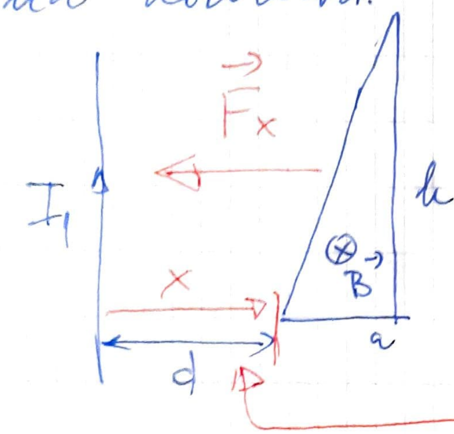
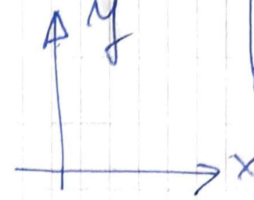
Kontura u obliku pravouglog trougla kateta a i b sa strujom I_2 i beskonačni provodnik sa strujom I_1 nalaze se u jednoj ravni i zauzimaju međusobni položaj kao na slici. Odrediti EM silu koja djeluje na konturu.





$$\boxed{F_x = I\frac{d\phi}{dx}}$$

$$\boxed{F_y = I\frac{d\phi}{dy}}$$

sila po generalizanoj koordinati (sila u pravcu x)

$$F_x = \frac{I_2 d\phi_1}{dx}$$

stavimo da je promjenljiva x!

$$\phi_1 = \frac{\mu_0 I_1 b}{2\pi a}\left(a - x\ln\frac{a+x}{x}\right)$$

$$F_y = I_2\frac{d\phi}{dy} = 0$$ EM sila ne djeluje u pravcu y-ose

$$F_x = I_2\frac{d\phi}{dx} = I_2\frac{d}{dx}\left[\frac{\mu_0 I_1 b}{2\pi}\left(1 - \frac{x}{a}\ln\frac{a+x}{x}\right)\right]$$

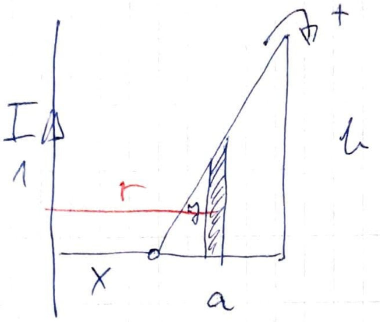
$$\left(-\frac{x}{a}\ln\frac{a+x}{x}\right)' = -\left(\frac{1}{a}\ln\frac{a+x}{x} + \frac{x}{a}\left(\frac{x}{a+x}\cdot\frac{1\cdot x - a + x}{x^2}\right)\right)$$

$$= -\left(\frac{1}{a}\ln\frac{a+x}{x} - \frac{1}{x+a}\right)$$

$$F_x = -\frac{\mu_0 I_1 I_2 b}{2\pi}\left(\frac{1}{a}\ln\frac{a+x}{x} - \frac{1}{x+a}\right) < 0$$

za $x = d \Rightarrow F_x < 0$ sila ne djeluje u pravcu povećanja koordinate

4.10. Dugi pravolinijski provodnik sa strujom I_1 i kontura u obliku pravouglog trougla zauzimaju međusobni položaj kao na slici. Izračunati fluks kroz konturu u odnosu na usvojeni pozitivni smjer obilaženja



$$d\Phi = \vec{B} \cdot d\vec{S}$$

$$B = \frac{\mu_0 I}{2 r \pi}$$

$$d\Phi = \frac{\mu_0 I}{2\pi r} y \, dr$$

$$y : r - x = b : a$$

$$\frac{y}{r-x} = \frac{b}{a}$$

$$y = \frac{b(r - x)}{a}$$

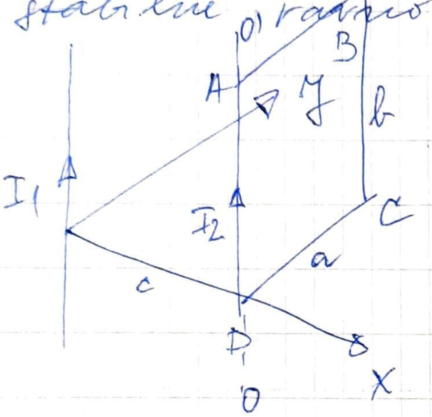
$$d\Phi = \frac{\mu_0 I}{2\pi r} \frac{b}{a} (r - x) \, dr$$

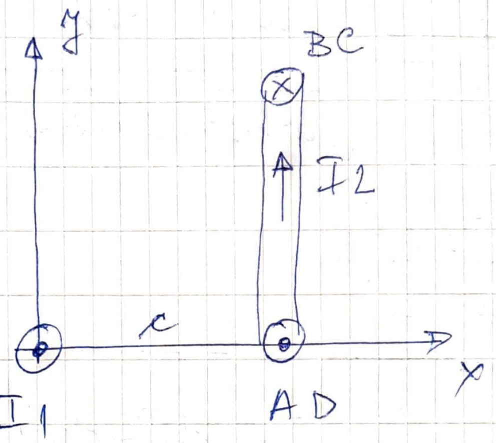
$$\Phi = \int d\Phi = \frac{\mu_0 I b}{2\pi a} \int_x^{a+x} \frac{r - x}{r} \, dr = \frac{\mu_0 I b}{2\pi a} \left(a - x \ln \frac{a+x}{x} \right)$$

Dug pravolinijski provodnik sa strujom I_1 i pravougaono kolo sa strujom I_2 zauzimaju položaj kao na slici. Poznate su dimenzije a i b i rastojanje c. Pravougaono kolo može da se obrće oko ose OO' koja prolazi kroz stranicu AD

a) Odrediti moment EM sila na konturu

b) Rad EM sila pri okretanju kola do položaja stabilne ravnoteže

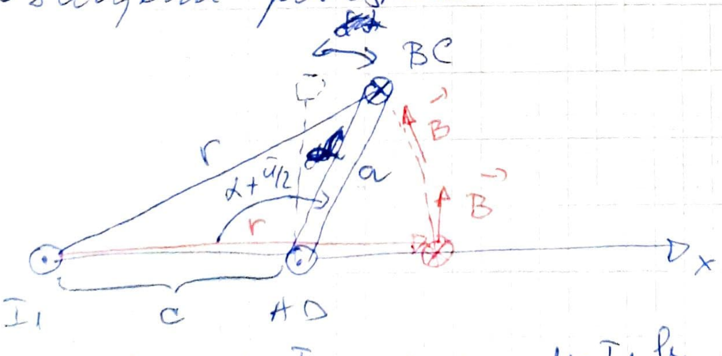


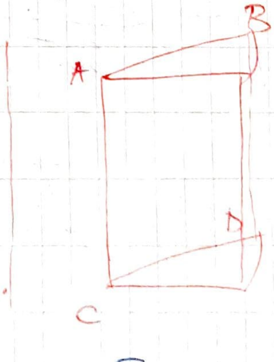


$$M = I_2 \frac{d\Phi}{d\alpha}$$

Da bi našli fluks kao f-ju ugla α pretpostavimo da se kontura okrenula za neki mali ugao $d\alpha$.

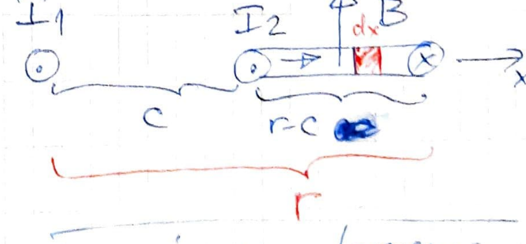
Fluks vektora $\vec{B}$ kroz površinu jednak je fluksu kroz oslonjenu površinu





$$d\Phi = \vec{B}_1 d\vec{s}$$

$$d\Phi = B_1 ds$$



$$d\Phi_1 = \frac{\mu_0 I_1}{2\pi x} b\, dx = \frac{\mu_0 I_1 b}{2\pi} \frac{dx}{x}$$

$$\Phi_1 = \int d\Phi_1 = \frac{\mu_0 I_1 b}{2\pi} \int_c^r \frac{dx}{x}$$

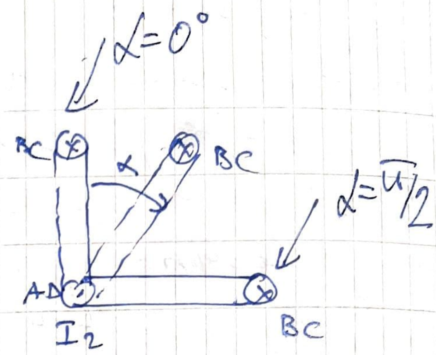
$$\Phi_1 = \frac{\mu_0 I_1 b}{2\pi} \ln\frac{r}{c} = \frac{\mu_0 I_1 b}{2\pi} \ln \frac{\sqrt{a^2+c^2+2ac\sin\alpha}}{c}$$

Kosinusna teorema

$$r = \sqrt{c^2+a^2-2ac\cos(\pi/2+\alpha)}$$

$$r = \sqrt{c^2+a^2+2ac\sin\alpha}$$

$$\Phi_1 = \frac{\mu_0 I_1 b}{2\pi} \ln \frac{\sqrt{a^2+c^2+2ac\sin\alpha}}{c}$$



$$M = I_2 \frac{d\Phi_1}{d\alpha}\Bigg|_{\alpha=0^\circ}$$

①
I_1

$$M = \frac{\mu_0 I_1 I_2 b}{2\pi} \frac{a c \cos\alpha}{\left(\sqrt{a^2+c^2+2ac\sin\alpha}\right)^2}\Bigg|_{\alpha=0^\circ}$$

$$M = \frac{\mu_0 I_1 I_2 abc}{2\pi(a^2+c^2)}$$

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b) $A = I_2 \Delta\Phi = I_2(\Phi'' - \Phi')$

$$\Phi' = \Phi_1\Big|_{\alpha=0^\circ} = \frac{\mu_0 I_1 b}{2\pi} \ln \frac{\sqrt{a^2+c^2}}{c}$$

$$\Phi'' = \Phi_1\Big|_{\alpha=\pi/2} = \frac{\mu_0 I_1 b}{2\pi} \ln \frac{a+c}{c}$$ položaj max fluksa

$$A = I_2(\Phi'' - \Phi') = \boxed{\frac{\mu_0 I_1 I_2 b}{2\pi} \ln \frac{a+c}{\sqrt{a^2+c^2}}}$$