EELE 354 Lab Assignment 8: Wiring Branch Circuits

Lab Overview:

While electrical engineers design the electrical systems, it's the electricians who perform the installation. The National Electric Code (NEC) is the de facto standard for the installation of electrical wiring and equipment in the United States. For electricians to becomes licensed, they will spend years as an apprentice studying and practicing the NEC standards.

While the NEC is the de facto standard, it is not a law. In fact many states and localities having their own electrical standards which, while generally based on NEC standards, can vary and do supersede the NEC. Thus, when performing electrical system installations, electricians must review the NEC, local and state standards, as well as the job specifications.

In this lab assignment, you will construct two different circuit branches that are typical of residential and small commercial electrical systems. The first branch is a multi-outlet circuit containing a ground fault-current interrupter (GFCI). The NEC specifies that a GFCI be installed in such places as bathrooms, kitchens, garages, crawl spaces, and outdoor locations. The second branch is a multi-switch lighting circuit that would be typical of a room with multiple entryways. The NEC specifies approved methods for wiring such circuits.

Objectives:

The objectives of this laboratory assignment are:

- Learn proper techniques and practices in wiring 120 V ac, single-phase branch circuits.
- Learn the operation of a GFCI outlet and learn how to wire it in the circuit.
- Learn the operation of three and four-way switches and learn how to wire them in a lighting circuit.

Pre-lab Assignment:

Read through the entire lab assignment.

While you might not have direct access to the NEC handbook, much of the general information that is specified in it can be found online. Using your book and/or the internet, determine the requisite wire sizing for a 15 A rated circuit, a 20 A rated circuit, and a 30 A rated circuit. Give your answers in the American Wire Gauge unit (AWG).

Lab Experiment:

Figure 1 shows a block diagram of the two branch circuits that you will construct in this lab. The first task will have you wire-up a two outlet circuit, with one of the outlets containing a GFCI. The second task will have you wire up a lighting circuit containing three switches. Two of these switches will be 3-way switches, and the other will be a 4-way switch. Your lab instructor will help you understand the functionality of 3 and 4-way switches during lab.

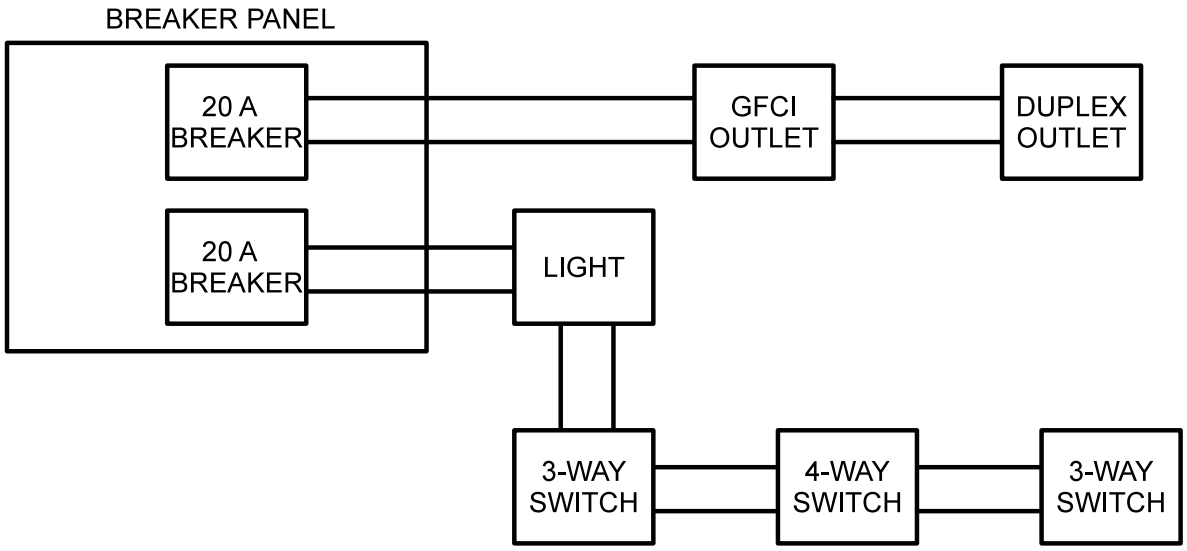

Figure 1: Block diagram topology of the two branch circuits.

Lab Experiment Part I: The GFCI Branch Circuit

1. **Prior to building your circuit, ensure that the two circuit breakers in the breaker panel are set to the off position.**

2. **Have your instructor approve your pre-lab.**

3. Build the GFCI circuit. Figure 2 shows the correct method for wiring a GFCI outlet in a circuit containing multiple outlets. NOTE: The image does not show the grounding of the receptacle boxes. You are required to ground them.

4. When finished, double check to make sure that all wire connections are secure and in the correct location. **Have your instructor approve your circuit.**

5. Energize your circuit by first flipping the corresponding circuit breaker in the breaker box to the on position, and second, flipping the lab bench outlet circuit breaker to the on position.

6. Measure the voltages at both outlets using your digital multimeter and record them in the table below.

	Phase-Neutral Voltage (V_{p-n})	Phase-Ground Voltage (V_{p-g})	Neutral-Ground Voltage (V_{n-g})
GFCI Outlet			
Duplex Outlet			

7. **Have your instructor test the GFCI operation of your circuit.**

8. De-energize your circuit by first flipping the lab bench outlet circuit breaker to the off position, and then flipping the GFCI circuit breaker in the breaker box to the off position.

Lab Experiment Part II: Multi-Switch Circuits

9. Build the multi-switch circuit. Figure 3 shows the correct method for wiring a three-switch circuit by using three-way and four-way switching techniques. NOTE: The image does not show the grounding of the receptacle boxes. You are required to ground them.

10. When finished, double check to make sure that all wire connections are secure and in the correct location. **Have your instructor approve your circuit.**

11. Energize your circuit by first flipping the corresponding circuit breaker in the breaker box to the on position, and second, flipping the lab bench outlet circuit breaker to the on position.

12. Complete the state table below by testing the operation of the circuit.

Switch 1 State	Switch 2 State	Switch 3 State	Lightbulb State
Off	Off	Off	
Off	Off	On	
Off	On	Off	
Off	On	On	
On	Off	Off	
On	Off	On	
On	On	Off	
On	On	On	

13. De-energize your circuit by first flipping the lab bench outlet circuit breaker to the off position, and then flipping the GFCI circuit breaker in the breaker box to the off position.

14. Disassemble your circuit, entirely. Leave the components and wires used at your workbench in proper order.

Lab Questions:

15. Why is wire sizing important both from an operations perspective and a safety perspective? Speculate as to what might happen if too small of wire is used for the current rating of a circuit.

16. Why, when the wires are out of sight (e.g. behind walls, inside conduit, etc) is it important that the correct color codes of wires be used?

17. Why are GFCI connected outlets so important in environments such as bathrooms, garages, crawl spaces, outdoors, boathouses, etc? Why are the circuit breakers insufficient?

Name and initial of lab partners:

Lab Partner 1: _____

Lab Partner 2: _____

Lab Partner 3: _____

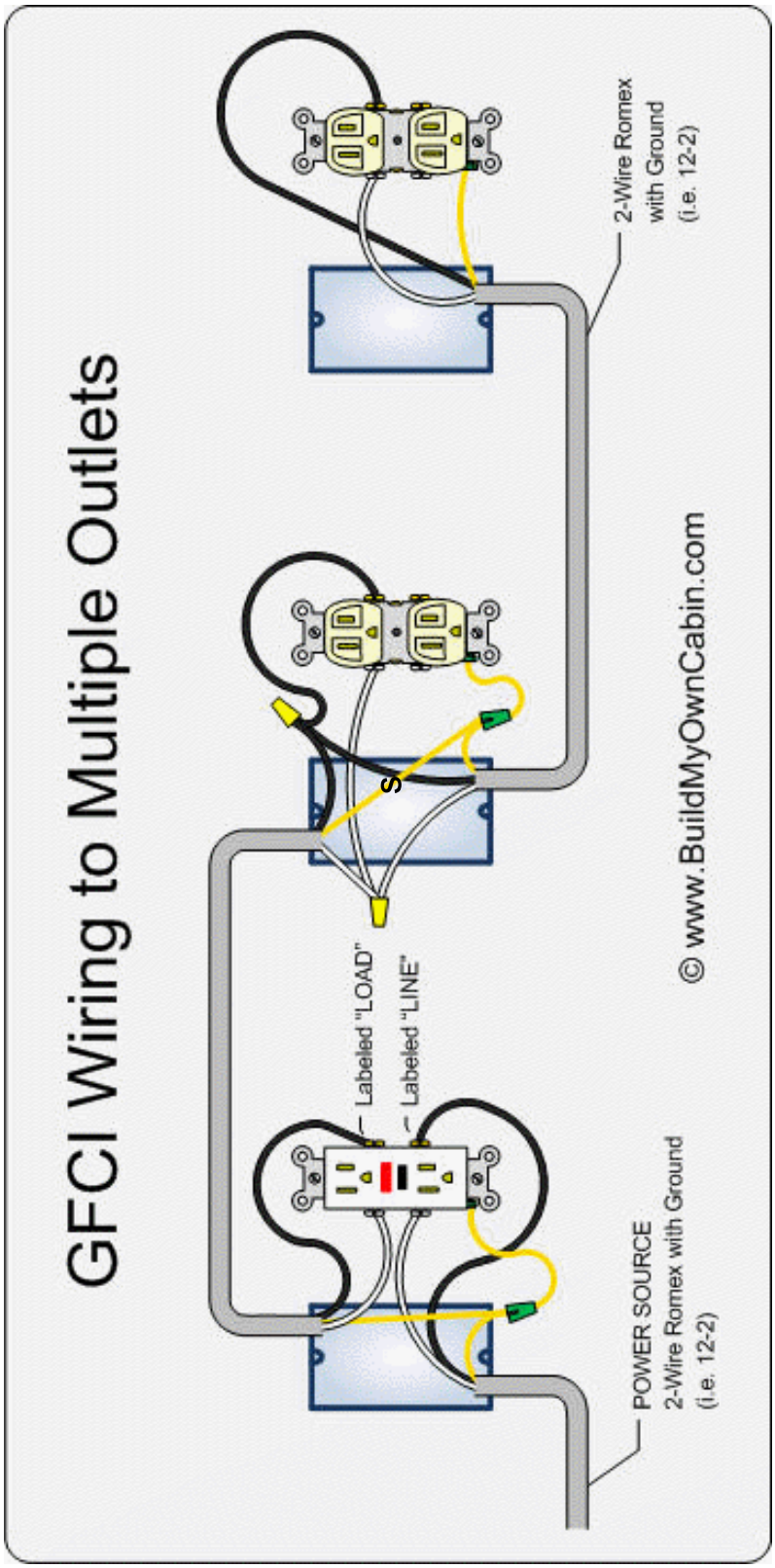

Figure 2: Wiring diagram for a multi outlet GFCI-connected circuit.

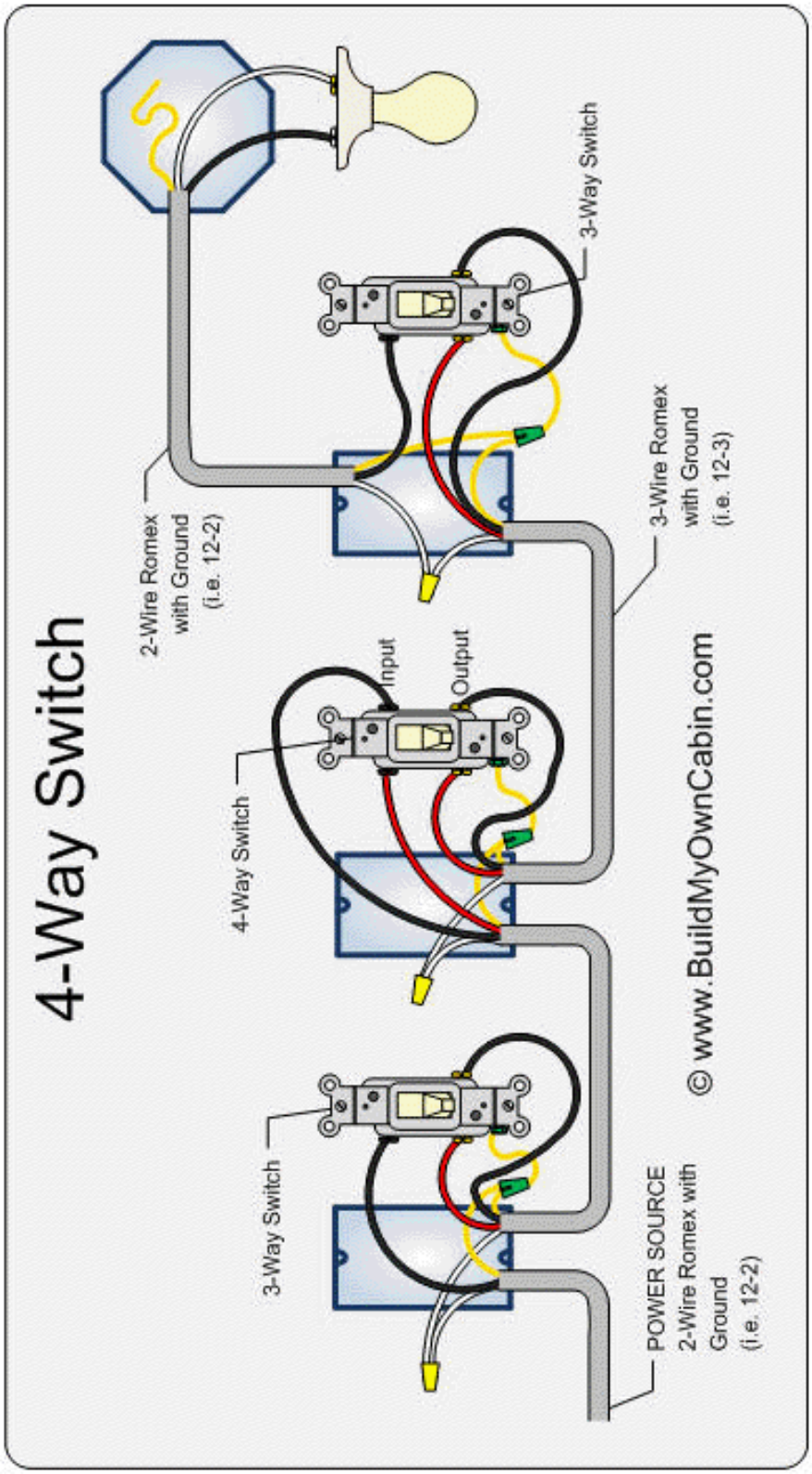

Figure 3: Wiring diagram for a multi-switch circuit.