Basic Electricity Project Based Learning Plan

Down to the Wire

Project Duration: 4 hours (single sitting)
Applicable Level: Utility apprentice.
Subjects: Basic Electricity
Standards: Enter any applicable standards here
Created by: Douglas Bushong

Yes	Elements of Project Learning
X	Organizes tasks around a driving questions
	Engages students in in-depth inquiry
	Includes a public audience
X	Establishes a need to know
X	Encourages voice and choice
X	Incorporates revision and reflection
	Students work in teams
	Students complete a teamwork agreement
	Includes students in the defining stage of their project
X	Includes students in the planning stage of their project
X	Students manage the successful completion of their project
X	Includes students in the evaluation of their project

Project Overview

The Basic Electricity course is a 2-week, 80-hour course that teaches the fundamentals of electrical theory and troubleshooting. Upon completion of the first week's exam and prior the introduction to troubleshooting, students will design simple electrical circuits based on specifications provided. This will be the apprentice's first taste of "hand's on" work in the electrical lab. After verifying that their circuits function, they will attempt to determine the specification requirements provided to each other student based on the functionality of the circuits.

Project Outcomes

A group of students will each build simple electrical circuits based on pre-defined specifications. These specifications will describe general safety rules and the circuit's purpose, but will not say how the circuit will achieve that purpose.

The goal of this project is threefold:

1. The students will translate functional circuit descriptions into wiring diagrams.
2. The students will safely wire circuits based on wiring diagrams of their own designs.
3. The students will interpret a circuit's function based on its wiring and arrangement.

In solving an electrical circuit problem, the students are learning the skills necessary to move on to the troubleshooting portion of the course. In order to properly troubleshoot a circuit, a technician must first be able to understand the function of each flow path. This project will teach them both sides of this translation process; they will make circuits from functional descriptions, and they will make functional descriptions based on circuits.

Upon completion of this project, there will be 6 circuit boards, and each student will have a set of 6 circuit descriptions (1 that was provided to them for their boards, and 5 that they wrote based circuit analysis).

Schedule

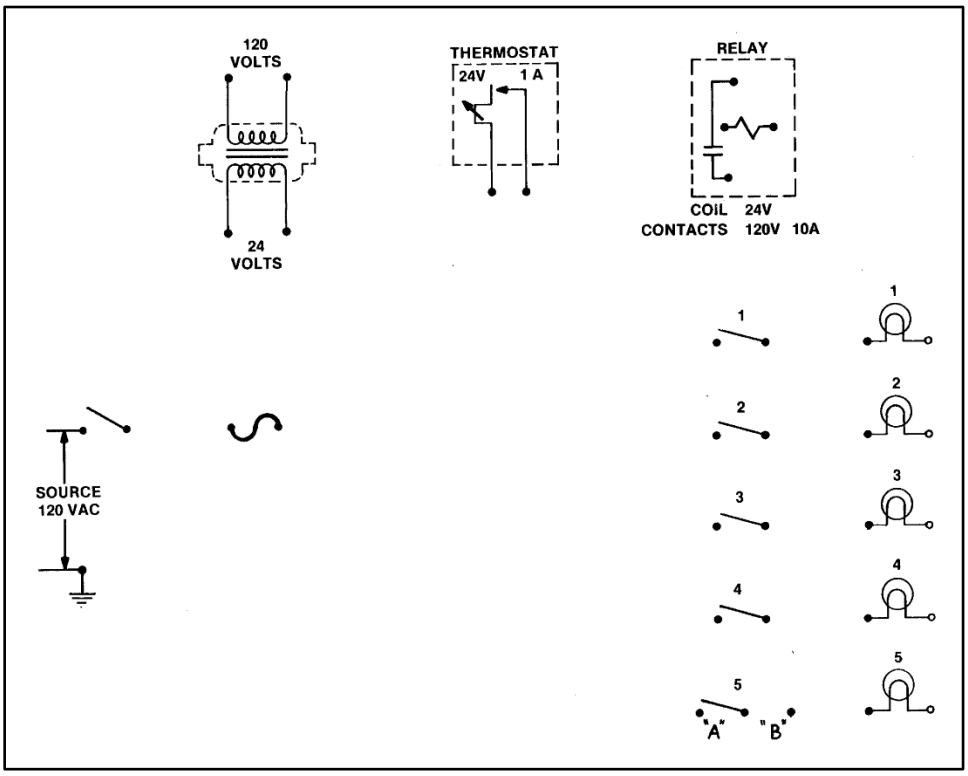
This project based learning will occur either after the theory exam on the first Friday afternoon, or on the morning of the following Monday.

Hour	Activities
0:00-0:30	The explanation for the project will take approximately 30 minutes. Examples of possible circuit configurations will be provided to the students to help explain the meaning of certain sets of instructions.
0:30-1:30	Students will have one hour to complete their own circuit designs based on specifications provided. This will include drawing the wiring diagram on a blank set of prints, reviewing the drawing with the instructor, wiring the circuit based on their drawings, conducting a safety review, and energizing the circuit. When this step is complete, the circuit should function as described in the specs.
1:30-3:00	Students will review the circuits of each other student. The students will draw the circuits as wired, and describe their interpretation of the circuit's function based on its operation. Students will have approximately 10 minutes on each board.
3:00-4:00	Students will return to the classroom and review the operation of the circuits. Students will compare their circuit analysis against the original specifications that were used to build the circuits, and discuss any discrepancies.

Project Specifics

The project begins with a brief overview of circuit wiring, and the expected consequences (brightness of the lamps, effect of opens, etc.) of connecting circuits in series and/or parallel. Students should also review switch types, including the number of poles/throws in a given switch. It will be important for the students to understand, for example, that SPDT means "single pole, double throw."

Here is the circuit template that the students will be using. When designing their circuits, they will draw lines between the components to represent wires.



Each of the 6 students will then be given one short description of the circuit that they are to complete. The instructor will review the circuits for safety and functionality at 3 key checkpoints:

- When the diagram is complete, but before the circuit is wired
- When the wiring is complete, but before the circuit is energized
- After the circuit is energized, but before students begin their circuit analysis.

During the first two reviews, the only corrections will be for safety; during the final review, students will be assessed and corrections will be made for functionality before proceeding into the circuit analysis.

Below are examples of the circuit descriptions that will be provided to the students. Again, only **one** description should be provided to each student. To the right are possible designs that would achieve the desired goal, but the students should not be marked off for variations in the design, provided the circuit works according to the specifications described in the circuit description.

Circuit Descriptions

Circuit 1: 5 lamps. All lamps will shine brightly (120V). One of the five lamps should be lit continuously; the other four should be controlled by four separate SPST switches.

Circuit 2: 5 lamps. Two lamps should burn continuously without a control device and shine dimly (60V). Two lamps should be controlled through one SPST switch, and should shine dimply (60V). One lamp should be controlled through two SPST switches, and if either of the two switches is open, the lamp should turn off.

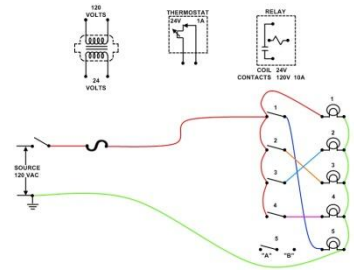
Circuit 3: 3 lamps. One lamp should be controlled by two SPST switches. If either of the two switches is shut, the lamp should shine brightly (120V); both switches should be open for the lamp to turn off. The other two lamps should be controlled by a single SPST switch, and should both shine brightly.

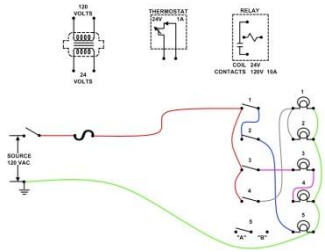
Circuit 4: 5 lamps. One lamp should shine brightly (120V), and should be controlled by two (2) single pole, single throw switches. If either of the two switches is open, the lamp should turn off. Two of the lamps should shine dimly (60V), and should be controlled by a single pole, single throw switch. The last two lamps should shine brightly (120V), and should be controlled by a single pole, single throw switch.

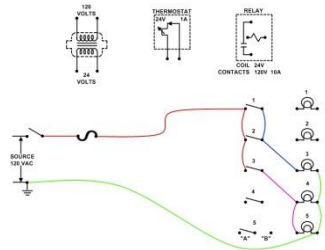
Circuit 5: 4 lamps. Controls for the circuit will be through a single pole, double throw switch. Two of the lamps should shine dimly (60V) when the SPDT switch is in one position, and the two other lamps should shine brightly (120V) when the SPDT switch is in the other position.

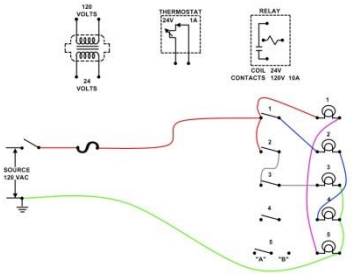
Circuit 6: 1 lamp. The lamp should be controlled with the contact of a 120V relay contact, and should shine brightly (120V) when it is on. The relay contains a 24V coil, so a 24V source will have to be created using a 5:1 step down transformer on the board. The relay coil will be controlled by a 24V thermostat.

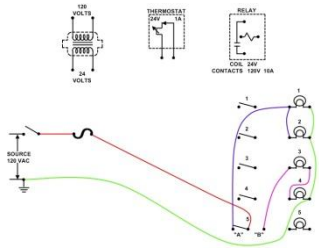
Examples of possible designs

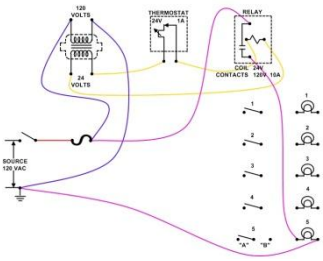












When the wiring is complete, the class will assess each circuit as a group. For each circuit, the student that designed the circuit will be moved to the classroom as each of the remaining students discusses the circuit and what it is designed to do. When the team comes to a consensus, the student who designed the circuit will return to the board and present what the original specifications were. The students will then have a short discussion comparing the original specs and the group's specifications before moving on to the next board. During the review, the instructor should encourage the students to ask questions and discuss the circuits together.

The instructor should be mindful that this represents the reality that these apprentice technicians will face in the field. They will occasionally have to design a circuit to spec, and they will frequently have to interpret the functionality of a circuit designed by others. In the field, like in this classroom, the analysis of a circuit is often a group effort.

Assessment

Students are to be given a copy of the assessment rubric below. Be mindful that the assessment should not be completed until the appropriate checkpoints in the course. Part 1 should not be assessed until the student has completed the circuit diagram and submitted it for review. Step 2 should not be assessed until the circuit construction is complete, but before the circuit is energized. Step 3 should be assessed after all of the circuit analysis is complete, and should be compared to the original design criteria assigned before step 1.

Rubric			
Part 1: Design (15 points total)	0-5 Points	6-14 Points	15 Points
Does the circuit design work as the specifications intended?	When the circuit is energized, the loads (lights) do not work as described.	The circuit worked for most of the functions described, but not all.	The circuit works as described in the specs.
Part 2: Safety (15 points total)	0 Points	10 Points	15 Points
Is the circuit electrically safe, and were the steps performed safely? ***NOTE: Safety is paramount and uncompromising in this lab. Use the precise scoring for this part of the evaluation.***	The student energized the circuit prior to safety review and/or without wearing electrical safety gloves.	The circuit had a direct, shorted connection to ground that was not corrected by the student. Proper personal protective equipment was used.	The circuit had no direct connections from the source to ground OR a short was found but corrected by the student during the safety review. Proper personal protective equipment was used.
Part 3: Analysis/Teamwork (6 points/circuit, 30 points total)	0-2 point	3-5 points	6 points
Does the circuit analysis of the other students' circuits match the specifications provided to them? ***Note: evaluate for each of the 5 circuit analyses.***	The circuit analysis did not include any of the functions described in the initial criteria. Any description provided was not correct.	Most of the circuit functions described match the initial criteria, but one our more functions was missing or incorrect.	The circuit functions described in the student's analysis matches the criteria presented to the original designer.