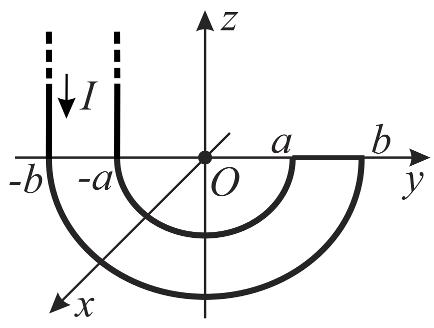
STUDIJSKI PROGRAM ENERGETIKA, ELEKTRONIKA I TELEKOMUNIKACIJE		
K TET Katedra za teorijsku elektrotehniku www.ktet.ftn.uns.ac.rs	Osnovi elektrotehnike 2 (I kolokvijum)	**K1** **20.10.2019.**

ZADACI

Zadatak 1. Veoma dugačak žičani provodnik, sa vremenski konstantnom strujom jačine I, savijen je kao što je prikazano na slici 1. Provodnik se sastoji od tri pravolinijska i dva lučna segmenta. Cela struktura leži u y-z ravni Dekartovog pravouglog koordinatnog sistema. Odrediti intenzitet vektora magnetske indukcije u koordinatnom početku (tačka O). Sredina je vazduh.

Brojne vrednosti: $I = 1\ A$, $a = 2\ cm$, $b = 3\ cm$.

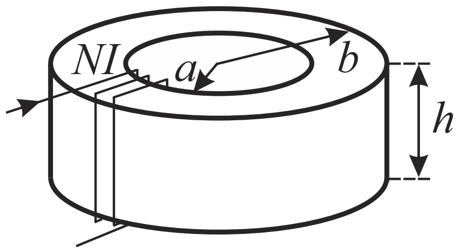


Slika 1.

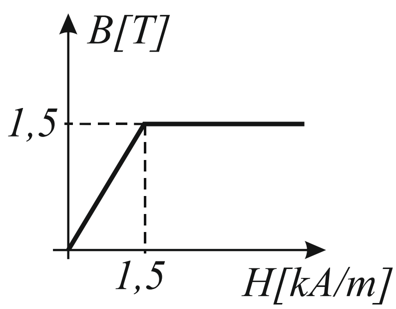
Zadatak 2. Na slici 2a je prikazano debelo torusno jezgro, načinjeno od materijala čija je magnetska karakteristika data na slici 2b. Na jezgro je ravnomerno i gusto namotan pobudni namotaj sa N zavojaka u kojima je uspostavljena struja jačine $I = 1{,}5\ A$. Odrediti:

a) broj namotaja N, tako da polovina jezgra bude u zasićenju,
b) režim rada torusnog jezgra kada se struja u namotajima poveća za 50%,
c) promenu magnetske energije u jezgru, koja nastaje pri promeni struje u namotajima, iz dela zadatka pod b).

Dimenzije jezgra su: $a = 2\ cm$, $b = 3\ cm$, visina $h = 2{,}5\ cm$.



Slika 2a.



Slika 2b.

PRAVILA POLAGANJA

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

STUDIJSKI PROGRAM ENERGETIKA, ELEKTRONIKA I TELEKOMUNIKACIJE

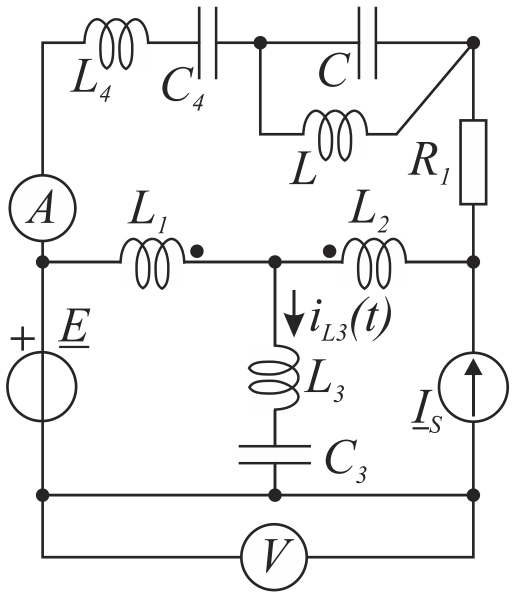
K	T E T	Osnovi elektrotehnike 2 (II kolokvijum)	K2
Katedra za teorijsku elektrotehniku www.ktet.ftn.uns.ac.rs			20.10.2019.

ZADACI

Zadatak 1. U mreži prostoperiodične struje prikazanoj na slici 1:

a) Odrediti aktivnu snagu naponskog generatora $\underline{E}$ i reaktivnu snagu strujnog generatora $\underline{I}_S$.
b) Odrediti pokazivanje idealnih mernih instrumenata.
c) Odrediti trenutnu vrednost struje kroz kalem induktivnosti L_3, $i_{L3}(t)$.

Brojni podaci su: $\underline{E} = 5\ V$, $\underline{I}_S = j2\ A$, $X_L = X_C = X_{L2} = 5\ \Omega$, $X_{L1} = 10\ \Omega$, $X_{L3} = X_{C3} = 15\ \Omega$, $X_{L4} = X_{C4} = 10\ \Omega$, $X_{L12} = 3\ \Omega$, $R_1 = 5\ \Omega$.

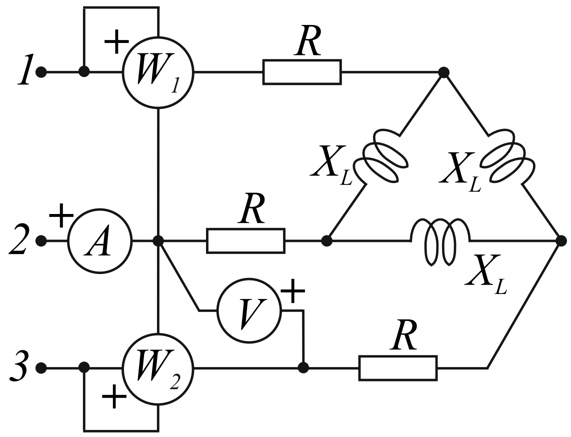


Slika 1.

Zadatak 2. Simetričan trofazni prijemnik priključen je 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) Skicirati fazorski dijagram svih veličina od kojih zavisi pokazivanje mernih instrumenata.

Brojni podaci su: $R = 30\ \Omega$, $X_L = 180\ \Omega$.



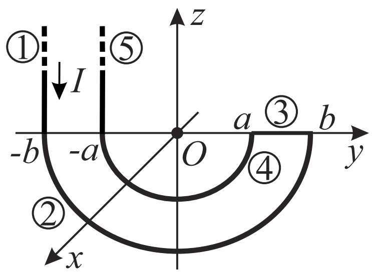
Slika 2.

PRAVILA POLAGANJA

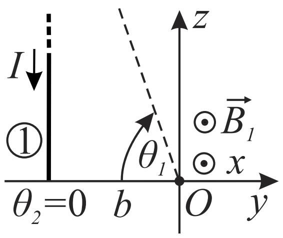
Za položen kolokvijum neophodno je tačno uraditi više od 50% svakog od zadataka. Svaki zadatak se boduje sa 25 poena. Kolokvijum traje jedan sat i trideset minuta.

Ispit iz OET2, 20.10.2019.

I-1



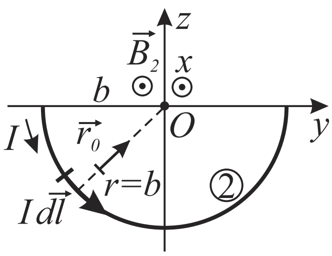
$$\boxed{\vec{B}_3 = 0} \qquad \sin\sphericalangle\left(\vec{dl}, \vec{r}_0\right) = 0$$



$\boxed{1}$ $\quad d = b, \qquad \theta_1 \to -\frac{\pi}{2}, \qquad \theta_2 = 0$

$$B_1 = \frac{\mu_0 I}{4\pi d}\left(\sin\theta_2 - \sin\theta_1\right) = \frac{\mu_0 I}{4\pi b}\left[0 - (-1)\right] = \frac{\mu_0 I}{4\pi b}$$

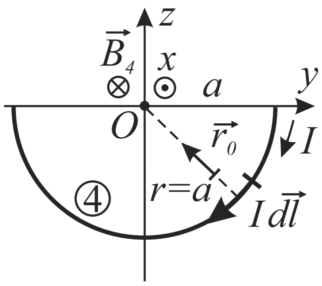
$$\boxed{\vec{B}_1 = \frac{\mu_0 I}{4\pi b} \cdot \vec{i}_x}$$



$$\vec{dB}_2 = \frac{\mu_0}{4\pi}\frac{I\,\vec{dl} \times \vec{r}_0}{r^2} \qquad dB_2 = \frac{\mu_0}{4\pi}\frac{I\,dl}{b^2} \qquad \sphericalangle\left(\vec{dl}, \vec{r}_0\right) = \frac{\pi}{2}$$

$$B_2 = \int dB_2 = \frac{\mu_0 I}{4\pi b^2}\int_0^{\frac{1}{2}2b\pi} dl = \frac{\mu_0 I}{4\pi b^2} b\pi = \frac{\mu_0 I}{4b}$$

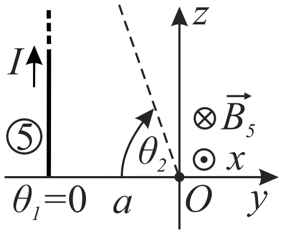
$$\boxed{\vec{B}_2 = \frac{\mu_0 I}{4b} \cdot \vec{i}_x}$$



$$\vec{dB}_4 = \frac{\mu_0}{4\pi}\frac{I\,\vec{dl} \times \vec{r}_0}{r^2} \qquad dB_4 = \frac{\mu_0}{4\pi}\frac{I\,dl}{a^2} \qquad \sphericalangle\left(\vec{dl}, \vec{r}_0\right) = \frac{\pi}{2}$$

$$B_4 = \int dB_4 = \frac{\mu_0 I}{4\pi a^2}\int_0^{\frac{1}{2}2a\pi} dl = \frac{\mu_0 I}{4\pi a^2} a\pi = \frac{\mu_0 I}{4a}$$

$$\boxed{\vec{B}_4 = \frac{\mu_0 I}{4a} \cdot \left(-\vec{i}_x\right)}$$



$\boxed{5}$ $\quad d = a, \qquad \theta_1 = 0, \qquad \theta_2 \to \frac{\pi}{2}$

$$B_5 = \frac{\mu_0 I}{4\pi d}\left(\sin\theta_2 - \sin\theta_1\right) = \frac{\mu_0 I}{4\pi a}(1 - 0) = \frac{\mu_0 I}{4\pi a}$$

$$\boxed{\vec{B}_5 = \frac{\mu_0 I}{4\pi a} \cdot \left(-\vec{i}_x\right)}$$

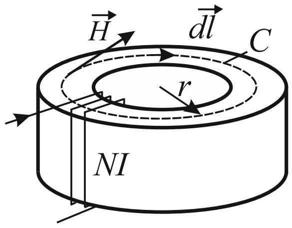
$$\boxed{\vec{B}_O = \vec{B}_1 + \vec{B}_2 + \vec{B}_3 + \vec{B}_4 + \vec{B}_5 = \left(\frac{\mu_0 I}{4\pi b} + \frac{\mu_0 I}{4b} - \frac{\mu_0 I}{4\pi a} - \frac{\mu_0 I}{4a}\right) \cdot \vec{i}_x}$$

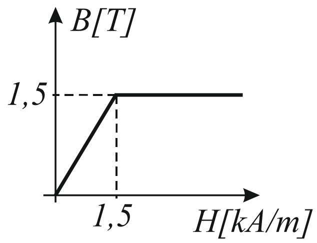
$$\boxed{\vec{B}_O = 6{,}9\ \mu T \cdot \left(-\vec{i}_x\right)}$$

Ispit iz OET2, 20.10.2019.

I-2

a)





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

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

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

$$I = 1{,}5\ A$$

$$r_c = a + \frac{1}{2}(b-a) = 2{,}5\,cm$$

$$\frac{NI}{2\pi r_c} = H_K \quad \to \quad N = \frac{H_K\,2\pi r_c}{I} = \frac{1500\cdot 2\pi\cdot 0{,}025}{1{,}5} \qquad \boxed{N = 157\ zavojaka}$$

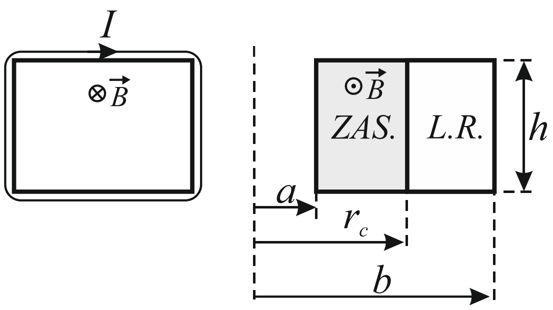
b)

$$I_1 = 1{,}5 I = 1{,}5\cdot 1{,}5 = 2{,}25\ A$$

$$H_{\min}(I_1) = \frac{NI_1}{2\pi b} = \frac{157\cdot 2{,}25}{2\pi\cdot 0{,}03} = 1875\ A/m \ > \ H_K \quad \to$$

$\boxed{\text{Jezgro u potpunom zasićenju.}}$

c)



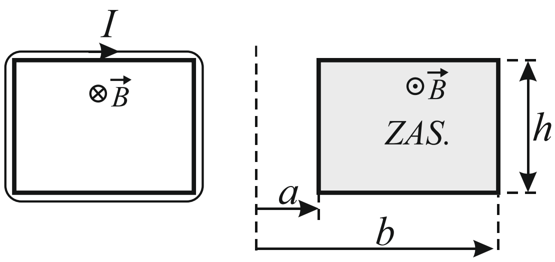
$$w_m = \frac{1}{2}BH = \frac{1}{2}\mu H^2$$

$$W_m = \int_V w_m\,dV$$

$$W_m = \frac{1}{2}B_K\,H_K\left(r_c^2 - a^2\right)\pi h + \int_{r_c}^{b}\frac{1}{2}\mu\left(\frac{NI}{2r\pi}\right)^2 2r\pi\,dr\,h$$

$$W_m = \frac{1}{2}B_K\,H_K\left(r_c^2 - a^2\right)\pi h + \frac{1}{2}\cdot\frac{1{,}5}{1500}\cdot\frac{N^2 I^2}{2\pi}h\ln\frac{b}{r_c}$$

$$W_m = 19{,}87\ mJ + 20{,}13\ mJ = 40\ mJ$$



$$W_{m1} = \frac{1}{2}B_K\,H_K\left(b^2 - a^2\right)\pi h$$

$$W_{m1} = 44{,}16\ mJ$$

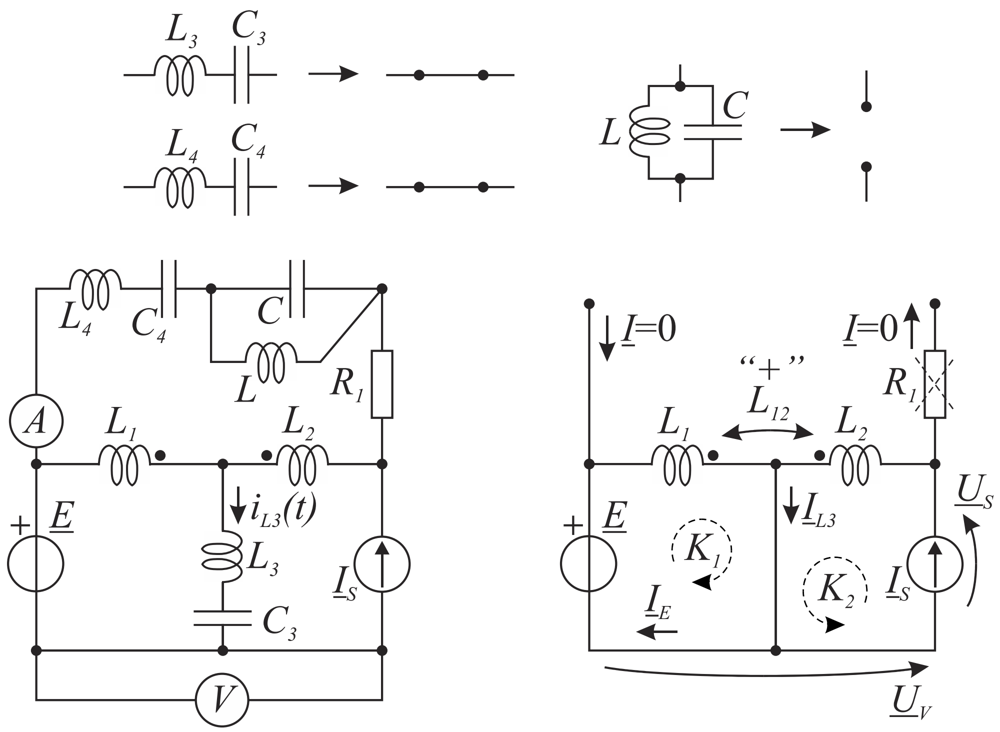
$$\Delta W_m = W_{m1} - W_m = 44{,}16\ mJ - 40\ mJ$$

$$\boxed{\Delta W_m = 4{,}16\ mJ}$$

<u>Ispit iz OET2, 20.10.2019.</u>

II-1

a)



$$K_1: \quad -\underline{E} + jX_{L1}\,\underline{I}_E + jX_{L12}\,\underline{I}_S = 0$$
$$K_2: \quad -\underline{U}_S + jX_{L2}\,\underline{I}_S + jX_{L12}\,\underline{I}_E = 0$$

$$K_1: \quad \underline{I}_E = \frac{\underline{E} - jX_{L12}\,\underline{I}_S}{jX_{L1}} = \frac{5 - j3\cdot j2}{j10} = \frac{5+6}{j10} = -j1{,}1\,A$$

$$K_2: \quad \underline{U}_S = jX_{L2}\,\underline{I}_S + jX_{L12}\,\underline{I}_E = j5\cdot j2 + j3\cdot(-j1{,}1) = -10+3{,}3 = -6{,}7\,V$$

$$\underline{S}_E = \underline{E}\,\underline{I}_E^{\,*} = 5\cdot j1{,}1 = j5{,}5\,VA$$

$$\boxed{P_E = \mathrm{Re}\{\underline{S}_E\} = 0\,W}$$

$$\underline{S}_{IS} = \underline{U}_S\,\underline{I}_S^{\,*} = -6{,}7\cdot(-j2) = j13{,}4\,VA$$

$$\boxed{Q_{IS} = \mathrm{Im}\{\underline{S}_{IS}\} = 13{,}4\,VAr}$$

b)

$$\boxed{I_A = 0\,A}$$

$$\boxed{U_V = 0\,V}$$

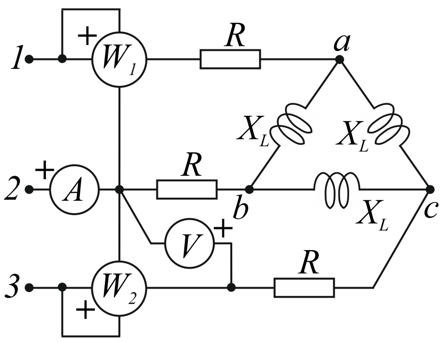
c)

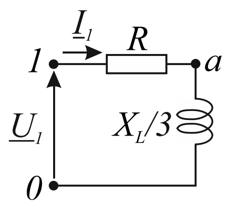
$$\underline{I}_{L3} = \underline{I}_E + \underline{I}_S = -j1{,}1 + j2 = j0{,}9\,A = 0{,}9\,e^{j90^\circ}\,A$$

$$\boxed{i_{L3}(t) = 0{,}9\cdot\sqrt{2}\cos(\omega t + 90^\circ)\,A}$$

II-2

a)





$$\underline{Z} = R + jX_L / 3 = (30 + j60)\,\Omega = 67{,}1\, e^{j63{,}43^\circ}\,\Omega$$

$$\underline{I}_1 = \frac{\underline{U}_1}{\underline{Z}} = \frac{230\, e^{j0^\circ}}{67{,}1\, e^{j63{,}43^\circ}} = 3{,}43\, e^{-j63{,}43^\circ}\ A$$

$$\underline{I}_2 = \underline{I}_1\, e^{-j120^\circ} = 3{,}43\, e^{-j183{,}43^\circ}\ A$$

$$\underline{I}_3 = \underline{I}_1\, e^{-j240^\circ} = 3{,}43\, e^{-j303{,}43^\circ}\ A$$

$$\boxed{I_A = \left|\underline{I}_2\right| = 3{,}43\ A}$$

$$\boxed{U_V = \left|U_{32}\right| = \sqrt{3}\left|\underline{U}_1\right| = \sqrt{3}\cdot 230 = 398{,}37\,V}$$

$$P_{W1} = \mathrm{Re}\left\{\underline{U}_{12}\,\underline{I}_1^{\,*}\right\} = U_{12}\, I_1 \cos\sphericalangle\left(\underline{U}_{12}, \underline{I}_1\right) = \sqrt{3} U_1\, I_1 \cos\left(30^\circ + 63{,}43^\circ\right)$$

$$P_{W1} = \sqrt{3}\cdot 230 \cdot 3{,}43 \cdot \cos 93{,}43^\circ$$

$$\boxed{P_{W1} = -81{,}75\,W}$$

$$P_{W2} = \mathrm{Re}\left\{\underline{U}_{32}\,\underline{I}_3^{\,*}\right\} = U_{32}\, I_3 \cos\sphericalangle\left(\underline{U}_{32}, \underline{I}_3\right) = \sqrt{3} U_1\, I_1 \cos\left(63{,}43^\circ - 30^\circ\right)$$

$$P_{W2} = \sqrt{3}\cdot 230 \cdot 3{,}43 \cdot \cos 33{,}43^\circ$$

$$\boxed{P_{W2} = 1140{,}35\,W}$$

b)