Midterm Quiz: Electronics 323
February 12, 2009

Formula sheet provided. Total 40 points. Individual values follow each question.

1. (a) Describe what sensors, actuators, and transducers are. Give two examples each of sensors and actuators along with a description of the relevent physical quantities. (6)

   (b) For the specific case of a cathode ray oscilloscope how do you, the external user, control the vertical scale. What is the "sensor" for this process? If the input signal is 10 mV RMS and you would like the amplitude of the waveform to be 3 divisions, corresponding to a deflection plate voltage of 15 V what internal amplification is involved? (4)

2. For a particular amplifier at low frequency the amplitude of $V_{in} = 0.05$ V and V_{out} is 1.9 V. The input resistance of the amplifier is 10 kΩ and the load resistance is 1 kΩ. The output resistance of the amplifier is 0.1 kΩ.

   (a) Please draw the equivalent circuit of the amplifier with the appropriate labels. You may consider the input to the amplifier to be an ideal voltage source. (3)

   (b) Calculate the actual voltage gain (easy) and the ideal voltage gain (a bit harder, need to now remove the effect of the load resistor). (3)

   (c) Calculate the power gain in decibels. (1)

   (d) Calculate the gain in decibels using the voltage ratio using the standard $20 \log_{10}(V_o/V_i)$ formula. Why doesn't the answer agree with the previous one? (2)

   (e) It turns out that the gain of this amplifier falls off at high frequencies. What could cause this effect and how could you modify the equivalent circuit diagram (just add it in with dashed lines to the previous drawing)? (2)

3. See the diagram of the high-pass filter on the next page. Explicitly calculate the decibel gain (or attenuation in this case) and phase change in V_{out} at a frequency of $f = (2\pi RC)^{-1}$. I assume you know how to handle the complex number conventions. Give a plot of gain and phase versus the log of the frequency (don't need to derive this; just use knowledge from class and lab). (6)

4. See the diagram of the non-inverting amplifier on the next page.

   (a) What is the name of the device represented by the triangle shape in the diagram? What are the usual assumptions for the voltage difference between the inputs labelled '+' and '-' and the amount of current that passes through these inputs for this particular device? (3)

   (b) Using these conventions and some circuit analysis determine the relationship between V_i and V_o. (4)

   (c) Does this circuit use negative feedback? What is the value of B? Using the formula for gain of a closed-loop system calculate the resulting gain for $A = 10^5$. What would the answer be if A approached infinity? (4)

   (d) Would you expect that the frequency response of this closed-loop system (as expressed in terms of bandwidth) to be better, worse, or equivalent to that of an open loop system? Why (can explain by considering the effect of variations in A on the gain calculated in part 4c)? (2)