CBSE ACADEMY PLUS

UNIT

07

ALTERNATING CURRENT

SECTION – A
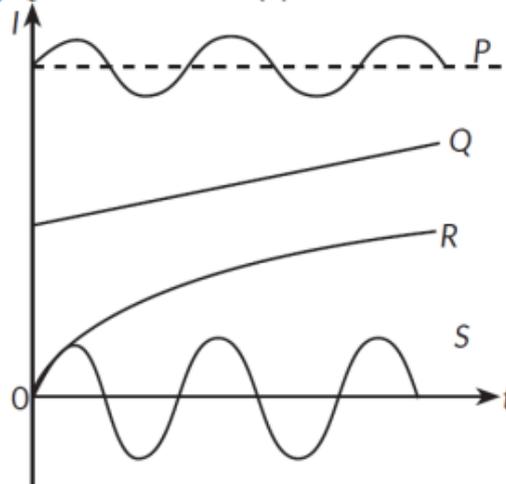### Questions 1 to 10 carry 1 mark each.

1. The figure shows variation of current (I) with time (t) in four devices P, Q, R and S. The device in which an alternating current flows is
   (a) P   (b) Q   (c) R   (d) S

2. An ac voltage $v = v_0 \sin\omega t$ is applied to a series combination of a resistor R and an element X. The instantaneous current in the circuit is $I = I_0 \sin\left(\omega t + \dfrac{\pi}{4}\right)$. Then which of the following is correct?
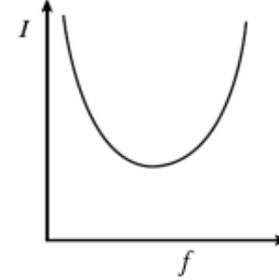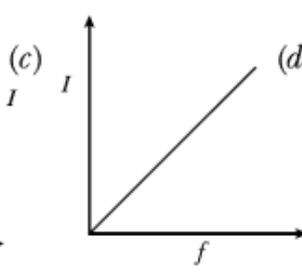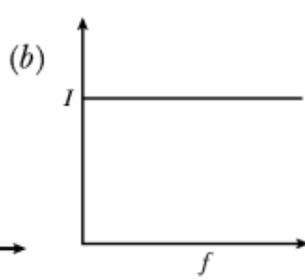   (a) X is a capacitor and $X_C = \sqrt{2}\ R$ (b) X is an inductor and $X_L = R$
   (c) X is an inductor and $X_L = \sqrt{2}\ R$ (d) X is a capacitor and $X_C = R$

3. Which of the following graphs represent the variation of current (I) with frequency (f) in an AC circuit containing a pure capacitor?

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4. An inductor, a capacitor and a resistor are connected in series across an ac source of voltage. If the frequency of the source is decreased gradually the reactance of
   (a) both the inductor and the capacitor decreases.
   (b) inductor decreases and the capacitor increases.
   (c) both the inductor and the capacitor increases.
   (d) inductor increases and the capacitor decreases.

5. If an AC voltage is applied to an LCR circuit, which of the following is true?
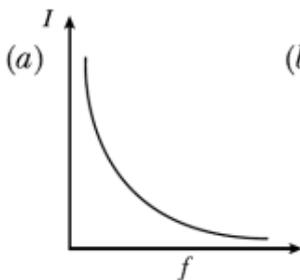   (a) I and V are out of phase with each other in R.
   (b) I and V are in phase in L while in C, they are out of phase.
   (c) I and V are out of phase in both C and L.
   (d) I and V are out of phase in L and in phase in C.

6. An ac circuit has a resistance of 12 ohm and an impedance of 15 ohm. The power factor of the circuit will be
   (a) 0.8   (b) 0.4   (c) 0.125   (d) 1.25

7. To reduce the resonant frequency in an LCR series circuit with a generator
   (a) the generator frequency should be reduced.
   (b) another capacitor should be added in parallel to the first.
   (c) the iron core of the inductor should be removed.
   (d) dielectric in the capacitor should be removed.

8. If the frequency of an AC is made 4 times of its initial value, the inductive reactance will be:
   (a) 2 times   (b) 3 times   (c) 4 times   (d) Unchanged

In the following questions 9 and 10, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

9. **Assertion (A):** The alternating current lags behind the emf by a phase angle of $\pi/2$, when AC flows through an inductor.
   Reason (R): The inductive reactance increase as the frequency of AC source decrease.
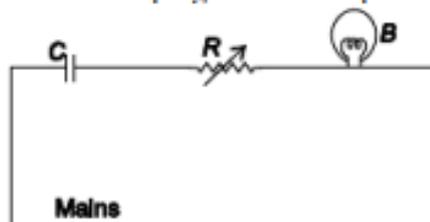
10. **Assertion (A):** In series LCR resonance circuit, the impedance is equal to the ohmic resistance.
    Reason (R): At resonance, the inductive reactance exceeds the capacitive reactance.

SECTION – B
Questions 11 to 14 carry 2 marks each.

11. A capacitor C, a variable resistor R and a bulb B are connected in series to the ac mains in circuit as shown. The bulb glows with some brightness. How will the glow of the bulb change if (i) a dielectric slab is introduced between the plates of the capacitor, keeping resistance R to be the same; (ii) the resistance R is increased keeping the same capacitance?

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12. An alternating voltage of frequency f is applied across a series LCR circuit. Let f_r be the resonance frequency for the circuit. Will the current in the circuit lag, lead or remain in phase with the applied voltage when (i) $f > f_r$, (ii) $f < f_r$? Explain your answer in each case.

<div align="center">OR</div>

In a series *LCR* circuit, obtain the conditions under which (i) the impedance of the circuit is minimum, and (ii) wattless current flows in the circuit.

13. Draw the graphs showing the variations of (i) inductive reactance, and (ii) capacitive reactance, with frequency of applied voltages in ac circuit. How do the values of (i) inductive, and (ii) capacitive reactance change, when the frequency of applied voltage is tripled?

<div align="center">OR</div>

A light bulb and an open coil inductor are connected to an ac source through a key as shown in the figure.
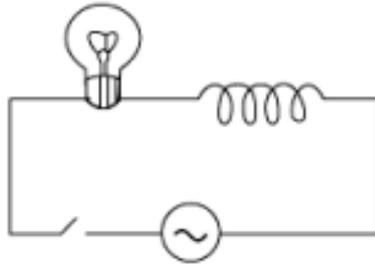

The switch is closed and after sometime, an iron rod is inserted into the interior of the inductor. The glow of the light bulb (a) increases; (b) decreases; (c) is unchanged, as the iron rod is inserted. Give your answer with reason. What will be your answer if ac source is replaced by a dc source?

14. The coil of an ac generator consists of 100 turns of wire, each of area 0.5m². The resistance of the wire is 100 Ω. The coil is rotating in a magnetic field of 0.8 T perpendicular to its axis of rotation, at a constant angular speed of 60 radian per second. Calculate the maximum emf generated and power dissipated in the coil.

<div align="center">

SECTION – C
Questions 15 to 17 carry 3 marks each.

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15. (a) The graphs (i) and (ii) represent the variation of the opposition offered by the circuit element to the flow of alternating current with frequency of the applied emf. Identify the circuit element corresponding to each graph.
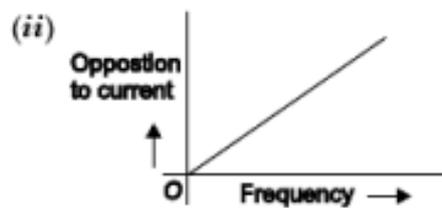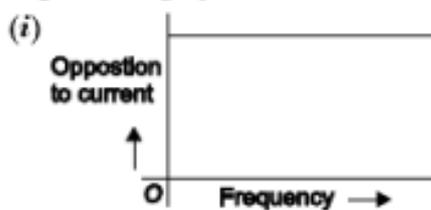

(b) Write the expression for the impedance offered by the series combinations of the above two elements connected across the ac. Which will be ahead in phase in this circuit, voltage or current?

16. Show that the current leads the voltage in phase by $\pi/2$ in an ac circuit containing an ideal capacitor.

17. The figure shows the graphical variation of the reactance of a capacitor with frequency of ac source.
(a) Find the capacitance of the capacitor.

(b) An ideal inductor has the same reactance at 100 Hz frequency as the capacitor has at the same frequency. Find the value of inductance of the inductor.

(c) Draw the graph showing the variation of the reactance of this inductor with frequency.

OR
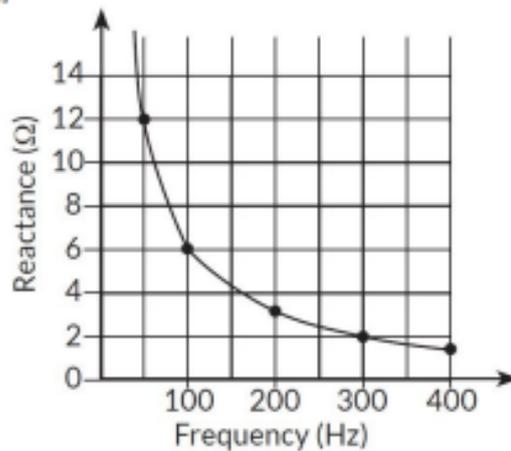
A resistor of 30 Ω and a capacitor of $\dfrac{250}{\pi}$ µF are connected in series to a 200 V, 50 Hz ac source.

Calculate (i) the current in the circuit, and (ii) voltage drops across the resistor and the capacitor (iii) Is the algebraic sum of these voltages more than the source voltage? If yes, solve the paradox.

SECTION – D
Questions 18 carry 5 marks.

18. (a) With the help of a labelled diagram, describe briefly the underlying principle and working of a step-up transformer.

(b) Write any two sources of energy loss in a transformer.

(c) A step-up transformer converts a low input voltage into a high output voltage. Does it violate law of conservation of energy? Explain.

OR

Describe briefly, with the help of a labelled diagram, the basic elements of an ac generator. State its underlying principle. Show diagrammatically how an alternating emf is generated by a loop of wire rotating in a magnetic field. Write the expression for the instantaneous value of the emf induced in the rotating loop.

SECTION – E (Case Study Based Questions)
Questions 19 to 20 carry 4 marks each.

19. LCR circuit:

Phasor technique is used to determine the amplitude and phase of current for an LCR series circuit. The solution at v = 0 is called the transient solution. Impedance diagram can be made for LCR circuit which is a right angle triangle. The AC curent in each elements of LCR is same at any time having same amplitude and phase. $i = i_m \sin(\omega t + \phi)$.
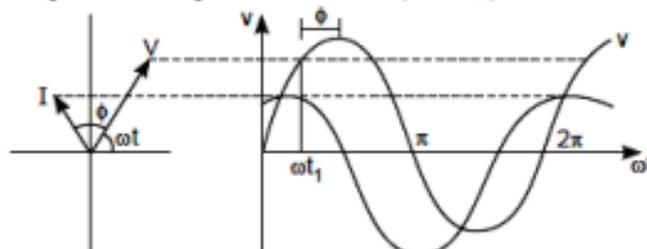
(i) What will be the length of the phasor in LCR circuit?

(a) $V_{Rm} = i_m R$, $V_{Lm} = i_m X_L$, $V_{Cm} = i_m X_C$

(b) $V_{Rm} = i_m R$, $V_{Lm} \neq i_m X_L$, $V_{Cm} = i_m X_C$

(c) $V_{Rm} = i_m X_C$, $V_{Lm} = i_m R$, $V_{Cm} = im X_L$

(d) None of these

(ii) I is the current in the circuit and V_R, V_L and V_C represent the voltage across circuit. What is the phase difference between I and V_L?

(a) V_L is parallel to I

(b) V_L and I in same line

(c) V_C is ahead of I by $\dfrac{\pi}{2}$

(d) None of the above

(iii) How does the phase angle f depends on VC and VL?

(a) $\tan\phi = V_{Cm} + V_{Lm}$

(b) $\tan\phi = V_{Cm} - V_{Lm}$

(c) $\tan\phi \neq V_{Cm}$

(d) None of the above

(iv) The phenomena of resonance occurs. When system

(a) oscillates at certain frequency.

(b) is having L and C.

(c) is having R and L only.

(d) none of the above.

OR

(iv) What is the condition for minimum impedance?

(a) $X_C = X_L$ (b) $X_C \neq X_L$ (c) $X_C = X_R$ (d) $X_C \neq X_R$

20. Power Associated with LCR Circuit:

In an a.c. circuit, values of voltage and current change every instant. Therefore, power of an a.c. circuit at any instant is the product of instantaneous voltage (E) and instantaneous current (I). The average power supplied to a pure resistance R over a complete cycle of a.c. is $P = E_v I_v$. When circuit is inductive, average power per cycle is $E_v I_v \cos\phi$.

600 mH   50 µF   10 Ω
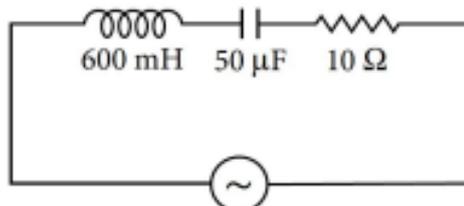
230 V, 60 Hz

In an a.c. circuit, 600 mH inductor and a 50 µF capacitor are connected in series with 10 Ω resistance. The a.c. supply to the circuit is 230 V, 60 Hz.

(i) The average power transferred per cycle to resistance is

(a) 10.42 W   (b) 15.25 W   (c) 17.42 W   (d) 13.45 W

(ii) The average power transferred per cycle to capacitor is

(a) zero   (b) 10.42 W   (c) 17.42 W   (d) 15 W

(iii) The average power transferred per cycle to inductor is

(a) 25 W   (b) 17.42 W   (c) 16.52 W   (d) zero

(iv) The total power transferred per cycle by all the three circuit elements is

(a) 17.42 W   (b) 10.45 W   (c) 12.45 W   (d) zero

OR

(iv) The electrical energy spend in running the circuit for one hour is

(a) 7.5×10^5 Joule   (b) 10×10^3 Joule   (c) 9.4×10^3 Joule   (d) 6.2×10^4 Joule

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