ZADACI 11.1

11.1-1.

$l = 1\,m$

$U = 1.11\,V$

$S = 1 \cdot 10^{-6}\,m^3$

$N = 6.24 \cdot 10^{18}$ $t = 1s$

$I, R, \rho, j, E = ?$

$$I = \frac{Q}{t} = \frac{Ne}{t} = \frac{6.24 \cdot 10^{18} \cdot 1.6 \cdot 10^{-19}}{1} = 9.98 \cdot 10^{-1} \simeq 1A$$

$$R = \frac{U}{I} = \frac{1.11}{1} = 1.11\,\Omega$$

$$R = \rho \frac{l}{S} \Rightarrow \rho = \frac{RS}{l} = \frac{1.11 \cdot 10^{-6}}{1} = 1.11 \cdot 10^{-6}\,\Omega m$$

$$j = \frac{I}{S} = \frac{1}{10^{-6}} = 1 \cdot 10^{6}\,\frac{A}{m}$$

$$E = \frac{U}{l} = 1.11\,\frac{V}{m}$$

11.1-2 $j = 8\,A/mm^2 = 8 \cdot 10^{-4}\,cm^2$

$N = 10^{22}\,el/cm^3$

$v = ?$

$I = S v e N \,|:S$ $j = \frac{I}{S}$

$$\frac{I}{S} = v e N$$

$$j = v e N$$

$$v = \frac{j}{eN} = \frac{8 \cdot 10^{-4}}{1.6 \cdot 10^{-19} \cdot 10^{22}} = 5 \cdot 10^{-1}\,cm/s = 5\,mm/s$$

11.1-3

$S_1 = 0{,}5 \cdot 10^{-6} = 5 \cdot 10^{-7}\ m$

$S_2 = 2 \cdot 10^{-6}\ m$

$J_2 = 10^6\ \frac{A}{m^2}$

$J = \frac{I}{S}$ $\qquad I_2 = J_2 S_2 = 2\ A = I$

$J_1 = \frac{I}{S_1} = \frac{2}{5 \cdot 10^{-5}} = 0.4 \cdot 10^7 = 4 \cdot 10^6$

11.1-4

$\rho = 1{,}11\ \Omega\ \frac{mm^2}{m} = 1{,}11 \cdot 10^{-6}\ \Omega\ m$

$U = 220\ V$; $t = 1\ s$

$W = 2000\ W$

$S = 0{,}23\ mm^2 = 0{,}23 \cdot 10^{-6}\ m^2 = 2{,}3 \cdot 10^{-7}\ m^2$

$W = I^2 R t = \frac{U^2}{R^2} R t = \frac{U^2}{R} t$

$WR = U^2 t$

$R = \frac{U^2 t}{W} = \frac{220^2 \cdot 1}{2000} = 24{,}2\ \Omega$

$I = \frac{U}{R} = \frac{220}{24{,}2} = 9{,}1\ A$

$R = \rho \frac{l}{S} \Rightarrow l = \frac{RS}{\rho} = \frac{24{,}2 \cdot 2{,}3 \cdot 10^{-7}}{1{,}11 \cdot 10^{-6}} = 5\ m$

II. 1-5.

$R_{20} = 100\ \Omega$

$\alpha = 0.004\ \frac{1}{°C}$

$\vartheta = 120\ °C$

$R_\vartheta = ?$

$$R_\vartheta = R_{20}[1 + \alpha(\vartheta - 20)]$$

$$= 100[1 + 0.004 \cdot 100]$$

$$= 100[1 + 0.4] = \underline{\underline{140\ \Omega}}$$

II. 1-6.

$R_{cu} = R_{Al}$

$l_{cu} = l_{Al}$

$S_{cu} = 1{,}5 \cdot 10^{-6}\ m$

$\rho_{cu} / \rho_{Al} = 0.63$

$S_{Al} = ?$

$$m = \frac{\rho}{V}$$

$$m_{cu} \sim \frac{1}{1{,}5} = 0.66$$

$$m_{Al} \sim \frac{0.63}{2.38} = 0{,}2$$

bakreni ima veću masu

$R_{cu} = R_{Al}$

$$\rho_{cu} \frac{l}{S_{cu}} = \rho_{Al} \frac{l}{S_{Al}}$$

$$\frac{\rho_{cu}}{\rho_{Al}} \cdot \frac{1}{S_{cu}} = \frac{1}{S_{Al}}$$

$$S_{Al} = S_{cu} \left(\frac{\rho_{cu}}{\rho_{Al}} \right)^{-1}$$

$$= 1{,}5 \cdot 10^{-6} \cdot 0.63^{-1}$$

$$= 2.38 \cdot 10^{-6}\ m^2$$

$$= 2.38\ mm^2$$

II.1-7 $R = 25\ \Omega$ $t = 1800\ s$

$U = 110\ V$

$$W = I^2 R t = \frac{U^2}{R^2} R t = \frac{U^2}{R} \cdot t = \frac{110^2}{25} \cdot 1800$$

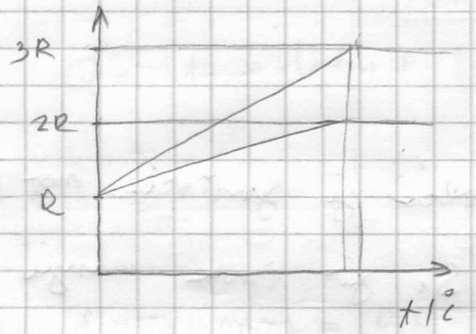
$$= 871\ kJ$$

$$U' = \frac{9}{10} U$$

$$W' = \frac{U'^2}{R} \cdot t = \frac{\left(\frac{9}{10} U\right)^2}{R} t = \frac{81}{100} \frac{U^2}{R} t = 0{,}81\ W$$

Smanji se 19 %

II.1-8



$$3R = R\,[1 + \alpha_1 (\vartheta - 20)]$$

$$2R = R\,[1 + \alpha_2 (\vartheta - 20)]$$

$$R = \alpha_1 (\vartheta - 20)$$

$$R = \alpha_2 (\vartheta - 20)$$

$$\frac{\alpha_1}{\alpha_2} = 2$$

II.1-9 $\Delta\vartheta = 40\,^\circ C$

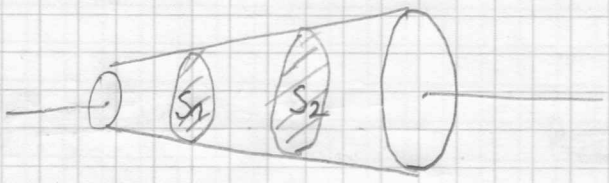
$\alpha = 0.004\ 1/^\circ C$

$\frac{R_\vartheta}{R} - 1 = ?$ 16 %

$R_\vartheta = R_{20}[1 + \alpha\Delta\vartheta]$

$\frac{R_\vartheta}{R_{20}} = 1.16$

II.1-10



$J_1 = \frac{I}{S_1}$ $J_2 = \frac{I}{S_2}$ a) veća je gustoća na presj

S_1 je ima manji pov

b) $J = kE = \frac{I}{S}$ jače je polje po presjeku S_1

II.1.-11 $R_1 = \rho\frac{l_1}{S} = 2\rho\frac{l}{S}$

$R_2 = \rho\frac{l_2}{2S} = \rho\frac{l}{2S}$

$V = r^2\pi$

$= S\,l$

$\frac{R_1}{R_2} = \frac{2\rho\frac{l}{S}}{\frac{1}{2}\rho\frac{l}{S}} = 4$

$R_1 = 4R_2$

$$S_1 l_1 = S_2 l_2$$

$$S l_1 = 2 S l_2$$

$$l_1 = 2 l_2$$

11.1-12.

$t_1 = 5h = 1.8 \cdot 10^4 s$

$I_1 = 2 A$

$t_2 = 2h = 7.2 \cdot 10^3 s$

$I_2 = 1 A$

$Q = ?$

$$Q = It = I_1 t_1 + I_2 t_2 = 3.6 \cdot 10^4 + 0.72 \cdot 10^4$$

$$= 4.32 \cdot 10^4 As$$

11.1-13. $d = 0.4 mm = 0.4 \cdot 10^{-3} m = 4 \cdot 10^{-4} m$

$l = 33 m$

$R_{20} = 80 \Omega$

$K = ?$

$$R = \rho \frac{l}{S}$$

$$\rho = \frac{RS}{l} \qquad K = \frac{l}{RS} = \frac{33}{80 \cdot 4\pi \cdot 10^{-8}}$$

$r = 2 \cdot 10^{-4}$

$S = r^2 \pi = 4\pi \cdot 10^{-8}$

$$= 0.0328 \cdot 10^8$$

$$= 3.28 \cdot 10^6 S/m$$

$$= 3.28 \, \Omega m / mm^2$$

II. 1-14

$d = 0.4\ mm \Rightarrow r = 0.2\ mm = 2 \cdot 10^{-4}\ m$

$N = 1620$

$l = 8.4\ cm = 8.4 \cdot 10^{-2}\ m$

$\rho = 1.75 \cdot 10^{-8}\ \Omega\ m$

$R = ?$

$$R = \rho \frac{l}{S} = 1.75 \cdot 10^{-8} \frac{8.4 \cdot 10^{-2}}{4\pi \cdot 10^{-8}}$$

$S = 4\pi \cdot 10^{-8}\ m \qquad = 1.17 \cdot 10^{-2}$

$\underline{N \cdot R = 18.95\ \Omega}$

II. 1-15

$S = 0.07\ mm^2 = 0.07 \cdot 10^{-6} = 7 \cdot 10^{-8}\ m^2$

$R = 2.5\ \Omega$

$K = \frac{1}{\rho} = 2 \cdot 10^{+6}\ S/m$

$l = ?$

$$R = \rho \frac{l}{S}$$

$l = KRS = 2 \cdot 10^{+6} \cdot 7 \cdot 10^{-8} \cdot 2.5 = 35 \cdot 10^{-2}$

$= 0.35\ m = \underline{350\ mm}$

11.1-16 d, l R_1

$1.2d, 0.8l$ R_2

$$R_1 = \rho \frac{l}{\left(\frac{d}{2}\right)^2 \pi} = 4\rho \frac{l}{d\pi}$$

$$R_2 = \rho \frac{0.8l}{0.36 d\pi} = 2.2\rho \frac{l}{d\pi}$$

$$\frac{R_2}{R_1} = \frac{2.2\rho \frac{l}{d\pi}}{4\rho \frac{l}{d\pi}}$$

$$= 0.55$$

$$R_2 = 0.55 R_1$$

11.1-17. $\alpha = 0.0039 \ 1/°C$

$\vartheta = ?$

$$R_\vartheta = 1.2 R_{20}$$

$$R_\vartheta = R_{20}\left[1 + \alpha(\vartheta - 20)\right]$$

$$1.2 R_{20} = R_{20} + R_{20}\alpha(\vartheta - 20)$$

$$0.2 R_{20} = R_{20}\alpha(\vartheta - 20) \quad | : R_{20}$$

$$0.2 = 0.0039(\vartheta - 20)$$

$$51.3 = \vartheta - 20$$

$$\vartheta = 71.3\,°C$$

11.1-18 $\Delta T = 100$

a) konstantan $\alpha = 0{,}00004$

$$R_v = R_{20}[1 + \alpha \Delta T]$$

$$= R_{20}[1 + 0{,}004]$$

$$= 1{,}004 R_{20}$$

0,4% povečanje

b) $\alpha = 0{,}004$

$$R_v = R_{20}[1 + \alpha \Delta T]$$

$$= R_{20}[1 + 0{,}4] \quad \underline{+40\%}$$

$$= 1{,}4 R_{20}$$

11.1-19

$R_{20} = 1000\ \Omega$

$\Delta T = 80\ °C$

$\underline{R_v = 400\ \Omega}$

$\alpha = ?$

$$R_v = R_{20}[1 + \alpha \Delta T]$$

$$R_v - R_{20} = R_{20} \alpha \Delta T$$

$$\alpha = \frac{R_v - R_{20}}{R_{20} \Delta T}$$

$$= \frac{-6 \cdot 10^2}{8 \cdot 10^4} = -0{,}75 \cdot 10^{-2}$$

$$= \underline{-7{,}5 \cdot 10^{-3}}$$

11. 1-20.

$\alpha_{Al} = 0.0037\ ^\circ C^{-1}$

$\alpha_{mj} = 0.0015\ ^\circ C^{-1}$

$R_{Al} = R_{mj} = 2\ \Omega$

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v t.d. $R_{Al} = 1.3 R_{MJ}$?

$R_{Al}, R_{MJ} = ?$

$R_\upsilon = R_{20}[1 + \alpha(\upsilon - 20)]$

$\cancel{R_{20}}[1 + \alpha_{Al}(\upsilon - 20)] \overset{1.3}{=} \cancel{R_{20}}[1 + \alpha_M(\upsilon - 20)]$

$1 + 0.0037(\upsilon - 20) = 1.3 + 1.3 \cdot 0.0015(\upsilon - 20)$

$-0.3 + 3.7 \cdot 10^{-3}(\upsilon - 20) = 1.95 \cdot 10^{-3}(\upsilon - 20)$

$1.75 \cdot 10^{-3}(\upsilon - 20) = 0.3$

$\upsilon - 20 = 171.43$

$\Delta T = 171.43\ ^\circ C$

$\upsilon = 191.43\ ^\circ C$

$R_{Al} = R_{20}[1 + \alpha \Delta T]$

$= 2[1 + 0.0037 \cdot 171.43] = 3.27\ \Omega$

$R_{mj} = R_{20}[1 + \alpha \Delta T]$

$= 2[1 + 0.0015 \cdot 171.43] = 2.514\ \Omega$

II.1-21

$U_1 = 12V$

$U_2 = 10V$

$t = 1h = 3600s$

$I_1 = 1.2\ A$

$Q = ?$

$R = \frac{U_1}{I_1} = 10\ \Omega$

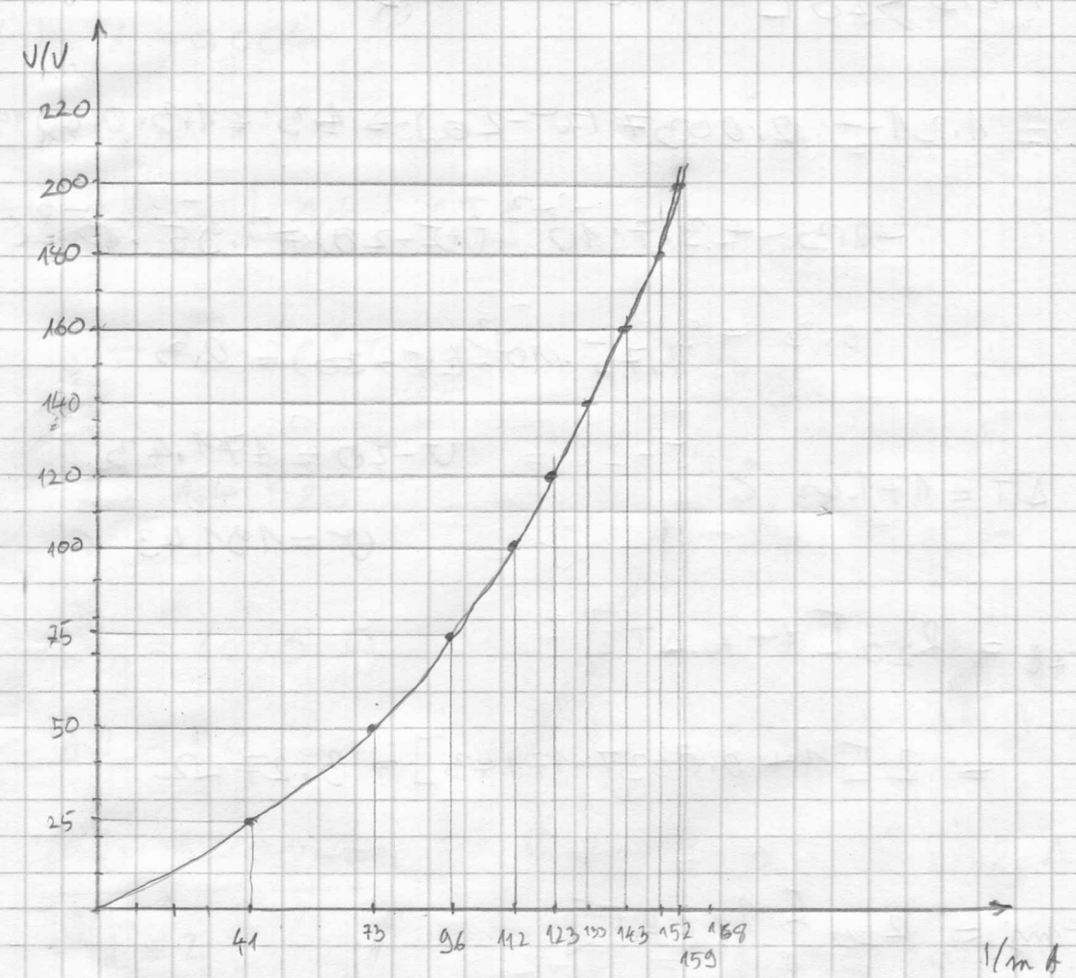
$I_2 = \frac{U_2}{R} = 1A$

$\bar{I} = \frac{I_1 + I_2}{2} = 1.1\ A$

$Q = I_m t = 1,1\ Ah$

$Q = I_n \cdot t = 1,2\ Ah$

II.1-21



a) $R_{25} = \frac{U}{I_{25}} = \frac{25}{41m} = 610\ \Omega$

$R_{100} = \frac{U}{I_{100}} = 893\ \Omega$

$R_{220} = \frac{U}{I_{220}} = 1310\ \Omega$

b) zbog 2 volt.

c) $P_{25} = I^2 R = I^2 \frac{U}{I} = UI = 25 \cdot 0.041 = 1.025\ W$

$P_{220} = UI = 220 \cdot 0.168 = 36.96$

$\frac{P_{220}}{P_{25}} = 36$ RAZL OD RJEŠENJA!