Precision Machining Technology I

8539/36 weeks

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Acknowledgments

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Course Description

Suggested Grade Level: 10 or 11

The demand for precision machinists is growing along with the resurgence of the U.S. manufacturing industry. Machinists are highly skilled, creative problem solvers who are task-oriented and self-directed individuals. In this first course, students are taught safety awareness and the foundations of machining, including how to accurately apply measurements, use engineering drawings and sketches, and apply metalworking theory in order to efficiently plan, manage, and perform general machine maintenance and machining jobs. This program is the first step to achieving National Institute for Metalworking Skills (NIMS) credentials, which the industry uses to recruit, hire, place, and promote individual workers. This course specifically aligns to Machining Knowledge Requirements and Dimensional Measurements Knowledge Requirements.

As noted in Superintendent’s Memo #058-17 (2-28-2017), this Career and Technical Education (CTE) course must maintain a maximum pupil-to-teacher ratio of 20 students to one teacher, due to safety regulations. The 2016-2018 biennial budget waiver of the teacher-to-pupil ratio staffing requirement does not apply.

Task Essentials Table

- Tasks/competencies designated by plus icons (⊕) in the left-hand column(s) are essential
- Tasks/competencies designated by empty-circle icons (○) are optional
- Tasks/competencies designated by minus icons (⊖) are omitted
- Tasks marked with an asterisk (*) are sensitive.

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Legend: ✦Essential ✔Non-essential ☹Omitted

Curriculum Framework

Ensuring Industrial Safety and Environmental Protection

Task Number 39
Comply with federal, state, and local safety requirements.

**Definition**
Compliance should include
- understanding the roles of the Occupational Safety and Health Administration (OSHA), Virginia Occupational Safety and Health (VOSH), and the Environmental Protection Agency (EPA)
- identifying the OSHA Hazard Communication Standard (HazCom)
- interpreting the information included on safety data sheets (SDS)
- describing the responsibilities of employers and employees under HazCom.

**Process/Skill Questions**
- Where should hazardous materials be stored?
- What information can be found on an SDS?
- Where can employees receive updates on industrial safety?

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**Task Number 40**

**Identify personal protective equipment (PPE) requirements.**

**Definition**
Identification could include procedures for inspecting, wearing, and removing
- eye protection
- respirator
- gloves
- hearing protection
- safety shoes.

Identification should also include explaining when particular PPE is required.

**Process/Skill Questions**
- Why is wearing jewelry and/or loose clothing prohibited while in the lab or on the job site?
- When should hand protection be used in the machine shop?
- When should ear protection be used in the machine shop?
- What are the possible hazards of grinding dust and producing hazardous fumes in the machine shop?
- What type of foot protection is required in the machine shop?

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**Task Number 41**

**Identify emergency first-aid procedures.**

**Definition**
Identification should include standard first-aid procedures and school policies regarding incidents involving
- bodily fluids
- electrical injuries
- eye injuries
- falls
- burns.

**Process/Skill Questions**

- What are the steps that should be followed after an accident?
- Why is knowing cardiopulmonary resuscitation (CPR) an important skill in the precision machining trade?
- Why is it important to be certified to administer first aid?
- Where might one locate the Automated External Defibrillator (AED) in a machine shop?

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**Task Number 42**

**Identify the types of fires and the methods used to extinguish them.**

**Definition**

Identification should include classifications of fires (e.g., Classes A, B, C, and D), causes and prevention of fires, types of extinguishers, and, when possible, the demonstrated use of a fire extinguisher, in accordance with government regulations and instructor guidelines.

**Process/Skill Questions**

- Why do fires have different classifications, and what are they?
- What is the fire triangle and the fire tetrahedron?
- What are the three things necessary to start a fire?
- Why is it important to know the classification of fire when trying to extinguish it?
- Why should extinguishers be inspected, and how often should they be inspected?
- What are the classifications of extinguishers?
- What is the proper technique to extinguish a fire?
- Where might one locate the fire extinguisher in the machine shop?
- What are the different degrees of electrical burns?

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**Task Number 43**

**Inspect course-specific hand and power tools to visually identify defects.**

**Definition**

Inspection of tools should include

- identifying components of machinery (e.g., guards, blades, moving parts, start/stop switches)
- identifying standard safety procedures (i.e., lab practices and manufacturer recommendations)
- observing a demonstration of the safe operation and use of each piece of machinery in the lab
- identifying tool defects.
Process/Skill Questions

- What are some of the basic power tools used in precision machining technology?
- What are the proper actions to take before using a circular saw? What are the proper actions to take before using a power drill?
- Why should a power tool always be grounded?
- Why is it important to use a ground-fault circuit interrupter (GFCI) when using power equipment?
- What should be done if power tools become damaged?

Task Number 44

Demonstrate lifting and carrying techniques.

Definition
Demonstration involves lifting and carrying materials and equipment based on the principles of

- lifting with the legs
- keeping the back straight
- holding the load close to the body
- getting help, if necessary.

Process/Skill Questions

- What are common injuries associated with improper lifting techniques?
- What can one do to prevent injury?
- How does positioning affect technique?

Task Number 45

Report personal injuries and environmental and equipment safety violations to the appropriate authority.

Definition
Report should include

- providing a verbal or written statement
- identifying the violation
- documenting the date when the incident or behavior was observed
- following the protocol for submitting the report to the instructor, supervisor, or the local OSHA inspector.

Process/Skill Questions

- What ethical considerations might be involved when reporting coworkers?
- Why is it important to follow reporting procedures?
- What is liability?

Task Number 46
Earn the General Industry OSHA 10 card.

**Definition**
Earning a General Industry OSHA 10 card will

- recognize that one has acquired 10 hours of safety instruction
- help teach national standards for personal safety within a lab environment
- validate safety skills to the industry
- help workers become more safety-conscious and responsible.

**Process/Skill Questions**

- What are the benefits of earning the Precision Machining Technology OSHA 10 card?
- What is OSHA, and how are its standards validated?
- Why was OSHA established, and how has it evolved?

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**Task Number 47**

**Pass a safety exam for lab/site safety and the use of tools and equipment specific to the manufacturing industry.**

**Definition**
Assessment must measure participation in safety training programs, including attending safety meetings and periodically demonstrating knowledge and skills gained from program topics (e.g., interpretation of SDS).

**Process/Skill Questions**

- How often should one participate in safety training programs?
- Why are retraining programs relevant to a company's insurance policy?
- What is workers' compensation?

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**Task Number 48**

**Demonstrate safe workplace practices. Task Number**

**Definition**
Demonstration should include

- adhering to safety rules while carrying out assigned responsibilities
- following procedures relating to first aid for injury or work-related illness
- documenting safety activities as required.

**Process/Skill Questions**

- What is considered appropriate protective clothing for working in a machine shop?
- What are some unsafe workplace practices?
- What are the main injuries associated with the machine workplace?
- What are required PPE items used by machinists? What are the safety glasses requirements?
- When should machine guards be used?
Task Number 49

Handle hazardous materials as assigned.

Definition

Handling should include

- identifying, moving, and storing hazardous materials in compliance with OSHA and EPA requirements and guidelines
- working as a member of a team that addresses routine handling and storage issues
- documenting safety activities as required.

Process/Skill Questions

- What is an SDS?
- Why should proper disposal procedures be strictly followed?
- Why are there laws protecting the environment?
- Why should hazardous material be properly labeled?
- Who should train employees on the proper handling of hazardous material?

Task Number 50

Describe the importance of the Occupational Safety and Health Administration (OSHA) standards and Environmental Protection Agency (EPA) regulations.

Definition

Description should include

- the importance of OSHA—safety standards are set to promote workplace safety by reducing incidents of worker injury or death and employer violations
- the importance of the EPA—regulations, based on Congressional laws, are established to protect the environment, reduce pollution, and promote conservation of environmental resources.

Process/Skill Questions

- What is the main role of the EPA in the precision machining industry?
- Why do some political groups and business owners want to reduce the regulations set by the EPA and OSHA?
- How was the industry regulated prior to the establishment of OSHA?

Exploring the Foundations of Machining

Task Number 51
Describe the formulas for determining speeds and feeds.

Definition
Description should include

- the formulas and their variables
- where to locate the speeds and feeds charts containing standard information.

Process/Skill Questions

- How are the spindle rotations per minute (RPM) determined for a lathe with a two-inch diameter aluminum shaft?
- What are the inches per minute for a half-inch diameter end mill (two fluted) when cutting aluminum?
- What is the maximum spindle speed for a six-inch diameter, half-inch wide, 80-grit grinding wheel? How might this information be located?

Task Number 52

Apply mathematical problem solving to machining operations.

Definition
Application should include using arithmetic, geometric, algebraic, and trigonometric operations when

- selecting and sequencing operations
- holding the work
- producing surfaces
- locating surfaces and center lines
- analyzing operations and sequences
- troubleshooting machine tools or cutting tools
- calculating speeds and feeds
- calculating operation times
- calculating dimensions from a blueprint
- factoring statistics required by control charts
- identifying the impact of a change of speed or feed
- calculating the volume of material stored
- using trade formulas to prepare a process plan
- performing benchwork and layout operations
- operating machine tools
- performing inspection and control functions
- solving for unknowns in right triangles
- analyzing parts for plane perpendicularity, Cartesian coordinates, concentricity, parallelism, straightness, flatness, circularity, and symmetry, with an accuracy required by the blueprint and industry standards.

Process/Skill Questions

- What tools are available to assist machinists in their calculations?
- What is a common machining task or problem that would require the machinist to apply principles of trigonometry?
- How are tolerances applied to dimensions?
Task Number 53

Describe the principles and technology of precision measurement operations.

Definition
Description should include

- determining the concentricity of a turned part to a lathe’s spindle
- inspecting dimensions of a finished part
- identifying precision transfer tools, such as telescoping gauges and adjustable parallels, to determine the compliance of a part of selected dimensions
- reading the following:
  - Micrometer
  - Vernier
  - Dial
  - Electronic calipers
  - Dial indicators
  - Coordinate Measuring Machines (CMM)
  - Portable Measuring Machines
  - On-Machine Measuring Equipment
  - Optical Comparators

Process/Skill Questions

- What are the four basic measurements made with a dial caliper?
- What are the basic operations performed with a combination square?
- What are the differences between scales and rulers?

Task Number 54

Apply the properties of the various materials to cutting conditions and problems.

Definition
Application involves determining

- the appropriate cutter material and coatings
- the appropriate cutter geometry
- the appropriate speeds and feeds for cutting various materials during turning, milling, drilling, and CNC operations.

Process/Skill Questions

- How is appropriate cutting geometry determined?
- How does speed and feed affect cutting?
- What are the advantages of using insert cutters?
Using Engineering Drawings and Sketches

Task Number 55

Interpret standard orthographic blueprints.

Definition

Interpretation should include

- gathering the geometric and dimensional data to sequence operations
- implementing a layout from the blueprint
- performing the inspection of a finished part
- preparing a checklist for determining dimensional compliance of a finished part.

Process/Skill Questions

- What is an orthographic blueprint?
- How does one use the blueprint to determine accuracy of the job?
- How many views are available on an orthographic blueprint?

Task Number 56

Apply tolerancing, title block, line types, and isometric projection of blueprints.

Definition

Application should include

- selecting the correct materials
- outlining the processes needed to complete the part
- practicing necessary measurement accuracy
- creating a quality report using the blueprint.

Process/Skill Questions

- What are the differences between orthographic and isometric projections?
- Which of these sketches (i.e., orthographic or isometric) present a more lifelike image of the part?
- Where are tolerances located on a blueprint?

Applying Measurements

Task Number 57
Apply semi-precision measuring instruments.

Definition
Application should include

- taking semi-precision measurements common in the machining industry, by using rulers and protractors, such as simple inside and outside calipers, to determine the compliance of a part of selected dimensions
- marking materials for cutting or location of features to be machined
- caring for instruments against environmental factors
- calibrating semi-precision measuring instruments as part of a quality assurance system.

Process/Skill Questions

- What are the names of several non-precision measuring instruments?
- What are non-precision transfer tools?
- What does a protractor measure?
- What are the different kinds of rulers or scales?

Task Number 58

Apply precision measuring instruments.

Definition
Applying precision instruments in the machining industry (e.g., determining the concentricity of a turned part to a lathe's spindle, inspecting dimensions of a finished part) should include determining the compliance of a part of selected dimensions by using the following:

- Micrometer
- Vernier
- Dial and electronic calipers
- Dial indicators
- Coaxial indicators
- Precision transfer tools
  - Telescoping gauges
  - Adjustable parallels

Process/Skill Questions

- What are the names of precision transfer tools?
- What is the difference, when transferring dimension, of using a basic tool as opposed to a precision measuring tool?
- What does a precision measuring tool measure more accurately?

Task Number 59

Convert measurements.

Definition
Conversions should include

- describing the significance of the task in the industry
- listing common standard and metric measurements
identifying the associated equations
converting fractions to decimals and vice versa.

Process/Skill Questions

- Why is it important to convert between systems?
- How many millimeters are in an inch?
- What is the formula for converting inches to millimeters?

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Task Number 60

Inspect simple parts, using precision tools and techniques.

Definition

Inspection should include

- developing an inspection plan
- identifying and selecting the required measuring instruments
- completing the required written inspection report
- making a decision to reject or accept each part
- providing a brief oral report of inspection procedures, results, and decisions
- making recommendations for part correction to achieve compliance.

Process/Skill Questions

- What are some precision measuring devices and how are they used?
- Why is temperature important when using precision measuring tools?

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Planning and Managing Machining Jobs

Task Number 61

Select machine tools for a given set of operations.

Definition

Selection should include

- applying machine tools theory
  - selecting appropriate machine tools for a given set of operations
  - operating machine tools to execute a specific operation
  - participating in a machine capability study
- identifying the common classes of machine tools
- explaining the function of the major subsystems of machine tools
- selecting and applying a given machine tool appropriately.

Process/Skill Questions

- What are the common types of machine tools?
- What is the function of the major subsystems of machine tools?
- What operations can be performed on a mill or a lathe?
• Why is job planning important?

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**Task Number 62**

**Manage job and task priorities.**

**Definition**

Management should include applying organizational skills

• to prioritize and complete assignments
• to work more efficiently
• to have a positive effect on the financial bottom line.

**Process/Skill Questions**

• How do machinists multitask in the machine shop?
• How does job efficiency affect the bottom line?
• How does the machinist’s attitude affect the company’s bottom line?

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**Performing Machining Jobs**

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**Task Number 63**

**Operate power saws for cutoff operations.**

**Definition**

Operation should include

• setting up the operation
• installing the appropriate blade in the power saw
• cutting a length of material to match the cut list on the process plan, accurate to within ±1/64 inch, with no sharp edges.

**Process/Skill Questions**

• What are some safety concerns when using power saws?
• Why is saw speed important?
• Why is it important to deburr a part after cutting it?

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**Task Number 64**

**Perform routine drill press operations.**
Definition

Performance should include

- setting up and operating drill presses
- identifying types of drills, using a drill and tap drill chart
- producing a part to match the process plan and blueprint specifications
- finishing the part to the following specifications:
  - four center-drilled locations, laying out a fifth location
  - at least one blind hole and one through hole
  - secondary operations, including reaming, spot facing, countersinking, counterboring, and counterdrilling
  - finishes at least 125 micro-inches
  - holes square within +.005 inch; drilled diameters within +.006 inch; reamed diameters within +.001 inch.

Process/Skill Questions

- What is the correct position of a drill press vise to the driller?
- What types of work holding can be used for drill press operations?
- What is a drill chart?
- What are the four drill types?
- What are the types of drill bits, and how is the proper one chosen?
- Why is drill speed important?
- Why should one refrain from putting a tapered shank drill bit into a drill chuck?
- Where are the start, stop, and emergency stop located on a drill press?
- Why is it important that the starting material is within the given blueprint specifications?

Task Number 65

Perform manual benchwork operations, including deburring parts, performing press fits, and using a bench vise and hand tools as applicable.

Definition

Performance should include

- using files, scrapers, and coated abrasives to deburr parts until they are free of sharp edges or burrs
- tapping holes in a newly machined part with holes prepared for tapping
- using an arbor press to a bushing in a hole prepared for the press fit
- using basic mathematics (e.g., whole number computation, algebra, basic geometry)
- acknowledging basic blueprint reading principles.

Process/Skill Questions

- What is the importance of deburring?
- What are some safety rules for using hand tools?
- Why is it important to follow proper process order and tool use procedures?
- Why is job planning important?
Task Number 66

Perform manual layout operations, including laying out the location of hole centers and surfaces.

Definition

Performance should include

- laying out hole locations, radii, and surfaces
- matching the specifications within an accuracy of ±.015 inch, based on the following criteria:
  - Layout ink is applied to the surface appropriately.
  - Lines are struck once.
  - Intersections are clean and clear.
  - Punch marks are centered on intersections.

Process/Skill Questions

- Why are accurate measuring procedures important when laying out?
- Why is proper tool selection important in layout operations?
- What tools are used in layout operations?
- What is entailed in properly caring for layout tools?
- What are the different line types used in locating hole centers and surfaces?

Task Number 67

Perform chucking operations for turning.

Definition

Performance should include

- selecting the proper chuck for manual turning operations
- installing and indicating three- and four-jaw chucks
- securing work and chuck
- calculating proper speeds and feeds according to general industry standards
- maintaining at least three diameters within ±.005 inch and the following requirements for the completed part:
  - one bore within ±.005 inch
  - one UNC external thread
  - one UNF internal thread
  - at least two chucking or other work-holding setups
  - finishes of at least 125 micro-inches with no sharp edges.

Process/Skill Questions

- What are the types and names of chucks?
- What is a split collet?
- What is the procedure for indicating a four-jaw chuck?
- Why is concentricity important in turning operations?
- Why is it important to place the chuck key in a safe location?
- Why should finish parts be deburred?
• What is a dial indicator?
• What are the steps to properly read a dial indicator?

Task Number 68
Perform between-centers turning operations for straight turning.

Definition

Performance should include

• producing a part that matches the process plan and the blueprint specifications
• using appropriate trade techniques and speeds and feeds
• matching the specifications, with at least three diameters within ±.002 inch
• finishing the part, based on the following criteria:
  o one UNC external thread
  o one UNF external thread
  o an end-for-end swap
  o finishes to be at least 125 micro-inches, with no sharp edges
  o one knurled workpiece
  o lathe dog for centering

Process/Skill Questions

• What is the practical function of turning between centers?
• What are some machine parts that may be turned between centers?
• Why should one not remove the center from a chuck before machining the part?
• What axes are used during turning between centers?

Task Number 69
Perform routine vertical milling.

Definition

Performance should include

• indicating machine vise and head
• producing a part matching the process plan and blueprint specifications, using appropriate trade techniques and speeds and feeds
• completing the part with the following specifications:
  o milling at least one slot
  o squaring up the part to within .005 inch, over 4 inches
  o locating at least two drilled and reamed holes within ±.005 inch
  o finishing surfaces to 125 micro-inches.

Process/Skill Questions

• Why would vertical milling be used?
• What are some advantages of vertical milling?
• Why are RPM and feed rate important when vertical milling?
• What are the uses of Woodruff keys?

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**Performing General Maintenance**

**Task Number 70**

**Perform general housekeeping.**

**Definition**

Performance should include

- keeping the duty station clean and safe for work
- keeping tools, workbenches, and manual equipment clean, maintained, and safe for work
- responding appropriately to safety hazards
- maintaining the cleanliness of the general work area
- identifying poor work conditions, such as limited lighting or ventilation
- adhering to the 5S principles.

**Process/Skill Questions**

- Why is it important to maintain a clean and orderly work area?
- What are the safety advantages that result from good housekeeping?
- How can good housekeeping improve one’s overall work efficiency?
- What are the 5S principles?

---

**Task Number 71**

**Perform preventive maintenance on machine tools.**

**Definition**

Performance should include

- running routine warm-up cycles
- inspecting and assessing the general condition of an assigned machine tool
- making routine adjustments as authorized, or reporting problems to supervision
- carrying out daily, weekly, and/or monthly routine upkeep chores cited on checklists for a given machine tool
- filling out the history forms for tracking maintenance
- making a brief oral report explaining the condition of the machine tools and the actions taken
- keeping a maintenance and repair record on each machine tool
- using a refractometer to measure coolant levels
- identifying options for dealing with tramp oils.

**Process/Skill Questions**

- What are the benefits of preventive maintenance?
- Why is documentation of maintenance important?
• Why is proper care, usage, and storage important for prolonging the life of a machine tool?
• What is the difference between detergent and nondetergent oils?

Applying Metalworking Theory

Task Number 72
Identify types of materials used in machining operations.

Definition
Identification should include

• identifying common materials and their principal properties relevant to machining tasks
• recognizing differences among ferrous and nonferrous materials
• acknowledging plastics and other nonmetal material properties
• recognizing magnetic and ductile materials
• explaining the changes to materials caused by heat-treating
• predicting the machinability of a part, based on its appearance, its call-out value on the blueprint, and its supplied hardness value.

Process/Skill Questions

• How might a file be used to determine the hardness of steel?
• How can a magnet help determine material type?
• How are plastics and nonmetals machined?

Task Number 73
Select tooling.

Definition
Selection should include correlating the assigned job to the following choices:

• Identifying the common classes of machine tools
• Identifying cutting tools, tool-holding devices, and work-holding devices
• Applying machine tools theory (e.g., selecting appropriate machine tools for a given set of operations, operating machine tools to execute a specific operation, participating in machine capability study)
• Explaining the function of the major subsystems of the machine tools
• Selecting and applying a given machine tool appropriately

Process/Skill Questions

• Why is it important to use the right tool for the job?
• What is a center cutting end mill?
• What is the purpose of a reamer?
• What is a center drill, and for what operations is it used?
Task Number 74

Calculate speeds and feeds.

Definition
Calculation should include applying material properties theory (e.g., predicting speeds and feeds and tooling requirements based on known properties of a material, responding to cutting conditions imposed by material properties).

Process/Skill Questions
- What is the difference between ferrous and nonferrous materials?
- What happens to steel when it is heat-treated?
- How do materials affect speeds and feeds?
- What is the difference between ductile and brittle materials?

Task Number 75

Secure work to the machine.

Definition
Securing work should be performed with one or more of the following:

- Basic vise
- Chuck
- Rotary table
- Indexing heads
- Strap clamps (e.g., slots, bridge)

Process/Skill Questions
- How should a vise be aligned?
- What is a four-jaw or independent chuck? In what situation might it be useful?
- Why should a vise be bolted down?
- Where are strap clamps used, and for what purpose?

Task Number 76

Select cutting fluids.

Definition
Selection should be based on the assigned job and include

- identifying process and materials
- identifying fluids and coolants (e.g., water-soluble, synthetics, partial synthetics, additives, oils)
- identifying potential hazards.
Process/Skill Questions

- Why are cutting fluids necessary? Are they always necessary?
- Why are there a variety of choices of cutting fluids?
- How do cutting fluids affect the shop’s bottom line?

Task Number 77

Apply cutting fluids.

Definition

Application should include

- applying the cutting fluids and coolants theory (e.g., selecting appropriate coolants and delivery systems for a selected set of operations, operating machine tools to execute a specific operation, using specified coolants and coolant delivery systems)
- identifying, selecting, and using appropriate coolants and coolant delivery systems.

Process/Skill Questions

- Why is coolant used?
- What is soluble oil?
- What are the types of coolants?

SOL Correlation by Task

<table>
<thead>
<tr>
<th>Task</th>
<th>Description</th>
<th>English</th>
<th>History</th>
<th>Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>39</td>
<td>Comply with federal, state, and local safety requirements.</td>
<td>10.5, 11.5</td>
<td>Govt 7, 8, 9, 15</td>
<td>CH.1</td>
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<tr>
<td>40</td>
<td>Identify personal protective equipment (PPE) requirements.</td>
<td>10.5, 11.5</td>
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<td>CH.1</td>
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<tr>
<td>41</td>
<td>Identify emergency first-aid procedures.</td>
<td>10.5, 11.5</td>
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<tr>
<td>42</td>
<td>Identify the types of fires and the methods used to extinguish them.</td>
<td>10.5, 11.5</td>
<td></td>
<td>CH.1</td>
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<tr>
<td>43</td>
<td>Inspect course-specific hand and power tools to visually identify defects.</td>
<td>10.5, 11.5</td>
<td></td>
<td>WHII 8</td>
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<tr>
<td>44</td>
<td>Demonstrate lifting and carrying techniques.</td>
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<tr>
<td>45</td>
<td>Report personal injuries and environmental and equipment safety violations to the appropriate authority.</td>
<td>10.5, 11.5</td>
<td>Govt 7, 8, 9, 15</td>
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<tr>
<td>46</td>
<td>Earn the General Industry OSHA 10 card.</td>
<td>10.5, 11.5</td>
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<tr>
<td>47</td>
<td>Pass a safety exam for lab/site safety and the use of tools and equipment specific to the manufacturing industry.</td>
<td>10.5, 11.5</td>
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<td>CH.1</td>
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<tr>
<td>48</td>
<td>Demonstrate safe workplace practices.</td>
<td>English: 10.5, 11.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>Handle hazardous materials as assigned.</td>
<td>English: 10.5, 11.5</td>
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<td></td>
<td></td>
<td>History: Govt 7, 8, 9, 15</td>
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<tr>
<td>50</td>
<td>Describe the importance of the Occupational Safety and Health Administration (OSHA) standards and Environmental Protection Agency (EPA) regulations.</td>
<td>English: 10.5, 11.5</td>
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<td></td>
<td>History: Govt 7, 8, 9, 15</td>
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<tr>
<td>51</td>
<td>Describe the formulas for determining speeds and feeds.</td>
<td>English: 10.5, 11.5</td>
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<td></td>
<td></td>
<td>Mathematics: A.1, A.4, AII.3</td>
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<tr>
<td>52</td>
<td>Apply mathematical problem solving to machining operations.</td>
<td>English: 10.5, 11.5</td>
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<td></td>
<td></td>
<td>History: WHI 5, 6</td>
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<tr>
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<td></td>
<td>Mathematics: A.1, A.4, G.2, G.3, G.4, G.8, G.14, AII.3, PS.1*, PS.4*</td>
<td></td>
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</tr>
<tr>
<td>53</td>
<td>Describe the principles and technology of precision measurement operations.</td>
<td>English: 10.5, 11.5</td>
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<tr>
<td></td>
<td></td>
<td>History: WHII 8</td>
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<tr>
<td>54</td>
<td>Apply the properties of the various materials to cutting conditions and problems.</td>
<td>English: 10.5, 11.5</td>
<td></td>
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</tr>
<tr>
<td>55</td>
<td>Interpret standard orthographic blueprints.</td>
<td>English: 10.5, 11.5</td>
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<td></td>
<td></td>
<td>Mathematics: G.2, G.3, G.8, G.13, G.14</td>
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<tr>
<td>56</td>
<td>Apply tolerancing, title block, line types, and isometric projection of blueprints.</td>
<td>English: 10.5, 11.5</td>
<td></td>
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</tr>
<tr>
<td>57</td>
<td>Apply semi-precision measuring instruments.</td>
<td>English: 10.5, 11.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>Apply precision measuring instruments.</td>
<td>English: 10.5, 11.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>Convert measurements.</td>
<td>English: 10.5, 11.5</td>
<td></td>
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</tr>
<tr>
<td>60</td>
<td>Inspect simple parts, using precision tools and techniques.</td>
<td>English: 10.5, 11.5</td>
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<tr>
<td>61</td>
<td>Select machine tools for a given set of operations.</td>
<td>English: 10.5, 11.5</td>
<td></td>
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<tr>
<td>62</td>
<td>Manage job and task priorities.</td>
<td>English: 10.5, 11.5</td>
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<tr>
<td>63</td>
<td>Operate power saws for cutoff operations.</td>
<td>English: 10.5, 11.5</td>
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<tr>
<td>64</td>
<td>Perform routine drill press operations.</td>
<td>English: 10.5, 11.5</td>
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<tr>
<td>65</td>
<td>Perform manual benchwork operations, including deburring parts, performing press fits, and using a bench vise and hand tools as applicable.</td>
<td>English: 10.5, 11.5</td>
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<td></td>
<td>Mathematics: A.1, A.4, G.2, G.3, G.4, G.8, G.9, G.13, G.14, AII.1</td>
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<tr>
<td>66</td>
<td>Perform manual layout operations, including laying out the location of hole centers and surfaces.</td>
<td>English: 10.5, 11.5</td>
<td></td>
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<tr>
<td>67</td>
<td>Perform chucking operations for turning.</td>
<td>Mathematics: A.1, A.4, AII.3</td>
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<tr>
<td>68</td>
<td>Perform between-centers turning operations for straight turning.</td>
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<tr>
<td>69</td>
<td>Perform routine vertical milling.</td>
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<tr>
<td>70</td>
<td>Perform general housekeeping.</td>
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<tr>
<td>71</td>
<td>Perform preventive maintenance on machine tools.</td>
<td>English: 10.5, 11.5</td>
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<tr>
<td>72</td>
<td>Identify types of materials used in machining operations.</td>
<td>English: 10.5, 11.5</td>
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<tr>
<td>73</td>
<td>Select tooling.</td>
<td>English: 10.5, 11.5</td>
<td></td>
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<tr>
<td>74</td>
<td>Calculate speeds and feeds.</td>
<td>Mathematics: A.1, A.4, AII.3</td>
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<tr>
<td>75</td>
<td>Secure work to the machine.</td>
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<tr>
<td>76</td>
<td>Select cutting fluids.</td>
<td>English: 10.5, 11.5</td>
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<tr>
<td>77</td>
<td>Apply cutting fluids.</td>
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</tbody>
</table>
Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials (Only apply to 36-week courses)

- CNC Milling and Turning Examination
- College and Work Readiness Assessment (CWRA+)
- Customer Service Examination
- Customer Service Specialist (CSS) Examination
- Machining-Level 1 Examinations
- Manufacturing Specialist Certification Examination
- Manufacturing Technician Level I Certification Examination
- National Career Readiness Certificate Assessment
- Pre-Manufacturing Technician I (PreMT1) Examination
- Precision Machining Assessment
- Professional Communications Certification Examination
- Workplace Readiness Skills for the Commonwealth Examination

Concentration sequences: A combination of this course and those below, equivalent to two 36-week courses, is a concentration sequence. Students wishing to complete a specialization may take additional courses based on their career pathways. A program completer is a student who has met the requirements for a CTE concentration sequence and all other requirements for high school graduation or an approved alternative education program.

- Precision Machining Technology II (8540/36 weeks, 280 hours)

Career Cluster: Manufacturing

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Occupations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintenance, Installation, and Repair</td>
<td>Millwright</td>
</tr>
<tr>
<td>Manufacturing Production Process Development</td>
<td>Precision Inspector, Tester, or Grader Production Manager</td>
</tr>
<tr>
<td>Production</td>
<td>Extruding and Drawing Machine Operator Tool and Die Maker</td>
</tr>
<tr>
<td>Quality Assurance</td>
<td>Quality Control Technician</td>
</tr>
</tbody>
</table>