$\boxed{\text{I}}$ $\mu_r = 3$, $\vec{B} = 7y\,\vec{a}_x - 4x\,\vec{a}_y$ $[\mu T]$

① $\vec{\nabla} \times \vec{B} = \mu \vec{J}$

$$\vec{J} = \frac{1}{\mu} \begin{vmatrix} a_x & a_y & a_z \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ 7y & -4x & 0 \end{vmatrix} = \frac{1}{\mu}\,\vec{a}_z\,(-4-7) = \frac{-11}{\mu}\,\vec{a}_z \cdot 10^{-6}$$

$$= -2{,}92\,\vec{a}_z \ \ A/m^2$$

$\boxed{|\vec{J}| = 2{,}9}$ $\rightarrow$ B

③ $$\vec{M} = \frac{\vec{B}}{\mu_0} - \vec{H} = \frac{\vec{B}}{\mu_0} - \frac{\vec{B}}{\mu_0\mu_r} = \frac{\vec{B}}{\mu_0}\left(1 - \frac{1}{\mu_r}\right)$$

$$= \frac{1}{\mu_0}\left(1 - \frac{1}{\mu_r}\right)\left[7y\,\vec{a}_x - 4x\,\vec{a}_y\right] \cdot 10^{-6}$$

$$M_x = \frac{1}{\mu_0}\left(1 - \frac{1}{\mu_r}\right) \cdot 7y \cdot 10^{-6} = \boxed{3{,}7y} \rightarrow \text{E}$$

$$M_y = -\frac{1}{\mu_0}\left(1 - \frac{1}{\mu_r}\right) \cdot 4x \cdot 10^{-6}$$

② $$\vec{J} = \vec{\nabla} \times \vec{M} = \begin{vmatrix} a_x & a_y & a_z \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ M_x & M_y & 0 \end{vmatrix} = \vec{a}_z \frac{1}{\mu_0}\left(1 - \frac{1}{\mu_r}\right)(-4-7)\,10^{-6}$$

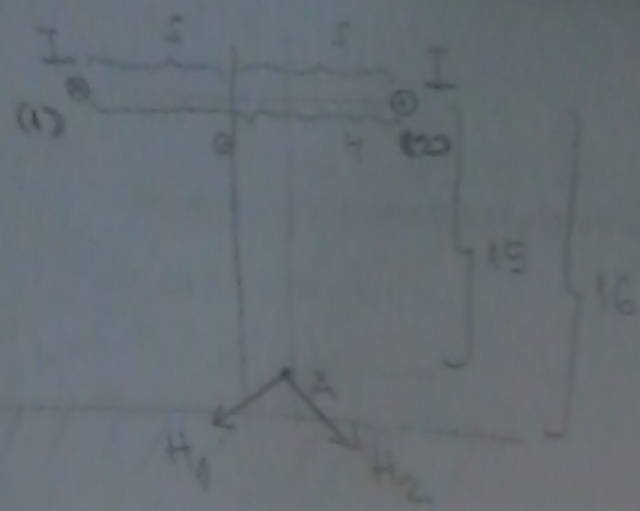
$$= \boxed{5{,}8} \ A/m^2 \longrightarrow \text{C}$$

④ $\vec{K}_m = \vec{M} \times \vec{a}_n$, $x = 0 \Rightarrow \vec{a}_n = \vec{a}_z$

$$\vec{K} = \begin{vmatrix} a_x & a_y & a_z \\ M_x & M_y & 0 \\ 0 & 0 & 1 \end{vmatrix} = M_y\,\vec{a}_x - M_x\,\vec{a}_y$$

$$|K_{mx}| = |M_y| = \boxed{2{,}1x} \ A/m \longrightarrow \text{E}$$

$\boxed{\text{II.}}$



$I = 100\,A$

H beskonačne strujnice $\vec{H} = \frac{I}{2r\pi}\vec{a_\alpha}$

(1) $r_1 = \sqrt{6^2 + 15^2} = 3\sqrt{29}$

$\vec{H_1} = \frac{100}{6\sqrt{29}\,\pi}\vec{a_\alpha}$

$\vec{a_\alpha} = -\frac{y}{r}\vec{a_x} - \frac{x}{r}\vec{a_y} = -\frac{15}{3\sqrt{29}}\vec{a_x} - \frac{6}{3\sqrt{29}}\vec{a_y}$

← ovo je definicija [illegible]

$\Rightarrow \vec{H_1} = -0{,}91468\,\vec{a_x} - 0{,}36587\,\vec{a_y}$

(2) $r_2 = \sqrt{4^2 + 15^2} = \sqrt{241}$

$\vec{H_2} = \frac{100}{\sqrt{241}\,\pi}\vec{a_\alpha}$

$\vec{a_\alpha} = +\frac{y}{r}\vec{a_x} - \frac{x}{r}\vec{a_y}$

$\vec{H_2} = 0{,}96823\,\vec{a_x} - 0{,}25766\,\vec{a_y}$

$\vec{H} = \vec{H_1} + \vec{H_2} = 0{,}05155\,\vec{a_x} - 0{,}62353\,\vec{a_y}$

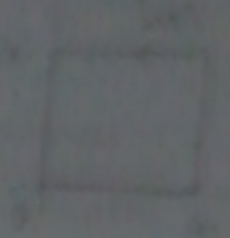
$\boxed{|\vec{H}| = 0{,}63}$ A/m $\rightarrow$ E

III.

$R = 500\,\Omega$

$a = 2{,}5\ m$

$\vec{B} = 0{,}3\cos(120\pi t - \pi y)\,\vec{a}_z\ [\mu T]$



$i(t = 30\ ms) = ?$

6. $e_{ind} = -\iint \frac{\partial \vec{B}}{\partial t}\,\vec{n}\,dS$ → ako sistav miruje (a cos mijenja)

$\frac{\partial \vec{B}}{\partial t} = -0{,}3 \cdot 120\pi \sin(120\pi t - \pi y)\,\vec{a}_z$

$e_{ind} = 0{,}3 \cdot 120\pi \int_0^a dx \int_0^a \sin(120\pi t - \pi y)\,dy =$

$= 0{,}3 \cdot 120\pi \cdot a \cdot (-0{,}40103) \cdot 10^{-6}$ → Casio

$i_{ind} = \frac{e_{ind}}{R} = 226{,}81 \cdot 10^{-9} A \approx \boxed{227}\ nA$ → F

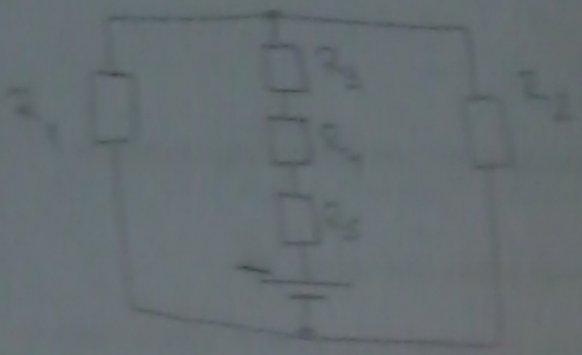
7. $\Phi(t = 20\,ms) = ?$

$\Phi = \iint_S \vec{B}\,\vec{n}\,dS = 0{,}3 \int_0^a dx \int_0^a \cos(120\pi t - \pi y)\,dy$

$= 300{,}32\ nWb$ Casio

→ B

IV



$R_1 = R_2$

$R_3 = R_5$

$R_4 = R_\delta$

8)

$$L = \frac{N^2}{R_m}$$

$$R_m = (R_1 \| R_2) + R_3 + R_4 + R_5 = \frac{R_1}{2} + 2R_3 + R_\delta$$

$$R_\delta = \frac{1}{\mu_0} \cdot \frac{\delta}{S_\delta} = \frac{1}{\mu_0} \cdot \frac{3 \cdot 10^{-3}}{20 \cdot 10^{-4}}$$

$$R_1 = \frac{1}{\mu_0 \mu_R} \cdot \frac{3L}{S} = \frac{1}{200\mu_R} \cdot \frac{3 \cdot 0{,}1}{20 \cdot 10^{-4}}$$

$$2R_3 = \frac{1}{\mu_0 \mu_R} \cdot \frac{L - \delta}{S} = \frac{1}{200\mu_R} \cdot \frac{0{,}097}{20 \cdot 10^{-4}}$$

$$R_m = 2{,}4808 \cdot 10^6 \ \Omega$$

$$L = 4{,}03 \text{ mH} \doteq \boxed{4} \text{ mH} \longrightarrow E$$

9) $B_\delta = 0{,}5$ T

$\Phi_\delta = \Phi_{Fe} \Rightarrow B_\delta S_\delta = B_{Fe} S_{Fe}$

$B_\delta = B_{Fe}$

$$\oint \vec{H} d\vec{l} = \sum I = NI = H_{Fe} l_{Fe} + H_\delta \delta$$

$3L - \delta$

$$\Rightarrow I = \frac{\frac{B}{\mu_0 \mu_R} l + \frac{B}{\mu_0} \delta}{N} = \frac{B}{\mu_0} \cdot \frac{\frac{l}{\mu_R} + \delta}{N}$$

$\vec{E} = 5\sin(1{,}5\cdot10^{8}t - 5x)\,\vec{a}_y$

(10) $\vec{\beta} = 5\,\boxed{\vec{a}_x} \rightarrow A$

(11) $\lambda = \frac{2\pi}{\beta} = \frac{2\pi}{5} = 1{,}26 \approx \boxed{1{,}3} \rightarrow C$

(12) $\varepsilon_r = ?$

$$\beta = \omega\sqrt{\mu_0\mu_r\varepsilon_0\varepsilon_r} \Rightarrow \varepsilon_r = \left(\frac{\beta}{\omega}\right)^2 \frac{1}{\mu_0\varepsilon_0\mu_r}$$

$\varepsilon_r = 49{,}93 \approx \boxed{50} \rightarrow E$

(13) $\vec{H}$ $\binom{t=35\,ns}{x=50}$

$$\vec{H} = \frac{1}{\mu\omega}\vec{\beta}\times\vec{E} = \frac{1}{\mu\omega}\begin{vmatrix} a_x & a_y & a_z \\ 5 & 0 & 0 \\ 0 & E_y & 0 \end{vmatrix} = \frac{5}{\mu\omega}E_y\,\vec{a}_z$$

$\vec{H}\,(x=50,\ t=35\,ns) = \boxed{-82{,}5\,\vec{a}_z} \rightarrow A$

mA/m

(14) $N_{av} = ?$

$$\vec{N} = \vec{E}\times\vec{H} = \begin{vmatrix} a_x & a_y & a_z \\ 0 & E_y & 0 \\ 0 & 0 & H_z \end{vmatrix} = E_y H_z\,\vec{a}_x =$$

$$= 5\cdot\frac{5}{\mu\omega}\cdot\sin^2(\quad)\,\vec{a}_x$$

$$\vec{N}_{av} = 25\,\frac{5}{\mu\omega}\,\frac{1}{2}\,\vec{a}_x = 165{,}79\ mW/m^2$$

$\approx \boxed{166} \rightarrow B$