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Real Time Computing Systems
EE 4770
Midterm Examination
12 March 1997, 8:40-9:30 CST

Problem 1 _____ (33 pts)

Problem 2 _____ (34 pts)

Problem 3 _____ (33 pts)

Alias _____

Exam Total _____ (100 pts)

Good Luck!

Problem 1: A circuit is to be designed to convert temperature $x \in [280 \text{ K}, 300 \text{ K}]$ to voltage $H(x) = (x - 280 \text{ K}) \frac{\text{V}}{4 \text{ K}}$ using a thermistor having model function $H_{t2}(x) = R_0 e^{\beta/x}$ with $\beta = 3000 \text{ K}$ and $R_0 = 0.059 \Omega$.

(a) Find a linear thermistor model appropriate to this problem using the method described in class. (In which the change in resistance with temperature (slope of model) matches H_{t2} at a particular point.) (8 pts)

(b) Find a linear thermistor model which matches H_{t2} at 280 K and 300 K. (7 pts)

(c) Draw the schematic of a circuit that could be used to generate the voltage. Show the sign (but not the value of) of voltage sources used. Show, but do **not** solve, an equation or equations that can be used to find the component values. The equation should be in terms of the first linear model function requested above, and should not contain symbols H_c , H_t , or H . (That is, instead of $H(x)$ the equation might contain $(x - 280 \text{ K}) \frac{\text{V}}{4 \text{ K}}$.) If a gain/offset amplifier is used, the equation may be in terms of A_5 and O_5 . (18 pts)

Problem 2: An object slides along a straight track ten meters long. Mounted on the object is a lamp which radiates uniformly in all directions. Photodiodes with response $H_{t1}(E) = E \frac{50 \mu\text{A}}{\text{mW}/\text{cm}^2}$ are available (purchased at low cost from a pet shop). Only light directly radiated from the lamp will reach the photodiodes.

(a) Suppose the lamp has a radiant flux of $\Phi = 1.7 \text{ W}$. Design a system to determine the location of the object and write the location, in meters, to variable `loc`. The solution should include the circuit and interface routine; all component and supply values must be specified. (15 pts)

(b) Unlike the first part, suppose that the radiant flux of the lamp is not known. Like the first part, the position is unknown. Using only photodiodes, design a system to convert the radiant flux, $x \in [0, 1.7 \text{ W}]$, into a floating-point number $H(x) = x/W$, to be written to variable `phi`. *Hint: use two photodiodes.* (19 pts)

Problem 3: Answer each question below.

(a) Show how marks are placed on a two-way relative coded displacement transducer and explain how these are used to determine direction. (11 pts)

(b) Explain how a linear variable differential transformer works. (11 pts)

(c) Explain the difference between practical and thermodynamic temperature scales. Why are practical temperature scales periodically revised? (11 pts)