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FISIKA 2

SOAL LATIHAN FISIKA II

Topik : Arus Bolak Balik

1. Dik : Rangkaian Seri RLC
$R = 148\ \Omega$ $f = 512\ Hz$
$C = 1{,}5 \cdot 10^{-6}\ F$ $V_{rms} = 35\ V$
$L = 35{,}7 \cdot 10^{-3}\ H$

Dit : $I_{rms} = \ldots ?$

Jawab : $X_L = \omega L$ $\omega = 2\pi f$
$X_L = 1024\pi \cdot 35{,}7 \cdot 10^{-3}$ $= 2\pi \cdot 512$
$X_L = 114{,}78\ \Omega$ $= 1024\pi\ rad/s$

$X_C = \frac{1}{\omega C} = \frac{1}{1024\pi \cdot 1{,}5 \cdot 10^{-6}} = 207{,}33\ \Omega$

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

$Z = \sqrt{(114{,}78 - 207{,}33)^2 + 148^2}$

$Z = 174{,}5\ \Omega$

$I_{rms} = \frac{V_{rms}}{Z} = \frac{35}{174{,}5} = 0{,}2\ A$

2. Dik : Rangkaian RLC sama seperti no. 1

Dit : a) V_{rms} masing-masing elemen ... ?
b) Daya listrik rata-rata ... ?

Jawab : a) $-V_{rms}(R) = I_{rms} \cdot R = 0{,}2 \cdot 148$

$V_{rms}(R) = 29{,}6\ V$

$-V_{rms}(L) = I_{rms} \cdot X_L = 0{,}2 \cdot 114{,}78$

$V_{rms}(L) = 22{,}95\ V$

$-V_{rms}(C) = I_{rms} \cdot X_C = 0{,}2 \cdot 207{,}33$

$V_{rms}(C) = 41{,}466\ V$

b) $P_{rt} = I_{rms} \cdot V_{rms} \cdot \cos\theta$

$\tan\theta = \frac{X_L - X_C}{R} = \frac{114{,}78 - 207{,}33}{148} = -0{,}625$

$\theta = -32^\circ$

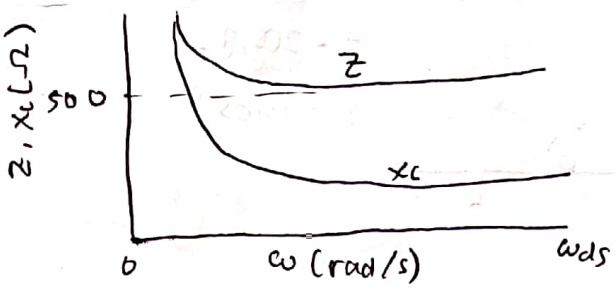
$P_{rt} = I_{rms}\ V_{rms} \cos\theta$

$P_{rt} = 0{,}2 \cdot 35 \cos(-32^\circ)$

$P_{rt} = 5{,}93\ watt$

3. Dik : kapasitor dan Resistor dipasang seri
$\omega_{ds} = 300\ rad/s$

$Z = 500\ \Omega$



Dit : R ... ? dan C ... ?

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

$X_C = \frac{1}{\omega C}$ → artinya semakin besar ω maka X_C akan semakin kecil sampai mendekati 0

a) $Z = \sqrt{R^2}$
$Z = R$
$R = 500\ \Omega$

b) $X_C = \frac{1}{\omega C}$ $C = \frac{1}{3 \cdot 10^4}$

$100 = \frac{1}{300 \cdot C}$ $C = 0{,}33 \cdot 10^{-4}\ F$

4. Dik : rangkaian RLC
$R = 200\ \Omega$ $f_d = 60\ Hz$
$C = 70\ HF = 70 \cdot 10^{-6}\ F$ $\mathcal{E}_m = 36\ V$
$L = 230\ mH = 230 \cdot 10^{-3}\ H$

Dit : (a) Z ... (b) ϕ .... (c) I ... (d) diagram fasor

Jawab : $X_C = \frac{1}{\omega_C} = \frac{1}{120\pi \cdot 70 \cdot 10^{-6}}$ $\omega = 2\pi f$
$= 2\pi \cdot 60 = 120\pi$
$= 37{,}9\ \Omega$

$X_L = \omega L = 120\pi \cdot 230 \cdot 10^{-3}$
$= 86{,}6\ \Omega$

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

$Z = \sqrt{200^2 + (86{,}6 - 37{,}9)^2}$

$Z = 205{,}8\ \Omega$

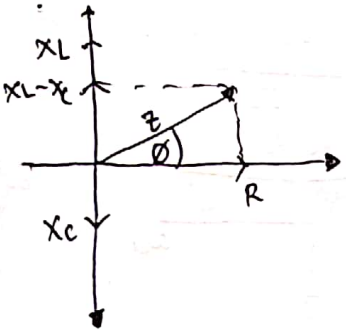
b) $\tan\phi = \frac{X_L - X_C}{R} = \frac{861,6 - 371,9}{200}$

$\tan\phi = 0,243$

$\phi = 13,65^\circ$

c) $I = \frac{\mathcal{E}}{Z} = \frac{36}{205,8} = 0,174\ A$

d) diagram fasor



$Z = 205,8\ \Omega$

$\phi = 13,65^\circ$

5. Dik : $\mathcal{E}_m = 220\ V$

$f = 400\ Hz$

$R = 220\ \Omega$

$L = 150 \cdot 10^{-3}\ H$

$C = 24 \cdot 10^{-6}\ F$

Dit : a) X_C
b) Z
c) I

Jika kapasitor ditambahkan, apakah d) X_C e) Z f) I bertambah/berkurang, atau tetap?

Jawab : a) $X_C = \frac{1}{\omega C} = \frac{1}{800\pi \cdot 24 \cdot 10^{-6}}$

$\omega = 2\pi f$

$\omega = 2\pi \cdot 400$

$\omega = 800\pi$

$X_C = 16,5\ \Omega$

b) $X_L = \omega L = 800\pi \cdot 150 \cdot 10^{-3}$

$X_L = 376,8\ \Omega$

$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{220^2 + (376,8 - 16,5)^2}$

$Z = 422,15\ \Omega$

c) $I_m = \frac{\mathcal{E}_m}{Z} = \frac{220}{422,15} = 0,52\ A$

Jika kapasitor ditambahkan terdapat 2 kemungkinan :

1. Secara pararel, maka $C_{total} = 2C$.

$X_C = \frac{1}{\omega C} = \frac{1}{\omega(2C)}$ → X_C akan semakin kecil

$Z = \sqrt{R^2 + (X_L - X_C)^2}$ → X_C kecil maka Z semakin besar

$I = \frac{\mathcal{E}}{Z}$ → Z besar maka I semakin kecil

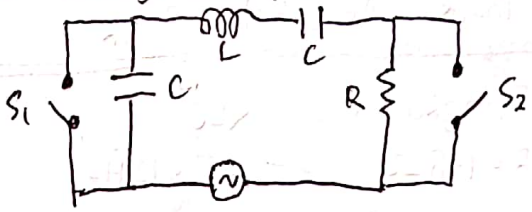
2. Secara seri, maka $C_{total} = \frac{C}{2}$

$X_C = \frac{1}{\omega C_t} = \frac{2}{\omega C}$ → X_C akan semakin besar

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

$I = \frac{\mathcal{E}}{Z}$ → I semakin besar

6. Dik : Rangkaian RLC seri dengan 2 saklar



Amplitudo $\mathcal{E} = 12\ V$

$f = 60\ Hz$

- kedua saklar dibuka, arus mendahului ggl sejauh $30,9^\circ$
- Ketika saklar S_1 ditutup dan saklar S_2 dibuka, ggl mendahului arus sejauh 15°.
- kedua saklar ditutup Arus = 447 mA

Dit : R ...? C ...? L ...?

Jawab :

- Ketika saklar ditutup : arus melewati L dan C . maka

$I = \frac{\mathcal{E}}{X_L - X_C}$ → $447 \cdot 10^{-3} = \frac{12}{X_L - X_C}$

$X_L - X_C = 26,84\ \Omega$ ...(1)

- S_1 ditutup dan S_2 dibuka : arus melewati R L C . maka

$\tan\theta = \frac{X_L - X_C}{R}$ (subtitusi persamaan 1)

$\tan 15 = \frac{26,84}{R}$ → $\boxed{R = 103\ \Omega}$

- Kedua saklar dibuka : arus melewati R, L, dan secara seri melewati 2C maka :

$\tan 30,9 = \frac{X_L - 2X_C}{R}$

$0,6 = \frac{X_L - 2X_C}{103}$

$X_L - 2X_C = 61,8$ ... (2)

eliminasi persamaan 1 dan 2

$X_L - X_C = 26,84$

$X_L - 2X_C = 61,8$ (−)

$X_C = -34,96\ \Omega$

$X_L + 34,96 = 26,84$

$X_L = -8,12\ \Omega$

$X_L = \omega L$

$8112 = 120\pi \cdot L$

$L = 0{,}021$

$\boxed{L = 21 \cdot 10^{-3}\ H}$

$\omega = 2\pi f$

$\omega = 2\pi \cdot 60$

$\omega = 120\pi$

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

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

$34{,}96 = \frac{1}{120\pi \cdot C}$

$C = 7{,}59 \cdot 10^{-5}$

$C = 75{,}9 \cdot 10^{-6}\ F$

Cseri

$\frac{1}{C_{total}} = \frac{1}{C} + \frac{1}{C}$

$C_{total} = \frac{C}{2}$

tanda minus berarti bahwa pada diagram fasor X_L kebawah dan X_C keatas

Jadi, besarnya $R = 103\ \Omega$, $L = 21 \cdot mH$, dan $C = 75{,}9\ MF$.

7. Dik: $R = 5\ \Omega$ $L = 60\ mH$ $fd = 60\ Hz$ $\mathcal{E} = 30\ V$

Jawab: a) Kapasitansi saat $P_{avg\ max}$

$P_{rata^2} = I_{rms}^2 R = \frac{\mathcal{E}_{rms}}{\sqrt{R^2 + (X_L - X_C)^2}} \cdot R$

$X_L = X_C \rightarrow P_{d(P)\ max}$

$C = \frac{1}{(2\pi f)^2 L} = \frac{1}{(2\pi \cdot 60)^2 \cdot 6 \cdot 10^{-2}} = 117\ MF$

b) $(X_L - X_C)^2 \rightarrow$ harus diperbesar

maka $C = 0 \rightarrow$ agar $P_{minimal}$ //

c) $P_{avg} = \left(\frac{\mathcal{E}_{rms}}{z}\right)^2 R = \left(\frac{\mathcal{E}_m}{\sqrt{2}}\right)^2 \cdot \frac{1}{R}$

$= \frac{\mathcal{E}_m^2}{2} \cdot \frac{1}{R} = \frac{30^2}{2 \cdot 5} = 90\ w$

d) $\cos\phi = \frac{R}{z} = 1$ $\phi = 0°$

e) Faktor daya adalah $\cos\phi$ yaitu 1

f) $C = 0$

$P_{avg} \left(\frac{\mathcal{E}}{z}\right)^2 \cdot R$

$\lim_{C \to 0} P_{avg} = 0$ //

g) $\cos\phi = \frac{R}{z}$ Jika $z \rightarrow +\infty$

maka $\cos\phi = 0 \rightarrow \phi = \pm\frac{\pi}{2}$

Vc naik sehingga $\mathcal{E}_m$ kebawah $\rightarrow$

$\cos\phi = -\frac{\pi}{2}$

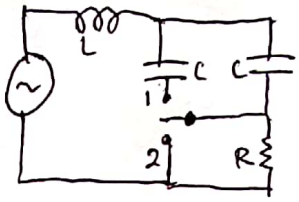
h) Faktor daya adalah $\cos\phi$ yaitu 0 //

8. Dik: $\mathcal{E} = 120\ V$ $f = 60\ Hz$

- Ketika saklar dibuka $\phi = 20°$
- Ketika saklar diposisi $1 \rightarrow \phi = 10°$
- Ketika saklar diposisi $2 \rightarrow I = 2A$

Dit: R, L, C ... ?

Jawab:



- Ketika saklar dibuka $\phi = 20°$

$\tan 20° = \frac{X_L - X_C}{R}$

$0{,}36 = \frac{X_L - X_C}{R}$ ... (1)

- Ketika saklar diposisi $1 \rightarrow \phi = 10°$

$\tan 10° = \frac{X_L - \frac{X_C}{2}}{R}$ $\frac{1}{X_{C\,total}} = \frac{1}{X_C} + \frac{1}{X_C}$

$0{,}18 = \frac{2X_L - X_C}{2R}$ $X_{C\,total} = \frac{X_C}{2}$

$0{,}36 = \frac{2X_L - X_C}{R}$ ... (2)

- Ketika saklar diposisi $2 \rightarrow I = 2\ A$

$I = \frac{\mathcal{E}}{z}$ $z = X_L - X_C$

$2 = \frac{120}{X_L - X_C}$

$X_L - X_C = 60\ \Omega$ ... (3)

Subtitusi persamaan (3) ke (1)

$0{,}36 = \frac{60}{R}$

$R = 166{,}6\ \Omega$

$0{,}36 = \frac{2X_L - X_C}{166{,}6}$ persamaan (2)

$2X_L - X_C = 60$ ... (4)

Persamaan (1) $\rightarrow 0{,}36 = \frac{X_L - X_C}{166{,}6}$

$X_L - X_C = 60$ ... (5)

eliminasi persamaan (4) dan (5)

$2X_L - X_C = 60$

$X_L - X_C = 60$ −

$\boxed{X_L = 0\ \Omega}$

$-X_C = 60$

$\boxed{X_C = -60\ \Omega}$

$X_L = \omega L$

$0 = 120\pi L$

$L = 0$ H

$\omega = 2\pi f$

$\omega = 2\pi . 60$

$\omega = 120\pi$

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

$60 = \frac{1}{120\pi C}$

$C = 4{,}42 . 10^{-5}$

$C = 44 . 10^{-6}$ F

Jadi, besarnya $R = 166{,}6\ \Omega$, $L = 0$ H, dan $C = 44$ MF.

9) Dik: Rangkaian RLC

Frekuensi kerja = 60 Hz

$V_L = 2V_R = 2V_C$

$\cancel{I} X_L = 2\cancel{I} . R = 2\cancel{I} . X_C$

Dit: a) sudut berapa arus tertinggal E ?

b) $\mathcal{E}_{max} = 30$ V, hambatan rangkaian untuk $I_{max} = 300$ mA

Jawab: $X_L = 2R$ $\quad R = X_C$

a) $\tan\phi = \frac{X_L - X_C}{R} = \frac{2R - R}{R} = \frac{R}{R} = 1$

$\phi = 45^\circ$

Arus tertinggal pd saat $V_{induktor}$ max, sudutnya = 45° //

b) $I_{max} = \frac{\mathcal{E}_{max}}{Z}$

$Z = \frac{\mathcal{E}_{max}}{I_{max}} = \frac{30}{300 . 10^{-3}} = 100\ \Omega$

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

$100 = \sqrt{R^2 + (2R - R)^2}$

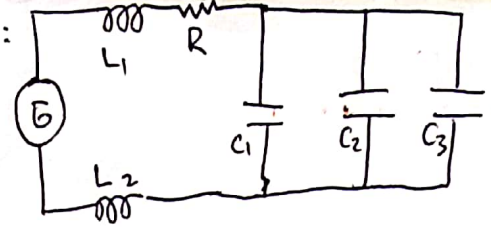
$100 = \sqrt{R^2 + R^2}$

$100 = \sqrt{2R^2}$

$100 = \sqrt{2}\, R$

$R = \frac{100}{\sqrt{2}} = 70{,}7\ \Omega$ //

10) Dik:



$R = 100\ \Omega$ $\quad L_1 = 1{,}7$ mH $\quad L_2 = 2{,}3$ mH

$C_1 = 4$ MF $\quad C_2 = 2{,}5$ MF $\quad C_3 = 3{,}5$ MF

Dit: frekuensi resonansi ...?

Apayang tergadi pd frekuensi resonansi jika: b) R dinaikkan

c) L_1 dinaikkan

d) C_3 dihilangkan dari rangkaian

Jawab: Frekuensi resonansi

$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{4 . 10^{-3} . 10 . 10^{-6}}}$ $L_{total} = 4$ mH, $C_{total} = 10$ MF

$\omega = 5000$ rad/s

$\omega = 2\pi f$

$5000 = 2\pi f \rightarrow f = 796{,}17$ Hz

b) R dinaikkan

karena frekuensi resonansi hanya dipengaruhi oleh besarnya Induktansi dan kapasitansi, maka jika R dinaikkan frekuensi resonansi tetap

c) L_1 dinaikkan

L_1 dinaikkan maka kecepatan sudut semakin kecil selanjutnya frekuensi resonansi akan semakin kecil pula.

d) C_3 dihilangkan dari rangkaian

C_3 dihilangkan maka kecepatan sudut semakin besar selanjutnya frekuensi resonansi akan semakin besar pula.