Alternating Current- L2

1. A coil has negligible resistance and an inductive reactance of $20\ \Omega$ at $50\ \text{Hz}$. If an AC source of $200\ \text{V}$ and $100\ \text{Hz}$ frequency is connected across the coil, the rms current in the coil will be

   A. $2.0\ \text{A}$

   B. $5.0\ \text{A}$

   C. $7.0\ \text{A}$

   D. $10.0\ \text{A}$

   We know that,

   $X_L = \omega L = 2\pi f L$

   $\Rightarrow 20 = 2\pi(50)L$

   $\Rightarrow L = \frac{1}{5\pi}\text{H}$

   When the coil is connected across the AC source,

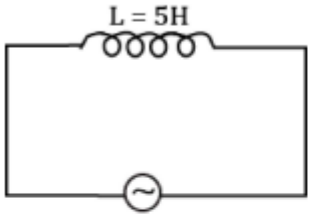
   $\therefore X_L' = 2\pi(100) \times \frac{1}{5\pi} = 40\ \Omega$

   Now,

   $i_{rms} = \frac{V_{rms}}{X_L'} = \frac{200}{40} = 5.0\ \text{A}$

   Hence, option (B) is the correct answer.

2. An inductor of inductance, $L = 5$ H is connected to an AC source having voltage, $V = 10\sin\left(10t + \frac{\pi}{6}\right)$. Find the inductive reactance.



A. $20\ \Omega$

B. $30\ \Omega$

C. $50\ \Omega$

D. $70\ \Omega$

3. A capacitor of capacitive reactance, $12\ \Omega$ is connected with an AC source having voltage, $V = 3\sin(\omega t + \pi/6)$. Find the expression of instantaneous current in the circuit.

A. $0.35\sin(\omega t + 2\pi/3)$

B. $0.25\sin(\omega t + 2\pi/3)$

C. $0.57\sin(\omega t - 2\pi/3)$

D. $0.15\sin(\omega t - 2\pi/3)$

$$I_0 = \frac{V_0}{X_C} = \frac{3}{12} = 0.25\ \text{A}$$

For a purely capacitive circuit, current leads ahead the voltage by $\pi/2$.

Therefore, instantaneous current in the circuit,

$I = 0.25\sin(\omega t + \pi/6 + \pi/2)$

$\Rightarrow I = 0.25\sin(\omega t + 2\pi/3)$

Hence, option (B) is the correct answer.

4. An inductor of inductance, $L = 5\ \text{H}$ is connected to an AC source having voltage, $V = 10\sin\left(10t + \frac{\pi}{6}\right)$. Find the peak value of current in the circuit.

A. $0.1\ \text{A}$

B. $0.2\ \text{A}$

C. $0.3\ \text{A}$

D. $0.4\ \text{A}$

Given:
Inductance, $L = 5\ \text{H}$
Voltage, $V = 10\sin\left(10t + \frac{\pi}{6}\right)$

So, peak value of current in the circuit,

$$i_0 = \frac{V_0}{X_L} = \frac{V_0}{\omega L} = \frac{10}{10 \times 5} = 0.2\ \text{A}$$

Hence, option (B) is the correct answer.

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5. An inductor of $1\ \mathrm{H}$ and a capacitor of $1\ \mu\mathrm{F}$ have equal reactance when connected to the same AC source at the same condition. The value of reactance is -

A. $10^4\ \Omega$

B. $10^2\ \Omega$

C. $10^3\ \Omega$

D. $10^5\ \Omega$

It is given that, $X_L = X_C$

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

$$\Rightarrow \omega^2 = \frac{1}{LC} = \frac{1}{1 \times 10^{-6}}$$

$$\therefore \omega = 10^3\ \mathrm{rad/s}$$

Now,

$$X_L = \omega L = 10^3 \times 1 = 10^3\ \Omega$$

$$\therefore X_L = X_C = 10^3\ \Omega$$

Hence, option (C) is the correct answer.