Assignment

ELECTROTECHNOLOGY
ELTK1100
ASSIGNMENT #6
(SOLUTIONS)

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1. (a)

$$d = 0.258\,in * \frac{1\ mil}{0.001\,in} = 258\,mils$$

$$A = d^2 = (258\ mils)^2 = 66564\,CM$$

$$R = \frac{\rho * \ell}{A} = \frac{10.37\ \frac{\Omega \cdot CM}{ft} * 50000\,ft}{66564\,CM} = 7.79\,\Omega$$

(b)

$$A\ \#8 = 16509\,CM$$

$$R = \frac{\rho * \ell}{A} = \frac{17\ \frac{\Omega \cdot CM}{ft} * 1.5\,mi * \frac{5280\ ft}{mi}}{16509\,CM} = 8.16\,\Omega$$

(c)

$$d = 0.259\,cm. = 0.00259\,m.$$

$$A = \frac{\pi\ d^2}{4} = \frac{\pi * (0.00259\,m)^2}{4} = 5.268 * 10^{-6}\,m^2$$

$$R = \frac{\rho * \ell}{A} = \frac{48.0 * 10^{-8}\,\Omega \cdot m * 800\,m}{5.268 * 10^{-6}\,m^2} = 72.9\,\Omega$$

(d)

$$d = 0.075\,in * \frac{1\ mil}{0.001\,in} = 75\,mils$$

$$A = d^2 = (75\,mils)^2 = 5625\,CM$$

$$R = \frac{\rho * \ell}{A} = \frac{42\ \frac{\Omega \cdot CM}{ft} * 250\,ft}{5625\,CM} = 1.87\,\Omega$$

2. **(a)** R_{T1} = 7.79Ω at T_1 = 20°C from **1 (a)**, R at 40°C will be

$$R_{T2} = \frac{1 + \alpha_o T_2}{1 + \alpha_o T_1} * R_{T1} = \frac{(1 + 0.00427 * 40°C)}{(1 + 0.00427 * 20°C)} * 7.79\Omega = \frac{1.1708}{1.0854} * 7.79\Omega = 8.40\Omega$$

(b) R_{T1} = 8.16Ω at T_1 = 20°C from **1 (b)**, R at 40°C will be

$$R_{T2} = \frac{1 + \alpha_o T_2}{1 + \alpha_o T_1} * R_{T1} = \frac{(1 + 0.00424 * 40°C)}{(1 + 0.00424 * 20°C)} * 8.16\Omega = \frac{1.1696}{1.0848} * 8.16\Omega = 8.80\Omega$$

3. **(a)** R_{T1} = 72.9Ω at T_1 = 20°C from **1 (c)**, R at 5°C will be 72.9Ω, since $\alpha_0 = 0$

(b) R_{T1} = 1.87Ω at T_1 = 20°C from **1 (d)**, R at 5°C will be

$$R_{T2} = \frac{1 + \alpha_o T_2}{1 + \alpha_o T_1} * R_{T1} = \frac{(1 + 0.00208 * 5°C)}{(1 + 0.00208 * 20°C)} * 1.87\Omega = \frac{1.0104}{1.0416} * 1.87\Omega = 1.81\Omega$$

4.

$$d = 0.08\,in * \frac{1\ mil}{0.001\,in} = 80\,mils$$

$$A = d^2 = (80\,mils)^2 = 6400\,CM$$

$$\rho = \frac{R * A}{\ell} = \frac{79.7\Omega * 6400\,CM}{850\,ft} = 600\ \frac{\Omega \cdot CM}{ft.}$$

$$R = \frac{\rho * \ell}{A}$$

$$\therefore\ \rho = \frac{R * A}{\ell}$$

From the resistivity tables, the material is nichrome.

5.

$$d = 0.812\,mm. = 0.000812\,m.$$

$$A = \frac{\pi d^2}{4} = \frac{3.14 * (0.000812\,m)^2}{4} = 5.178 * 10^{-7} m^2$$

$$\rho = \frac{R * A}{\ell} = \frac{4.15\Omega * 5.178 * 10^{-7} m^2}{125\,m} = 1.719 * 10^{-8}\Omega \cdot m$$

From the resistivity tables, the material is copper.

6.

$$R = \ell * \frac{\Omega}{1000\ ft}$$
$$\ell = R * \frac{1000\ ft}{\Omega}$$
$$\ell = 5\Omega * \frac{1000 ft}{0.0618\Omega} = 80906 ft$$

or

$$A\ 3/0\ Copper = 167810\ CM$$
$$R = \frac{\rho * \ell}{A}$$
$$\ell = \frac{R * A}{\rho} = \frac{5\Omega * 167810 CM}{10.37 \frac{\Omega \cdot CM}{ft}} = 80911\ ft$$

7. To find the length of 3/0 copper wire that has a resistance of 5Ω@30°C, we must find the resistance of the wire at 20°C. You must find this because the Tables have data for the different materials at 20°C.

$$R_{T2} = \frac{1 + \alpha_o T_2}{1 + \alpha_o T_1} * R_{T1} = \frac{(1 + 0.00427 * 20°C)}{(1 + 0.00427 * 30°C)} * 5\Omega = \frac{1.0854}{1.1281} * 5\Omega = 4.81\Omega$$

$$R = \ell * \frac{\Omega}{1000\ ft}$$
$$\ell = R * \frac{1000\ ft}{\Omega}$$
$$\ell = 4.81\Omega * \frac{1000\ ft}{0.0618\Omega} = 77832 ft$$

or

$$A\ 3/0\ Copper = 167810 CM$$
$$R = \frac{\rho * \ell}{A}$$
$$\ell = \frac{R * A}{\rho} = \frac{4.81\Omega * 167810 CM}{10.37 \frac{\Omega \cdot CM}{ft}}$$
$$= 77836 ft$$

8.

$$R_{T2} = \frac{1 + \alpha_o T_2}{1 + \alpha_o T_1} * R_{T1}$$
$$R_{T2}\left(1 + \alpha_o T_1\right) = \left(1 + \alpha_o T_2\right) R_{T1}$$
$$R_{T2} + R_{T2}\ \alpha_o T_1 = R_{T1} + R_{T1}\ \alpha_o T_2$$
$$R_{T2}\ \alpha_o T_1 - R_{T1}\ \alpha_o T_2 = R_{T1} - R_{T2}$$
$$\alpha_o\left(R_{T2}\ T_1 - R_{T1}\ T_2\right) = R_{T1} - R_{T2}$$
$$\alpha_o = \frac{R_{T1} - R_{T2}}{R_{T2}\ T_1 - R_{T1}\ T_2}$$
$$= \frac{(61.8\Omega - 50\Omega)}{(50\Omega * 70°C - 61.8\Omega * 10°C)}$$
$$= \frac{11.8}{2882}$$
$$= 0.004094 \frac{\Omega}{\Omega \cdot °C}$$

The material is silver (0.0041).

9.

$$R_{T2} = \frac{1 + \alpha_o T_2}{1 + \alpha_o T_1} * R_{T1}$$

$$\frac{R_{T2}}{R_{T1}} = \frac{1 + \alpha_o T_2}{1 + \alpha_o T_1}$$

$$\frac{R_{T2}}{R_{T1}} * \left(1 + \alpha_o T_1\right) = 1 + \alpha_o T_2$$

$$\left[\frac{R_{T2}}{R_{T1}} * \left(1 + \alpha_o T_1\right)\right] - 1 = \alpha_o T_2$$

$$T_2 = \frac{\left[\frac{R_{T2}}{R_{T1}} * \left(1 + \alpha_o T_1\right)\right] - 1}{\alpha_o}$$

$$= \frac{\left[\frac{180\Omega}{150\Omega} * (1 + 0.00427 * 20°C)\right] - 1}{0.00427}$$

$$= \frac{[1.2 * 1.0854] - 1}{0.00427}$$

$$= 70.8°C$$