# Scope & Sequence

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| Course Name: Precision Metal Manufacturing II**TSDS PEIMS Code:** 13032600 | **Course Credit:** 2.0**Course Requirements:** This course is recommended for students in grades 11-12. **Prerequisites:** Precision Metal Manufacturing I.**Recommended Prerequisites:** Precision Metal Manufacturing II Lab. |
| **Course Description:** Precision Metal Manufacturing II will provide students the knowledge, skills, and technologies required for employment in precision machining. While this course is designed to provide necessary skills in machining, it also provides a real-world foundation for any engineering discipline. This course addresses a variety of materials such as plastics, ceramics, and wood in addition to metal. Students will develop knowledge of the concepts and skills related to these systems to apply them to personal and career development. This course supports integration of academic and technical knowledge and skills. Students will have opportunities to reinforce, apply, and transfer knowledge and skills to a variety of settings and problems. Knowledge about career opportunities, requirements, and expectations and the development of workplace skills prepare students for success. This course is designed to provide entry-level employment for the student or articulated credit integration into a community college and dual credit with a community college with completion of the advanced course. |
| **NOTE:** This is a suggested scope and sequence for the course content. This content will work with any textbook or instructional materials. If locally adapted, make sure all TEKS are covered. |
| **Total Number of Periods****Total Number of Minutes****Total Number of Hours** | 350 Periods15,750 Minutes262.5 Hours\* | \*Schedule calculations based on 175/180 calendar days. For 0.5 credit courses, schedule is calculated out of 88/90 days. Scope and sequence allows additional time for guest speakers, student presentations, field trips, remediation, extended learning activities, etc. |
| **Unit Number, Title, and Brief Description** | **# of Class Periods\***(assumes 45-minute periods)Total minutes per unit | **TEKS Covered****130.360 Knowledge and skills** |
| **Unit 1: Technical Knowledge for Precision Metal Manufacturing**This unit will include lessons on terminology and skills that are associated with technical reading and writing, mathematics, and science knowledge specifically pertaining to metal fabrication and machining. Students will refer to *The Machinery's Handbook* regularly throughout this course. Students will learn about all the different resources, including *The Machinery's Handbook* and the internet, that can be used such as, cutting feeds and speeds, various formulas for different projects, clamping exercises, different cutting techniques, etc.  | 20 Periods900 Minutes | 3. The student applies the technical knowledge and skills of advanced precision metal manufacturing. The student is expected to:(A) apply the technical aspects found in *The Machinery's Handbook* resource; and(B) select appropriate resources from the Internet as applied to manufacturing |
| **Unit 2: Workplace Regulations, Safety & Compliance**This unit will expose students to the important regulations and safety standards that are implemented within this industry. Students will learn that such practices are in place to manage resources to minimize losses and liabilities to businesses in the industry. During this unit students will review and apply basic knowledge regarding safe use of professional precision metal manufacturing equipment. Students will demonstrate the proper use and care of Personal Protection Equipment (PPE) used in precision metal manufacturing. | 15 Periods675 Minutes | 1. The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:(H) follow written and oral instructions and adhere to established business practices, policies, and procedures, including health and safety rules2. The student explores the employability characteristics of a successful worker in the global economy. The student is expected to:(F) demonstrate skills related to health and safety in the workplace as specified by appropriate governmental regulations |
| **Unit 3: Manual Machining Skills Review**Students will recall the functionality of lathe components including bed, tool post, Chuck, head stock, tail stock, legs, Gear chain, lead screw, carriage, cross slide, split nut, apron, chip pan, guide ways, etc. Students will recall the functionality of mill machine components including the head, knee, worktable, column, base, saddle, etc. Students will develop and design an approved lathe and milling part and will manufacture the part to their created print with zero defects and practice safety skills during the entire process.  | 30 Periods1,350 Minutes | 4. The student builds on the manual machining skills gained in Precision Metal Manufacturing I. The student is expected to:(A) develop a detailed turning part such as the National Institute for Metalworking Skills (NIMS) Level 1 turning, chucking, or turning between centers part with zero defects (100% to the print) in a safe manner; and(B) develop a detailed milling part such as the NIMS Level 1 milling part with zero defects (100% to the print) in a safe manner |
| **Unit 4: Introduction to CNC**Students will use multiple resources to research the history and developments of numerical controlled machines. Students will identify and distinguish between the different types of CNC machines used in the industry and understand the individual purpose each machine has in the industry. Students will learn the importance of practicing safety while operating CNC machines and will utilize these skills throughout the program of study. Student will complete various exercises and projects focused around CNC safety. Students will learn the different ways programs can be loaded into the machine and will be able to demonstrate each method.  | 25 Periods1,125 Minutes | 5. The student learns about standard computer numerical control (CNC) machinery. The student is expected to:(A) research the history of numerical control machines;(B) distinguish among different types of CNC machines used in the industry;(C) demonstrate safety rules for CNC operation;(D) demonstrate the methods by which programs can be entered into a controller; and(E) use appropriate machining terminology to enhance CNC vocabulary |
| **Unit 5: CNC Systems**Students will research different drive motors used on CNC machinery. Student will design parts in accordance with the cartesian coordinate system. Students will complete parts using absolute and incremental positioning methods and learn the pros and cons to each. Students will complete dimensioning exercises and manufacture parts to prints with both datum and delta dimensioning. | 25 Periods1,125 Minutes | 6. The student appraises various CNC systems to differentiate the development and implementation of those systems. The student is expected to:(A) examine the types of drive motors used on CNC machinery;(B) explain the Cartesian coordinate system;(C) differentiate between absolute and incremental positioning; and(D) illustrate the difference between datum and delta dimensioning |
| **Unit 6: CNC Process Planning**During this unit students will learn about process planning and tool selection required prior to using CNC machines. Students will determine the proper feeds and speeds for common materials used in the industry and demonstrate the use of carbide inserts when necessary. Students will develop a detailed process plan including proper tool selection, proper feeds and speeds, cutting and finishing specifications, sequence of operation, and inspection points. Students will use different types of tooling throughout the program and demonstrate the purpose of each tool to complete jobs.  | 30 Periods1,350 Minutes | 7. The student learns the process planning and tool selection within a CNC lab environment. The student is expected to:(A) develop a detailed process plan, including proper tool selection, feeds, and speeds, for the material being cut and finish specifications on the engineering drawing, logical sequence of operations, and appropriate inspection points;(B) develop a logical sequence of operations and appropriate inspection points;(C) demonstrate use of carbide inserts; and(D) apply various carbide inserts by determining the correct type, grade, style, feed, and speed for the most common materials machined in a basic machine shop 8. The student evaluates tool changing and tool offset registers in the CNC lab environment. The student is expected to:(A) perform various types of tool changes;(B) demonstrate quick change tooling used on CNC milling machines;(C) demonstrate appropriate tool storage;(D) demonstrate the proper use of tool offset registers;(E) determine tool offset length; and(F) incorporate tool offsets for a set up |
| **Unit 7: CNC Lathe Processes and Procedures**Students will identify and study components of the CNC lathe. Students will be responsible for maintenance of the machines and visually inspecting tooling in machines for wear and make sure all lubricants are at operational levels. Students will test the coolant with a refractometer for proper density and adjust accordingly in order to reach the correct mixture in accordance with operation manual and suggested levels from the coolant manufacturer. Students will follow a power up and power down procedure and complete each step at 100% before operating the machine. Students will then also demonstrate the use of the jog controls on the operator panel to jog the lathe axis. Students will install tools and tool holders in the automatic tool changer locations according to work instructions and job documentation. Students will also locate and set workpiece to zero on a CNC lathe. Students will learn the process of running the machine in automatic mode.  | 35 Periods1,575 Minutes | 9. The student operates a CNC lathe. The student is expected to:(A) use equipment commonly associated with a CNC lathe in a safe manner;(B) recognize, name, and describe the function of the primary components of a CNC lathe;(C) perform preventative maintenance checks on a CNC lathe such as checking all fluid levels, system pressure, tooling wear, and component lubrication and cleaning;(D) test the coolant for proper density and adjust accordingly to reach the correct mixture;(E) perform a power up on a standard CNC lathe;(F) demonstrate the use of the jog controls on the operator panel to jog the lathe's axes;(G) demonstrate the ability to locate, assemble, and measure tooling according to work instructions and job documentation;(H) install tools and tool holders in the automatic tool changer locations according to work instructions and job documentation;(I) locate and set workpiece to zero on a CNC lathe;(J) set any required work offsets for the part to be machined after a basic tool setting process has been completed;(K) set the proper geometry/tool offsets for each tool in a standard tool setting process;(L) operate a CNC lathe in automatic mode; and(M) illustrate the proper power down process on a CNC lathe |
| **Unit 8: CNC Milling Machine Processes and Procedures**Students will be responsible for maintenance of the milling machines and keeping up with maintenance logs similar to what is seen in the industry every week. Students will visually inspect tooling in machines for wear and make sure all lubricants are at operation levels. Students will test the coolant with a refractometer for proper density and adjust accordingly to reach the correct mixture in accordance with operation manual and suggested levels from the coolant manufacturer. Student will follow a power up and power down procedure and complete each step at 100% before operating the CNC milling machine. Students will then also demonstrate the use of the jog controls on the operator panel to jog the mill axis. Students will install tools and tool holders in the automatic tool changer locations according to work instructions and job documentation. Students will also locate and set workpiece to zero on a CNC mill. Students will learn the process of running the machine in automatic mode.  | 35 Periods1,575 Minutes | 10. The student operates a CNC mill. The student is expected to:(A) use equipment commonly found on and around a CNC mill in a safe manner;(B) recognize, name, and describe the function of the primary components of a CNC mill;(C) perform preventative maintenance checks on a CNC mill such as checking all fluid levels, system pressure, tooling wear, and component lubrication and cleaning;(D) test the coolant for proper density and adjust accordingly in order to reach the correct mixture;(E) perform a power up on a standard CNC mill;(F) demonstrate the use of the jog controls on the operator panel to jog the mill's axes;(G) demonstrate the ability to locate, assemble, and measure tooling using a presetter or other means according to work instructions and job documentation;(H) install tools and tool holders in the automatic tool changer locations according to work instructions and job documentation;(I) locate and set workpiece to zero on a CNC mill;(J) set any required work offsets for the part to be machined after a basic tool setting process has been completed;(K) set the proper geometry/tool offsets for each tool in a standard tool-setting process;(L) operate a CNC mill in automatic mode; and(M) illustrate the proper power down process on a CNC mill |
| **Unit 9: Advanced Quality Control** Students will understand the use of technological resources to access, manipulate, and produce information, products, and services related to quality control in manufacturing. Students will discuss the American Society of Mechanical Engineers (ASME) Y14.5M standard that defines geometric dimensioning and tolerancing. Students will analyze and develop drawings with GD&T; students will manufacture their parts based on their drawing with accuracy. Students know the reasons for inspection and quality control in the manufacture of machined and formed parts and how they relate to quality control. | 25 Periods1,125 Minutes | 13. The student develops a deeper understanding of quality control. The student is expected to:(A) evaluate engineering drawings using geometric dimensioning and tolerancing;(B) discuss the American Society of Mechanical Engineers (ASME) Y14.5M standard that defines geometric dimensioning and tolerancing; and(C) appraise various quality control/management programs |
| **Unit 10: Manual CNC Lathe Programming**Students will do work based learning combined with online software to learn how to determine coordinates for arcs and angles and determine cutter offsets. Students will apply print reading skills and math skills to determine appropriate tools paths through project based learning programming. Students will use simulators and/or resources to practice programming simple operations on the CNC lathe such face, turn, cut radiuses, angles, grooves, and threads. Students will work on learning G codes and programming on the CNC lathe. Students will be provided an engineering drawing to program and manufacture a part such as a NIMS Level 1 CNC lathe part with zero defects. Students will apply these skills by project based learning.  | 30 Periods1,350 Minutes | 11. The student learns to manually program a CNC lathe without the help of computer-aided design or manufacturing (CAD/CAM) software. The student is expected to:(A) calculate trigonometry to determine coordinates from technical drawings to cut arcs and angles;(B) use trigonometry for determining cutter offsets;(C) use appropriate mathematical skills to solve problems while programming a CNC lathe;(D) write a simple program to face and turn;(E) write a simple program to cut radiuses, angles, grooves, and threads;(F) write a program using cutter radius compensation;(G) write a program using canned cycles such as G71; and(H) write a program and produce a complex part such as a NIMS Level 1 CNC lathe part with zero defects |
| **Unit 11: Manual CNC Mill Programming**Student will do work based learning combined with online software to learn how to determine coordinates for arcs and angles and determine cutter offsets. Students will apply print reading skills and math skills to determine appropriate tools paths through project based learning programming. Students will use simulators and/or resources to practice programming simple operations on the CNC mill such as hole operations, cutting radiuses and angles. Students will be provided am engineering drawing to program and manufacture a part such as a NIMS Level 1 CNC milling part with zero defects. Students will apply these skills by project based learning. | 30 Periods1,350 Minutes | 12. The student learns to manually program a CNC mill (without the help of CAD/CAM software). The student is expected to:(A) use trigonometry to determine coordinates from technical drawings to cut arcs and angles;(B) use trigonometry for determining cutter offsets;(C) use appropriate mathematical skills to solve problems while programming a CNC lathe;(D) write a simple program to perform hole operations;(E) write a simple program to cut radiuses and angles;(F) write a program using cutter radius compensation and ramping; and(G) write a program and produce a complex part such as a NIMS Level 1 CNC milling part with zero defects |
| **Unit 12: Employability Skills**This unit explores the professional standards and employability skills required by business and industry. Students will grow to understand that responsibility, time management, organization, positive attitude, and good character have a large impact on employability and job retention. Students will understand the professional ethics legal responsibilities pertaining to the manufacturing industry. Students will also be able to identify and describe the work ethic needed for career advancement in the manufacturing industry (e.g., skill sets, work schedules, travel/relocation, teamwork, communication skills, flexibility and adaptability etc.).  | 25 Periods1,125 Minutes | 1. The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:(A) express ideas to others in a clear, concise, and effective manner through written and verbal communication;(B) convey written information that is easily understandable to others;(C) demonstrate acceptable work ethics in reporting for duty and performing assigned tasks as directed;(D) conduct oneself in a manner acceptable for the profession and work site such as suitable dress and polite speech;(E) comply with all applicable rules, laws, and regulations;(H) follow written and oral instructions and adhere to established business practices, policies, and procedures, including health and safety rules; and(I) prioritize tasks, follow schedules, and tend to goal-relevant activities in a way that uses time in an effective, efficient manner2. The student explores the employability characteristics of a successful worker in the global economy. The student is expected to:(C) demonstrate the standards required in the workplace such as interviewing skills, flexibility, willingness to learn new skills and acquire knowledge, self-discipline, self-worth, positive attitude, and integrity in a work situation; and(E) communicate effectively with others in the workplace to clarify objectives |
| **Unit 13: Professional Development**During this unit, students will learn more about the qualities and characteristics required to be successful in business and industry. While a basic understanding and development of employability skills will help students obtain employment, they will learn that developing leadership skills will aid them in job retention and potential promotion opportunities. This unit will help students better understand the various career opportunities within the manufacturing industry. Students will develop a career plan designed to achieve their career goals within this industry. Students will focus on expanding their knowledge about the education, training, and/or certification required to obtain employment in the industry. Students will develop a career plan designed to achieve their career goals within this industry. | 25 Periods1,125 Minutes | 1. The student demonstrates professional standards/employability skills as required by business and industry. The student is expected to:(F) review with some critical eye the fine, detailed aspects of both quantitative and qualitative work processes and end products;(G) evaluate systems and operations; identify causes, problems, patterns, or issues; and explore workable solutions or remedies to improve situations2. The student explores the employability characteristics of a successful worker in the global economy. The student is expected to:(A) determine academic knowledge and skills required for postsecondary education;(B) identify employers' expectations to foster positive customer satisfaction; and(D) evaluate progress toward personal career goals |