Electromagnetic Induction And Alternating Currents JEE Main PYQ - 2

Total Time: 25 Minute **Total Marks:** 40

Instructions

Instructions

1. Test will auto submit when the Time is up.
2. The Test comprises of multiple choice questions (MCQ) with one or more correct answers.
3. The clock in the top right corner will display the remaining time available for you to complete the examination.

Navigating & Answering a Question

1. The answer will be saved automatically upon clicking on an option amongst the given choices of answer.
2. To deselect your chosen answer, click on the clear response button.
3. The marking scheme will be displayed for each question on the top right corner of the test window.

Electromagnetic Induction And Alternating Currents

1. When the rms voltages V_L, V_C and V_R are measured respectively across the inductor L, the capacitor C and the resistor R in a series LCR circuit connected to an AC source, it is found that the ratio $V_L : V_C : V_R = 1 : 2 : 3$. If the rms voltage of the AC sources is $100\,V$, the V_R is close to: **(+4, -1)**

April 9, 2014

a. $50\,V$

b. $70\,V$

Click Here for Solution

c. $90\,V$

d. $100\,V$

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2. In the pure inductive circuit, the curves between frequency and reciprocal of inductive reactance $\frac{1}{}$ is: **(+4, -1)**

a. inversely proportional

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b. directly proportional

c. equivalent

d. None of these

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3. In a discharging RC circuit, at what time the electrical potential energy will become the half of its initial value? [in terms of time constant of RC circuit,] **(+4, -1)**

Click Here for Solution

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4. An alternating voltage source $V = 260\sin(628t)$ is connected across a pure inductor of $5mH$ Inductive reactance in the circuit is : **(+4, -1)**

a. 3.14Ω

b. $6.28S$

Click Here for Solution

c. 0.318Ω

d. 0.5Ω

5. In a series LR circuit with $X_L = R$, power factor is P_1 If a capacitor of capacitance C with $X_C = X_L$ is added to the circuit the power factor becomes P_2 The ratio of P_1 to P_2 will be : **(+4, -1)**

30-Jan-2023 Shift 1

a. $1 : 2$

b. $1 : 3$

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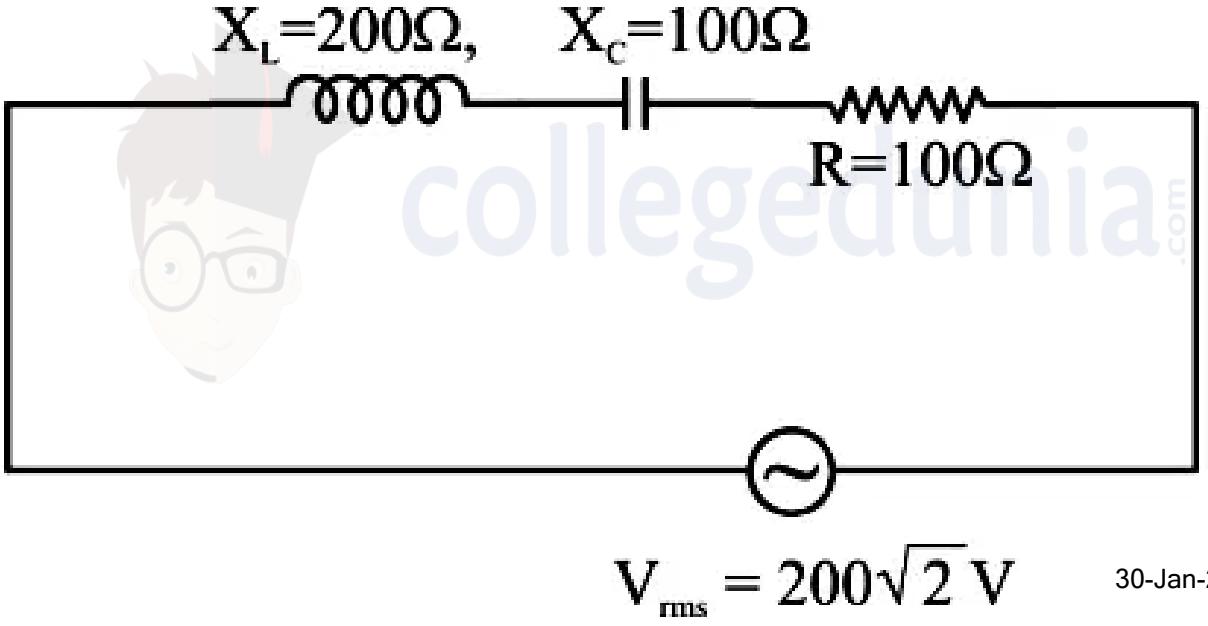
c. $1 : 1$

d. $1 : \sqrt{2}$

6. In the given circuit, rms value of current (I_{rms}) through the resistor R is: **(+4, -1)**



30-Jan-2023 Shift 2

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

b. $20A$

Click Here for Solution

c. $2A$

d. $2\sqrt{2}A$

7. A series LCR circuit consists of $R = 80\Omega$, $X_L = 100\Omega$, and $X_C = 40\Omega$. The input voltage is 2500 $\cos(100\pi t)V$. The amplitude of current, in the circuit, is ___A **(+4, -1)**

31-Jan-2023 Shift 2

8. The variation of impedance (Z) with angular frequency (w) for two electrical elements is shown in the graph given. If XL,Xc, and R are inductive reactance, capacitive reactance and resistance respectively, then **(+4, -1)**

   a. A is resistor B is inductor

   b. A is inductor B is capacitor

   Click Here for Solution

   c. A is inductor B is resistor

   d. A is capacitor B is inductor

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9. Given below are two statements: one is labeled as Statement (1) and the other is labeled as Statement (2). **(+4, -1)**
   Statement (1): An LCR circuit connected to an AC source has maximum average power at resonance.
   Statement (2): A resistor-only circuit with zero phase difference has maximum average power.
   In the light of the above statements, choose the correct option:

   a. (1) and (2) both are correct

   b. (1) is correct but (2) is incorrect

   Click Here for Solution

   c. (1) is incorrect but (2) is correct

   d. Both (1) and (2) are incorrect

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10. To increase the resonant frequency in seriesLCR circuit, **(+4, -1)**

    a. Source frequency should be increased

    b. Another resistance should be added in series with the first resistance.

    c. Another capacitor should be added in series with the first capacitor

    d. The source frequency should be decreased

    25-Jul-2022-Shift-1

    Click Here for Solution

Answers

1. **Answer: c**

Explanation:

$I = \frac{V_{rms}}{Z} = \frac{V_{rms}}{\sqrt{R^2+(X_L-X_C)^2}} = \frac{100}{\sqrt{9x^2+x^2}} = \frac{100}{\sqrt{10x^2}}$

Since $V_L : V_C : V_R = 1 : 2 : 3$

$X_L = X_C : X_R = 1 : 2 : 3$

$= x : 2x : 3x$

now $V_R = I\,(3x)$

$= \frac{100}{\sqrt{10x^2}}.3x$

$\approx 94.87\,V$

Concepts:

1. Alternating Current:

An alternating current can be defined as a current that changes its magnitude and polarity at regular intervals of time. It can also be defined as an electrical current that repeatedly changes or reverses its direction opposite to that of Direct Current or DC which always flows in a single direction as shown below.

Alternating Current Production

Alternating current can be produced or generated by using devices that are known as alternators. However, alternating current can also be produced by different methods where many circuits are used. One of the most common or simple ways of generating AC is by using a basic single coil AC generator which consists of two-pole magnets and a single loop of wire having a rectangular shape.

Application of Alternating Current

AC is the form of current that are mostly used in different appliances. Some of the examples of alternating current include audio signal, radio signal, etc. An alternating current has a wide advantage over DC as AC is able to transmit power over large distances without great loss of energy.

2. **Answer: a**

Explanation:

Correct option is (A)

$X_L = 2\pi f L$

$\Rightarrow X_L \propto f$

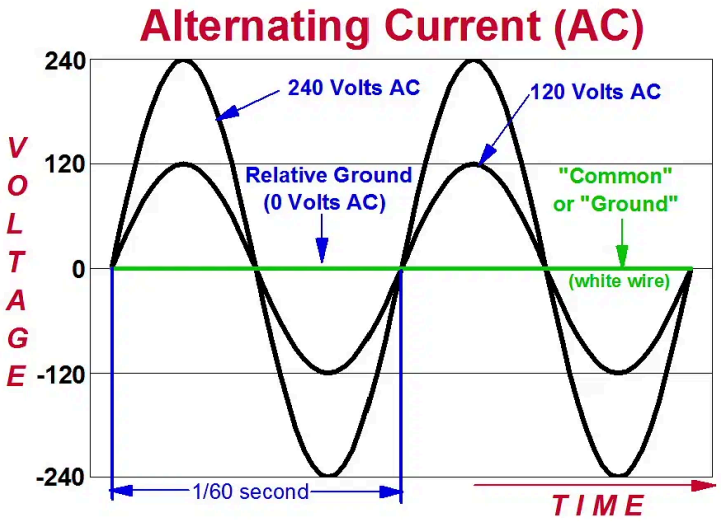
$\Rightarrow \frac{1}{X_L} \propto \frac{1}{f}$

i.e., graph between XL1 and f will be a hyperbola.

Concepts:

1. AC Voltage:

When voltage changes its direction after every half cycle is known as alternating voltage. The current flows in the circuit at that time are known as alternating current. The **alternating current(AC)** follows the **sine function** which changes its polarity concerning time. Most of the electrical devices are operating on the ac voltage.



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3. **Answer: 0.34 - 0.34**

Explanation:

Explanation:

Let $_0$ be the initial charge on the capacitor.

Thus, the initial electrical potential energy of the capacitor is $_0 = \frac{^2_0}{2}$

Let in time , the electrical potential energy will become half of its initial value.

The electrical potential energy of the capacitor at time is

$= \frac{^2}{2}$

where is the charge on the capacitor at time .

In a discharging RC circuit, charge at any time is given as

$= \ _0^{- /}$

where is the time constant of the circuit.

$= \frac{1}{2}\ ^2_0\ ^{-2 /}$

Now, according to the given condition

$= \frac{1}{2}\ _0$ or, $\frac{1}{2}\ ^2_0\ ^{-2} = \frac{1}{2}\frac{^2_0}{2}$ or, $\frac{1}{2} = \ ^{-2}$

Taking natural logarithms of both sides, we get

$\ln(12) = -2\tau$ or, $-0.693 = -\frac{2}{}$ or, $= 0.34$

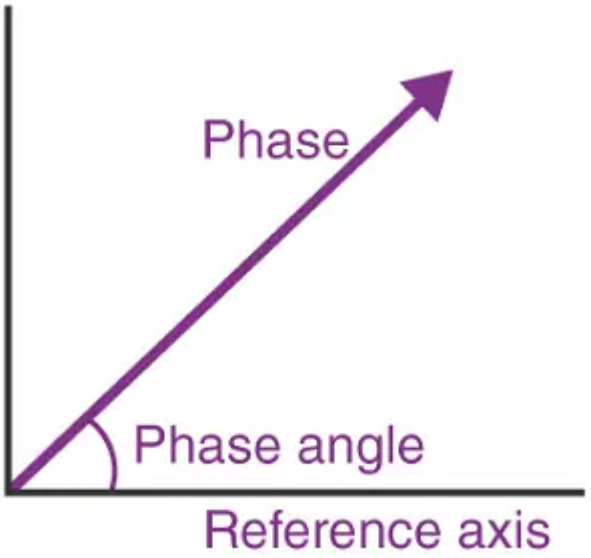
This is the time in which the electrical potential energy becomes half of its initial value.

Hence, the correct answer is 0.34 .

Concepts:

1. LCR Circuit:

An LCR circuit, also known as a resonant circuit, or an RLC circuit, is an electrical circuit consist of an inductor (L), capacitor (C) and resistor (R) connected in series or parallel.

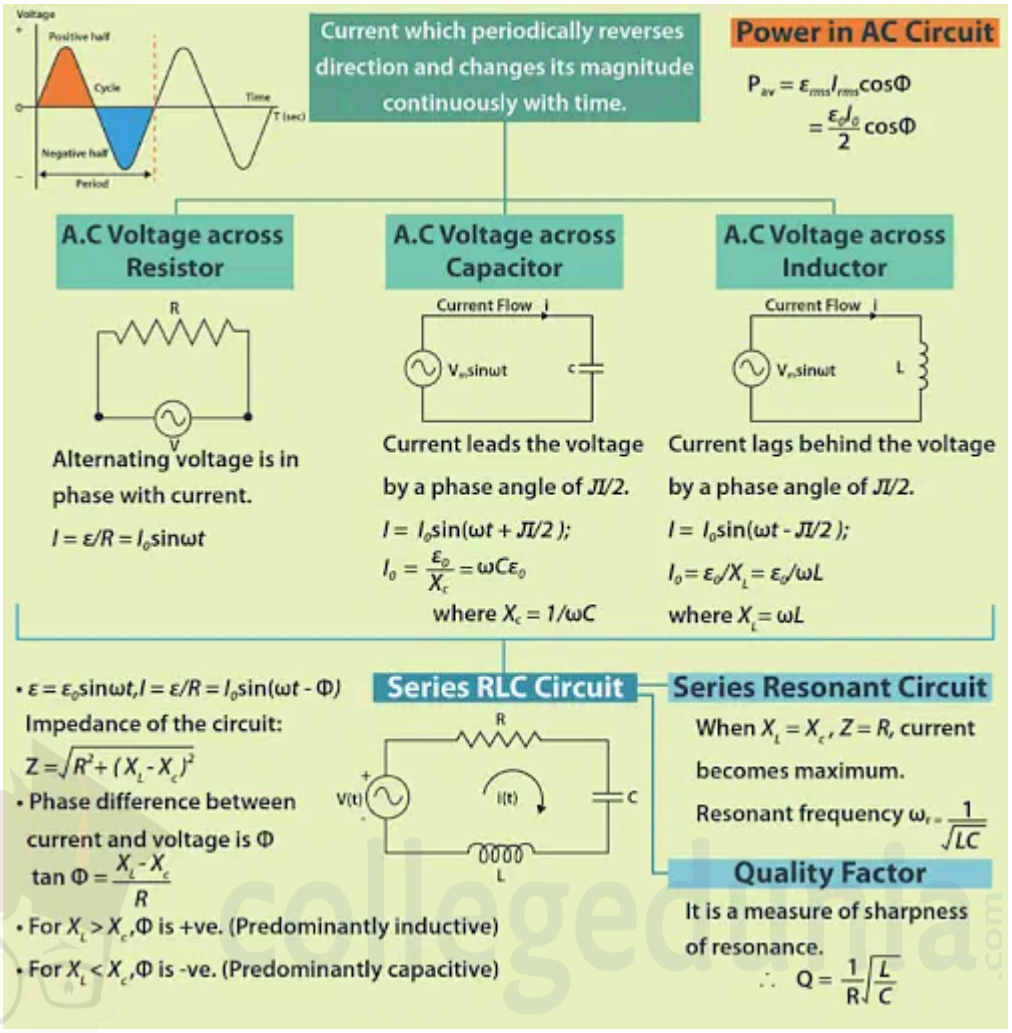


Current Vs Voltage Graph

Series LCR circuit

When a constant voltage source is connected across a resistor a current is induced in it. This current has a unique direction and flows from the negative to positive terminal. Magnitude of current remains constant.

Alternating current is the current if the direction of current through this resistor changes periodically. An AC generator or AC dynamo can be used as AC voltage source.



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4. Answer: a

Explanation:

The correct answer is (A) : 3.14Ω

Concepts:

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Alternating Current Production

Alternating current can be produced or generated by using devices that are known as alternators. However, alternating current can also be produced by different methods where many circuits are used. One of the most common or simple ways of generating AC is by using a basic single coil AC generator which consists of two-pole magnets and a single loop of wire having a rectangular shape.

Application of Alternating Current

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5. **Answer: d**

Explanation:

$$P = \frac{R}{Z} \Rightarrow P_1 = \frac{R}{\sqrt{R^2+X_L^2}} = \frac{R}{R\sqrt{2}} \left(\text{ as } X_L = R\right)$$
$$P_1 = \frac{1}{\sqrt{2}}$$
$$P_2 = \frac{R}{\sqrt{R^2+(X_L-X_L)^2}} = P_2 = 1$$
$$\frac{P_1}{P_2} = \frac{1}{\sqrt{2}}$$

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6. **Answer: c**

Explanation:

The correct answer is (C) : $2A$

$z = \sqrt{100^2 + (200 - 100)^2}$

$= 100\sqrt{2}\Omega$

$i_{rms} = \frac{V_{rms}}{z} = \frac{200\sqrt{2}}{100\sqrt{2}}$

$= 2A$

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7. **Answer: 25 - 25**

Explanation:

The correct answer is 25.

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8. **Answer: b**

Explanation:

The correct option is (B): A is inductor B is capacitor

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9. **Answer: a**

Explanation:

Statement (1) is correct. An LCR circuit connected to an AC source has maximum average power at resonance. At resonance, the reactive components of the circuit cancel each other out, leaving only the resistance to limit the flow of current. This results in maximum current flow and maximum power transfer to the circuit. Statement (2) is incorrect. A resistor only circuit with zero phase difference does not

necessarily have maximum average power. The power in a resistor only circuit is given by $P = \frac{V^2}{R}$, where V is the voltage across the resistor and R is its resistance. Maximum power occurs when the voltage across the resistor is at its maximum. This occurs when the circuit has a phase difference of 90 degrees, not zero.
Therefore, the correct option is (1) is correct but (2) is incorrect.
Answer. A

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10. **Answer: c**

Explanation:

The correct option is (C)

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