

## ME 121: Homework 4

**Due May 4, 2016**

### Group Assignment

1. Complete the calibration of the salinity sensor. At the start of class, the instructor will evaluate your salinity sensor system according to Checklist 3, which is available on the Homework page of the class web site. Note that the last step of the checklist is that your system displays a plausible salinity value on the LCD when the flow loop is running. This last step is worth 15 points.
2. Build two cascade control circuits using transistors and relays to control the two solenoid valves on your group's fish tank. The circuit should have flyback diodes across the coils of the relays and the solenoid valves. Write an Arduino program to alternate energizing the solenoid valves, holding one open for one second while the other one is closed, and then switch. The pattern should be: valve A on and valve B off, wait one second, valve A off and valve B on, wait one second, valve A on and valve B off, wait one second, ... Be ready to display the operation of this circuit at the start of class. Note that the completion of this assignment includes the preliminary checklists on page 8 and page 10 of the Fish Tank Overview document from Lecture 1.

Bonus 5 points: Install a potentiometer on your circuit board. Use the potentiometer to adjust the delay in the solenoid valve cycle between 0.5 and 2 seconds.

### Individual Assignment

3. A batch of masonry cement is made by mixing three 5-gallon buckets of wet sand with one 70 lb<sub>f</sub> bag of masonry mix and 3 gallons of water. The sand used in the mix is partially wet, containing an unknown amount of water.
  - a. If the final batch of "mud" contains 11.3% water by weight when the desired consistency is reached, how many gallons of water did the sand used in the mixture contain? Assume wet sand and dry sand occupy the same volume.  
Answer: 1.48 gal
  - b. What is the weight of the final batch of mud?

Be sure to follow the systematic presented in class when solving this problem. Remember that learning the correct solution process is just as important as getting the correct answer.

Potentially useful information for this problem:

Specific weight of water = 8.33 lb<sub>f</sub>/gal.

Specific weight of dry sand = 111 lb<sub>f</sub>/ft<sup>3</sup>.

1 gal = 0.1337 ft<sup>3</sup>

4. Use the relay included in the Sparkfun Inventors Kit to build a circuit that alternates the lighting of a red and a yellow LED. Each LED should be on for one second.

You can watch a video of the solution at

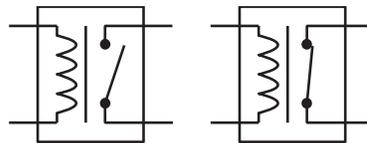
<http://www.youtube.com/watch?v=MEYkkPwxMi4>

5. Go to the Digikey web site and locate the 12 V relay, part number PB370-ND. Download the datasheet for the T77Series relay from the manufacturer. PB370-ND is the part number for the *vendor*, Digikey.

- a. What is the name of the manufacturer?
- b. What is the *manufacturer's part number* for the item that Digikey stocks as part number PB370-ND?
- c. From the data sheet and the manufacturer's part number, fill in the following table of performance characteristics for the relay

Category of protection	
Contact rating and coil power	
Coil voltage	

- d. Using the information from the data sheet, which of the following symbols is an accurate representation of the relay?



Copy the symbol to your homework sheet. Write a once sentence description or justification for your choice.

*Future Hint:* You should be able to create a hand sketch of the relay symbol on an exam. On an exam, a digital copy-paste operation will not be feasible. Be sure you can draw this symbol from memory, by hand on a blank piece of paper.

- e. The relay has four pins in an asymmetric pattern. In the fish tank salinity control system, the relay will be used to switch power to a solenoid valve. A circuit controlled by a transistor energizes the coil in the relay. Which two of the four pins should be connected in the transistor side of the cascade switch circuit? Which two of the four pins should be connected to the solenoid side of the cascade switch circuit? Use a hand sketch to illustrate how the connections are to be made.

*Hint:* One of the pictures on the data sheet makes this sketch easy.