CareerClusters™ PATHWAYS TO COLLEGE & CAREER READINESS
Manufacturing

Learning that works for Colorado CTE®

Colorado CTE Course – Scope and Sequence

Course Name	Introduction to Machining	Course Details	Credit= 1.0
		Course = 0.50 Carnegie Unit Credit	**Prerequisite: Introduction to Manufacturing** **CTE Credential: CTE Manufacturing**
Course Description	Basic fundamentals in the operation of machine tools are studied, including measuring tools, benchmark and layout, and tool grinding. The student performs various machine operations using the engine lathe, milling machine, vertical drills, and surface grinders. Second semester of this course covers additional blue print reading, advanced inspection, tool & cutter grinding, horizontal mill setup & operation, CAD/CAM 2D, GD & T, conventional lathe operations, and intermediate milling machine & engine lathe.		
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
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	Maintain safety records and demonstrate adherence to industry standard practices regarding general machine safety, tool safety, and fire safety to protect all personnel and equipment. For example, when operating tools and equipment, regularly inspect and carefully employ the appropriate personal protective equipment (PPE) as recommended by	

			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).	Occupational, Safety & Health Administration (OSHA) regulations, 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. Incorporate safety procedures and complete the safety test with 100 percent accuracy. . Adhering to proper safety guidelines, develop a schedule and create documents for a checklist to perform daily, weekly, and/or monthly routine maintenance on hand tools, conventional machines, and computer numerical control (CNC) machine tools. The checklist should also include, but is not limited to, cleaning the work area and appropriately handling and disposing of environmentally hazardous materials	
Blueprints and Layout		Interpret engineering drawings to determine	Apply knowledge of engineering drawings to	Demonstrate technical literacy in the	

		product dimensions and specifications.	machining processes. Student is expected to: (E) examine and comprehend standard orthographic prints; (F) examine and comprehend standard GD&T orthographic prints; and (G) identify and utilize GD&T datum, symbols, and tolerances. Use precision measuring and layout instruments and inspection processes to ensure quality of a finished product. Student is expected to: (A) differentiate between basic measuring instruments; (B) compare various precision measuring instruments; (C) recognize basic surface plate instruments; and (D) convert metric measurements	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. Classify and compare the different types of dimensions on drawings needed to produce a part or an object. Read and interpret drawings that are dimensioned in fractional inches, decimal inches, and in metric units. For example, drawings dimensioned in decimal parts of a unit indicate greater precision. Examine and interpret drawings to manufacture an object. Report and define information necessary to complete a machining task, such as the materials to be used, required surface finish, tolerances, quantity of units, scale, assembly and subassembly instructions, past revisions, and the name of the object. Explain the	

			and dimensions to inches.	interpretation of drawings and provide supporting evidence. Given a set of machining drawings, distinguish between the detail and the assembly drawings. Compare and contrast the characteristics and applications of each. Describe a multistep Procedure to use the drawings in order to complete a series of tasks related to a given assignment. For example, use the scale of a drawing to determine dimensions not explicitly shown on the drawing.	
Metal Manufacturing		Understand metal manufacturing industry and skills related to metal machining professions.	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	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 processes, and automated machining processes. Cite evidence to support the information presented. Investigate how the role of a machinist has changed with	

			Institute (ANSI), and American Petroleum Institute (API); (B) examine the theory of shielded metal arc welding and gas metal arc welding; and (C) examine the sheet metal industry.	the evolution of machining technology. • Describe the various machining job categories and their characteristics. • Research a range of postsecondary institutions (e.g., colleges of applied technology, community colleges, and four-year universities) and professional organizations (National Institute for Metalworking Skills[NIMS]) to identify the skills, education, and training requirements to become a machinist. 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). Discuss the information contained within the	

				resources and how they control metal fabrication standards.	
Hand and Machine Tool Equipment		Apply and adapt basic hand and machine tool processes to create machined parts per industry specifications.	The student differentiates the function and application of the tools, equipment, technologies, and materials used in metal manufacturing. The student is expected to: (A) use hand and power tools and equipment commonly employed in metal manufacturing; and (B) dispose of environmentally hazardous materials used in metal manufacturing. The student applies the technical concepts and skills of the machining industry to simulated and actual work situations. The student is expected to:	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) Calculate the speeds, feeds, and depth of cut for various machines and determine the tools needed for machining a simple part. Correctly interpret recorded measurements and use them to setup or adapt a process.	

			(A) use various work mounting procedures on all appropriate machines; (B) operate machine tools such as drill press, lathe, saw, grinders, and milling machines; (C) execute lathe procedures such as cutting threads, turning tapers, drilling, reaming, polishing, knurling, and boring; and (D) execute milling procedures such as milling flat surfaces, bevels, chamfers, grooves, and key-way seats needed to machine precision pieces; and (E) Develop basic CNC programming/operations.	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: a. Lines: layout dye, scriber, divider, surface plate, v-blocks, straightedge, squares. b. Angles: plain protractor, vernier protractor	
Materials		Understand common materials used in the machining process. Examine material properties and tooling processes to create finished products.	Apply knowledge of metal material in the machining process. Student is expected to: (A) explain how metals are classified	Using the following classifications, explain how metals are classified, identify general characteristics of each type, and describe Related safety precautions that should be applied during machining procedures.	

			(B) indicate safety precautions associated with machining of metals; and (C) identify chemical and physical properties of commonly machined metals.	a. Ferrous metals b. Nonferrous metals c. High-temperature metals d. Rare metals Examine the role of cutting fluids and coolants in the machining process. List fluids and coolants for common machines or cutting applications. Investigate the chemical and physical properties of materials used in the machining process. Considering the following common materials, list the principle properties relevant to machining tasks. a. Carbon steels b. Stainless steels c. Structural steels d. Cast iron e. Aluminum	
Production Process		Develop skills for project and job planning to ensure quality parts creation.	Demonstrate job process planning. Student is expected to: (A) examine basic problem solving; (B) assess basic decision making rules; (C) consider process constraints;	Formulate strategies to manufacture a simple part. The strategies should include designing a flow process that organizes equipment and materials needed for cutting, drilling, milling, grinding, and/or other machining operations. Also, organize a plan for layout, setup, and performance of tapping,	

			(D) organize process flow; and (E) create efficiency and standardization.	countersinking, counterboring, and reaming as needed. Implement the above strategies to manufacture the part. Simulate the work of a machining team to develop and manufacture a product idea, accounting for given specifications and potential constraints. Prior to manufacturing the product, use the following multistep process to outline a plan demonstrating how the product will be manufactured efficiently. The plan should include justification for the number of parts needed, how the parts were standardized, and the ability to process the parts. a. Develop initial designs b. Refine designs c. Create a conceptual model and prototype. d. Present design ideas e. Obtain management approval for design. f. Manufacture the final product.	
Welding		Apply the technical concepts and skills of the welding	Demonstrate the ability to review a welding procedure specification	Identify, sketch, and explain the five basic weld joint designs (e.g., butt, lap, tee,	

		industry to simulated and actual work situations.	and conduct a welding procedure test. 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 (D) inspect groove and fillet welds to AWS, CWB, ANSI, and API codes.	outside corner, and edge). Find examples of various joint designs applied to structures on or around campus and take pictures to present to classmates. 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. Demonstrate how to make single-and multiple-pass fillet welds and groove welds with backing on plain carbon steel. Describe various examples of defects found in welded Products. Research the American Welding Society (AWS) Specification for Welding Procedure and Performance Qualification (AWSB2.1/B2.1M) to learn more about Welding Procedure Specifications and the use of the document. Explain the significance of this document for machining and metal standards and inspection.	

Sheet Metal		Understand and apply concepts of sheet metal to perform work according to industry specifications.	The student applies the technical concepts and skills of the sheet metal industry to simulate actual work situations. The student is expected to: (A) use mathematics in precision measuring operations; and (B) interpret, engineering drawings, charts, and diagrams as related to the sheet metal industry. (8) The student differentiates the concepts that form the technical knowledge and skills of sheet metal manufacturing. The student is expected to: (A) analyze the types, sizes, and properties of sheet metal materials; (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. (9) The student understands the function and application of the tools, equipment, technologies, and materials used in sheet metal manufacturing. The student is expected to: (A) practice safe use of equipment; and (B) dispose of hazardous materials used in sheet metal manufacturing. (10) 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.		
Quality Control		Understand quality control processes for metal machining and manufacturing. Analyze processes and finished products to ensure compliance with job specifications.	Student understands quality control processes applied to machining. Student is expected to: (A) evaluate proper piece part inspection procedures (B) recognize and explain control and improvement processes; (C) understand how National Institute of Standards Technology (NIST) guidelines are applied in the industry; and (D) investigate common testing techniques used in manufacturing quality control.	Measure, weigh, and visually inspect machined parts. Record 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. Drawing upon multiple resources, research both destructive and nondestructive testing used as quality control techniques to prevent manufacturing defects in machining technology. Explain the importance of accurate measuring tools that are calibrated by the National Institute of Standards Technology (NIST) guidelines. In addition, explore other testing techniques such as	

				the use of coordinate measuring machines (CMM), use of optical comparators, radiographic inspection, magnetic particle inspection, ultrasonic inspection, and laser inspection. Compare and contrast testing techniques and provide specific examples for when they are most appropriately used. Cite evidence to justify the examples.	
Career Planning		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;	Demonstrate career-readiness practices: • Create a continuing education plan that identifies the need for further education and training options • Prepare for exams leading to certifications recognized by business and industry • Develop skills needed to enter the workforce • Evaluate resources that keep workers current in the career field	Updates to ICAP Participation in SkillsUSA or TSA Leadership Development practices and activities

			(C) investigate 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 machining technology; and (D) investigate industry certification requirements.	• Demonstrate skills and attitudes needed for lifelong learning • Apply effective money management strategies • Adopt career planning skills • Create/complete job applications • Construct successful resumes and cover letters • Demonstrate effective interviewing skills • Build teamwork and interpersonal relations • Construct organizational structures and work relations • Develop employment relations • Comprehend and practice acceptable work place ethics and behavior • Accept group participation and teamwork • Evolve personal group leadership skills	
