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Real Time Systems
EE 4770
Midterm Examination*
19 March 1993, 8:40–9:30

Problem 1 _____ (33 pts)

Problem 2 _____ (34 pts)

Problem 3 _____ (33 pts)

Alias _____

Exam Total _____ (100 pts)

Good Luck!

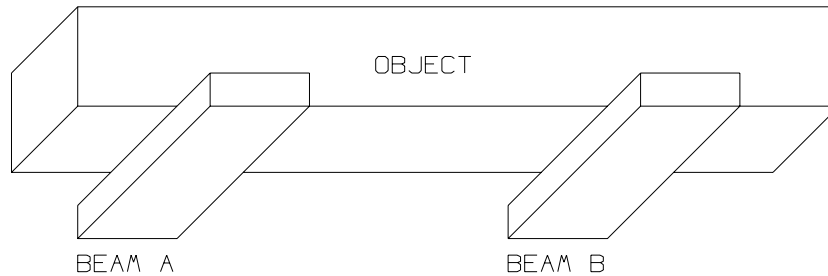
The wording of the questions on this exam may have been modified so that they are consistent with terminology used this semester.

Problem 1: Design a circuit to measure temperature using a thermistor (including a linearizing resistor) and an inverting amplifier. The circuit is to measure temperature in the range of $x \in [210 \text{ K}, 250 \text{ K}]$ with an output voltage given by $H(x) = \frac{(x-210 \text{ K})}{4 \text{ K}}$ V. The output is to be most accurate at the center of the temperature range. The thermistor has $R_o = 0.0500 \Omega$ and $\beta = 3250 \text{ K}$. Draw the circuit, and give values for all components and voltage sources. (33pts)

Problem 2: A shelf consists of two parallel beams (see diagram), with an object resting on both beams. If the object is not centered or if the weight is not evenly distributed then the beams will experience different forces. Strain gauges, on each beam, are used to measure the forces. The weight of the object can be found by taking the sum of the forces on the beams. Strain gauges can be placed on the beams such that there will be a strain of 10^{-5} for every Newton of force.

Design a circuit to weigh the object using ideal strain gauges with $R_0 = 1.00 \text{ k}\Omega$ at 300 K. (34pts)

- The circuit output should be $H(x) = 0.10 \frac{\text{V}}{\text{N}}x$, where $x \in [0, 100 \text{ N}]$ is the weight of the object.
- Draw the schematic diagram and include all component and power supply values. If you use an instrumentation amplifier specify its gain.
- Show the placement of the strain gauges. Be sure to label the strain gauges on both the circuit and shelf diagram.
- The circuit should include temperature compensation.



Problem 3: Briefly answer each of the following.

(a) Draw a diagram of a Hall effect sensor used as a proximity sensor. Include the object being measured and all relevant magnetic fields, currents, and voltages. (11pts)

(b) Write the integers 27 to 33 in gray code. (11pts)

(c) What is the advantage and disadvantage of a phototransistor over a photodiode? (11pts)

Have a good spring break!