STUDIJSKI PROGRAM ZA PRIMENJENO SOFTVERSKO INŽENJERSTVO

K TET Katedra za teorijsku elektrotehniku www.ktet.ftn.uns.ac.rs	Osnovi elektrotehnike (I kolokvijum)	**K1** **09.02.2019.**

ZADACI

Zadatak 1. Na slici 1 je prikazan poprečni presek koaksijalnog kabla, poluprečnika elektroda $a = 1\ mm$ i $b = 8\ mm$, dužine $L = 1\ m$, sa dva sloja dielektrika, permitivnosti $\varepsilon_1 = 10\varepsilon_0$ i $\varepsilon_2 = 9\varepsilon_0$. Granična površina između dielektrika se nalazi na poluprečniku $c = 4\ mm$. Kabl je priključen na izvor napona U.

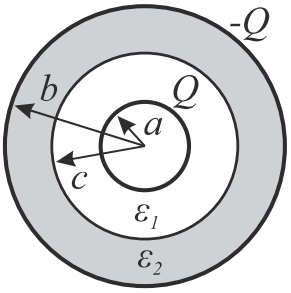
a) Odrediti kako se u zavisnosti od rastojanja tačke od centra kondenzatora menjaju intenziteti vektora električnog pomeraja i vektora jačine električnog polja.

b) Izračunati brojnu vrednost za kapacitivnost kabla.

c) Izračunati količinu naelektrisanja na unutrašnjoj elektrodi Q, ako gustina vezanog naelektrisanja uz graničnu površinu u dielektriku permitivnosti ε_1 iznosi $\sigma_{v1} = 200\ \mu C/m^2$.

d) Odrediti napon U na koji je priključen kabl.

Ostali brojni podaci: $\varepsilon_0 = 8{,}85 \cdot 10^{-12}\ F/m$.



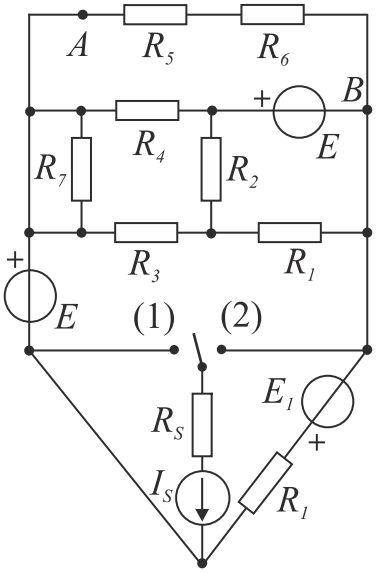
Slika 1.

Zadatak 2. Kada se u kolu vremenski konstantne struje sa slike 1 preklopnik prebaci iz položaja (1) u položaj (2), napon između tačaka A i B poraste za 15 V.

a) Primenjujući teoremu superpozicije, odrediti vrednost struje strujnog generatora, I_S.

b) Odrediti snagu naponskog generatora E_1 kada je preklopnik u položaju (1). Prilikom rešavanja primeniti metodu potencijala čvorova.

Ostali brojni podaci: $R_1 = R_2 = R_3 = 10\ \Omega$, $R_4 = R_7 = 30\ \Omega$, $R_5 = 6\ \Omega$, $R_6 = 9\ \Omega$, $E = 5\ V$, $E_1 = 10\ V$.



Slika 2.

PRAVILA POLAGANJA

Za položen kolokvijum je neophodno sakupiti više od 50% poena na svakom od zadataka. Svaki zadatak se boduje sa 25 poena. Kolokvijum traje jedan sat i trideset minuta.

STUDIJSKI PROGRAM ZA PRIMENJENO SOFTVERSKO INŽENJERSTVO

K TET Katedra za teorijsku elektrotehniku www.ktet.ftn.uns.ac.rs	Osnovi elektrotehnike (II kolokvijum)	**K2** **09.02.2019.**

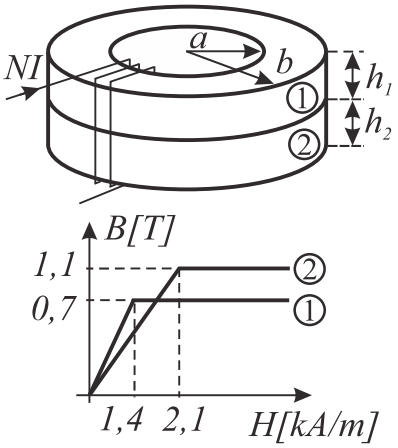
ZADACI

Zadatak 1. Na slici 1 je prikazano debelo torusno jezgro, načinjeno od dva različita materijala, kao i njihove krive prvobitnog magnetisanja. Na jezgro je ravnomerno namotano $N = 170$ zavojaka u kojima se uspostavila struja jačine I. Odrediti:

a) jačinu struje, I, pri kojoj će polovina dela jezgra načinjenog od materijala 1 biti u zasićenju, i

b) fluks vektora magnetske indukcije kroz poprečni presek jezgra, pri struji određenoj pod a).

Dimenzije jezgra su: $a = 3\ cm$, $b = 5\ cm$, $h_1 = h_2 = 1\ cm$.

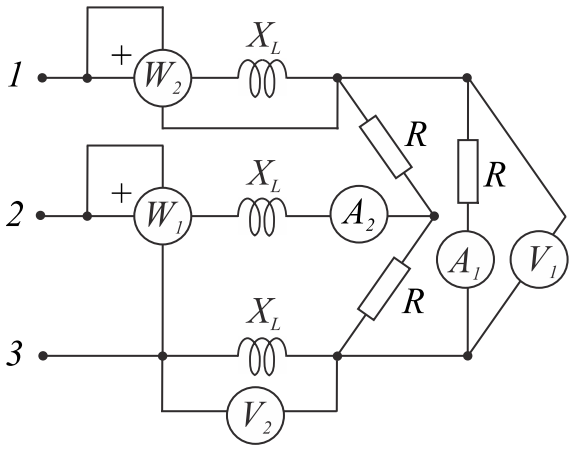


Slika 1.

Zadatak 2. Trofazni prijemnik, otpornosti $R = 15\ \Omega$, priključen je preko trofaznog voda reaktanse $X_L = 5\ \Omega$, na simetričnu trofaznu mrežu faznog napona prve faze $\underline{U}_1 = 230\ V$, kao što je prikazano na slici 2.

a) Odrediti pokazivanje idealnih mernih instrumenata.

b) Na fazorskom dijagramu nacrtati fazore svih veličina od kojih zavisi pokazivanje instrumenata.



Slika 2.

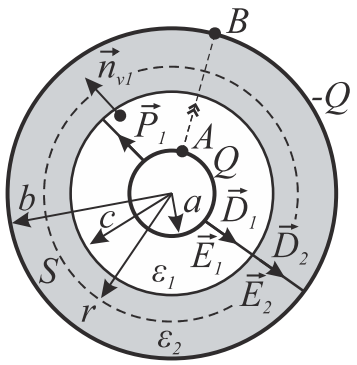
PRAVILA POLAGANJA

Za položen kolokvijum je neophodno sakupiti više od 50% poena na svakom od zadataka. Svaki zadatak se boduje sa 25 poena. Kolokvijum traje jedan sat i trideset minuta.

PSI ISPIT 09.02.2018.

K1 Z1

a)



Granični uslov:

$D_{n1} = D_{n2} \qquad D_1 = D_2 = D$

$E_{t1} \neq E_{t2}$

$$\oint_S \vec{D} \cdot \vec{ds} = Q_{slobodno\ u\ S}$$

$$\int_S D\, ds = Q$$

$$D 2\pi r L = Q$$

$$\boxed{D = \frac{Q}{2\pi r L}, \qquad a \le r \le b}$$

$$\boxed{E_1 = \frac{D}{\varepsilon_1} = \frac{Q}{2\pi\varepsilon_1 r L}, \qquad a \le r \le c}$$

$$\boxed{E_2 = \frac{D}{\varepsilon_2} = \frac{Q}{2\pi\varepsilon_2 r L}, \qquad c \le r \le b}$$

b)

$$C = \frac{Q}{U}$$

$$U_{AB} = \int_A^B \vec{E} \cdot \vec{dl} = \int_a^b E dr = \int_a^c E_1 dr + \int_c^b E_2 dr = \int_a^c \frac{Q}{2\pi\varepsilon_1 r L} dr + \int_c^b \frac{Q}{2\pi\varepsilon_2 r L} dr = \frac{Q}{2\pi L}\left(\frac{1}{\varepsilon_1}\ln\frac{c}{a} + \frac{1}{\varepsilon_2}\ln\frac{b}{c}\right)$$

$$C = \frac{2\pi L}{\frac{1}{\varepsilon_1}\ln\frac{c}{a} + \frac{1}{\varepsilon_2}\ln\frac{b}{c}} = \frac{2\pi \cdot 1}{\frac{1}{10\varepsilon_0}\ln 4 + \frac{1}{9\varepsilon_0}\ln 2}$$

$$\boxed{C = 257{,}86\ pF}$$

c)

$$\sigma_{v1} = \vec{P}_1 \cdot \vec{n}_{v1} = P_1(r = c) = D - \varepsilon_0 E_1 = D - \varepsilon_0 \frac{D}{\varepsilon_1} = \left(1 - \frac{1}{\varepsilon_{r1}}\right) D = \left(1 - \frac{1}{10}\right)\frac{Q}{2\pi c L} = \frac{9}{10}\frac{Q}{2\pi c L}$$

$$Q = \frac{\sigma_{v1} \cdot 20\pi c L}{9} = \frac{100 \cdot 10^{-6} \cdot 20\pi \cdot 5 \cdot 10^{-3} \cdot 1}{9}$$

$$\boxed{Q = 5{,}59\ \mu C}$$

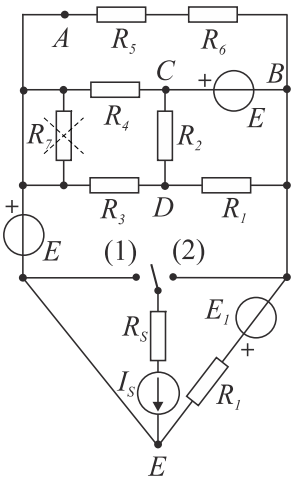
d)

$$U = \frac{Q}{C} = \frac{5{,}59 \cdot 10^{-6}}{257{,}86 \cdot 10^{-12}}$$

$$\boxed{U = 21{,}66\ kV}$$

K1 Z2

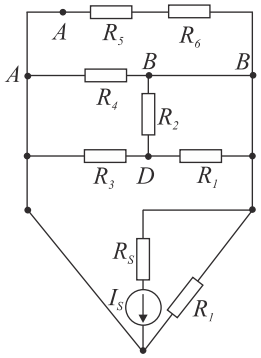
a)

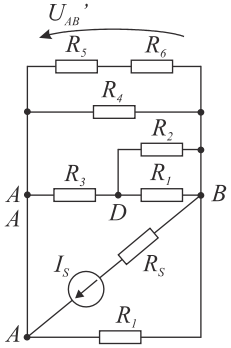


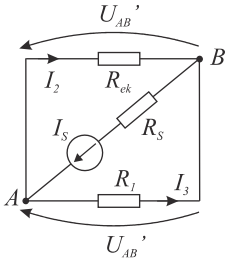
$$\boxed{\begin{matrix}\text{Svi}\\ \text{generatori}\\ (2)\end{matrix}} = \boxed{\begin{matrix}\text{Svi}\\ \text{sem } I_S\\ (1)\end{matrix}} + \boxed{\begin{matrix}\text{Samo}\\ I_S\end{matrix}}$$

$$U_{AB}^{(2)} = U_{AB}^{(1)} + U_{AB}'$$
$$\Delta U_{AB} = U_{AB}^{(2)} - U_{AB}^{(1)} = U_{AB}'$$
$$U_{AB}' = \Delta U_{AB} = 15\,V$$

Samo I_S:

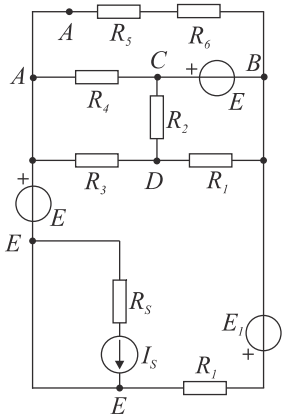


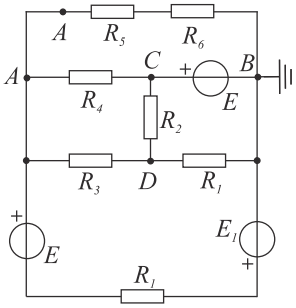




$$R_{ek} = \left[\left(R_1 \| R_2\right) + R_3\right] \| R_4 \| \left(R_5 + R_6\right)$$
$$R_{ek} = \left[\left(10 \| 10\right) + 10\right] \| 30 \| \left(6 + 9\right)$$
$$R_{ek} = \left[5 + 10\right] \| 30 \| 15 = 10 \| 15$$
$$R_{ek} = 6\,\Omega$$
$$I_2 = \frac{U_{AB}'}{R_{ek}} = \frac{15}{6} = 2{,}5\,A$$
$$I_3 = \frac{U_{AB}'}{R_1} = \frac{15}{10} = 1{,}5\,A$$
$$I_S = I_2 + I_3 \qquad \boxed{I_S = 4\,A}$$

b)





$$V_B = 0\,V, \qquad V_C = E = 5\,V$$
$$V_A\left(\frac{1}{R_1}+\frac{1}{R_3}+\frac{1}{R_4}+\frac{1}{R_5+R_6}\right) - V_C\left(\frac{1}{R_4}\right) - V_D\left(\frac{1}{R_3}\right) = \frac{E+E_1}{R_1}$$
$$V_D\left(\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}\right) - V_A\left(\frac{1}{R_3}\right) - V_C\left(\frac{1}{R_2}\right) = 0$$

$$V_A\left(\frac{1}{10}+\frac{1}{10}+\frac{1}{30}+\frac{1}{6+9}\right) - 5\cdot\left(\frac{1}{30}\right) - V_D\left(\frac{1}{10}\right) = \frac{5+10}{10} \quad /\cdot 30$$
$$V_D\left(\frac{1}{10}+\frac{1}{10}+\frac{1}{10}\right) - V_A\left(\frac{1}{10}\right) - 5\cdot\left(\frac{1}{10}\right) = 0 \qquad /\cdot 10$$

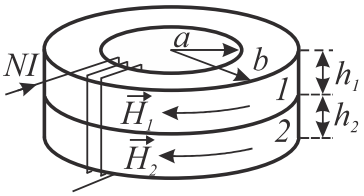
$$9\,V_A - 3\,V_D = 50$$
$$3\,V_D - V_A = 5$$

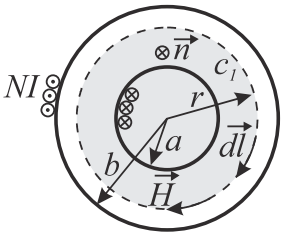
$$V_A = 6{,}875\,V$$
$$V_D = 3{,}958\,V$$

$$I_1 = \frac{E_1 + E + V_B - V_A}{R_1} = 0{,}8125\,A$$

$$P_{E1} = E_1\,I_1 = 10 \cdot 0{,}8125$$
$$\boxed{P_{E1} = 8{,}125\,W}$$

K2 Z1





Granični uslov: $H_{1t} = H_{2t} = H$

$$\oint_C \vec{H}\cdot\vec{dl} = NI$$

$$H\,2\pi r = NI$$

$$H = \frac{NI}{2\pi r} \qquad a \le r \le b$$

a)

$$r_z = a + \frac{1}{2}(b-a) = 4\ cm$$

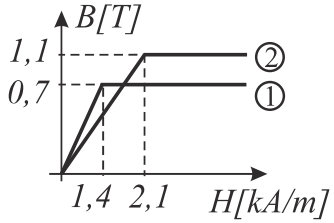
$$\frac{NI}{2\pi r_z} = H_{c1} = 1400\ A/m \quad \rightarrow \quad I = \frac{H_{c1}\,2\pi r_z}{N} = \frac{1400\cdot 2\pi\cdot 0{,}04}{170} \qquad \boxed{I = 2{,}07\ A}$$

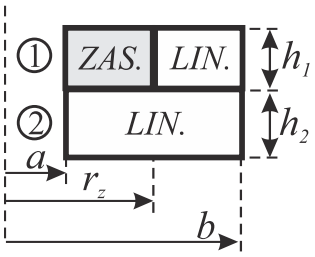
b)

$$H_{2\max}(r=a) = \frac{NI}{2\pi a} = 1866{,}9\ A/m$$

$$H_{2\min}(r=b) = \frac{NI}{2\pi b} = 1120{,}1\ A/m$$

Sledi da je materijal 2 u linearnom rezimu rada.





$$\Phi = \Phi_1 + \Phi_2$$

$$\Phi_1 = B_{c1}(r_z - a)\,h_1 + \int_{r_z}^{b} \mu_1 \frac{NI}{2\pi r}\,dr\,h_1 =$$

$$\Phi_1 = 0{,}7(0{,}04 - 0{,}03)\,0{,}01 + \frac{0{,}7}{1400}\,\frac{170\cdot 2{,}07}{2\pi}\cdot 0{,}01\cdot \ln\frac{0{,}05}{0{,}04}$$

$$\Phi_1 = 7\ \mu Wb + 62{,}5\ \mu Wb$$

$$\boxed{\Phi_1 = 69{,}5\ \mu Wb}$$

$$\Phi_2 = \int_a^b \mu_2 \frac{NI}{2\pi r}\,dr\,h_2 = \frac{1{,}1}{2100}\,\frac{NI}{2\pi}\,h_2 \ln\frac{b}{a}$$

$$\Phi_2 = \frac{1{,}1}{2100}\,\frac{170\cdot 2{,}07}{2\pi}\cdot 0{,}01\cdot \ln\frac{0{,}05}{0{,}03}$$

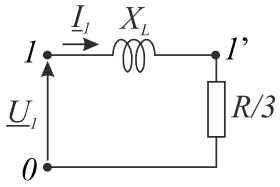
$$\boxed{\Phi_2 = 149\ \mu Wb}$$

$$\Phi = \Phi_1 + \Phi_2 = 69{,}5\ \mu Wb + 149\ \mu Wb$$

$$\boxed{\Phi = 211{,}5\ \mu Wb}$$

K2 Z2

a)



$$\underline{I}_1 = \frac{\underline{U}_1}{jX_L + \frac{R}{3}} = \frac{230\,e^{j0°}}{(5+j5)} = \frac{230\,e^{j0°}}{5\sqrt{2}e^{j45°}} = 32{,}53\,e^{-j45°}\ A$$

$$I_{A1} = \frac{|\underline{I}_1|}{\sqrt{3}} = \frac{32{,}53}{\sqrt{3}}$$

ili $I_{A1} = \dfrac{|\underline{U}'_{13}|}{R} = \dfrac{\sqrt{3}\frac{R}{3}|\underline{I}_1|}{R}$

$$\boxed{I_{A1} = 18{,}78\,A}$$

$$U_{V1} = R \cdot I_{A1}$$

$$\boxed{U_{V1} = 281{,}7\,V}$$

$$U_{V2} = |\underline{U}_{11'}| = X_L \cdot |\underline{I}_1| = X_L \cdot I_1$$

$$\boxed{U_{V2} = 162{,}65\,V}$$

$$I_{A2} = |\underline{I}_2| = I_1$$

$$\boxed{I_{A2} = 32{,}53\,A}$$

$$P_{W1} = \mathrm{Re}\{\underline{U}_{23}\,\underline{I}_2^{\,*}\} = U_{23}\,I_2\cos\sphericalangle(\underline{U}_{23}, \underline{I}_2) = \sqrt{3}\,U_1\,I_1\cos(30° + 45°) = \sqrt{3}\cdot 230\cdot 32{,}53\cdot\cos 75°$$

$$\boxed{P_{W1} = 3354\,W}$$

$$P_{W2} = \mathrm{Re}\{\underline{U}_{11'}\,\underline{I}_1^{\,*}\} = \mathrm{Re}\{X_L\,\underline{I}_1\,\underline{I}_1^{\,*}\}$$

$$\boxed{P_{W2} = 0\,W}$$

b)

