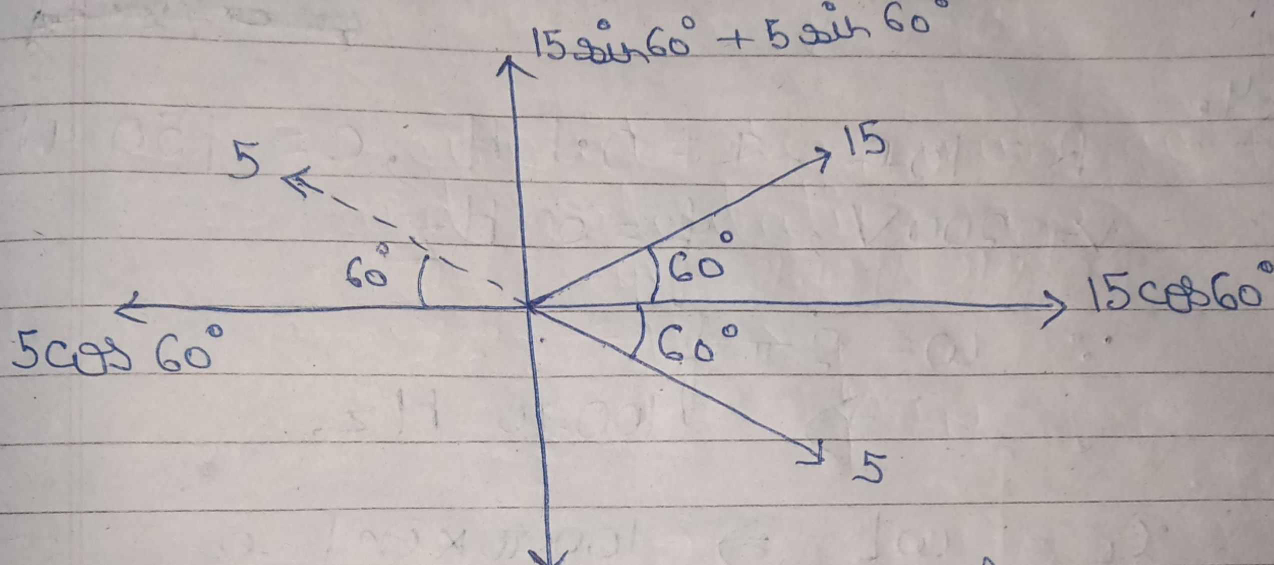
BEE Assignment no. 2

[~~Roll~~ Anmol Baranwal -- 2820208]

Ans3. $i_1 = 15 \sin(\omega t + \pi/3)$

$i_2 = 5 \sin(\omega t - \pi/3)$

Find $i_1 - i_2$.



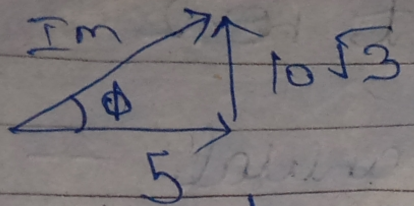
$i_1 - i_2 \Rightarrow i_1 + (-i_2)$

x-component $\Rightarrow 15\cos 60° - 5\cos 60°$
$\Rightarrow 5$

Y-component $\Rightarrow 20 \times \frac{\sqrt{3}}{2} \Rightarrow 10\sqrt{3}$
$(5 \sin 60° + 5 \sin 60°)$

$Im = \sqrt{x^2 + Y^2}$
$= \sqrt{25 + 300} = \sqrt{325}$

$= 18.02$ A



$$\phi = \tan^{-1}\left(\frac{y}{x}\right) \Rightarrow \tan^{-1}(2\sqrt{3})$$

$$73.9^\circ$$

$$I_r = 18.02 \sin(\omega t + 73.9^\circ)$$

Ans24.

$$R = 10\,\Omega,\ L = 0.1\text{ H},\ C = 150\ \mu F$$

$$V = 200\text{ V},\ f = 50\text{ Hz}$$

$$\because\ \omega = 2\pi f \Rightarrow 100\pi\text{ Hz}$$

$$X_L = \omega L \Rightarrow 100\pi \times 0.1\ \Omega \Rightarrow 10\pi\ \Omega \Rightarrow 31.4\ \Omega$$

$$x_C = \frac{1}{\omega C} \Rightarrow \frac{10^6}{100\pi \times 150}$$
$$\Rightarrow 21.2\ \Omega$$

(i) Impedance,
$$Z = \sqrt{R^2 + (x_L - x_C)^2}$$
$$= \sqrt{(10)^2 + (31.4 - 21.2)^2}$$
$$\Rightarrow 14.28\ \Omega$$

(ii) current $\Rightarrow \frac{V}{Z}$
$$\Rightarrow \frac{200}{14.28} \Rightarrow 14\ A$$

(iii) Power factor
$$\Rightarrow \frac{R}{Z} \Rightarrow \frac{10}{14.28} \Rightarrow 0.7$$

(iv) Impedance of coil (Z_c) $\Rightarrow \sqrt{(10)^2 + (31.4)^2}$
$$\Rightarrow 33\ \Omega$$

voltage drop across coil
$$\Rightarrow I \times Z_c \Rightarrow 14 \times 33 \Rightarrow 462\ V$$

(v) voltage across condenser
$$\Rightarrow 14 \times 21.2 \Rightarrow 296.8\ V$$

Ans 6. $z = 4 - 3j\ \Omega$

$(\because z = R - jX_c)$

$\therefore R = 4\,\Omega,\ X_c = 3\,\Omega$

~~Active Power ⇒ I~~

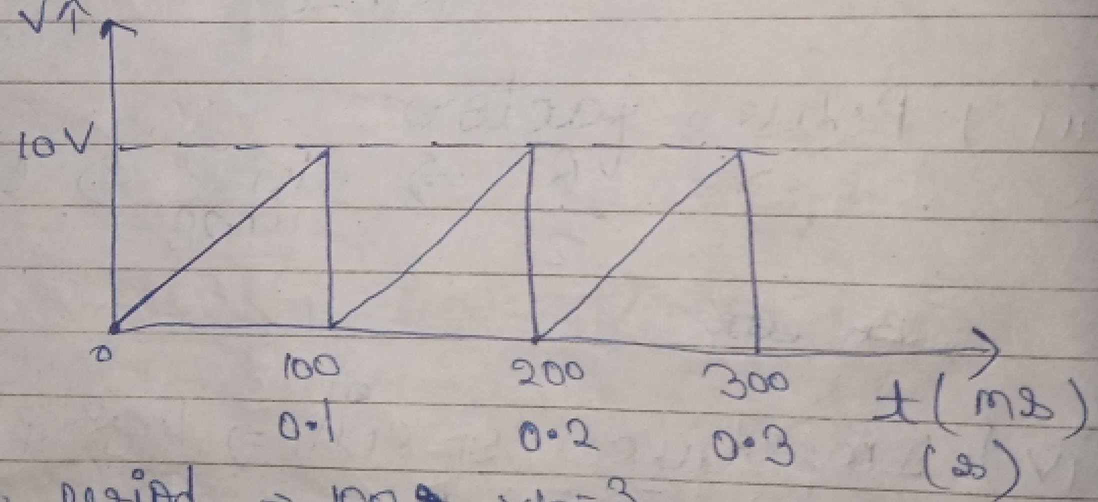
$i = 5\cos(100\pi t + 100)\ A$

$I_m = 5A$

Active Power $\Rightarrow I_m^2 R$

$\Rightarrow 25 \times 4 \Rightarrow 100\,W$

Ans 7.



Time period $\Rightarrow 100 \times 10^{-3}\ s$

$\Rightarrow 0.1\ s$

(i) frequency $\Rightarrow \frac{1}{T} \Rightarrow 10\ Hz$

(ii) RMS value ⇒

from figure

$$v(t) = \frac{t}{\cancel{10}} \times \frac{10}{0.1} + 0$$

$$v(t) \Rightarrow 100t$$

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T v^2(t)\,dt}$$

$$= \sqrt{\frac{1}{0.1}\int_0^{0.1} 10^4 \times t^2\,dt}$$

$$\Rightarrow \sqrt{\frac{10^5}{3}\left[t^3\right]_0^{0.1}}$$

$$\Rightarrow \sqrt{\frac{10^2}{3}} \Rightarrow \frac{10}{\sqrt{3}}\ V$$

$$V_{avg} = \frac{1}{T}\int_0^T v(t)\,dt$$

$$= \frac{1}{0.1}\int_0^{0.1} (100t)\,dt$$

$$\Rightarrow \frac{10^3}{2}\left[t^2\right]_0^{0.1}$$

$$\Rightarrow \frac{10}{2} \Rightarrow 5V$$

(iii) Form factor

$$\Rightarrow \frac{V_{rms}}{V_{avg}} \Rightarrow \frac{10}{5\sqrt{3}} \Rightarrow \frac{2}{1.732}$$

$$\Rightarrow 1.154$$

~~Ans 2.~~ Ans 5. $P_R = 500\ W$

$V_R = 100\ W$

~~Ans~~

$P_{coil} = 100\ W$, $V_{coil} = 50\ V$

$\because P_R = \frac{(V_R)^2}{R}$

$R \Rightarrow \frac{100 \times 100}{500} \Rightarrow 20\ \Omega$

$V_R = R I$

$100 = 20 \times I \Rightarrow I = 5A$

$P_{coil} = I^2 R_c$

resistance of coil $\leftarrow$ $R_c = \frac{100}{25} \Rightarrow 4\ \Omega$

$Z = \frac{V}{I} = \frac{50}{5} = 10$

$X_L = \sqrt{Z^2 - R^2} = \sqrt{(10)^2 - (4)^2}$

$\Rightarrow 9.168\ \Omega$

$\therefore$ Reactance $= 9.168\ \Omega$

Combined resistance $= 20+4 = 24\Omega$

combined impedance,

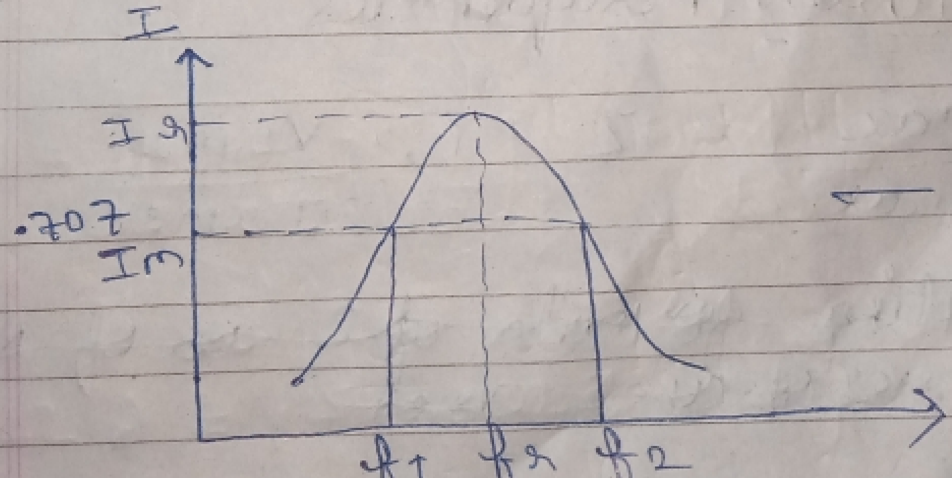
$Z_r = \sqrt{(R+r)^2 + (X_L)^2}$

$= \sqrt{(24)^2 + (9.168)^2} = 25.6\ \Omega$

$V = Z_r I \Rightarrow 25.6 \times 5 \Rightarrow 128\ V$

Ans 1. Selectivity (RLC resonant circuit)

Selectivity of a circuit is a measure of its ability to reject any frequencies either side of the points. A more selective circuit will have narrower bandwidth whereas a less selective circuit will have a wider bandwidth. The selectivity of a series resonance circuit can be controlled by adjusting the value of resistance keeping all the other components the same.



← (1)

(BW) Band width $\Rightarrow f_2 - f_1$

$$\text{Selectivity} \Rightarrow \frac{f_r}{BW} \Rightarrow \frac{f_r}{f_2 - f_1}$$

Band width

~~for~~ in figure (1)

Range of frequencies over which circuit current is equal to or more than 70.7 % of max current.

$B.W. = f_2 - f_1$

f_1 = lower cutoff frequency

f_2 = upper cutoff frequency

$$f_1 = f_r - \frac{B.W.}{2}$$

$$f_2 = f_r + \frac{B.W.}{2}$$

Half-Power Frequencies

$\because \frac{V_{max}}{I_{max}} = Z$, $\frac{V_{rms}}{I_{rms}} = R$

~~putting formula of Z as of RLC resonance circ~~

$$\Rightarrow \frac{V_{max}}{I_{max}} = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$

$$\Rightarrow \left(\frac{V_{max}}{I_{max}}\right)^2 = R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2$$

$$\Rightarrow \left(\omega L - \frac{1}{\omega C}\right) = \sqrt{\left(\frac{V_{max}}{I_{max}}\right)^2 - R^2}$$

$$\Rightarrow \frac{V_{max}}{I_{max}} = \frac{\sqrt{2}\, V_{rms}}{I_{rms}}$$

as half-power frequencies are obtained by setting

$$Z = \sqrt{2} R$$

$$\Rightarrow \left(\omega L - \frac{1}{\omega C}\right) = \sqrt{2\frac{V_{rms}^2}{I_{rms}^2} - R^2}$$

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

$$\omega^2 L - \frac{1}{C} = \omega(\pm R)$$

$$\omega^2 L - \omega(\pm R) - \frac{1}{C} = 0$$

for +ve R

$$\omega^2 L - \omega R - (1/C) = 0$$

$$\omega_1 = \frac{R \pm \sqrt{R^2 + 4L/C}}{2L}$$

$$\cancel{\omega_2 = R - \sqrt{R}}$$

$$\because \omega \neq -ve$$

$$\omega_1 = \frac{R + \sqrt{R^2 + 4L/C}}{2L}$$

similarly for negative term of R

$$\omega^2 L + \omega R - (1/C) = 0$$

$$\omega_3 = \frac{-R + \sqrt{R^2 + 4L/C}}{2L}$$

(excluding one value since ω cannot be negative)

ω_1 and ω_3 are Half-power frequencies

$$\omega_1 = \frac{+R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}}$$

$$\omega_3 = \frac{-R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}}$$

<u>Ans2.</u> coil I $\Rightarrow$

$$R_1 = 1.5\,\Omega \quad , Z_1 = 6\,\Omega$$

$$x_{L_1} = \sqrt{(Z_1)^2 - (R_1)^2}$$

$$\Rightarrow \sqrt{33.75}$$

$$\Rightarrow 5.81\,\Omega$$

coil II $\Rightarrow$

$R_2 = 2\Omega$,

let inductive reactance of second coil is $x\ \Omega$.

$X_{L2} = x\ \Omega$

Impedance of whole circuit

$\Rightarrow \frac{V}{I} \Rightarrow \frac{230}{7}$

$$\therefore \frac{230}{7} = \sqrt{(1.5+2)^2 + (5.81+x)^2}$$

$$\sqrt{(32.85)^2 - 12.25} = 5.81 + x$$

$$\sqrt{1066.8725} = 5.81 + x$$

$$32.66 = 5.81 + x$$

$$x = 26.85$$

inductance of second coil (L)

$$\omega L = 26.85$$

$$2\pi \times 50 \times L = 26.85$$

$$L \Rightarrow \frac{0.2685}{3.14}\ H$$

$$\Rightarrow \underline{85.5\ mH}$$