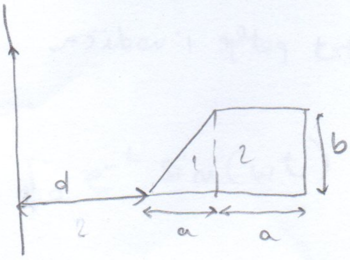
VOD(C)

Petje
1.3.

pr. 3.36



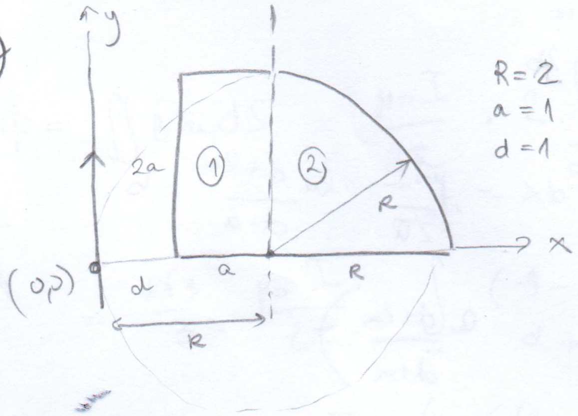
$$dS_1 = \int_d^{d+a} (x-2)\,dx \quad \rightarrow \text{jedn. pravca}$$

$$dS_2 = \int_{d+a}^{d+2a} dx$$

$$\phi = \phi_1 + \phi_2$$

$$\phi_1 = \frac{\mu_0 I}{2\pi}\left(\int_d^{d+a} \frac{x-2}{x}\,dx + \int_{d+a}^{d+2a} \frac{dx}{x} \right)$$

ZI 14/15



$R = 2$
$a = 1$
$d = 1$

$$dS_1 = y \cdot dx$$

$$dS_1 = \int_d^{a+d} 2a \cdot dx$$

$$dS_2 = y \cdot dx = \int_R^{2R} \sqrt{2Rx - x^2}\,dx$$

• pomaknuta kružnica

$$(x-R)^2 + y^2 = R^2$$

$$y = +\sqrt{R^2 - (x-R)^2} \quad \text{desna polovina}$$

$$y = \sqrt{2Rx - x^2}$$

$$\phi_1 = \iint \vec{B}\,\vec{n}\,dS = \int \frac{\mu_0 I}{2\pi x}\,dS_1 = \frac{\mu_0 I}{2\pi}\int_d^{d+a} \frac{2a}{x}\,dx$$

$$= \frac{\mu_0 I}{2\pi} \cdot 2a \cdot \ln\frac{d+a}{d} = \frac{\mu_0 I}{2\pi}\, 2\ln 2$$

$$\phi_2 = \int \frac{\mu_0 I}{2\pi x}\,dS_2 = \frac{\mu_0 I}{2\pi}\int_R^{2R} \frac{\sqrt{2Rx - x^2}}{x}\,dx = \frac{\mu_0 I}{2\pi}(\pi - 2)$$

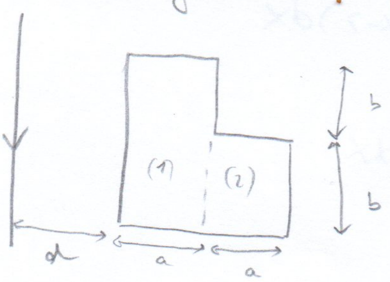
$$\phi = \phi_1 + \phi_2 = \frac{\mu_0 I}{2\pi}\left(2\ln 2 + \pi - 2\right) \qquad M = \frac{\phi}{I} = \frac{\mu_0}{2\pi}\left(2\ln 2 + \pi - 2\right)$$

$$\int_2^4 \frac{\sqrt{4x - x^2}}{x}\,dx = \left| \begin{matrix} x = t^2 \\ dx = 2t\,dt \\ t = \sqrt{x} \quad \sqrt{2}, 2 \end{matrix} \right| = \int_{\sqrt{2}}^{2} \frac{\sqrt{4t^2 - t^4}}{t^2}\, 2\cancel{t}\,dt = 2\int_{\sqrt{2}}^{2} \sqrt{4 - t^2}\,dt \; \left| \begin{matrix} t = 2\sin h \\ dt = 2\cos h\,dh \\ h = \sin^{-1}\frac{t}{2} \quad \frac{\pi}{4}, \frac{\pi}{2} \end{matrix} \right.$$

$$= 2\int_{\sin^{-1}\frac{\sqrt{2}}{2}}^{\sin^{-1} 1} \sqrt{4 - 4\sin^2 h}\; 2\cos h\,dh = 8\int_{\frac{\pi}{4}}^{\frac{\pi}{2}} \cos^2 h\,dh = 8\left(\frac{h}{2} + \frac{1}{4}\sin 2h\right)\Bigg|_{\frac{\pi}{4}}^{\frac{\pi}{2}}$$

$$= 8\left(\frac{\pi}{4}\cdot\frac{1}{2} + \frac{1}{4}\left(\sin\pi - \sin\frac{\pi}{2}\right)\right) = 8\left(\frac{\pi}{8} - \frac{1}{4}\right) = \pi - 2$$

pr. 3.6. Odrediti mag. tok kroz petlju i međuinduktivitet petlje i vodiča



za ∞ strujnicu: $B = \dfrac{\mu_0 I}{2\pi r}$

$$\phi = \iint \bar{B}\bar{n}\,dS \qquad dS = dx\,dy = \int_d^{d+a} 2b\,dx$$

$$\phi_1 = \iint_S \bar{B}\bar{n}\,dS = \frac{\mu_0 I}{2\pi}\int_d^{d+a} \frac{1}{x}\cdot 2b\,dx$$

$$= \frac{\mu_0 I}{2\pi}\ln\left(\frac{d+a}{d}\right)\cdot 2b$$

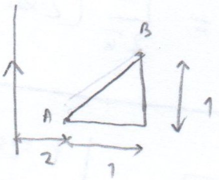
$$\phi_2 = \iint_S \bar{B}\bar{n}\,dS = \frac{\mu_0 I}{2\pi}\int_{d+a}^{d+2a} \frac{1}{x}\cdot b\,dx = \frac{\mu_0 I}{2\pi}\ln\frac{d+2a}{d+a}\cdot b$$

$$\phi = \phi_1 + \phi_2 = \frac{\mu_0 I}{2\pi}\left(2b\ln\frac{d+a}{d} + b\ln\frac{d+2a}{d+a}\right)$$

$$M = \frac{\phi}{I}\ [H] \qquad \phi\ [Tm^2]$$

$$M = \frac{\mu_0}{2\pi}\left(2b\ln\frac{d+a}{d} + b\ln\frac{d+2a}{d+a}\right).$$

pr. 3.34



A(2,0)
B(3,1)

$$dS = dx\,dy = \int_2^3 (x-2)\,dx$$

pravac:

$$y - 0 = \frac{1-0}{3-2}(x-2)$$

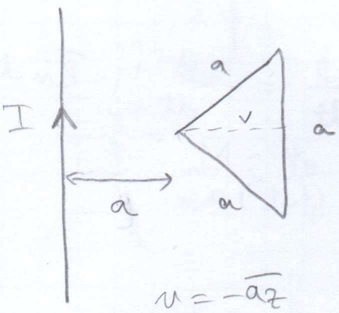
$$y = x - 2$$

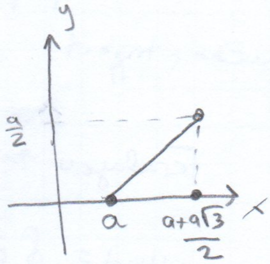
$$\phi = \iint \bar{B}\bar{n}\,dS = \frac{\mu_0 I}{2\pi}\int_2^3 \frac{1}{x}(x-2)\,dx = \frac{\mu_0 I}{2\pi}\left(1 - 2\ln\frac{3}{2}\right)$$

$$M = \frac{\phi}{I} = \frac{\mu_0}{2\pi}\left(1 - 2\ln\frac{3}{2}\right)$$

zI 16/17

3. $i(t) = I_0 e^{-t} \sin(\omega t)$





$A(a, 0)$

$B\left(a+\frac{a\sqrt{3}}{2}, \frac{a}{2}\right)$

$v = \frac{a\sqrt{3}}{2}$

$$y = \frac{\frac{\cancel{a}}{\cancel{2}}}{\cancel{a}+\frac{a\sqrt{3}}{\cancel{2}}-\cancel{a}}(x-a)$$

$$y = \frac{\sqrt{3}}{3}(x-a)$$

$$\phi = \iint \bar{B}\,\bar{n}\,dS = \frac{\mu_0 I}{2\pi} \cdot 2 \int_a^{a+\frac{a\sqrt{3}}{2}} \frac{\sqrt{3}}{3}(x-a) \cdot \frac{1}{x}\,dx$$

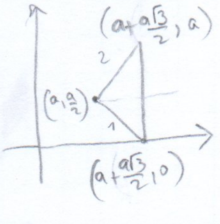
$$= \frac{2\sqrt{3}}{3} \frac{\mu_0 I}{2\pi} \int_a^{a+\frac{a\sqrt{3}}{2}} \left(1 - \frac{a}{x}\right) dx$$

$$= \frac{2\sqrt{3}}{3} \frac{\mu_0 I}{2\pi} \left(\cancel{a} + \frac{a\sqrt{3}}{2} - \cancel{a} - a \ln \frac{\cancel{a}+\frac{a\sqrt{3}}{2}}{\cancel{a}} \right)$$

$$\phi = \frac{2\sqrt{3}}{3} \frac{\mu_0 I}{2\pi} \left(\frac{a\sqrt{3}}{2} - a \ln\left(1 + \frac{\sqrt{3}}{2}\right)\right)$$

$$\phi = \frac{2\sqrt{3}}{3} \frac{\mu_0}{2\pi} a \left(\frac{\sqrt{3}}{2} - \ln\left(1+\frac{\sqrt{3}}{2}\right)\right) \cdot I_0 e^{-t} \sin(\omega t)$$

$$u_{ind} = -\frac{d\phi}{dt} = -\frac{2\sqrt{3}}{3} \frac{\mu_0}{2\pi} a \left(\frac{\sqrt{3}}{2} - \ln\left(1+\frac{\sqrt{3}}{2}\right)\right) I_0 \left[-e^{-t} \sin\omega t + e^{-t} \cdot \omega \cos\omega t \right]$$



1 $y_1 - 0 = \dfrac{\frac{a}{2}}{\cancel{a} - \cancel{a} - \frac{a\sqrt{3}}{2}}\left(x - a - \frac{a\sqrt{3}}{2}\right)$

$$y_1 = -\frac{\sqrt{3}}{3}\left(x - a - \frac{a\sqrt{3}}{2}\right)$$

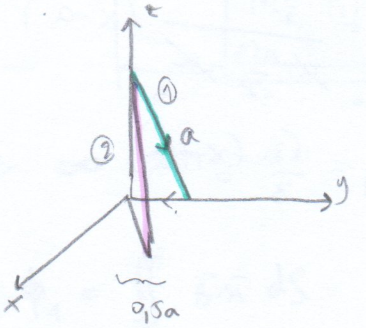
$$y_1 = -\frac{\sqrt{3}}{3} x + \frac{\sqrt{3}}{3} a + \frac{3a}{6}$$

$$y_1 = -\frac{\sqrt{3}}{3} x + \frac{2\sqrt{3}a + 3a}{6}$$

$$\phi = \bar{z}uj \int_{a}^{a+\frac{a\sqrt{3}}{2}} \frac{1}{x} \int_{y_1}^{y_2} dy$$

Zl 13/14 Kontura na slici se nalazi u polju $\bar{H} = H_0 \sin(\omega t)\,\bar{a}_x$

Kontura je jednakostraničan trokut. Odrediti ind. napon

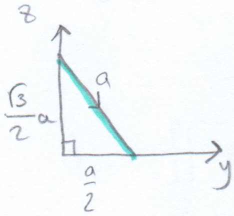


Faradayev zakon

$$U_{ind} = \oint_c \bar{E}\, d\bar{l} = -\frac{d\Phi}{dt} = -\frac{d}{dt}\iint_S \bar{B}\bar{n}\, dS$$

$$\bar{B} = \mu \bar{H} = \mu H_0 \sin(\omega t)\,\bar{a}_x$$

①



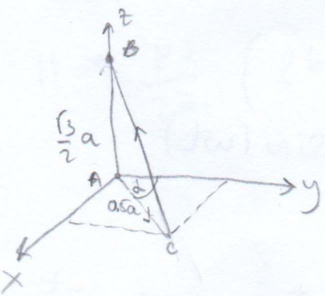
$$\sqrt{a^2 - \frac{a^2}{4}} = \frac{\sqrt{3}}{2}a$$

$$\bar{n} = -\bar{a}_x \qquad dS = dy\,dz = \frac{\frac{\sqrt{3}}{2}a\cdot\frac{a}{2}}{2} = \frac{\sqrt{3}}{8}a^2$$

$$\Phi_1 = \iint \bar{B}\bar{n}\, dS = \mu H_0 \sin(\omega t)\,\bar{a}_x\cdot(-\bar{a}_x)\cdot\frac{\sqrt{3}}{8}a^2$$

$$\Phi_1 = -\mu H_0 \sin\omega t\cdot\frac{\sqrt{3}}{8}a^2$$

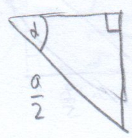
②



$A(0,0,0)$

$C(\frac{a}{2}\sin\alpha, \frac{a}{2}\cos\alpha, 0)$

$B(0,0,\frac{\sqrt{3}}{2}a)$

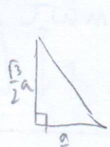


$\sin\alpha = \frac{x}{\frac{a}{2}} \qquad x = \frac{a}{2}\sin$

$\cos\alpha = \frac{y}{\frac{a}{2}} \qquad y = \frac{a}{2}\cos\alpha$

$$\begin{vmatrix} x & y & z \\ \frac{a}{2}\sin\alpha & \frac{a}{2}\cos\alpha & 0 \\ 0 & 0 & \frac{\sqrt{3}}{2}a \end{vmatrix} = x\left(\frac{\sqrt{3}}{2}a\cdot\frac{a}{2}\cos\alpha\right) - y\left(\frac{\sqrt{3}}{2}a\cdot\frac{a}{2}\sin\right.$$

$dS = dx\,dy$



$$dS = \frac{\frac{\sqrt{3}}{2}a\cdot\frac{a}{2}}{2} = \frac{\sqrt{3}}{8}a^2$$

$$x\left(\frac{\sqrt{3}}{2}\frac{a^2}{2}\cos\alpha\right) - y\left(\frac{\sqrt{3}}{2}\frac{a^2}{2}\sin\alpha\right) = 0 \quad / : \frac{\sqrt{3}}{2}\frac{a^2}{2}$$

$$x\cos\alpha + y\sin\alpha = 0$$

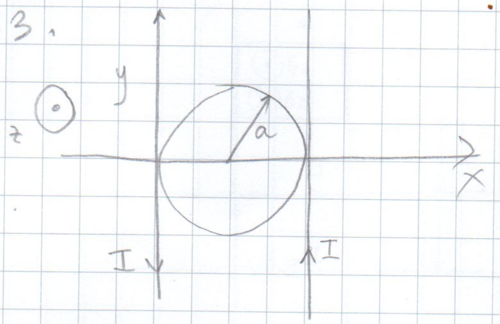
$$\bar{n} = \bar{a}_x\cos\alpha - \bar{a}_y\sin\alpha$$

$$\Phi_2 = \iint \bar{B}\bar{n}\, dS = \mu H_0 \sin\omega t\;\bar{a}_x\cdot(\bar{a}_x\cos\alpha + \bar{a}_y\sin\alpha)\cdot\frac{\sqrt{3}}{8}a^2$$

$$= \mu H_0 \sin\omega t\cdot\cos\alpha\cdot\frac{\sqrt{3}}{8}a^2$$

$$\Phi = \mu H_0 \sin\omega t\,\frac{\sqrt{3}}{8}a^2(\cos\alpha - 1) \qquad U_{ind} = -\frac{d\Phi}{dt} = -\frac{a^2\sqrt{3}}{8}\mu H_0 \cos\omega t\cdot\omega(\cos\alpha - 1$$

3.



I = 5A

d = 2a a = 1,5 cm

M = ?

$$M = \frac{\Psi_{12}}{I_2}$$

$$\Psi = \oint_{C_1} A_2 \, dl_1$$

$$M = \frac{\Psi_{12}}{I} = 2\frac{\phi_1}{I}$$

$$\phi = \iint_S B \, n \, dS \qquad B = \frac{\mu_0 I}{2\pi r} \bar{a_\phi} \qquad \bar{a_\phi} = \bar{a_z}$$

$n = \bar{a_z}$

$$\bar{B} \cdot \bar{n} = \frac{\mu_0 I}{2\pi x}$$

$$\phi = \int_{x=0}^{2a} \frac{\mu I}{2\pi \cdot x} \cdot 2 \cdot \sqrt{a^2 (x-a)^2} \, dx$$

$$(x-a)^2 + y^2 = a^2$$

=

$$y = \pm\sqrt{a^2 - (x-a)^2}$$

$$\phi = \frac{\mu I}{\pi} a \int_0^{2a} \frac{\sqrt{a^2 (x-a)^2}}{x} dx = \frac{\mu I}{\pi} \cdot a \int_0^{2a}$$

$$\underline{d = a} \qquad \ell = a \qquad \rightarrow (a) - \cancel{\sqrt{a^2 - a^2}}$$

$$0 - \sqrt{0 -}$$

$$\frac{\sqrt{x^2 - 2x}}{x} = \sqrt{1 - \frac{2}{x}}$$

$$\frac{\sqrt{R^2 - t^2}}{d - t} dt \qquad d - x = t$$

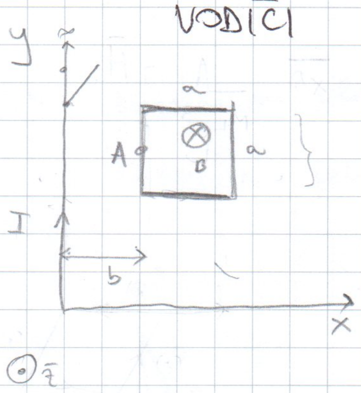
$x = d - t$

$dx = -dt$

20

3.

VODIČI



$R_{uk} = 1\,\Omega$

$a = 1\,m$

$b = 1\,m$

$I = 1\,A$

$Q_{uk} = ?$

$\bar{I} = I\bar{a}_y$

pr. 1.2.1

$$\bar{H} = \bar{a}_\phi \frac{I}{2\pi r}$$

Faraday : $e_{ind} = -\dfrac{d\Phi}{dt}$

$$\bar{H} = -\bar{a}_z \frac{I}{2\pi x}$$

$$dQ = i(t)\,dt$$

$$Q = \int i(t)\,dt = \int \frac{e_{ind}}{R}\,dt = -\frac{1}{R}\int \frac{d\Phi}{dt}\,dt = -\frac{\Phi}{R}$$

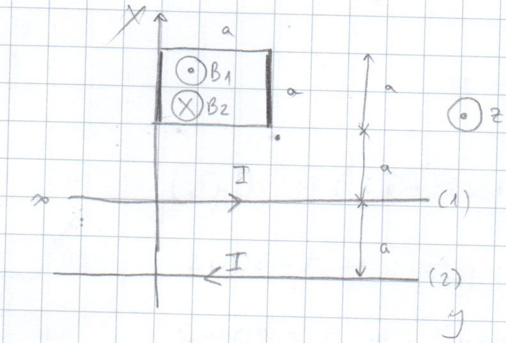
$$= -\frac{\Phi}{R} = -\frac{1}{R}\iint B\,n\,dS$$

$\bar{B} = \mu\bar{H}$ $\quad \bar{n} = \bar{a}_z$ $\quad dS = dx\,dy$

$$Q = -\frac{1}{R}\int_{x=b}^{a+b}\int_{y=0}^{a} -\mu \cdot \frac{I}{2\pi x}\,dx\,dy = \frac{\mu I}{2\pi R}\,\ln a \cdot \ln\frac{a+b}{b} = 138.62\,\mu C$$

2012

5)



$a = 1\,m$

$I = 10\cos(314t)\ A$

$R_{str} = 1\,\Omega$

Iznos vršne vrijednosti ind. struje [μA] koja teče kvadratnom petljom

$$U_{ind} = -\frac{d}{dt}\iint_S \bar{B}\,\bar{n}\,dS$$ → struja se promjenjuje u vremenu pa se zato inducira napon (Faraday)

$$B = \mu \frac{I}{2\pi r}\,\bar{a}_r \qquad \text{(pr. 1.7.1.)}$$

(1) $$B_1 = \mu \frac{I}{2\pi x}\,\bar{a}_z \qquad B_2 = \mu \frac{I}{2\pi x}\,(-\bar{a}_z)$$

$$\Phi_1 = \iint_S \bar{B}\,\bar{n}\,dS = \frac{\mu I}{2\pi}\int_{x=a}^{2a}\frac{dx}{x}\int_{y=0}^{a}dy = \frac{\mu\cdot a I}{2\pi}\ln 2$$

$$\Phi_2 = \iint_S \bar{B}\,\bar{n}\,dS = \frac{\mu I}{2\pi}\int_{x=2a}^{3a} - \frac{a\,dx}{x}\int_{y=0}^{a}dy = -\frac{\mu a I}{2\pi}\ln\frac{3}{2}$$

$$\Phi_{uk} = \frac{\mu\cdot a}{2\pi}\left[\ln 2 - \ln\frac{3}{2}\right]\cdot 10\cos 314t = \frac{5\mu}{\pi}\ln\frac{4}{3}\cos 314t$$

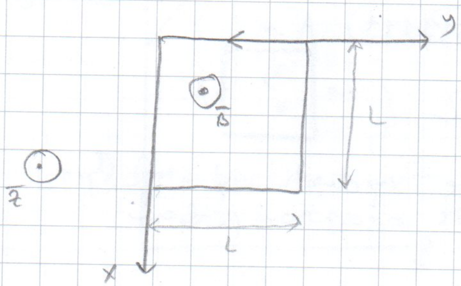
$$e_{ind} = -\frac{d\Phi}{dt} = 500\,\mu\,\ln\frac{4}{3}\sin 100\pi t$$

$$i = \frac{e_{ind}}{4R} = \underbrace{125\,\mu\,\ln\frac{4}{3}}\ \sin 100\pi t$$

$$|i| = 45.18\,\mu A$$

2013.

3)



$R_{uk} = 500\,\Omega$

$L = 2{,}5\ m$

$\bar{B} = 0.3\cos(120\pi t - \pi y)\,\bar{a}_z$ [μT]

Iznos struje u petlji za $t = 30\,ms$

ϕ [mWb] za $t = 20\,ms$

a) $$e_{ind} = \iint_S \frac{dB}{dt}\, n\, dS$$

$$\frac{dB}{dt} = -0.3\cdot 120\pi\cdot\sin(120\pi t - \pi y)\,\bar{a}_z$$

$$\bar{n} = \bar{a}_z, \quad dS = dx\,dy$$

$$e_{ind} = \int_{x=0}^{L} dx \int_{y=0}^{L} -0.3\cdot 120\pi \sin(120\pi t - \pi y)\, dy$$

$$= L\cdot 36\pi \int_{y=0}^{L} -\sin(120\pi t - \pi y)\,dy = -L\cdot\frac{36\cancel{\pi}}{\cancel{\pi}}\cos(120\pi t - \pi y)\Big|_0^L$$

$$= -36L\cos(\pi y - 120\pi t)\Big|_0^L = -36L\left[\cos(\pi L - 120\pi t) - \cos 120\pi t\right]_{t=3}$$

$$e_{ind} = 1{,}134\cdot 10^{-4}\ V$$

$$I_{ind} = \frac{e_{ind}}{R} = \frac{1{,}134\cdot 10^{-4}}{500} = 226{,}8\ \mu A$$

$n \to \bar{a}_z$

$B \to \bar{a}_z$

$\bar{a}_z\cdot\bar{a}_z = 1$

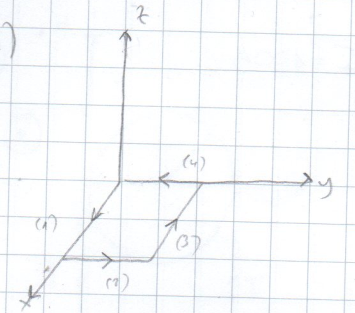
b) $$\phi = \iint_S B\, n\, dS = \int_{x=0}^{L} dx \int_{y=0}^{L} 0.3\cos(120\pi t - \pi y)\cdot 10^{-6}\, dy$$

$$= 0.3\cdot 10^{-6} L\left[\sin(120\pi t - \pi L) - \sin(120\pi t)\right]\Big|_{t=20\,ms}$$

$$\phi = 300.82\ \mu W$$

2012

4)



$$\bar{H} = \frac{1}{2y+4}\,\bar{a_x}$$

$a = 1\,m \qquad I(mA) = ?$

$$\oint H\,dl = \iint J_n\,dS = I$$

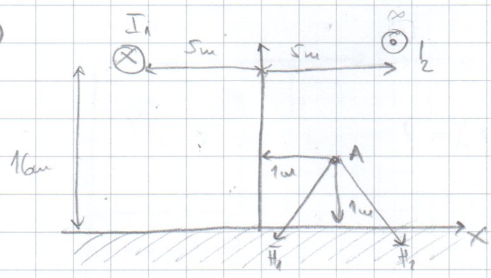
$$I = \int_{\substack{x=0\\y=0}}^{1} H\,dx\,\bar{a_x} + \int_{\substack{y=0\\x=1}}^{1} H\,dy\,\bar{a_y} + \int_{\substack{x=1\\y=1}}^{0} H\,dx\,\bar{a_x} + \int_{\substack{y=1\\x=0}}^{0} H\,dy\,\bar{a_y} =$$

$$I = \frac{1}{2y+4}\Big|_{y=0} - \frac{1}{2y+4}\Big|_{y=1} = \frac{1}{4} - \frac{1}{6} = \frac{2}{24} = \frac{1}{12}$$

VODIČI

2013.

2)



- Istosmjerni prijenos $I = 100A$

$\bar{B}(A) = ?$

$\bar{H} = \bar{a}_r \dfrac{I}{2\pi r}$ r - najkraća udaljenost od vrsta promatranja do vodiča

$|I_1| = |I_2|$ $I_1 = I\bar{a}_z$

$I_2 = -I\bar{a}_z$

$a_r = \dfrac{1}{r}(\pm y\,\bar{a}_x \pm x\,\bar{a}_y)$ $r = \sqrt{x^2 + y^2}$

$\bar{H} = \dfrac{I}{2\pi r^2}(\pm \Delta y\,\bar{a}_x \pm \Delta x\,\bar{a}_y)$

① prvi vodič:

$\Delta x = 6m$ $\Delta y = 15m$

$r = \sqrt{6^2 + 15^2} = 3\sqrt{29}\ m$

$\bar{H}_1 = \dfrac{I}{522\pi}(-15\,\bar{a}_x - 6\bar{a}_y)$

gledaj kako je vektor okrenut

$\bar{H}_1 = -0{,}914\,\bar{a}_x - 0{,}3658\,\bar{a}_y$

② drugi vodič

$\Delta x = 4m$ $\Delta y = 15m$

$r = \sqrt{4^2 + 15^2} = \sqrt{241}$

$\bar{H}_2 = \dfrac{I}{482\pi}(+15\bar{a}_x - 4\bar{a}_y)$

$\bar{H}_2 = 0{,}9905\,\bar{a}_x - 0{,}26415\,\bar{a}_y$

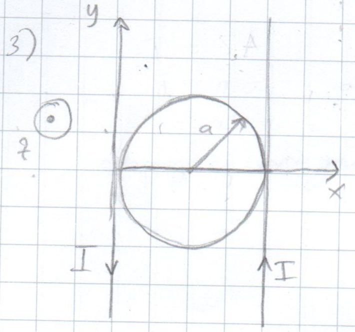
$\bar{H}_{uk} = \bar{H}_1 + \bar{H}_2$

$\bar{H}_{uk} = 0{,}0765\,\bar{a}_x - 0{,}62995\,\bar{a}_y$

$|\bar{H}| = 0{,}63\ A/m$

2012.

3)



$I = 5A$

$d = 2a$, $a = 1{,}5\,cm$

$r = a$

$M = ?$

$$M = \frac{\Psi_{12}}{I_2}$$

2 petlje, C_1 i C_2. Petljom C_1 teče struja I_1, a C_2 teče struja I_2. Naj. tok je povezan strujom petljom C_2, a obuhvaćen s C_1

$$\Psi_{12} = \oint_{C_1} A_2 \, dl_1 \qquad \text{pr. 7.3.9.}$$

2 strujnice $\rightarrow$ 2x

$$M = \frac{\Psi_{uk}}{I} = \frac{2\phi}{I}$$

$$\phi = \iint_S B\,n\,dS \quad , \quad B = \frac{\mu_0 I}{2\pi r}\,\bar{a}_\phi \qquad \bar{a}_\phi = \bar{a}_z$$

(pr. 7.3.9.)

$r = x$

$dS = 2y\,dx$ jer imamo pot. sym. kruž. prsten po osi y

$(x-a)^2 + y^2 = a^2$

$y = \pm\sqrt{a^2 - (x-a)^2}$

$$\phi = \iint_S \bar{B}\,\bar{n}\,dS$$

$\bar{n} = \bar{a}_z$

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

$$\phi = \int_{x=0}^{2a} \frac{\mu I}{2\pi x} \cdot 2y\,dx = \int_0^{2a} \frac{\mu I}{2\pi x} \cdot 2\sqrt{a^2-(x-a)^2}\,dx = \mu_0\, I \cdot a$$

$$M = \frac{2\phi}{I} = 2\mu_0 \cdot a = 3\mu_0$$

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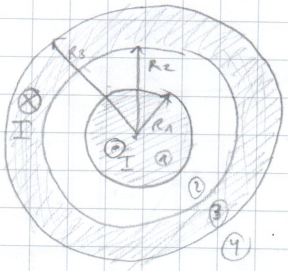
2)



∞ dugi vodič

$I = 2\,A$

jednolika raspodjela gustoće struje po presjeku

$R_1 = 1\,m$, $R_2 = 2\,m$, $R_3 = 2{,}5\,m$

cilindrični koos.

Amperov zakon, kružni zakon protjecanja $\operatorname{rot}\bar{H} = \bar{J} + \frac{\partial \bar{D}}{\partial t}$

$$\operatorname{rot}\bar{H} = \bar{a}_z \frac{1}{r}\frac{\partial}{\partial r}(r H_\phi) = \bar{J}$$

pr. 2.1.6.

1) $0 \le r \le R$

$$\operatorname{rot}\bar{H}_1 = \frac{1}{r}\frac{\partial}{\partial r}(r H_\phi) = \bar{a}_z \frac{I}{R_1^2 \pi}$$

$$r H_1 = \frac{I}{R_1^2 \pi}\frac{r^2}{2} + C_1$$

$$H_1 = \frac{I}{2\pi R_1^2}\cdot r + \frac{C_1}{r} \qquad \text{za } r=0,\ H \ne \infty \quad C_1 = 0$$

$$\bar{H}_1 = a_\phi \frac{I}{2\pi R_1^2}\cdot r$$

2) $R_1 \le r \le R_2$

$$\operatorname{rot}\bar{H}_2 = \bar{a}_z \frac{1}{r}\frac{\partial}{\partial r}(r H_\phi) = 0$$

$$H_2 = \frac{C_2}{r}$$

$$\oint_c \bar{H}_2\, dl = I \qquad \bar{H}_2 = a_\phi \frac{I}{2\pi r}$$

$$H_2 \cdot 2\pi R_1 = I$$

$$C_2 = \frac{I}{2\pi}$$

3) $R_2 \le r \le R_3$ $\quad I = I(-\bar{a}_z)$

$$\operatorname{rot}\bar{H}_3 = \frac{1}{r}\frac{\partial}{\partial r}(r H_\phi)$$

$$= -\bar{a}_z \frac{I}{(R_3^2 - R_2^2)\pi}$$

površina zeleno vijenca $R_3^2\pi - R_2^2\pi$

$$\bar{H}_3 = \frac{I}{(R_2^2 - R_3^2)\pi}\cdot\frac{r}{2} + \frac{C_3}{r}$$

$r \to R_2$ $\quad H_3(R_2) = H_2(R_2)$ vrijedi

$$C_3 = \frac{I}{2\pi}\left(\frac{R_3^2}{R_3^2 - R_2^2}\right)$$

$$\bar{H}_3 = \frac{I}{2\pi(R_2^2 - R_3^2)}\cdot r + \frac{1}{r}\cdot\frac{I}{2\pi}\cdot\frac{R_3^2}{R_3^2 - R_2^2}$$

4) $r \ge R_3$

$$\operatorname{rot}\bar{H}_4 = \frac{1}{r}\frac{\partial}{\partial r}(r H_\phi) = 0$$

$$H_4 = \frac{C_4}{r}$$

$\oint H_4\, dl = 0$ jer struje teku u različitim smjerovima