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NPTEL

Courses » Industrial Instrumentation

Announcements **Course** Forum Progress Mentor

Unit 4 - Week 3

Week 3 Assignment on Temperature Measurements

1) ***2 points***

For a K-type thermocouple, thermoelectric voltage at 50 °C and 500 °C are 2.023 m and 20.644 mV, respectively when the reference junction is kept at 0 °C. Thermoelectr voltage versus temperature relation is approximated as, $e_{0-t} = a \times t + b \times t^2$. Fc certain temperature (t_1) of the hot junction, the thermocouple shows 10 mV, with th reference junction at 25 °C. Find, the unknown temperature 't_1' of the hot junction.

- a) 269.4 ℃
- b) 278.5 ℃
- c) 298.7 ℃
- d) None of these

Accepted Answers:
a) 269.4 ℃

2) ***2 points***

Resistance-temperature relation for a thermistor is give by, $R = R_0 \exp\left[\beta\left(\frac{1}{T} - \frac{1}{T_0}\right)\right]$ where 'R' is resistance of thermistor at temperature T, R_0 is resistance of thermistor temperature T_0. β = 3800 K, is a constant for a particular thermistor. It is known that fi T_0 = 25 °C, R_0 = 1250 Ω ± 5 %. Calculate the maximum error in measurement temperature T = T_1, if resistance R at temperature T_1 is measured to be 2000 Ω.

- a) 0.98 K
- b) 1.64 K
- c) 1.11 K
- d) 1.06 K

Accepted Answers:
c) 1.11 K

3) Based on Figure 1., answer question (3) and (4) *2 points*

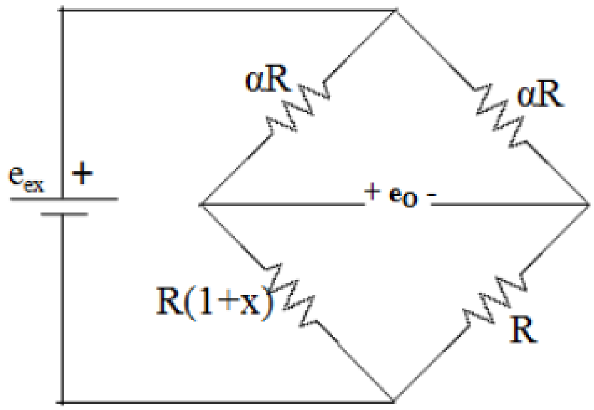

Figure 1

3)

Assume α = 1, find the normalised sensitivity (of e_O/e_{ex}) of the circuit for very small x.

- a) 0.25
- b) 0.5
- c) 0.75
- d) 1.0

Accepted Answers:
a) 0.25

4) *3 points*

If it is required to keep the maximum non-linearity within 5 % over the range of between 0 and 0.5, then evaluate the minimum value α.

- a) 7
- b) 8
- c) 9
- d) 10

Accepted Answers:
c) 9

5) *2 points*

If the circuit in Figure 2 is used in place of Figure 1, for RTD signal conditioning, then fin out (i) the normalised sensitivity (of e_O/e_{ex}) of the circuit with-respect-to x and (i maximum non-linearity of the output voltage V_O.

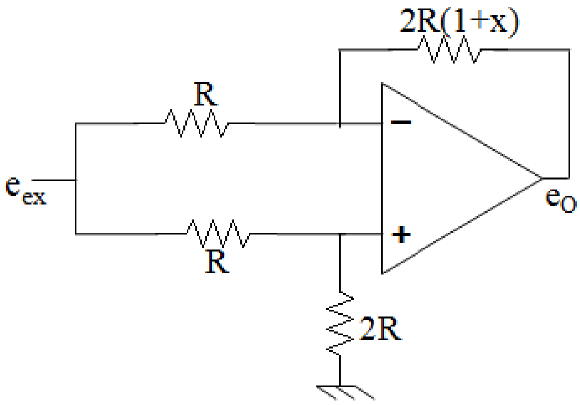

Figure 2

- a) (i) 0.25; (ii) 0 %
- b) (i) 0.67; (b) 0 %
- c) (i) 0.5; (ii) 0.25 %
- d) (i) 0.5; (ii) 0 %

Accepted Answers:

b) (i) 0.67; (b) 0 %

6) **2 points**

Figure 3 shows two circuits for improving the linearity of thermistor response. I maximum allowable non-linearity is 2 %, then which of the two circuits can be used for a larger input range? (Assume, $R_1 = R_2 = R$ and $R_T = R\times(1+x)$)

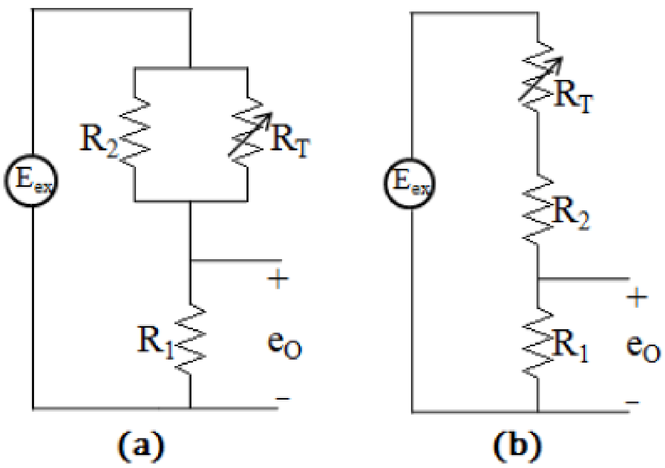

Figure 3

- a) circuit (a)
- b) circuit (b)
- c) Both have same input range
- d) Insufficient data

Accepted Answers:

b) circuit (b)

7) **2 points**

The following circuit, in Figure 4, is used to measure temperature using a Pt-100 RTD (R_t (assume, 1st order resistance-temperature relation for the RTD). The constant current source provides 1 mA current. Resistances of the lead wires are, $R_{L1} = R_{L2} = 0.6\ \Omega$ and $R_L = R_{L4} = 0.7\ \Omega$. If the voltmeter shows 138.5 mV, what is the measuring temperature (Temperature coefficient of resistance $\alpha = 0.00392\ \Omega/\Omega$-°C)

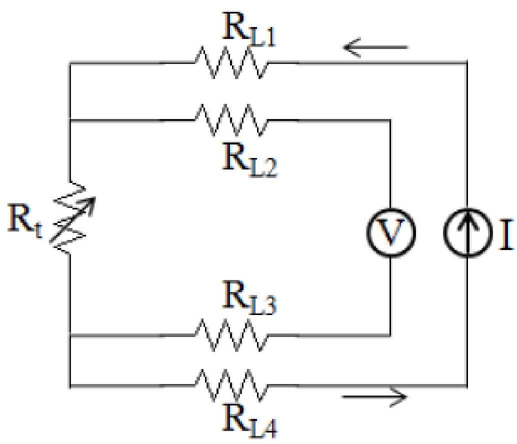

Figure 4

- a) 138.5 °C
- b) 100 °C
- c) 39.2 °C
- d) 98.2 °C

Accepted Answers:
d) 98.2 °C

8) **2 points**

Figure 5 shows a parallel combination of thermocouples. e_1, e_2 and e_3 are the generate thermoelectric voltages at the output of the individual thermocouples as shown in th figure. Determine the expression for voltage e_O as shown in the figure.

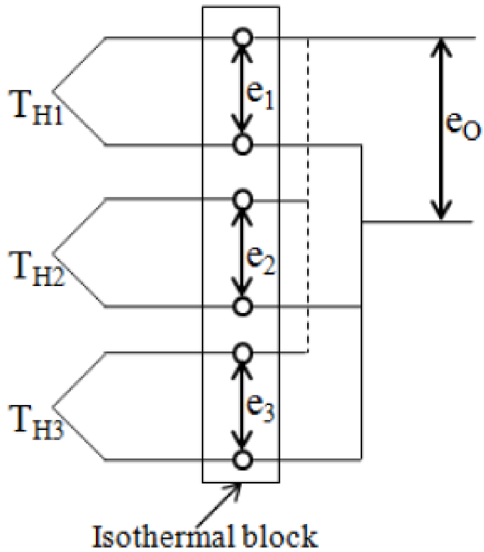

Figure 5

- a) $e_O = (e_1+e_2+e_3)/3$
- b) $e_O = (e_1+e_2+e_3)$
- c) $e_O = (e_1 \times e_2 \times e_3)$
- d) None of these

Accepted Answers:
a) $e_O = (e_1+e_2+e_3)/3$

Previous Page

End