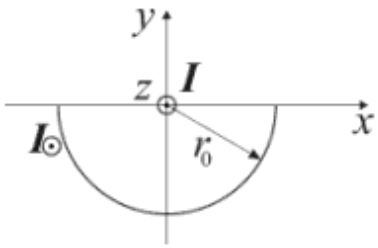
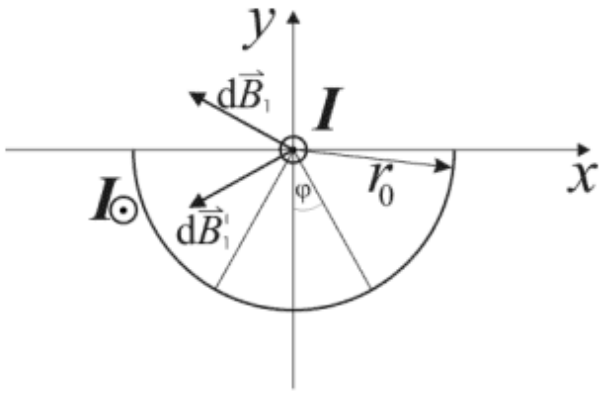
1. Določite silo na enoto dolžine na premi vodnik, ki leži v osi žleba! Tako žleb kot premi vodnik vodita tok I v smeri osi z.



Izračunamo gostoto magnetnega pretoka v osi žleba, ki jo povzroča tok v žlebu in nato silo s katero le-ta deluje na premi vodnik.



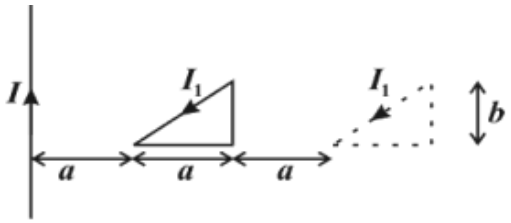
$$d\vec{B} = -\vec{e}_x 2 d\vec{B}_1 \cos\varphi, \quad dI = \frac{I}{\pi} d\varphi$$

$$\vec{B} = -\vec{e}_x \int_0^{\pi/2} 2 \frac{\mu_0 I}{2\pi^2 r_0} \cos\varphi \, d\varphi = -\vec{e}_x \frac{\mu_0 I}{\pi^2 r_0}$$

$$d\vec{F} = I d\vec{l} \times \vec{B} = I dl \vec{e}_z \times (-\vec{e}_x) B$$

$$d\vec{F} / dl = I\vec{e}_z \times (-\vec{e}_x) B = -\vec{e}_y \frac{\mu_0 I^2}{\pi^2 r_o}$$

2. Koliko dela opravi magnetna sila pri premiku trikotne zanke s tokom I_1 v črtkano lego? Dolg premi vodnik vodi tok I.



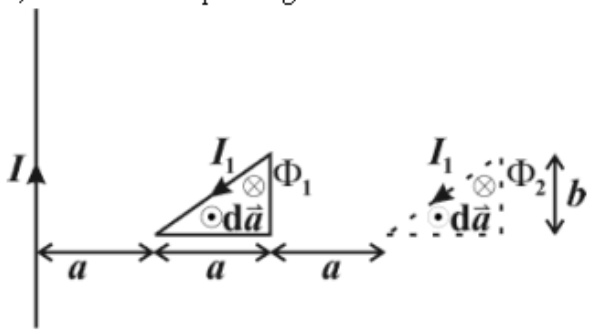
Pretok skozi zanko se z oddaljevanjem od premega vodnika spreminja le zaradi toka I. Označimo z ϕ_1 magnetni pretok skozi zanko v legi A in z ϕ_2 pretok skozi zanko v legi B, zaradi toka I premega vodnika.

$$\Phi_1 = \int \vec{B}\mathrm{d}\vec{a} = -\int_a^{2a} \frac{\mu_0 I}{2\pi r}\frac{b}{a}(r-a)\mathrm{d}r = -\frac{\mu_0 I}{2\pi}(b - b\ln 2)$$

$$\Phi_2 = \int \vec{B}\mathrm{d}\vec{a} = -\int_{3a}^{4a} \frac{\mu_0 I}{2\pi r}\frac{b}{a}(r-3a)\mathrm{d}r = -\frac{\mu_0 I}{2\pi}\left(b - 3b\ln\frac{4}{3}\right)$$

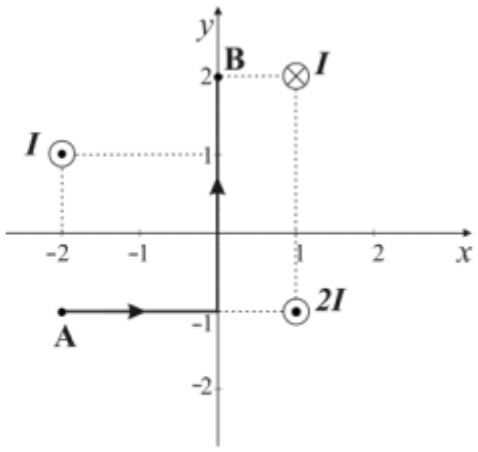
$$A = I_1(\Phi_2 - \Phi_1) = I_1\left[-\frac{\mu_0 I}{2\pi}\left(b - 3b\ln\frac{4}{3}\right) + \frac{\mu_0 I}{2\pi}(b - b\ln 2)\right] =$$

$$= \frac{\mu_0 I_1 I}{2\pi} b\left(3\ln\frac{4}{3} - \ln 2\right)$$



(minus pri ϕ_1 in ϕ_2 je zaradi neujemanja smeri ploskvice in pretoka)

3. Kolikšna je magnetna napetost vzdolž krivulje L, med točkama A in B? ($I = 1$ A)



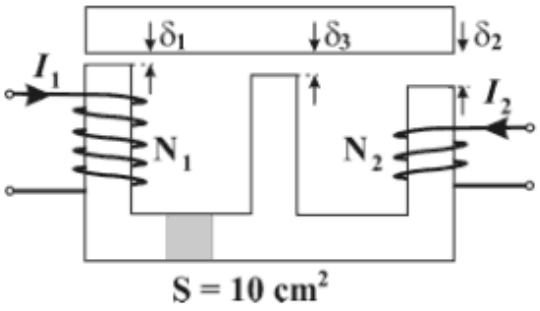
$$\Theta_{AB} = \int_A^B \vec{H} \mathrm{d}\vec{l} = \frac{I}{2\pi}\left(\frac{\pi}{2} + arctg\,\frac{1}{2}\right) + \frac{I}{2\pi}\,\frac{\pi}{4} - \frac{2I}{2\pi}\,arctg 3 = 0{,}05\ \mathrm{A}$$

4. Ravnina $z = 0$ je meja med magnetnima snovema. V prostoru z < 0 s permeabilnostjo $\mu = 10\mu_0$ je gostota magnetnega pretoka $\vec{B} = -\vec{e}_x 200\mu_0 + \vec{e}_y 750\mu_0 + \vec{e}_z 100\mu_0$ T. V prostoru z > 0 je permeabilnost $\mu = 5\mu_0$. Na meji je tokovna obloga $\vec{K} = \vec{e}_x 250$ A/m. Kolikšna je gostota magnetnega pretoka $\vec{B}$ v prostoru z > 0?

$$\vec{n} \times (\vec{H}_1 - \vec{H}_2) = \vec{K};\ \ \vec{H}_1 = \frac{\vec{B}_1}{\mu};\ \ (0,0,-1) \times (-20 - H_{2x},\ 75 - H_{2y},\ 10 - H_{2z}) = (250,0,0)$$

Primerjamo ustrezne koeficiente in dobimo: $H_{2y} = -175$ A/m $H_{2x} = -20$ A/m, vemo tudi, da se normalna komponenta $\vec{B}$ pri prehodu skozi mej ohranja.
$\vec{B}_2 = \mu \vec{H}_2$. Dobimo: $\vec{B}_2 = -\vec{e}_x 100\mu_0 - \vec{e}_y 875\mu_0 + \vec{e}_z 100\mu_0$ T

5. Kolikšne so gostote magnetnih pretokov v posameznih režah v primeru, ko smemo magnetne upornosti železa zanemariti? ($I_1 = 2$ A, $I_2 = 1$ A, $N_1 = 200$, $N_2 = 100$, $\delta_1 = 1$ mm, $\delta_3 = 2$ mm, $\delta_2 = 3$ mm)



$$\Phi_3 = \Phi_2 - \Phi_1; \quad R_{\delta 1} = \frac{\delta_1}{\mu_0 S}; \; R_{\delta 3} = 2R_{\delta 1}; \quad R_{\delta 2} = 3R_{\delta 1}$$

$$I_1N_1 = R_{\delta 1}\Phi_1 - R_{\delta 3}\Phi_3 \Rightarrow I_1N_1 = R_{\delta 1}\Phi_1 - 2R_{\delta 1}(\Phi_2 - \Phi_1)$$

$$\underline{I_1N_1 + I_2N_2 = R_{\delta 1}\Phi_1 + R_{\delta 2}\Phi_2 \Rightarrow} \underline{I_1N_1 + I_2N_2 = R_{\delta 1}\Phi_1 + 3R_{\delta 1}\Phi_2}$$

$$\Phi_1 = \frac{15I_1N_1 + 6I_2N_2}{33R_{\delta 1}}; \quad \Phi_2 = \frac{6I_1N_1 + 9I_2N_2}{33R_{\delta 1}};$$

$$\Phi_3 = \frac{-9I_1N_1 + 3I_2N_2}{33R_{\delta 1}};$$

$$B_{\delta 1} = \frac{\Phi_1}{S}; \qquad B_{\delta 2} = \frac{\Phi_2}{S}; \qquad B_{\delta 3} = \frac{\Phi_3}{S}$$