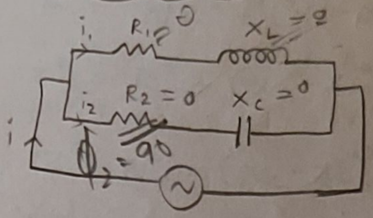
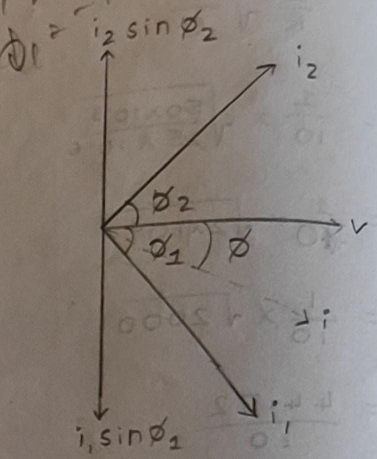
24.10.24

RLC in Parallel :

$\phi_1 = 0$, 90





$$\boxed{\begin{aligned} x &= i_1 \cos\phi_1 + i_2 \cos\phi_2 \\ y &= i_2 \sin\phi_2 - i_1 \sin\phi_1 \end{aligned}}$$

$i = \sqrt{x^2 + y^2}$

$= \sqrt{(i_1 \cos\phi_1 + i_2 \cos\phi_2)^2 + (i_2 \sin\phi_2 - i_1 \sin\phi_1)^2}$

$$\boxed{\begin{aligned} i_1 &= \frac{V}{Z_1} \\ i_2 &= \frac{V}{Z_2} \\ Z_1 &= \sqrt{R_1^2 + X_L^2} \\ Z_2 &= \sqrt{R_2^2 + X_C^2} \end{aligned}}$$

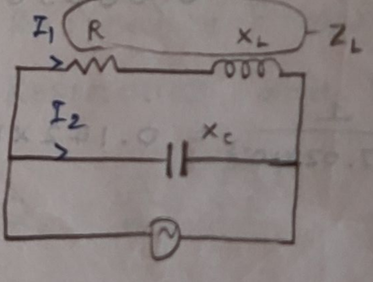
$\boxed{\cos\phi = \frac{x}{i}}$

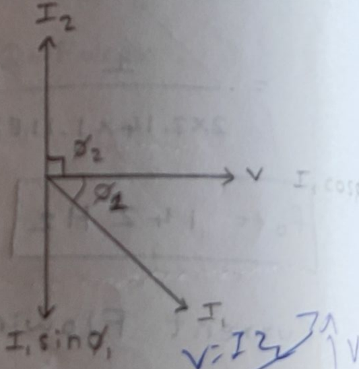
$\boxed{\tan\phi = \frac{y}{x}}$

$\boxed{\cos\phi_1 = \frac{R_1}{Z_1}}$

$\boxed{\cos\phi_2 = \frac{R_2}{Z_2}}$

$Z_1 = \cos\phi R_1$





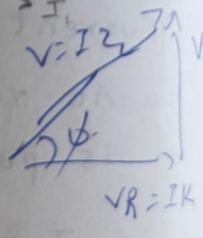
At resonance :

Sum of reactances = 0

$I_2 - I_1 \sin\phi_1 = 0$

$\downarrow$

$\frac{V}{X_C} - \frac{V}{Z_L}\left(\frac{X_L}{Z_L}\right) = 0 \Rightarrow \frac{1}{X_C} = \frac{X_L}{Z_L^2}$



$Z_L^2 = X_L X_C = \omega L \left(\frac{1}{\omega C}\right)$

$Z_L^2 = \frac{L}{C}$; $Z_L^2 = \frac{L}{C}$

$Z_L^2 = \frac{L}{C}$

$Z_L = \sqrt{R^2 + X_L^2}$

$\therefore \quad R^2 + X_L^2 = \frac{L}{C}$

$X_L^2 = \frac{L}{C} - R^2$

$X_L = \sqrt{\frac{L}{C} - R^2}$

$\downarrow$

ωL

$\downarrow$

$2\pi f L = \sqrt{\frac{L}{C} - R^2}$

$$\boxed{f_0 = \frac{1}{2\pi L}\sqrt{\frac{L}{C} - R^2}} \quad \text{(or)} \quad \boxed{f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}}$$

If $R = 0$; $\boxed{f_0 = \frac{1}{2\pi}\sqrt{\frac{1}{LC}}}$

admitance $= \frac{1}{R}$

series $\frac{1}{R} > \frac{1}{Z}$ $= \frac{1}{R} + j\frac{1}{X_C} \times \frac{j}{j}$ $\quad j^2 = -1$

parallel $Z >$

$\frac{1}{Z} = \frac{1}{R} - \frac{1}{jX_C}$

$\frac{1}{Z} = \frac{jX_C - R}{RjX_C}$

$Q_0 = \frac{\omega_0 L}{R}$

$Z = \frac{-RjX_C}{R - jX_C} \times \frac{R + jX_C}{R + jX_C}$

$Z = \frac{}{CR}$

$Z = Z' - jZ''$

$\left(\frac{-R^2 jX_C + RX_C^2}{R^2 + X_C^2}\right.$

$Z' = \frac{R^2 X_C^2}{R^2 + X_C^2} - j\frac{R^2 X_C}{R^2 + X_C^2}$

Q) The current seen in each branch of a two branched parallel circuit are given by the expression : $i_A = 7.07 \sin\left(314t - \frac{\pi}{4}\right)$

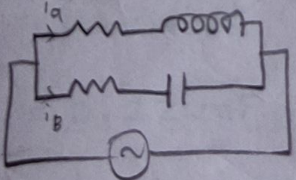
$i_B = 21.2 \sin\left(314t + \frac{\pi}{3}\right)$,

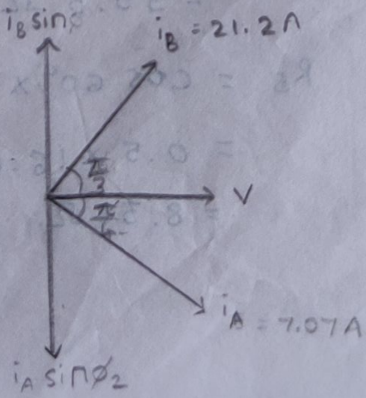
$V = 354 \sin(314t)$

Calculate the ohmic value of the component assuming that all the components are in pur State whether the reactive components are inductive or capacitive.

A) Given :

$i_A = 7.07 \sin\left(314t - \frac{\pi}{4}\right)$





$$x = i_a \cos \phi_1 + i_2 \cos \phi_2$$

$$= 7.07 \cos 45^\circ + 21.2 \cos 60^\circ$$

$$= 7.07 \left(\frac{1}{\sqrt{2}}\right) + 21.2 \left(\frac{1}{2}\right)$$

$$= 15.6 \text{ A}$$

$\frac{1}{\sqrt{2}} = 0$

$\frac{\sqrt{3}}{2} = 0.$

$$y = 21.2 \sin 60^\circ - 7.07 \sin 45^\circ$$

$$= 21.2 \left(\frac{\sqrt{3}}{2}\right) - 7.07 \left(\frac{1}{\sqrt{2}}\right)$$

$$= 13.36 \text{ A}$$

$$i = \sqrt{x^2 + y^2}$$

$$= \sqrt{(15.6)^2 + (13.36)^2}$$

$$= 20.53 \text{ A}$$

$$\tan \phi = \frac{y}{x} = \frac{13.36}{15.6} = 0.856$$

$$\phi = \tan^{-1}(0.856)$$

$$\boxed{\phi = 40.5^\circ}$$

$$Z_A = \frac{V}{I_A} = \frac{354}{7.07} = 50.07 \ \Omega$$

$$Z_B = \frac{V}{I_B} = \frac{354}{21.2} = 16.69 \ \Omega$$

WKT :

$$\cos \phi_A = \frac{R_A}{Z_A}$$

$$R_A = \cos \phi_A \, Z_A$$

$$= \cos 45^\circ \times 50.07$$

$$= 0.707 \times 50.07$$

$$= 35.5 \ \Omega$$

$$R_B = \cos 60^\circ \times 16.69$$

$$= 0.5 \times 16.69$$

$$= 8.34 \ \Omega$$

$$Z_A = \sqrt{R_A^2 + X_L^2}$$

$$(Z_A)^2 = (R_A)^2 + (X_L)^2$$

$$X_L^2 = (Z_A)^2 - (R_A)^2$$

$$X_L = \sqrt{(Z_A)^2 - (R_A)^2}$$

$$= \sqrt{(50.07)^2 - (35.5)^2}$$

$$= \sqrt{2507 - 1260.2}$$

$$= \sqrt{1246.8}$$

$$X_L = 35.3$$

$$\downarrow$$

$$\omega L = 35.3$$

$$\downarrow$$

$$314 L = 35.3$$

$$L = \frac{35.3}{314} = 0.112\ H$$

Similarly;

$$X_C = \sqrt{(Z_B)^2 - (R_B)^2}$$

$$= \sqrt{(16.69)^2 - (8.34)^2}$$

$$= \sqrt{278.5 - 69.5}$$

$$= \sqrt{209}$$

$$X_C = 14.45$$

$$\downarrow$$

$$\frac{1}{\omega C} = 14.45$$

$$C = \frac{1}{314 \times 14.45} = \frac{1}{4537.3}$$

$$C = 0.22\ mF$$