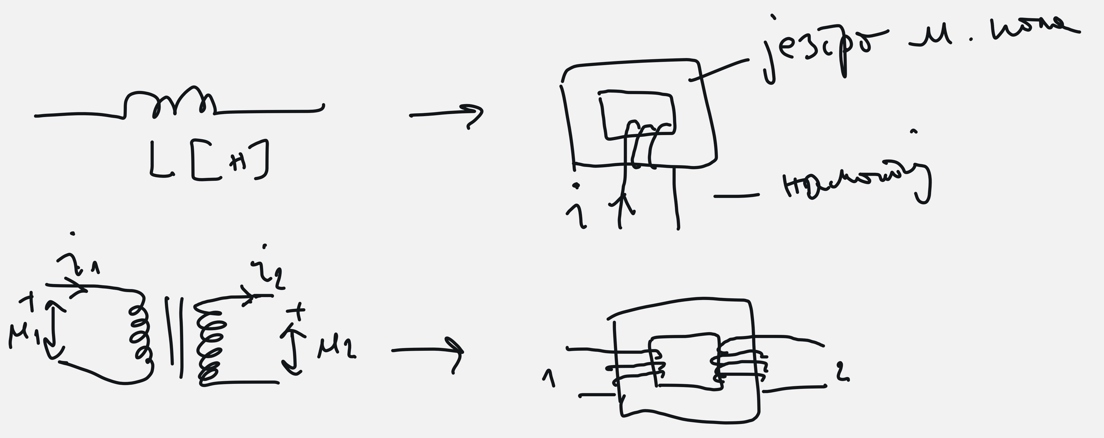
МАГНЕТНА КОЛА



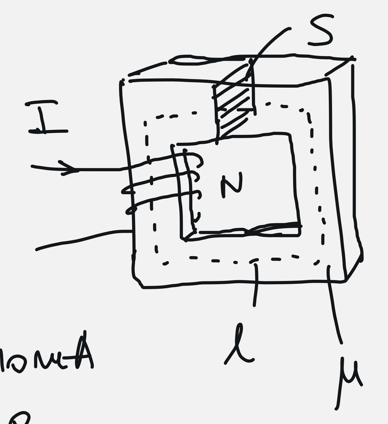
$i \to B, H, \Phi$

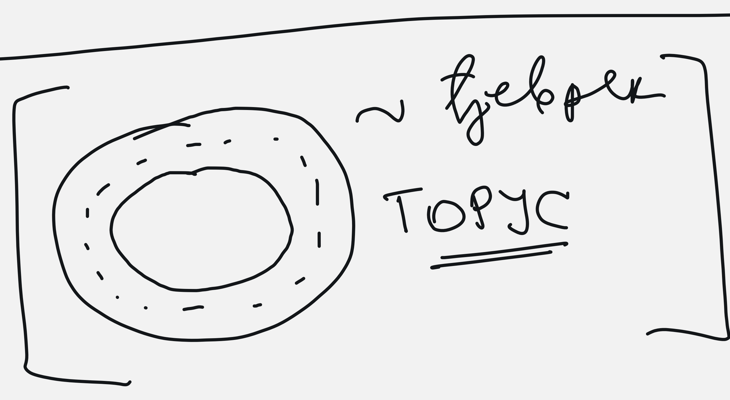
$[T]\,[\frac{A}{m}]\,[Wb]$

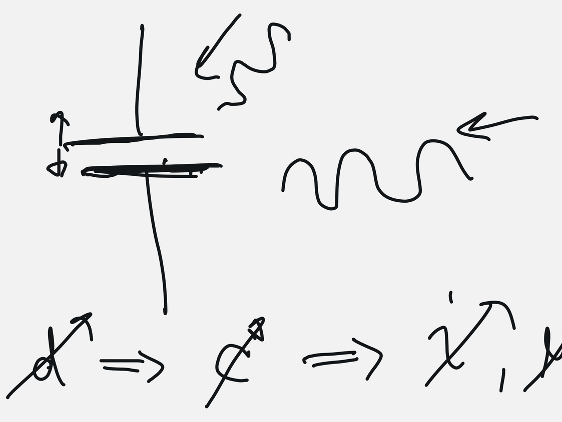
Решавање м. кола → 1. Амперов закон (~ Гаусов з. у електростатици)
→ 2. Ел. коло ЈС

---

(1)







$I = 10mA$

$N = 800$

$l = 20cm$

$S = 4cm^2$

$\mu = 10^{-4}\frac{H}{m}$ $\left(\mu = \mu_r \mu_0,\ \mu_0 = 4\pi\cdot 10^{-7}\frac{H}{m}\right)$

$\mu_r \approx 80$

$B, H, \Phi, w_m, W_m, L = ?$

$[T, \frac{A}{m}, Wb, J/m^3, J, H]$

решење

1. Амперов закон

$$\oint_C \vec{H}\cdot d\vec{l} = \sum_{S_c} I$$

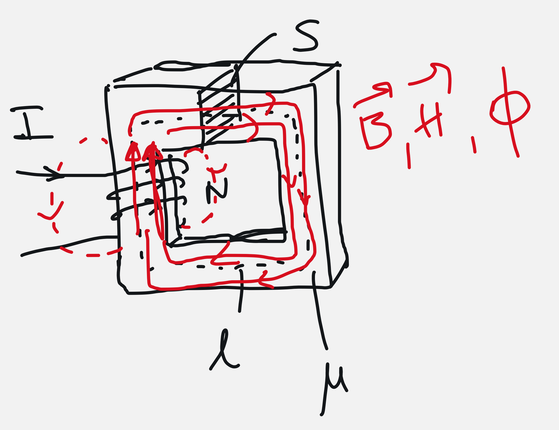
$$\sum_{C} H_i l_i = \sum_{S_c} I \qquad i = 1,2,\dots$$

$S_i = ?\quad \mu_i = ?$

$i_{max} = 1$

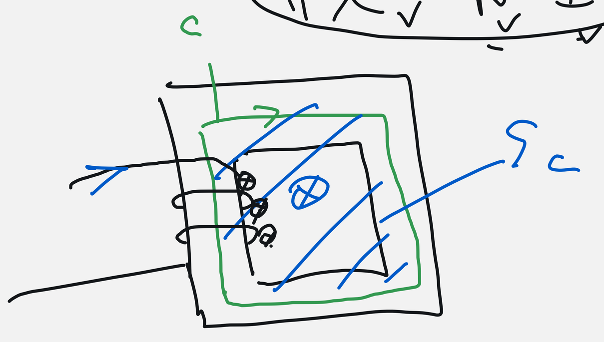
$\Phi = \vec{B}\cdot\vec{S} \approx B\cdot S$

$\Phi = const$



$$H\cdot l = N\cdot I$$

$$H = \frac{N\cdot I}{l}$$



$$H = \frac{800\cdot 10mA}{20cm} = 40\frac{A}{m}$$

(мал. магн.)

$$B = \mu H = 10^{-4}\frac{H}{m}\cdot 40\frac{A}{m} = 4\cdot 10^{-3}\,T = 4mT$$

$$\Phi = B\cdot S = 4mT\cdot 4cm^2 = 16\cdot 10^{-7}\,Wb = 1{,}6\,\mu Wb$$

$$w_m = \frac{1}{2}BH = \frac{1}{2}40\cdot 4m = 80\,mJ/m^3$$

$$W_m = w_m\cdot V = w_m\cdot S\cdot l = 80\frac{mJ}{m^3}\cdot 20cm\cdot 4cm^2 = 6{,}4\,\mu J$$

$80cm^3 = 80\cdot 10^{-6}\,m^3$

$L \stackrel{def.}{=} \frac{\Psi}{I}$; $\Psi(\Phi_{uk})$ – кроз намотај

$(C \stackrel{def.}{=} \frac{Q}{U})$

$\Psi = N\cdot\Phi_{кроз\ S}$

$$L = \frac{N\cdot\Phi}{I} = \frac{N\cdot B\cdot S}{I} = \frac{N\cdot\mu H\cdot S}{I} = \frac{N\cdot\mu\cdot\frac{NI}{l}S}{I}$$

$$L = \frac{N^2\mu S}{l} = \frac{800^2\cdot 10^{-4}\frac{H}{m}\cdot 4\cdot 10^{-4}m^2}{20\cdot 10^{-2}m} = 128\cdot 10^{-3}\,H = 128\,mH$$

$(C = \frac{\varepsilon S}{d})$

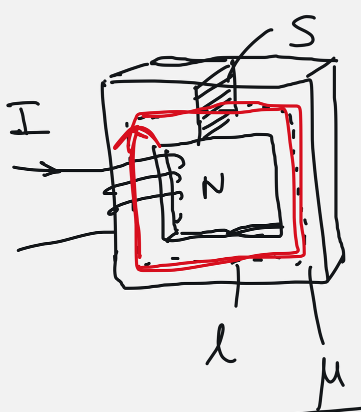
$\frac{1}{2}\Psi I$

$$W_L = \frac{1}{2}LI^2 = \frac{1}{2}\cdot 128mH\cdot(10mA)^2 = \dots = 64\cdot 10^{-7}\,J = 6{,}4\,\mu J$$

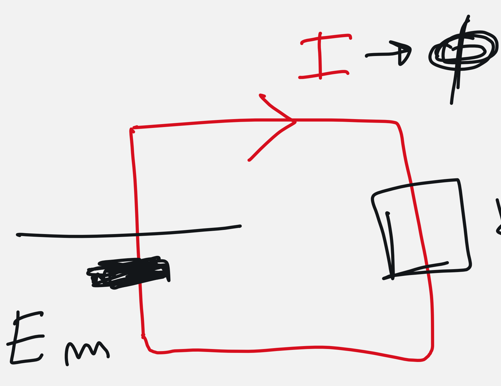
$(10^{-2})^2 = 10^{-4}$

$(W_C = \frac{1}{2}CU^2)$

(2) ел. коло ЈС

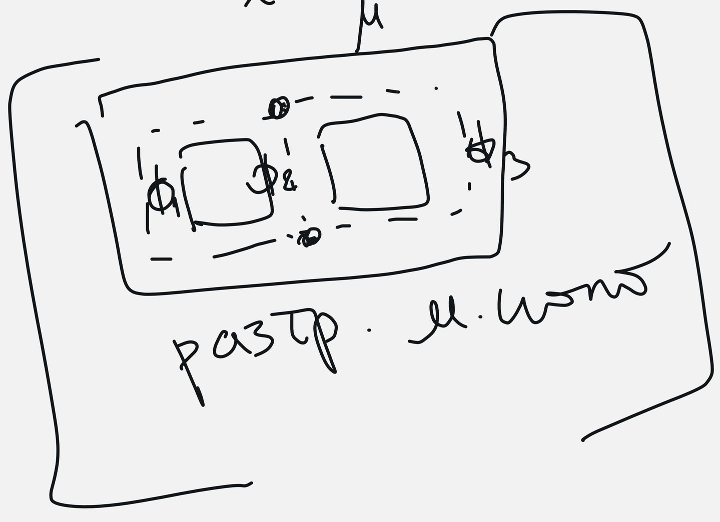


$\Phi \leftrightarrow I$



$$R_m = \frac{l}{\mu\cdot S} \qquad \left(R_{el} = \frac{\rho\cdot l}{S} = \frac{l}{\gamma\cdot S}\right)$$

$E_m = NI$



$$\Phi = \frac{E_m}{R_m} = \frac{NI}{\frac{l}{\mu S}} = \frac{\mu S N I}{l}$$

$$B = \frac{\Phi}{S} = \frac{\mu N I}{l}$$

$$H = \frac{B}{\mu} = \frac{NI}{l}$$

$$w_m = \frac{1}{2}B\cdot H = \dots \qquad W_m = w_m\cdot V = w_m\cdot S\cdot l$$

$$L = \frac{\Psi}{I} = \frac{N\cdot\Phi}{I} = \frac{N\frac{E_m}{R_m}}{I} = \frac{N\cdot\frac{NI}{R_m}}{I} = \frac{N^2}{R_m}$$

②

$N = 100$

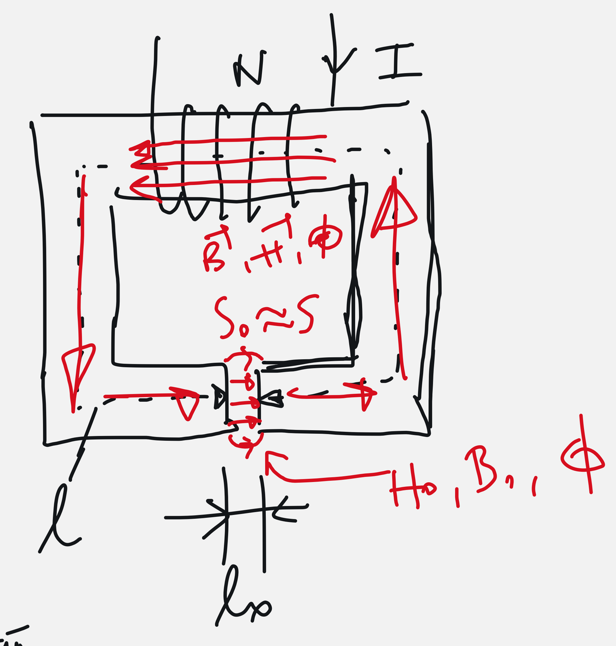
$I = 20\,mA$

$l = 10\,cm$

$l_0 = 1\,mm$

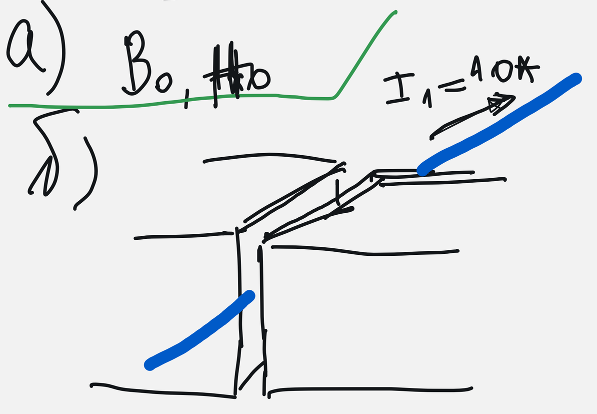
$S = 1\,cm^2 \to$ квадрат

$\mu_r = 300$



а) B_0, H_0

б)



$\vec{F}_{на\, I_1} = ?$

в) $L = ?$

г) $W_{m0} = ?$

а) решение н. конт!

1. А. З.

$$\sum_C H_i l_i = \sum_{S_C} I$$

$$H \cdot l + H_0 l_0 = NI$$

? ?

$$\frac{B}{\mu_r \mu_0} l + \frac{B_0}{\mu_0} l_0 = NI$$

$$\phi = B \cdot S = B_0 S_0, \quad S_0 \approx S$$

$$\Rightarrow B_0 \approx B$$

$$B = B_0 = \frac{NI}{\frac{l}{\mu_r \mu_0} + \frac{l_0}{\mu_0}} = \frac{\mu_0 NI}{l/\mu_r + l_0}$$

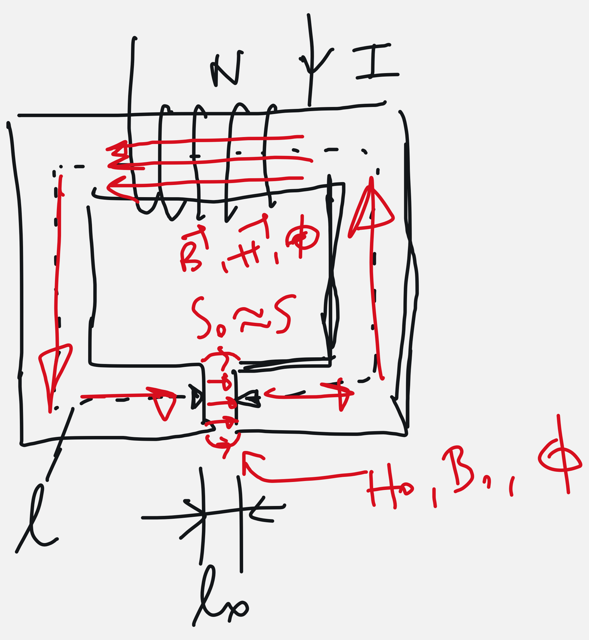
$$B = B_0 = \frac{4\pi \cdot 10^{-7} \cdot 100 \cdot 0{,}02}{0{,}1/300 + 1 \cdot 10^{-3}} \Big/ \frac{300}{300} = \frac{\ldots}{0{,}4} \; 10M.$$

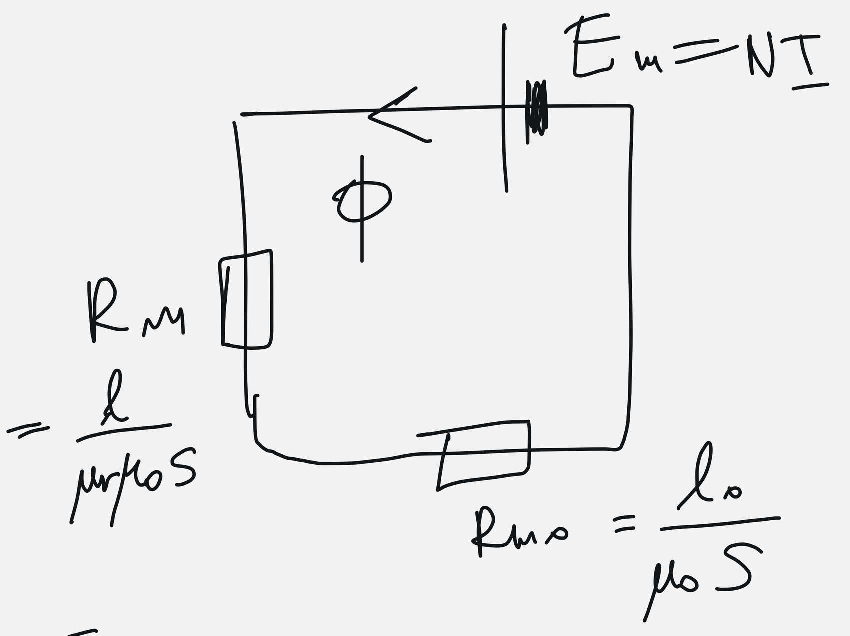
$$\frac{24\pi \cdot 10^{-5}}{0{,}4} = 6\pi \cdot 10^{-4} = 1{,}9\,mT$$

(1,9)

$$H_0 = \frac{B_0}{\mu_0} = \frac{NI}{l/\mu_r + l_0} = \ldots = \text{\_\_} \frac{A}{m}$$

2. Екв. конт ЈС





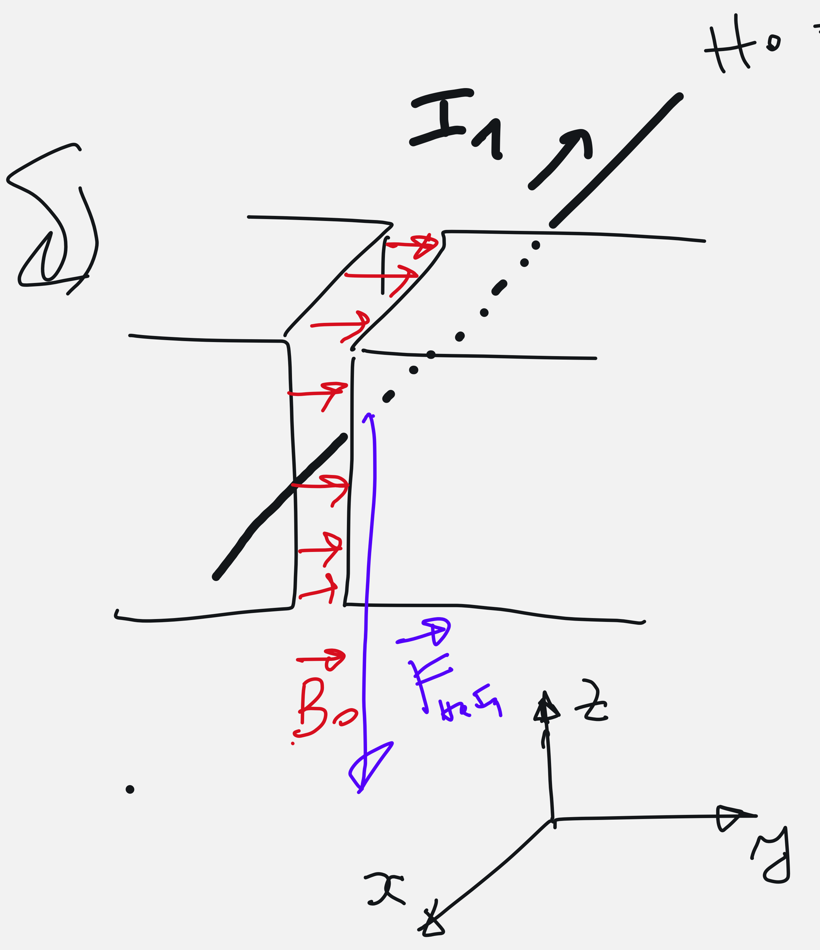
$$\phi = \frac{E_m}{R_{m0} + R_m} = \frac{NI}{\frac{l}{\mu_r \mu_0 S} + \frac{l_0}{\mu_0 S}}$$

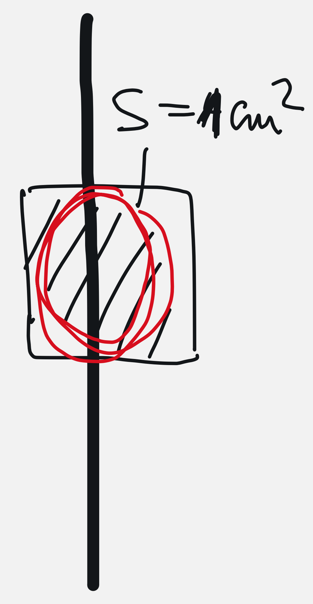
$$\phi = \frac{\mu_0 NIS}{l/\mu_r + l_0}$$

$$B = B_0 = \frac{\phi}{S} = \frac{\mu_0 NI}{l/\mu_r + l_0} = \ldots$$

$$H_0 = \frac{B_0}{\mu_0} = \frac{NI}{l/\mu_r + l_0} = \ldots$$

б)





$$\vec{F}_{на\, I_1} = I_1 \vec{l} \times \vec{B}_0$$

$$l = \sqrt{S} = 1\,cm$$

$$\vec{F}_{на\, I_1} = I_1 \sqrt{S}\,(-\vec{i}) \times B_0 \vec{j} = I_1 \sqrt{S} B_0 (-\vec{k})$$

$$|\vec{F}| = 10A \cdot 1\,cm \cdot 1{,}9\,mT = 0{,}19\,mN$$

в) г) без I_1

в) $$L = \frac{\Psi}{I} = \ldots = \frac{N^2}{R_{m\,екв}} = \frac{N^2}{R_m + R_{m0}} = \frac{N^2}{\frac{l}{\mu_r \mu_0 S} + \frac{l_0}{\mu_0 S}} = \frac{\mu_0 S N^2}{\frac{l}{\mu_r} + l_0} = \ldots = \text{\_\_}\,H$$

г) $$W_{m0} = w_{m0} \cdot V_0 = \frac{1}{2} B_0 H_0 \cdot S_0 l_0 = \frac{1}{2} \frac{B_0^2}{\mu_0} \cdot S l_0 = \ldots = \text{\_\_}\,J$$

$$\left[W_m = \frac{1}{2} L I^2 = W_m + W_{m0} = \ldots \right]$$

$$\frac{1}{2} B \cdot H \cdot S \cdot l$$