EET 433 – CONTROL SYSTEMS: ANALYSIS AND DESIGN
HOMEWORK ASSIGNMENT #1 - Basic Concepts

First, read Chapter 1 entirely. With this information and your prior knowledge, you should be able to answer the problems in this assignment.

Some of the following problems are based on concepts that have been taught in previous courses and are essential knowledge for a senior BSEET student. If you are unsure of how to solve them, consult your notes and textbooks from your prior courses. If you don’t remember where it was taught or feel lost, the library is a good place to hang out for a while.

Showing your work in detail and explaining your approach to the problems will not only improve your communication skills but also your grade.

1. An instrument has an accuracy of ±0.5% Full Scale and measures resistance from 0 to 1500 Ω. What is the uncertainty in an indicated measurement of 397 Ω?

2. A sensor has a sensitivity of 0.5 mV/ °C and an accuracy of ± 1%. If the temperature is known to be 60 °C, what can be said with absolute certainty about the output voltage?

3. A pressure sensor measures 44 psi just before a sudden change to 70 psi. The sensor measures 52 psi at a time 4.5 seconds after the change. What is the sensor time constant?

4. A photocell with a 35 ms time constant is used to measure light flashes. How long after a sudden dark-to-light flash before the cell output is 80% of the final value?

5. A control systems student monitored flow rate for a week and recorded the following values as gal/min: 10.1, 12.2, 9.7, 8.8, 11.4, 12.9, 10.2, 10.5, 9.8, 11.5, 10.3, 9.3, 7.7, 10.2, 10.0 and 11.3. Find the mean, mode, range and standard deviation for this data.

6. Explain how the basic strategy of control is employed in an air-conditioning system for a room. What is the controlled variable? What is the manipulated variable?

7. Construct a block diagram of a refrigerator control system. Define each block in terms of the refrigerator components.
8.- A pressure measurement system uses a sensor that converts pressure into voltage with the following sensitivity: $V_p = 0.5 \, \sqrt{p}$. This voltage is then converted into a current. As the pressure varies from 0 to 100 psi, the current varies from 4 to 20 mA.
   a) Find the equation for the conversion of voltage to current
   b) What is the pressure change that will cause the current to change from 19 mA to 20 mA?
   c) What is the pressure change that will cause the current to change from 4 mA to 5 mA?
   d) In both, b) and c) the current has changed the same amount by 1 mA. Does the change in pressure is also the same? Explain your answer
   f) Plot current versus pressure. Is this a linear or non-linear relationship?

9.- The figure below shows a simple level-control system in which a closed relay opens the valve and an open relay closed the valve. Input flow is not controlled. The relay closes at 6.0 V and opens again at 4.8 V. The level sensor has a transfer function of $V_o = 0.8 \, h + 0.4 \, V$.
   a) Find the amplifier gain (K) required to open the valve when the level reaches 1.5 m
   b) At what level does the valve close?
   c) Suppose $Q_1 = 5 \, \text{m}^3/\text{min}$, $Q_2 = 2 \, \text{m}^3/\text{min}$ and $Q_{out} = 9 \, \text{m}^3/\text{min}$ (when open). What is the period of the level oscillation?