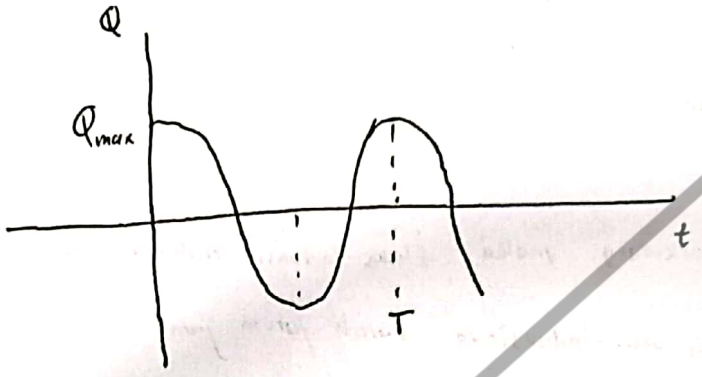
Solusi Tutorial 5 Fisika Dasar 2B ITB

oleh: Wawan K

A. Pertanyaan

① fungsi muatan pada kapasitor sebagai fungsi waktu saat osilasi



$$Q(t) = Q_{max} \cos(\omega t)$$

waktu untuk mencapai Q_{max} adalah satu periode (T)

$$\omega = \frac{1}{\sqrt{LC}}$$

$$\frac{2\pi}{T} = \frac{1}{\sqrt{LC}}$$

$$T = 2\pi\sqrt{LC}$$

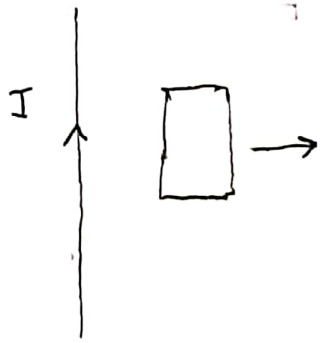
untuk (a) $C_{ekiv} = C+C+C = 3C$

(b) $C_{ekiv} = \frac{1}{2}C + C = \frac{3}{2}C$

(c) $C_{ekiv} = C$

maka urutan waktunya (a), (b), (c)

② a)



fluks induksi yg menambah

waian adalah masuk bidang,

Sehingga arah arus Induksinya

searah jarum jam

b) jika arus berkurang, maka fluks Induksi arahnya masuk bidang pada loop.

Sehingga arah arus Induksinya searah jarum jam.

③ a) Sesuai hukum lenz, fluks induksi keluar bidang, maka fluks awal masuk bidang

Jadi, arah medan magnet masuk bidang

b) tidak ada keterangan B induksi atau B awal kumana, sehingga tidak dapat ditentukan

c) $\mathcal{E} = BLV$

$\mathcal{E}_1 = B(2L)V = 2BLV$

$\mathcal{E}_2 = BLV$

maka $\mathcal{E}_2 < \mathcal{E}_1$

④ pada sumber AC maka L akan bersifat Induktif (X_L)

$$I = \frac{V_s}{\sqrt{R^2 + X_L^2}} = \frac{V_s}{\sqrt{R^2 + \omega^2 L^2}}$$

Sehingga : $V_R = I\,R$

$$V_R = \left(\frac{V_s}{\sqrt{R^2 + \omega^2 L^2}} \cdot R \right)$$

④ $V_R = \dfrac{V_s R}{\sqrt{R^2 + \omega^2 L^2}}$

Sehingga $V_R \sim \dfrac{1}{L}$

maka urutannya c, b, a

⑤ $F_{net} = BiL - mg = 0$

maka : $i = \dfrac{mg}{BL} = \dfrac{|\varepsilon|}{R} = \dfrac{1}{R}\left|\dfrac{d\Phi_B}{dt}\right|$

$$\frac{mg}{BL} = \frac{1}{R}\left|\frac{d\Phi_B}{dt}\right|$$

$$\frac{mg}{BL} = \frac{B}{R}\left|\frac{dA}{dt}\right|$$

$$\frac{mg}{BL} = \frac{B}{R}\frac{dx}{dt}L$$

$$\frac{mg}{BL} = \frac{BV_t L}{R}$$

$$\boxed{V_t = \frac{mgR}{B^2L^2}}$$

B. SOAL

oleh : Wawan K

① Fluks berubah karena loop berputar. Sudut antara medan dan normal loop berubah dari 0 ke 90°.

: ggl rata-rata :

$$\varepsilon = -\frac{\Delta\Phi_B}{\Delta t} = -\frac{AB\Delta\cos\theta}{\Delta t}$$

$$= -\frac{\pi\,(0{,}0925)^2\,(1{,}5)\,(\cos(90)^\circ - \cos 0^\circ)}{0{,}20\,s}$$

$$\boxed{\varepsilon = 0{,}20\,V}$$

② a) Tegangan step down adalah :

$$V_S = V_P\left(\frac{N_S}{N_P}\right) = 120\,V\left(\frac{10}{500}\right) = 2{,}4\,V$$

b) dengan hukum ohm, arus pada sekunder (lumporan)

$$I_S = \frac{V_S}{R_S} = \frac{2{,}4\,V}{15\,\Omega} = 0{,}16\,A$$

maka $$I_P = I_S\left(\frac{N_S}{N_P}\right) = (0{,}16\,A)\left(\frac{10}{500}\right)$$

$$\boxed{I_P = 3{,}2\times10^{-3}\,A}$$

c)

③ frekuensi sudut osilasi LC adalah :

$$\omega = \frac{1}{\sqrt{LC}}$$

Energi listrik dan energi magnet sebagai fungsi waktu :

$$U_E = \frac{q^2}{2C} = \frac{Q^2}{2C}\cos^2(\omega t + \phi)$$

$$U_B = \frac{1}{2}Li^2 = \frac{1}{2}L\omega^2 Q^2 \sin^2(\omega t + \phi) = \frac{Q^2}{2C}\sin^2(\omega t + \phi)$$

- Nilai maksimum $U_E = \frac{Q^2}{2C}$ yang merupakan total energi rangkaian U
- Nilai maksimum $U_B = \frac{Q^2}{2C}$, dapat ditulis $U_B = \frac{LI^2}{2}$ dengan $I = \omega Q$.

a) $\omega = 2\pi f$

$$2\pi f = \frac{1}{\sqrt{LC}}$$

$$4\pi^2 f^2 C = \frac{1}{L}$$

$$L = \frac{1}{4\pi^2 f^2 C}$$

$$= \frac{1}{4(3,14)^2 (10,1 \times 10^3)^2 (340 \times 10^{-6})}$$

$$L = 6,89 \times 10^{-7}\ H$$

③ b) Energi total rangkaian

$$U = \frac{1}{2} L i^2$$

$$= \frac{1}{2} (6{,}89 \times 10^{-7}\ H)(7{,}20 \times 10^{-3}\ A)^2$$

$$U = 1{,}79 \times 10^{-11}\ J$$

c)

$$U = \frac{Q^2}{2C}$$

$$Q = \sqrt{2CU} = \sqrt{2\,(340 \times 10^{-6}\ F)(1{,}79 \times 10^{-11}\ J)}$$

$$Q = 1{,}10 \times 10^{-7}\ C$$

④ a) frekuensi resonansi

$$f = \frac{1}{\sqrt{LC}}$$

$$L_{ekivalen} = L_1 + L_2 = 250 \times 10^{-3} + 500 \times 10^{-3} = 750 \times 10^{-3}\ H$$

$$C_{ekivalen} = C_{23} + C_1 \qquad \frac{1}{C_{23}} = \frac{1}{C_2} + \frac{1}{C_3}$$

$$= 175 \times 10^{-6} + 470 \times 10^{-6} \qquad \frac{1}{C_{23}} = \frac{1}{350 \times 10^{-6}} + \frac{1}{350 \times 10^{-6}}$$

$$C_{ekiv} = 645 \times 10^{-6}\ F$$

$$C_{23} = \frac{1}{2} C = \frac{1}{2} (350 \times 10^{-6})$$

$$C_{23} = 175 \times 10^{-6}\ F$$

④ a) frekuensi resonansi

$$f = \frac{1}{\sqrt{L_{ekiv} \cdot (C_{ekiv})}}$$

$$= \frac{1}{\sqrt{(750 \times 10^{-3})(645 \times 10^{-6})}}$$

$$f = 4{,}5 \times 10^{-3} \times 10^{4}$$

$$= 4{,}5 \times 10^{1}\ Hz$$

$$f = 45\ Hz$$

b) $$f = \frac{1}{\sqrt{LC}}$$

$L_{ekiv} = L_1 + L_2 = 2L_1 = 2 \times 250 \times 10^{-7} = 500 \times 10^{-3}\ H$

$C_{ekiv} = C_{23} = 175 \times 10^{-6}\ F$

$$f = \frac{1}{\sqrt{500 \times 10^{-3} \times 175 \times 10^{-6}}}$$

$f = 0{,}106 \times 10^{3} = 106{,}9\ Hz$

⑤ a) $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$Z = \sqrt{330^2 + (75{,}36 - 66{,}348)^2}$

$Z = \sqrt{108\,900 + 81{,}21}$

$Z = 342\ \Omega$

$X_L = \omega L$

$= 2\pi f L$

$= 2(3{,}14)(40)(300 \times 10^{-3})$

$X_L = 75{,}36\ \Omega$

$X_C = \frac{1}{\omega C} = \frac{1}{2(3{,}14)(40)(60 \times 10^{-6})}$

$X_C = 66{,}348$

$\tan \phi = \frac{X_L - X_C}{R}$

$= \frac{75{,}36 - 66{,}348}{330}$

$\tan \phi = \frac{9{,}012}{330}$

$\phi = \tan^{-1}\left(\frac{9{,}012}{330}\right)$

$\phi = 1{,}56^\circ$

$I_{rangkaian} = \frac{V_s}{Z} = \frac{50}{342} = 0{,}146\ A$

b) $P_{avg} = \frac{\varepsilon_m^2 R}{2Z^2}$ atau $P_{disipasi} = V_{rf} I_{rf} \cos\phi$

$= \frac{V_m}{\sqrt{2}} \frac{V_m}{\sqrt{2}} \frac{1}{Z} \frac{R}{Z} = \frac{\varepsilon_m^2 R}{2Z^2}$

(5) b)

$$P_{avg} = \frac{\mathcal{E}_m^2 R}{2\left[R^2 + (\omega L - 1/\omega C)^2\right]}$$

dengan $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$

.) dengan meninjau fungsi dari C, P_{avg} memiliki nilai terbesar saat faktor Z memiliki nilai terkecil. hal ini terjadi saat $X_L = X_C$

$$\omega L = \frac{1}{\omega C}$$

$$C = \frac{1}{\omega^2 L}$$

maka $C = \frac{1}{2\pi f L}$

$$= \frac{1}{2(3,14)(40)(300 \times 10^{-3})}$$

$$C = 0,0132\ F$$

$$C = 1,32 \times 10^{-2}\ F$$

(6) $\Delta V = E\,\Delta \ell$

$$\frac{d\Phi}{dt} = E(2\pi r) \rightarrow \mathcal{E}(2\pi r) = \frac{d\Phi_B}{dt} = \frac{d}{dt}(BA)$$

$$= A\frac{dB}{dt} = \pi r^2 a$$

⑥ Hal ini berarti

$$\frac{E}{r} = \frac{a}{2}$$

dengan melihat grafik

$$\frac{400 \times 10^{-6}}{2 \times 10^{-2}} = \frac{a}{2}$$

$$a = 400 \times 10^{-4}$$

$$\boxed{a = 4 \times 10^{-2}\ T/s}$$

⑦ a) $\mathcal{E} = BLV$

$= (0{,}60)(0{,}15)(0{,}40)$

$\mathcal{E} = 0{,}036\ V$

b) dengan hukum ohm, arus induksi

$$i = \frac{\mathcal{E}}{R} = \frac{0{,}036\,V}{20\,\Omega} = 1{,}8 \times 10^{-3}\ A$$

dengan arahnya searah jarum jam

c)

$P = i^2 R$

$P = (1{,}8 \times 10^{-3})^2 \times 20 = 6{,}48 \times 10^{-5}\ W$

(8) Impedansi total

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$X_L = \omega L$$

$$= 2\pi f L$$

$$= 2\,(3{,}14)(10^3)(28 \times 10^{-3})$$

$$X_L = 175{,}84\,\Omega$$

$$Z = \sqrt{(8700)^2 + (175{,}84 - 25477{,}7)^2}$$

$$X_C = \frac{1}{\omega C}$$

$$= \sqrt{75690 \quad + (640184{,}47)}$$

$$= \frac{1}{2(3{,}14)(10^3)(6250 \times 10^{-12})}$$

$$\boxed{Z = 8736{,}7\,\Omega}$$

$$X_C = 25{,}47 \times 10^3\,\Omega$$

Sudut fasa

$$\tan\phi = \frac{X_L - X_C}{R} = \frac{175{,}84\,\Omega - 25{,}47 \times 10^3\,\Omega}{8700\,\Omega}$$

$$\phi = \tan^{-1}(-2{,}908)$$

$$\boxed{\phi = -71{,}02^\circ}$$

$$\text{Arus rms} = \frac{V_{rms}}{Z} = \frac{V_{max}}{\sqrt{2}}\,\frac{1}{Z} = \frac{725\,V}{\sqrt{2}\,(8736{,}7)} = 0{,}0586\,A$$

(9) dimulai arus nol saat $t=0$ (saat saklar di tutup) arus dlam rangkaian bertambah berdasarkan

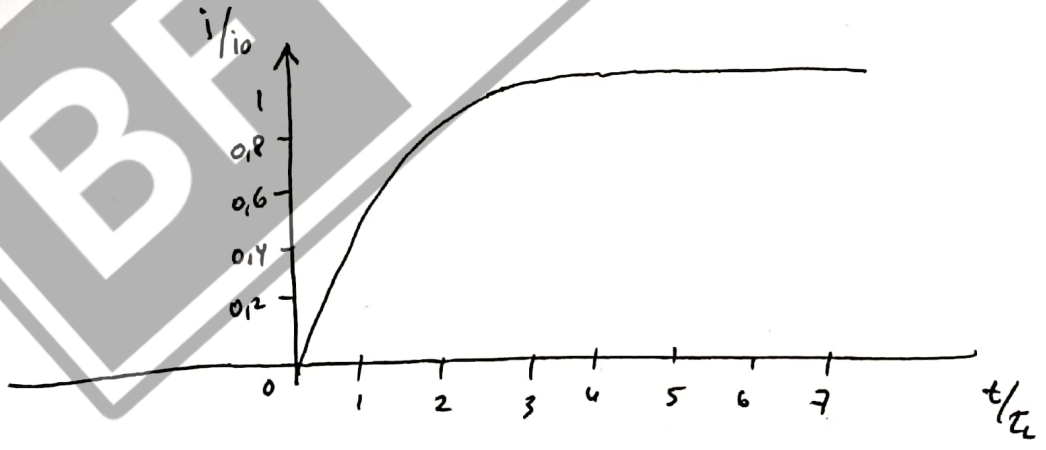
$$i = \frac{\varepsilon}{R}\left(1 - e^{-t/\tau_L}\right) \qquad \tau_L = \frac{L}{R} = \text{konstanta waktu}$$

maka : $$0{,}990\ \frac{\varepsilon}{R} = \frac{\varepsilon}{R}\left(1 - e^{-t/\tau_L}\right)$$

$$\ln(0{,}0010) = -(t/\tau)$$

$$\frac{t}{\tau} = 6{,}91$$

$$\boxed{t = 6{,}91\,\tau_L}$$



(10) a) Impedansi

$$Z = \frac{80V}{1{,}25A} = 64\Omega$$

b) kita dapat menulis

$$\cos\phi = \frac{R}{Z} \Rightarrow \quad R = Z\cos\phi$$

$$= (64)\cos(0{,}650\ \text{rad})$$

$$R = 50{,}9\Omega$$

c) karena arus mendahului tegangan, maka rangkaian bersifat kapasitif