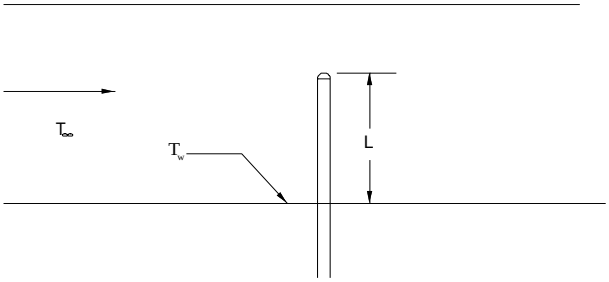
King Abdulaziz University
College of Engineering
Mechanical Engineering Department

MEP 365
Fall 2022
Thermal measurements
HW # 7 (Temp. measure 2)

1-Estimate the conduction error e_c for a temperature sensor shown in the sketch. Information about the sensor is:



-Thermal conductivity k=**40** W/m.K

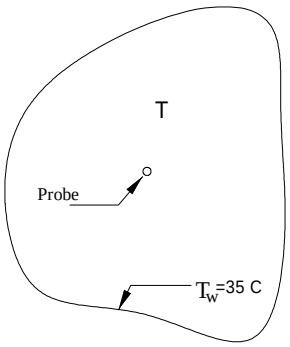
-Heat transfer coefficient between the flow and the sensor is 10 W/m^2.K

-Assume the sensor to be a rod of diameter 2mm, and length L=5 cm

-The fluid temperature T_∞ =70° C.

-Take the wall temperature to be 60° C.

2-Consider a probe with emissivity of ε_p=0.8 located in a large room as shown below. The sensor is enclosed by a radiation shield with emissivity ε_s=0.5. The air temperature T_∞ =24°C, and the enclosure temperature is **50°** C. The heat transfer between the probe and air is 10 W/m^2.K, Estimate the probe temperature and the radiation error once not considering the shield and once when considering the shield.



3-The temperature of a high speed flow at Mach number **M=0.8** is to be measured. Assume a recovery ratio r=0.8. What is the recovery error? Take the sound speed to be 340 m/s. If T_∞=90° C, determine T_p, and the stagnation temperature T_t?

4- A spherical thermocouple bead has a diameter of=1 mm and initial temperature of T_i=300 K. The thermocouple properties are ρ=7900 kg/m^3, C_p=450 J/kg.K. The thermocouple is suddenly exposed to convection environment at temperature of T_∞=500 K. The convective heat transfer is h=**60** W/m^2.K Determine the time constant of the probe, and draw the temperature variation of the thermocouple with time.

5- One proposed equation for relating the temperature and electric resistance of a thermistor is Steinhart and Hart equation which is given by

$$\frac{1}{T} = A + Bln(R) + C.[\ln(R)]^3$$

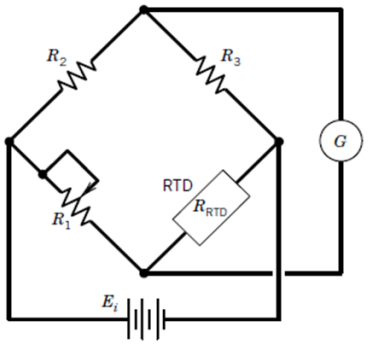
Where T in Kelvin, R in Ohm.

case	T (°C)	R (Ohm)
1	5	25000
2	25	10000
3	45	4000

If the following information is given for one thermistor

a) Calculate the constants A, B and C.
b) Using the found values of the constants, calculate the temperature if the resistance is 7000 Ω

6-Consider a Wheatstone bridge in a voltage deflection mode used with RTD to measure temperature. Three of the resistances are of value 25 Ohm. One arm of the Wheatstone has an RTD. If the input voltage to the bridge is 5 V, and deflected voltage is 0.5 V, calculate the resistance of the RTD and its temperature. For this RTD take T_0=0 °C, R_0=25 Ohm and α=0.004 1/°C.



7-Problem No. 8.41 in your textbook