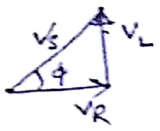
Q.1 A 120V, 100 Watt lamp is to be connected to a 220V, 50Hz AC supply. What value of pure inductance should be connected in series in order to run the lamp on rated voltage.

Solution:

$V_R = 120V$

$V_L = ?$

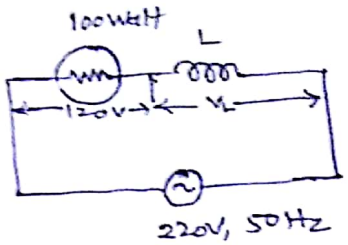
$V_S = V_R + jV_L$



$V_S = \sqrt{V_R^2 + V_L^2}$

$220V = \sqrt{120^2 + V_L^2}$

$V_L = 184.39$ Volt



⇒ Current through the lamp and inductance is same.

Current Through lamp $I = \frac{P}{V} = \frac{100}{120}$ A

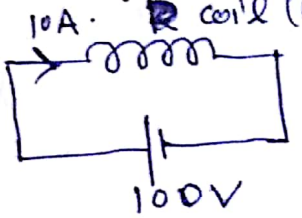
$V_L = I X_L = I \times 2\pi f L$

$L = \frac{V_L}{I \cdot X 2\pi f}$

$L = \frac{184.39}{\frac{100}{120} \times 2 \times \pi \times 50}$

$\boxed{L = 0.7046 \text{ H}}$

Q.2 A coil connected to 100V DC supply draws 10 A and the same coil connected 100V, AC voltage of frequency 50 Hz draws 5A. Calculate the parameters of the coil and power factor.



Sol. coil means a resistance and inductance both.

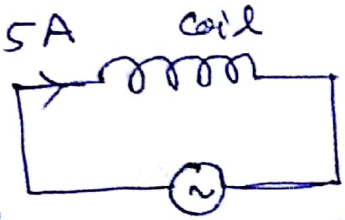
let impedance of coil $z = R + jX_L$

$X_L = 2\pi f L$

(1) in case of dc $f = 0$, Hence $X_L = 0$

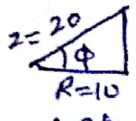
Hence resistance of coil $R = \frac{V}{I} = \frac{100}{10}$

$R = 10\Omega$



(2) in Case of AC supply impedance of coil

$|Z| = \frac{V}{I} = \frac{100}{5} = 20\Omega$



$\sqrt{R^2 + X_L^2} = 20 \Rightarrow X_L = 17.32\Omega$

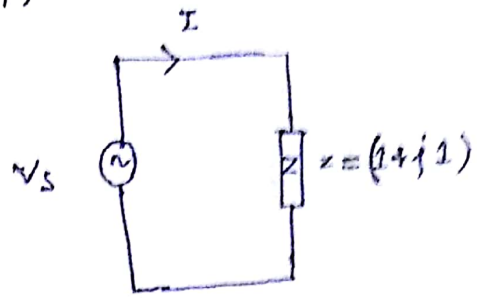
$\Rightarrow L = X_L / 2\pi f = 0.05$ H

$\cos\phi = R/Z$

$\cos\phi = 0.5$

Q.3 A Load having impedance of $(1+j1)\ \Omega$ is connected to an ac voltage represented as $V = 20\sqrt{2}\cos(\omega t + 10^\circ)$ Volt. Find the current in load expressed in the form of

$$i = I_m \sin(\omega t + \phi)$$



$$Z = 1+j1 = |Z| \angle \phi$$

$$|Z| = \sqrt{1^2+1^2} = \sqrt{2}$$

$$\phi = \tan^{-1}\left(\frac{1}{1}\right) = 45^\circ$$

$$Z = \sqrt{2} \angle 45^\circ$$

Voltage across the load $V = 20\sqrt{2}\cos(\omega t + 10^\circ)$

$$= 20\sqrt{2}\sin(\omega t + 100^\circ)$$

$$V_{rms} = \frac{V_m}{\sqrt{2}} \angle 100^\circ$$

$$V_{rms} = \frac{20\sqrt{2}}{\sqrt{2}} \angle 100^\circ = 20 \angle 100^\circ$$

Current Through load $I = \frac{V}{Z} = \frac{20 \angle 100^\circ}{\sqrt{2} \angle 45^\circ}$

$$I = 14.144 \angle 55^\circ \ (\text{rms})$$

$$I_{rms} = 14.144$$

$$I_m = 14.144 \times \sqrt{2} = 20 \text{ and } \phi = 55^\circ$$

$$\boxed{i = 20 \sin(\omega t + 55^\circ)}$$

Q.4 A emf is given by $100 \sin(314t - \frac{\pi}{4})$ volt is applied to a circuit and the current is $20 \sin(314t - \frac{\pi}{2})$ A. Find (i) frequency (ii) Circuit elements.

Sol. $\omega t = 314t$

$2\pi f = 314$

$\boxed{f = 50 \text{ Hz}}$

$$E = \frac{100}{\sqrt{2}} \angle -\frac{\pi}{4} \qquad I = \frac{20}{\sqrt{2}} \angle -\frac{\pi}{2}$$

$$Z = \frac{E}{I} = \frac{\frac{100}{\sqrt{2}} \angle -\frac{\pi}{4}}{\frac{20}{\sqrt{2}} \angle -\frac{\pi}{2}} = 5 \angle (90^\circ - 45^\circ) = 5 \angle 45^\circ$$

$$Z = R + jX_L = 5\cos 45^\circ + j5\sin 45^\circ$$

$$Z = \frac{5}{\sqrt{2}}(1+j)$$

$R = 5/\sqrt{2}\ \Omega$, $X_L = 5/\sqrt{2}\ \Omega \Rightarrow L = \frac{X_L}{2\pi}$