Name ______________________________

# Real Time Computing Systems

# EE 4770

# Midterm Examination

15 March 1995, 8:40-9:30 CST

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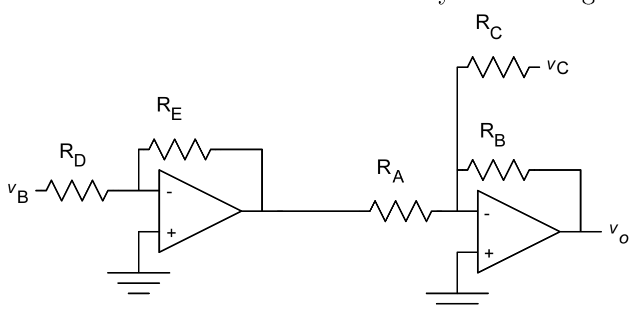
|---|---|---|
| Problem 1 | __________ | (34 pts) |
| Problem 2 | __________ | (33 pts) |
| Problem 3 | __________ | (33 pts) |
| Exam Total | __________ | (100 pts) |

Alias ______________________________

*Good Luck!*

Problem 1: Finish the design of a circuit and interface routine to convert process variable $x \in [250\,\mathrm{K}, 350\,\mathrm{K}]$, the temperature in a system, to $H(x) = \frac{x}{{}^\circ\mathrm{C}}$, to be written in variable `tee`. The value should have a precision of no less than $\pm 0.05\,{}^\circ\mathrm{C}$. Take into account the non-linear response of the thermistor. (34 pts)

- Use a thermistor and thermistor model $H_{t2}(x) = R_0 e^{\beta/x}$ where $\beta = 2500\,\mathrm{K}$ and $R_0 = 0.03\,\Omega$.
- Use an $H_{\mathrm{ADC}(7\,\mathrm{V},\mathrm{b})}$ analog-to-digital converter with the minimum number of bits, $b$, necessary to meet the precision requirement. *Be sure to take into account the non-linear response of the thermistor when computing b.** The part of the design completed makes full use of the ADC's dynamic range.



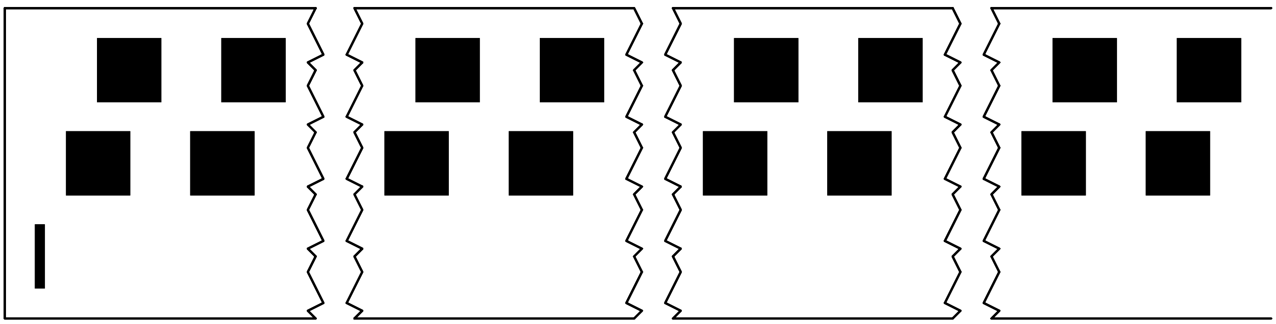

The following values have already been found: $v_B = 5\,\mathrm{V}$, $R_D = 500\,\mathrm{k\Omega}$, $R_E = H_{t2}(x)$, $R_A = 1\,\mathrm{k\Omega}$, $R_C = 2.64\,\mathrm{M\Omega}$, $v_C = 1\,\mathrm{V}$, and $R_B = 1.12\,\mathrm{M\Omega}$. The output of the gain/offset circuit is then $A_5(R_E - O_5)$, where $A_5 = 11.24\,\mathrm{mA}$ and $O_5 = 37.95\,\Omega$.

* This sentence was not included in the original exam.

Problem 2: Design a circuit to convert process variable $x \in [0, 10\,\frac{\text{mW}}{\text{sr}}]$, the radiant intensity of a light source, to a voltage, $v_o = H(x) = x\,\frac{\text{sr}}{\text{mW}}\,\text{V}$. The circuit is to use two photodiodes, one placed 30 cm from the light source, the other placed 70 cm from the light source. Design the circuit so that the output is based on the average radiant intensity seen by the two photodiodes. The photodiodes have sensitivity $K_s = 5\,\frac{\mu\text{A}\,\text{cm}^2}{\text{mW}}$. The light source radiates uniformly in all directions. (33 pts)

Problem 3: Answer each question below. Brief answers will be appreciated. Please do not give multiple-choice answers.

($a$) A relative coded displacement transducer has the following disadvantage: the counter value may be incorrect from the time the power is turned on until the index mark passes under the mark reader. Since there is only one index mark, this may take a while. Modify the two-way relative CDT shown below by adding three index marks (for a total of four), so that the counter can be properly set at four different positions. Leave the other tracks unchanged. Explain how the counter would be reset to one of the four correct values given only the output of the three mark-reading transducers. (15 pts)



($b$) How does a magnetic reluctance proximity transducer work? Could it be used to measure displacement? Explain. (9 pts)

($c$) Why are new practical temperature scales defined every few decades? Why does the thermodynamic temperature scale stay the same? (9 pts)