Alternating Current

Question1

An inductor and a resistor are connected in series to an AC supply. If the potential difference across the inductor and the resistor are 180 V and 240 V respectively, then the voltage of the AC supply is

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Options:

A.

300 V

B.

420 V

C.

60 V

D.

210 V

Answer: A

Solution:

- In an **L-R series circuit**,
- Voltage across resistor: $V_R = 240\,\text{V}$
- Voltage across inductor: $V_L = 180\,\text{V}$

We are asked to find the **supply voltage** V.

Step 1: Relation between voltages in series L-R circuit

In a series L-R circuit, the resistor voltage V_R and the inductor voltage V_L are **90° out of phase** (since V_R is in phase with current, and V_L leads the current by 90°).

Hence, the total voltage is obtained by the **vector sum**:

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

Step 2: Substitute given values

$$V = \sqrt{(240)^2 + (180)^2}$$

$$V = \sqrt{57600 + 32400} = \sqrt{90000} = 300 \text{ V}$$

✅ **Final Answer:**

300 V

Option A

Question2

The frequency of an alternating voltage is 50 Hz . The time taken for instantaneous voltage to increase from zero to half of its peak voltage is

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Options:

A.

$\frac{1}{800}$ s

B.

$\frac{1}{600}$ s

C.

$\frac{1}{300}$ s

D.

$\frac{1}{200}$ s

Answer: B

Solution:

$$V = V_0 \sin \omega t$$
$$\Rightarrow \frac{V_0}{2} = V_0 \sin \omega t$$
$$\Rightarrow \frac{1}{2} = \sin \omega t \Rightarrow \omega t = \frac{\pi}{6}$$
$$\Rightarrow 2\pi f t = \frac{\pi}{6} \Rightarrow 2\pi \times 50 \times t = \frac{\pi}{6}$$
$$\Rightarrow \quad t = \frac{1}{600} \text{ s}$$

Question3

A capacitor and a resistor are connected in series to an AC source. If the ratio of the capacitive reactance of the capacitor and the resistance of the resistor is $4 : 3$, then the power factor of the circuit is

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Options:

A. 0.3

B. 0.8

C. 0.6

D. 0.5

Answer: C

Solution:

Given,

The ratio of the capacitive reactance X_C to the resistance R is $4 : 3$.

Let, $X_C = 4k$

$R = 3k$

Then, the impedance Z of the series $R - C$ circuit is given by

$$Z = \sqrt{R^2 + X_C^2}$$

$$Z = \sqrt{(3k)^2 + (4k)^2}$$

$$Z = 5k$$

We know that, the power factor is the cosine of the phase angle ϕ between the total impedance and the resistive part of the impedance.

$$\cos\phi = \frac{R}{Z}$$

$$\cos\phi = \frac{3k}{5k}$$

$$\cos(\phi) = 0.6$$

Question4

An inductor of inductive reactance R, a capacitor of capacitive reactance $2R$ and a resistor of resistance R are connected in series to an AC source. The power factor of the series $L - C - R$ circuit is

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Options:

A. $\frac{1}{\sqrt{2}}$

B. $\frac{1}{\sqrt{3}}$

C. $\frac{1}{4}$

D. $\frac{\sqrt{3}}{2}$
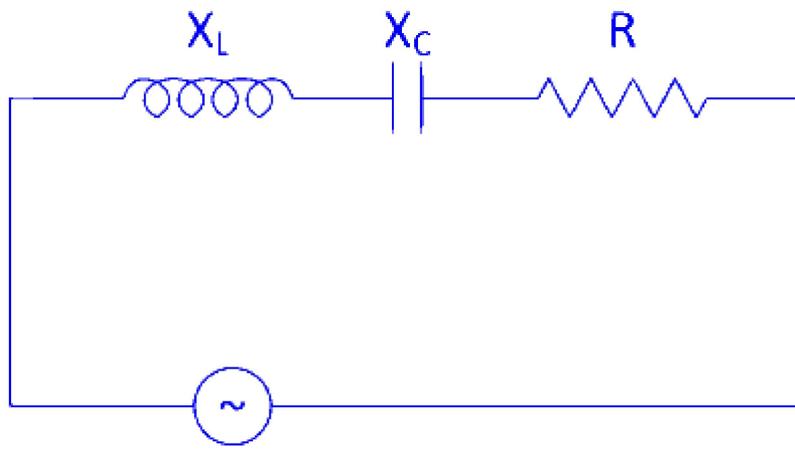
Answer: A

Solution:

Given,

Inductive reactance, $X_L = R$

Capacitive reactance, $X_C = 2R$

Resistor $= R$

Power factor, $\cos\phi$ is given by

$$\cos\phi = \frac{R}{Z}$$

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

$$\cos\phi = \frac{R}{\sqrt{R^2+(R-2R)^2}}$$

$$\cos\phi = \frac{R}{\sqrt{2R^2}} = \frac{1}{\sqrt{2}}$$

Question5

An inductor and a resistor are connected in series to an AC source of 10 V . If the potential difference across the inductor is 6 V , then the potential difference across the resistor is

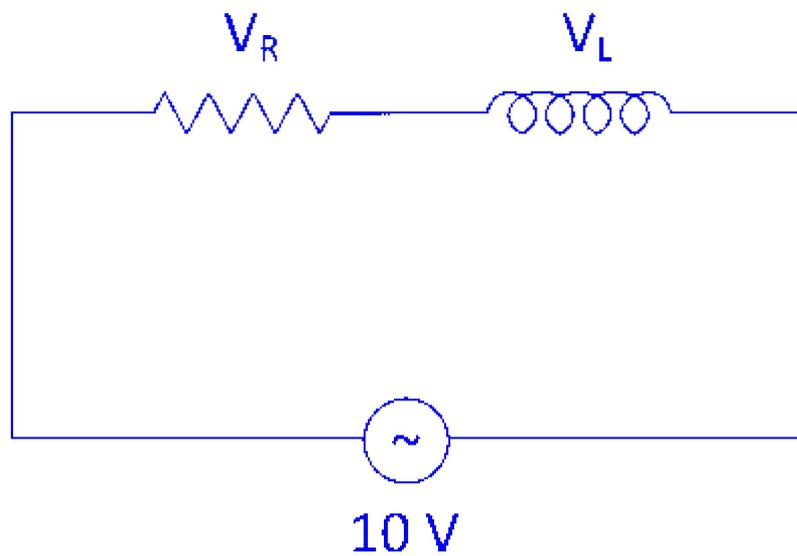**TG EAPCET 2024 (Online) 10th May Morning Shift**

Options:

A. 4 V

B. 10 V

C. 6 V

D. 8 V

Answer: D

Solution:

Given, $V_L = 6$ V

$V_{RMS} = 10$ V

As the circuit consists only L and R

$$V_{RMS} = \sqrt{V_R^2 + V_L^2}$$

Squaring both sides

$$V_{RMS}^2 = V_R^2 + V_L^2$$

$$V_R^2 = V_{RMS}^2 - V_L^2$$

$$= (10)^2 - (6)^2$$

$$V_R^2 = 100 - 36 = 64$$

$$V_R = 8 \text{ V}$$

Question6

In a series $L - C - R$ circuit, if the current leads the source voltage, then

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Options:

A. $X_C > X_L$

B. $x_L > x_C$

C. $X_L = X_C \neq 0$

D. $X_L = X_C = 0$

Answer: A

Solution:

In a series $L - C - R$ circuit where the current leads the voltage source, the reactance (X) is predominantly capacitive, meaning the capacitive reactance (X_C) is greater than the inductive reactane (X_L).

Mathematically, it can be expressed as $X_C > X_L$ This imbalance the capacitive and inductive reactance values results in the leading current behaviour.

Question7

In an ideal step up transformer, if the input voltage and input power are V_1 and R_1 respectively and the output voltage and output power are V_2 and P_2 respectively, then

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Options:

A.

$V_1 = V_2; P_1 = P_2$

B.

$V_1 > V_2; P_1 > P_2$

C.

$V_1 = V_2; P_1 = P_2$

D.

$V_1 < V_2; P_1 < P_2$

Answer: D

Solution:

In an ideal step-up transformer, the input voltage is denoted as V_1 and the input power as P_1. Similarly, the output voltage is V_2, and the output power is P_2.

For an ideal step-up transformer:

The output voltage (V_2) is greater than the input voltage (V_1). This means that the transformer increases the voltage at the output compared to the input.

The power in an ideal transformer is conserved, meaning there is no power loss. Therefore, the input power (P_1) is equal to the output power (P_2).

In summary, in an ideal step-up transformer, $V_2 > V_1$ and $P_1 = P_2$.

Question8

The power factor of an AC circuit containing peak current 2 A and peak voltage 1 V is $1/2$, then the angle between voltage and current is

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Options:

A. $30°$

B. $45°$

C. $90°$

D. $60°$

Answer: D

Solution:

Given:

Peak current = 2 A

Peak voltage = 1 V

Power factor $= \frac{1}{2}$

The power factor is defined as the ratio of real power to apparent power. For an AC circuit, it can also be described as $\cos \phi$, where ϕ is the phase angle between the current and the voltage.

Here is the derivation:

Power factor $= \frac{\text{Peak voltage}}{\text{Peak current}} = \frac{1}{2}$

Since the power factor is also expressed as:

Power factor $= \cos \phi$

We set up the equation:

$\cos \phi = \frac{1}{2}$

Solving for ϕ, we get:

$\phi = \cos^{-1}\left(\frac{1}{2}\right)$

This leads to:

$\phi = 60°$

Therefore, the angle between the voltage and current is $60°$.