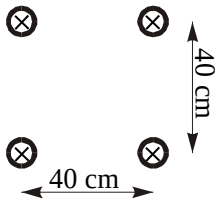
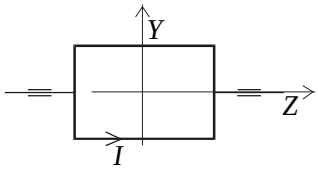
OSNOVE ELEKTROTEHNIKE II (UNI)
izpit, 18. april 2000

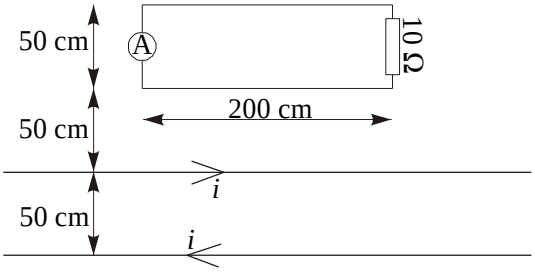
1. Snop štirih vzporednih tokovodnikov vodi tok 2000 A. Izracunajte magnetno silo na enega od njih na dolžini 50 metrov!



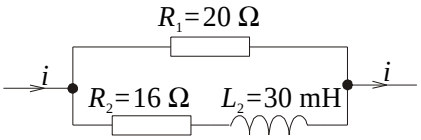
2. Pravokotna tokovna zankica leži v (*Y*-*Z*) ravnini in je vrtljiva okrog osi *Z*. Za kolikšen kot se bo (iz narisane lege) zavrtela okrog osi *Z*, ko jo bomo izpostavili magnetnemu polju gostote $\mathbf{B}/\mathrm{mT} = 30\mathbf{e}_x - 40\mathbf{e}_y$?



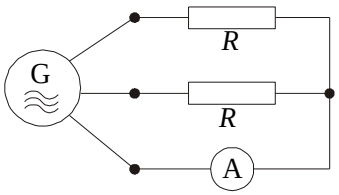
3. Ob dvovodu s harmonicnim tokom $i(t)/\mathrm{A} = 20\sin(100\pi\mathrm{s}^{-1}t)$ se nahaja pravokotna prevodna zanka z dodatnim uporom upornosti $R = 10\,\Omega$. Kolikšno efektivno vrednost induciranega toka meri idealen ampermeter, ce zanemarimo upornost zanke in pojav samoindukcije?



4. Dolocite delovno moc P_1 na R_1, P_2 na R_2 in jalovo moc Q_2 na L_2, ce vzbujamo vezje s harmonicnim tokom $i(t)/\mathrm{A} = 20\sin(400\mathrm{s}^{-1}t)$!



5. Trifazni sinhronski generator $3\times 400\,\mathrm{V_{ef.}}$ obremenimo z dvema enakima uporoma upornosti $R = 50\,\Omega$. Kolikšen efektivni tok meri ampermeter?



OSNOVE ELEKTROTEHNIKE II (UNI)
Izpit, 18. 4. 2000, Rešitve

1. Koordinatni sistem izberemo npr. tako, da os X kaže v desno, os Y navzgor in os Z iz lista papirja:

$$\vec{F}_{\text{na spodnjega desnega}} = -\frac{I}{4} l \vec{e}_z \times \vec{B}$$

$$\vec{B} = -\vec{e}_y \frac{\mu_0 I/4}{2\pi(40\text{ cm})} - \vec{e}_x \frac{\mu_0 I/4}{2\pi(40\text{ cm})} + \frac{\mu_0 I/4}{2\pi\sqrt{2}(40\text{ cm})} \left(-\vec{e}_x \frac{1}{\sqrt{2}} - \vec{e}_y \frac{1}{\sqrt{2}}\right)$$

$$\vec{B} = \frac{\mu_0 I/4}{2\pi(40\text{ cm})} \frac{3}{2} \left(-\vec{e}_x - \vec{e}_y\right)$$

$$\vec{F}_{\text{na spodnjega desnega}} = \left(-\vec{e}_x + \vec{e}_y\right) \frac{\mu_0 (I/4)^2}{2\pi(40\text{ cm})} \frac{3}{2} l \doteq 9.38\text{ N} \left(-\vec{e}_x + \vec{e}_y\right) \ , \ F \doteq 13.3\text{ N}$$

2.

$$\vec{S}_0 = S(-\vec{e}_x) \ , \ \vec{S}_1 \| \vec{B} \ , \ \vec{S}_1 = S\left(\frac{3\vec{e}_x - 4\vec{e}_y}{\sqrt{9+16}}\right) = S\left(\frac{3}{5}\vec{e}_x - \frac{4}{5}\vec{e}_y\right)$$

$$\cos\varphi = \frac{\vec{S}_0 \cdot \vec{S}_1}{S^2} = -\frac{3}{5} \implies \varphi \doteq 127^\circ$$

3.

$$\phi = \frac{\mu_0 i(2\text{ m})}{2\pi}\left(\ln\frac{1}{0.5} - \ln\frac{1.5}{1}\right) = \frac{\mu_0 i(2\text{ m})}{2\pi}\ln\frac{1}{0.75}$$

$$U_{\text{ind. ef}} = \frac{1}{\sqrt{2}}\frac{\mu_0(2\text{ m})}{2\pi}\ln\frac{1}{0.75}(20\text{ A})(100\pi\text{ s}^{-1}) \doteq 511\ \mu\text{V} \ , \ I_{\text{A}} = \frac{U_{\text{ind. ef}}}{10\ \Omega} \doteq 51.1\ \mu\text{A}$$

4.

$$i(t) = 20\cos\left(\omega t - \frac{\pi}{2}\right)\text{ A} \implies \underline{I} = -20\text{j}$$

$$\underline{I}_1 + \underline{I}_2 = \underline{I} \ , \ R_1\underline{I}_1 = (R_2 + \text{j}\omega L_2)\underline{I}_2 \implies \underline{I}_1 = \frac{R_2 + \text{j}\omega L_2}{R_1 + R_2 + \text{j}\omega L_2}\underline{I} \ , \ \underline{I}_2 = \frac{R_1}{R_1 + R_2 + \text{j}\omega L_2}\underline{I}$$

$$\underline{I}_1 = \frac{16 + \text{j}12}{36 + \text{j}12}\underline{I} \ , \ \underline{I}_2 = \frac{20}{36 + \text{j}12}\underline{I} \implies I_1 \doteq 10.54\text{ A} \ , \ I_2 \doteq 10.54\text{ A}$$

$$P_1 = \mathcal{R}e\left\{\frac{1}{2}R_1 I_1^2\right\} \doteq 1.11\text{ kW} \ , \ P_2 = \mathcal{R}e\left\{\frac{1}{2}R_2 I_2^2\right\} \doteq 889\text{ W}$$

$$Q_2 = \mathcal{I}m\left\{\frac{1}{2}\text{j}\omega L_2 I_2^2\right\} \doteq 667\text{ VAr}$$

5. $\underline{V}_{\text{zvezd.}} = \underline{U}_C \ , \ \underline{I}_C = -(\underline{I}_A + \underline{I}_B) = -\left(\frac{\underline{U}_{AC}}{R} + \frac{\underline{U}_{BC}}{R}\right)$

$$\underline{U}_B = \underline{U}_A \text{e}^{-\text{j}120^\circ} = \underline{U}_A\left(-\frac{1}{2} - \text{j}\frac{\sqrt{3}}{2}\right) \ , \ \underline{U}_C = \underline{U}_A \text{e}^{+\text{j}120^\circ} = \underline{U}_A\left(-\frac{1}{2} + \text{j}\frac{\sqrt{3}}{2}\right)$$

$$\underline{U}_{AC} + \underline{U}_{BC} = \underline{U}_A - \underline{U}_C + \underline{U}_B - \underline{U}_C = \underline{U}_A\left(1 - \frac{1}{2} - \text{j}\frac{\sqrt{3}}{2} + 1 - \text{j}\sqrt{3}\right) = 3\underline{U}_A\left(\frac{1}{2} - \text{j}\frac{\sqrt{3}}{2}\right)$$

$$I_{\text{Amp.}} = I_{c,\text{ ef}} = \frac{3U_{A,\text{ ef}}}{R} = 3\frac{(400\text{ V})/\sqrt{3}}{50\ \Omega} \doteq 13.9\text{ A}$$