UNIVERSITY OF ALASKA FAIRBANKS

COLLEGE OF ENGINEERING AND MINES
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING

COURSE CODE	EE F102 F01 (CRN: 34544)
COURSE NAME	INTRODUCTION TO ELECTRICAL AND COMPUTER ENGINEERING
SEMESTER	SPRING
YEAR	2022
TYPE AND NUMBER OF SUBMISSION	HOMEWORK 4
METHOD OF SUBMISSION	ONLINE TO : maher.albadri@alaska.edu
DATE OF ASSIGNMENT	THURSDAY 03 FEB 2022

DUE DATE OF SUBMISSION	FRIDAY 11 FEB 2022	**DUE TIME OF SUBMISSION**	23:59

STUDENT NAME	Jacob Guenther

MAKE THIS FORM A "COVER PAGE" FOR YOUR HOMEWORK SUBMISSION.

FOR THE TA USE ONLY

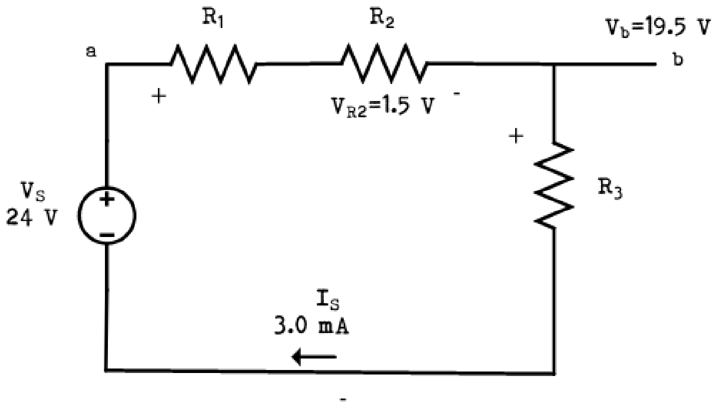
REMARKS:

FOR THE TA USE ONLY

PROBLEM NUMBER	MAXIMUM POINTS POSSIBLE	POINTS EARNED
PROBLEM 1	50	
PROBLEM 2	50	
PROBLEM 3	50	
TOTAL	150	

1 Problem HW-4-1

(1) For the electric circuit shown with the given information,



- (a) Determine the voltage across R_1.
Solution:

$$V_{R1} = V_s - (V_b + V_{R1})$$
$$V_{R1} = 24V - (19.5V + 1.5V)$$
$$V_{R1} = 3V$$

Answer: The voltage across R_1 is **3 V**

- (b) Determine the powers P_1, P_2, P_3 in mW, consumed in resistors R_1, R_2, and R_3 respectively. **Note:**

$$P = I \cdot V \tag{1}$$

Solution:

$$\begin{aligned} P_1 &= I_s \cdot V_{R1} \\ &= 3.0mA \cdot 3V \\ &= 9.0mW \\ P_2 &= I_s \cdot V_{R2} \\ &= 3.0mA \cdot 1.5V \\ &= 4.5mW \\ P_3 &= I_s \cdot V_{R3} \\ &= 3.0mA \cdot 19.5V \\ &= 58.5mW \end{aligned}$$

Answer:

  - P_1 = **9.0 mW**
  - P_2 = **4.5 mW**
  - P_3 = **58.5 mW**

- (c) Determine the total power, in mW, supplied by the voltage source.
Solution:

$$\begin{aligned} P_{total} &= P_1 + P_2 + P_3 \\ &= 9.0mW + 4.5mW + 58.5mW \\ &= 71.0mW \end{aligned}$$

Answer: The total power supplied is **71.0 mW**.

- (c) Determine the values of the resistors R_1, R_2, and R_3, in ohms.
  Note:

$$R = \frac{V}{I} \tag{2}$$

  Solution:

$$\begin{aligned}
I_s &= 3.0\text{mA} \cdot \frac{1\text{A}}{1000\text{mA}} \\
&= 0.003\text{A} \\
R_1 &= \frac{V_{R1}}{I_s} \\
&= \frac{3\text{V}}{0.003\text{A}} \\
&= 1000\Omega \\
R_2 &= \frac{V_{R2}}{I_s} \\
&= \frac{1.5\text{V}}{0.003\text{A}} \\
&= 500\Omega \\
R_3 &= \frac{V_{R3}}{I_s} \\
&= \frac{19.5\text{V}}{0.003\text{A}} \\
&= 6500\Omega
\end{aligned}$$

  Answer:

  - $\mathbf{R_1 = 1000\Omega}$
  - $\mathbf{R_2 = 500\Omega}$
  - $\mathbf{R_3 = 6500\Omega}$

2 Problem HW-4-2

(2) A 30 m long copper conductor has a cross-sectional area of 0.75 cm^2 and its operating temperature is 35 degrees C. The temperature coefficient (α) of the copper wire is 0.00393 per degrees C and the resistivity is $1.723 \times 10^{-8}\Omega$m.

- (a) Determine the total resistance of the conductor, in mΩ.
  Note:

$$R = \frac{\rho \cdot L}{A} \tag{3}$$

Solution:

$$\begin{aligned}
\text{Area} &= 0.75\text{cm}^2 \\
&= 0.75\text{cm}^2 \cdot \frac{1\text{m}}{100\text{cm}} \cdot \frac{1\text{m}}{100\text{cm}} \\
&= 0.000075\text{m}^2 \\
\text{R} &= 1.723 \times 10^{-8}\Omega\text{m}\frac{30\text{m}}{0.000075\text{m}^2} \\
&= 0.06892\Omega\text{R} = 0.06892\Omega \cdot \frac{1000\text{m}\Omega}{1\Omega} \\
&= 68.92\text{m}\Omega
\end{aligned}$$

Answer: The total resistance of the conductor is **68.92 mΩ**.

- (b) Determin the conductor resistance at 140 degrees F.
  Note:

$$\Delta R = k\Delta T \tag{4}$$

$$\alpha = \frac{k}{R_{T0}} \tag{5}$$

$$^\circ\text{C} = \frac{^\circ\text{F} - 32}{\frac{9}{5}} \tag{6}$$

Solution:

$$\begin{aligned}
\text{T} &= \frac{140^\circ\text{F} - 32}{\frac{9}{5}} \\
&= 60^\circ\text{C} \\
\Delta\text{T} &= 60^\circ\text{C} - 35^\circ\text{C} \\
&= 25^\circ\text{C} \\
k &= \alpha \cdot R_{T0} \\
&= 0.00393 \cdot \frac{1}{^\circ\text{C}} \cdot 0.06892\Omega \\
&= 0.00027086\frac{\Omega}{^\circ\text{C}} \\
\Delta R &= 0.00027086\frac{\Omega}{^\circ\text{C}} \cdot 25^\circ\text{C} \\
&= 0.0067715\Omega \\
\text{R}_{140F} &= \text{R} + \Delta\text{R} \\
&= 0.06892\Omega + 0.0067715\Omega \\
&= 0.0756915\Omega \\
&= 0.0756915\Omega \cdot \frac{1000\text{m}\Omega}{1\Omega} \\
&= 75.69\text{m}\Omega
\end{aligned}$$

Answer: The resistance of the conductor at 140 degrees F is **75.69 mΩ**.

3 Problem HW-4-3

(3) A thermistor has the following initial data:

- B = 5500 ° K
- $R_{T0} = 10.5k\Omega$
- T_0 = 29 °C
- (a) Determine the the resistance, in kΩ, of the thermistor at the following temperatures:

  * $T_1 = -20°C$
  * $T_2 = -15°C$
  * $T_3 = -10°C$
  * $T_4 = -5°C$
  * $T_5 = 0°C$
  * $T_6 = 10°C$
  * $T_7 = 20°C$
  * $T_8 = 30°C$
  * $T_9 = 40°C$
  * $T_{10} = 50°C$
  * $T_{11} = 100°C$

Note:

$$R_{T1} = R_{T0} \cdot exp[B(\frac{1}{T_1} - \frac{1}{T_0})] \tag{7}$$

$$°\mathrm{K} =° \mathrm{C} + 217.15 \tag{8}$$

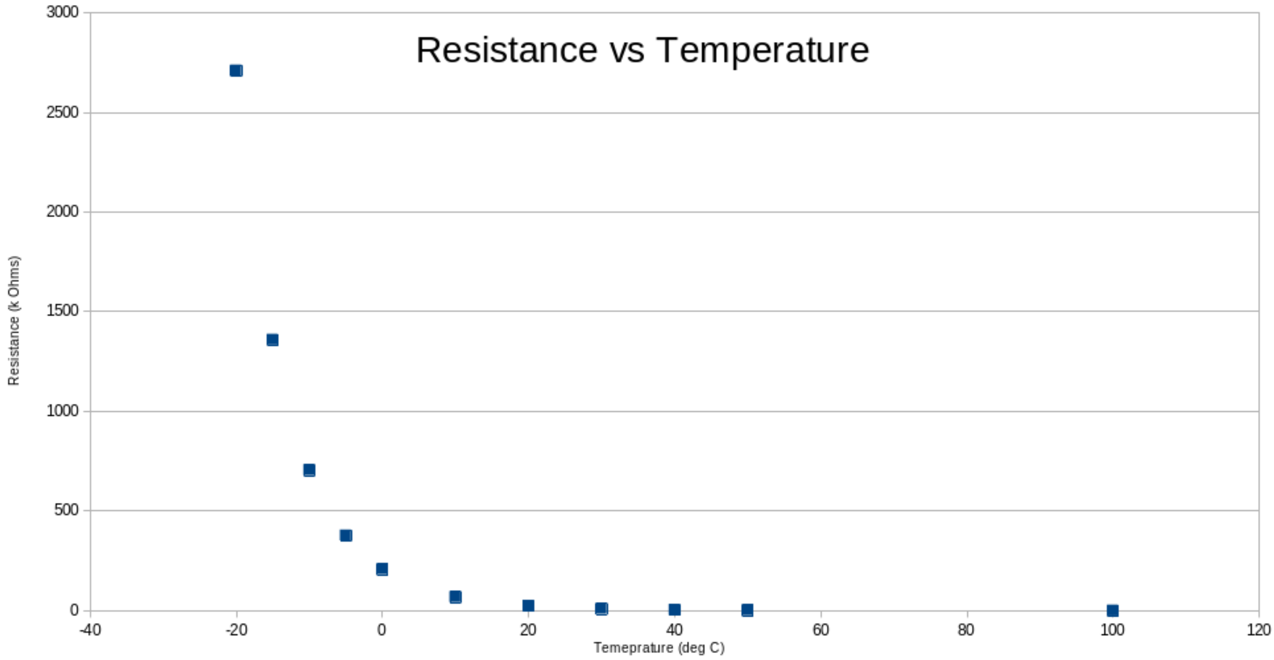
Solution:

$$\begin{aligned}
T_0 &= 29°\mathrm{C} \\
&= 29 + 217.15 \\
&= 246.15°\mathrm{K} \\
T_1 &= -20°\mathrm{C} \\
&= -20 + 217.15 \\
&= 197.15°\mathrm{K} \\
R_{T0} &= 10.5k\Omega \\
R_{T0} &= 10500\Omega \\
R_{T1} &= 10500\Omega exp[5500°\mathrm{K} \cdot (\frac{1}{197.15°\mathrm{K}} - \frac{1}{246.15°\mathrm{K}})] \\
&= 2710303.973\Omega \\
&= 2710303.973\Omega \cdot \frac{1\mathrm{k}\Omega}{1000\Omega} \\
&= 2710.303\mathrm{k}\Omega
\end{aligned}$$

The rest where done in excel.
Answer:

Temperature Name	Temperature (°C)	Resistance (kΩ)
T_1	-20°C	2710.303kΩ
T_2	-15°C	1359.395kΩ
T_3	-10°C	704.92kΩ
T_4	-5°C	377.032kΩ
T_5	0°C	207.554kΩ
T_6	10°C	68.057kΩ
T_7	20°C	24.517kΩ
T_8	30°C	9.592kΩ
T_9	40°C	4.0373kΩ
T_{10}	50°C	1.913kΩ
T_{11}	100°C	0.0706kΩ

- (b) Plot the resistance values (y-axis) versus temperature (x-axis).



4 References

[1] Denise Thorsen, Maher Al-Badri, INTRODUCTION TO ELECTRICAL AND COMPUTER ENGINEERING, University of Alaska Fairbanks, 2022.