CareerClusters™ PATHWAYS TO COLLEGE & CAREER READINESS
Manufacturing

Learning that works for Colorado CTE®

Colorado CTE Course – Scope and Sequence

Course Name	Principles of Manufacturing	Course Details Course = 0.50 Carnegie Unit Credit	Credit = 1.0
Course Description	In Principles of Manufacturing, students are introduced to knowledge and skills used in the proper application of principles of manufacturing. The study of manufacturing technology allows students to reinforce, apply, and transfer academic knowledge and skills to a variety of interesting and relevant activities. Students will gain an understanding of what employers require to gain and maintain employment in manufacturing careers.		
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 #	13002	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
Manufacturing Today		Understand the societal and economic impact of manufacturing in the United States and around the world. Understand how technology impacts manufacturing trends and processes. Evaluate a wide range of career pathway opportunities for success in Manufacturing.	The student applies manufacturing concepts to specific problems. The student is expected to: (A) distinguish between disciplines such as engineering, science, manufacturing, and technology The student describes the factors that affect the evolution of technology. The student is expected to: (B)evaluate how the development of technology in	Analyze a manufacturing segment and report on the significant achievements or technology within the last 5-10 years. Explain the impact within global, economic, environmental, and societal contexts. Define employment expectations of entry-level employees in local employment situations (hiring requirements, basic job expectations, etc.) Explain roles and relationships of entities within the industry	SkillsUSA Personal Skills Framework Updates to Student ICAP and career goals

			manufacturing is influenced by past events The student selects and reports on career opportunities, requirements, and expectations in manufacturing and technology. The student is expected to: (A) investigate an area of interest in manufacturing; (B) analyze the various specializations in manufacturing; and (C) describe the functions of engineers, technologists, and technicians	(i.e. relationships of unions, government agencies, industry associations, OSHA, etc.) Explore a range of new and emerging trends in advanced manufacturing. A trend could be the change in the types of skills needed in manufacturing, the use of computers, or the use of advanced materials in recent years. Examples include the following: a. Sensing, measurement, and process control b. Materials design, synthesis, and processing c. Digital manufacturing technologies d. Sustainable manufacturing e. Nanomanufacturing f. Flexible electronics manufacturing g. Biomanufacturing h. Additive manufacturing i. Industrial robotics j. Advanced forming and joining technologies Research one or more of these trends in depth, and compile, review, and revise a presentation or a paper explaining both the technical aspects involved (i.e., what skills are needed) and the effects on businesses, workers, and society	

Industry Regulations and Workplace Safety		Understand and apply practices and procedures required to maintain jobsite safety. Understand the major compliance and regulatory considerations within the manufacturing industry.	The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to: (A) identify federal laws and rules applicable to the workplace and enforcement agencies such as the Equal Employment Opportunity Commission and the Occupational Safety and Health Administration (OSHA) The student practices safe work habits. The student is expected to: (A) master relevant safety tests based on OSHA guidelines and principles; and (B) use Material Safety Data Sheets (MSDS) to analyze, store, and safely dispose of hazardous materials.	Obtain OSHA 10 certificate and be able to state basic safety requirements for the industry. Accurately read, interpret, and demonstrate adherence to safety rules, including rules published by the (1) Manufacturing Skill Standards Council (MSSC), (2) rules pertaining to electrical safety, (3) Occupational Safety and Health Administration (OSHA) guidelines, (4) American Society for Testing Materials, (4) ANSI Z49.1: Safety and Welding, Cutting, and Allied Processes, and (5) state and national code requirements. Be able to distinguish between rules and explain why certain rules apply. 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.	
Communication and Terminology		Use effective communication skills and strategies (listening, speaking, reading, writing and graphic	The student applies communication, mathematics, and science knowledge and skills to manufacturing activities.	Define manufacturing and describe how it is used to solve problems. Research the five general steps of manufacturing (preparation,	SkillsUSA Personal Skills Framework

		communications) to work with clients and colleagues. Use vocabulary, symbols and formulas commonly used in manufacturing. Locate, organize, analyze, apply and communicate information from multiple sources and perspectives.	The student is expected to: (A) demonstrate communication techniques consistent with industry standards; (B) locate relevant information needed to solve problems; and (C) analyze science principles used to solve problems.	processing, assembly, finishing, and packaging). Select a product and trace its development through each of the five steps. For example, deliver a presentation explaining how a smart phone goes from raw materials to final packaged product. Distinguish between primary and secondary processes involved in the manufacture of industrial goods into finished products. Summarize in a graphic illustration or narrative how different processes make use of specific manufacturing applications, such as the use of welding in assembling processes. Relate the specific operations required to implement the following secondary processes: a. Casting and molding (e.g., sand casting) b. Forging (e.g., metal forming) c. Separating (e.g., machining) d. Assembling (e.g., welding) e. Direct digital and additive manufacturing (e.g., 3-D printing) f. Finishing (e.g., electroplating) g. Stamping (e.g., stamping press) h. Injection Molds (e.g., injecting material into a mold)	
Technology in the Workplace		Understand how computerized systems are	The student describes the factors that affect the	Report on a significant technological device or	SkillsUSA Employability

		integral to businesses' effectiveness and completing workplace tasks with accuracy and efficiency. Identify and describe the social, economic, and environmental impacts of a technological process, product, or system. Use systems thinking to analyze the influence of technology on history and the shaping of contemporary issues.	evolution of technology. The student is expected to: (A) analyze how changes in technology affect manufacturing practices; (B) evaluate how the development of technology in manufacturing is influenced by past events; (C) analyze the international effects of technology; (D) demonstrate how advancements in technology have affected the field of engineering; and (E) evaluate the factors that affect the implementation of new ideas	technique developed in the manufacturing industry and its impact on either safety or productivity. Research the history of manufacturing. Summarize its evolution from the Industrial Age to the rise of mechanization and automation in the manufacturing industry. Create a timeline or infographic that identifies milestones in the industry that led to today's advanced manufacturing environments. For example, discuss both the history of the assembly line and the use of robots, describing how they transformed the manufacturing industry. Explain that manufacturing is a technological system that transforms raw materials into products in a central location (e.g., a factory). Technological systems include the following elements: inputs, processes, outputs, feedback, and goals. As a team, select a manufacturing system, such as metal fabrication, and use diagrams and other multimedia to demonstrate its operation. Identify each	Skills Framework

				element and explain its role in the system. Explore the onset of advanced manufacturing and explain how it applies information, automation, computation, software, sensing, and networking to make traditional processes more efficient. Describe how advanced manufacturing incorporates the use of modern materials and recent discoveries in physical and biological sciences. For example, report on the use of nanotechnology.	
Introduction to Commercial Equipment		Use existing and emerging technology, to investigate, research, and produce products and services, including new information, as required in the Manufacturing workplace environment. Demonstrate basic knowledge of using and maintaining professional manufacturing equipment.	Manufactures products using the appropriate tools, equipment, machines, materials, and technical processes. The student is expected to: (A) analyze the processes needed to complete a project such as initiate, plan, execute, monitor and control, and close; and (B) use a variety of tools and equipment to produce an item (C) understand basic scientific principles involved in electromechanical, chemical, thermal,	In teams, investigate the role of a manufacturing engineer in designing efficient manufacturing systems. Create samples of the following documents which engineers often use to ensure that manufacturing operations are completed in a logical and efficient order. Use the sample documents to manage the completion of short projects and assignments in this course. Documents include the following: a. Operation sheet b. Flow process chart c. Operations process chart. Identify and explain the equipment, equipment setup,	SkillsUSA Workplace Skills Grounded in Academics SkillsUSA Manufacturing-related Competitions

			hydraulic, and pneumatic processes as they relate to manufacturing technologies used in production.	and techniques that apply to the following operations: a. Sawing b. Drilling c. Grinding d. Milling Properly set controls and speeds of the machines; remove and replace parts; and visually examine machined surfaces for meeting the given specifications. Compare and contrast the two types of fluid power systems (pneumatic and hydraulic). Describe and explain the components they have in common; then identify the characteristics that render certain advantages to using one system over the other. For example, heavy construction machinery often uses hydraulic systems because they have the ability to support heavy loads.	
Materials		Apply scientific information to the manufacturing process, including the chemical and physical properties of materials.	Identify and describe a wide range of materials used in manufacturing: organic, inorganic, engineering (metallic, polymeric, ceramic, composite), and non-engineering (gases and liquids). Distinguish between the materials and provide	In teams, research the major material properties: physical, mechanical, chemical, thermal, electrical/magnetic, acoustical, and optical. Considering the use of materials in the various areas of advanced manufacturing (e.g., welding, machining, mechatronics, and electromechanical	

			examples of how they are converted into products.	technology), discuss the following: a. Characteristics that make up the physical properties of a material b. How the mechanical properties affect the way a material will react to forces or loads c. How natural elements react with a material and affect its performance d. Characteristics that make up thermal properties of a material (e.g., thermal resistance, thermal expansion, thermal emission, thermal shock resistance) e. Three major groups of materials that carry an electrical current (e.g., conductors, semiconductors, resistors) f. Two major properties that describe how a material reacts to sound waves (e.g., acoustical transmission, acoustical reflection) g. Three general optical properties (e.g., color, light transmission, light reflection). Explain why these properties are important to the selection and application of materials in a production setting.	
Measurement and Layout		Describe and layout a project according to specifications or engineering drawings.	Identify and demonstrate proper use of the following typical measuring tools, including:	Identify and describe how the isometric and the orthographic views and the tolerance, scale, and material	

			(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 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.	from an engineering drawing are used with an actual part. 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 critical to making parts properly. Select a typical part and correctly demonstrate the following steps, or use a similar multistep procedure, to lay out the shape of a part. a. Measure off the part size on standard stock. b. Cut the part blank out of the standard stock. c. Draw center lines for holes and arcs. d. Locate holes and arcs. e. Mark centers of holes. f. Draw tangent lines. g. Layout straight cuts Explain calibration, tolerancing, and conditions that cause parts to fall out of tolerance.	
