710 James Robertson Pkwy
Nashville, TN 37243
Phone: (615) 741-2731

@TNedu
Tennessee Education
www.TN.gov/Education

CTSO Course Alignments: Principles of Machining II

Below you will find standards for the Principles of Machining II course aligned with competitive events from appropriate career and technical student organizations (CTSOs). Knowing the aligned events for your organization will allow you to have additional tools for teaching course standards, as well as increase student engagement and preparation in your CTSO activities. The final column recommends potential tools from other CTSO organizations. Even if your students are not participating in these organizations, available rubrics, tools, and materials can also add to the instructional resources at your disposal for best teaching your content.

Important to note: While the aligned activities below can be important tools in teaching course standards, it is important to note that events may not cover a standard in its entirety and should not be the sole instructional strategy used to address a standard.

	STANDARD	ALIGNED SkillsUSA COMPETITIVE EVENTS/PROGRAMS	OTHER POTENTIAL CTSO TOOLS & RESOURCES
1	Determine the appropriate units and record accurate and repeatable measurements of length, diameter, and thickness to complete projects using: a. Rules, gages, calipers, and micrometers b. Tools equipped with dials, vernier scales, and digital readouts c. Both metric and English scales d. Appropriate standards of accuracy and precision e. Satisfactory tolerances permissible for a given task For example, while grinding a piece to a specified thickness, measurements with a metric vernier caliper are used to achieve a value within the tolerance specified by the drawing. (TN Reading 3, 7; TN Math N-Q, G-GMD)	• **SkillsUSA**: Precision Machining Technology, CNC Milling, CNC Turning	• **FFA:** Agricultural Technology and Mechanical Systems, Forestry
2	Determine the appropriate units and record accurate and repeatable measurements of angles to complete projects by: a) Applying principles of trigonometry, Cartesian geometry, and/or polar geometry, distinguishing when and which principles apply to a given machining task. b) Using angle gages, a plate protractor, a universal bevel protractor with vernier scale, square, and/or a sine bar and gage blocks or adjustable parallel. For example, measure the angle formed by two surfaces of a machined part to the nearest 0.01 degree using a sine bar. (TN Reading 3, 7; TN Math N-Q, A-REI, F-TF, G-SRT)		

3	Determine the appropriate units and record accurate and repeatable measurements of material properties such as hardness, pH, and load/elongation test curves of stress, strain, modulus, and yield. Interpret test values and curves, and use calculated results to make informed decisions. For example, measure the Rockwell hardness of a piece of stainless steel to determine the recommended cutting speed with a carbide-tipped cutting tool. (TN Reading 3, 4; TN Math N-Q, A-SSE, A-CED, A-REI, G-MD)		
4	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 Occupational, Safety & Health Administration (OSHA) regulations. Incorporate safety procedures and complete safety test with 100 percent accuracy. (TN Reading 1, 2, 3, 7; TN Math N-Q)	• **SkillsUSA**: Occupational Health and Safety	• **FFA:** Agricultural Technology and Mechanical Systems
5	Visualize and interpret engineering drawings for projects to a. Create an accurate bill of materials b. Identify and interpret geometric dimensioning and tolerancing symbols and nomenclature c. Identify primary and secondary datums For example, lay out correctly dimensioned bolt holes in a radial pattern specified by a drawing, and select proper tools to complete the required operations. (Reading 3, 4, 7; TN Writing 4; TN Math N-Q, G-CO, G-GMD, G-MG)		
6	Anticipate the consequences and handling requirements of metals, alloys, ceramics, polymers, and composites to properly and safely handle and machine these materials. For example, research the material properties for the bill of materials for a project in preparation for choosing cutting tools, speeds, and handling. (TN Reading 1, 4, 5; TN Writing 4, 7; TN Math N-Q)		

7	Manage and coordinate the operation of the cutting pieces, feeds, and mounts associated with both manual and computer-numerical-controlled (CNC) machining tools to complete advanced projects involving: a. Milling machines, such as indexing operations using a dividing head and rotary tables b. Lathes, such as re-chase and internal threads, taper turning with taper attachments and compound rests, internal tapered surfaces, follower and steady rests c. Grinders, such as grinding pieces between centers, operating radius dressers, cylindrical grinders, and inside diameter (ID) grinders For example, select the correct cutting tools and speeds for the CNC processes to create Delrin (plastic) shafts and gears for a class robotics project. (TN Reading 3, 7; TN Math N-Q, G-C, G-GMD, G-MG)	• **SkillsUSA**: CNC Milling, CNC Turning	
8	Correctly, safely, and efficiently schedule, configure, administer, and verify heat-treatments to machined parts according to blueprint specifications. For example, while properly attired and equipped, use an oven or torch to harden and temper a W1-grade steel bolt to yield a hardened, tamper-proof bolt. (Reading 3, 5, 7; TN Math N-Q, A-REI, G-MG)		
9	Solve manufacturing-related problems by analyzing and weighing the constraining factors including schedule, cost, materials, and equipment, as well as productivity, regulations, maintenance, and quality. For example, as part of an assigned machining project, draft, obtain approval, and implement a schedule for completion, including ordering materials, planning the sequence of machining and stepwise approvals, and determining a target for final delivery, justifying all recommendations with supporting evidence. (TN Reading 1, 5, 7; TN Writing 1, 4, 7; TN Math N-Q)		
10	Employ statistical quality control test methods and techniques, especially on large volume processes, to minimize defects and waste due to poor quality. For example, use statistical sampling, measuring, and charting to monitor and detect the need for corrective action on a mass production of thread cutting. Upon completion of testing, draft a written report documenting the findings in the proper format that a quality control inspector would deliver to a supervisor or other superior. (TN Reading 3; TN Writing 2, 4, 6, 7; TN Math N-Q)		

11	Explore and develop one's skills with new and emerging machining and manufacturing technologies, such as 3D printing, laser etching, computer-controlled machining, and digital manufacturing methods. For example, produce a small plastic part using a 3D printer, and then produce the same part with a CNC production method using G- and M-codes; compare the material cost and waste, manpower, scheduling, etc. of the two methods and provide written justification to persuade a prospective manufacturer, wholesaler, or other supplier why one method is more cost-effective, efficient, or profit-maximizing than the other. (TN Reading 3, 4, 7; TN Writing 1, 4; TN Math N-Q)		• **FCCLA**: Advocacy
12	Demonstrate and practice teamwork, problem-solving, and decision-making skills required for success as a career machinist in a manufacturing environment. Applying the skills acquired in the previous standards, examine a given manufacturing problem to research and plan a solution that will result in the creation of a prototype for a manufactured product. This process will include but is not limited to the following: a. Reading and interpreting relevant engineering drawings b. Assessing prototyping processes c. Using engineering drawings as a planning tool for programming software to design the prototype d. Crafting appropriate documentation and justification of decisions made in the design process, for the purposes of explaining as well as persuading e. Creating a presentation for the design and construction of the manufactured product (TN Reading 3, 4, 7, 9; TN Writing 1, 2, 4, 7; TN Math N-Q)		
ALL	**CAN BE USED WITH ALL/MOST STANDARDS**	• **SkillsUSA**: Career Pathways Showcase	• **FCCLA**: Illustrated Talk, • **TSA:** CNC Production, Manufacturing Prototype