

Course Outline

Energy, Environment, and Utilities

REVISED: August/2017

Job Title
Electrician

72-75-50

Career Pathway:
Energy and Power Technology

Electrician/1: Fundamentals

Industry Sector:
Energy, Environment, and
Utilities

Credits: 10

Hours: 120

O*NET-SOC CODE:
47-2111.00

Course Description:

This competency-based course is the first in a sequence of five designed for electrical technician and electrician trainees. It provides students with technical instruction and practical experience in workplace safety, trade mathematics, fundamental electrical concepts, storage batteries in direct current (DC) circuits, Ohm's Law, alternating current (AC), and resource management. The competencies in this course are aligned with the California High School Academic Content Standards and the California Career Technical Education Model Curriculum Standards.

CBEDS Title:
Introduction to Electrical Power
Systems

Prerequisites:
None.

CBEDS No.:
5583

NOTE: For Perkins purposes this course has been designated as an **introductory** 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

p. 14

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 PAUL PIDOUX and MARCELA BAKER 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
Energy, Environment and Utilities 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 Energy, Environment, and Utilities academic alignment matrix for identification of standards.

2.0 Communications

Acquire, and accurately use Energy, Environment, and Utilities 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 Energy, Environment, and Utilities 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 Energy, Environment, and Utilities 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 Energy, Environment, and Utilities 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 Energy, Environment, and Utilities 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 organization.

10.0 Technical Knowledge and Skills

Apply essential technical knowledge and skills common to all pathways in the Energy, Environment, and Utilities sector.

11.0 Demonstration and Application

Demonstrate and apply the knowledge and skills contained in the Energy, Environment, and Utilities anchor standards, pathway standards, and performance indicators in classroom, laboratory, and workplace settings, and through the SkillsUSA career technical student organization.

Energy, Environment, and Utilities Sector Pathway Standards

B. Energy and Power Technology Pathway

The Energy and Power Technology pathway provides learning opportunities for students interested in preparing for careers in the energy and power industries.

Sample occupations associated with this pathway:

- ◆ Energy Efficiency Evaluation Specialist
- ◆ Energy Engineer
- ◆ Energy Generation/Power Distribution, Maintenance, Inspection, and Repair Technicians
- ◆ Energy/Building Retrofit Specialist
- ◆ Plant/Field Weatherization Installer

- B1.0 Explore the basic conventional and emerging principles and concepts of the energy industry, including energy production, energy transmission, and alternative energy technologies.
- B2.0 Identify various conventional electric power generation fuel sources and the cost and efficiency issues associated with each.
- B3.0 Investigate emerging and alternative electric power generation technologies and fuel sources.
- B4.0 Understand nonnuclear power generation plant operations (coal, oil, natural gas, solar, wind, geothermal power, hydroelectric, or biofuel).
- B5.0 Understand and apply basic knowledge and skills necessary for nuclear power generation and nuclear power plant personnel.
- B6.0 Research methods of energy procurement, transmission, distribution, and storage.
- B7.0 Understand the interrelationships among components of systems.

CBE
Competency-Based Education

COMPETENCY-BASED COMPONENTS
for the Electrician/1: Fundamentals Course

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>A. ORIENTATION AND SAFETY</p> <p>Understand, apply, and evaluate the safety rules, procedures, and acceptable work habits.</p> <p>(3 hours)</p>	<ol style="list-style-type: none"> 1. Describe class expectations. 2. Describe class rules. 3. Demonstrate the ability to read and follow instructions. 4. Identify standard shop procedures. 5. Describe shop safety rules and regulations. 6. Describe first aid practices that apply to electrical technicians and electricians. 7. Describe and demonstrate Cardio-Pulmonary Resuscitation (CPR). 8. Describe the California Occupational Safety and Health Administration (Cal/OSHA) regulations that apply to electrical technicians and electricians. 9. Describe the Environmental Protection Agency (EPA) regulations that apply to electrical technicians and electricians. 10. Describe the National Electrical Code (NEC) and its role in safeguarding the work conditions of electricians. 11. Pass the designated safety test with 100% accuracy. 	<p>Career Ready Practice: 1, 2, 3, 6, 12</p> <p>CTE Anchor: Communications: 2.1, 2.2 Health and Safety: 6.1, 6.2, 6.4, 6.6, 6.7, 6.8, 6.9, 6.11, 6.16 Ethics and Legal Responsibilities: 8.2 Technical Knowledge and Skills: 10.2</p> <p>CTE Pathway: B4.1</p>
<p>B. MATHEMATICS</p> <p>Understand, apply, and evaluate the basic mathematical functions.</p> <p>(20 hours)</p>	<ol style="list-style-type: none"> 1. Describe the metric system and its trade applications. 2. Describe the decimal system and its trade application. 3. Describe the fractional system and its trade applications. 4. Solve various basic math problems such as addition, subtraction, multiplication, and division and their trade applications. 5. Transpose three-element formulas. 6. Solve trade problems using three-element formulas. 7. Describe the appropriate mathematical calculations to solve for the unknowns. 8. Solve various trade problems using powers of ten. 	<p>Career Ready Practice: 1, 5</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.3 Problem Solving and Critical Thinking: 5.2, 5.4</p> <p>CTE Pathway: B1.8, B2.4</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>C. FUNDAMENTAL ELECTRICAL CONCEPTS</p> <p>Understand, apply, and evaluate the fundamental electrical concepts.</p> <p>(14 hours)</p>	<ol style="list-style-type: none"> 1. Define the following: <ol style="list-style-type: none"> a. electricity b. static electricity c. direct current (DC) d. magnets e. magnetism f. polarity g. magnetic polarity h. magnetic metals i. nonmagnetic metals j. conductors k. insulators l. semiconductors m. electrons 2. List five sources of electricity. 3. Describe the fundamentals of electric theory. 4. Describe the fundamentals of direct current (DC) theory. 5. Describe the flow of power in DC circuits. 6. Describe the operation of a simple battery or cell. 7. Describe polarity as it applies to batteries. 8. Describe the features and functions of the following: <ol style="list-style-type: none"> a. conductors b. insulators c. semiconductors 9. Analyze the electron structure of conductors and insulators. 10. List several examples of the following: <ol style="list-style-type: none"> a. magnetic metals b. nonmagnetic metals 11. Describe the relationship between magnetism and electricity. 12. Draw a diagram of a basic generator showing its polarities and outputs. 	<p>Career Ready Practice: 1, 3, 5</p> <p>CTE Anchor: Communications: 2.1 Problem Solving and Critical Thinking: 5.1, 5.3 Technical Knowledge and Skills: 10.1</p> <p>CTE Pathway: B1.3, B1.4, B1.5, B2.1, B2.2, B2.3, B4.1, B4.4, B5.1, B6.1</p>
<p>D. STORAGE BATTERIES IN DIRECT CURRENT (DC) CIRCUITS</p> <p>Understand, apply, and evaluate the fundamentals of DC circuits using storage batteries.</p> <p>(2 hours)</p>	<ol style="list-style-type: none"> 1. List the parts of a battery. 2. List various types of batteries such as dry cell and wet cell. 3. Describe the function of batteries. 4. Describe and demonstrate the proper techniques for checking and maintaining storage batteries. 5. Describe the operation of simple DC circuits. 6. Draw a schematic diagram of a simple DC circuit. 	<p>Career Ready Practice: 1, 3</p> <p>CTE Anchor: Communications: 2.1, 2.2 Technical Knowledge and Skills: 10.1</p> <p>CTE Pathway: B1.4</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>E. OHM'S LAW</p> <p>Understand, apply, and evaluate Ohm's law to solve circuit problems.</p>	<ol style="list-style-type: none"> 1. Define the following: <ol style="list-style-type: none"> a. voltage b. amperage/current flow c. resistance d. power e. electrical power f. mechanical power g. energy 2. List the other names for voltage. 3. List the other names for current flow. 4. List the other forms of resistance. 5. Define the following: <ol style="list-style-type: none"> a. Ohm's law b. Kirchhoff's law c. Lenz's law d. Thevenin's Theorem e. Norton's Theorem f. work as related to Ohm's law 6. Draw a simple circuit illustrating the principle of Ohm's law. 7. Solve various Ohm's law problems for: <ol style="list-style-type: none"> a. voltage b. current c. resistance d. power 8. List the five elements present in electrical circuits. 9. List the three effects of electrical power. 10. Describe the relationship of electrical to mechanical power. 11. Define the following: <ol style="list-style-type: none"> a. series circuit b. parallel circuit 12. Draw a simple series circuit. 13. List the rules governing current and voltage in series circuits. 14. Perform calculations related to given series circuits to find the following: <ol style="list-style-type: none"> a. voltages b. currents c. resistance d. powers 15. Draw a simple parallel circuit. 16. List the rules governing voltage and current in a parallel circuit. 17. Draw voltage and current paths in given circuits. 18. Solve various problems for unknown quantities in voltage and current paths in given circuits. 19. Describe the rules for equal resistances in parallel circuits. 20. Describe the formula for two unequal resistances in parallel circuits. 	<p>Career Ready Practice: 1, 2, 3, 5</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.3 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4 Technical Knowledge and Skills: 10.1, 10.2, 10.6</p> <p>CTE Pathway: B1.4, B7.3, B7.5</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(40 hours)	<ol style="list-style-type: none"> 21. Find the combined values of given unequal resistances in parallel circuits. 22. Write the formula for several unequal resistances in parallel circuits. 23. Solve given problems using unequal values of resistances in parallel circuits. 24. Describe the features and functions of series, parallel, and series-parallel circuits. 25. Reduce to simplest form series-parallel circuits. 26. Solve various problems relating to series-parallel circuits. 27. Describe the practical effects of series resistances in electrical circuits. 28. State the NEC requirements for voltage drop in electrical circuits as a percentage of voltage. 29. List commonly used wire sizes in the electrical trade. 30. Describe the relationship between numerical size and physical size of commonly used wire. 31. Describe the effects of the following on each other: <ol style="list-style-type: none"> a. wire size b. length c. resistance d. current carrying capacity 32. List the common types of insulation encountered in the trade. 	
<p>F. ALTERNATING CURRENT (AC) THEORY</p> <p>Understand, apply, and evaluate the AC theory.</p>	<ol style="list-style-type: none"> 1. Define the following: <ol style="list-style-type: none"> a. alternating current (AC) b. Root Mean Square (RMS) c. hertz d. phase e. phase angles f. inductance g. Electromagnetic Force (EMF) h. reactance i. capacitance j. capacitive reactance k. impedance 2. Apply the rules of magnetism and electricity to the generation of the sine wave. 3. Calculate the values of RMS and peak voltages or currents. 4. Calculate the amount of time in a sine wave. 5. Describe the theory behind AC generation. 6. Describe single- and three-phase power systems and their generation. 7. Differentiate between DC, single-phase, and three-phase power systems. 8. Describe the units of measure for inductance. 9. Describe flux linkages by means of drawings. 10. List electrical equipment having or using inductance. 	<p>Career Ready Practice: 1, 2, 3, 5</p> <p>CTE Anchor: Communications: 2.1, 2.2, 2.3, 2.4 Problem Solving and Critical Thinking: 5.1, 5.2, 5.3, 5.4 Health and Safety: 6.1, 6.6, 6.8, 6.9 Ethics and Legal Responsibilities: 8.2 Technical Knowledge and Skills: 10.1</p> <p>CTE Pathway: B1.3, B1.4, B1.5, B4.1, B6.1, B7.1, B7.3, B7.4, B7.5</p>

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
(40 hours)	<ol style="list-style-type: none"> 11. Explain inductive reactance using counter EMF. 12. Describe the characteristics of voltages in circuits. 13. Describe the characteristics of magnetism/electromagnetism. 14. Describe the Theory of Superposition. 15. Describe the use of the Theory of Superposition in solving for multiple voltages sources circuits. 16. Describe the operation and characteristics of three wire systems. 17. Demonstrate phase relationships using current and voltage sine waves. 18. Compare and contrast: <ol style="list-style-type: none"> a. maximum voltage b. maximum current c. effective (RMS) voltage d. effective (RMS) current e. average voltage f. average current g. peak to peak voltage h. peak to peak current 19. List the components that utilize mutual inductance. 20. Differentiate between reactance and power factor impedance. 21. Describe transformer action. 22. Compare transformer turns ratio with voltage and current ratios. 23. Describe the general rules of transformer operation. 24. Compare the following types of transformers: <ol style="list-style-type: none"> a. step-up transformer b. step-down transformer c. isolation transformer d. autotransformer 25. List operating conditions important to the transformer. 26. Compare the input and output power of a transformer. 27. Calculate the efficiency of transformers. 28. Describe the nameplate information on transformers. 29. Describe the selection of and installation of transformers. 30. Describe different distribution systems. 31. Calculate the input and output currents of transformers. 32. Describe the safe use of the current transformer. 33. Demonstrate the ability to measure transformer parameters. 34. Demonstrate the ability to make proper polarity connections. 35. List the parts of capacitors. 36. Describe the construction of capacitors. 37. List cautions to be observed when using capacitors. 38. Calculate capacitive reactance. 39. List various uses of capacitive devices. 40. Compare real and reactive power. 41. Describe power factor. 42. List various reasons to minimize power factor. 43. Describe two main methods of reducing power factor. 	

COMPETENCY AREAS AND STATEMENTS	MINIMAL COMPETENCIES	STANDARDS
<p>G. RESOURCE MANAGEMENT</p> <p>Understand, apply, and evaluate resource management in the electrical industry.</p> <p>(1 hour)</p>	<ol style="list-style-type: none"> 1. Define the following: <ol style="list-style-type: none"> a. resources b. management c. sustainability 2. Describe the management of the following resources: <ol style="list-style-type: none"> a. time b. materials c. personnel 3. List specific examples of effective management of the following in the electrical industry: <ol style="list-style-type: none"> a. time b. materials c. personnel 4. Describe the following benefits of effective resource management in the electrical industry: <ol style="list-style-type: none"> a. profitability b. company growth c. stability 	<p>Career Ready Practice: 1, 2, 3, 8, 11</p> <p>CTE Anchor: Communications: 2.1 Problem Solving and Critical Thinking: 5.1, 5.4 Responsibility and Flexibility: 7.1, 7.2, 7.3, 7.4, 7.6 Ethics and Legal Responsibilities: 8.3, 8.4, 8.5</p> <p>CTE Pathway: B1.6</p>

SUGGESTED INSTRUCTIONAL MATERIALS and OTHER RESOURCES

TEXTS AND SUPPLEMENTAL BOOKS

Gerrish, Howard H., W.E. Dugger, Jr. and K.P. DeLuca. Electricity, 10th Edition. Goodheart-Willcox. 2009.

Miller, Charles R. NFPA's Pocket Electrical References. Jones and Bartlett Publishers, 2006.

National Fire Protection Association. User's Guide to the National Electrical Code, 2008 Edition. Jones and Bartlett Publishers, 2009

Stallcup, James G. Stallcup's Electrical Grounding and Bonding Simplified, 2008 Edition. Jones and Bartlett Publishers, 2010

Stauffer, H. Brooke. NFPA's Residential Wiring, 3rd Edition. Jones and Bartlett Publishers, © 2009. ISBN: 9780763752606.

Trout, Charles M. Essentials of Electric Motors and Controls. Jones and Bartlett Publishers, 2010.

Williams, Noel. NEC Q&A: Questions and Answers on the National Electrical Code. Jones and Bartlett Publishers, 2007.

RESOURCES

Employer Advisory Board members

CTE Model Curriculum Standards

<http://www.cde.ca.gov/ci/ct/sf/documents/energyutilities.pdf>

Local representatives of the IBEW

Representatives/members of the International Association of Electrical Inspectors

www.americangreenjobs.net

COMPETENCY CHECKLIST

TEACHING STRATEGIES and EVALUATION

METHODS AND PROCEDURES

- A. Lecture and discussion
- B. Multi-media presentations
- C. Visual aids
- D. Reference reading and study
- E. Individualized instruction

EVALUATION

SECTION A – Orientation and Safety – Pass the safety test with 100% accuracy.

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

SECTION C – Fundamental Electrical Concepts – Pass all assignments and exams on fundamental electrical concepts with a minimum score of 80% or higher.

SECTION D – Storage Batteries in Direct Current (DC) Circuits – Pass all assignments and exams on storage batteries in direct current (DC) circuits with a minimum score of 80% or higher.

SECTION E – Ohm’s Law – Pass all assignments and exams on Ohm’s Law with a minimum score of 80% or higher.

SECTION F – Alternating Current Theory – Pass all assignments and exams on alternating current theory with a minimum score of 80% or higher.

SECTION G – Resource Management – Pass all assignments and exams on resource management 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.
