Saitechinfo NEET JEE Academy

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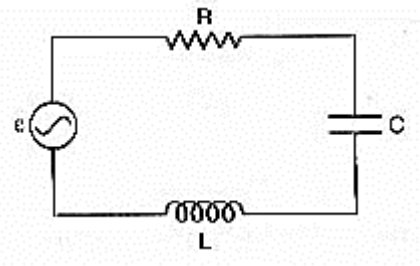
ALTERNATING CURRENT

Class 12 - Physics

Time Allowed: 1 hour and 30 minutes **Maximum Marks: 46**

1. Show that the current leads the voltage in phase by $\frac{\pi}{2}$ in an AC circuit containing an ideal capacitor. **[3]**
2. A series L-C-R circuit is connected to an AC source (200 V, 50 Hz). The voltages across the resistor, capacitor and inductor are respectively 200 V, 250 V and 250 V. **[3]**
   i. The algebraic sum of the voltages across the three elements is greater than the voltage of the source. How is this paradox resolved?
   ii. Given the value of the resistance of R is 40Ω. Calculate the current in the circuit.
3. A sinusoidal voltage of peak value 10 V is applied to a series LCR circuit in which resistance, capacitance, and inductance have values of 10 Ω, 1 μF and 1 H respectively. Find **[3]**
   i. the peak voltage across the inductor at resonance
   ii. quality factor of the circuit.
4. i. An LCR series circuit is connected to an ac source. If the angular resonant frequency of the circuit is ω_0, will the current lead or lag behind or be in phase with the voltage when $\omega < \omega_0$ and why? **[3]**
   ii. We cannot step up a dc voltage using a transformer. Why?
   iii. On what principle does a metal detector work?
5. Derive an expression for the impedance of an a.c. circuit with an inductor L and a resistor R in series. Also obtain the expression for average power in this circuit. **[5]**
6. A small town with a demand of 800 kW of electric power at 220 V is situated 15 km away from an electric plant generating power at 440 V. The resistance of the two wirelines carrying power is 0.5 Ω per km. The town gets power from the line through a 4000 - 220 V step-down transformer at a sub-station in the town. **[5]**
   a. Estimate the line power loss in the form of heat.
   b. How much power must the plant supply, assuming there is negligible power loss due to leakage?
   c. Characterize the step-up transformer at the plant.
7. i. Describe, with the help of a suitable diagram, the working principle of a step-up transformer. Obtain the relation between input and output voltages in terms of the number of turns of primary and secondary windings and the currents in the input and output circuits. **[5]**
   ii. Given the input current 15 A and the input voltage of 100 V for a step-up transformer having 90% efficiency, find the output power and the voltage in the secondary if the output current is 3 A.
8. A series of LCR circuit is connected to a variable frequency 230 V source, L = 5.0 H, $C = 80\mu F$, $R = 40\Omega$ **[5]**

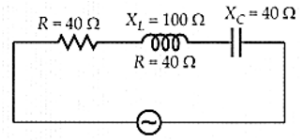


i. Determine the source frequency which drives the circuit in resonance.

ii. Obtain the impedance of the circuit and the amplitude of current at the resonating frequency.

iii. Determine the rms potential drops across the three elements of the circuit. Show that the potential drop across the LC combination is zero at the resonating frequency.

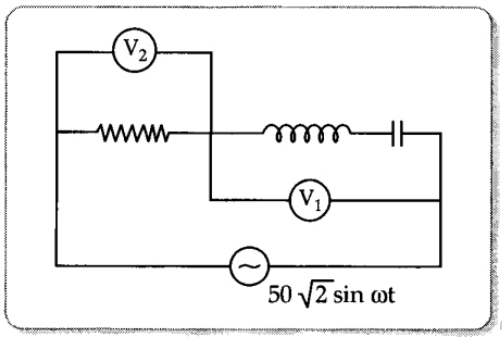
9. The power factor of the circuit shown in the figure is **[1]**



a) 0.2 b) 0.6

c) 0.8 d) 0.4

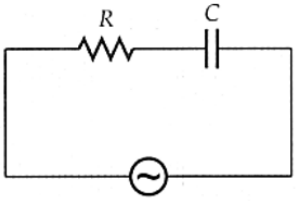
10. If the reading of the voltmeter V_1 is 40 V, then the reading of voltmeter V_2 is **[1]**



a) 15 V b) 30 V

c) 58 V d) 29 V

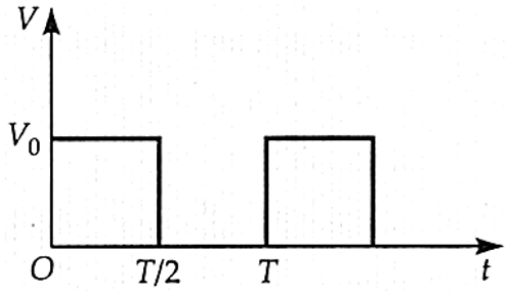
11. A 50 Hz a.c. source of 20 V is connected across R and C as shown in the figure. The voltage across R is 12 V. **[1]**
The voltage across C is



a) not possible to determine, unless values of R and C are given b) 10 V

c) 16 V d) 8 V

12. The rms value of potential difference V shown in the figure is **[1]**



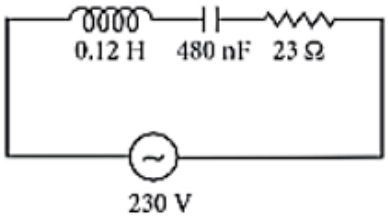
a) V_0 b) $\frac{V_0}{\sqrt{3}}$

c) $\frac{V_0}{2}$ d) $\frac{V_0}{\sqrt{2}}$

13. **Read the text carefully and answer the questions:** **[5]**

When the frequency of ac supply is such that the inductive reactance and capacitive reactance become equal, the impedance of the series LCR circuit is equal to the ohmic resistance in the circuit. Such a series LCR circuit is known as resonant series LCR circuit and the frequency of the ac supply is known as resonant frequency. Resonance phenomenon is exhibited by a circuit only if both L and C are present in the circuit. We cannot have resonance in a RL or RC circuit.

A series LCR circuit with L = 0.12H, C = 480 nF, R = 23 Ω is connected to a 230 V variable frequency supply.



(a) Find the value of source frequency for which current amplitude is maximum.

a) 770 Hz b) 550.52 Hz

c) 663.48 Hz d) 222.32 Hz

(b) The value of maximum current is

a) 50.25 A b) 14.14 A

c) 22.52 A d) 47.41 A

(c) The value of maximum power is

a) 5500 W b) 2299.3 W

c) 2200 W d) 4700 W

(d) What is the Q-factor of the given circuit?

a) 25 b) 42.21

c) 21.74 d) 35.42

(e) At resonance which of the following physical quantity is maximum?

a) Current b) Neither Impedance and Current

c) Both Impedance and Current d) Impedance

Question No. 14 to 18 are based on the given text. Read the text carefully and answer the questions: **[5]**

A transformer is essentially an a.c. device. It cannot work on d.c. It changes alternating voltages or currents. It does not affect the frequency of a.c. It is based on the phenomenon of mutual induction. A transformer essentially consists of

two coils of insulated copper wire having a different number of turns and wound on the same soft iron core.

The number of turns in the primary and secondary coils of an ideal transformer are 2000 and 50 respectively. The primary coil is connected to the main supply of 120 V and secondary coil is connected to a bulb of resistance 0.6 Ω.

14. The value of voltage across the secondary coil is

a) 10V
b) 5V
c) 2V
d) 3V

15. The value of current in the bulb is

a) 15A
b) 5A
c) 7A
d) 3A

16. The value of current in primary coil is

a) 2.52 A
b) 0.125 A
c) 1.51 A
d) 3.52 A

17. Power in primary coil is

a) 15W
b) 20W
c) 10W
d) 5W

18. Power in secondary coil is

a) 7W
b) 8W
c) 15W
d) 20W

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