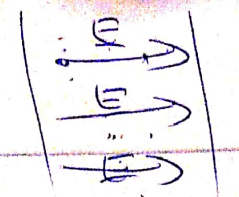
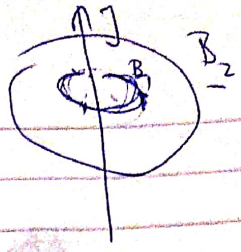
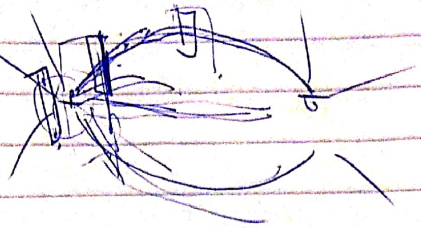
Mágneses indukció





$\underline{B} = \underline{E}$ from electrostatics

↑ lifejtett erő
egy töltött testre



$\vec{M}$ = forgató nyomaték

Poynting-vektor ∈ fény terjedése

Mágneses térerősség (B + anyag)

$H = B/\mu_0$

Mágneses fluxus = erővonalak száma

ϕ

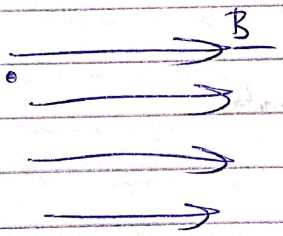
Önindukciós együttható

$L \rightarrow$ const

$M \approx Q$ from electrostatics

Lorentz erő $\quad F = BJl \quad F = Q\,v \times B$

Mágneses tér elektromos töltésre
erőt fejt ki.



Feszültségek

$$U_{ind} = -N\frac{\Delta B A}{\Delta t} = -L\cdot\frac{\Delta I}{\Delta t}$$

↑ tekercs induktivitása

Tekercs / Kondenzátor

$X_L = L\cdot\omega$ (= $2\pi f$) — 90° késés I U-hoz képest

Kondenzátor: $X_C = \frac{1}{C\omega}$: 90° siettés I U-hoz képest

Transzformátor: $U \sim N$ $\quad \frac{U_1}{U_2} = \frac{N_1}{N_2}$

1. PRIMER
2. SZEKUNDER

$$\begin{pmatrix} I_1N_1 = I_2N_2 \\ P_1 = P_2 \\ U_1I_1 = U_2I_2 \end{pmatrix}$$

$L = 50\,mH$

$f = 50\,Hz \Rightarrow \omega = 2\pi f = 100\pi$

$C = 20\,\mu F$

feladat: $\frac{U_1}{U_2} \rightarrow \frac{N_1}{N_2}$

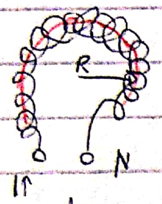
Mágnesesség

Lenz tv:

(Erőt hoz létre)

A mágneses tér változása indukálja a feszültséget.

Az indukált áramnak az iránya olyan, hogy gátolja az indukáló folyamatot.



Maxwell egyenletek

$$\oint \underline{E} \cdot d\underline{l} = \emptyset$$

$$-\frac{\partial}{\partial t} \iint_A \underline{B} \cdot d\underline{A}$$

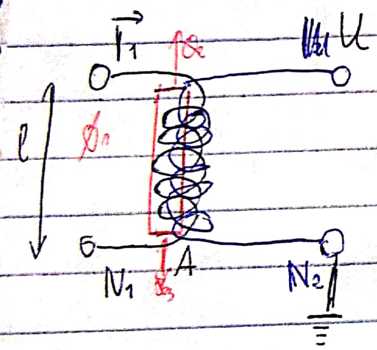
kör, menetszám, áram

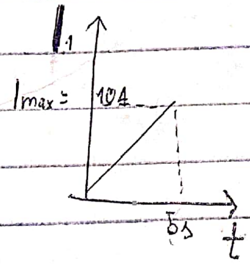
$$B \cdot \overbrace{2R\pi}^{\text{kör}} = \mu_0 \cdot NI$$

$$\oint \underline{B} \cdot d\underline{l} = \mu_0 \iint_A \underline{j} \cdot d\underline{A} + \mu_0 \varepsilon_0 \frac{\partial}{\partial t} \iint_A \underline{E} \cdot d\underline{A}$$

$$B = \frac{\mu_0}{2\pi} \frac{NI}{R}$$

Szekunder tekercs





$l = 0{,}1 m$

$A = 0{,}1 m^2$

kiesik (skaláris szorzat $\underline{E} \cdot \underline{el} = \emptyset$)

$$B \cdot l + \emptyset_1 + \emptyset_2 + \emptyset_3$$

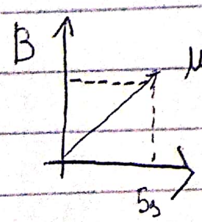
↑ kívül

egy menet

$$\mathcal{E}_1 = -\frac{\partial}{\partial t} B \cdot A$$

$$B = \mu_0 \frac{N_1 I_1}{l}$$

$$\mathcal{E} = N_2 \cdot \mathcal{E}_1 = -A \cdot N_2 \cdot \frac{\partial B}{\partial t}$$



$$\mu_0 \cdot \frac{N_1 \cdot I_{max}}{l}$$

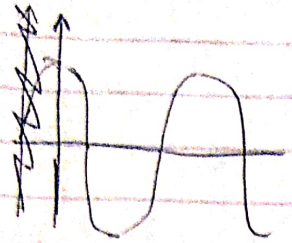
$$\mathcal{E} = -A \cdot N_2 \frac{\partial}{\partial t} \mu_0 \cdot \frac{N_1 I_1}{l}$$

$$\mathcal{E} = -\mu_0 \frac{A N_1 N_2}{l} \cdot \frac{\partial I_1}{\partial t}$$

$$\mathcal{E} = -\mu_0 \frac{A N_1 N_2}{l} \cdot \frac{I_{max}}{t_{max}}$$

Váltakozó áram

A1 → áram v. feszültség időben változik



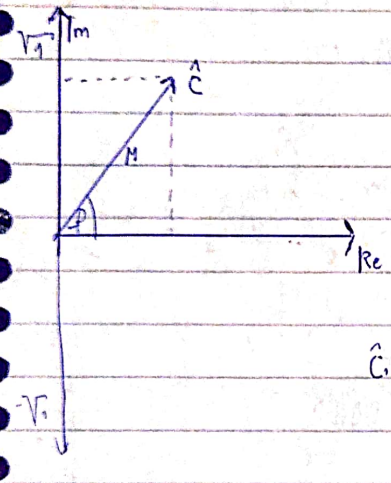
$$I(t) = I_0 \cos(\omega t + \varphi_0)$$

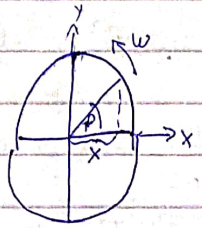
$$\omega = 2\pi f$$

Imaginárius számok (Komplex) ← imaginárius

$\sqrt{-3996} = \sqrt{3996 \cdot (-1)} \Rightarrow \sqrt{3996} \cdot \sqrt{-1} \rightarrow \sqrt{3996}\, i$

$$i = \sqrt{-1}$$





$\hat{C}_1 \cdot C_2 \rightarrow$ Maggnitudó = $C_1 C_{m_2}$
Szög = $C_{szög} + C_{szög}$

$$\hat{C} = a + bi$$

$$\hat{C} = M \cdot e^{i\varphi}$$

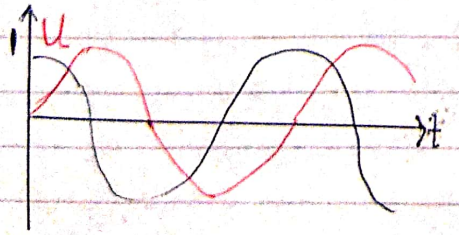
$$\hat{C}_2 = M_2 e^{i\varphi_2}$$

$$\hat{C}_1 \cdot \hat{C}_2 = M_1 \cdot M_2 \cdot e^{i(\varphi_1 + \varphi_2)}$$

$$I(t) = I_0 \cdot \cos(\omega t + \varphi_0) = Re\left(I_0 e^{i(\omega t + \varphi_0)}\right) = Re\left(I_0 \cdot e^{i\varphi_0} \cdot e^{i\omega t}\right) = Re\left(\hat{I}_0 \cdot e^{i\omega t}\right)$$

$$U(t) = U_0 \cdot \cos(\omega t + \varphi_1) = Re\left(\hat{U}_0 e^{i\omega t}\right)$$

$$\hat{U}_1 \cdot \hat{U}_2 = M_1 M_2 + e^{i(\varphi_1 + \varphi_2)}$$

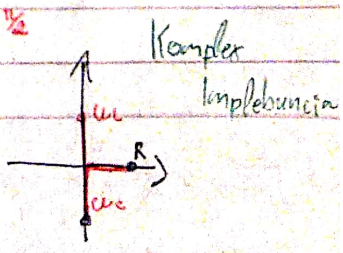


90°-ot késik

$$I(t) = I_0 \cdot \cos(\omega t) \qquad \hat{I} = I_0$$

$$U(t) = U_0 \cdot \cos(\omega t + \tfrac{\pi}{2}) \qquad \hat{U} = U_0 \cdot e^{i\frac{\pi}{2}}$$

$$\frac{\hat{U}_0}{\hat{I}_0} = \frac{U_0 e^{-\frac{\pi}{2}i}}{I_0} = \underbrace{2\pi f}_{\omega} C e^{-\frac{\pi}{2}i} = Z_C$$



20.12
20.18
20.27
20.31
20.38
20.41
20.43
20.45

20.12

$d = 0{,}5\,m$
$I = 100\,A$

$B = \frac{\mu_0}{2\pi} \cdot \frac{I}{r}$ ($\mu_0 = 4\pi \cdot 10^{-7}$)

$\frac{4\pi \cdot 2 \cdot 10^{-7}}{2\pi} \cdot \frac{100}{0{,}5} = 2 \cdot 2 \cdot 10^{-7} \cdot 10^{2} = 4 \cdot 10^{-5}\ T$

$H = \frac{B}{\mu_0}$

$\frac{4 \cdot 10^{-5}}{4\pi \cdot 10^{-7}} = \frac{10^{-5}}{10^{-7}} \cdot \frac{1}{\pi} = \frac{1}{\pi} 10^{2} = \frac{100}{\pi} \approx 31{,}83\ \frac{A}{m}$

20.18

$l = 6\,cm$
$N = 300$
$I = 1\,A$
$H = ?$
$B = ?$

$B = \mu_0 \frac{I \cdot N}{l}$

$B = 4\pi \cdot 10^{-7} \cdot \frac{1 \cdot 300}{0{,}06} = 2\pi \cdot 10^{-5} \approx 0{,}0000628\ T$

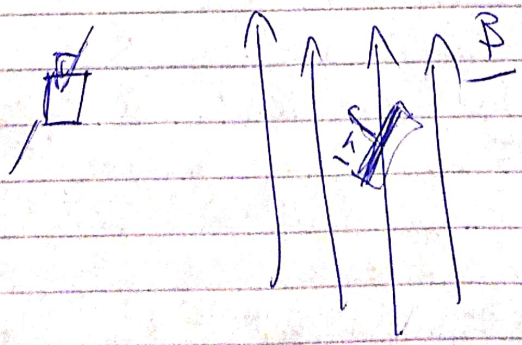
$H = \frac{B}{\mu_0}$

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

$H = \frac{1 \cdot 300}{0{,}06} = 5000\ \frac{A}{m}$

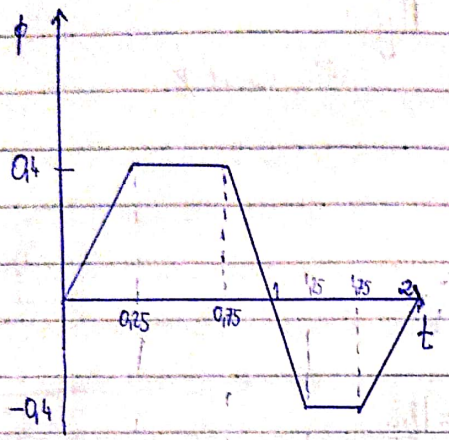
20.27

$A = 0{,}1 \cdot 0{,}1\,m = 0{,}01\,m^2$
$\alpha = 30°$
$B = \frac{1{,}5\ Vs}{m^2}$
$M = 0{,}05\ Nm$
$I = ?$



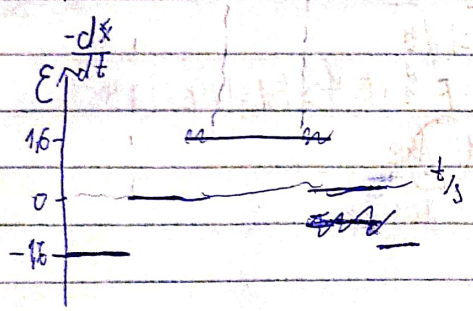
$M = I \cdot A \times B$

20.23



$$\oint E \cdot dl = -\frac{\partial}{\partial t} \cdot \phi_m$$

$$\mathcal{E} = -\frac{\partial \phi}{\partial t}$$



20.25

$t = 0{,}5\,s$

$I = 0{,}5\,A$

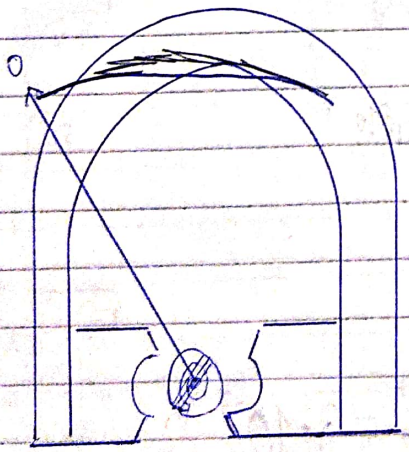
$U = 0{,}12\,V$

$L = ?$

$$U = L\frac{\Delta I}{\Delta t}$$

$$0{,}12\,\frac{0{,}5}{0{,}5} = 0{,}12\,H$$

20.44



$B = 0{,}25\,T \quad \left(\frac{Vs}{m^2}\right)$

$N = 300$

$d = 2\,cm \Rightarrow A = d^2 = 4\,cm^2 = 4 \cdot 10^{-4}\,m^2$

$M_{max} = 3 \cdot 10^{-5}\,Nm$

$$\underline{M} = \underline{\mu} \times \underline{B}$$

$$M_{max} = \mu B = IAB$$

$$Mt = N \cdot M_{max} = N \cdot I \cdot A \cdot B = M_r$$

$$I = \frac{M_r}{N \cdot A \cdot B} = \frac{3 \cdot 10^{-5}}{300 \cdot 4 \cdot 10^{-4} \cdot 0{,}25} = 10^{-3}\,A$$

Kiszámolva:

$$\frac{0-U_1}{R_2}+\frac{U-U_1}{R_3}+\frac{U_2-U_1}{R_6}=0$$

$$\frac{0-U_2}{R_4}+\frac{U-U_2}{R_5}+\frac{U_1-U_2}{R_6}=0$$

$$U+U_2-3U_1=0 \qquad \text{I.}$$
$$U+U_1-3U_2=0 \qquad \text{II.}$$

$$3\text{I}+\text{II}$$
$$3U-9U_1+U+U_1=0$$
$$-8U_1=-4U_1$$
$$U_1=\frac{U}{2}$$
$$U_2=\frac{U}{2}$$

$$I_1=\frac{U}{R_1}$$
$$I_2=\frac{U_1-0}{R_2}=\frac{U}{2R_2}$$
$$I_4=\frac{U_2-0}{R_4}=\frac{U}{2R_4}$$

$$I=\frac{U}{R_1}+\frac{U}{2R_2}+\frac{U}{2R_4}=U\left(\frac{1}{R_1}+\frac{1}{2R_2}+\frac{1}{2R_4}\right)$$
$$R_e=\frac{U}{I}=\frac{U}{U\left(\frac{1}{R_x}+\dots\right)}$$

$$R_e=\frac{1}{\frac{1}{1}+\frac{1}{2}+\frac{1}{2}}=\frac{1}{2}\,\Omega$$

20.38

$l = 0{,}1\,m$

$B = 0{,}5\,\frac{Vs}{m^2}$

$\alpha = 30°$

$I = 10\,A$

Lorentz-erő?

20.41

$l = 0{,}2\,m$

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

$N = 300$

$I = 5\,A$

$t = 0{,}01\,s$

$U_i = ?$

$$U_i = \frac{\Delta \Phi}{\Delta t}$$

$$U_i = -N \cdot \frac{\Delta \Phi}{\Delta t} = -N \cdot \frac{\Delta (B \cdot A)}{\Delta t}$$

20.43

$\Delta \Phi$

valahol van egy szinusz

20.45

Lorentz-erő + mechanikai