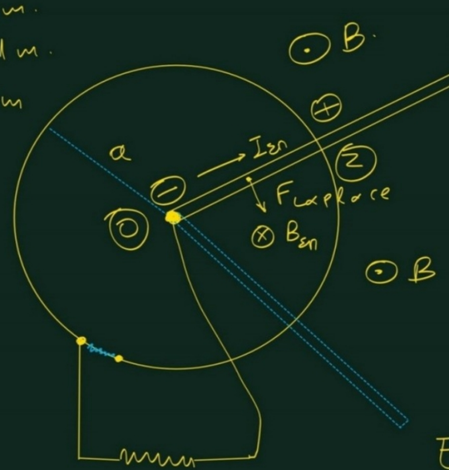
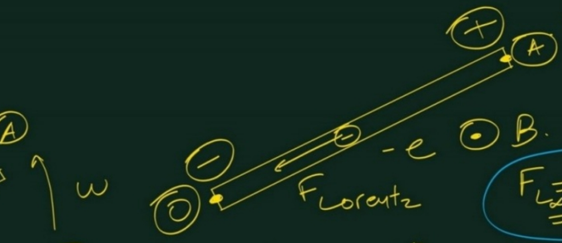
Ασκ. 5.219 (Μαθ)

$\ell = OA = 1,6\,m$.
$OZ = \alpha = 1\,m$.
$R^* = 0,4\,\Omega/m$ για τον OA.
$V_1 = 0,2\,V$.
$R_1 = 0,1\,\Omega$
$B = 2\,T$.

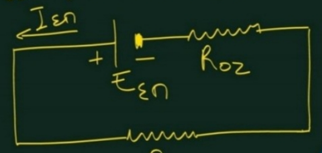




$F_{L_{ορ}} = B I_{επ} \alpha = 2 \cdot 2 \cdot 1 \Rightarrow F_{L_{ορ}} = 4\,N$

α) $R_{OZ} = R^* \cdot OZ = R^* \cdot \alpha = 0,4 \cdot 1 = 0,4\,\Omega$

β) Ισοδύναμο κύκλωμα.



$V_1 = I_{επ} R_1 \Rightarrow 0,2 = I_{επ} \cdot 0,1 \Rightarrow I_{επ} = 2\,A$.

$E_{επ} = I_{επ}(R_1 + R_{OZ}) \Rightarrow E_{επ} = 2 \cdot (0,1 + 0,4) \Rightarrow E_{επ} = 1\,Volt$.

$E_{επ} = \frac{1}{2} B \omega \alpha^2 \Rightarrow 1 = \frac{1}{2} \cdot 2 \cdot \omega \cdot 1^2 \Rightarrow$

$\omega = 1\,rad/sec$

γ) $\omega = 1\ rad/sec \Rightarrow$

$\frac{2\pi}{T} = 1 \Rightarrow T = 2\pi\ sec$

$Q = I_{\epsilon\pi}^2 (R_1 + R_{o2}) \cdot t \Rightarrow$

$Q = I_{\epsilon\pi}^2 (R_1 + R_{o2}) \cdot 10T \Rightarrow$

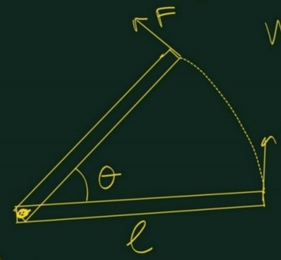
$Q = 2^2 \cdot (0,1+0,4) \cdot 10 \cdot 2\pi \Rightarrow$

$Q = 4 \cdot 0,5 \cdot 10 \cdot 2\pi \Rightarrow$

$Q = 40\pi\ Joule$

δ) Το έργο της σταθερής δύναμης F που ασκείται κάθετα στο άκρο A του μοχλού γίνεται θερμότητα στις αντιστάσεις.

Δηλαδή: $P_F = P_{R_{o2}}$ (εξίσωση ισχύων)



$W_F = F \cdot \ell \cdot \theta \Rightarrow$

$\frac{\Delta W_F}{\Delta t} = F \cdot \ell \cdot \frac{\Delta \theta}{\Delta t} = F \cdot \ell \cdot \omega$

$P_{R_{o2}} = I_{\epsilon\pi}^2 (R_1 + R_{o2})$

Άρα: $I_{\epsilon\pi}^2 (R_1 + R_{o2}) = F \cdot \ell \cdot \omega \Rightarrow 2^2 \cdot (0,1+0,4) = F \cdot 1,6 \cdot 1 \Rightarrow$

$2 = 1,6F \Rightarrow F = \frac{2}{1,6} \Rightarrow F = 1,25N$

Ασκ. 5.220 (Εξετάσεις 1993)

$L_1 = 1\,m$

$L_2 = 2\,m$

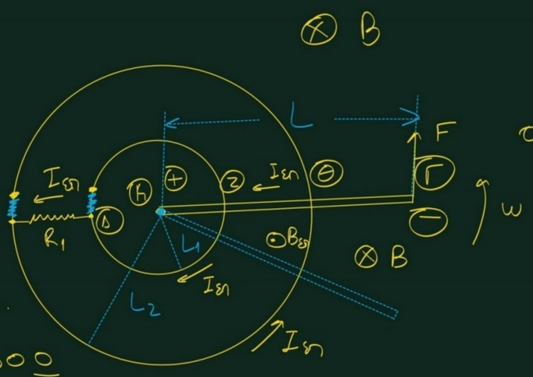
$B = 5\,T$

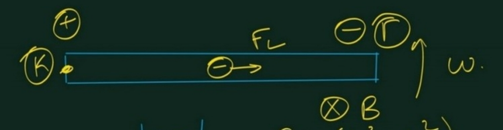
$R_1 = 600\,\Omega$

$L = 2,5\,m$

$\omega = 10\,rad/s$

$R_{K\Gamma} = 1000\,\Omega$





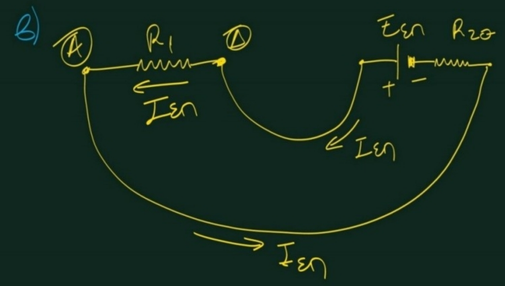
α) $E_{\varepsilon\pi} = \dfrac{|\Delta\Phi|}{\Delta t} = \dfrac{B\pi(L_2^2 - L_1^2)}{T} =$

$= \dfrac{B\pi(L_2^2 - L_1^2)}{\frac{2\pi}{\omega}} = \dfrac{1}{2} B\omega(L_2^2 - L_1^2)$

με $V_2 > V_\Theta$

Άρα: $E_{\varepsilon\pi} = \frac{1}{2} \cdot 5 \cdot 10 \cdot (4-1) = 25 \cdot 3 \Rightarrow E_{\varepsilon\pi} = 75\,Volt$

β)



Αφού το $I_{ε\eta}$ έχει φορά από το Δ στο Α τότε είναι:

$$I_{ε\eta}=\frac{E_{ε\eta}}{R_1+R_{2\theta}} \Rightarrow$$

$$I_{ε\eta}=\frac{75}{1000} \Rightarrow$$

$$I_{ε\eta}=0,075\,A.$$

$$R_{2\theta}=\frac{2\theta}{K\Gamma}\cdot R_{K\Gamma} \Rightarrow$$

$$R_{2\theta}=\frac{L_2-L_1}{L}\cdot R_{K\Gamma} \Rightarrow$$

$$R_{2\theta}=\frac{2-1}{2,5}\cdot 1000 \Rightarrow$$

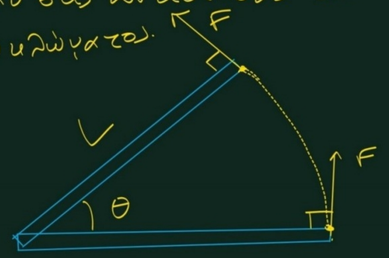
$$R_{2\theta}=400\,\Omega$$

γ) $V_\Delta - I_{ε\eta}\cdot R_1 = V_A \Rightarrow$

$V_A - V_\Delta = -I_{ε\eta}\cdot R_1 \Rightarrow$

$$V_{A\Delta}=-\frac{75}{1000}\cdot 600 \Rightarrow V_{A\Delta}=-45\,Volt$$

δ) Η ισχύς της δύναμης F είναι ίση με την ηλεκτρική ισχύ στις αντιστάσεις του κυκλώματος.



$W_F = F \cdot L \cdot \theta$

$\frac{\Delta W_F}{\Delta t} = F \cdot L \cdot \frac{\Delta \theta}{\Delta t} \rightarrow$

$P_F = F \cdot L \cdot \omega$

$P_F = P_{R_{ολ}} \Rightarrow$

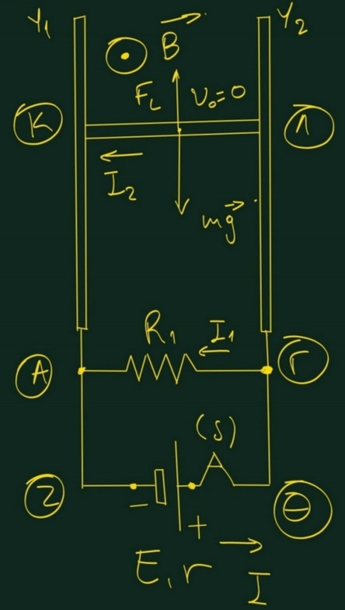
$F \cdot L \cdot \omega = I_{εν}^2 (R_{2ο} + R_1) \Rightarrow$

$F \cdot 2,5 \cdot 10 = \left(\frac{75}{1000}\right)^2 \cdot 1000 \Rightarrow$

$25F = \frac{75 \cdot 75}{1000} \Rightarrow$

$F = \frac{225}{1000} \Rightarrow F = 0,225\,N$

Ασκ. 5.215 (Μαθ)



$m = 0{,}5\,kg$

$\ell = 1\,m$

$R_{K\Lambda} = R$

ο αγωγός ΚΛ αρχικά ισορροπεί ($\upsilon_0 = 0$)

$\vec{g}$

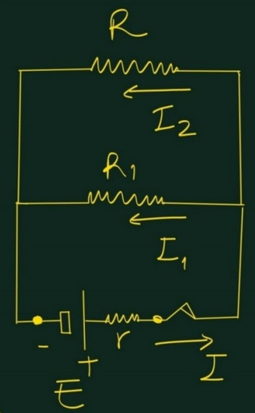
$E = 8\,Volt$

$r = 0{,}4\,\Omega$

$R_1 = 3\,\Omega$

$B = 1\,T$

α) Το $\vec{B}$ πρέπει να έχει φορά προς τα έξω επειδή η F_L στον αγωγό έχει φορά προς τα πάνω.



$F_L = mg \Rightarrow$

$BI_2\ell = mg \Rightarrow$

$1 \cdot I_2 \cdot 1 = 5 \Rightarrow$

$I_2 = 5\,A$

$I_2 \cdot R = I_1 R_1 \Rightarrow$

$5R = I_1 \cdot 3 \Rightarrow$

$I_1 = \frac{5R}{3}$.

$$I = I_1 + I_2 = \left(\frac{5R}{3} + 5\right)$$

$$I = \frac{E}{R_{\sigma\upsilon}} = \frac{E}{r + \frac{R_1 R}{R_1 + R}} = \frac{E(R_1 + R)}{r(R_1 + R) + R_1 R}$$

$$I = \frac{5R}{3} + 5$$

$$I = \frac{E(R_1+R)}{r(R_1+R)+R_1R_2} = \frac{8(3+R)}{0,45(3+R)+3R}$$

$$\frac{5R+15}{3} = \frac{8(R+3)}{0,45(3+R)+3R} \Rightarrow$$

$$\frac{5(\cancel{R+3})}{3} = \frac{8(\cancel{R+3})}{0,45(R+3)+3R} \Rightarrow$$

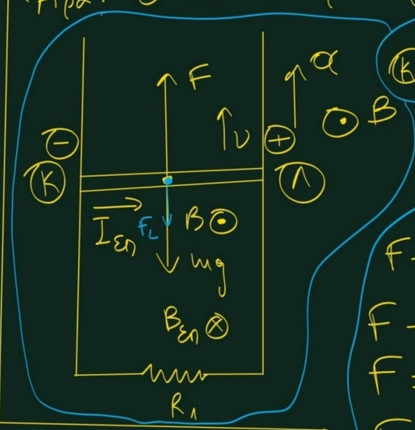
$$2,25\cdot(R+3)+15R = 24 \Rightarrow$$

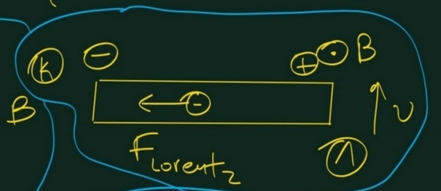
$$17,25R = 24-6,75 \Rightarrow 17,25R = 17,25 \Rightarrow R = 1\,\Omega$$

β) i) $\alpha = 2-0,5v$ (SI)

Η ταχύτητα γίνεται οριακή και σταθερή όταν γίνει $\alpha = 0$

Άρα: $0 = 2-0,5v_{op} \Rightarrow v_{op} = 4\,m/s$ (προς τα πάνω)





$$F - mg = ma \Rightarrow$$

$$F - 5 - F_L = 0,5(2-0,5v) \Rightarrow$$

$$F = 5 + F_L + 1 - 0,25v \Rightarrow$$

$$F = 6 + F_L - 0,25v \quad (SI)$$

$$F_L = 0,25v$$

$$F = 6\,N$$

$P_F = \vec{F} \cdot \vec{v} = F \cdot v$

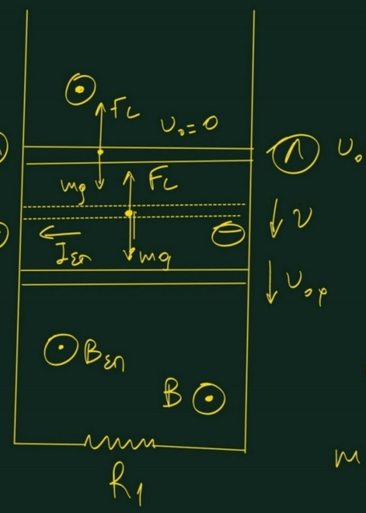
αφού $\vec{F} \uparrow\uparrow \vec{v}$.

Άρα: $P_F = (6 - 0{,}25v) \cdot v$

Άρα γ.α $v = 1\,m/s$ έχουμε:

$P_F = 6 - 0{,}25 \Rightarrow P_F = \frac{5{,}75}{6}\,Watt$.

γ) i)



Τη στιγμή $t = 0$ ο αγωγός διαρρέεται από το ρεύμα I_2

$F_L = B I_2 \ell = 5N$

$W = mg = 5N$

$mg - F_L = ma \Rightarrow$

$mg - B I_{επ} \ell = ma \Rightarrow$

$mg - B \cdot \frac{E_{επ}}{R_1 + R} \ell = ma \Rightarrow$

$mg - \frac{B^2 \ell^2 v}{R_1 + R} = ma \Rightarrow$

$5 - \frac{v}{4} = 0{,}5a \Rightarrow 0{,}5a = 5 - 0{,}25v \Rightarrow$

$a = 10 - 0{,}5v\,(SI)$

$a(t=0) \Rightarrow v = v_{op} = 20\,m/s$

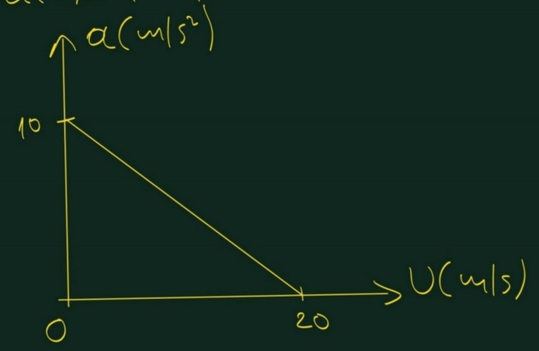
προς τα κάτω

$a = 10 - 0{,}5v$

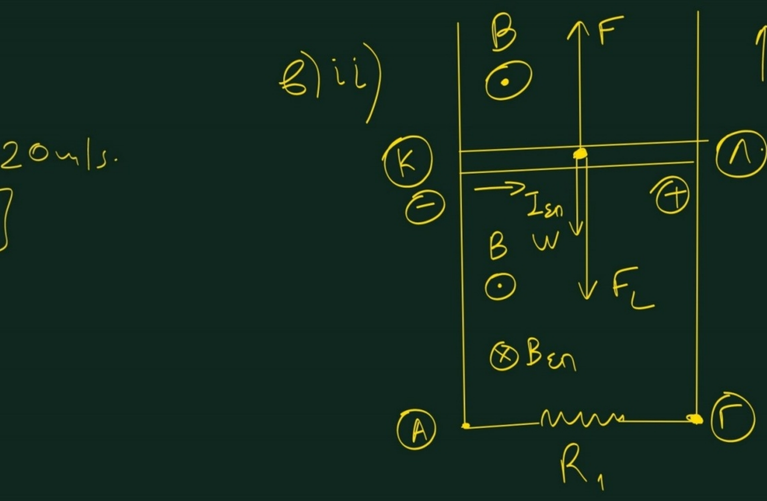
$a = 0 \Rightarrow v = v_{op} = 20\,m/s$.

$A_C \propto v \in [0, 20]$

$a(0) = 10\,m/s^2$



B) i i)



$\uparrow a \uparrow v$.

$\uparrow (+)$

$F - F_L - mg = ma$

$F_L = BI_{επ}\ell = B\dfrac{Bv\ell}{R_1+R}\ell =$

$= 1 \cdot \dfrac{1 \cdot v \cdot 1}{4} \cdot 1 = \dfrac{v}{4} \Rightarrow$

$F_L = 0{,}25v\,(SI)$

Αφ: $F - F_L - mg = ma \Rightarrow F - 0{,}25v - 0{,}5 \cdot 10 = 0{,}5(2 - 0{,}5v)$

$\Rightarrow F - 0{,}25v - 5 = 1 - 0{,}25v \Rightarrow F = 6N$ (διπλό)

$P_F = F \cdot v_1 = 6 \cdot 1 \Rightarrow \boxed{P_F = 6\,Watt}$

Αυτεπαγωγή πηνίου.

$$E_{αυτ} = -L\frac{\Delta i}{\Delta t}$$

Για ομογενοειδές:

$$B = \mu_0 n i$$

$$E_{επ} = -N\frac{\Delta \Phi}{\Delta t} = -N\cdot \mu_0 n \cdot \frac{\Delta i}{\Delta t}\cdot S$$

$$E_{επ} = E_{αυτ} \Rightarrow -L\frac{\Delta i}{\Delta t} = -N\mu_0 n \frac{\Delta i \cdot S}{\Delta t} \Rightarrow$$

$$L = N\mu_0 n = \mu_0 \frac{N\cdot S}{\ell}\cdot \ell \Rightarrow \boxed{L = \mu_0 \frac{N^2}{\ell}\cdot S}$$ ← μενό

$$-L\cdot\frac{\Delta i}{\Delta t} = iV = \frac{\Delta q}{\Delta t}\ (V)$$

Αν στο εσωτερικό του πηνίου υπάρχει υλικό μαγνητικής διαπερατότητας μ θα έχουμε:

$$B = \mu\mu_0 n i \text{ και}$$

$$L = \mu\mu_0 \frac{N^2}{\ell}\cdot S.$$

Ασκ. 5.66 σελ. 229.

$l = 0{,}5\ m$

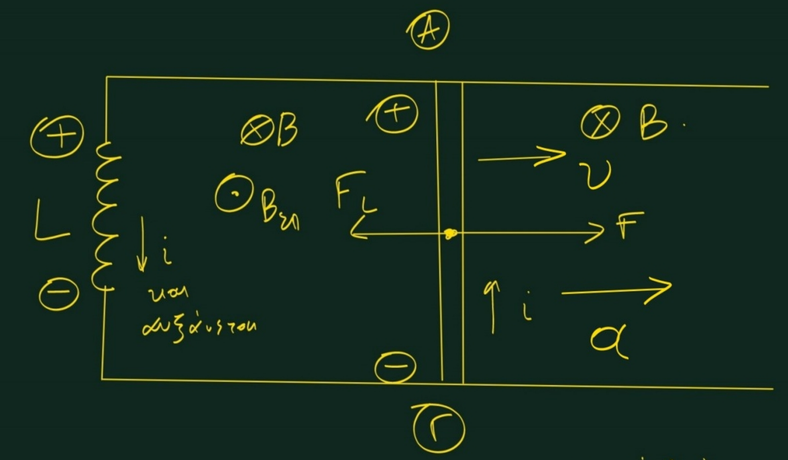
$L = 25 \cdot 10^{-3}$ Henry (Σωληνοειδές)

$m = 150\ g = 0{,}15\ Kg$

$R = 5 \cdot 10^{-2}\ \Omega$

$B = 0{,}1\ T$

Αγωγός δύναμη F τέτοια ώστε: $i = 2t + 3\ (SI)$



α) $E_{αυτ} = -L\dfrac{\Delta i}{\Delta t} = -L \cdot \dfrac{i(t) - i(0)}{t - 0} =$

$= -L \cdot \dfrac{2t + 3 - (2 \cdot 0 + 3)}{t} = -2L = -2 \cdot 25 \cdot 10^{-3} \Rightarrow$

$E_{αυτ} = -50 \cdot 10^{-3} \Rightarrow |E_{αυτ}| = 0{,}05\ Volt$

β) $E_{επ} - iR = |E_{ωζ}| \Rightarrow$

$$E_{επ} - iR = L \cdot \frac{\Delta i}{\Delta t} \Rightarrow$$

$$Bvl - iR = L \cdot \frac{\Delta i}{\Delta t} \Rightarrow$$

$$0,1 \cdot v \cdot 0,5 - i \cdot 5 \cdot 10^{-2} = 25 \cdot 10^{-3} \cdot \frac{\Delta i}{\Delta t} \Rightarrow$$

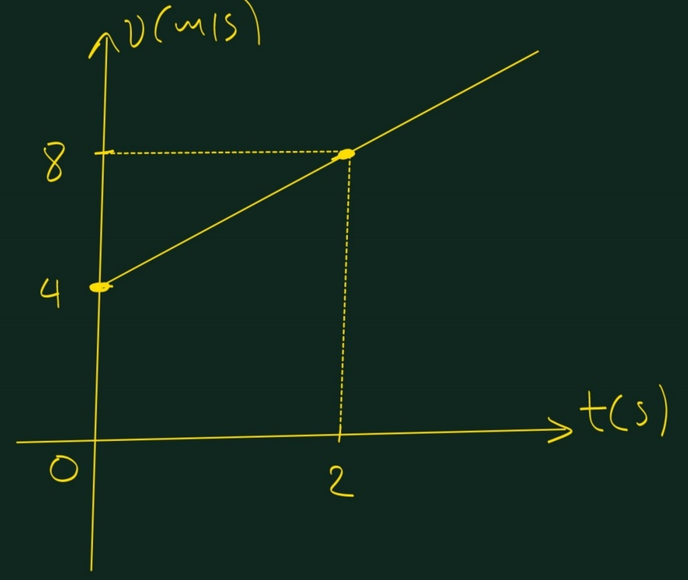
$$5 \cdot 10^{-2} \cdot v - 5 \cdot 10^{-2} i = 2,5 \cdot 10^{-2} \cdot \frac{\Delta i}{\Delta t} \Rightarrow$$

$$2v - 2i = \frac{\Delta i}{\Delta t} \Rightarrow 2v - 2 \cdot (2t + 3) = 2 \Rightarrow$$

$$v - 2t - 3 = 1 \Rightarrow v = 4 + 2t \ (SI)$$

$v(0) = 4 \ m/s$.

$v(2) = 8 \ m/s$.



γ) $v(t) = 2t + 4$

$$\frac{\Delta v}{\Delta t} = \frac{v(t) - v(0)}{t - 0} =$$

$$= \frac{2t + 4 - (2 \cdot 0 + 4)}{t} =$$

$$= \frac{2t}{t} = 2 \, m/s^2 \Rightarrow$$

$\alpha = 2 \, m/s^2$ (σταθερή)

δ) $\Sigma F = ma \Rightarrow F - F_L = ma \Rightarrow$

$F - Bil = ma \Rightarrow$

$F - 0,1(2t+3) \cdot 0,5 = 0,15 \cdot 2 \Rightarrow$

$F - 0,1t - 0,15 = 0,3 \Rightarrow$

$F = 0,1t + 0,45$ (SI)

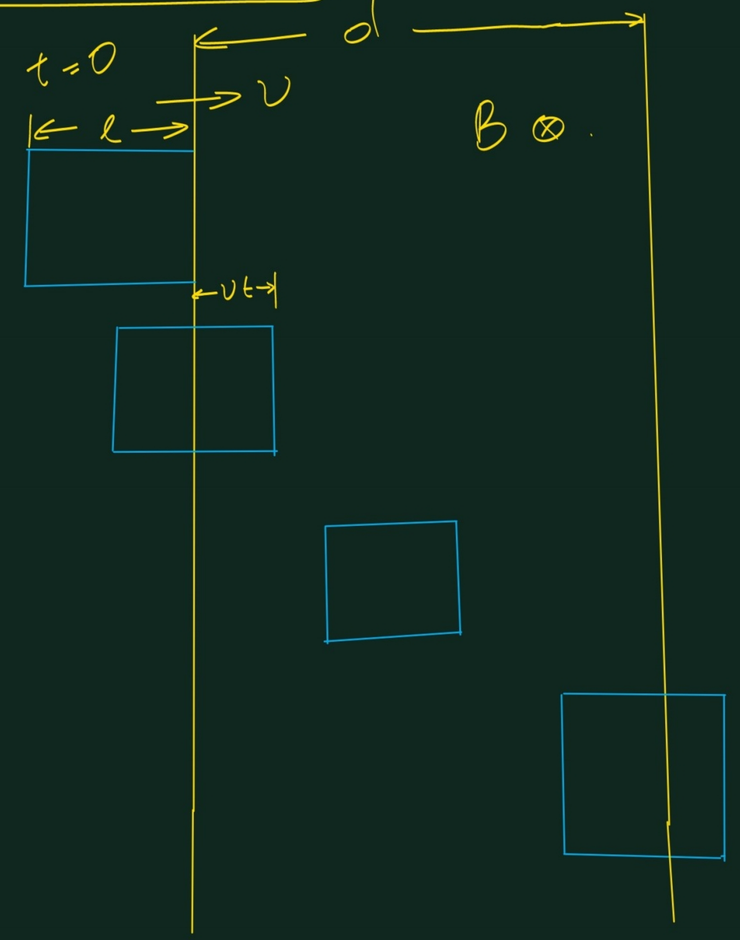
$P_F = \vec{F} \cdot \vec{v} = F \cdot v = (0,1t + 0,45) \cdot (2t + 4)$

Άρα: $P_F(4) = (0,1 \cdot 4 + 0,45) \cdot (8 + 4) =$

$= 0,85 \cdot 12 = 0,8 \cdot 12 + 0,05 \cdot 12 =$

$= 9,6 + 0,6 = 10,2$ Watt

Ασκ. 5.67 σελ. 226.)



α) $t=0$ εισαγωγή.

$t = t_1 = \frac{\ell}{\upsilon}$ (χρόνος εισόδου)

$t_2 = \frac{d-\ell}{\upsilon}$ (χρόνος παραμονής)

$t_3 = \frac{\ell}{\upsilon}$ (χρόνος εξόδου)

$\Phi_{max} = B\ell^2 = 0,4 \cdot 0,25^2 = 0,4 \cdot 0,25 \cdot 0,25 =$

$= 0,1 \cdot 0,25 = 0,025 =$

$= 2,5 \cdot 10^{-2}$ Wb.

$t_1 = \frac{0,25}{0,05} = 5$ sec

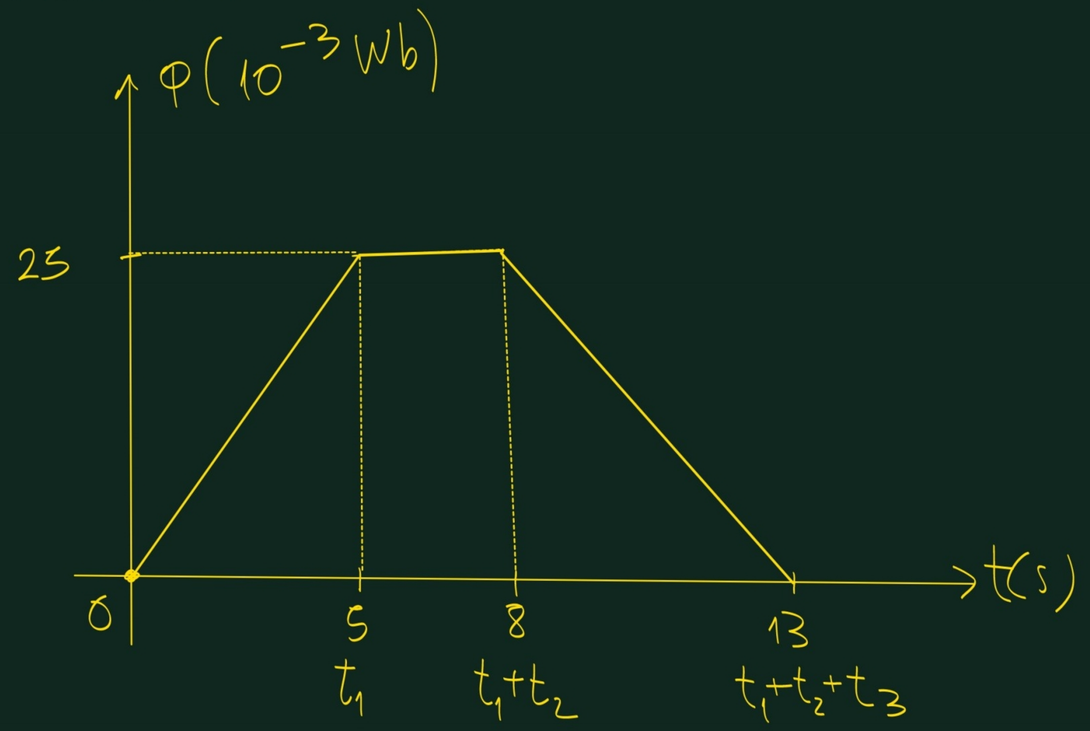
$t_2 = \frac{0,4-0,25}{0,05} = 3$ sec

$t_3 = 5$ sec.

$\Phi = B l \cdot vt = 0{,}4 \cdot 0{,}25 \cdot 0{,}05 \cdot t = 0{,}1 \cdot 0{,}05t \Rightarrow$

$\Phi(t) = 5 \cdot 10^{-3} t$ (ελάσσον)

$\Phi_{max} = 25 \cdot 10^{-3}$ Wb.



$\Phi = \lambda t + b$

$\Phi(8) = 25 \Rightarrow 8\lambda + b = 25$

$\Phi(13) = 0 \Rightarrow 13\lambda + b = 0 \Rightarrow$

$b = -13\lambda$.

$8\lambda - 13\lambda = 25 \Rightarrow \lambda = -5$

$b = +65$.

$\Phi(t) = -5t + 65$ (mWb)

$$\Phi(t) = \begin{cases} 5t, & 0 \le t \le 5\,\text{sec} \\ 25, & 5 < t \le 8\,\text{sec} \\ -5t+65, & 8 < t \le 13\,\text{sec} \end{cases} \quad (\text{mWb})$$

Β) $E_{\varepsilon\eta} = -N \cdot \frac{\Delta\Phi}{\Delta t}$

$N = 1$

Από $0 \to 5$ sec.

$E_{\varepsilon\eta} = -1 \cdot \frac{\Phi(5) - \Phi(0)}{5 - 0} \Rightarrow$

$E_{\varepsilon\eta} = -\frac{25 \cdot 10^{-3} - 0}{5} \Rightarrow$

$E_{\varepsilon\eta} = -5 \cdot 10^{-3}$ Volt

Από $5 \to 8$ sec:

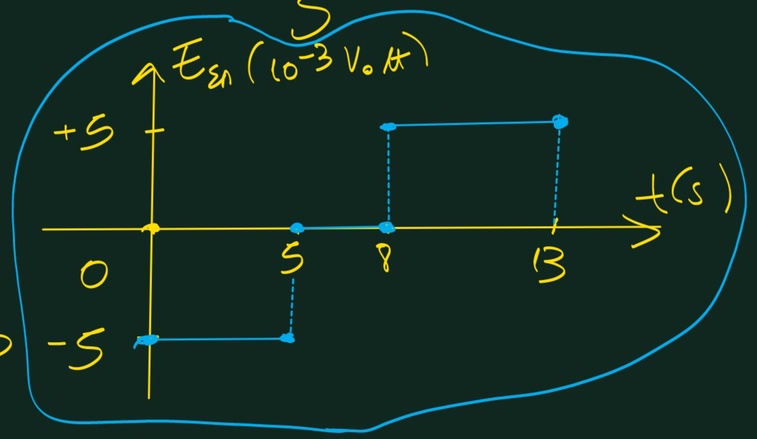
$E_{\varepsilon\eta} = -N \cdot \frac{\Delta\Phi}{\Delta t} = -1 \cdot \frac{\Phi(8) - \Phi(5)}{8 - 5} = -\frac{25 \cdot 10^{-3} - 25 \cdot 10^{-3}}{3} = 0$ Volt

Από $8 \to 13$ sec.

$E_{\varepsilon\eta} = -N \cdot \frac{\Delta\Phi}{\Delta t} = -1 \cdot \frac{\Phi(13) - \Phi(8)}{13 - 8} = -\frac{0 - 25 \cdot 10^{-3}}{5} \Rightarrow$

$E_{\varepsilon\eta} = 5 \cdot 10^{-3}$ Volt

Άρα: $E_{\varepsilon\eta} = \begin{cases} -5 \cdot 10^{-3}, & 0 \le t \le 5 \\ 0, & 5 < t \le 8 \\ 5 \cdot 10^{-3}, & 8 < t \le 13 \end{cases}$ (SI)



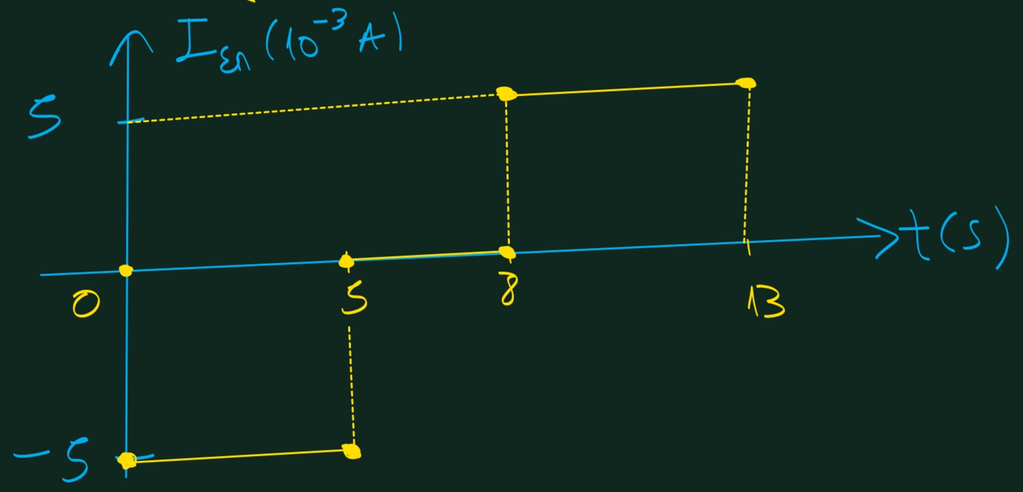
γ) $R_{πλαισίου} = R^* \cdot 4l = 1 \cdot 4 \cdot 0{,}25 = 1\,\Omega$.

$I_{επ} = E_{επ} / R_{πλ}$.

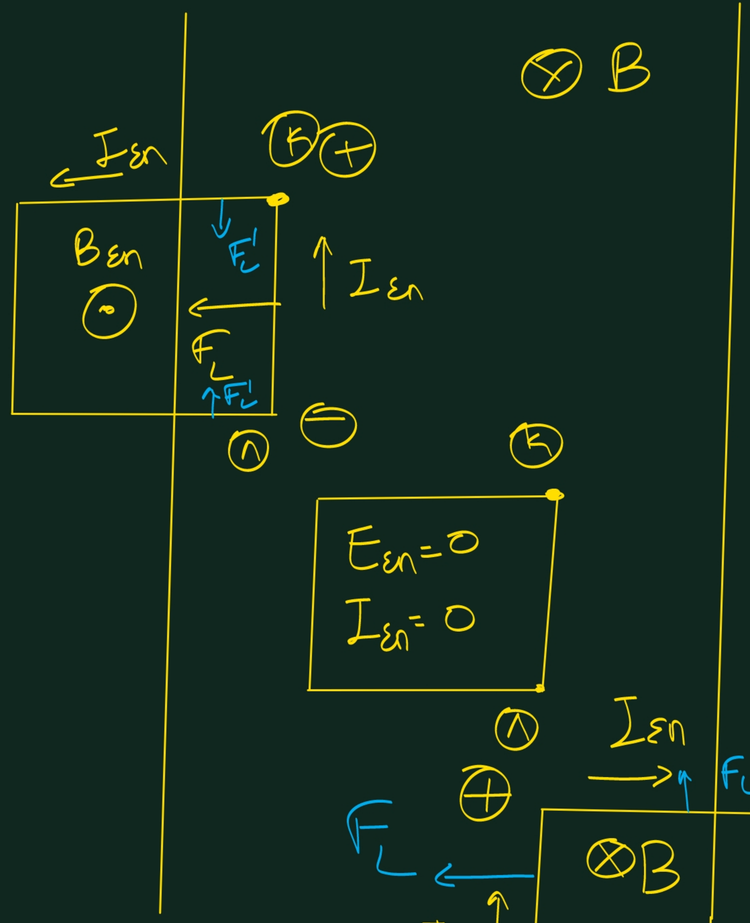
$$I_{επ} = \begin{cases} -5 \cdot 10^{-3}, & 0 \le t \le 5 \\ 0, & 5 < t \le 8 \\ 5 \cdot 10^{-3}, & 8 < t \le 13 \end{cases}$$

Το συνολικό φορτίο που διέρχεται από μία διατομή του πλαισίου κατά την είσοδο και την έξοδο είναι μηδέν.

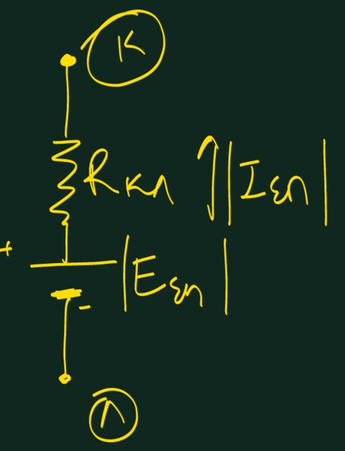
$$Q_{ολ} = \sum_{0}^{13} I_{επ} \cdot \Delta t = 0.$$



δ)



Κατά την είσοδο:



$V_\Lambda + |E_{\varepsilon\pi}| - |I_{\varepsilon\pi}| R_{K\Lambda} = V_K \Rightarrow$

$V_K - V_\Lambda = |E_{\varepsilon\pi}| - |I_{\varepsilon\pi}| \cdot R_{K\Lambda} \Rightarrow$

$V_{K\Lambda} = 5 \cdot 10^{-3} - 5 \cdot 10^{-3} \cdot 0{,}25 \Rightarrow$

$V_{K\Lambda} = 3{,}75 \cdot 10^{-3}$ Volt.

$R_{K\Lambda} = R^* \cdot \ell = 0{,}25\,\Omega$

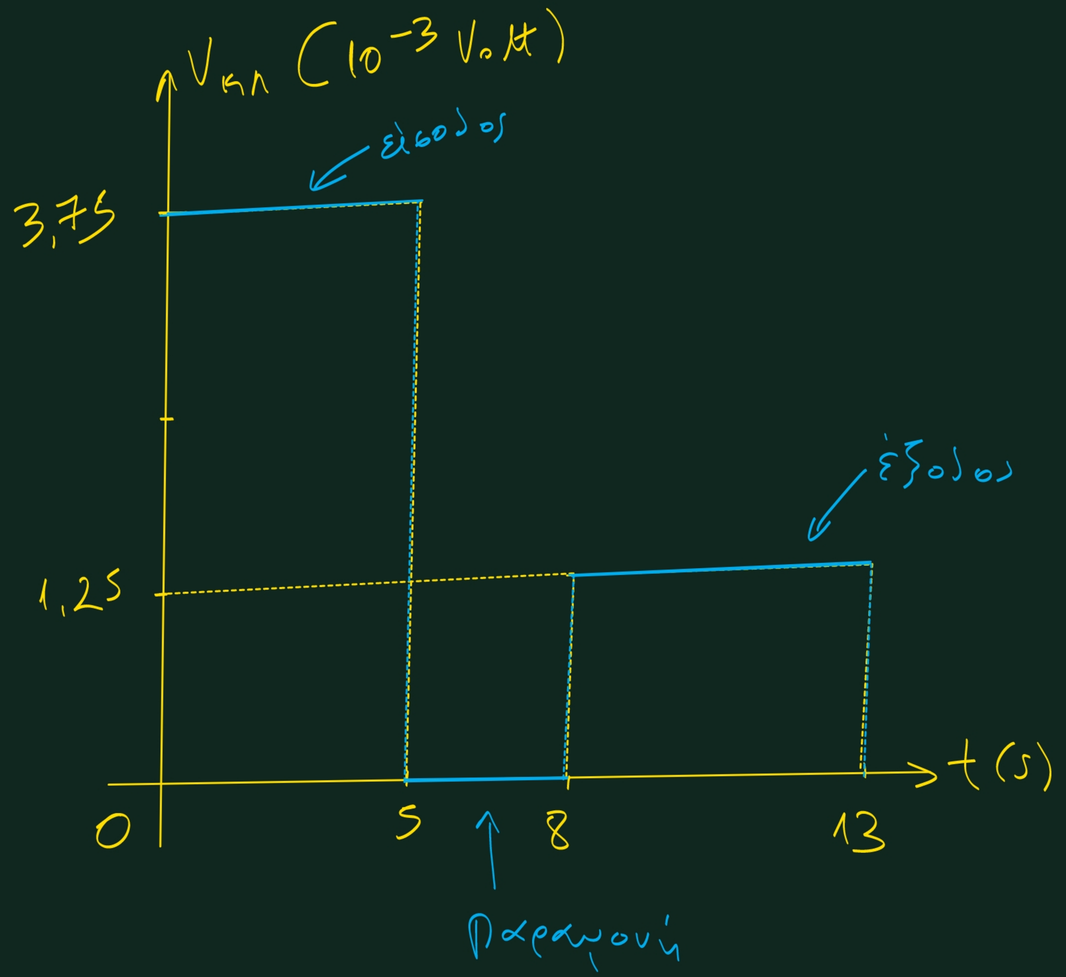
Κατά την έξοδο:

$V_K - I_{\varepsilon\pi} \cdot R_{K\Lambda} = V_\Lambda \Rightarrow$

$V_K - V_\Lambda = I_{\varepsilon\pi} \cdot R_{K\Lambda} \Rightarrow$

$V_{K\Lambda} = 5 \cdot 10^{-3} \cdot 0{,}25 \Rightarrow$

$V_{K\Lambda} = 1{,}25 \cdot 10^{-3}$ Volt


$V_{\text{κλ}}$ (10^{-3} Volt)
εισόδου
3,75
1,25
εξόδου
t (s)
0
5
8
13
παραμονή