Name ________________________________

Real Time Computing Systems

EE 4770

Midterm Examination

18 March 1998, 7:30-9:30 CST

Problem 1	__________	(35 pts)
Problem 2	__________	(30 pts)
Problem 3	__________	(35 pts)
Exam Total	__________	(100 pts)

Alias ________________________________

Good Luck!

Problem 1: Design a system to convert temperature, $x \in [150\,\mathrm{K}, 300\,\mathrm{K}]$, to a floating point number, `temp` $= H(x) = x/\mathrm{K}$, using the new Transducer Z. An algebraic model function for the new Transducer Z is not available but a lookup table, `HtZ`, is. Table `HtZ` is a 4096-element array which stores the resistance of the sensor in ohms from a temperature of $100\,\mathrm{K}$ (`HtZ[0]=870`) to $400\,\mathrm{K}$ (`HtZ[4095]=6500`). (The temperature range covered by the lookup table is larger than is needed for this problem.) The relationship between the array index and temperature is linear. (The relationship between temperature and resistance is *not* linear.) An inverse table, `HtZi` is also available; element zero, `HtZi[0]=100`, gives the temperature in Kelvins when the resistance is $870\,\Omega$ and `HtZi[4095]=400` gives the temperature when the resistance is $6500\,\Omega$. The relationship between array index and resistance is also linear. The resistance of the new Transducer Z is $1200\,\Omega$ at $150\,\mathrm{K}$ and $5000\,\Omega$ at $300\,\mathrm{K}$.

(*a*) Design the conditioning circuit and interface routine. If the gain/offset amplifier is used, the solution can show values for A_5 and O_5 instead of each resistor and voltage source, otherwise show all component and supply values. Show the code for any specialized procedures called.

- The design should use a 12-volt, 16-bit ADC and make full use of its dynamic range.
- Use interpolation to attain maximum precision.

(25 pts)

(*b*) Write a procedure that returns the precision of the circuit above (in Kelvins). (The procedure will have to examine the lookup tables.) (10 pts)

Problem 2: (*a*) Design a circuit to convert temperature, $x \in [200\,\mathrm{K}, 300\,\mathrm{K}]$, to a voltage, $H(x) = (x - 200\,\mathrm{K})\frac{10\,\mathrm{V}}{100\,\mathrm{K}}$ using three-wire RTDs with model function $H_\mathrm{t}(x) = 100\,\Omega(1{+}0.0005x/{}^\circ\mathrm{C})$. (RTD resistance is $100\,\Omega$ at $0\,{}^\circ\mathrm{C}$.) (For reference, $273.15\,\mathrm{K} = 0\,{}^\circ\mathrm{C}$.) The circuit should compensate for wire resistance and should not use an excessive amount of hardware. Show all supply and component values. *Hint: Derive an alternate model function* $H_\mathrm{ta}(x) = R_\mathrm{a}(1 + \alpha\Delta x)$, *where* $\Delta x = x - 200\,\mathrm{K}$. (30 pts)

Problem 3: Answer each question below.

(*a*) Provide an example of a large-displacement pressure transducer and a small-displacement pressure transducer. For each, give examples of whatever other transducers are necessary to convert pressure to an electrical quantity. Provide an advantage that each one has over the other. (12 pts)

(*b*) Why should the transducers in a cross-correlation speed or flow-rate sensor be close together? (Answer the question for either a speed or a flow-rate sensor.) The answer should describe a situation in which it would be difficult for the sensor to operate if the transducers were far apart but easy to operate if they were close together. (12 pts)

(*c*) Describe how a single thermistor can be used to measure flow rate (as in a hot-wire anemometer). (11 pts)