Abu. 5.219.

$l = 1{,}6\,m$

$r^* = 0{,}4\,\Omega/m$

$a = 1\,m$

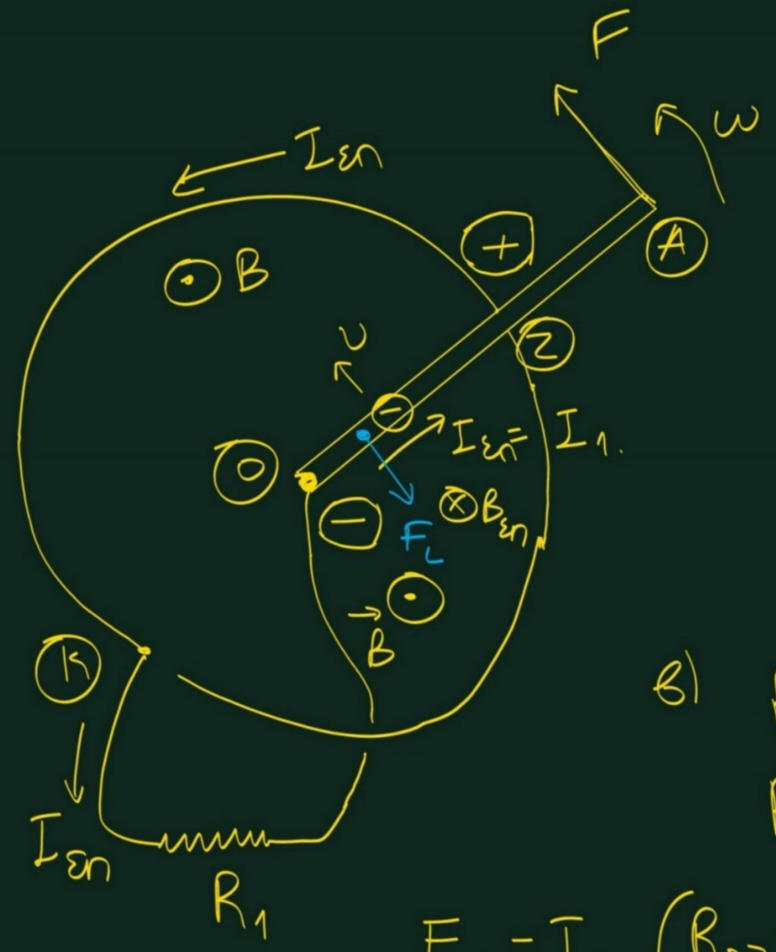
$R_1 = 0{,}1\,\Omega$

$OZ = a$

$OA = l$

$V_1 = 0{,}2\,Volt$

$B = 2T$



a) $V_1 = I_1 \cdot R_1 \Rightarrow$

$0{,}2 = I_1 \cdot 0{,}1 \Rightarrow I_1 = 2\,A.$

$F_L = B \cdot OZ \cdot I_1 \Rightarrow$

$F_L = B\,a \cdot I_1 \Rightarrow$

$F_L = 2 \cdot 1 \cdot 2 \Rightarrow F_L = 4\,N$

$I_{en} = I_1 = 2\,A.$

b) $R_{OZ} = r^* \cdot OZ = 0{,}4 \cdot 1 = 0{,}4\,\Omega$

$R_1 = 0{,}1\,\Omega$

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

$E_{en} = 1\,Volt$

$$E_{\varepsilon\eta} = \frac{1}{2} B\omega \cdot OZ^2 = \frac{1}{2} B\omega a^2 \Rightarrow$$

$$1 = \frac{1}{2} \cdot 2 \cdot \omega \cdot 1 \Rightarrow \omega = 1\,rad/sec.$$

γ) $Q_{R_{o\lambda}} = I_{\varepsilon\eta}^2 (R_1 + R_{o2}) \cdot 10T =$

$$= I_{\varepsilon\eta}^2 \cdot (R_1 + R_{o2}) \cdot 10 \cdot \frac{2\pi}{\omega} \Rightarrow$$

$$= 2^2 \cdot 0{,}5 \cdot 10 \cdot \frac{2\pi}{1} =$$

$$= 20 \cdot 2\pi \Rightarrow Q_{R_{o\lambda}} = 40\pi \text{ Joule}$$

δ) $W_F = Q_{R_{o\lambda}}$ (από διατήρηση ενέργειας) ← ΘΕ για περιστροφή.

Άρα: $F \cdot 2\pi l = I_{\varepsilon\eta}^2 (R_1 + R_{o2}) \cdot T \Rightarrow$

$$F \cdot 2\pi \cdot 1{,}6 = 4 \cdot 0{,}5 \cdot \frac{2\pi}{1} \Rightarrow$$

$$F = \frac{2\pi \cdot 2}{2\pi \cdot 1{,}6} \Rightarrow$$

$$F = \frac{2}{1{,}6} \Rightarrow F = \frac{5}{4} \Rightarrow$$

$$F = 1{,}25\,N$$

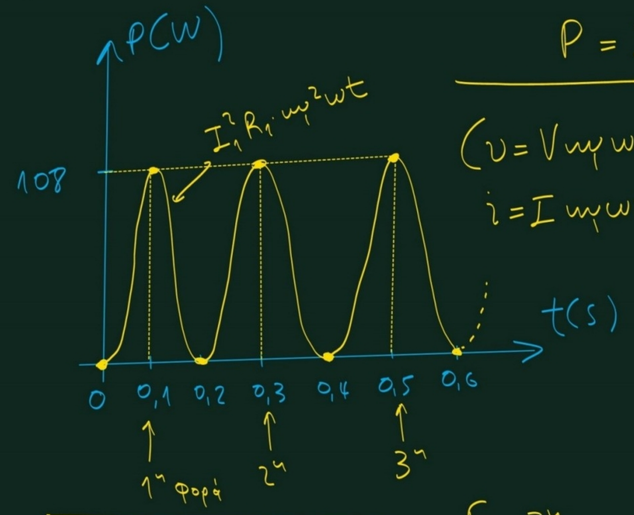
Ασκ. 6.99

α) $P = vi \Rightarrow P = i^2 R_1 \Rightarrow$

$$P = I^2 R_1 \cdot \eta\mu^2 \omega t$$

$(v = V\eta\mu\omega t$

$i = I\eta\mu\omega t)$



Αρα: $P_{max} = I^2 R_1 \Rightarrow$

$108 = I^2 \cdot 12 \Rightarrow$

$I^2 = 9 \Rightarrow I = 3A.$

$V = I \cdot R_1 = 3 \cdot 12 = 36$ Volt

$T = 0,4$ sec $\Rightarrow$

$\frac{2\pi}{\omega} = 0,4 \Rightarrow \omega = \frac{2\pi}{0,4} \Rightarrow$

$\omega = 5\pi$ rad/sec

Συνεπώς: $i = I \cdot \eta\mu\omega t \Rightarrow i = 3\eta\mu(5\pi t)$ (SI)

και $v = V \cdot \eta\mu\omega t \Rightarrow v = 36\eta\mu(5\pi t)$ (SI)

β) Για 3η φορά: $t_1 = 0,1 + (3-1) \cdot 0,2$

$$\boxed{t_1 = 0,1 + 9 \cdot 0,2 = 0,1 + (10-1) \cdot 0,2 = 0,1 + 1,8 = 1,9 \text{ sec}}$$

$$Q = I_{\varepsilon\nu}^2 R_1 \cdot t_1 \Rightarrow$$

$$Q = \frac{1}{2} I^2 R_1 t_1 \Rightarrow$$

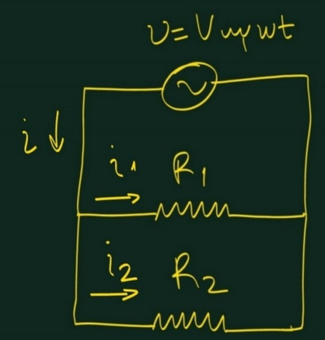
$$Q = \frac{1}{2} \cdot 9 \cdot 12 \cdot 1{,}9 \Rightarrow$$

$$Q = 54 \cdot 1{,}9 =$$

$$= 54 \cdot 2 - 54 \cdot 0{,}1$$

$$= 108 - 5{,}4 = 102{,}6 \text{ Joule}$$

γ) i)



$R_1 = 12\,\Omega$

$R_2 = 4\,\Omega$

$$\upsilon = 36\,\eta\mu(5\pi t)$$

$$i_1 = \frac{\upsilon}{R_1} = 3\,\eta\mu(5\pi t)$$

Apα: $I_1 = 3A$

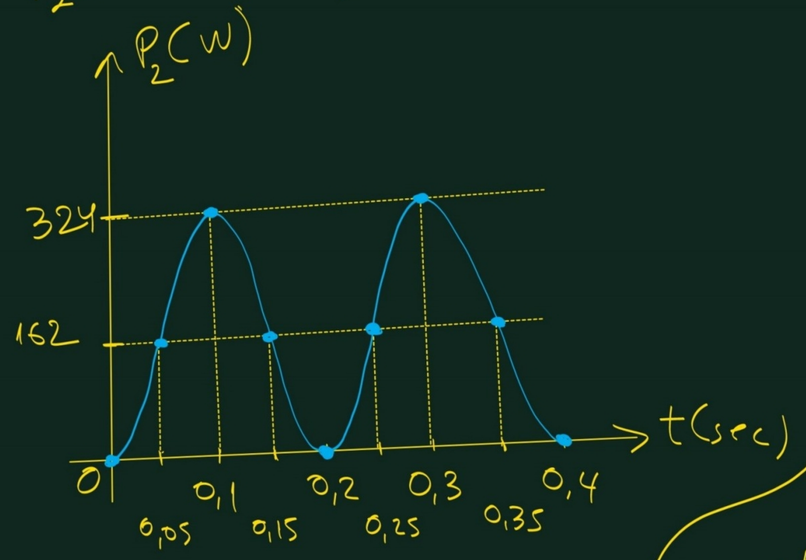
$$I_{\varepsilon\nu,1} = \frac{I_1}{\sqrt{2}} = \frac{3}{\sqrt{2}} = \frac{3\sqrt{2}}{2} A$$

ii) $i_2 = \frac{\upsilon}{R_2}$

$$P_2 = i_2^2 R_2 = \frac{\upsilon^2}{R_2} = \frac{36^2}{4}\eta\mu^2(5\pi t) = 324\,\eta\mu^2(5\pi t)$$

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{5\pi} = 0{,}4 \text{ sec}$$

$P_2(t) = 324\,\eta\mu^2(5\pi t)$ (SI) $T = 0{,}4\,sec$



iii) $R_{ισ} = \frac{R_1 R_2}{R_1 + R_2} = \frac{12 \cdot 4}{12+4} = \frac{12 \cdot 4}{16} = 3\,\Omega$

$i = i_1 + i_2 = \left(\frac{U}{R_1} + \frac{U}{R_2}\right)$

$= \frac{U}{R_{ισ}} = \frac{V}{R_{ισ}}\,\eta\mu(\omega t) \Rightarrow$

$i = \frac{36}{3}\,\eta\mu(5\pi t) = 12\,\eta\mu(5\pi t)$ (SI)

Αρα: $I = 12\,A$ $\quad I_{ενν} = \frac{I}{\sqrt{2}} = \frac{12}{\sqrt{2}} = 6\sqrt{2}\,A$

$\bar{P} = I^2 \cdot R_{ισ} = (6\sqrt{2})^2 \cdot 3 = 36 \cdot 6 = 216\,Watt$

Ασκ. 5.66 σελ. 229.

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

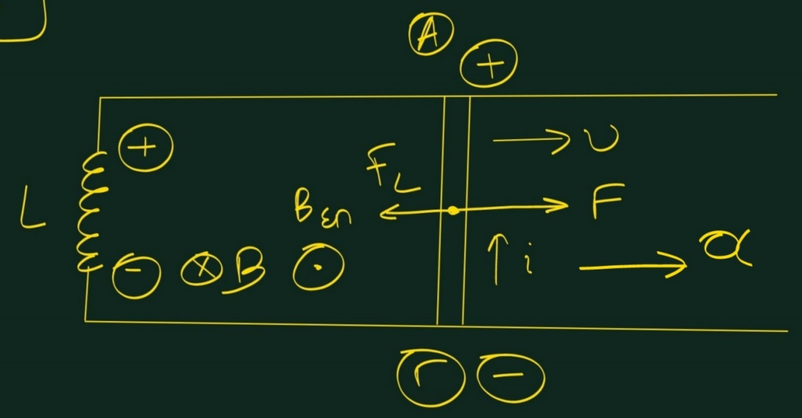
$L = 25 \cdot 10^{-3}$ Henry

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

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

$B = 0{,}1\,T$

$i = 2t + 3$ (SI)



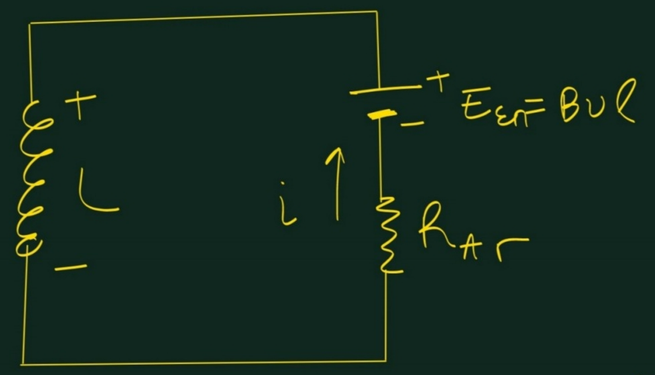
α) Κατ' απόλυτη τιμή έχουμε:

$$|E_{\alpha\nu\tau}| = L\frac{|\Delta i|}{\Delta t} = L\frac{|i(t) - i(0)|}{t - 0} = 25 \cdot 10^{-3}\,\frac{(2t + 3 - (2 \cdot 0 + 3))}{t}$$

$$= 25 \cdot 10^{-3} \cdot 2 = 50 \cdot 10^{-3} = 5 \cdot 10^{-2}\ \text{Volt}$$

Άρα: $|E_{\alpha\nu\tau}| = 0{,}05$ Volt με την πολικότητα που φαίνεται στο σχήμα

β) Ισοδύναμο κύκλωμα.



$$i(t) = 2t + 3$$

$$\frac{\Delta i}{\Delta t} = \frac{di}{dt} = \frac{i(t) - i(0)}{t - 0} =$$

$$= \frac{2t + 3 - (2 \cdot 0 + 3)}{t - 0} = \frac{2t}{t} = 2\,A/s.$$

Από το 2ο Κανόνα Kirchoff (KVL)

Έχουμε: $E_{επ} = iR_{Αγ} + V_L \Rightarrow Bυl = i(t) \cdot R_{Αγ} + |E_{αυτ}| \Rightarrow$

$$0{,}1 \cdot υ \cdot 0{,}5 = (2t+3) \cdot 5 \cdot 10^{-2} + 5 \cdot 10^{-2} \Rightarrow$$

$$υ \cdot 5 \cdot 10^{-2} = (2t+3) \cdot 5 \cdot 10^{-2} + 5 \cdot 10^{-2} \Rightarrow υ(t) = 2t + 3 + 1 \Rightarrow υ(t) = 2t + 4 \ (SI)$$

γ) $v(t) = 2t + 4$ (SI)

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

$$\frac{\Delta v}{\Delta t} = 2 \ m/s^2$$

$$P_F = F \cdot v = 0{,}1(t + 4{,}5) \cdot (2t + 4) \Rightarrow$$

$$P_F(4) = 0{,}1 \cdot 8{,}5 \cdot 12 \Rightarrow$$

$$P_F(4) = 0{,}1 \cdot 102 \Rightarrow$$

$$P_F = 10{,}2 \ Watt$$

δ) Η κίνηση είναι ομαλά επιταχυνόμενη.

$$F - F_L = ma \Rightarrow$$

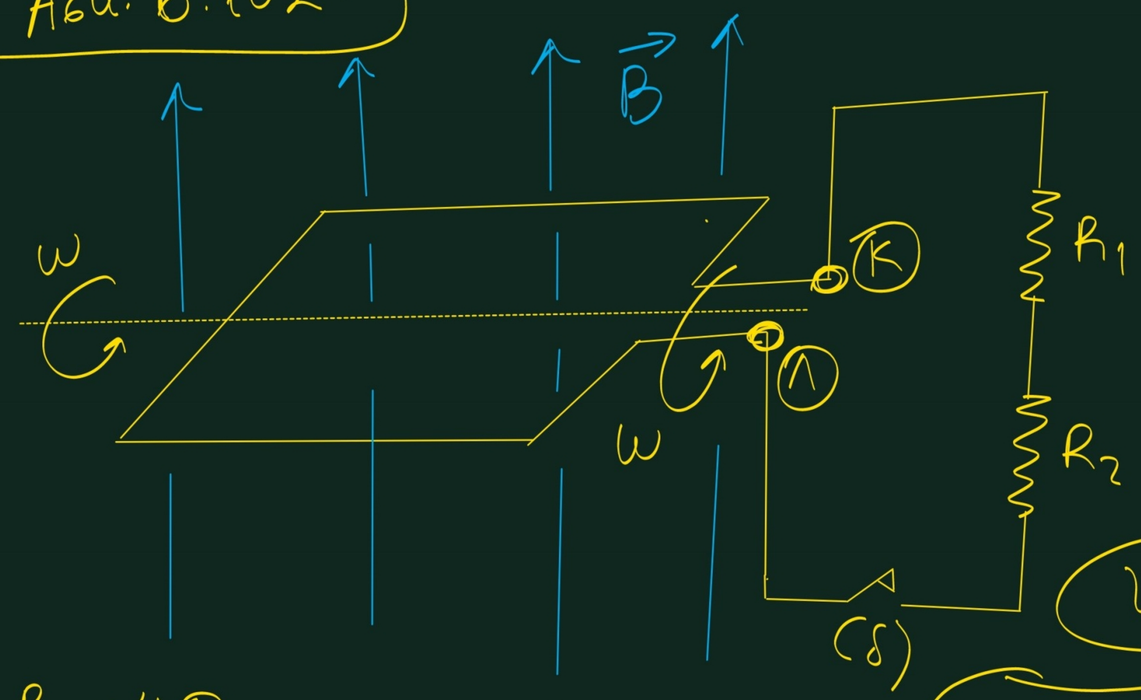
$$F - Bil = ma \Rightarrow$$

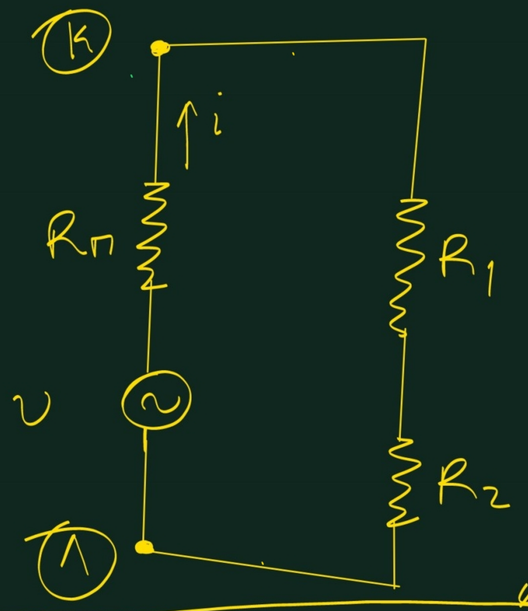
$$F - 0{,}1(2t + 3) \cdot 0{,}5 = 0{,}15 \cdot 2 \Rightarrow$$

$$\frac{F}{0{,}1} - \underbrace{\cancel{0{,}1}}_{1}(2t + 3) \cdot 0{,}5 = \underbrace{\cancel{0{,}3}}_{3} \Rightarrow 10F - (2t + 3) \cdot 0{,}5 = 3 \Rightarrow$$

$$10F = t + 1{,}5 + 3 \Rightarrow F = 0{,}1(t + 4{,}5)$$

Ασκ. 6.102.





πολική τάση

$$\upsilon_{K\Lambda} = \upsilon_\pi = \upsilon - i R_\pi$$

$R_\pi = 4\,\Omega$

$\omega = 10\pi$ r/s

$V = 30$ Volt

$V_\pi = 18$ Volt

$P_1 = 18$ W

α) $R_{ολ} = R_\pi + R_1 + R_2$

$(V = NBA\omega)$

$\upsilon = V \cdot \eta\mu\omega t$

$i = I \cdot \eta\mu\omega t$

$\upsilon_\pi = V_\pi \cdot \eta\mu\omega t$

$$v_n = v - iR_n \Rightarrow$$

$$V_n \cdot \sin\omega t = V \cdot \sin\omega t - IR_n \cdot \sin\omega t \Rightarrow$$

$$V_n = V - I \cdot R_n \Rightarrow$$

$$18 = 30 - I \cdot 4 \Rightarrow$$

$$4I = 12 \Rightarrow I = 3A.$$

$$R_{ol} = \frac{V}{I} = \frac{30}{3} = 10\,\Omega$$

$$v_n = i(R_1 + R_2) = v_{KA}$$

Αρα: $v - iR_n = i(R_1 + R_2) \Rightarrow$

$$v = i(R_1 + R_2 + R_n) \Rightarrow$$

$$V \sin\omega t = I \sin\omega t (R_1 + R_2 + R_n) \Rightarrow$$

$$\frac{V}{I} = R_1 + R_2 + R_n = R_{ol}$$

β) $\bar{P}_1 = \frac{V_{\varepsilon\nu,1}^2}{R_1} = \frac{I_{\varepsilon\nu}^2 \cdot R_1^2}{R_1} = \frac{1}{2} I^2 R_1 \Rightarrow 18 = \frac{1}{2} \cdot 9 \cdot R_1 \Rightarrow R_1 = 4\,\Omega$

$$R_{ol} = R_1 + R_2 + R_n \Rightarrow 10 = 4 + R_2 + 4 \Rightarrow R_2 = 2\,\Omega$$

(αφού $I_{\varepsilon\nu} = \frac{I}{\sqrt{2}}$)

Αρα: $\bar{P}_2 = \frac{1}{2} I^2 R_2 = \frac{1}{2} \cdot 9 \cdot 2 \Rightarrow \bar{P}_2 = 9$ Watt

γ) Θερμότητα στο πλαίσιο:

$$Q_n = I_{\varepsilon\varphi}^2 \cdot R_n \cdot t$$

$$t = 50T = 50 \cdot \frac{2\pi}{\omega} =$$

$$= 50 \cdot \frac{2\pi}{10\pi} \Rightarrow t = 10\,sec$$

Άρα: $Q_n = \frac{1}{2} I^2 \cdot R_n \cdot t \Rightarrow$

$$Q_n = \frac{1}{2} \cdot 9 \cdot 4 \cdot 10 \Rightarrow$$

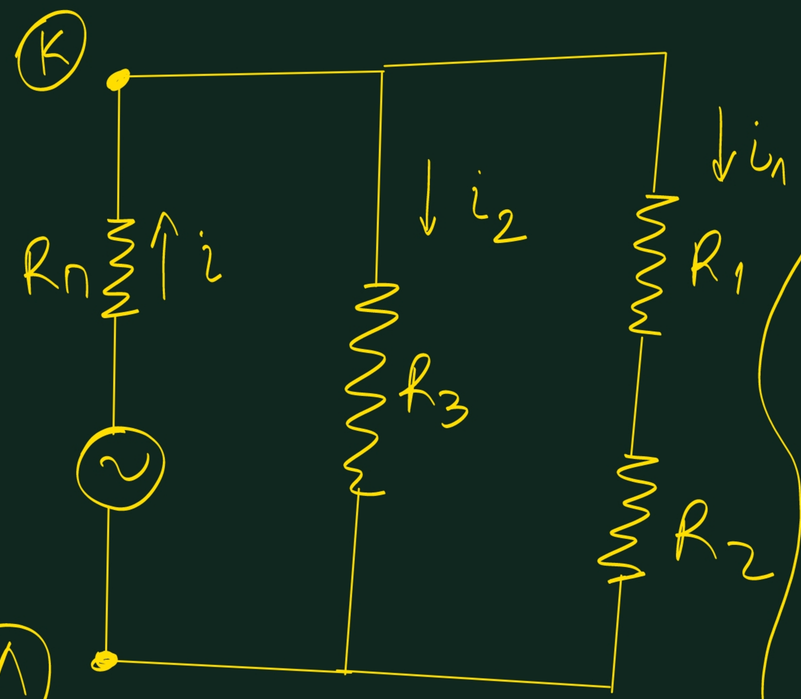
$$Q_n = 180\ Joule.$$

$\vec{P}_3 \leq 15W$ για κανονική λειτουργία.

$\vec{P}_3 \simeq 16{,}6\,Watt$ άρα καίγεται

Άρα: $\overline{P}_3 = \frac{1}{2} I_2^2 \cdot R_3 = \frac{1}{2} \cdot \frac{100}{9} \cdot 3 = \frac{150}{9} = \frac{50}{3}$ Watt

δ)



$v = V_{\eta\mu\omega t}$

$V = 30\,Volt$

$$I_2 \cdot R_3 = I_1 (R_1 + R_2) \Rightarrow$$

$$I_2 \cdot 3 = I_1 \cdot 6 \Rightarrow I_2 = 2I_1$$

$$I = I_1 + I_2 \Rightarrow 5 = 3I_1 \Rightarrow I_1 = \frac{5}{3} A$$

$$I_2 = \frac{10}{3} A.$$

$$R_{o\lambda} = R_n + \frac{R_3 (R_1 + R_2)}{R_3 + R_1 + R_2} \Rightarrow$$

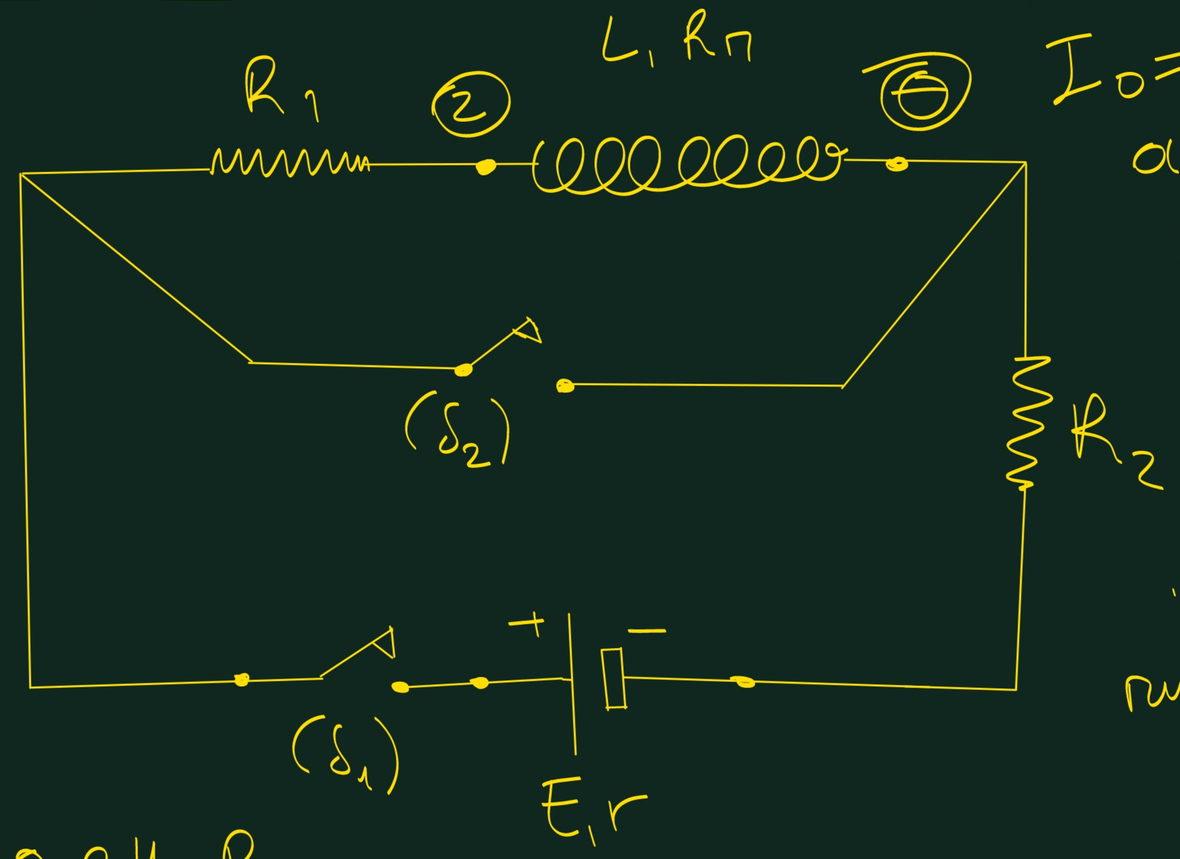
$$R_{o\lambda} = 4 + \frac{3 \cdot (4+2)}{3+4+2} \Rightarrow$$

$$R_{o\lambda} = 4 + \frac{3 \cdot 6}{9} \Rightarrow$$

$$R_{o\lambda} = 4 + \frac{18}{9} = 6\,\Omega$$

$$I = \frac{V}{R_{o\lambda}} = \frac{30}{6} = 5A.$$

Ασκ. 7.95.



$L = 0,2\,H$, R_π

$R_1 = 2\,\Omega$, $R_2 = 4\,\Omega$

$E = 100\,Volt$

$r = 1\,\Omega$

$I_0 = 10\,A$ (γέγιστο)

α) Αν ο (δ_1) είναι κλειστός και ο (δ_2) ανοιχτός, έχουμε κύκλωμα «φόρτισης» του πηνίου.

$$E = i\left(R_1 + R_\pi + r\right) + L \cdot \frac{\Delta i}{\Delta t}$$

Όταν το ρεύμα είναι γέγιστο, το πηνίο συμπεριφέρεται σα βραχυκύκλωμα.