, including alloys and pure metals and	Explore the cause and effects of oxidation on metal, what types of metal are best used for products based on functionality and quality. Design an experiment or analyze a specific application under a given set of conditions or constraints. Report on the findings and present an analysis of your results. Using the following classifications, explain how metals are classified, identify general characteristics of each	

			their properties. The student is expected to: (A) analyze the types, sizes, and properties of sheet metal materials.	type, and describe related safety precautions that should be applied during machining procedures. • Ferrous metals • Nonferrous metals • High-temperature metals • Rare metals Present on the various metals used in sheet metal, including alloys and pure metals and their properties. Cite common applications and considerations for selection criteria based on their application. Analyze and describe a variety of quality control constraints on manufacturing materials, parts, and processes that impact the suitability of a given (electromechanical) production process. Collect and interpret data that includes, but is not limited to, physical and electrochemical properties such as size, mass, hardness, pH, temperature, conductivity, rate, and so forth, and synthesize the results to yield a clear, written documentation of the findings.	

Sheet Metal Manufacturing		Demonstrate practices related to sheet metal fabrication processes. Identify common sheet metal seams and construct the common seams used in sheet metal development.	The student applies the knowledge and skills of sheet metal manufacturing in simulated and actual work situations. The student is expected to: (A) draw simple metal layouts; and (B) construct common sheet metal seams	Utilize Sheet Metal layout and principles and practices to identify common sheet metal seams: • Lap seams (plain, offset, corner) • Lock Seam • Hemmed Edge (single, double) • Wired Edge Demonstrate fastening techniques: • Drill and rivet • Soldering • Notching • Metal screws	