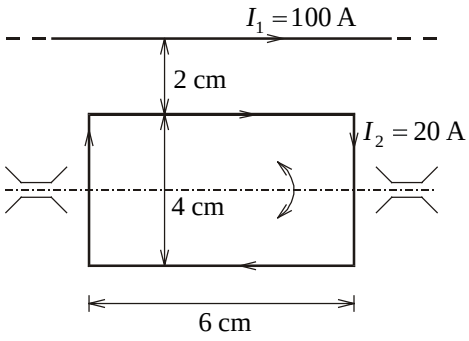
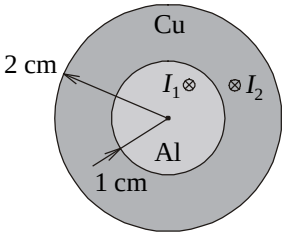
OSNOVE ELEKTROTEHNIKE II (UNI)
izpit, 28. 06. 1999

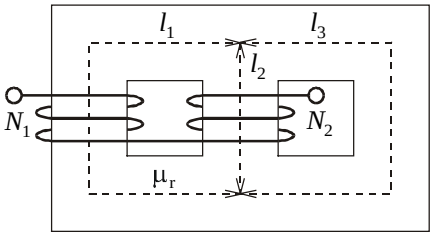
1. Pravokotna tokovna zanka je prosto vrtljiva okrog svoje osi. Izračunajte absolutno vrednost navora magnetnih sil na zanko, ko jo zavrtimo v lego, ki je pravokotna na narisano!



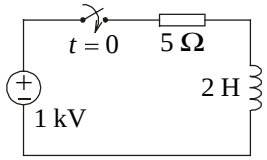
2. Bakrena cev in aluminijast stržen oblikujeta tokovodnik, ki vodi enosmerni tok $I_1 + I_2 = 100$ A. Specifična prevodnost bakra je za 60% večja od specifične prevodnosti aluminija. Izračunajte gostoto magnetnega pretoka na meji stika materialov!



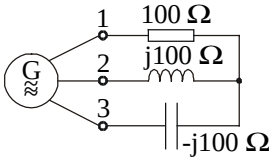
3. Izpeljite izraz za induktivnost tuljave z dvodelnim navitjem ($N_1 = N_2 = 150$) na linearnem tristebrnem feromagnetnem jedru z relativno permeabilnostjo $\mu_r = 8000$ in enotnim presekom $S = 10\,\text{cm}^2$ ter s srednjimi dolžinami magnetnih poti $l_1 = l_3 = 30$ cm in $l_2 = 10$ cm!



4. Koliko procentov končne magnetne energije se akumulira v magnetnem polju tuljave v času dveh časovnih konstant po vklopu stikala?



5. Trifazni napetostni generator $3\times 400/230\ \text{V}_{\text{ef}}$ napaja nesimetrično trifazno breme. Določite delovno moč, ki se sprošča na uporu!



OSNOVE ELEKTROTEHNIKE II (UNI)
Izpit, 28. 06. 1999, Rešitve

1.

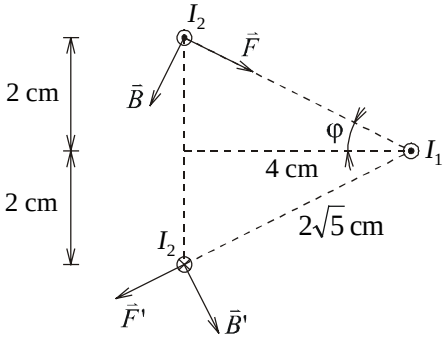
$$M = 2 \cdot F \cdot (2\,\text{cm}) \cdot \sin(90^\circ - \varphi) \quad , \quad F = I_2 \cdot (6\,\text{cm}) \cdot B$$

$$B = \frac{\mu_0 I_1}{2\pi(2\sqrt{5}\,\text{cm})} \quad , \quad \sin(90^\circ - \varphi) = \cos\varphi = \frac{4\,\text{cm}}{2\sqrt{5}\,\text{cm}}$$

$$M = 2\frac{\mu_0 I_1 I_2 (6\,\text{cm})}{2\pi(2\sqrt{5}\,\text{cm})}(2\,\text{cm})\frac{4\,\text{cm}}{2\sqrt{5}\,\text{cm}}$$

$$M = \frac{\mu_0 (100\,\text{A})(20\,\text{A})(6\,\text{cm})(2\,\text{cm})(4\,\text{cm})}{\pi(4 \cdot 5\,\text{cm}^2)}$$

$$M = 19.2 \cdot 10^{-6}\ \text{Nm}$$



2.

$$B = \frac{\mu_0 I_1}{2\pi(1\,\text{cm})} \quad , \quad I_1 R_1 = I_2 R_2 \quad \Rightarrow \quad I_1 \frac{\rho_{Al} l}{S_{Al}} = I_2 \frac{\rho_{Cu} l}{S_{Cu}} \quad \Rightarrow \quad I_1 = I_2 \frac{\rho_{Cu}}{\rho_{Al}} \frac{S_{Al}}{S_{Cu}}$$

$$S_{Al} = \pi(1\,\text{cm})^2 \quad , \quad S_{Cu} = \pi\left((2\,\text{cm})^2 - (1\,\text{cm})^2\right) = \pi \cdot 3\,\text{cm}^2 \quad , \quad I_1 = I_2 \cdot \frac{1}{1.6} \cdot \frac{1}{3} \cong 0.208 I_2$$

$$I_2 = 100\,\text{A} - I_1 \quad , \quad I_1 = 0.208 \cdot (100\,\text{A} - I_1) \quad \Rightarrow \quad I_1 \cong 17.2\,\text{A} \quad , \quad B \cong 3.45 \cdot 10^{-4}\,\text{T}$$

3.

$$L = \psi / i \quad , \quad \psi = N_1\phi_1 + N_2\phi_2$$

$$\phi_1 = B_1 S = \mu_0\mu_r H_1 S \quad , \quad \phi_2 = B_2 S = \mu_0\mu_r H_2 S$$

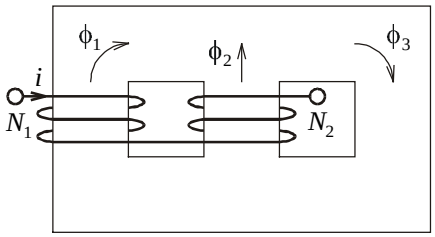
$$L = \mu_0\mu_r S(N_1 H_1 + N_2 H_2)/i \quad , \quad H_1 l_1 - H_2 l_2 = N_1 i - N_2 i$$

$$H_2 l_2 + H_3 l_3 = N_2 i \quad , \quad B_1 + B_2 = B_3 \,\big|\, :\mu_0\mu_r$$

$$(30\,\text{cm})H_1 - (10\,\text{cm})H_2 = 150i - 150i = 0 \quad \Rightarrow \quad H_2 = 3H_1$$

$$H_1 + H_2 = H_3 \quad \Rightarrow \quad H_3 = 4H_1$$

$$(10\,\text{cm}) \cdot 3H_1 + (30\,\text{cm}) \cdot 4H_1 = 150i \quad \Rightarrow \quad H_1 = (100\,\text{m}^{-1})i \quad , \quad H_2 = (300\,\text{m}^{-1})i \quad , \quad L \cong 0.6\,\text{H}$$



4. Tok skozi tuljavo označimo z i; $i(t \le 0) = 0$.

$$t > 0: \ (5\,\Omega)i + (2\,\text{H})\frac{\text{d}i}{\text{d}t} = 1\,\text{kV} \quad \Rightarrow \quad \frac{\text{d}i}{\text{d}t} = 500\,\text{A/s} - (2.5\,\text{s}^{-1})i = (-2.5\,\text{s}^{-1}) \cdot (i - 200\,\text{A}) \quad \Rightarrow$$

$$\frac{\text{d}i}{(i - 200\,\text{A})} = (-2.5\,\text{s}^{-1}) \cdot \text{d}t \quad \Rightarrow \quad \int_0^{i(t)} \frac{\text{d}i}{(i - 200\,\text{A})} = \int_0^t (-2.5\,\text{s}^{-1}) \cdot \text{d}t \quad \Rightarrow$$

$$\ln\frac{i(t) - 200\,\text{A}}{-200\,\text{A}} = (-2.5\,\text{s}^{-1})t = \frac{-t}{0.4\,\text{s}} \quad \Rightarrow \quad i(t) = (200\,\text{A}) \cdot \left(1 - \text{e}^{-t/(0.4\,\text{s})}\right) \quad , \quad \tau = 0.4\,\text{s}$$

$$i(2\tau) \cong 173\,\text{A} \quad , \quad i(t >> \tau) = 200\,\text{A}$$

$$W_\text{m}(t) = \frac{1}{2} L \cdot i^2(\text{t}) \quad , \quad W_\text{m}(2\tau) \cong 29.9\,\text{kJ} \quad , \quad W_\text{m}(t >> \tau) \cong 40\,\text{kJ} \quad , \quad \frac{W_\text{m}(2\tau)}{W_\text{m}(t >> \tau)} \cong 0.748 = 74.8\,\%$$

5.

$$\underline{V}_\text{zvezd.} = \frac{\dfrac{\underline{U}_1}{100\,\Omega} + \dfrac{\underline{U}_1 \text{e}^{-\text{j}120^\circ}}{\text{j}100\,\Omega} + \dfrac{\underline{U}_1 \text{e}^{\text{j}120^\circ}}{-\text{j}100\,\Omega}}{\dfrac{1}{100\,\Omega} + \dfrac{1}{\text{j}100\,\Omega} + \dfrac{1}{-\text{j}100\,\Omega}} = \underline{U}_1(1 + \text{e}^{-\text{j}210^\circ} + \text{e}^{\text{j}210^\circ}) = \underline{U}_1(1 - \sqrt{3})$$

$$P = \frac{\left|\underline{U}_1 - \underline{V}_\text{zvezd.}\right|^2}{100\,\Omega} = \frac{(\sqrt{3}U_1)^2}{100\,\Omega} = \frac{(400\,\text{V}_\text{ef})^2}{100\,\Omega} = 1600\,\text{W}$$