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Electrical

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The Research and Curriculum Unit (RCU), located in Starkville, MS, as part of Mississippi State University, was established to foster educational enhancements and innovations. In keeping with the land grant mission of Mississippi State University, the RCU is dedicated to improving the quality of life for Mississippians. The RCU enhances intellectual and professional development of Mississippi students and educators while applying knowledge and educational research to the lives of the people of the state. The RCU works within the contexts of curriculum development and revision, research, assessment, professional development, and industrial training.

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Mr. William Harold Jones, Chair
Mr. Charles McClelland, Vice Chair
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Mr. Claude Hartley
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Mike Barkett, State Director, Mississippi Construction Education Foundation, Ridgeland, MS

Standards

Standards are superscripted in each unit and are referenced in the appendices. Standards in the *Electrical Curriculum Framework and Supporting Materials* are based on the following:

Contren Learning Standards
The NCCER developed and published a set of industry standards that are taught nationwide by contractors, associations, construction users, and secondary and postsecondary schools called the **Contren Learning Series.** When developing this set of standards, the NCCER assembled a team of subject matter experts that represented construction companies and schools across the nation. Each committee met several times and combined experts' knowledge and experience to finalize the set of national industry standards. This curriculum has been aligned to modules in the Contren Learning Series as endorsed by the National Center for Construction Education and Research (NCCER). Students who study this curriculum using the Contren Learning Series materials under the supervision of an instructor who has been certified by the NCCER are eligible to be tested on each module. Students who successfully pass these tests may be certified to the NCCER by the instructor and will receive documentation from NCCER.

Common Core State Standards Initiative
The Common Core State Standards provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy. Copyright 2010. National Governors Association Center for Best Practices and Council of Chief State School Officers. **All rights reserved.** States and territories of the United States as well as the District of Columbia that have adopted the Common Core State Standards in whole are exempt from this provision and no attribution to the National Governors Association Center for Best Practices and Council of Chief State School Officers is required. Reprinted from http://www.corestandards.org/.

National Educational Technology Standards for Students
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21st Century Skills and Information and Communication Technologies Literacy Standards
In defining 21st century learning, the Partnership for 21st Century Skills has embraced five content and skill areas that represent the essential knowledge for the 21st century: global awareness; civic engagement; financial, economic, and business literacy; learning skills that encompass problem-solving, critical-thinking, and self-directional skills; and Information and Communication Technology (ICT) literacy.

Preface

Secondary career and technical education programs in Mississippi are faced with many challenges resulting from sweeping educational reforms at the national and state levels. Schools and teachers are increasingly being held accountable for providing true learning activities to every student in the classroom. This accountability is measured through increased requirements for mastery and attainment of competency as documented through both formative and summative assessments.

The courses in this document reflect the statutory requirements as found in Section 37-3-49, Mississippi Code of 1972, as amended (Section 37-3-46). In addition, this curriculum reflects guidelines imposed by federal and state mandates (Laws, 1988, ch. 487, §14; Laws, 1991, ch. 423, §1; Laws, 1992, ch. 519, §4 eff. from and after July 1, 1992; Carl D. Perkins Vocational Education Act IV, 2007; and No Child Left Behind Act of 2001).

Electrical Executive Summary

Pathway Description

Electrical is a pathway in the Architecture and Construction career cluster. Study in the course allows an individual to prepare for employment and/or continued education in the electrical field. Skills developed through the course of study assist students in meeting requirements for the NCCER certification. Students are provided the opportunity to participate in Career and Technical Student Organizations to include SkillsUSA.

Industry Certification

The NCCER developed and published a set of industry standards that are taught nationwide by contractors, associations, construction users, and secondary and postsecondary schools called the Contren Learning Series. When developing this set of standards, the NCCER assembled a team of subject matter experts that represented construction companies and schools across the nation. Each committee met several times and combined experts' knowledge and experience to finalize the set of national industry standards.

As a part of the accreditation process, all Mississippi construction instructors will be required to successfully complete the Instructor Certification Training Program. This program ensures that instructors possess a deep knowledge of content of the standards.

This state-of-the-art curriculum is modeled after the eight Mississippi NCCER Accredited Training and Education Facilities (ATEF). In order to become an NCCER ATEF program, school districts must meet a set of guidelines including the following:

1. Use the approved curriculum.
2. All instructors must be NCCER certified.
3. All completed Form 200s and release forms on all student completions are to be forwarded to MCEF for proper approval. MCEF will in turn forward to NCCER for processing.
4. Follow NCCER guidelines on test security and performance profiles.
5. Have an active advisory committee with at least two commercial contractors involved.
6. Follow safety practices and Occupational Safety and Health Administration (OSHA) standards used in the class and lab areas.
7. Involve commercial contractors in class presentations or field trips.
8. All construction programs must be included in the accreditation process.
9. Show active involvement in student leadership development (e.g., VICA and SkillsUSA).
10. Provide demonstrated placement into construction-related occupations, and provide timely reports to MCEF.

Districts will be required to complete a self-evaluation of all programs and host a site visit from industry to ensure proper lab, safety, and instructional procedures are in place.

Assessment

Students will be assessed using the Secondary Electrical Year Two MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://www.rcu.msstate.edu/Curriculum/CurriculumDownload.aspx. All students will test after year one of the Construction program. A second test covering the second year material in Electrical will be administered to students upon completion of their program. If there are questions regarding assessment of this program, please contact the Architecture and Construction instructional design specialist at the Research and Curriculum Unit at 662.325.2510.

Student Prerequisites

In order for students to be successful in the Electrical program, the following student prerequisites are in place:

1. C or higher in English (the previous year)
2. C or higher in Math (last course taken or the instructor can specify the math)
   or
3. Instructor Approval and TABE Reading Score (eighth grade or higher)
   or
4. Instructor Approval

Licensure Requirements

A 978 educator license is required to teach the Electrical pathway. This endorsement licenses a person to teach the following secondary courses:

993101 Construction
993102 Safety and Orientation to Construction
993103 Introduction to Construction
993120 Electrical
993121 Theory and Application of Electrical I
993122 Theory and Application of Electrical II

Minimum Requirements for this Endorsement:

1. Education
   - Applicant must have earned a two-year college degree (associate degree) or higher from an accredited institution of higher education. [Exception: Teachers with a currently valid license and endorsement #352 Electrical may earn this endorsement based on that #352 endorsement even if two-year college degree is not earned. All other requirements for this endorsement must be satisfied.]

2. Technology Literacy and Related Assessment of that Competency
   - Applicant must validate technology competency by attaining the established minimum score or higher on an assessment approved by the Mississippi Department of Education (MDE). The assessment must be directly related to technology competency required by the grade level and subject matter being taught. Approved assessments for this license are IC3, Propulse, or other specific assessment created by third-party vendors, authorized by the Local Education Agency (LEA) and approved by the MDE.

3. Occupational Experience and Related Assessment of that Experience
   - Applicants with an associate degree must have at least two years of verifiable occupational experience in the past ten years. Experience must be appropriate to the subject to be taught.
   - Applicants with a bachelor or higher degree must have at least one year of verifiable occupational experience in the past ten years. Experience must be appropriate to the subject to be taught.

   This endorsement requires the following assessment(s) of occupational expertise:
   National Center for Construction Education and Research (NCCER), National Craft Assessment and Certification Program: Earn required score on Commercial Electrician assessment. OR Other teacher occupational competency assessment approved by the MDE Office of Career and Technical Education.

4. Teacher Education Preparation and Related Assessment(s) of that Education
   - Applicant must enroll immediately in Vocational Instructor Preparation (VIP) program or the College and Career Readiness Educator Program (CCREP).

- Applicant must complete the individualized professional development plan (PDP) requirements of the VIP or CCREP program prior to the expiration date of the three-year vocational license.
- Applicant must successfully complete the Contren instructor certification.
- Applicant must successfully complete a certification for online learning workshop, module, or course that is approved by the Mississippi Department of Education.
- Applicant must successfully complete the Construction certification workshop, module, or course that is approved by the Mississippi Department of Education.

Note #1: If the applicant meets all requirements listed above, that applicant will be issued a 978 endorsement—a five-year license. If the applicant does not meet all requirements, the applicant may be issued a three-year endorsement (license), and all requirements stated above must be satisfied prior to the ending date of that license.

Professional Learning

The professional learning itinerary for the middle school or individual pathways can be found at www.rcu.msstate.edu. If you have specific questions about the content of each training session provided, please contact the Research and Curriculum Unit at 662.325.2510 and ask for the Professional Learning Specialist.

Course Outlines

Option 1—Two One-Carnegie-Unit Courses

Course Description: **Theory and Application of the Electrical I**

The Theory and Application of the Electrical I course consists of an in-depth study of electrical theory and an introduction to wiring. This one-Carnegie-unit course should only be taken after students successfully pass Safety and Orientation to Construction and Introduction to Construction.

Course Description: **Theory and Application of Electrical II**

The Theory and Application of Electrical II course consists of an in-depth study of devices and boxes, hand bending, conductors and cables, and electrical drawings. This one-Carnegie-unit course should only be taken after students successfully pass Theory and Application of Electrical I.

Theory and Application of Electrical I —Course Code: 993121

Unit Number	Unit Name	Hours
1	Orientation and Safety (Review and Reinforcement)	6
2	Introduction to Electrical Theory	30
3	Introduction to NEC and Residential Wiring	50
Total		86

Theory and Application of Electrical II —Course Code: 993122

Unit Number	Unit Name	Hours
4	Devices and Boxes	50
5	Hand Bending	30
6	Conductors and Cables	30
7	Electrical Construction Drawings	14
Total		124

Option 2—One Two-Carnegie-Unit Course

Course Description: Electrical (993120)

The Electrical course consists of an in-depth study of electrical theory, introduction to wiring, devices and boxes, hand bending, conductors and cables, and electrical drawings. This two-Carnegie-unit course should only be taken after students successfully pass Electrical. Upon the completion of the two courses, students will have the knowledge to complete the Contren Level I Certification.

Electrical—Course Code: 993120

Unit Number	Unit Name	Hours
1	Orientation and Safety (Review and Reinforcement)	6
2	Introduction to Electrical Theory	30
3	Introduction to NEC and Residential Wiring	50
4	Devices and Boxes	50
5	Hand Bending	30
6	Conductors and Cables	30
7	Electrical Construction Drawings	14
Total		210

Electrical Research Synopsis

Introduction

People in the Electrical Technology occupational category install, maintain, and oversee electrical and power systems for residential, commercial, and manufacturing establishments. Nearly 80 percent of electricians work in construction (US Bureau of Labor Statistics, 2011). Other industries, however, do employ electricians. Skills for electrical occupations may be obtained in on-the-job training but may require as much as an advanced degree.

Needs of the Future Workforce

There were over 1.1 million people employed in electrical occupations in the United States in 2010. The field is predicted to grow about as fast as average in the Unites States (16 percent), as well as in Mississippi (14 percent) over the projection decade, 2010 through 2020 (EMSI, 2011). Job prospects are best for electrical employees with diverse skills, formal education, and experience. (EMSI, 2011).

Region	2010 Jobs	2020 Jobs	Change	% Change	Openings	2011 Median Hourly Earnings
Regional Total	**9,068**	**10,339**	**1,271**	**14%**	**3,754**	**$20.17**
State Total	**10,836**	**12,559**	**1,723**	**16%**	**4,670**	**$19.55**
National Total	**1,138,593**	**1,174,887**	**36,294**	**3%**	**360,330**	**$24.20**

Source: EMSI Complete Employment - 2011.2

Perkins IV Requirements

The Electrical curriculum will meet Perkins IV requirements of high-skill, high-wage, and/or high-demand occupations by offering students a program of study, including secondary, postsecondary, and/or IHL courses that will prepare them for occupations in this field. Additionally, the Electrical curriculum is integrated with Common Core academic standards and 21st Century Skills.

Workforce Learning

The curriculum for Electrical combines effective classroom instruction with hands-on training. Students are provided opportunities and are required to apply instructional competencies to authentic lab experiences, where they will demonstrate skills and knowledge previously learned in the classroom. Learning strategies may include field trips, career preparation, and experience learned from those already in the profession.

Summary of Standards

The standards to be included in the Electrical curriculum are the NCCER, 21st Century Skills, the National Educational Technology Standards for Students (NETS-S), and the Common Core standards. Combining these standards to create this document will result in highly skilled, well-rounded students who are prepared to enter secondary education with the technology and career planning skills necessary.

Transition to Postsecondary Education

Articulated Secondary Course		Articulated Postsecondary Course
S Electrical (CIP: 46.0302)	Construction Residential Maintenance (46.0401 Building Property Maintenance and Management)	CRM 1514 – Electrical
S Electrician (CIP 46.0302)	PS Electrical Technology (CIP	ELT 1192 – 3 Fundamentals of

	46.0302 Electrical)	Electricity

Articulation credit from Secondary Electrical to Postsecondary Construction Residential Maintenance or Postsecondary Electrical Technology will be awarded beginning with the fall semester of 2014. Secondary students must have completed the Secondary Electrical program and scored at the 80 percentile or higher on the Mississippi Career Planning and Assessment System (MS-CPAS2). The Mississippi Community College Board will forward the scores for each district to the Director of Admissions/Registrar at each postsecondary institution. No grade will be given on the transcript; only hours granted will be transcripted (therefore making no changes to quality points). Twelve (12) additional hours must be earned before credit is transcripted. No cost will be assessed on credit assigned to a student receiving articulated credit. MS-CPAS2 scores may be accepted for up to 12 months after they are published.

Best Practices

Innovative Instructional Technologies

Recognizing that today's students are digital learners, the classroom should be equipped with tools that will teach them in the way they need to learn. The Electrical curriculum includes teaching strategies that incorporate current technology. Each classroom should incorporate one teacher desktop or laptop. It is suggested that each classroom be equipped with an interactive white board and projector, intensifying the interaction between students and teachers during class. Teachers are encouraged to make use of the latest online communication tools such as wikis, blogs, and podcasts. They are also encouraged to teach using the content delivery system Blackboard, which introduces students to education in an online environment and places the responsibility of learning on the student.

Differentiated Instruction

Students learn in a variety of ways. Some are visual learners, needing only to read information and study it to succeed. Others are auditory learners, thriving best when information is read aloud to them. Still others are tactile learners, needing to participate actively in their learning experiences. Add the student's background, emotional health, and circumstances, and a very unique learner emerges. To combat this, the Electrical curriculum is written to include several instructional methods by using the Understanding by Design (UbD) approach. This method of instruction design leads students to a deeper understanding of course material and provides multiple opportunities for students to succeed in different ways. Many activities are graded by rubrics that allow students to choose the type of product they will produce. By providing various teaching and assessment strategies, students with various learning styles can succeed.

Career and Technical Education Student Organizations

There are student organizations for students that would be relevant to this curriculum. Teachers are encouraged to charter one of these organizations if one is not already available to students. The suggested organization for this course is SkillsUSA. Contact information for this and other related organizations is listed under "Professional Organizations" in this document.

Conclusions

Based on the previous information, the Electrical curriculum will be filled with opportunities to develop workforce skills. Widely used teaching strategies such as cooperative learning, problem-based learning, and demonstration will also be included. These will help to prepare students for the hands-on instruction they will likely receive upon entering the workforce. Because many of the instructors make use of the rubrics and teaching and assessment strategies, they will continue to be included in the curriculum document. The curriculum document will be updated regularly to reflect the needs of the electrical workforce.

Professional Organizations

SkillsUSA
14001 SkillsUSA Way
Leesburg, VA 20176
703.777.8810
http://www.skillsusa.org/

NCCER
3600 NW 43rd Street, Bldg. G
Gainesville, FL 32606
http://www.nccer.org/

International Association of Electrical Inspectors
901 Waterfall Way
Richardson, TX 75080
www.iaei.org

National Electrical Contractors Association
576 Trabert Avenue
Atlanta, GA 30318
www.necanet.org

Using this Document

Unit Number and Title

Suggested Time on Task
An estimated number of clock hours of instruction that should be required to teach the competencies and objectives of the unit. A minimum of 140 hours of instruction is required for each Carnegie unit credit. The curriculum framework should account for approximately 75–80% of the time in the course.

Competencies and Suggested Performance Indicators
A competency represents a general concept or performance that students are expected to master as a requirement for satisfactorily completing a unit. Students will be expected to receive instruction on all competencies. The suggested performance indicators represent the enabling and supporting knowledge and performances that will indicate mastery of the competency at the course level.

Suggested Teaching Strategies
This section of each unit indicates research-based strategies that can be used to enable students to master each competency. Emphasis has been placed on strategies that reflect active learning methodologies. Teachers should feel free to modify or enhance these suggestions based on needs of their students and resources available in order to provide optimum learning experiences for their students.

Suggested Assessment Strategies
This section indicates research-based strategies that can be used to measure student mastery. Examples of suggested strategies could include rubrics, class participation, reflection, and journaling. Again, teachers should feel free to modify or enhance these suggested assessment strategies based on local needs and resources.

Integrated Academic Topics, 21st Century Skills and Information and Communication Technology Literacy Standards, ACT College Readiness Standards, and Technology Standards for Students
This section identifies related academic topics as required in the Subject Area Testing Program (SATP) in Algebra I, Biology I, English II, and U.S. History from 1877, which are integrated into the content of the unit. Research-based teaching strategies also incorporate ACT College Readiness standards. This section also identifies the 21st Century Skills and Information and Communication Technology Literacy skills. In addition, national technology standards for students associated with the competencies and suggested objectives for the unit are also identified.

References
A list of suggested references is provided for each unit. The list includes some of the primary instructional resources that may be used to teach the competencies and suggested objectives. Again, these resources are suggested, and the list may be modified or enhanced based on needs and abilities of students and on available resources.

Unit 1: Orientation and Safety (Review and Reinforcement)

Understandings and Goals

Enduring Understandings
In this unit, the student will:

- Describe employment opportunities and responsibilities.
- Describe safety issues that are inherent to this field.

Essential Questions

- What type of career paths and job opportunities are available in your area?
- What are the expectations of a beginning electrician?

Vocabulary

Identify and review the unit vocabulary.

Electrical Service
Occupational Safety and Health Administration (OSHA)
On-the-job training (OJT)
Double insulated/ungrounded tool
Fibrillation
Grounded tool
Ground fault circuit interrupter (GFCI)

Suggested Learning Experiences

Competency 1: Describe the apprenticeship/training process for electricians. (DOK 1, ELO)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Identify an employment pathway and the tools used by job seekers. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	a. Have each student use the Internet or newspapers to choose a job for which he or she is qualified and prepare a resume and cover letter that can be used to apply for the selected job. Have an industry speaker present to the class about the many choices in the electrical field and the work environment.	a. Résumé rubric
b. Explain the general requirements for apprenticeship programs. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	b. Have all students go online and access the NCCER Web site. Locate materials that provide access to apprenticeship information. Explain the pathways with varying educational attainment: GED to college degree.	b. Start a portfolio.

Competency 2: Describe various career paths/opportunities one might follow in the electrical trade. (DOK 1, ELO)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Describe employment opportunities and responsibilities. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	a. Explain educational and career opportunities including starting salaries, job locations, and working conditions that will be available to students after they complete the program.	a. Journal rubric
b. Identify common electrical systems. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	b. Have students brainstorm and list as many electrical items as possible that students interact with in one day.	b. Presentation rubric

Competency 3: Develop a task plan and a hazard assessment for a given task and select the appropriate personal protective equipment (PPE) and work methods to safely perform the task. (DOK 2, ELO)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Explain the importance of following all safety rules and company safety policies. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	a. Identify, discuss, and demonstrate terms, rules, and procedures related to shop/lab and industry safety. (Contren Core Text Basic Safety Unit and Level I Orientation to the Trade Unit). Provide the students with a list of terms and have them define the terms. Pair the students to quiz each other on the definitions in preparation for a written exam.	a. Student participation will be monitored by the teacher, and the written exam will be utilized to test student knowledge.
b. Describe how to avoid	b. Using the guidelines provided for personal safety	b. Performance rubric

on-site accidents. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	(i.e., clothing, jewelry, hair, eyes, and ears). Divide the students into pairs and assign each pair one of the guidelines. Each pair will demonstrate the "dos and don'ts" of the guideline.	
c. Demonstrate the appropriate use and care of personal protective equipment. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	c. Have an industry speaker present to the class the necessity of safety in the work environment. Remind students why they must wear PPE, especially for the skin and eyes.	c. Evaluate student presentations using presentation rubric.

Competency 4: Review general safety rules for working in a shop/lab and industry. (DOK 1, ELO)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Describe how to avoid on-site accidents. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	a. Identify, discuss, and demonstrate terms, rules, and procedures related to shop/lab and industry safety. (Contren Core Text Basic Safety Unit and Level I Introduction to Electrical Unit)	a. Student participation will be monitored by the teacher, and the written exam will be graded.
b. Explain the relationship between housekeeping and safety. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	b. Demonstrate the dangers of poor housekeeping using an illustration or actual shop simulation. Required written tests will follow each section of guidelines for safety rules and procedures.	b. Student participation will be monitored by the teacher, and the written exam will be graded.
c. Explain the importance of following all OSHA safety regulations and company safety policies. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	c. Provide the students with a list of terms and have them define the terms. Pair the students to quiz each other on the definitions in preparation for a written exam. Access the OSHA Web site to reference terms, videos, and regulations.	c. Student participation will be monitored by the teacher, and the written exam will be graded.
d. Recognize, explain, and maintain personal protective equipment. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	d. Divide the students into pairs and assign each pair one of the guidelines provided for personal safety (i.e., clothing, jewelry, hair, eyes, and ears). Have each pair demonstrate the "dos and don'ts" of the guidelines	d. The "dos and don'ts" exercise will be critiqued with a peer review.
e. Explain the importance of reporting all on-the-job injuries, accidents, and near misses. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	e. Have an industry speaker present to the class the necessity of safety in the work environment. Have students write a summary of the presentation. Provide a sample accident report for the students to practice completing.	e. The summary of the speaker's presentation will be critiqued using a rubric. Use completed report key to grade the activity.
f. Explain the need for evacuation policies and the importance of following them. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	f. Review and practice evacuation procedures. Required written tests will follow each section of guidelines for safety rules and procedures.	f. Written exams will be graded.
g. Explain the employer's	g. Have the class discuss various scenarios concerning	g. Written exams will be

substances abuse policy and how it relates to safety. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	operating equipment will under the influence of substances. Required written tests will follow each section of guidelines for safety rules and procedures.	graded.
h. Explain the safety procedures when working near pressurized or high temperature systems. (CS1, CS2, CS6, CS8, CS11, CS16, CCSL1, CCSL2, CCSL3, T1, T2, T4, T6)	h. Using video or field trip to a plant with high temperature or pressurized systems, explain the safety procedures. Required written tests will follow each section of guidelines for safety rules and procedures.	h. Written exams will be graded.
Note: SAFETY IS TO BE TAUGHT AS AN ONGOING PART OF THE COURSE THROUGHOUT THE YEAR.		
Note: Instruction for a portion of this unit may be accomplished in an online environment.		

Performance Task

Wiring Down Under

You are a journeyman electrician, supervising two groups of workers. One group is responsible for the rough in and the other is responsible for final electrical connections. The task is to install underground wiring 20 ft below ground in the vicinity of gas lines. It is an eight-hour job with a total of four people. Each group must develop a task plan, a hazard assessment, and select the proper PPE necessary. The plan must identify and include all reasonable considerations for the job. You will be judged on all safety measures, the performance of the task, and the maintenance the workspace.

Attachments for Performance Task

Use the Performance Assessment.

Unit Resources

Books:

American Association for Vocational Instructional Materials. (2002). *Developing safety skills for shop or home.* Winterville, GA: AVVIM.

Bevelacqua, A., & Stilp, R. (1998). *Hazardous materials field guide.* Albany, NY: Delmar.

Croft, T., Summers, W. I., & Hartwell, F. P. (2008). *American electrcian's handbook.* Retrieved August 29, 2011, from http://www.amazon.com/American-Electricians-Handbook-15th-Edition/dp/B001F6ND8O

Goetsch, D. (2000). *The safety and health handbook.* Upper Saddle River, NJ: Pearson Prentice Hall.

National Center For Construction Education and Research. (2004). *Core curriculum: Introductory craft skills.* Upper Saddle River, NJ: Prentice Hall.

Rosenberg, P. (2007). *DeWALT® construction safety/OSHA professional reference.* Clifton Park, NY: Delmar Learning.

VanCise, D., & VanCise, M. (2004). *Construction industry guide to OSHA for residential and light commercial construction.* Berne, NY: UHAI.

Web sites:

Electrician 2. Retrieved August 29, 2011, from http://electrician2.com/

Mike Holt. Retrieved August 29, 2011, from http://www.mikeholt.com/
National Electrical Contractors Association. Retrieved June 13, 2011, from http://www.necanet.org/

National Fire Protection Association. Retrieved June 13, 2011, from http://www.nfpa.org/index.asp

Occupational Safety and Health Administration. Retrieved June 13, 2011, from http://www.osha.gov/

The Construction Safety Council. Retrieved June 13, 2011, from http://www.buildsafe.org/

The Hanford Fire Department. Retrieved June 13, 2011, from http://www.hanford.gov/page.cfm/HanfordFireDepartment

Unit 2: Introduction to Electrical Theory, Circuits, and Test Equipment

Understandings and Goals

Enduring Understandings
In this unit, the student will:

- Define the units of measurement that are used to measure the properties of electricity.
- Explain the difference between conductors and insulators.
- Explain the basic characteristics and calculation of series, parallel, and combination circuits.
- Identify and explain the operation of and describe the following pieces of test equipment.

Essential Questions

- How would knowing the difference between AC and DC power help me choose my career path?
- What does Ohm's law have to do with understanding the electrical field?

Vocabulary

Identify and review the unit vocabulary.

Ampere
Ammeter
Atom
Battery
Circuit
Coil
Continuity
Current
Electron
Frequency
Ohm
Ohm's law
Power
Proton
Resistance
Series circuit
Transformer
Volt
Voltage drop
Watt

Suggested Learning Experiences

Competency 1: Define the units of measurement that are used to measure the properties of electricity. (DOK 1, ELC, ERS, ETE)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Describe laws of electrical charges including like and unlike charges. (CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR6, CCR7, CCR8, CCR9, , CCL3, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM16, CCM22, CCM23, CCM26, CCM33, CCM37, CCM40, CCM41, CCM42, CCM45, CCM52, CCM53, T2, T4, T6)	a. The teacher will demonstrate voltage presence, current drop, positive and negative charges, and resistance changes.	a. Test
b. Describe methods of generating electricity including solar, chemical, mechanical, and thermal. (CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR6, CCR7, CCR8, CCR9, , CCL3, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM16, CCM22, CCM23, CCM26, CCM33, CCM37, CCM40, CCM41, CCM42, CCM45, CCM52, CCM53, T2, T4, T6)	b. Students will discuss the most common supplier of AC and DC power.	b. Field trip. Have students keep a journal or written reflection.
c. Describe the terms and scientific principles associated with direct current electricity. (CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR6, CCR7, CCR8, CCR9, , CCL3, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM16, CCM22, CCM23, CCM26, CCM33, CCM37, CCM40, CCM41, CCM42, CCM45, CCM52, CCM53, T2, T4, T6)	c. Students will discuss electrical principles and give examples.	c. Group work assessment rubric
d. Define terms associated with the nature of matter, including physical	d. Students will research, identify, and discuss terms they will use in the electrical profession.	d. Test on terminology

characteristics of matter (elements, compounds, atoms, electrons, protons, and neutrons). (CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR6, CCR7, CCR8, CCR9, , CCL3, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM16, CCM22, CCM23, CCM26, CCM33, CCM37, CCM40, CCM41, CCM42, CCM45, CCM52, CCM53, T2, T4, T6)		

Competency 2: Explain the difference between conductors and insulators. (DOK 1, ELC, ERS, ETE)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Identify electrical materials including conductors and insulators. (CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR6, CCR7, CCR8, CCR9, , CCL3, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM16, CCM22, CCM23, CCM26, CCM33, CCM37, CCM40, CCM41, CCM42, CCM45, CCM52, CCM53, T2, T4, T6)	a. Discuss with students the material used to create conductors and insulators then demonstrate how conductors and insulators differ from each other. Have students locate information about conductors and insulators in the NEC codebook.	a. Test and performance assessment

Competency 3: Explain the basic characteristics and calculation of series, parallel, and combination circuits. (DOK 2, ELC, ERS, ETE)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Draw and construct a series, parallel, and combination circuit with a minimum of three resistances. (CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR6, CCR7, CCR8, CCR9, , CCL3, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM16, CCM22, CCM23, CCM26, CCM33, CCM37, CCM40, CCM41, CCM42, CCM45, CCM52, CCM53, T2, T4, T6)	a. The teacher will discuss and give examples of different circuits. The student will determine what circuits will be used to properly identify each of the three types.	a. Performance rubric
b. Calculate and measure circuit parameters for a	b. Use Ohm's law chart to calculate answers. Discuss how to add using Ohm's law chart.	b. Performance rubric

series, parallel, and combination circuit. (CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR6, CCR7, CCR8, CCR9, , CCL3, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM16, CCM22, CCM23, CCM26, CCM33, CCM37, CCM40, CCM41, CCM42, CCM45, CCM52, CCM53, T2, T4, T6)		
c. Calculate, using Kirchhoff's voltage law, the voltage drop in series, parallel, and series-parallel circuits. (CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR6, CCR7, CCR8, CCR9, , CCL3, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM16, CCM22, CCM23, CCM26, CCM33, CCM37, CCM40, CCM41, CCM42, CCM45, CCM52, CCM53, T2, T4, T6)	c. Calculate and measure circuit parameters for a series-parallel circuit.	c. Test for correctness
d. Calculate, using Kirchhoff's current law, the total current in parallel and series-parallel circuits. (CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR6, CCR7, CCR8, CCR9, , CCL3, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM16, CCM22, CCM23, CCM26, CCM33, CCM37, CCM40, CCM41, CCM42, CCM45, CCM52, CCM53, T2, T4, T6)	d. Demonstrate use of Kirchhoff's law to calculate circuit parameters for a series-parallel circuit including voltage, current, resistance, and power.	d. Test for correctness

Competency 4: Identify and explain the operation of and describe the following pieces of test equipment. (DOK 2, ELC, ERS, ETE)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Discuss meter usage and purpose for given projects. (CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR6, CCR7, CCR8, CCR9, , CCL3, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9,	a. Teacher will discuss various meters and provide a scenario to have students identify what meter to use and why.	a. Performance assessment rubric

CCM10, CCM15, CCM16, CCM22, CCM23, CCM26, CCM33, CCM37, CCM40, CCM41, CCM42, CCM45, CCM52, CCM53 , CCR6, CCR7, CCR8, CCR9, , CCL3, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM16, CCM22, CCM23, CCM26, CCM33, CCM37, CCM40, CCM41, CCM42, CCM45, CCM52, CCM53, T2, T4, T6)		
b. Demonstrate the types of electrical/electronic testing equipment using the proper safety procedures. (CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR6, CCR7, CCR8, CCR9, , CCL3, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM16, CCM22, CCM23, CCM26, CCM33, CCM37, CCM40, CCM41, CCM42, CCM45, CCM52, CCM53, T2, T4, T6)	b. Have students select, demonstrate, and test a simple circuit using the following test equipment: • Voltmeter • Ohmmeter • Clamp-on ammeter • Multimeter • Megohmmeter • Motor and phase rotation testers	b. Group work assessment
Note: Instruction for a portion of this unit may be accomplished in an online environment.		

Performance Task

Safety First

You are a journeyman electrician who must identify the safety hazards associated with various types of test equipment. The task is to change out a high voltage power panel at a subway station during normal daytime working conditions. You must identify safety mistakes in a given situation, determine correct procedures, and present the scenario, mistakes found, and procedures which should have been used to the class.

Report out on safety factors, proper use and maintenance of test equipment, and proper PPE, and then describe accidents that can occur while using test equipment. You will be judged on all safety measures, the performance of the task, and maintaining the workspace.

*Note to teacher: Divide students into groups and give each group a scenario or case study (written or on video) involving an accident. Use photos to enhance scenario.

Attachments for Performance Task

Use Performance Task rubric and Lockout/Tagout rubric for evaluation.

Unit Resources

Books:

Callanan, M. & Wusinich, B. (2007). *Electrical systems based on the 2008 NEC.* Homewood, IL: American Technical.

Fletcher, G. (2004). *Residential construction academy house wiring.* Clifton Park, NY: Delmar Learning.

Henry, T. (2007). *Dictionary for the electrician with formulas.* Winter Park, FL: Henry.

Herman S. (2007). *Alternating current fundamentals.* Clifton Park, NY: Delmar Learning.

Herman S. (2007). *Direct current fundamentals.* Clifton Park, NY: Delmar Learning.

Herman S. (2003). *Residential construction academy electrical principles.* Clifton Park, NY: Delmar Learning.

Holzman, H. (2008). *Modern residential wiring.* Tinely Park, IL: Goodheart-Willcox.

Mazur, G. A. & Zurlis, P. A. (2003) *Electrical principles and practices.* Homewood, IL: American Technical.

Mix, F. (2008). *House wiring simplified.* Tinely Park, IL: Goodheart-Willcox.

National Center For Construction Education and Research. (2000). *Electrical level 1.* Upper Saddle River, NJ: Prentice Hall.

National Center For Construction Education and Research. (2002). *Construction technology volume one.* Upper Saddle River, NJ: Prentice Hall.

National Fire Protection Association. (2008). *National electrical code*. Quincy, MA: Author.

National Joint Apprenticeship Training Committee. (2004). *AC theory.* Clifton Park, NY: Delmar Learning.

National Joint Apprenticeship Training Committee. (2004). *DC theory.* Clifton Park, NY: Delmar Learning.

Web sites:

Coastal Contractor. Williston, VT: Hanley-Wood Network. Retrieved June 13, 2011, from http://www.coastalcontractor.net/cgi-bin/filereader.pl?template=1

Contracting Business [Free subscription]. Cleveland, OH: Penton Media. Retrieved June 13, 2011, from http://subscribe.penton.com/cb/

Electrical Contractor. Bethesda, MD: Matrix Group International. Retrieved June 13, 2011, from http://www.ecmag.com/

Fine Homebuilding. Newton, CT: Taunton Press. Retrieved June 13, 2011, from http://www.taunton.com/finehomebuilding/

The Journal of Light Construction. Williston, VT: Hanley Wood, LLC. Retrieved June 13, 2011, from http://www.jlconline.com/cgi-bin/jlconline.storefront

Unit 3: Introduction to the National Electrical Code and Residential Electrical Services

Understandings and Goals

Enduring Understandings
In this unit, the student will:

- Explain the purpose, navigational layout, and history of the *NEC*.
- Describe the purpose of the National Electrical Manufacturers Association and the NFPA.
- Explain the role of the National Electrical Code in residential wiring and describe how to determine electric service requirements for dwellings.
- Explain the types and purposes of grounding equipment.
- Calculate and select service-entrance equipment.
- Select the proper wiring methods for various types of residences.
- Compute branch circuit loads and explain their installation requirements.
- Size outlet boxes and select the proper type for different wiring methods.
- Describe rules for installing electric space heating and HVAC equipment.
- Describe the installation rules for electrical systems around swimming pools, spas, and hot tubs.
- Explain how wiring devices are selected and installed.
- Describe the installation and control of lighting fixtures.

Essential Questions

- Why are the standards found in the NEC important guidelines for electricians?
- Are all those chapters in the NEC necessary?
- How is knowing how to calculate the minimum ampacity for single-family dwellings important to the safety and durability of a structure?

Vocabulary

Identify and review the unit vocabulary.

Appliance

Articles

Bonding bushings

Branch circuit

Chapters

Conductors

Exceptions

Feeder

Fine print notes

Load center

Metal clad cable

National Electrical Manufacturers Association

National Fire Protection Association

Nonmetallic cable

Parts

Romex

Rough-in

Sections

Service drop

Service entrance

Service entrance

Service equipment

Service lateral

Switch

Switch leg

Suggested Learning Experiences

Competency 1: Explain the purpose, navigational layout, and history of the *NEC.* (DOK 1, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Discuss why the NEC was formed and the role it plays in daily work. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	a. Teacher will discuss the codebook and give examples of its use.	a. Teacher-created/guided activity.
b. Discuss all sections of the handbook, all tabs, and their importance. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	b. Students will discuss the codebook and give examples of its use.	b. Teacher observation
c. List specific terms of importance to help navigate through the handbook. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	c. Students will locate information in the codebook based on a given scenario or question.	c. Test

Competency 2: Describe the purpose of the National Electrical Manufacturers Association (NEMA) and the National Fire Protection Association (NFPA). (DOK 1, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)		
Suggested Performance	**Suggested Teaching Strategies**	**Suggested Assessment**

Indicators		Strategies
a. Discuss the purpose of the NEMA and the NFPA standards. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	a. The teacher will define the terms of each organization and have the students discuss the similarities and differences of each organization.	a. Teacher observation
b. Explain the role of nationally recognized testing laboratories. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	b. Have students identify the requirements of a national testing lab and then have a discussion about what equipment is affected by a national testing lab.	b. Class discussion and teacher observation

Competency 3: Explain the role of the National Electrical Code in residential wiring and describe how to determine electric service requirements for dwellings. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Describe what materials are necessary for various service entrances. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	a. Teacher will discuss the minimum requirements to wire service entrances based on the NEC code.	a. Test

Competency 4: Explain the types and purposes of grounding equipment. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Understand ground fault circuit interrupter	a. Explain the purpose of ground fault circuit interrupters and tell where they must be installed.	a. Class discussion and teacher observation

(GFCI) and the role they play in making electrical connections. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	Discuss the amount of current it takes to trip a 20 amp circuit breaker. Explain the grounding requirements of a residential electric service.	
b. Identify the different types of grounding electrodes. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	b. Demonstrate 4-5 electrodes and NEC codebook location. Students should be able to identify, install, and connect GFCI to circuit.	b. Performance rubric
c. Identify installations that require GFCI protection according to NEC. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	c. Students should identify where GFCI is required and the NEC codebook section that it is found in.	c. Performance rubric and/or test

Competency 5: Calculate and select service-entrance equipment. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Understand service-entrance requirements according to NEC specifications. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7,	a. Teacher should identify the parts of a service entrance, state clearances for service drops in varying situations, and describe service requirements for manufactured homes.	a. Teacher observation and/or teacher-created/guided activity

CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)		

Competency 6: Select the proper wiring methods for various types of residences. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Understand NEC specifications that apply to multiple structures. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	a. Discuss proper wiring methods based on NEC specifications. Students should then choose the proper wiring methods based on a given sample specifications scenario.	a. Teacher observation and/or teacher-created/guided activity

Competency 7: Compute branch circuit loads and explain their installation requirements. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Select the minimum number of branch circuits of typical single-dwelling house based on service calculators. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	a. Teacher will use NEC standards to calculate the minimum use of branch circuits.	a. Teacher-created/guided activity

Competency 8: Size outlet boxes and select the proper type for different wiring methods. (DOK 3, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Discuss NEC requirements for outlet boxes. (CS6, CS7, CS8, CS9, CS11,	a. Select proper size and type of box based on NEC requirements.	a. Teacher-created/guided activity

CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)		
b. Identify different wiring methods used in residential wiring. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	b. Teacher will develop scenarios that will require students to identify types of wiring and conduit based on specifications. Students will then identify the proper materials from the discussion.	b. Test

Competency 9: Describe rules for installing electric space heating and HVAC equipment. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Understand wiring requirements. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	a. Teacher will demonstrate how to wire according to code. Student will then refer to NEC and code requirements to connect according to blueprint.	a. Test

Competency 10: Describe the installation rules for electrical systems around swimming pools, spas, and hot tubs. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Determine NEC requirements for wiring around water. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15,	a. Teacher will demonstrate how to install wire when water hazards are present and then demonstrate GFCI protection for receptacles in and around water hazards.	a. Teacher-created/guided activity

CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)		

Competency 11: Explain how wiring devices are selected and installed. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Identify the materials needed to install the electrical system in a home. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16 T2, T4, T6)	a. Install wiring devices to NEC specifications and according to blueprint using wiring chart for required circuits.	a. Test for NEC knowledge
b. Describe the importance of having and following electrical blueprints when installing an electrical system. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	b. Discuss blueprint importance and locate items based on given scenario. Demonstrate reading a metal tape measure.	b. Teacher-created/guided activity on blueprints and/or test

Competency 12: Describe the installation and control of lighting fixtures. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Understand requirements of installing lighting fixtures. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CS1, CS2, CS4, CS5, CCR6, CCR7, CCR8, CCR9, CCL4, CCM1, CCM2, CCM3, CCM4,CCM5, CCM6, CCM7, CCM8, CCM9, CCM10, CCM15, CCM22, CCM23, CCM26, CCM31, CCM32, CCM33, CCM40, CCM42, CCM45, CCM46, T2, T4, T6)	a. Determine the specific power needs of a particular lighting fixture according to local codes, house design, climate, and technology.	a. Observation
Note: Instruction for a portion of this unit may be accomplished in an online environment.		

Performance Task

Making the ConNECtion

You are an apprentice electrician working alone today. Following the NEC code information, make a proper electrical connection by wiring a receptacle in an area where GFCI is required. The electrical connection must carry enough current to power a light bulb. You will be judged on all safety measures, the performance of the task, and maintaining the workspace.

*Note to teacher: Teacher will provide numerous photos that students must use to correctly identify faults and safety issues with each scenario.

Attachments for Performance Task

Use Performance rubric and Lockout/Tagout rubric for evaluation.

Unit Resources

Books:

Callanan, M. & Wusinich, B. (2007). *Electrical systems based on the 2008 NEC.* Homewood, IL: American Technical.

Croft, T., Summers, W. I., & Hartwell, F. P. (2008). *American electrcian's handbook.* Retrieved August 29, 2011, from http://www.amazon.com/American-Electricians-Handbook-15th-Edition/dp/B001F6ND8O

Herman S. (2003). *Residential construction academy electrical principles.* Clifton Park, NY: Delmar Learning.

Holzman, H. (2008). *Modern residential wiring.* Tinely Park, IL: Goodheart-Willcox.

Mazur, G. A. & Zurlis, P. A. (2003) *Electrical principles and practices.* Homewood, IL: American Technical.

Mix, F. (2008). *House wiring simplified.* Tinely Park, IL: Goodheart-Willcox.

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National Center For Construction Education and Research. (2002). *Construction technology volume one.* Upper Saddle River, New Jersey: Prentice Hall.

National Fire Protection Association. (2008). *National electrical code*. Quincy, MA: Author.

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Coastal Contractor. Williston, VT: Hanley-Wood Network. Retrieved June 14, 2011, from http://www.coastalcontractor.net/cgi-bin/filereader.pl?template=1

Contracting Business [Free subscription]. Cleveland, OH: Penton Media. Retrieved June 14, 2011, from http://subscribe.penton.com/cb/

Electrical Contractor. Bethesda, MD: Matrix Group International. Retrieved June 14, 2011, from http://www.ecmag.com/

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The Journal of Light Construction. Williston, VT: Hanley Wood, LLC. Retrieved June 14, 2011, from http://www.jlconline.com/cgi-bin/jlconline.storefront

Unit 4: Devices Boxes, Raceways, and Fittings

Understandings and Goals

Enduring Understandings
In this unit, the student will:

- Identify, select, and install various types and sizes of raceways and fittings for a given application.
- Identify the appropriate conduit body for a given application.
- Describe the different types of nonmetallic and metallic boxes.
- Calculate the NEC fill requirements for boxes under 100 cubic inches.

Essential Questions

- How do you select proper sized device boxes based on NEC requirements?
- How do you select proper raceways and fittings based on NEC requirements?

Vocabulary

Identify and review the unit vocabulary.

Accessible
Approved
Bonding wires
Cable trays
Conduit
Connector
Explosion-proof
Handy box
Junction box
Kick
Outlet box
Pull box
Raceways
Raintight
Splice
Tap
Trough
Underwriters Laboratories
Waterproof
Watertight
Weatherproof
Wireways

Suggested Learning Experiences

Competency 1: Identify, select and install various types and sizes of raceways and fittings for a given application. (DOK 2, ELS, EDB, EHB, ECC)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Understand various types of raceways as well as tubing and cable trays used for raceways. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR1, CCR2, CCR4, CCR6, CCR7, CCR8, CCM2, CCM3, CCM4, CCM6, CCM10, CCM22, CCM23, CCM31, CCM33, CCM37, CCM40, CCM42, CCM45, CCM48, CCM49, CCM52, CCM53, T2, T3, T6)	a. Describe procedures for installing raceways on various surfaces.	a. Observation
b. Identify various methods used to fabricate (join) and install raceway systems. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR1, CCR2, CCR4, CCR6, CCR7, CCR8, CCM2, CCM3, CCM4, CCM6, CCM10, CCM22, CCM23, CCM31, CCM33, CCM37, CCM40, CCM42, CCM45, CCM48, CCM49, CCM52, CCM53, T2, T3, T6)	b. Students will install a standard raceway to a given scenario.	b. Performance rubric

Competency 2: Identify the appropriate conduit body for a given application. (DOK 2, ELS, EDB, EHB, ECC)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Discuss metal and nonmetallic conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for designated services. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR1, CCR2, CCR4, CCR6, CCR7, CCR8, CCM2, CCM3, CCM4, CCM6, CCM10, CCM22, CCM23, CCM31, CCM33, CCM37, CCM40, CCM42, CCM45, CCM48,	a. Students will provide metal and nonmetallic conduit sizes, grades, and weights for each service indicated.	a. Observation

CCM49, CCM52, CCM53, T2, T3, T6)		

Competency 3: Describe the different types of nonmetallic and metallic boxes. (DOK 1, ELS, EDB, EHB, ECC)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Discuss NEC standards for use of nonmetallic and metallic boxes based on indicated service requirements. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR1, CCR2, CCR4, CCR6, CCR7, CCR8, CCM2, CCM3, CCM4, CCM6, CCM10, CCM22, CCM23, CCM31, CCM33, CCM37, CCM40, CCM42, CCM45, CCM48, CCM49, CCM52, CCM53, T2, T3, T6)	a. Students will identify the appropriate box type and size for a given application and demonstrate the appropriate method for mounting a given box.	a. Teacher-created/guided activity

Competency 4: Calculate the NEC fill requirements for boxes under 100 cubic inches. (DOK 2, ELS, EDB, EHB, ECC)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Understand wiring requirements for various installations. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR1, CCR2, CCR4, CCR6, CCR7, CCR8, CCM2, CCM3, CCM4, CCM6, CCM10, CCM22, CCM23, CCM31, CCM33, CCM37, CCM40, CCM42, CCM45, CCM48, CCM49, CCM52, CCM53, T2, T3, T6)	a. Students will calculate the maximum number of wires for a particular conduit based on NEC requirements.	a. Refer to NEC Table
Note: Instruction for a portion of this unit may be accomplished in an online environment.		

Performance Task

Be Flexible

You are an apprentice electrician. Your job today is to install a flexible raceway system to consist of all fittings and several boxes and to make sure it complies with the blueprint. Read the blueprint carefully. Describe structural conditions that could affect the installation. Determine all materials and tools necessary to install and terminate the indicated raceway. Square and level the raceway runs making sure the runs are straight and the fittings are tight. Terminate the raceway system. All raceway connections must meet NEC code. You will be judged on all safety measures, the performance of the task, and the maintenance the workspace.

Attachments for Performance Task

Use the performance rubric as a guide.

Unit Resources

Books:

Callanan, M. & Wusinich, B. (2007). *Electrical systems based on the 2008 NEC.* Homewood, IL: American Technical.

Croft, T., Summers, W. I., & Hartwell, F. P. (2008). *American electrcian's handbook.* Retrieved August 29, 2011, from http://www.amazon.com/American-Electricians-Handbook-15th-Edition/dp/B001F6ND8O

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Herman S. (2007). *Alternating current fundamentals.* Clifton Park, NY: Delmar Learning.

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National Joint Apprenticeship Training Committee. (2004). *DC theory.* Clifton Park, NY: Delmar Learning.

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The Journal of Light Construction. Williston, VT: Hanley Wood, LLC. Retrieved June 14, 2011, from http://www.jlconline.com/cgi-bin/jlconline.storefront

Unit 5: Hand Bending

Understandings and Goals

Enduring Understandings
In this unit, the student will:

- Identify the methods for hand bending and installing conduit.
- Determine conduit bends.
- Make 90-degree bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender.

Essential Questions

- Are there guiding principles associated with bending conduit?
- What mathematical considerations are there when installing raceways?

Vocabulary

Identify and review the unit vocabulary.

90 degree bend

Back-to-back bend

Concentric bends

Offsets

Rise

Segment bend

Stub-up

Suggested Learning Experiences

Competency 1: Identify the methods for hand bending and installing conduit. (DOK 2, ELS, EHB, ERF, ECD)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Understand various hand bending techniques. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR5, CCR6, CCR7, CCR8, CCM3, CCM4, CCM5, CCM15, CCM28, CCM29, CCM33, CCM37, CCM40, CCM42, CCM45, T2, T5, T6)	a. Teacher will discuss hand benders and their application, describe the various types of hand bending equipment, and demonstrate bending methods.	a. Teacher-created/guided activity and test and/or lab assignment

Competency 2: Determine conduit bends. (DOK 2, ELS, EHB, ERF, ECD)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Understand conduit bends and their uses. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR5, CCR6, CCR7, CCR8, CCM3, CCM4, CCM5, CCM15, CCM28, CCM29, CCM33, CCM37, CCM40, CCM42, CCM45, T2, T5, T6)	a. The teacher will demonstrate how to mock up a conduit run using a piece of solid wire, explain the NEC requirements pertaining to conduit bends, and discuss the principle of "Gain" and how it applies to the correct bend required for conduit.	a. Observation and test and/or lab assignment

Competency 3: Make 90-degree bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender. (DOK 2, ELS, EHB, ERF, ECD)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Examine the many bends required to run wire. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR5, CCR6, CCR7, CCR8, CCM3, CCM4, CCM5, CCM15, CCM28, CCM29, CCM33, CCM37, CCM40, CCM42, CCM45, T2, T5, T6)	a. Identify tools used cut, ream, and thread conduit. Describe how to bend PVC using a heating unit.	a. Observation/written test and/or lab assignment
b. Cut, ream, and thread conduit. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR5, CCR6, CCR7, CCR8, CCM3, CCM4, CCM5, CCM15, CCM28, CCM29, CCM33, CCM37, CCM40, CCM42, CCM45, T2, T5, T6)	b. The teacher will show how to make and check the 90° one-shot bend, back-to-back bends, offsets, kicks, and saddle bends.	b. Performance rubric
Note: Instruction for a portion of this unit may be accomplished in an online environment.		

Performance Task

Making the Cut

Today you are a journeyman electrician. Using the proper tools, you must cut one long piece of conduit and thread to a given specification based on the location that you will place the raceway. The conduit must couple with another piece of conduit to meet industry standards. All tools must be handled safely and according to prior training. You will be judged on all safety measures, the performance of the task, and the maintenance the workspace.

Attachments for Performance Task

Use the performance rubric to assess tool selection and proper completion of the exercise.

Unit Resources

Books:

Callanan, M. & Wusinich, B. (2007). *Electrical systems based on the 2008 NEC.* Homewood, IL: American Technical.

Croft, T., Summers, W. I., & Hartwell, F. P. (2008). *American electrcian's handbook.* Retrieved August 29, 2011, from http://www.amazon.com/American-Electricians-Handbook-15th-Edition/dp/B001F6ND8O

Fletcher, G. (2004). *Residential construction academy house wiring.* Clifton Park, NY: Delmar Learning.

Henry, T. (2007). *Dictionary for the electrician with formulas.* Winter Park, FL: Henry.

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Herman S. (2007). *Direct current fundamentals.* Clifton Park, NY: Delmar Learning.

Herman S. (2003). *Residential construction academy electrical principles.* Clifton Park, NY: Delmar Learning.

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National Joint Apprenticeship Training Committee. (2004). *DC theory.* Clifton Park, NY: Delmar Learning.

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Coastal Contractor. Williston, VT: Hanley-Wood Network. Retrieved August 10, 2006, from http://www.coastalcontractor.net/cgi-bin/filereader.pl?template=1

Contracting Business [Free subscription]. Cleveland, OH: Penton Media. Retrieved September 12, 2006, from http://subscribe.penton.com/cb/

Electrician 2. Retrieved August 29, 2011, from http://electrician2.com/

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The Journal of Light Construction. Williston, VT: Hanley Wood, LLC. Retrieved August 10, 2006, from http://www.jlconline.com/cgi-bin/jlconline.storefront

Unit 6: Conductors and Cables

Understandings and Goals

Enduring Understandings
In this unit, the student will:

- From the cable markings, describe the insulation and jacket material, conductor size and type, number of conductors, temperature rating, voltage rating, ampacity, and permitted uses.
- Identify the NEC requirements for color coding of conductors.
- Install conductors in a raceway system.

Essential Questions

- How are cable markings related to electrical circuits?
- What are conductors of electricity?
- How do you determine the size of electrical conductors?

Vocabulary

Identify and review the unit vocabulary.

Ampacity

Capstan

Fish tape

Mouse

Wire grip

Suggested Learning Experiences

Competency 1: From the cable markings, describe the insulation and jacket material, conductor size and type, number of conductors, temperature rating, voltage rating, ampacity, and permitted uses. (DOK 2, ELS, ELC, ECC)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Discuss materials commonly used for conducting electricity. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR1, CCR2, CCR6, CCR7, CCR8, CCM3, CCM4, CCM5, CCM15, CCM33, CCM37, CCM40, CCM42, CCM45, T2, T3, T4, T6)	a. The students will identify electrical materials including conductors, insulators, and semiconductors.	a. Observation and lab assignment
b. Understand wiring materials and their ampacity. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16 T2, T3, T4, T6)	b. The students will describe voltage ratings of cables and conductors.	b. Test and/or worksheets
c. Use mathematical formulas to solve electrical needs. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR1, CCR2, CCR6, CCR7, CCR8, CCM3, CCM4, CCM5, CCM15, CCM33, CCM37, CCM40, CCM42, CCM45, T2, T3, T4, T6)	c. Have students calculate various loads to demonstrate knowledge of a given scenario.	c. Use amp/volt meter in the lab

Competency 2: Identify the NEC requirements for color coding of conductors. (DOK 2, ELS, ELC, ECC)

Suggested Performance Indicators	Suggested Teaching Strategies	Suggested Assessment Strategies
a. Discuss what the different colors of wire mean. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR1, CCR2, CCR6, CCR7, CCR8, CCM3, CCM4, CCM5, CCM15, CCM33, CCM37, CCM40, CCM42, CCM45, T2, T3, T4, T6)	a. The students will choose various wiring options for a given scenario based on NEC specifications.	a. Teacher-created/guided activity and test and/or lab assignments

Competency 3: Install conductors in a raceway system. (DOK 2, ELS, ELC, ECC)

Suggested Performance	Suggested Teaching Strategies	Suggested Assessment

Indicators		Strategies
a. Discuss appropriate conductors according to NEC codes. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR1, CCR2, CCR6, CCR7, CCR8, CCM3, CCM4, CCM5, CCM15, CCM33, CCM37, CCM40, CCM42, CCM45, T2, T3, T4, T6)	a. Teacher will demonstrate conductor selection based on blueprint requirements.	a. Performance rubric
b. Select all tools and materials to install appropriate conductor in and indicated service. (CS6, CS7, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR1, CCR2, CCR6, CCR7, CCR8, CCM3, CCM4, CCM5, CCM15, CCM33, CCM37, CCM40, CCM42, CCM45, T2, T3, T4, T6)	b. Students will identify the necessary materials and safety issues surrounding the tool use and connection of a given service requirement.	b. Performance test in the lab
Note: Instruction for a portion of this unit may be accomplished in an online environment.		

Performance Task

It's Like Pulling Wire

You are an apprentice electrician. Today, your task is to pull wire through an existing raceway at a commercial building. You should be able to select the proper conductors and tools and pull sixty feet of wire per specifications. All wire runs should be free of any kinks in the wire or nicks in the insulation. You will be judged on all safety measures, the performance of the task, and maintaining the workspace.

Attachments for Performance Task

Use the performance rubric to insure proper tool selection and installation.

Unit Resources

Books:

Callanan, M. & Wusinich, B. (2007). *Electrical systems based on the 2008 NEC.* Homewood, IL: American Technical.

Croft, T., Summers, W. I., & Hartwell, F. P. (2008). *American electrcian's handbook.* Retrieved August 29, 2011, from http://www.amazon.com/American-Electricians-Handbook-15th-Edition/dp/B001F6ND8O

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Miller, C. R. (2005). *Illustrated guide to the National Electric Code* (3rd ed.). Clifton Park, NY: Thomson/Delmar Learning.

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National Fire Protection Association. (2008). *National electrical code*. Quincy, MA: Author.

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National Joint Apprenticeship Training Committee. (2004). *DC theory.* Clifton Park, NY: Delmar Learning.

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Electrical Contractor. Bethesda, MD: Matrix Group International. Retrieved June 14, 2011, from

Fine Homebuilding. Newton, CT: Taunton Press. Retrieved June 14, 2011, from http://www.taunton.com/finehomebuilding/

The Journal of Light Construction. Williston, VT: Hanley Wood, LLC. Retrieved June 14, 2011, from http://www.jlconline.com/cgi-bin/jlconline.storefront

Unit 7: Basic Electrical Construction Drawings

Understandings and Goals

Enduring Understandings
In this unit, the student will:

- Explain the basic layout of a set of construction drawings.
- Identify the types of lines used on construction drawings.
- Using multiple scales, state the actual dimensions of a given drawing component.
- Interpret electrical drawings, including site plans, floor plans, detail drawings and equipment schedules.
- Describe the type of information included in electrical specifications.

Essential Questions

- How do title blocks determine project direction?
- Why is a detail drawing considered to be a "requirement" of any project?
- What types of information would be necessary in a title block?

Vocabulary

Identify and review the unit vocabulary.

Architectural Drawings
Block diagrams
Blueprints
Detail drawing
Dimensions
Electrical drawing
Elevation drawing
Floor plan
One line diagram
Plan view
Power-riser
Diagram
Scale
Schedule
Schematic diagram
Sectional view
Shop drawing
Site plan
Written specifications

Suggested Learning Experiences

Competency 1: Explain the basic layout of a set of construction drawings. (DOK 2, ELS, ENC, EHB, ECD)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Discuss common terms associated with a drawing. (CS6, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR4, CCR5, CCR6, CCR8, CCR9, CCM4, CCM5, CCM33, CCM37, CCM40, CCM45, T2, T3, T6)	a. The students will identify specific terms associated with a given scenario.	a. Test
b. Describe the information included in the title block of a construction drawing. (CS6, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR4, CCR5, CCR6, CCR8, CCR9, CCM4, CCM5, CCM33, CCM37, CCM40, CCM45, T2, T3, T6)	b. Using an example blueprint, have the students interpret each section of a title block drawing to include a title block.	b. Teacher-created worksheet

Competency 2: Identify the types of lines used on construction drawings. (DOK 2, ELS, ENC, EHB, ECD)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Understand what each line represents when using drawings. (CS6, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR4, CCR5, CCR6, CCR8, CCR9, CCM4, CCM5, CCM33, CCM37, CCM40, CCM45, T2, T3, T6)	a. Discuss what each type of line means in a given scenario.	a. Teacher-created worksheet Test

Competency 3: Using multiple scales, state the actual dimensions of a given drawing component. (DOK 2, ELS, ENC, EHB, ECD)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Understand scales and how to use them when interpreting drawings. (CS6, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR4, CCR5, CCR6, CCR8, CCR9, CCM4, CCM5, CCM33, CCM37, CCM40, CCM45, T2, T3, T6)	a. Demonstrate using a set of scaled drawings, how to select the correct scale (tool) and interpret dimensions.	a. Test

Competency 4: Interpret electrical drawings, including site plans, floor plans, detail drawings and equipment schedules. (DOK 2, ELS, ENC, EHB, ECD)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Read equipment schedules found on electrical blueprints. (CS6, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR4, CCR5, CCR6, CCR8, CCR9, CCM4, CCM5, CCM33, CCM37, CCM40, CCM45, T2, T3, T6)	a. Discuss blueprint and schedule specifications. Interpret blueprint and schedule specifications and make a connection given a set of drawings.	a. Performance rubric

Competency 5: Describe the type of information included in electrical specifications. (DOK 1, ELS, ENC, EHB, ECD)		
Suggested Performance Indicators	**Suggested Teaching Strategies**	**Suggested Assessment Strategies**
a. Identify information included in electrical specifications. (CS6, CS8, CS9, CS11, CS12, CS13, CS14, CS16, CCR4, CCR5, CCR6, CCR8, CCR9, CCM4, CCM5, CCM33, CCM37, CCM40, CCM45, T2, T3, T6)	a. Using a set of blueprints, have the students interpret site plans, floor plans and detailed drawings.	a. Observation
Note: Instruction for a portion of this unit may be accomplished in an online environment.		

Performance Task

Get Wired Up

Today you are an apprentice electrician. You are given a set of electrical construction drawings to wire a residential kitchen. You should select the proper tools and materials based on the information taken from the drawings. Your duties will include reading blueprints and identifying all receptacles to be wired. The completed project must power an electrical appliance to simulate a household product. You will be judged on all safety measures, the performance of the task, and maintaining the workspace.

Attachments for Performance Task

Use the performance rubric to insure proper tool selection and installation.

Unit Resources

Books:

Brown, W., & Dorfmueller, D. (2005). *Print reading for construction*. Tinley Park, IL: Goodheart-Wilcox.

Croft, T., Summers, W. I., & Hartwell, F. P. (2008). *American electrcian's handbook.* Retrieved August 29, 2011, from http://www.amazon.com/American-Electricians-Handbook-15th-Edition/dp/B001F6ND8O

Huth, M., & Wells, W. (2005). *Understanding construction* d*rawings* (4th ed.). Albany, NY: Delmar.

Joyce, M. (2004). *Blueprint reading and drafting for plumbers.* Albany, NY: Delmar.

Koel, L. (2000). *Construction print reading*. Albany, NY: Delmar.

National Joint Apprenticeship Training Committee. (2008). *Blueprint reading for electricians.* Clifton Park, NY: Delmar Learning.

Proctor, T., & Toenjes, L. (2005). *Printreading for residential and light commercial construction.* Homewood, IL: American Technical.

Other:

Meridian Education Corporation (Producer). (n.d.) *Blueprints: Planning a building* [Videotape]. Available from Meridian Education Corporation, 236 E. Front St., Bloomington, IL 61701.

Student Competency Profile

Student's Name: _____

This record is intended to serve as a method of noting student achievement of the competencies in each unit. It can be duplicated for each student, and it can serve as a cumulative record of competencies achieved in the course.

In the blank before each competency, place the date on which the student mastered the competency.

Unit 1: Orientation and Safety (Review and Reinforcement)		
	1.	Describe the apprenticeship/training process for electricians. (DOK 1, ELO)
	2.	Describe various career paths/opportunities one might follow in the electrical trade. (DOK 1, ELO)
	3.	Develop a task plan and a hazard assessment for a given task and select the appropriate personal protective equipment (PPE) and work methods to safely perform the task. (DOK 2, ELO)
	4.	Review general safety rules for working in a shop/lab and industry. (DOK 1, ELO)
Unit 2: Introduction to Electrical Theory, Circuits, and Test Equipment		
	1.	Define the units of measurement that are used to measure the properties of electricity. (DOK 1, ELC, ERS, ETE)
	2.	Explain the difference between conductors and insulators. (DOK 1, ELC, ERS, ETE)
	3.	Explain the basic characteristics and calculation of series, parallel, and combination circuits. (DOK 2, ELC, ERS, ETE)
	4.	Identify and explain the operation of and describe the following pieces of test equipment. (DOK 2, ELC, ERS, ETE)
Unit 3: Introduction to the National Electrical Code and Residential Electrical Services		
	1.	Explain the purpose, navigational layout, and history of the *NEC.* (DOK 1, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)
	2.	Describe the purpose of the National Electrical Manufacturers Association (NEMA) and the National Fire Protection Association (NFPA). (DOK 1, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)
	3.	Explain the role of the National Electrical Code in residential wiring and describe how to determine electric service requirements for dwellings. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)
	4.	Explain the types and purposes of grounding equipment. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)
	5.	Calculate and select service-entrance equipment. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)
	6.	Select the proper wiring methods for various types of residences. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)
	7.	Compute branch circuit loads and explain their installation requirements. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)
	8.	Size outlet boxes and select the proper type for different wiring methods. (DOK 3, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)

	9.	Describe rules for installing electric space heating and HVAC equipment. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)
	10.	Describe the installation rules for electrical systems around swimming pools, spas, and hot tubs. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)
	11.	Explain how wiring devices are selected and installed. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)
	12.	Describe the installation and control of lighting fixtures. (DOK 2, ELS, ELC, ELT, ENC, EDB, EHB, ERF, ECC, ECD, ERS)
Unit 4: Devices Boxes, Raceways, and Fittings		
	1.	Identify, select and install various types and sizes of raceways and fittings for a given application. (DOK 2, ELS, EDB, EHB, ECC)
	2.	Identify the appropriate conduit body for a given application. (DOK 2, ELS, EDB, EHB, ECC)
	3.	Describe the different types of nonmetallic and metallic boxes. (DOK 1, ELS, EDB, EHB, ECC)
	4.	Calculate the NEC fill requirements for boxes under 100 cubic inches. (DOK 2, ELS, EDB, EHB, ECC)
Unit 5: Hand Bending		
	1.	Identify the methods for hand bending and installing conduit. (DOK 2, ELS, EHB, ERF, ECD)
	2.	Determine conduit bends. (DOK 2, ELS, EHB, ERF, ECD)
	3.	Make 90-degree bends, back-to-back bends, offsets, kicks, and saddle bends using a hand bender. (DOK 2, ELS, EHB, ERF, ECD)
Unit 6: Conductors and Cables		
	1.	From the cable markings, describe the insulation and jacket material, conductor size and type, number of conductors, temperature rating, voltage rating, ampacity, and permitted uses. (DOK 2, ELS, ELC, ECC)
	2.	Identify the NEC requirements for color coding of conductors. (DOK 2, ELS, ELC, ECC)
	3.	Install conductors in a raceway system. (DOK 2, ELS, ELC, ECC)
Unit 7: Basic Electrical Construction Drawings		
	1.	Explain the basic layout of a set of construction drawings. (DOK 2, ELS, ENC, EHB, ECD)
	2.	Identify the types of lines used on construction drawings. (DOK 2, ELS, ENC, EHB, ECD)
	3.	Using multiple scales, state the actual dimensions of a given drawing component. (DOK 2, ELS, ENC, EHB, ECD)
	4.	Interpret electrical drawings, including site plans, floor plans, detail drawings and equipment schedules. (DOK 2, ELS, ENC, EHB, ECD)
	5.	Describe the type of information included in electrical specifications. (DOK 1, ELS, ENC, EHB, ECD)

Appendix A: Activities and Rubrics

Business Letter Assessment Rubric

	Excellent **4 Points**	**Proficient** **3 Points**	**Needs Improvement** **2 points**	**Unsatisfactory** **1 Point**
Layout/Design	Creatively designed, easily read, excellent business letter	Attractive, easy to read, good business letter	Appears busy or boring, difficult to read, needs improvement	Unattractive or inappropriate, very difficult to read, not acceptable
Information, Style, Audience, Tone	Information is accurate and complete, very well written and presented	Well written and interesting to read	Some information is provided but is limited or inaccurate	Poorly written, inaccurate, or incomplete
Accurate Parts	Complete with all required parts	Some elements may be missing	Most elements are missing or out of place	Proper form for a letter is not used
Grammar, Punctuation, Wording	Excellent presentation, style, grammar, and punctuation	Fair presentation, style, grammar, and punctuation	Missing information, inaccurate punctuation and/or grammar	Grammar, punctuation, and wording poor
Following Directions and Guidelines	Always on task, always follows directions	Followed directions with some guidance	Required a good bit of extra guidance	Did not follow directions and did not ask for extra help

Case Study Assessment Rubric

	Excellent **4 Points**	**Accomplished** **3 Points**	**Needs Improvement** **2 Points**	**Unsatisfactory** **1 Point**
Comprehension	Shows complete understanding of the issues and grasps implications beyond the immediate issue	Asks for more details to clarify understanding of the issue	Shows partial understanding of the issue but does not ask for clarification	Resists attempts to get clarification
Strategizing	Develops realistic strategies that would provide a satisfactory conclusion	Chooses appropriate strategies that may satisfy	Shows evidence of strategy that may or may not satisfy	Needs assistance to choose a strategy
Innovation	Devises more than one resolution to the problem	Offers a solution	Offers a solution with a limited point of view	Shows some understanding of the problem
Communications	Convincingly communicates resolution	Explains solution so that others can understand	Conveys an opinion	Unsure of how to explain

Group Discussion Rubric

	Beginning	Developing	Accomplished	Exemplary	Score
	1 point	2 points	3 points	4 points	
Group Discussions	Rarely contributed to discussions of the group	Contributed good effort to discussions of the group	Contributed great effort to discussions of the group	Contributed exceptional effort to discussions of the group	
On-task Behavior	Exhibited on-task behavior inconsistently	Exhibited on-task behavior some of the time	Exhibited on-task behavior most of the time	Exhibited on-task behavior consistently	
Helping Others	Did not assist other group members	Seldom assisted other group members	Occasionally assisted other group members	Assisted other group members	
Listening	Ignored ideas of group members	Seldom listened to ideas of group members	Occasionally listened to ideas of group members	Always listened to ideas of group members	

Group Work Assessment Rubric

	Highly Successful	Meeting Success	Experiencing Difficulty	Score
	3 points	2 points	1 point	
Sharing	Shared ideas with others	Occasionally shared ideas with others	Seldom shared ideas with others	
Listening	Always listened to peers	Occasionally listened to peers	Ignored ideas of peers	
Respecting	Interacted with, encouraged, and supported ideas of others	Occasionally encouraged and supported others	Seldom encouraged and supported others	
Participating	Shared task equally with group members	Did most of the task	Did very little of the task	

Job Sheet or Performance Task Rubric

Advanced	*Proficient*	*Basic*	*Unacceptable*
Student follows all safety regulations without prompting. (3 points)	Student follows all safety regulations but may require limited reminders or prompting. (2 points)	Student follows all or nearly all safety regulations but requires significant reminders. (1 points)	Student does not follow most safety regulations. (0 points)
Student properly diagnoses problem according to manufacturer guidelines and specifications within manufacturer specified time limits. (3 points)	Student properly diagnoses problem according to manufacturer guidelines and specifications but may take additional time. (2 points)	Student properly diagnoses problem according to manufacturer guidelines and specifications with limited assistance. (1 points)	Student's work is not performed to manufacturer guidelines and specifications. (0 points)
Student quickly and accurately diagnoses problems and accurately determines causes of malfunction based on information obtained from resources. (3 points)	Student accurately diagnoses problems and accurately determines causes of malfunction based on information obtained from resources. (2 points)	Student diagnoses problem with limited assistance. With limited assistance, student determines causes of malfunction based on information obtained from resources. (1 points)	Student is unable to diagnose problem. (0 points)
Job sheet includes all customer information, lists all requested repairs, and contains correct calculations with no items missing. Written report is accurate and complete, and it demonstrates thorough understanding of systems and how they operate, safety procedures, and the importance of manufacturer recommendations. (3 points)	Job sheet includes customer information, lists requested repairs, and contains correct calculations but may include up to two errors or omissions. Written report is accurate and complete, and it demonstrates solid understanding of systems and how they operate, safety procedures, and the importance of manufacturer recommendations. (2 points)	Job sheet includes customer information, lists requested repairs, and contains correct calculations but may include up to three errors or omissions. Written report is mostly accurate and complete, and it demonstrates understanding of types of systems and how they operate, safety procedures, and the importance of manufacturer recommendations. (1 points)	Job sheet includes customer information, lists requested repairs, and contains correct calculations but may include up to four errors or omissions. Written report is inaccurate and/or incomplete, or it indicates limited to no understanding of types of systems and how they operate, safety procedures, and the importance of manufacturer recommendations. (0 points)

Lockout/Tagout Checklist

_____ 1. Identified all sources of electrical energy for the equipment or circuits in question.

_____ 2. Disabled backup energy sources such as generators and batteries.

_____ 3. Identified all shut-offs for each energy source.

_____ 4. Notified all personnel that equipment and circuitry must be shut off, locked out, and tagged out. (Simply turning a switch off is NOT enough.)

_____ 5. Shut off energy sources and lock switchgear in the **OFF** position. Each worker should apply his or her individual lock. Did not give key to anyone else.

_____ 6. Tested equipment and circuitry to make sure they are de-energized. This must be done by a qualified person.

_____ 7. Depleted stored energy by bleeding, blocking, grounding, and so forth.

_____ 8. Applied a tag to alert other workers that an energy source or piece of equipment has been locked out.

_____ 9. Made sure everyone is safe and accounted for before equipment and circuits were unlocked and turned back on. Note that only a qualified person may determine when it is safe to re-energize circuits.

National Institute of Occupational Safety and Health. Retrieved June 30, 2011, from http://www.cdc.gov/niosh/docs/2002-123/2002-123d.html#

Performance Assessment

Student's Name _____

Date_____

Task to be performed_____

	Possible Points	Points Awarded
Safety Personal safety (glasses, clothing, etc.) Safe use of tool Safely performs the task	25	
Performance of the Task **Insert specific procedures for each performance activity** Follows the task instructions Performs the task efficiently Performs the task satisfactorily	50	
Lab Maintenance Area cleanup (clean and tidy) Area organization (before, during, and after the task)	25	
Total	100	

Comments for deductions:

Instructor's Signature_____

Portfolio Assessment Rubric

	Excellent 5 Points	Good 4 Points	Needs Some Improvement 3 Points	Needs Much Improvement 2 Points	Unsatisfactory 1 Point	Score
Visual Appeal						
Cover Page						
Table of Contents						
Letter of Introduction						
Letter of Recommendation						
Résumé						
Content						

Poster Assessment Rubric

	Exemplary	Accomplished	Developing	Beginning	Score
	4 Points	3 Points	2 Points	1 Point	
Required Content	The poster includes all required content elements, as well as additional information.	All required content elements are included on the poster.	All but one of the required content elements is included on the poster.	Several required content elements were missing.	
Labels	All items of importance on the poster are clearly labeled with labels that are easy to read.	Almost all items of importance on the poster are clearly labeled with labels that are easy to read.	Many items of importance on the poster are clearly labeled with labels that are easy to read.	Labels are too small to read or no important items are labeled.	
Attractiveness	The poster is exceptionally attractive in terms of design, layout, and neatness.	The poster is attractive in terms of design, layout, and neatness.	The poster is acceptably attractive though it may be a bit messy.	The poster is distractingly messy or very poorly designed.	
Grammar	There are no grammatical or mechanical mistakes on the poster.	There are one to two grammatical or mechanical mistakes on the poster.	There are three to four grammatical or mechanical mistakes on the poster.	There are more than four grammatical or mechanical mistakes on the	

				poster.	

Presentation Assessment Rubric

	Exemplary	Accomplished	Developing	Beginning	Score
	4 points	**3 points**	**2 points**	**1 point**	
Content	Clear, appropriate, and correct	Mostly clear, appropriate, and correct	Somewhat confusing, incorrect, or flawed	Confusing, incorrect, or flawed	
Clarity	Logical, interesting sequence	Logical sequence	Unclear sequence	No sequence	
Presentation	Clear voice and precise pronunciation	Clear voice and mostly correct pronunciation	Low voice and incorrect pronunciation	Mumbling and incorrect pronunciation	
Visual Aids	Attractive, accurate, grammatically correct	Adequate, mostly accurate, few grammatical errors	Poorly planned, somewhat accurate, some grammatical errors	Weak, inaccurate, many grammatical errors	
Length	Appropriate length	Slightly too long or short	Moderately too long or short	Extremely too long or short	
Eye Contact	Maintains eye contact, seldom looking at notes	Maintains eye contact most of time but frequently returns to notes	Occasionally uses eye contact but reads most of information	No eye contact because reading information	

PRESENTATION EVALUATION SHEET

_____/16 Preparation
_____/28 Organization
_____/24 Thoroughness
_____/19 Extra Materials
_____/13 Actual Presentation

Preparation:

1. _____/2 Information written (neatly)
2. _____/2 Sources used listed
3. _____/5 Worked every day (did not waste time)
4. _____/5 Had all materials ready for use
5. _____/2 Cooperative

Organization

1. _____/2 Report in a logical order
2. _____/2 Interesting manner
3. _____/20 Notebook check
4. _____/2 Understanding of topic
5. _____/2 Spelling and sentence structure (did not copy from books)

Thoroughness

1. _____/5 Main points given
2. _____/5 Details to explain given
3. _____/5 Information presented clearly
4. _____/4 More than one source used
5. _____/5 Extra materials are appropriate

Extra Materials

1. _____/2 Neatness
2. _____/7 Creativity
3. _____/2 Dramatic value
4. _____/3 Useful
5. _____/5 Correctness

Actual Presentation

1. _____/3 Speaks clearly and distinctly
2. _____/2 Uses extra materials effectively
3. _____/2 Posture
4. _____/2 Pronounces all words correctly
5. _____/2 Organized in thought

_____/100 Total points earned

Résumé Assessment Rubric

	Excellent **25 Points**	**Well Done** **20 Points**	**Meets Standards** **15 Points**	**Beginning** **10 Points**	**No Evidence** **0 Points**	**Score**
Format	Résumé contains name, address, objective, education, experience, and references. All words spelled correctly.	Résumé contains at least six of the criteria with no more than two spelling errors.	Résumé contains at least five of the criteria with no more than four spelling errors.	Résumé contains minimal information with more than four spelling errors.	Assignment was not submitted.	
Education	Education includes all schools attended, graduation dates, diploma/degree awarded, and major field of study.	Education includes three of the criteria.	Education includes two of the criteria.	Education includes one of the criteria.	Assignment was not submitted.	
Experience	Experience includes internships, entry level jobs, and current position.	Experience includes two of the criteria.	Experience includes one of the criteria.	Experience includes current position only.	Assignment was not submitted.	
Factual	Résumé contains factual names and dates and is believable.	Résumé is fairly believable with factual names or dates.	Résumé has unrealistic dates or names.	Résumé is unrealistic and contains conflicting information.	Assignment was not submitted.	

Role-Play or Skit Assessment Rubric

	Excellent **4 Points**	**Good** **3 Points**	**Average** **2 Points**	**Needs Improvement** **1 Point**	**Total**
Accuracy	All information was accurate.	Almost all information was accurate.	Most information was accurate.	Very little information was accurate.	
Role	Excellent character development present. Student contributed in a significant manner.	Good character development present. Student contributed in a cooperative manner.	Fair character development present. Student may have contributed.	Little or no character development present.. Student did not contribute much at all.	
Knowledge Gained	Student can clearly explain several ways in which his character "saw" things differently than other characters and can explain why.	Student can clearly explain several ways in which his character "saw" things differently than other characters.	Student can clearly explain one way in which his character "saw" things differently than other characters.	Student cannot explain any way in which his character "saw" things differently than other characters.	
Props	Student used several props and showed considerable creativity.	Student used one or two appropriate props that made the presentation better.	Student used one or two props that made the presentation better.	Student used no props to make the presentation better.	
Required Elements	Student included more information than required.	Student included all required information.	Student included most required information.	Student included less information than required.	

Web Site Search
Checklist

Web Site Search:	**Yes**	**No**
ProStart		
FCCLA		
SkillsUSA		
Coahoma Community College		
Copiah-Lincoln Community College		
East Central Community College		
East Mississippi Community College		
Hinds Community College		
Holmes Community College		
Itawamba Community College		
Jones Junior College		
Meridian Community College		
Mississippi Delta Community College		
Mississippi Gulf Coast Community College		
Northeast Mississippi Community College		
Northwest Mississippi Community College		
Pearl River Community College		
Southwest Mississippi Community College		
Alcorn State University		
Jackson State University		
Mississippi State University		
Mississippi University for Women		
Mississippi Valley State		
University of Southern Mississippi		
University of Mississippi		

Written Report Assessment Rubric

	Exemplary	Accomplished	Developing	Beginning	Score
	4 points	**3 points**	**2 points**	**1 point**	
Content	Clear thesis and focus that remains apparent	Thesis and focus that remains apparent	Addresses subject matter with minimal support	Does not focus on topic	
Grammar	Correct and effective use of grammar and mechanics	Occasional errors in use of grammar and mechanics	Problems in use of grammar and mechanics	Repeated errors in use of grammar and mechanics	
Organization	Ideas flow smoothly and logically with clarity and coherence	Logical order and appropriate sequencing of ideas with adequate transition	Some evidence of an organizational plan or strategy	Lacks organization	

WRITTEN REPORT EVALUATION SHEET

_____/16 Preparation
_____/28 Organization
_____/24 Thoroughness
_____/19 Extra Materials
_____/13 Final Report

Preparation:

6. _____/2 Information written (neatly)
7. _____/2 Sources used listed
8. _____/5 Worked every day (did not waste time)
9. _____/5 Had all materials ready for use
10. _____/2 Cooperative

Organization

6. _____/2 Report in a logical order
7. _____/2 Interesting manner
8. _____/20 Notebook check
9. _____/2 Understanding of topic
10. _____/2 Spelling and sentence structure (did not copy from books)

Thoroughness

6. _____/5 Main points given
7. _____/5 Details to explain given
8. _____/5 Information presented clearly
9. _____/4 More than one source used
10. _____/5 Extra materials are appropriate

Extra Materials

6. _____/2 Neatness
7. _____/7 Creativity
8. _____/2 Dramatic value
9. _____/3 Useful
10. _____/5 Correctness

Final Report

6. _____/3 Written clearly
7. _____/2 Organized
8. _____/2 Sources documented correctly
9. _____/2 Spelling
10. _____/2 Grammar
11. _____/2 Neatness

_____/100 Total points earned

Appendix B: Glossary

90° bend: A bend that changes the direction of the conduit by 90°

Accessible: Able to be reached, as for service or repair

Ammeter: An instrument for measuring electrical current

Ampacity: The current in amperes a conductor can carry continuously under the conditions of use without exceeding its temperature rating

Ampere (A): A unit of electrical current. For example, one volt across one ohm of resistance causes a current flow of one ampere.

Appliance: Equipment designed for a particular purpose (for example, using electricity to produce heat, light, or mechanical motion). Appliances are usually self-contained, are generally available for applications other than industrial use, and are normally produced in standard sizes or types.

Approved: Meeting the requirements of an appropriate regulatory agency

Architectural drawings: Working drawings consisting of plans, elevations, details, and other information necessary for the construction of a building. Architectural drawings usually include:

- A site (plot) plan indicating the location of the building on the property
- Floor plans showing the walls and partitions for each floor or level
- Elevations of all exterior faces of the building
- Several vertical cross sections to indicate clearly the various floor levels and details of the footings, foundations, walls, floors, ceilings, and roof construction
- Large-scale detail drawings showing such construction details as may be required

Articles: The main topics of the *NEC,* beginning with *NEC Article 90,* Introduction, and ending with *NEC Article 830,* Network-Powered Broadband Communications Systems

Atom: The smallest particle to which an element may be divided and still retain the properties of the element

Back-to-back bend: Any bend formed by two 90° bends with a straight section of conduit between the bends

Battery: A DC-voltage source consisting of two or more cells that convert chemical energy into electrical energy

Block diagram: A single-line diagram used to show electrical equipment and related connections. See power-riser diagram.

Blueprint: An exact copy or reproduction of an original drawing

Bonding bushing: A special conduit bushing equipped with a conductor terminal to take a bonding jumper. It also has a screw or other sharp device to bite into the enclosure wall to bond the conduit to the enclosure without a jumper when there are no concentric knockouts left in the wall of the enclosure.

Bonding jumper: A bare or green insulated conductor used to ensure the required electrical conductivity between metal parts required to be electrically connected. Bonding jumpers are frequently used from a bonding bushing to

the service-equipment enclosure to provide a path around concentric knockouts in an enclosure wall, and they may also be used to bond one raceway to another.

Bonding wire: A wire used to make a continuous grounding path between equipment and ground

Branch circuit: The portion of a wiring system extending beyond the final overcurrent device protecting a circuit

Cable trays: Rigid structures used to support electrical conductors

Capstan: The turning drum of the cable puller on which the rope is wrapped and pulled

Chapters: Nine chapters that form the broad structure of the *NEC*

Circuit: A complete path for current flow

Coil: A number of turns of wire, especially in spiral form, used for electromagnetic effects or for providing electrical resistance

Concentric bends: 900 bends made in two or more parallel runs of conduit with the radius of each bend increasing from the inside of the run toward the outside

Conductor: A material through which it is relatively easy to maintain an electric current

Conduit: A round raceway, similar to pipe, that houses conductors

Connector: Device used to physically connect conduit or cable to an outlet box, cabinet, or other enclosure

Continuity: An electrical term used to describe a complete (unbroken) circuit that is capable of conducting current. Such a circuit is also said to be closed.

Coulomb: An electrical charge equal to 6.25 x 1018 electrons or 6,250,000,000,000,000,000 electrons; the common unit of quantity used for specifying the size of a given charge

Current (I): The movement, or flow, of electrons in a circuit; measured in amperes

d'Arsonval meter movement: A meter movement that uses a permanent magnet and moving coil arrangement to move a pointer across a scale

Detail drawing: An enlarged, detailed view taken from an area of a drawing and shown in a separate view

Developed length: The actual length of the conduit that will be bent

Dimensions: Sizes or measurements printed on a drawing

Double-insulated/ungrounded tool: An electrical tool that is constructed so that the case is insulated from electrical energy. The case is made of a nonconductive material.

Electrical drawing: A means of conveying a large amount of exact, detailed information in an abbreviated language; consists of lines, symbols, dimensions, and notations to accurately convey an engineer's designs to electricians who install the electrical system on a job

Electrical service: The electrical components that are used to connect the commercial power to the premises wiring system

Electron: A negatively charged particle that orbits the nucleus of an atom

Elevation drawing: An architectural drawing showing height, but not depth; usually the front, rear, and sides of a building or object

Exceptions: Follow the applicable sections of the *NEC* and allow alternative methods to be used under specific conditions

Explosion-proof: Designed and constructed to withstand an internal explosion without creating an external explosion or fire

Exposed location: Not permanently closed in by the structure or finish of a building; able to be installed or removed without damage to the structure

Feeder: A circuit, such as conductors in conduit or a cable run, that carries current from the service equipment to a subpanel or a branch circuit panel or to some point in the wiring system

Fibrillation: Very rapid irregular contractions of the muscle fibers of the heart that result in the heartbeat and pulse going out of rhythm with each other

Fine print note (FPN): Explanatory material that follows specific *NEC* sections

Fish tape: A hand device used to pull a wire through a conduit run

Floor plan: A drawing of a building as if a horizontal cut were made through a building at about window level and the top portion removed. The floor plan is what would appear if the remaining structure were viewed from above.

Frequency: The number of cycles completed each second by a given AC voltage; usually expressed in hertz. One hertz equals one cycle per second.

Gain: The distance saved by the arc of a 900 bend. Because a conduit bends in a radius and not at right angles, the length of conduit needed for a bend will not equal the total determined length.

Ground fault circuit interrupter (GFCI): A protective device that functions to de-energize a circuit or portion thereof within an established period of time when a current to ground exceeds some predetermined value. This value is less than that required to operate the overcurrent protective device of the supply circuit.

Grounded tool: An electrical tool with a three-prong plug at the end of its power cord or some other means to ensure that stray current travels to ground without passing through the body of the user. The ground plug is bonded to the conductive frame of the tool.

Handy box: Single-gang outlet box used for surface mounting to enclose receptacles or wall switches on concrete or concrete block construction of industrial and commercial buildings; nongangable; also made for recessed mounting; also known as a utility box

Insulator: A material through which it is difficult to conduct an electric current

Joule (f): A unit of measurement that represents one newton-meter (Nm), which is a unit of measure for doing work

Junction box: An enclosure where one or more raceways or cables enter and in which electrical conductors can be, or are, spliced

Kick: A bend in a piece of conduit, usually less than 45°, made to change the direction of the conduit

Kilo: A prefix used to indicate one thousand. For example, one kilowatt is equal to one thousand watts.

Kirchhoff's current law: The statement that the total amount of current flowing through a parallel circuit is equal to the sum of the amounts of current flowing through each current path

Kirchhoff's voltage law: The statement that the sum of all the voltage drops in a circuit is equal to the source voltage of the circuit

Load center: A type of panelboard that is normally located at the service entrance of a residential installation. It usually contains the main disconnect.

Matter: Any substance that has mass and occupies space

Mega: A prefix used to indicate one million. For example, one megawatt is equal to one million watts.

Metal-clad (Type Me) cable: A type of cable with a metal jacket that is popular for use in residential and small commercial wiring systems. In general, it may be used for both exposed and concealed work in normally dry locations. It may also be used as service-entrance cable and in other locations as permitted by the *NEC.*

Mouse: A cylinder of foam rubber that fits inside the conduit and is then propelled by compressed air or vacuumed through the conduit run, pulling a line or tape

National Electrical Manufacturers Association (NEMA): The association that maintains and improves the quality and reliability of electrical products

National Fire Protection Association (NFPA): The publishers of the *NEC* that develop standards to minimize the possibility and effects of fire

Nationally Recognized Testing Laboratories (NRTLs): Product safety certification laboratories that are responsible for testing and certifying electrical equipment

Neutrons: Electrically neutral particles (neither positive nor negative) that have the same mass as a proton and are found in the nucleus of an atom

Nonmetallic-sheathed (Type NM) cable: A type of cable that is popular for use in residential and small commercial wiring systems. In general, it may be used for both exposed and concealed work in normally dry locations. See also Romex.

Nucleus: The center of an atom, containing the protons and neutrons of the atom

Occupational Safety and Health Administration (OSHA): The federal government agency established to ensure a safe and healthy environment in the workplace

Offsets: An offset (kick) is two bends placed in a piece of conduit to change elevation to go over or under obstructions or for proper entry into boxes, cabinets, and so forth.

Ohm (Ω): The basic unit of measurement for resistance

Ohm's law: A statement of the relationships among current, voltage, and resistance in an electrical circuit: current (I) equals voltage (E) divided by resistance (R); expressed as a mathematical formula: 1= *E/R*

Ohmmeter: An instrument used for measuring resistance

One-line diagram: A drawing that shows, by means of lines and symbols, the path of an electrical circuit or system of circuits along with the various circuit components; also called a single-line diagram

On-the-job training (OJT): Job-related learning acquired while working

Outlet box: A metallic or nonmetallic box installed in an electrical wiring system from which current is taken to supply some apparatus or device

Parallel circuits: Circuits containing two or more parallel paths through which current can flow

Parts: Certain articles in the *NEC* are subdivided into parts. Parts have letter designations (e.g., Part A).

Plan view: A drawing made as though the viewer were looking straight down (from above) on an object

Polychlorinated biphenyls (PCBs): Toxic chemicals that may be contained in liquids used to cool certain types of large transformers and capacitors

Power: The rate of doing work or the rate at which energy is used or dissipated. Electrical power is the rate of doing electrical work. Electrical power is measured in watts.

Power-riser diagram: A single-line block diagram used to indicate the electric service equipment, service conductors and feeders, and subpanels. Notes are used on power-riser diagrams to identify the equipment; indicate the size of conduit; show the number, size, and type of conductors; and list related materials. A panelboard schedule is usually included with power riser diagrams to indicate the exact components (panel type and size), along with fuses, circuit breakers, etc., contained in each panelboard.

Protons: The smallest positively charged particles of an atom; contained in the nucleus of an atom

Pull box: A sheet metal box-like enclosure used in conduit runs to facilitate the pulling of cables from point to point in long runs, or to provide for the installation of conduit support bushings needed to support the weight of long riser cables, or to provide for turns in multiple conduit runs

Raceway systems: Conduit, fittings, boxes, and enclosures that house the conductors in an electrical system

Raceways: Enclosed channels designed expressly for holding wires, cables, or busbars, with additional functions as permitted in the *NEC*

Raintight: Constructed or protected so that exposure to a beating rain will not result in the entrance of water under specified test conditions

Relay: An electromechanical device consisting of a coil and one or more sets of contacts; used as a switching device

Resistance (R): An electrical property that opposes the flow of current through a circuit; measured in ohms

Resistor: Any device in a circuit that resists the flow of electrons

Rise: The length of the bent section of conduit measured from the bottom, centerline, or top of the straight section to the end of the bent section

Romex: General Cable's trade name for Type M cable; often used generically to refer to any nonmetallic-sheathed cable

Rough-in: The installation of the raceway system (including conduit, boxes, and enclosures), wiring, or cable

Roughing in: The first stage of an electrical installation, when the raceway, cable, wires, boxes, and other equipment are installed. This is the electrical work that must be done before any finishing work can be done.

Scale: On a drawing, the size relationship between an object's actual size and the size it is drawn; also refers to the measuring tool used to determine this relationship

Schedule: A systematic method of presenting equipment lists on a drawing in tabular form

Schematic: A type of drawing in which symbols are used to represent the components in a system

Schematic diagram: A detailed diagram showing complicated circuits, such as control circuits

Sectional view: A cutaway drawing that shows the inside of an object or building

Sections: Parts and articles are subdivided into sections. Sections have numeric designations that follow the article number and are preceded by a period (e.g., 501.4).

Segment bend: A large bend formed by multiple short bends or shots

Series circuit: A circuit with only one path for current flow

Series circuits: Circuits with only one path for current flow

Series-parallel circuits: Circuits that contain both series and parallel current paths

Service drop: The overhead conductors, through which electrical service is supplied, between the last power company pole and the point of their connection to the service facilities located at the building

Service entrance: The point where power is supplied to a building (including the equipment used for this purpose). The service entrance includes the service main switch or panelboard, metering devices, overcurrent protective devices, and conductors/raceways for connecting to the power company's conductors.

Service lateral: The underground conductors through which service is supplied between the power company's distribution facilities and the first point of their connection to the building or area service facilities located at the building.

Service-entrance conductors: The conductors between the point of termination of the overhead service drop or underground service lateral and the main disconnecting device in the building

Service-entrance equipment: Equipment that provides overcurrent protection to the feeder and service conductors, a means of disconnecting the feeders from energized service conductors, and a means of measuring the energy used

Shop drawing: A drawing that is usually developed by manufacturers, fabricators, or contractors to show specific dimensions and other pertinent information concerning a particular piece of equipment and its installation methods

Site plan: A drawing showing the location of a building or buildings on the building site. Such drawings frequently show topographical lines, electrical and communication lines, water and sewer lines, sidewalks, driveways, and similar information.

Solenoid: An electromagnetic coil used to control a mechanical device such as a valve

Splice: Connection of two or more conductors

Stub-up: Another name for the rise in a section of conduit; also, a term used for conduit penetrating a slab or the ground

Switch: A mechanical device used for turning an electrical circuit on and off

Switch leg: A circuit routed to a switch box for controlling electric lights

Tap: Intermediate point on a main circuit where another wire is connected to supply electrical current to another circuit

Transformer: A device consisting of one or more coils of wire wrapped around a common core; commonly used to step voltage up or down

Trim-out: After rough-in, the installation and termination of devices and fixtures

Trough: A long, narrow box used to house electrical connections that could be exposed to the environment

Underwriters Laboratories, Inc. (UL): An agency that evaluates and approves electrical components and equipment

Valence shell: The outermost ring of electrons that orbit about the nucleus of an atom

Volt (V): The unit of measurement for voltage (electromotive force or difference of potential). One volt is equivalent to the force required to produce a current of one ampere through a resistance of one ohm.

Voltage (E): The driving force that makes current flow in a circuit; also referred to as electromotive force or difference of potential

Voltage drop: The change in voltage across a component that is caused by the current flowing through it and the amount of resistance opposing it

Voltmeter: An instrument for measuring voltage. The resistance of the voltmeter is fixed. When the voltmeter is connected to a circuit, the current passing through the meter will be directly proportional to the voltage at the connection points.

Waterproof: Constructed so that moisture will not interfere with successful operation

Watertight: Constructed so that water will not enter the enclosure under specified test conditions

Watt (W): The basic unit of measurement for electrical power

Weatherproof: Constructed or protected so that exposure to the weather will not interfere with successful operation

Wire grip: A device used to link pulling rope to cable during a pull

Wireways: Steel troughs designed to carry electrical wire and cable

Written specifications: A written description of what is required by the owner, architect, and engineer in the way of materials and workmanship. Together with working drawings, the specifications form the basis of the contract requirements for construction.

Appendix C: Industry Standards

Secondary Electrical (Y2)

Industry Standards Crosswalk for Secondary Electrical (Y2)

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
Industry Standards								
ELO		x						
ELS		x		x	x	x	x	x
ELC			x	x			x	
ELT			x	x				
ENC				x				x
EDB				x	x			
EHB				x	x	x		x
ERF				x		x		
ECC				x	x		x	
ECD				x		x		x
ERS			x	x				
ETE			x					
ELO				x				
ELS								

ELO Orientation to the Electrical Trade
ELS Electrical Safety
ELC Electrical Circuits
ELT Electrical Theory
ENC Introduction to the National Electrical Code
EDB Device Boxes
EHB Hand Bending
ERF Raceways and Fittings
ECC Conductors and Cables
ECD Basic Electrical Construction Drawings
ERS Residential Electrical Services
ETE Electrical Test Equipment

Appendix D: 21st Century Skills[1]

21st Century Crosswalk for Secondary Electrical (Y2)								
	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
21st Century Standards								
CS1		x						
CS2		x						
CS3								
CS4								
CS5								
CS6		x		x	x	x	x	x
CS7			x	x	x	x	x	
CS8		x	x	x	x	x	x	x
CS9			x	x	x	x	x	x
CS10								
CS11		x	x	x	x	x	x	x
CS12			x	x	x	x	x	x
CS13			x	x	x	x	x	x
CS14			x	x	x	x	x	x
CS15								
CS16		x	x	x	x	x	x	x

CSS1-21st Century Themes

CS1 Global Awareness

1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions, and lifestyles in a spirit of mutual respect and open dialogue in personal, work, and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business, and Entrepreneurial Literacy

1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national, and global levels
3. Understanding the local and global implications of civic decisions

CS4 Health Literacy

1. Obtaining, interpreting, and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance, and stress reduction
3. Using available information to make appropriate health-related decisions
4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

[1] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water, and ecosystems.
2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.).
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.
4. Take individual and collective action toward addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues).

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation

1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

CS7 Critical Thinking and Problem Solving

1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

CS8 Communication and Collaboration

1. Communicate Clearly
2. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy

1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy

1. Analyze Media
2. Create Media Products

CS11 ICT Literacy

1. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability

1. Adapt to change
2. Be Flexible

CS13 Initiative and Self-Direction

1. Manage Goals and Time
2. Work Independently
3. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills

1. Interact Effectively with others
2. Work Effectively in Diverse Teams

CS15 Productivity and Accountability

1. Manage Projects
2. Produce Results

CS16 Leadership and Responsibility

1. Guide and Lead Others
2. Be Responsible to Others

Appendix E: Common Core Standards

Common Core Crosswalk for Secondary Electrical (Y2)

	Units	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5	Unit 6	Unit 7
Common Core Standards								
CCR1				x	x		x	
CCR2				x	x		x	
CCR3								
CCR4				x	x			x
CCR5				x		x		x
CCR6			x	x	x	x	x	x
CCR7			x	x	x	x	x	
CCR8			x	x	x	x	x	x
CCR9			x	x				x
CCR10								
CCW1								
CCW2								
CCW3								
CCW4								
CCW5								
CCW6								
CCW7								
CCW8								
CCW9								
CCW10								
CCSL1		x						
CCSL2		x						
CCSL3		x						
CCSL4								
CCSL5								
CCSL6								
CCL1								
CCL2								
CCL3			x					
CCL4			x	x				
CCL5								
CCL6								
CCM1			x	x				
CCM2			x	x	x			
CCM3			x	x	x	x	x	
CCM4			x	x	x	x	x	x
CCM5			x	x		x	x	x
CCM6			x	x	x			
CCM7			x	x				
CCM8			x	x				
CCM9			x	x				
CCM10			x	x	x			
CCM11								
CCM12								
CCM13								
CCM14								
CCM15			x	x		x	x	
CCM16			x					
CCM17								
CCM18								
CCM19								
CCM20								
CCM21								

CCM22			x	x	x			
CCM23			x	x	x			
CCM24								
CCM25								
CCM26			x	x				
CCM27								
CCM28						x		
CCM29						x		
CCM30								
CCM31				x	x			
CCM32				x				
CCM33			x	x	x	x	x	x
CCM34								
CCM35								
CCM36								
CCM37			x		x	x	x	x
CCM38								
CCM39								
CCM40			x	x	x	x	x	x
CCM41			x					
CCM42			x	x	x	x	x	
CCM43								
CCM44								
CCM45			x	x	x	x	x	x
CCM46				x				
CCM47								
CCM48					x			
CCM49					x			
CCM50								
CCM51								
CCM52			x		x			
CCM53			x		x			

English Language Arts (6-12)

College and Career Readiness Anchor Standards for *Reading*

Key Ideas and Details

CCR1: Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text.

CCR2: Determine central ideas or themes of a text, and analyze their development; summarize the key supporting details and ideas.

CCR3: Analyze how and why individuals, events, and ideas develop and interact over the course of a text.

Craft and Structure

CCR4: Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone.

CCR5: Analyze the structure of texts, including how specific sentences, paragraphs, and larger portions of the text(e.g., a section, chapter, scene, or stanza) relate to each other and the whole.

CCR6: Assess how point of view or purpose shapes the content and style of a text.

Integration of Knowledge and Ideas

CCR7: Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.

CCR8: Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

CCR9: Analyze how two or more texts address similar themes or topics in order to build knowledge or to compare the approaches the authors take.

Range of Reading and Level of Text Complexity

CCR10: Read and comprehend complex literary and informational texts independently and proficiently.
Mathematics (High School)

College and Career Readiness Anchor Standards for *Writing*

Text Types and Purposes

CCW1: Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.

CCW2: Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.

CCW3: Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.

Production and Distribution of Writing

CCW4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

CCW5: Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

CCW6: Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others.

Research to Build and Present Knowledge

CCW7: Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation.

CCW8: Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism.

CCW9: Draw evidence from literary or informational texts to support analysis, reflection, and research.

Range of Writing

CCW10: Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

College and Career Readiness Anchor Standards for *Speaking and Listening*

Comprehension and Collaboration

CCSL1: Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.

CCSL2: Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.

CCSL3: Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric.

Presentation of Knowledge and Ideas

CCSL4: Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

CCSL5: Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations.

CCSL6: Adapt speech to a variety of contexts and communicative tasks, demonstrating command of formal English when indicated or appropriate.

College and Career Readiness Anchor Standards for *Language*

Conventions of Standard English

CCL1: Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

CCL2: Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

Knowledge of Language

CCL3: Apply knowledge of language to understand how language functions in different contexts, to make effective choices for meaning or style, and to comprehend more fully when reading or listening.

Vocabulary Acquisition and Use

CCL4: Determine or clarify the meaning of unknown and multiple-meaning words and phrases by using context clues, analyzing meaningful word parts, and consulting general and specialized reference materials, as appropriate.

CCL5: Demonstrate understanding of figurative language, word relationships, and nuances in word meanings.

CCL6: Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Mathematics (High School)

Number and Quantity

The Real Number System

CCM1: Extend the properties of exponents to rational exponents.

CCM2: Use properties of rational and irrational numbers.

Quantities

CCM3: Reason quantitatively and use units to solve problems.

The Complex Number System

CCM4: Perform arithmetic operations with complex numbers.

CCM5: Represent complex numbers and their operations on the complex plane.

CCM6: Use complex numbers in polynomial identities and equations.

Vector and Matrix Quantities

CCM7: Represent and model with vector quantities.

CCM8: Perform operations on vectors.

CCM9: Perform operations on matrices and use matrices in applications.

Algebra

Interpret the structure of expressions

CCM10: Write expressions in equivalent forms to solve problems.

Arithmetic with Polynomials and Rational Expressions

CCM11: Perform arithmetic operations on polynomials.

CCM12: Understand the relationship between zeros and factors of polynomials.

CCM13: Use polynomial identities to solve problems.

CCM14: Rewrite rational expressions.

Creating Equations

CCM15: Create equations that describe numbers or relationships.

Reasoning with Equations and Inequalities

CCM16: Understand solving equations as a process of reasoning, and explain the reasoning.

CCM17: Solve equations and inequalities in one variable.

CCM18: Solve systems of equations.

CCM19: Represent and solve equations and inequalities graphically.

Functions

CCM20: Understand the concept of a function and use function notation.

CCM21: Interpret functions that arise in applications in terms of the context.

CCM22: Analyze functions using different representations.

Building Functions

CCM23: Build a function that models a relationship between two quantities.

CCM24: Build new functions from existing functions.

Linear, Quadratic, and Exponential Models

CCM25: Construct and compare linear, quadratic, and exponential models, and solve problems.

CCM26: Interpret expressions for functions in terms of the situation they model.

Trigonometric Functions

CCM27: Extend the domain of trigonometric functions using the unit circle.

CCM28: Model periodic phenomena with trigonometric functions.

CCM29: Prove and apply trigonometric identities.

Geometry

CCM30: Experiment with transformations in the plane.

CCM31: Understand congruence in terms of rigid motions.

CCM32: Prove geometric theorems.

CCM33: Make geometric constructions.

Similarity, Right Triangles, and Trigonometry

CCM34: Understand similarity in terms of similarity transformations.

CCM35: Prove theorems involving similarity.

CCM36: Define trigonometric ratios, and solve problems involving right triangles.

CCM37: Apply trigonometry to general triangles.

Circles

CCM38: Understand and apply theorems about circles.

CCM39: Find arc lengths and areas of sectors of circles.

Expressing Geometric Properties with Equations

CCM40: Translate between the geometric description and the equation for a conic section.

CCM41: Use coordinates to prove simple geometric theorems algebraically.

Geometric Measurement and Dimension

CCM42: Explain volume formulas, and use them to solve problems.

CCM43: Visualize relationships between two-dimensional and three-dimensional objects.

Modeling with Geometry

CCM44: Apply geometric concepts in modeling situations.

Statistics and Probability

CCM45: Summarize, represent, and interpret data on a single count or measurement variable.

CCM46: Summarize, represent, and interpret data on two categorical and quantitative variables.

CCM47: Interpret linear models.

Making Inferences and Justifying Conclusions

CCM48: Understand and evaluate random processes underlying statistical experiments.

CCM49: Make inferences and justify conclusions from sample surveys, experiments, and observational studies.

Conditional Probability and the Rules of Probability

CCM50: Understand independence and conditional probability and use them to interpret data.

CCM51: Use the rules of probability to compute probabilities of compound events in a uniform probability model.

Using Probability to Make Decisions

CCM52: Calculate expected values, and use them to solve problems.

CCM53: Use probability to evaluate outcomes of decisions.

Appendix F: National Educational Technology Standards for Students (NETS-S)

NETS Crosswalk for Secondary Electrical (Y2)											
	Course	**Unit 1**	**Unit 2**	**Unit 3**	**Unit 4**	**Unit 5**	**Unit 6**	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**
NETS Standards											
T1		x									
T2		x	x	x	x	x	x	x			
T3					x		x	x			
T4		x	x	x			x				
T5						x					
T6		x	x	x	x	x	x	x			

T1 Creativity and Innovation
T2 Communication and Collaboration
T3 Research and Information Fluency
T4 Critical Thinking, Problem Solving, and Decision Making
T5 Digital Citizenship
T6 Technology Operations and Concepts

T1 Creativity and Innovation
Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology. Students do the following:
a. Apply existing knowledge to generate new ideas, products, or processes.
b. Create original works as a means of personal or group expression.
c. Use models and simulations to explore complex systems and issues.
d. Identify trends and forecast possibilities.

T2 Communication and Collaboration
Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others. Students do the following:
a. Interact, collaborate, and publish with peers, experts, or others employing a variety of digital environments and media.
b. Communicate information and ideas effectively to multiple audiences using a variety of media and formats.
c. Develop cultural understanding and global awareness by engaging with learners of other cultures.
d. Contribute to project teams to produce original works or solve problems.

T3 Research and Information Fluency
Students apply digital tools to gather, evaluate, and use information. Students do the following:
a. Plan strategies to guide inquiry.
b. Locate, organize, analyze, evaluate, synthesize, and ethically use information from a variety of sources and media.
c. Evaluate and select information sources and digital tools based on the appropriateness to specific tasks.

d. Process data and report results.

T4 Critical Thinking, Problem Solving, and Decision Making

Students use critical-thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources. Students do the following:

a. Identify and define authentic problems and significant questions for investigation.
b. Plan and manage activities to develop a solution or complete a project.
c. Collect and analyze data to identify solutions and/or make informed decisions.
d. Use multiple processes and diverse perspectives to explore alternative solutions.

T5 Digital Citizenship

Students understand human, cultural, and societal issues related to technology and practice legal and ethical behavior. Students do the following:

a. Advocate and practice safe, legal, and responsible use of information and technology.
b. Exhibit a positive attitude toward using technology that supports collaboration, learning, and productivity.
c. Demonstrate personal responsibility for lifelong learning.
d. Exhibit leadership for digital citizenship.

T6 Technology Operations and Concepts

Students demonstrate a sound understanding of technology concepts, systems, and operations. Students do the following:

a. Understand and use technology systems.
b. Select and use applications effectively and productively.
c. Troubleshoot systems and applications.
d. Transfer current knowledge to learning of new technologies.