1. In an AC circuit, the power factor

A. is unity when the circuit contains an ideal resistor only.

B. is zero when the circuit contains an ideal inductor only.

C. Both options (A) and (B) ✓

D. None of these

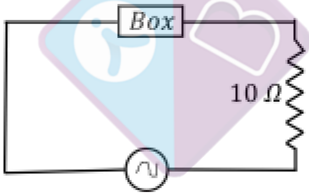
The power factor of AC circuit is $\cos\phi$.

For pure resistive AC circuit, $\phi = 0^\circ \Rightarrow \cos\phi = 1$

For pure inductive AC circuit, $\phi = 90^\circ \Rightarrow \cos\phi = 0$

Hence, option (C) is the correct answer.

2. In the circuit shown in the figure, the power factor of the box is 0.5 and the power factor of the circuit is $\sqrt{3}/2$. Current leads the voltage. Find the effective resistance of the box.



A. $1\,\Omega$

B. $3\,\Omega$

C. $5\,\Omega$ ✓

D. $7\,\Omega$

The power factor of the box is 0.5.

So, $\cos\phi_1 = 0.5 \Rightarrow \phi_1 = 60^\circ$

Also, the power factor of the circuit is $\sqrt{3}/2$.

So, $\cos\phi_2 = \sqrt{3}/2 \Rightarrow \phi_2 = 30^\circ$

Let R be the effective resistance of the box. Then,

$$\tan\phi_1 = \frac{X_C}{R} \Rightarrow \sqrt{3} = \frac{X_C}{R} \quad \ldots(1)$$

Also,

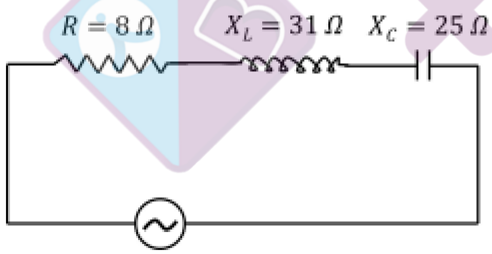
$$\tan\phi_2 = \frac{X_C}{R+10} \Rightarrow \frac{1}{\sqrt{3}} = \frac{X_C}{R+10} \quad \ldots(2)$$

On solving equations (1) and (2), we get,

$R = 5\ \Omega$

Hence, option (C) is the correct answer.

3.The given AC RLC circuit is connected to an AC source of $110\ \mathrm{V}; 50\ \mathrm{Hz}$. The power factor of the circuit is -

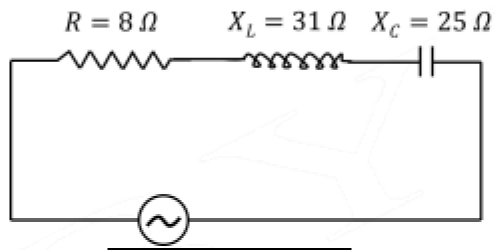


A. 0.56

B. 0.64

C. 0.80

D. 0.33



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

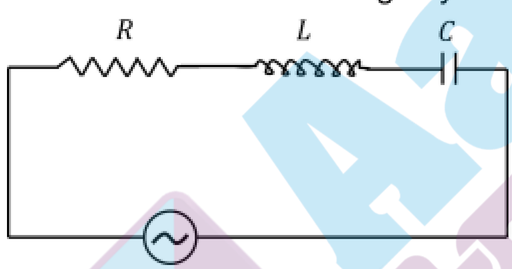
$\Rightarrow Z = \sqrt{8^2 + (31 - 25)^2} = 10\ \Omega$

So, power factor,

$\cos\phi = \frac{R}{Z} = \frac{8}{10} = 0.80$

Hence, option (C) is the correct answer.

4. For the given AC RLC circuit, at a particular frequency (f) of the AC source, the current leads the voltage by 45°. The relation between R, L and C is -

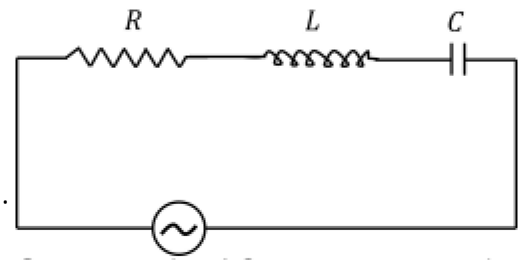


A. $C = \frac{1}{2\pi f(2\pi f L - R)}$

B. $C = \frac{1}{2\pi f(2\pi f L + R)}$

C. $C = \frac{1}{\pi f(2\pi f L - R)}$

D. $C = \frac{1}{\pi f(2\pi f L + R)}$



Suppose, the AC source voltage is given by,

$V = V_m \sin(\omega t)$

Then, the AC in the circuit is,

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

So,

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

$$\Rightarrow \tan 45^\circ = \frac{X_C - X_L}{R}$$

$$\Rightarrow R = X_C - X_L$$

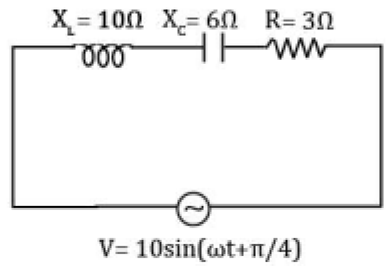
$$\Rightarrow R = \frac{1}{\omega C} - \omega L$$

$$\Rightarrow R = \frac{1}{2\pi f C} - 2\pi f L$$

$$\Rightarrow C = \frac{1}{2\pi f(2\pi f L + R)}$$

Hence, option (B) is the correct answer.

5. For the given AC LCR circuit, at a particular frequency of the AC source, the expression for current (i) as a function of time (t) will be -

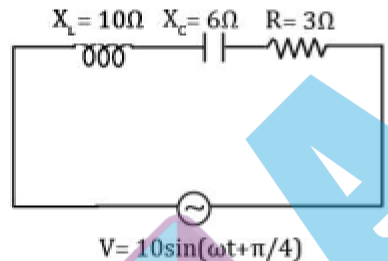


A. $i = 4\sin(\omega t + 8^\circ)$

B. $i = 4\sin(\omega t - 8^\circ)$

C. $i = 2\sin(\omega t - 8^\circ)$

D. $i = 2\sin(\omega t + 8^\circ)$



$$\tan\phi = \frac{X_L - X_C}{R} = \frac{10-6}{3} = \frac{4}{3}$$

$$\Rightarrow \phi = 53^\circ$$

$\Rightarrow$ Voltage lead the current by 53° as $X_L > X_C$

So, current,

$$i = \frac{V_0}{Z}\sin(\omega t + 45^\circ - 53^\circ)$$

$$\Rightarrow i = \frac{10}{\sqrt{3^2 + (10-6)^2}}\sin(\omega t - 8^\circ)$$

$$\Rightarrow i = 2\sin(\omega t - 8^\circ)$$

Hence, option (C) is the correct answer.