

Agricultural Engineering 1 & 2
Davis Senior High School
Alex Hess, Instructor

Electrical Contracting Services

Agricultural Mechanics Pathway, Agriculture & Natural Resource Industry Sector
Grade Levels: 9 & 10 **Date:** Fall 2013

Lesson Overview

Students will demonstrate basic understanding of electrical systems commonly found in agricultural structures. Students will also demonstrate basic proficiency in wiring and fixture installation that meet National Electric Code (NEC) requirements and Electrical Scope of Work specifications commonly used in industry when contracting with the trades. Students will be divided into Electrical Company Build Teams and act as electrical companies bidding for a contract for a large agricultural land development that includes multiple structures. Students will calculate voltage, resistance, current and power using Ohms law, then use it to determine loading of an electrical circuit. Students will use a digital multi-meter for testing and problem solving. The focal point of the unit is for students to build a California Ag Mechanics CDE Electrical Board and have each Electrical Company Build Team compete against each other for the best electrical install. Competition will be based on demonstrated knowledge and skill (budget and bidding, electrical board construction craftsmanship, quality of installation, electrical problem solving and troubleshooting, quality and code inspection, and ability to meet performance objectives).

Materials Included in this Lesson

Other Materials for this Lesson

- Worksheets
- Observation data collection sheets
- Scope of Work- Electrical
- Material Pricing sheets
- Sample estimating form
- Copy of residential building plans
- Schematic of Electric Project Design
- Electrical Formulas
- Copy of pertinent NEC code
- Electrician's installation tools
- Calculators
- Paper/Pencils
- Rubrics

2	Sht.	½ C-C Plywood or OSB exterior grade
40	ea.	4" sq. Electrical boxes with ½" knockouts
20	ea.	½" EMT Box connectors
20	ea.	½" PVC Box connectors
10	ft.	½" EMT
10	ft.	½" PVC electrical conduit
40	ea.	grounding screws (#8)
40	ea.	mounting screws
30	ea.	4" square blank cover
50	ea.	½" NM cable clamps
20	ea.	duplex receptacle 115 vac
20	ea.	switch
20	ea.	3 way switches

10	ea.	4 way switch
10	ea.	common lighting fixtures
250	ft.	14-2 NM cable with ground 100ft
2	ft.	14-3 NM cable with ground 100ft
250	ea.	Wire nuts (orange) 2 14gauge bare solid copper wire
250	ea.	Wire nuts (yellow) 3 to 4 14gauge bare solid copper wire

Skills the Student will Learn

- A. Collaboration
- B. Electrical circuit analysis
- C. Financial Planning
- D. Wiring technique
- E. Circuit building
- F. Reading electrical plans

Student Deliverables

- A. Report-Backs
- B. De-bugged, working, and properly wired circuit
- C. Financial reports (budget, work estimate, actual)
- D. Project built and wired to code
- E. Wiring diagram scheme
- F. Project built and wired to specifications

Length of Lesson: 10 Days

Activity Day One

Budget and Finance: Creating a budget to determine project feasibility. The Finance lead is provided worksheets, price sheets, estimating forms and directions. Based on a pre-determined design, build period, and scope of work, students will create a budget for building and installing an electrical project. After budgeting, each group is assigned the task (homework) to submit a secret bid by a given deadline. They can talk to other groups, talk to each other, and request information from the instructor. All bids will be filed and used during project build (students will be "paid and billed" for materials, services, change orders, and meeting deadlines during the construction phase). There are three objectives of the activity- 1) Get students actively engaged in budgeting and estimating, 2) Have students demonstrate and practice financial responsibility, and 3) Prepare a basis for students to analyze their performance after the project build.

Activity Day Two

Walk-about (facilities and school site walking tour) contest preparation. A 3-4 slide PowerPoint presentation of stud wall electrical installs (prior to sheet rock) are presented. A school district electrician from Maintenance & Operations talks with the class about building and site electrical systems. We tour the school barn, shop, solar array, and site. Project schematics and schematics for Electrical build and install are provided to students. Contest rules are distributed.

Activity Day Three

Demonstration Day Safety, Proper tools use, and skills (wire stripping, conduit installation, wire pulling, proper installation of a light, switch, and duplex receptacle) are demonstrated for the students and students practice wire stripping and connecting by making an electrical cord. Contest rules are discussed.

Winning bid and bid ranking announced (may be completed +/- one day)

Activity Day Four

Build day 1: Students build and wire project, contest format. Each team is competing for time, accuracy, workmanship, Code, materials used, and functioning system. All wire, caps, grounds, and connections must pass inspection prior to closing/sealing fixtures. Circuit must be operational after closed/sealed. Fines and grade penalties accrue for jobs not completed.

Activity Day Five

Build day 2: Students build and wire project, contest format. Each team is competing for time, accuracy, workmanship, Code, materials used, and functioning system. All wire, caps, grounds, and connections must pass inspection prior to closing/sealing fixtures. Circuit must be operational after closed/sealed. Fines and grade penalties accrue for jobs not completed. Inspections order is completed and submitted in anticipation of wire completion.

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Activity Day Six

Build day 3: Students build and wire project, contest format. Each team is competing for time, accuracy, workmanship, Code, materials used, and functioning system. All wire, caps, grounds, and connections must pass inspection prior to closing/sealing fixtures. Circuit must be operational after closed/sealed. Fines and grade penalties accrue for jobs not completed.

Activity Day Seven

Circuit Testing & Quality Assurance Day: Students passing or waiting for final inspection are provided a system to debug. Once debugged and working the team must submit a written report detailing how they used the testing equipment to find the bug, what they did to fix the bug, and how might the bug be avoided in the future. In addition to using a multi-meter, students are provided debugging guidelines. While teams are testing and debugging, team wiring projects are inspected for quality and craftsmanship.

Activity Day Eight

Each student is to explain the relationship between voltage, amperage, resistance, and power in single-phase alternating current (AC) circuits by describing its use in the shop and using Ohms/Power laws to explain electrical demands and issues in the shop. One problem solving activity is for students to use electric motor labels and welders labels to estimate the electrical needs of the shop during peak performance periods. Students will provide a wiring diagram scheme that layouts the shop to their liking.

Activity Day Nine

Walk the Build Site: A walking tour of a local building development will be conducted. The tour will be during a build phase prior to drywall installation. A site manager or local inspector will show plans and discuss code requirements. (The walking tour of a local build site to view electrical installations is listed for Activity Day Ten, but may occur on any possible during the unit).

Enrichment Suggestions

- Students install or replace a light fixture or duplex receptacle at home under the supervision and advance approval of their parent.
- Students create a plan for fluorescent light of the school barn and determine the solar panel requirements required to power the system.
- Students calculate the peak load of the shop if all equipment was operating at the same time.

Student Resources

NFPA NEC (2011): National Electrical Code Read Online
<http://archive.org/stream/gov.law.nfpa.nec.2011/nfpa.nec.2011#page/n137/mode/2up>

Basics of Your Home's Electrical System - The Home Depot
<http://youtu.be/nZVeOgusxqk>

Introduction to Ohm's Law
http://youtu.be/_jX3dezzMg

Ca. Common Core Addressed

- **Reading Standards for Literacy in Science and Technical Subjects- RLST**
- 9-10.3 Follow precisely a complex multistep procedure
- 9-10.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases
- 9-10.5 Analyze the structure of the relationships among concepts in a text
- **Writing Standards- WS**
- 9-10.7 Conduct short as well as more sustained research projects to solve a problem
- 9-10.9. Draw evidence from literary or informational texts to support analysis, reflection, and research.
- **Scientific and Engineering Practices – SEP**
- **Crosscutting Concept – CC**
- **Engineering, Technology, and the Applications of Science – ETS**

Ca. CTE Foundation Standards

- **5.0 Problem Solving and Critical Thinking**
 - 5.3 Use systems thinking
 - 5.4 Interpret information and draw conclusions
- **7.0 Responsibility and Flexibility**
 - 7.6 Demonstrate knowledge and practice of responsible financial management.
- **8.0 Ethics and Legal Responsibilities**
 - 8.1 Access, analyze, and implement quality assurance standards of practice.
 - 8.2 Identify regulatory agencies, entities, laws, and regulations
- **9.0 Leadership and Teamwork**
 - 9.10 Understand how to organize and structure work
- **10.0 Technical Knowledge and Skills**
 - 10.2 Comply with the rules, regulations, and expectations
 - 10.3 Construct projects and products
- **11.0 Demonstration and Application**
 - 11.1 Utilize work-based/workplace learning experiences
 - 11.2 Demonstrate proficiency

Ca. CTE Pathway Standards

- **B3.0 Demonstrate basic electricity principles and wiring practices commonly used in agriculture.**
 - B3.1 Explain the relationship between voltage, amperage, resistance, and power
 - B3.2 Use proper electrical test equipment for AC and direct current (DC) circuits.

- B3.3 Analyze and correct basic circuit problems
- B3.4 Implement proper basic electrical circuit and wiring techniques
- B3.5 Interpret basic agricultural electrical plans.
- B3.6 Complete an electrical project, including

Lesson Plan Relevance To Externship

The relevance of this lesson to my Externship at The New Home Company relates directly to installation of electrical circuits in new home construction. I spent time working in each of the companies departments and gained new insights into each phase of a project from Land Acquisition to Customer Service. Most of my time was in the field experiencing homes in every phase of construction (from conceptual drawing to handing keys over to the a buyer).

Communication, teamwork, financial responsibility, quality products, superior construction quality and craftsmanship, attention to detail, and customer service were all very impressive. I focused on a lesson in electrical because of the direct connection with the New Company's work in the field and aspects of the trade (that they modeled for me) that I could bring into the classroom. Additionally, I am fortunate enough to have had an externship that may break ground in the local area in the near future.

Rubric for the (title) Project

Student Deliverables	1 Exceeds Expectations	2 Meets Expectations	3 Approaches Expectations	4 Fails to meet Expectations
De-bugged circuit				
Financial reports				
Project				
Wiring diagram scheme				