NAME (please print) _____

UNIVERSITY OF CALIFORNIA
Electrical Engineering and Computer Sciences

EECS 145L Electronic Transducer Lab
MIDTERM #2 (100 points maximum)

(closed book, equation sheet provided, calculators OK)
(You will not receive full credit if you do not show your work)
For the following problems, you may use any circuit components from the 145L lab.

PROBLEM 1 (16 points)

Sketch a circuit that uses a one-turn 1 kΩ circular resistor to convert a shaft angle (0° to 300°) into an output voltage (0.00 V to 3.00 V) that is proportional to the angle. The circuit must be able to drive a 1 kΩ load.

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PROBLEM 2 (16 points)

Sketch a circuit that uses a PIN photodiode to convert light intensity (0 to 6.24 x 10^9 photons per s) into an output voltage (0.0 V to 1.0 V) that is proportional to the intensity. (*Hint:* 6.24 x 10^9 electrons per s = 1 nA) Assume that the photodiode converts photons into electron-hole pairs with 100% efficiency.

PROBLEM 3 (16 points)

Sketch a circuit that uses a resistive strain gauge to convert strain ($-10^{-3} < \Delta L/L < 10^{-3}$) into an output voltage (–1.00 V to +1.00 V) that is proportional to the strain. The strain gauge has an unstrained resistance of 100 Ω and a gauge factor G_s of 2.00.

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PROBLEM 4 (52 points)

You are designing a thermocouple-based system for measuring the temperature of a furnace (T_f) over the temperature range from 25 °C to 500 °C with an absolute accuracy of 2 °C and do not want to provide ice to stabilize the temperature of the reference junction at 0 °C. Instead, you decide to leave the reference junction in the air of the room and measure the temperature of the room (T_r) with a solid-state temperature sensor. The correction of the thermocouple output for room temperature will be done by a voltage-summing circuit.

Assume the following:

- The thermocouple sensitivity is 50 μV/°C.
- The solid state temperature sensor produces 1 μA per °K. Note that 0 °C = 273 °K.

a. **(18 points)** Sketch a circuit that uses a thermocouple to produce an output V_a = 0.25 V when the temperature difference between the sensing and the reference junction is 25 °C and V_a = 5.00 V when the temperature difference is 500 °C. Label all necessary analog circuit elements and signal lines. Include the thermocouple wires and furnace. (It is not necessary to include analog filtering).

b. **(18 points)** Sketch a circuit that converts the solid-state temperature sensor current into a voltage V_b that has the same sensitivity (V/°C) as the thermocouple circuit **a**. Draw a block diagram and label all necessary analog circuit elements and signal lines. Show where the solid-state temperature sensor is placed in the diagram of part **a.** above. (It is not necessary to include analog filtering)

c. **(16 points)** Sketch a circuit that combines the outputs of circuits **a.** and **b.** to provide a voltage V_c that is proportional to the furnace temperature (0.25 V at 25°C and 5.00 V at 500 °C) and does not depend on the room temperature.