KIRKWOOD
SCHOOL DISTRICT

PRECISION MACHINING II 9-12

Approved by KSD Board of Education: May 19, 2025

Course Description:
Students will study the physical characteristics of common metal types and explore how these properties affect the design of a project. Students will also learn advanced manufacturing techniques, such as CNC machining using a plasma cutter. Machine proficiency will be demonstrated through the design and construction of numerous open-ended projects, including jewelry making, scrap metal art, a 3-D welded object, and a project of the student's own design at the end of the course. All projects are the student's to keep. Students will calculate a bill of materials and pay for their final project.

Grade Level: 9-12 Grade (semester)

Unit Scope and Sequence

Unit 1: Computer-Aided Machining/Manufacturing
Unit 2: Advanced Machining Techniques/Processes
Unit 3: Capstone Project

Course Enduring Understandings:

- **Safety First**: Understanding and following proper safety protocols is essential to preventing injuries and ensuring a productive workshop environment.
- **Tool Mastery**: Proficiency in using hand tools, power tools, and machines is fundamental for shaping, joining, and finishing metal projects.

Course Essential Questions:

- What safety procedures must be followed when working with metal and operating tools?
- How do we properly use and maintain hand tools, power tools, and machines in metalworking?

PRECISION MACHINING II 9-12
Unit 1: Computer-Aided Machining/Manufacturing

In this unit, students will use software to design parts and projects that are to be manufactured on the CNC plasma cutter.

Unit Essential Learning Targets	
Enduring Understandings	***Essential Questions***
• Well-planned designs ensure that parts meet specifications and function properly when manufactured on a CNC plasma cutter. • Computer-aided design (CAD) software allows machinists to turn ideas into precise, manufacturable parts. • Digital design tools allow for greater flexibility in prototyping, customization, and problem-solving. • Combining technical skills with creativity allows for innovative problem-solving and unique project designs.	• How does the CNC plasma cutter operate? • How do we create precise drawings using the Design Edge software? • How do we take a completed design from the computer and machine our part on the CNC plasma cutter? • How does careful design impact the accuracy and functionality of CNC-manufactured parts? • How do digital design tools enhance creativity, customization, and problem-solving in manufacturing?
Students must know:	***Students must be able to:***
• How to create a basic drawing in Design Edge (Plasma Cam). • How to replicate a specific (dimensioned) technical drawing in Design Edge. • How to import graphics into the Design Edge program. • How to troubleshoot drawings & make the design cuttable.	• Recreate full-scale drawings using the Design Edge (Plasma Cam) program. • Create and cut a personal project on the plasma cutter. • Set up and create technical drawings using the Design Edge (Plasma Cam) software. • Create customized personal designs using the Design Edge (Plasma Cam) software. • Set up and successfully cut a drawing using the CNC Plasma Cutter.

PRECISION MACHINING II 9-12
Unit 1: Computer-Aided Machining/Manufacturing

Missouri Competency Machinist Standards (MCMS)

Priority Standard: Applied Mathematics (MCMS.4)
Supporting Standards:
- Applied mathematics of coordinate systems (MCMS.4.B).

Priority Standard: Machine Controls and Navigation (MCMS.12)
Supporting Standards:
- Demonstrates knowledge of digital file types (e.g., txt, docx, xlsx) (MCMS.12.B).

Priority Standard: Software Technologies (MCMS.13)
Supporting Standards:
- Demonstrates knowledge of the fundamentals of Computer-Aided-Manufacturing (MCMS.13.A.1).
- Demonstrates knowledge of the fundamentals of G-code Program Verification
- (MCMS.13.A.2).
- Demonstrates knowledge of the fundamentals of Direct Numerical Control
- (MCMS.13.A.3).

PRECISION MACHINING II 9-12
Unit 2: Advanced Machining Techniques/Processes

In this unit, students will use the skills and knowledge gained through the training and practice with both hand tools, power tools, manual machining, and CNC machining in order to create open-ended assigned projects.

Unit Essential Learning Targets

Enduring Understandings	***Essential Questions***
• Applying knowledge of various machining techniques demonstrates understanding and skill development. • Adjustments and refinements are necessary to improve the accuracy and functionality of a project. • Combining technical skills with creativity allows for innovative problem-solving and unique project designs.	• What machining techniques and or processes are used in the creation of jewelry? • How can we use the scrap metal in the shop for both practical and creative projects? • Using learned manufacturing techniques, can you design, price, and build a small Patio Table, Trash Can, or Fire Pit?
Students must know:	***Students must be able to:***
• The different manufacturing techniques/options used in the creation of assigned projects. Techniques include: ○ CNC machining ○ Usage of the Metal Lathe ○ Usage of the Vertical Mill	• Choose the most appropriate manufacturing technique for a given application to create a custom project. • Research and apply different machining techniques and processes as they relate to: ○ Making jewelry ○ Using Scrap Metal to create projects ○ Designing and building a Patio Table, Trash Can, or Fire Pit.

Missouri Competency Machinist Standards (MCMS)

Priority Standard: Applied Mathematics (MCMS.4)
Supporting Standards:
- Applied mathematics of coordinate systems (MCMS.4.B).

Priority Standard: Machine Controls and Navigation (MCMS.12)
Supporting Standards:
- Demonstrates knowledge of digital file types (e.g., bmp, jpeg, pcm) (MCMS.12.B).

Priority Standard: Software Technologies (MCMS.13)
Supporting Standards:
- Demonstrates knowledge of the fundamentals of Computer-Aided-Manufacturing (MCMS.13.A.1).
- Demonstrates knowledge of the fundamentals of Direct Numerical Control (MCMS.13.A.3).

PRECISION MACHINING II 9-12
Unit 3: Capstone Project

In this unit, students will use the skills & knowledge gained through Precision Machining 1 and 2 to design, price, and build a project of the student's choice.

Unit Essential Learning Targets

Enduring Understandings	***Essential Questions***
• Understanding when to use hand tools, power tools, manual machining, or CNC machining impacts efficiency, accuracy, and quality. • Adjustments, refinements, and problem-solving are necessary to turn an idea into a successful finished product. • Encountering and overcoming machining and design challenges strengthens technical skills and problem-solving abilities.	• How do we machine parts on the vertical mill? • How do we machine parts on the metal lathe? • How do different machining techniques—hand tools, power tools, manual machining, and CNC machining—work together to create a finished project? • How do you determine the best machining process for different aspects of a project?
Students must know:	***Students must be able to:***
• How to use the design process to fabricate a project from the ground up. • How to use problem-solving throughout the design process. • How to apply cost analysis to projects. • Which manufacturing processes/techniques are most appropriate for the student-generated project.	• Sketch and fully dimension project ideas using isometric sketch paper or an appropriate CAD program (Fusion 360, Onshape, etc). • Calculate overall project material cost by itemizing parts using a spreadsheet/electronic document. • Fabricate the chosen project from the student-generated plans. • Plan, sketch, price & manufacture a project of the student's choice.

Missouri Competency Machinist Standards (MCMS)

PRECISION MACHINING II 9-12
Unit 3: Capstone Project

Priority Standard: Safety (MCMS.1).
Supporting Standards:
- Safety for fire prevention/suppression (MCMS.1.B).
- Safety using Personal Protective Equipment, or PPE (MCMS.1.D).
- Safety including Emergency Stop Systems (MCMS.1.G).

Priority Standard: Applied Mathematics (MCMS.4)
Supporting Standards:
- Applied mathematics of coordinate systems (MCMS.4.B).

Priority Standard: Machine Technologies and Accessories (MCMS.7).
Supporting Standards:
- Demonstrates understanding of the fundamentals of machine types and configurations (MCMS.7.A.1).
- Demonstrates understanding of the fundamentals of machine capabilities (MCMS.7.A.2).
- Demonstrates understanding of work holding devices (MCMS.7.B).
- Demonstrates understanding of accessories and attachments of machines (MCMS.7.C).

Priority Standard: Mechanical Design (MCMS.10).
Supporting Standards:
- Demonstrates understanding of limits and fixes (MCMS.10.A).
- Demonstrates understanding of fixturing concepts (MCMS.10.B).

Priority Standard: Cutting Tool and Holder Technologies (MCMS.11).
Supporting Standards:
- Demonstrates understanding of cutting parameters (MCMS.11.C).

Priority Standard: Machine Controls and Navigation (MCMS.12)
Supporting Standards:
- Demonstrates knowledge of digital file types (e.g., bmp, jpeg, pcm) (MCMS.12.B).

Priority Standard: Software Technologies (MCMS.13)
Supporting Standards:
- Demonstrates knowledge of the fundamentals of Computer-Aided-Manufacturing (MCMS.13.A.1).
- Demonstrates knowledge of the fundamentals of G-code Program Verification
- (MCMS.13.A.2).
- Demonstrates knowledge of the fundamentals of Direct Numerical Control
- (MCMS.13.A.3).