

4th Year Manufacturing Technology

COURSE OUTLINE

1. Course Title: **Pre-Engineering & Mechanical Design**

2. CBEDS Title: **Mechanics and Engineering Technology**

3. CBEDS Number:

4. Job Titles:

Machinist

Tool & Die Maker

Manufacturing Engineer

Welder - Fabricator

Mechanical Engineer

Manufacturing Technician

5. Course Description:

A one-year course focusing on precision machining advanced product development, manufacturing process and leadership skills. Students will gain independent experience working on closer tolerance parts and multi-part assemblies using computer Numerical Control (CNC) machines. Students' will expand their knowledge of concepts and practical application of product development, design and manufacture of a marketable product to include: exploring current product development methodologies and select a product to manufacture with multiple component parts, design the manufacturing processes, work within various clearances, and meet plan specifications. Students will gain skill in above industrial occupations by working on a variety of activities and projects including: personal safety, good housekeeping practices, the use of hand and bench tools, types of metals, a variety of types of welding, and a variety of manual and CNC machine tool types and earn entry level certifications in the Precision Machining Industry. Integrated throughout the course are career preparation standards, which include basic academic skills, communication, interpersonal skills, problem solving, workplace safety, technology, and academic and employment literacy.

Student Outcomes and Objectives:

Students will:

1. Design, develop, plan and manufacture a marketable product including
 - a. Problem statement, understanding customer needs, product design specifications.
 - b. Product design planning, project plan, critical path method (CPM)
 - c. Establish product function, functional decomposition, sketch concept, decision matrices.
 - d. Design for the environment, green design, design for zero waste, design for disassembly, and product manufacturing.
2. Expand their understanding of metal working technologies by making machined or fabricated parts within a variety of clearances.
 - a. Grind right and left-hand tool bit (six angles, three positions)
 - b. Face, turn, cut and thread on lathe
3. Refine applied math and precision measurement techniques.
4. Have been exposed to various manufacturing mass production techniques.
5. Follow written and verbal instructions: safety, metal working skills and housekeeping organization.
6. Develop problem identification and solving skills.
7. Develop teamwork and group skills.
8. Demonstrate the ability to read a blueprint and draw part sketches.
9. Demonstrate the ability to design and manufacture prototype projects from sketches using a variety of materials.

10. Interpret drawings, measure and inspect parts produced, machine or fabricate assignments within specified tolerances.

Career Pathway

Recommended Sequence	Courses
Introductory	Beginning Metal Manufacturing Technology
Skill Building	Metal Art/Advanced Manufacturing Technology or Computer Aided Design
Advanced Skill	Product Development & Manufacturing (Metals 3) Pre-Engineering & Mechanical Design (Metals 4)

Instructional Unit: Career Preparation:

English Language Arts Standards:

Grade 8: Reading – 1.3: Use the word meanings within the appropriate context and show ability to verify those meanings by definition, restatement, example, comparison, or contrast.

Grade 8: Reading – 2.1: Compare and contrast the features and elements of consumer material to gain meaning from documents (e.g., warranties, contracts, product information, and instructional materials).

Grade 8: Reading – 2.6: Use information from a variety of consumer, workplace, and public documents to explain a situation or decision and to solve a problem.

Grade 8 Writing – 1.3: Support theses or conclusions with analogies, paraphrases, quotations, opinions from authorities, comparisons, and similar devices.

Grade 8 Writing – 2.5: Write documents related to career development, including simple business letters and job applications:

- a. Present information purposefully and succinctly and meet the needs of the intended audience.
- b. Follow the conventional format for the type of document (e.g., letter of inquiry, memorandum).

Grade 8 Language Conventions -- 1.4: Grammar: Edit written manuscripts to ensure that correct grammar is used.

Grade 8 Language Conventions -- 1.5: Punctuation and Capitalization: Use correct punctuation and capitalization.

Grade 8 Language Conventions -- 1.6: Spelling: Use correct spelling conventions.

Grade 8 Listening and Speaking -- 1.2: Comprehension: Paraphrase a speaker's purpose and point of view and ask relevant questions concerning the speaker's content, delivery, and purpose.

Grade 8 Listening and Speaking -- 1.3: Organization and Delivery of Oral Communication: Organize information to achieve particular purposes by matching the message, vocabulary, voice modulation, expression, and tone to the audience and purpose.

Grade 11/12 Writing – 2.5: Write job applications and résumés:

- a. Provide clear and purposeful information and address the intended audience appropriately.
- b. Use varied levels, patterns, and types of language to achieve intended effects and aid comprehension.
- c. Modify the tone to fit the purpose and audience.
- d. Follow the conventional style for that type of document (e.g., résumé, memorandum) and use page formats, fonts, and spacing that contribute to the readability and impact of the document.

Grade 11/12 Language Conventions – 1.2: Produce legible work that shows accurate spelling and correct punctuation and capitalization.

Math Standards:

Grade 7: Number Sense – 1.2: Add, subtract, multiply, and divide rational numbers to whole-number powers.

Grade 7: Number Sense – 1.3: Convert fractions to decimals and percents and use these representations in estimations, computations, and applications.

Grade 7: Number Sense – 1.7: Solve problems that involve discounts, markups, commissions, and profit and compute simple and compound interest.

Grade 7: Mathematical Reasoning – 1.1: Analyze problems by identifying relationships, distinguishing relevant from irrelevant information, identifying missing information, sequencing and prioritizing information, and observing patterns.

Grade 7: Mathematical Reasoning – 1.3: Determine when and how to break a problem into simpler parts.

Grade 7: Mathematical Reasoning – 2.1: Use estimation to verify the reasonableness of calculated results.

Grade 7: Mathematical Reasoning – 2.7: Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.

Grade 7: Mathematical Reasoning – 2.8: Make precise calculations and check the validity of the results from the context of the problem.

Grade 7: Mathematical Reasoning – 3.1: Evaluate the reasonableness of the solution in the context of the original situation.

Instructional Unit: Product Development and Manufacturing

English Language Arts Standards:

Grade 9-10: Listening and Speaking –1:

Students formulate adroit judgments about oral communication. They deliver focused and coherent presentations of their own that convey clear and distinct perspectives and solid reasoning. They use gestures, tone, and vocabulary tailored to the audience and purpose.

Comprehension:

1.1:***Formulate judgments about the ideas under discussion and support those judgments with convincing evidence.

Organization and Delivery of Oral Communication:

1.6:***Present and advance a clear thesis statement and choose appropriate types of proof (e.g., statistics, testimony, specific instances) that meet standard tests for evidence, including credibility, validity, and relevance.

Mathematics Standards:

Grade 9-12: Algebra I – 3.0: Students solve equations and inequalities involving absolute values.

Grade 9-12: Algebra I – 4.0: Students simplify expressions before solving linear equations and inequalities in one variable, such as $3(2x-5) + 4(x-2) = 12$.

Grade 9-12: Geometry - Cartesian Coordinates.

Science Standards:

Grade 9-12: Physics: Heat and Thermodynamics – 3: Energy cannot be created or destroyed, although in many processes energy is transferred to the environment as heat. As a basis for understanding this concept:

a. *Students know* heat flow and work are two forms of energy transfer between systems.

Grade 9-12: Chemistry: Gases and Their Properties – 4:

The kinetic molecular theory describes the motion of atoms and molecules and explains the properties of gases.

6. Hours: Students receive up to 180 hours of classroom instruction.

7. Prerequisites: Product Development & Manufacturing (Metals 3) or by special arrangement by teacher.

8. Date (of creation/revision): March 2009

9. Course Outline

COURSE OUTLINE

Upon successful completion of this course, students will be able to demonstrate the following skills necessary for entry-level employment.

Instructional Units and Competencies	Course Hours	Model Curr. Standards	CA Academic Content Standards	CAHSEE
<p>I. CAREER PREPARATION STANDARDS</p> <p>A. Career Planning and Management.</p> <ol style="list-style-type: none"> 1. Know the personal qualifications, interests, aptitudes, knowledge, and skills necessary to succeed in careers. <ol style="list-style-type: none"> a. Students will identify skills needed for job success b. Students will identify the education and experience required for moving along a career ladder. 2. Understand the scope of career opportunities and know the requirements for education, training, and licensure. <ol style="list-style-type: none"> a. Students will describe how to find a job. b. Students will select two jobs in the field and map out a timeline for completing education and/or licensing requirements including the field of teaching. c. Students will research manufacturing professional to find what courses and certifications they offer. 3. Develop a career plan that is designed to reflect career Interests, pathways, and postsecondary options. <ol style="list-style-type: none"> a. Students will conduct a self—assessment and explain how professional qualifications affect career choices. 4. Understand the role and function of professional organizations, industry associations, and organized labor in a productive society. <ol style="list-style-type: none"> a. Contact two professional organization and identify the steps to become a member. 5. Understand the past, present and future trends that affect careers, such as technological developments and societal trends, and the resulting need for lifelong learning. <ol style="list-style-type: none"> a. Students will describe careers in child-related fields. b. Students will identify work-related cultural differences to prepare for a global workplace. 6. Know the main strategies for self-promotion in the hiring process, such as completing job applications, resume writing, interviewing skills, and preparing a portfolio. <ol style="list-style-type: none"> a. Students will write and key a resume, cover letters, thank you letters, and job applications. b. Students will participate in mock job interviews. <p>B. Technology.</p> <ol style="list-style-type: none"> 1. Understand past, present and future technological advances as they relate to a chosen pathway. 2. Understand the use of technological resources to gain access to, manipulate, and produce information, products and services. 3. Understand the influence of current and emerging technology on selected segments of the economy. 4. Use appropriate technology in the chosen career pathway. 	<p>10 Additional hours are integrated throughout the course</p>	<p>Manufacturing & Product Development Industry 3.0, 4.0, 5.0, 6.0 7.0 , 8.0, 9.0 NIMS Precision Machining Standards Level I: 10.1.1 10.1.3 10.1.4 11.1.1 11.1.2</p>	<p>Language Arts (8) R 1.3, 2.6 W1.3, 2.5. LC 1.4,1.5 1.6 LS1.2, 1.3, (9/10) R2.1,2.3,2 W2.5 Level I: LC1.4 LS 1.1, 2.3 (11/12) R2.3 W2.5 LC1.2 <u>Math</u> (7) NS1.2, 1.7 MR 1.1,1.3 2.7,2.8, 3.1</p>	<p>Lang. Arts R 8.2.1 (9/10) R 2.1, 2.3 W2.5 Math (7) NS 1.2, 1.3, 1.7 MR 1.1, 2.1, 3.1</p>

<p>C. Problem solving and Critical Thinking.</p> <ol style="list-style-type: none"> 1. Apply appropriate problem-solving strategies and critical thinking to work-related issues and tasks. 2. Understand the systematic problem-solving models that incorporate input, process, outcome and feedback components. 3. Use critical thinking skills to make informed decisions and solve problems. 4. Apply decision-making skills to achieve balance in the multiple roles of personal, home, work and community life. <p>D. Health and Safety.</p> <ol style="list-style-type: none"> 1. Know policies, procedures, and regulations regarding health and safety in the workplace, including employers' and employees' responsibilities. 2. Understand critical elements of health and safety practices related to storing, cleaning and maintaining tools, equipment, and supplies. <p>E. Responsibility & Flexibility.</p> <ol style="list-style-type: none"> 1. Understand the qualities and behaviors that constitute a positive and professional work demeanor. 2. Understand the importance of accountability and responsibility in fulfilling personal, community, and workplace roles. 3. Understand the need to adapt to varied roles and responsibilities. 4. Understand that individual actions can affect the larger community. <p>F. Ethics and Legal Responsibilities</p> <ol style="list-style-type: none"> 1. Know the major local, district, state, and federal regulatory agencies and entities that affect the industry and how they enforce laws and regulations. 2. Understand the concept and application of ethical and legal behavior consistent with workplace standards. <ul style="list-style-type: none"> a. Contact a business and obtain a copy of their rules for employment. b. Role play different ethical scenarios. 3. Understand the role of personal integrity and ethical <p>G. Leadership and Teamwork.</p> <ol style="list-style-type: none"> 1. Understand the characteristics and benefits of teamwork, leadership, citizenship in the school, community, and workplace settings. 2. Understand the ways in which professional associations, and competitive career choices, and contribute to employability. 3. Understand how to organize and structure work individually and in teams for effective performance and attainment of goals. 4. Know multiple approaches to conflict resolution and their appropriateness for a variety of situations in the workplace. 5. Understand how to interact with others in ways that demonstrate respect for individual and cultural differences and for the attitudes and feelings of others. 			
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Instructional Units and Competencies	Hours	Industry Standards.	CA Academic Standards.	CAHSEE
1.1. Product Development and Manufacturing	70			
<u>1.2. Module 1: Job Planning, Benchwork and Layout:</u>		Mfg. & Product Develop. Industry Sector Foundation Standards 6.0 6.4	ER2.5, 2.6, EWA2.1c, 2.1e, 2.6a EW1.3, 1.5, 2.3f, 2.6a & b, EWO1.2, ELSS1.8c ESA2.2d&f, 2.6a	ELA. 9-10; R; 2.6; W; 2.3f, 2.6a & b. M. 7; NS; 1.2, 1.3; MG; 1.2, 2.4 & 3.1,
<p>Bench metal: Designed to enhance skills needed for using hand tools and performing bench Metal work. Included is the use of arbor presses, work holding and hand tools, hacksaws, files, reamers, taps and dies, finishing tools, bushings bearings and assembly tools.</p> <p>Bench work: Tap holes. Use files, scrapers, and coated abrasives to deburr parts. Use arbor presses to perform interference fits. Use bench vises and hand tools appropriately.</p>		Machine & Forming Technology Pathway C1.0, 1.1, 1.2, 1.3 C2.0, 2.2 C3.0, 3.2	MNS1.2, 1.3 MMG1.1, 1.2, 2.4, 3.1, MMR2.8, MA3.0 SPS2d, 3f SP1d, SIE1b&c, 11	
<p>Layout: Designed to enhance skills for layout out hole locations, radii and surfaces to Match the drawing and specifications. Students are required to perform all work Necessary to produce the part given the raw material, drawing, process plan, Layout tooling and measuring instruments. Lay out the location of hold centers and surfaces with an accuracy of +/- .015.</p>		Marketing, Sales, & Service Industry Sector D1.0, 1.6 D3.0, 3.1, 3.2, 3.3, 3.4	SSH10.3.2 SSH11.2.5	
<u>1.3. Module 1: Task Planning and Management:</u>				
<p>Designed to allow the student hands-on skill advancement in task planning and management. Emphasis will be on part process planning and all work necessary to produce route and process sheets.</p>				
<p>Task Process Planning Develop a process plan for a part requiring milling, drilling, turning, or grinding. Complete an operation sheet detailing the process plan and required speeds, feeds, depth of cuts, and coolant needs.</p>				
<p>Performance Standard Given a detail drawing of a part requiring milling, drilling, turning, and grinding, oral instructions, and appropriate references, the student is required to formulate a set of strategies specifying the required speeds and feeds, depth of cuts, and coolant needs. Make a 5- to 15-minute presentation explaining each of the process plan steps to be taken; identify all major components and functions of the machine tools; all major hand tools, measuring tools, surface finishes, and materials; and provide the rationale for the selected speeds and feeds, depth of cuts, and coolant needs.</p>				
<ul style="list-style-type: none"> ▪ Product Design Process ▪ Product Design Specifications ▪ Planning and Scheduling ▪ Conceptual Design Phase ▪ Detail Design <ul style="list-style-type: none"> ○ CAD modeling ○ Design simulation ○ Manufacturing documentation ▪ Design for Manufacturing and Assembly <ul style="list-style-type: none"> ○ Fabrication guidelines ○ Assembly efficiency ▪ Design for Reliability <ul style="list-style-type: none"> ○ Reliability and failure ○ Risk assessment ○ Preliminary hazard analysis ○ Failure modes and effects analysis ○ Design for safety ▪ Human Factors in Design ▪ Design for the environment <ul style="list-style-type: none"> ○ Green design ○ Design for zero waste ○ Design for disassembly ○ Product remanufacturing 				

Instructional Units and Competencies	Hours	Industry Standards.	CA Academic Standards.	CAHSEE
<p>Focus Area 2: Manual Machine Tool Operations</p> <p>Using a combination of the metal working processes below student will produce, inspect and assemble a Metal Machined Product consisting of multiple parts.</p> <p>CNC TURNING OPERATIONS (LATHE)</p> <ol style="list-style-type: none"> 1. Work holding /Tool holding 2. Cutting Tools 3. Speed and Feeds 4. Setup 5. Facing, Turning, Boring, Threading 	40			
<p>CNC MILLING OPERATIONS</p> <ol style="list-style-type: none"> 1. Cutting Tools 2. Speed and Feeds 3. Climb vs Conventional Milling 4. Setup 5. Workholding / Tool holding 6. Facing, slotting, boring, and squaring. 		<p>NIMS Precision Machining Standards; Level I;</p> <p>3.1.2</p> <p>Machine & Forming Technology Pathway C2.0, C2.2 C9.0, C9.1</p>	<p>ELA. 7; W; 1.3; LS; 2.3.</p> <p>ELA. 8; R' 2.5, W 2.6a.</p> <p>ELA. 11-12; W; 2.1c & e, WO; 1.2, LS; 1.8c & 2.3c</p>	<p>ELA. 9-10; R; 2.6; W; 1.5, 2.3f, 2.6a & b</p> <p>M. 7; NS; 1.2, 1.3; AF; 1.5; MG; 1.2, MR; 2.1 & 2.8.</p> <p>M. 8-12; A; 3.0 & 5.0.</p>
<p>Manufacturing Processes</p> <ol style="list-style-type: none"> 1. Drilling Tools 2. Sharpening drills 3. Drill Press Operations & Safety 4. Speeds and Feeds 		<p>NIMS Precision Machining Standards; Level I;</p> <p>Machine & Forming Technology Pathway C2.0, C9.1</p>	<p>ELA. 7; LS; 2.3.</p> <p>ELA. 8; R' 2.5, W 2.6a.</p> <p>ELA. 9-10; LS; 1.7 & 2.2f.</p> <p>ELA. 11-12; WO; 1.2, LS; 1.8c & 2.3c</p> <p>S. 8; Phy. Sci.; 1c & f & 2d.</p> <p>S. 9-12; Physics; 1d; IE; 1</p> <p>SS. 8; HG; 8.12.9</p> <p>SS. 10; WH; 10.3.2</p> <p>SS. 12; E; 12.2.8</p>	<p>ELA. 9-10; R; 2.6; W; 2.3f, 2.6a & b.</p> <p>M. 7; NS; 1.2, 1.3; MG; 3.1, MR; 2.1, 2.8 & 3.3.</p> <p>M. 8-12; A; 3.0, 5.0 & 13.0.</p>

Instructional Units and Competencies	Hours	Industry Standards.	CA Academic Standards	CAHSEE
<u>Area of Focus 3: Welding and Fabrication</u> Using a combination of the metal working processes below student will produce, inspect and assemble Metal Fabricated products consisting of multiple parts. Mechanical and Welded assembly techniques : 1. Oxy- Acetylene (Gas) 2. MIG (Wire Welding)	30			
Fabrication Techniques <ul style="list-style-type: none">• Fixture design and construction• Fabrication alignment• Planning for welding distortion		Machine & Forming Pathway C2.1 Welding Technology Pathway D1.2 D2.2 D3.0	ELA. 7; LS; 2.3 ELA. 8; W; 2.6a ELA. 9-10; LS; 2.2f ELA. 11-12; R; 2.3; W; 1.6 & 2.1c; WO; 1.2; LS; 1.8c, 2.1a & 2.3c S. 9-12; IE; 1b & c.	ELA. 9-10; W; 1.5, 2.3f 2.6a & b. M. 7; NS; 1.2, 1.3; AF; 3.2; MG; 1.1, 1.2, 3.1 & 3.3, MR; 1.1, 2.1, 2.8 & 3.3.
Metallurgy: For Machining and Fabrication <ul style="list-style-type: none">• Ferrous and non-ferrous metals• Material physical properties				
PROCESS IMPROVEMENT for Machining and Fabrication 1. Analyze production process 2. Formulate process adjustments 3. Notification of supervisor and employees 4. Perform process adjustments 5. Evaluate effectiveness	10	NIMS Precision Machining Standards; Level I; 7.1.3 Machine & Forming Technology Pathway C7.1		
GENERAL MAINTENANCE 1. Tools, workbench, manual and equipment cleanliness 2. Inspection and assessment of tool and equipment condition 3. Routine adjustments 4. Daily, weekly and/or monthly routine maintenance 5. Non-routine maintenance strategies 6. Tooling Maintenance 7. Referral process for tooling repair	10	NIMS Precision Machining Standards; Level I; C5.3 ELA. 7; LS; 2.3 ELA. 8; R; 2.2 & 2.5; W; 2.6a ELA. 9-10; LS; 2.2f ELA. 11-12; W; 2.1e; WO; 1.2; LS; 1.8c, 2.1a & 2.3c S. 8; Phys. Sci.; 3f	ELA. 9-10; R; 2.6; W; 1.5, 2.3f 2.6a & b.	
BLUEPRINTS 1. Blueprint reading 2. Sketching working drawings 3. Identify specifications & tolerances 4. Determine required materials and materials specifications	10	Machine & Forming Technology Pathway C1.1	ELA; 11-12; R 2.6	

10. Additional recommended/optional items

- a. Articulation: None.
- b. Academic credit: 10 Elective Credits

c. Instructional strategies:

- Lecture Discussion
- Laboratory
- Projects

d. Instructional materials: Teacher and NIMS Certification Generated

e. Certificates: NIMS Certifications: Machining Level 1: Module 1: Measurement, Safety and Materials