UNIVERSITY OF CALIFORNIA, BERKELEY
Electrical Engineering and Computer Sciences Department

EECS 145L Electronic Transducer Lab
MIDTERM #2 (100 points maximum)
November 22, 2004

(closed book, calculators OK, equation sheet provided)
(You will not receive full credit if you do not show your work)

PROBLEM 1 (20 points)

1a   (10 points) What are the technical requirements of the ground fault interrupter circuit?

1b   (10 points) Describe how the ground fault interrupter circuit functions to meet those requirements.

PROBLEM 2 (40 points)

You wish to measure air temperatures near 20°C using the thermistor bridge shown below.
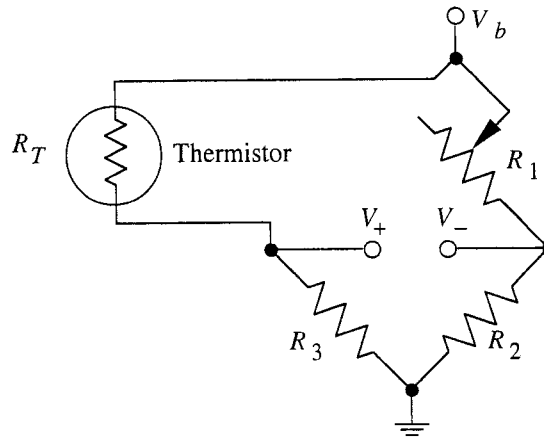
Assume the following:

- $R_2 = R_3 = 10\ k\Omega$.
- You use an instrumentation amplifier with a gain of 5: $V_0 = 5\ (V_+ - V_-)$.
- The thermistor resistance R_T is 10.0 kΩ at 20 °C
- $dR_T/dT = -300\ \Omega/°C$ at 20 °C.

You then perform a series of experiments to explore the thermistor self-heating of your system.

Experiment 1: With $V_b = 1$ volt and the thermistor in **water** at 20°C, you adjust R_1 to make the amplifier output $V_0 = 0.000$ volts. (Assume that there is no self heating in water)

2a. (4 points) What are the values of R_1 and R_T?

2b. (8 points) What electrical power is produced in the thermistor?

Experiment 2: You then move the thermistor to **air** at 20 °C, wait a while, and find that the amplifier output $V_0 = 0.05$ volts ($V_b = 1$ volt).

2c.   (8 points) What is the thermistor resistance R_T?

2d.   (7 points) What is the temperature of the thermistor?

2e.   (7 points) What electrical power is produced in the thermistor?

2f.   (6 points) What is the thermal dissipation coefficient in W per C°?

PROBLEM 3 (40 points)

Design a system that converts sound into light for transmission down an optical fiber and then converts the optical signal back into sound.

Assume the following

1   You have a microphone that produces a maximum differential signal of 100 mV p-p (peak-to-peak) at the maximum sound intensity that you need to consider.

2.   The microphone wires have 60 Hz electromagnetic pickup of pure 10 mV common mode (for simplicity assume zero differential 60 Hz pickup).

3.   You have an light emitting diode (on one end of the optical fiber) that should produce 100 mA p-p when the microphone signal is at maximum.

4.   You have a photodiode (on the other end of the optical fiber) that produces 1 mA p-p when the light emitting diode is producing its maximum signal (100 mA p-p input).

5.   The loudspeaker should be driven at 10 V p-p when the microphone signal is at maximum. The speaker has an input impedance of 10 Ω.

6.   Each element in the system should be operated in a linear mode (output proportional to input).

In your design you should provide enough detail so that a skilled technician could be able to build it and understand how it works. Include all necessary components and label all signals with their maximum (p-p) amplitude. You may use any circuit components used in the laboratory exercises or discussed in lecture, but keep it simple.