

Course Outline

Manufacturing and Product Development

REVISED: August/2017

Job Title

Welder

Career Pathway:

Welding and Materials Joining

Industry Sector:

Manufacturing and Product Development

O*NET-SOC CODE:

51-4121.06

CBEDS Title:

Welding Technology

CBEDS No.:

5619

77-95-70

Welding/3

Credits: 15

Hours: 180

Course Description:

This competency-based course is the last in a sequence of three designed for welding. It provides students with technical instruction and practical experience in basic welding which incorporates principles of sustainable and green technology. Instruction includes an introduction, reviews of workplace safety policies and procedures. Emphasis is placed on the basic geometric and trigonometric requirements of the industry and the tools, equipment and techniques used in groove welding, air carbon arc process and combination welding. It also focuses on meeting the requirements of the City of Los Angeles Departmental Welding Exams adopted from the American Welding Society (AWS) procedures. An introduction to fabrication and robotics are also included. 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:

Enrollment requires successful completion of the Welding/2 (77-95-60) course.

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.



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

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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

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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.

pp. 7-12

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.

EVALUATION PROCEDURES

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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

Thanks to KARL PORTER and LUZ GRANADOS for developing and editing this curriculum. Acknowledgment is also given to ERICA ROSARIO for designing the original artwork for the course covers.

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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.

Manufacturing and Product Development Pathway Standards

C. Welding and Materials Joining Pathway

The Welding and Materials Joining pathway provides students with an understanding of manufacturing processes and systems common to careers in welding and related industries. The following pathway standards are based on, but not limited to, well established American Welding Society (AWS) EG2.0 Guidelines for the Entry Level Welder. Representative topics include the interpretation and layout of welded and assembled-part prints, cutting, mechanical bonding, joining, cohesive bonding, adhesive bonding, and mechanical fastening.

Sample occupations associated with this pathway:

- ◆ Metal Fabricator
- ◆ Sales
- ◆ Welders, Cutters, and Fitters
- ◆ Welding Inspector
- ◆ Welding Engineer

- C1.0 Interpret and demonstrate the planning and layout operations used in the welding processes.
- C2.0 Understand and demonstrate how materials can be processed through the use of welding tools and equipment.
- C3.0 Differentiate and apply various types of welding assembly processes.
- C4.0 Understand finishing processes and the differences between various types of finishing materials used in the manufacture of welded parts and products.
- C5.0 Understand and defend the purposes and processes of inspection and quality control in welding manufacturing processes.
- C6.0 Explore and understand various welding systems that require standard hand and machine tools.
- C7.0 Understand various automated welding systems, welding design for manufacturing, flexible manufacturing systems, and materials resource planning.
- C8.0 Understand various joining or combining processes, including welding processes used in manufacturing, maintenance, and repair.
- C9.0 Understand how a manufacturing company is organized and the elements of welding production management.

CBE
Competency-Based Education

COMPETENCY-BASED COMPONENTS
for the Welding/3 Course

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>A. INTRODUCTION AND SAFETY</p> <p>Review, apply, and evaluate classroom and workplace policies and procedures used in accordance with federal, state, and local safety and environmental regulations.</p>	<ol style="list-style-type: none"> 1. Review the scope and purpose of the course. 2. Review the overall course content as a part of the Linked Learning Initiative. 3. Review classroom policies and procedures. 4. Review the different occupations in the Transportation Industry Sector which have an impact on the role of welders. 5. Review the opportunities available for women in the welding field. 6. Review the purpose of the California Occupational Safety and Health Administration (Cal/OSHA) and its laws governing welders. 7. Review the impact of Environmental Protection Agency (EPA) legislation on Manufacturing and Product Development Industry Sector practices in protecting and preserving the environment. 8. Review and demonstrate techniques for contacting the proper authorities for the removal of hazardous materials based on EPA standards. 9. Review and demonstrate the use of the Material Safety Data Sheet (MSDS) as it applies to the welding industry. 10. Review classroom and workplace first aid and emergency procedures according to American Red Cross (ARC) standards. 11. Review how each of the following insures a safe workplace: <ol style="list-style-type: none"> a. employees' rights as they apply to job safety b. employers' obligations as they apply to job safety c. role of the Division of Workers' Compensation (DWC) d. safe use and storage of flammable liquids, materials, and safety supplies e. wearing of eye protection f. removal of jewelry g. avoidance of loose clothing h. never leaving an operating machine unattended i. not stopping and starting a machine for someone else 12. Pass the safety exam with 100% accuracy. 	<p>Career Ready Practice: 2, 4, 5, 10, 11</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.4 Career Planning and Management: 3.1 Technology: 4.3 Problem Solving and Critical Thinking: 5.2, 5.3 Health and Safety: 6.1, 6.3, 6.4, 6.5, 6.6, 6.7, 6.8 Responsibility and Flexibility: 7.2, 7.3 Ethics and Legal Responsibilities: 8.4 Leadership and Teamwork: 9.4, 9.6 Technical Knowledge and Skills: 10.1, 10.2, 10.3 Demonstration and Application: 11.3</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(5 hours)		CTE Pathway: C1.1, C1.3, C2.2, C2.3, C2.4, C3.1, C3.2, C5.3, C5.5, C6.1, C6.2, C6.3, C6.5, C6.7, C6.8, C9.1, C9.2, C9.3
B. TRADE MATHEMATICS III Understand, apply, and evaluate the mathematical requirements used in the welding industry.	<ol style="list-style-type: none"> 1. Define the following: <ol style="list-style-type: none"> a. line b. parallel lines c. perpendicular lines d. angles e. polygon f. perimeter g. circumference h. area i. volume j. lateral area k. surface area l. quadrilaterals m. circles 2. Identify and describe the following: <ol style="list-style-type: none"> a. properties of parallel lines b. types of triangles c. parts of a triangle d. properties of quadrilaterals e. properties of circles f. formulas for prisms, pyramids, and cylinders g. Pythagorean theorem 3. Describe and demonstrate the following: <ol style="list-style-type: none"> a. solving problems involving the perimeter, circumference, area, volume, lateral area, and surface area of common geometric figures b. computing the volumes and surface areas of prisms, pyramids, cylinders, cones, and spheres c. computing areas of polygons, including rectangles, scalene triangles, equilateral triangles, rhombi, parallelograms, and trapezoids d. determining how changes in dimensions affect the perimeter, area, and volume of common geometric figures and solids e. finding and using measures of sides and of interior and exterior angles of triangles and polygons to classify figures and solve problems f. proving relationships between angles in polygons by using properties of complementary, supplementary, vertical, and exterior angles g. proving the Pythagorean theorem h. using the Pythagorean theorem to determine distance and 	Career Ready Practice: 2, 5, 10, 11 CTE Anchor: Communications: 2.5 Technical Knowledge and Skills: 10.1, 10.2, 10.4 CTE Pathway: C5.4, C5.6, C7.2, C7.4, C7.5, C8.1

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(15 hours)	find missing lengths of sides of right triangles i. performing basic constructions with a straightedge and compass, such as angle bisectors, perpendicular bisectors, and the line parallel to a given line through a point off the line j. using coordinate geometry, including the midpoint of a line segment, the distance formula, and various forms of equations of lines and circles k. using trigonometric functions to solve for an unknown length of a side of a right triangle, given an angle and a length of a side l. using angle and side relationships in problems with special right triangles, such as 30°, 60°, and 90° triangles and 45°, 45°, and 90° triangles	
C. GROOVE WELDS Understand and apply the tools and techniques used in welding various types of grooves in all positions. (50 hours)	1. Define groove welding. 2. Identify the various types of groove welds. 3. Identify and describe the features and functions of the following: a. corner butt groove weld b. lay-out and fit-up of V-butts with back-up strip 4. Describe and demonstrate the following: a. preparation of lay-out and fit-up of V-butts with back-up strip b. tacking procedures c. root pass technique in groove welding d. welding sequence and technique in groove welding e. fit-up procedures on single and double V-groove welds f. fit-up procedures on single and double bevels g. fit-up procedures on double V-grooves and double bevels with a spacer h. single and double "U" grooves i. single and double "J" grooves j. fit-up procedure on single and double square groove welding k. welding techniques for plug or slot welding l. orbit butt tube welding m. fit-up procedures on various grooves without a back-up strip 5. Identify and perform the following types of groove welds: a. corner b. single vee with back up c. single vee open d. single level with back up e. single level open f. double vee and double level g. fillet soundness h. pipe 2-G, 5-G, and 6-G	Career Ready Practice: 2, 4, 5, 10, 11 CTE Anchor: Communications: 2.1, 2.2, 2.4 Career Planning and Management: 3.1 Technology: 4.3 Problem Solving and Critical Thinking: 5.2, 5.3 CTE Pathway: C1.1, C1.3, C2.2, C2.3, C3.1, C3.2

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>D. AIR CARBON ARC PROCESS</p> <p>Understand, apply, and evaluate the tools, equipment, and techniques used in air-carbon arc cutting.</p> <p>(50 hours)</p>	<ol style="list-style-type: none"> 1. Identify and describe the features and functions of the following: <ol style="list-style-type: none"> a. air carbon arc cutting equipment b. air carbon arc electrode holder c. leads and hoses 2. Describe the following: <ol style="list-style-type: none"> a. safety measures and procedures as they apply to air carbon arc cutting and gouging b. importance of air supply c. how to determine the correct compressed air pressure d. correct position and direction of air-jet e. correct electrode angle in gouging f. correct arc length during operations 3. Describe and demonstrate the following: <ol style="list-style-type: none"> a. setting up the power supply b. hooking up leads and hoses c. selecting proper carbon electrodes for various jobs d. using air carbon electrodes in all positions e. carbon electrode stick-out f. performing metal electrode arc cutting g. air carbon arc cutting and gouging h. performing air metallic arc cutting i. performing oxygen arc cutting 	<p>Career Ready Practice: 2, 4, 5, 10, 11</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.4 Career Planning and Management: 3.1 Technology: 4.3 Problem Solving and Critical Thinking: 5.2, 5.3</p> <p>CTE Pathway: C1.1, C1.3, C2.2, C2.3, C3.1, C3.2</p>
<p>E. COMBINATION WELDING</p> <p>Understand, apply, and evaluate the tools, equipment, safety issues, and techniques commonly used in combination welding.</p> <p>(10 hours)</p>	<ol style="list-style-type: none"> 1. Identify each of the following combination welding equipment and describe its use: <ol style="list-style-type: none"> a. tungsten-arc welding (GTAW) equipment b. gas metal-arc welding (GMAW) equipment 2. Describe and demonstrate the use of the following: <ol style="list-style-type: none"> a. GTAW welding equipment b. GMAW welding equipment c. submerge arc welding (SAW) equipment d. air-carbon arc cutting (AAC) equipment 	<p>Career Ready Practice: 2, 4, 5, 10, 11</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.4 Career Planning and Management: 3.1 Technology: 4.3 Problem Solving and Critical Thinking: 5.2, 5.3</p> <p>CTE Pathway: C1.1, C1.3, C2.2, C2.3, C3.1, C3.2</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>F. FABRICATION</p> <p>Understand, apply, and evaluate the basic of fabrication.</p> <p>(5 hours)</p>	<ol style="list-style-type: none"> 1. Define the following: <ol style="list-style-type: none"> a. fabrication b. metal fabrication c. semiconductor fabrication d. optics fabrication e. stonemasonry f. fab shops 2. Describe fabrication application. 	<p>Career Ready Practice: 2, 4, 5, 10, 11</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.4 Career Planning and Management: 3.1 Technology: 4.3 Problem Solving and Critical Thinking: 5.2, 5.3</p> <p>CTE Pathway: C1.1, C1.3, C2.2, C2.3, C3.1, C3.2, C8.2, C8.3</p>
<p>G. ROBOTICS</p> <p>Understand and apply the basics of robotics.</p> <p>(5 hours)</p>	<ol style="list-style-type: none"> 1. Define robotics. 2. Describe robotics as an aspect of welding. 3. Describe the relationship between robotics and the following: <ol style="list-style-type: none"> a. electronics b. mechanics c. software 4. Identify and describe the following structural parts of a robot: <ol style="list-style-type: none"> a. links b. effectors (hands) <ol style="list-style-type: none"> i. mechanical grippers ii. vacuum grippers iii. general purpose effectors c. actuators (muscles) d. joints 5. Define and describe the following: <ol style="list-style-type: none"> a. pneumatic b. hydraulics c. flywheel energy storage d. organic garbage e. radioactive source 	<p>Career Ready Practice: 2, 4, 5, 10, 11</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.4 Career Planning and Management: 3.1 Technology: 4.3 Problem Solving and Critical Thinking: 5.2, 5.3</p> <p>CTE Pathway: C7.1, C7.2, C7.3, C7.4, C7.5</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>H. CITY OF LOS ANGELES DEPARTMENTAL EXAM</p> <p>Understand and apply the geometric joint design, welding symbols, and city codes per American Welding Society (AWS) D1-1 and D1-3, in preparation for the City of Los Angeles Departmental Welding Exams.</p> <p>(40 hours)</p>	<ol style="list-style-type: none"> 1. Identify and describe the following: <ol style="list-style-type: none"> a. destructive testing b. radiographic/X-ray testing c. side bends, root bends, and face bends d. magnetic particle inspection e. visual inspection f. ultrasonic inspection 2. Describe application and procedures for taking the City of Los Angeles, Departmental Welding Exams. 3. Pass the AWS D1-1 exam with a score of 70% or better. 4. Pass the AWS D1-3 exam with a score of 70% or better. 5. Identify and describe various city welding codes in accordance to AWS D1-1, structural steel. 6. Identify and describe various city welding codes in accordance to AWS D1-3. 7. Pass the practical welding exam according to AWS guidelines. 	<p>Career Ready Practice: 2, 4, 5, 8, 9, 10, 11, 12</p> <p>CTE Anchor: Communications: 2.3, 2.4, 2.5, 2.6 Career Planning and Management: 3.2, 3.3, 3.5, 3.6, 3.7 Technology: 4.5 Problem Solving and Critical Thinking: 5.1, 5.2 Responsibility and Flexibility: 7.3, 7.4 Leadership and Teamwork: 9.3 Technical Knowledge and Skills: 10.4</p> <p>CTE Pathway: C2.3, C3.1, C3.2, C3.3, C9.1, C9.2, C9.3</p>

SUGGESTED INSTRUCTIONAL MATERIALS and OTHER RESOURCES

TEXTBOOKS

Blondeau, Regis. Metallurgy and the Mechanics of Welding. Wiley, John & Sons, 2008.

Bowditch, William A., Kevin E. Bowditch, and Mark A. Bowditch. Welding Technology Fundamentals. Goodheart-Wilcox Publisher, 2009.

Jeffus, Larry. Welding: Principles and Applications, 6th Edition. Cengage Learning, 2007.

Kou, Sindo. Welding Metallurgy, 2nd Edition. Wiley, John & Sons, Incorporated, 2002.

Ruck, James. Welding Projects, 2nd Edition. Goodheart-Willcox Publisher, 2005.

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>

American Welding Society, 550 N.W. LeJeune Road, Miami, Florida 33126; Phone: 800-443-9353,

<http://www.aws.org>

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 – Introduction and Safety – Pass the safety test with 100% accuracy.

SECTION B – Trade Mathematics III – Pass all assignments and exams on trade mathematics III with a minimum score of 80% or higher.

SECTION C – Groove Welds – Pass all assignments and exams on groove welds with a minimum score of 80% or higher.

SECTION D – Air Carbon Arc Process – Pass all assignments and exams on air carbon arc process with a minimum score of 80% or higher.

SECTION E – Combination Welding – Pass all assignments and exams on combination welding with a minimum score of 80% or higher.

SECTION F – Fabrication – Pass all assignments and exams on fabrication with a minimum score of 80% or higher.

SECTION G – Robotics – Pass all assignments and exams on robotics with a minimum score of 80% or higher.

SECTION H – City of Los Angeles Departmental Exam – Pass all assignments and exams on city of Los Angeles departmental exam with a minimum score of 70% or higher, or according to AWS guidelines.

Statement for Civil Rights

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