Course Outline

Manufacturing and Product Development **REVISED: August/2017**

Job Title
Machinist

Career Pathway:
Machining and Forming Technologies

Industry Sector:
Manufacturing and Product Development

O*NET-SOC CODE:
51-4041.00

CBEDS Title:
Machining and Forming Technologies

CBEDS No.:
5635

79-95-70

Machinist: Computer Numeric Controls

Credits: 15 **Hours:** 180

Course Description:
This competency-based course provides experience in fabricating increasingly complex parts and instruments for the machine tool industry. It stresses additional mathematical and computational skills applicable to the industry. Students are given practical experiences on a minimum of one automated machine. Development of performance skills necessary for employment is emphasized. The competencies in this course are aligned with the California High School Academic Content Standards and the California Career Technical Education Model Curriculum Standards.

Prerequisites:
Computer science and machine lab experience is desirable.

NOTE: For Perkins purposes this course has been designated as a **capstone** course.

This course cannot be repeated once a student receives a Certificate of Completion.

Los Angeles Unified School District
Division of Adult and Career Education
Instructional and Couseling Services Unit
Adult Curriculum Office
www.wearedace.org

COURSE OUTLINE COMPETENCY-BASED COMPONENTS

A course outline reflects the essential intent and content of the course described. Acceptable course outlines have six components. (Education Code Section 52506). Course outlines for all apportionment classes, including those in jails, state hospitals, and convalescent hospitals, contain the six required elements:

(EC 52504; 5CCR 10508 [b]; Adult Education Handbook for California [1977], Section 100)

COURSE OUTLINE COMPONENTS	**LOCATION**
GOALS AND PURPOSES	Cover

The educational goals or purposes of every course are clearly stated and the class periods are devoted to instruction. The course should be broad enough in scope and should have sufficient educational worth to justify the expenditure of public funds.

The goals and purpose of a course are stated in the COURSE DESCRIPTION. Course descriptions state the major emphasis and content of a course, and are written to be understandable by a prospective student.

PERFORMANCE OBJECTIVES OR COMPETENCIES	pp. 8-11

Objectives should be delineated and described in terms of measurable results for the student and include the possible ways in which the objectives contribute to the student's acquisition of skills and competencies.

Performance Objectives are sequentially listed in the COMPETENCY-BASED COMPONENTS section of the course outline. Competency Areas are units of instruction based on related competencies. Competency Statements are competency area goals that together define the framework and purpose of a course. Competencies fall on a continuum between goals and performance objectives and denote the outcome of instruction.

Competency-based instruction tells a student before instruction what skills or knowledge they will demonstrate after instruction. Competency-based education provides instruction which enables each student to attain individual goals as measured against pre-stated standards.

Competency-based instruction provides immediate and continual repetition and In competency-based education the curriculum, instruction, and assessment share common characteristics based on clearly stated competencies. Curriculum, instruction and assessment in competency-based education are: explicit, known, agreed upon, integrated, performance oriented, and adaptive.

COURSE OUTLINE COMPETENCY-BASED COMPONENTS (continued)

COURSE OUTLINE COMPONENTS	LOCATION
INSTRUCTIONAL STRATEGIES	p. 13
Instructional techniques or methods could include laboratory techniques, lecture method, small-group discussion, grouping plans, and other strategies used in the classroom. Instructional strategies for this course are listed in the TEACHING STRATEGIES AND EVALUATION section of the course outline. Instructional strategies and activities for a course should be selected so that the overall teaching approach takes into account the instructional standards of a particular program, i.e., English as a Second Language, Programs for Adults with Disabilities.	
UNITS OF STUDY, WITH APPROXIMATE HOURS ALLOTTED FOR EACH UNIT	Cover
The approximate time devoted to each instructional unit within the course, as well as the total hours for the course, is indicated. The time in class is consistent with the needs of the student, and the length of the class should be that it ensures the student will learn at an optimum level. Units of study, with approximate hours allotted for each unit are listed in the COMPETENCY AREA STATEMENT(S) of the course outline. The total hours of the course, including work-based learning hours (community classroom and cooperative vocational education) is listed on the cover of every CBE course outline. Each Competency Area listed within a CBE outline is assigned hours of instruction per unit.	pp. 8-11
EVALUATION PROCEDURES	p. 13
The evaluation describes measurable evaluation criteria clearly within the reach of the student. The evaluation indicates anticipated improvement in performances as well as anticipated skills and competencies to be achieved. Evaluation procedures are detailed in the TEACHING STRATEGIES AND EVALUATION section of the course outline. Instructors monitor students' progress on a continuing basis, assessing students on attainment of objectives identified in the course outline through a variety of formal and informal tests (applied performance procedures, observations, and simulations), paper and pencil exams, and standardized tests.	
REPETITION POLICY THAT PREVENTS PERPETUATION OF STUDENT ENROLLMENT	Cover
After a student has completed all the objectives of the course, he or she should not be allowed to reenroll in the course. There is, therefore, a need for a statement about the conditions for possible repetition of a course to prevent perpetuation of students in a particular program for an indefinite period of time.	

ACKNOWLEDGMENTS

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CALIFORNIA CAREER TECHNICAL EDUCATION MODEL CURRICULUM STANDARDS
Manufacturing and Product Development Industry Sector
Knowledge and Performance Anchor Standards

1.0 Academics
Analyze and apply appropriate academic standards required for successful industry sector pathway completion leading to postsecondary education and employment. Refer to the Manufacturing and Product Development academic alignment matrix for identification of standards.

2.0 Communications
Acquire and accurately use Manufacturing and Product Design sector terminology and protocols at the career and college readiness level for communicating effectively in oral, written, and multimedia formats.

3.0 Career Planning and Management
Integrate multiple sources of career information from diverse formats to make informed career decisions, solve problems, and manage personal career plans.

4.0 Technology
Use existing and emerging technology, to investigate, research, and produce products and services, including new information, as required in the Manufacturing and Product Design sector workplace environment.

5.0 Problem Solving and Critical Thinking
Conduct short, as well as more sustained, research to create alternative solutions to answer a question or solve a problem unique to the Manufacturing and Product Design sector using critical and creative thinking, logical reasoning, analysis, inquiry, and problem-solving techniques.

6.0 Health and Safety
Demonstrate health and safety procedures, regulations, and personal health practices and determine the meaning of symbols, key terms, and domain-specific words and phrases as related to the Manufacturing and Product Design sector workplace environment.

7.0 Responsibility and Flexibility
Initiate, and participate in, a range of collaborations demonstrating behaviors that reflect personal and professional responsibility, flexibility, and respect in the Manufacturing and Product Design sector workplace environment and community settings.

8.0 Ethics and Legal Responsibilities
Practice professional, ethical, and legal behavior, responding thoughtfully to diverse perspectives and resolving contradictions when possible, consistent with applicable laws, regulations, and organizational norms.

9.0 Leadership and Teamwork
Work with peers to promote divergent and creative perspectives, effective leadership, group dynamics, team and individual decision making, benefits of workforce diversity, and conflict resolution as practiced in the SkillsUSA career technical student organizations.

10.0 Technical Knowledge and Skills
Apply essential technical knowledge and skills common to all pathways in the Manufacturing and Product Design sector, following procedures when carrying out experiments or performing technical tasks.

11.0 Demonstration and Application
Demonstrate and apply the knowledge and skills contained in the Manufacturing and Product Design anchor standards, pathway standards, and performance indicators in classroom, laboratory, and workplace settings, and through the SkillsUSA career technical student organizations.

B. Machining and Forming Technologies Pathway

The Machine and Forming Technologies pathway provides students with an understanding of manufacturing processes and systems common to careers in machine tool and materials forming industries. Representative topics include: trade vocabulary; shop math; basic material identification; proper use of hand and machine tools; reading precision measuring tools within .001" and the interpretation of machined and formed-part prints; the cutting, shaping, fastening, and finishing of machined parts; fixtures: forging, molding (casting), cold forming, and shearing processes.

Sample occupations associated with this pathway:

- CAD/CAM Specialist
- CNC Machinist
- Manufacturing Engineer
- Materials/Supply Management Specialist
- Quality Assurance Technician

B1.0 Validate that a provided part meets specifications from its engineering drawing by comparing specifications (geometric dimensioning and tolerancing) and by demonstrating proper technique using appropriate precision measuring tools.

B2.0 Describe and layout a project according to specifications or engineering drawings. Demonstrate proper technique with layout tools and work-holding devices such as: three- and four-jaw chucks, collet chucks, angle plates, sine bars, parallels, and v-blocks to machine a real part.

B3.0 Research and compare the properties of two metals using two different material specifications and a process specification.

B4.0 Demonstrate a cutoff saw operation(s) to produce a length of bar stock to specification.

B5.0 Demonstrate bending, shaping, other metal forming, and fabrication techniques, including processes such as basic hand filing, knurling on a lathe, forging metal shapes or objects, green sand casting, sheet metal machines, spot welding equipment or rivets, cold form bending with cold forming machinery or homemade devices, and shapes (tooling) to achieve a specific design specification.

B6.0 Identify and select the right grinding wheel; perform wheel dressing; and grind the provided part/material to the size and surface finish specifications provided.

B7.0 Perform a series of routine boring operations from a set of specifications or a drawing and explain the selection of proper tools (drill, reamer, countersink, spot facer, counter bore, tap, and center drill) for each step of the process.

B8.0 Describe and demonstrate the machining of an external and internal taper, knurled part, and threaded and bored part on an engine lathe to plan specification or drawing to produce a part and measure each end diameter within tolerance.

B9.0 Produce parts to specification using a boring head or angular cutting with a sine bar, a keyway, and pockets with a typical vertical mill.

B10.0 Produce parts to specifications or drawings provided on a computer numerical controlled (CNC) mill or lathe. Demonstrate common functions or controls through manual input and through programmed (stored) input. Introduce basic G and M Code Programming focusing on the use of the Cartesian coordinate system and machine axis.

B11.0 Understand and defend the purposes and processes of inspection and quality control in machining and forming processes.

COMPETENCY-BASED COMPONENTS
for the Machinist: Computer Numeric Controls Course

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
A. ORIENTATION Understand the scope of the course, including the development of numerical equipment for and occupational opportunities in the field of numerical control in the machine tool industry. (2 hours)	1. Describe the history of and the occupational opportunities in the field of numerical control. 2. Define course objectives and limits of course coverage.	**Career Ready Practice:** 1, 3, 4, 5, 9, 10, 12 **CTE Anchor:** Career Planning and Management: 3.4, 3.5, 3.7, 3.9 Health and Safety: 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8 Ethics and Legal Responsibilities: 8.1, 8.2, 8.3, 8.4 Technical Knowledge and Skills: 10.1, 10.2, 10.3 Demonstration and Application: 11.2 **CTE Pathway:** B1.1, B2.5, B3.1, B4.1, B5.1, B6.1, B7.1, B8.1, B8.2, B9.1, B10.1
B. BASIC MACHINE SHOP AS APPLIED TO NUMERICAL CONTROLS Identify and select various combinations of metals and alloys required for industrial functions.	1. Identify metal coding. 2. Identify various steel alloys. 3. Identify cast iron. 4. Identify aluminum alloys. 5. Describe cutting tools and methods of use.	**Career Ready Practice:** 1 **CTE Anchor:** Technical Knowledge and Skills: 10.1

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(18 hours)		**CTE Pathway:** B3.1, B3.2, B4.1, B4.2, B10.1, B10.3
C. NUMERICAL CONTROL EQUIPMENT AND LANGUAGE Describe the various types of numerically controlled machines and the potential and limitations of numerically controlled equipment. (4 hours)	1. Distinguish between the types of lathes. 2. Distinguish between the types of milling machines.	**Career Ready Practice:** 1 **CTE Anchor:** Technical Knowledge and Skills: 10.1 **CTE Pathway:** B2.5, B8.1, B8.2, B9.1, B9.2
D. OPERATOR RESPONSIBILITIES Demonstrate familiarity with communication media used in numerical controlled machinery. (12 hours)	1. Classify different types of machine tools. 2. Understand and explain retrofitting of conventional equipment. 3. Explain tolerances. 4. Analyze ways to control the possibilities of human error. 5. Explain various coding systems. 6. Compare coordinates. 7. Differentiate language of tape such as: a. word address b. block address c. tab sequential	**Career Ready Practice:** 1 **CTE Anchor:** Technical Knowledge and Skills: 10.1 **CTE Pathway:** B10.2, B10.3, B10.4
E. PROGRAMMING Describe procedures and equipment necessary to produce a control tape; review simple numerical-control drawing specifications and the techniques used to identify point coordinates and designate machine axes; Describe tool coding methods and positioning. (114 hours)	1. Describe manuscript preparation operations such as: a. point identification b. feed and speed specifications c. tool location and positioning 2. Plan tape preparation and operate perforation equipment. 3. Program point-to-point such as: a. language code b. tape formats c. writing programs 4. Verify tape. 5. Demonstrate tape mounting and tool adjustment. 6. Test tool performance. 7. Prepare materials for parts fabrication. 8. Define tape shortage/breakage.	**Career Ready Practice:** 1 **CTE Anchor:** Technical Knowledge and Skills: 10.1 **CTE Pathway:** B5.1, B5.3, B10.1, B10.2, B10.3, B10.4, B10.5

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
F. CONTINUOUS PATH VERSUS POINT-TO-POINT PROGRAMMING Differentiate between path and point-to-point programming. (12 hours)	1. Define differences in: a. tape format b. auxiliary codes	**Career Ready Practice:** 1 **CTE Anchor:** Technical Knowledge and Skills: 10.1 **CTE Pathway:** B10.2, B10.3
G. QUALITY CONTROL Perform ordinary lathe operations. (12 hours)	1. Use and care for precision equipment such as: a. height gauge b. dial indicators c. Johannson blocks d. vernier calipers e. surface gauge f. micrometer g. comparator h. protractor i. tolerances and allowances	**Career Ready Practice:** 1 **CTE Anchor:** Health and Safety: 6.3 Technical Knowledge and Skills: 10.1 **CTE Pathway:** B1.1, B1.2, B1.3, B2.1, B2.4
H. EMPLOYABILITY SKILLS Understand job searching techniques. (3 hours)	1. Identify potential employers. 2. Locate sources of employment information. 3. Write a résumé. 4. Prepare applications. 5. Participate in mock interview; locate and secure interview sessions.	**Career Ready Practice:** 3 **CTE Anchor:** Communications: 2.3, 2.4 Career Planning and Management: 3.4, 3.7 **CTE Pathway:** B11.5

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
I. REVIEW AND EVALUATION Pass written and performance tests as assigned. (3 hours)	1. Pass written tests given periodically through the course. 2. Pass performance tests.	**Career Ready Practice:** 1 **CTE Anchor:** Technical Knowledge and Skills: 10.1 **CTE Pathway:** B1.1, B2.1, B2.2, B2.3, B2.4

SUGGESTED INSTRUCTIONAL MATERIALS and OTHER RESOURCES

TEXTBOOKS

Boothroyd, Geoffrey and Winston A. Knight. Fundamentals of Machining and Machine Tools, 3rd Edition. Taylor and Francis, Inc. November 2005.

Oberg, Erik, Franklin D. Jones, Holbrook L. Horton, et al. Machinery's Handbook, 27th Edition. Industrial Press, Inc. April 2004.

Walker, John R. Machining Fundamentals. Goodheart-Wilcox Publisher, January 2004.

RESOURCES

Employer Advisory Board members

CTE Model Curriculum Standards for Manufacturing and Product Development:
http://www.cde.ca.gov/ci/ct/sf/documents/manproddev.pdf

National Tooling and Machining Association (NTMA), 9300 Livingston Rd., Fort Washington, MD 20744. Phone: (800) 248-6862.
Precision Machined Products Association (PMPA), 6700 West Snowville Rd., Brecksville, OH 44141-3292. Phone: (440) 526-0300. Fax: (440) 526-5803.
Precision Metalforming Association Educational Foundation (PMAEF), 6363 Oak Tree Blvd., Independence, OH 44131-2500. Phone: (216) 901-8800. Fax: (216) 901-9190.

COMPETENCY CHECKLIST

TEACHING STRATEGIES and EVALUATION

METHODS AND PROCEDURES

A. Lectures and discussions

B. Demonstrations and participation

C. Multimedia presentations

D. Individualized instruction

E. Role-playing

F. Guest speakers

G. Field trips and field study experiences

H. Projects

EVALUATION

SECTION A – Orientation – Pass all assignments and exams on orientation with a minimum score of 80% or higher.

SECTION B – Basic Machine Shop as Applied to Numerical Controls – Pass all assignments and exams on basic machine shop as applied to numerical controls with a minimum score of 80% or higher.

SECTION C – Numerical Control Equipment and Language – Pass all assignments and exams on numerical control equipment and language with a minimum score of 80% or higher.

SECTION D – Operator Responsibilities – Pass all assignments and exams on operator responsibilities with a minimum score of 80% or higher.

SECTION E – Programming– Pass all assignments and exams on programming with a minimum score of 80% or higher.

SECTION F – Continuous Path Versus Point-to-Point Programming– Pass all assignments and exams on continuous path versus point-to-point programming with a minimum score of 80% or higher.

SECTION G – Quality Control – Pass all assignments and exams on quality control with a minimum score of 80% or higher.

SECTION H – Employability Skills – Pass all assignments and exams on employability skills with a minimum score of 80% or higher.

SECTION I – Review and Evaluation– Pass all assignments and exams on review and evaluation with a minimum score of 80% or higher.

Statement for Civil Rights

All educational and vocational opportunities are offered without regard to race, color, national origin, gender, or physical disability.