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Class 12 Physics Chapterwise PYQs

2026 – 2003 | All CBSE Board Papers

Chapter-wise previous year questions, sorted by marks and year

Chapter 7: Alternating Current

Table of Contents

1-Mark Questions (58 questions · Section A · MCQ)

Q1. In a series LCR circuit, the voltage across the resistor, capacitor and inductor is 10 V each. If the capacitor is short circuited, the voltage across the inductor will be:

(A) 10 V
(B) $5\sqrt{2}$ V
(C) $\frac{5}{\sqrt{2}}$ V
(D) $10\sqrt{2}$ V

[2026 • Set 55-1-1]

Q2. A resistor and an inductor of negligible resistance are connected in series to a 20 V ac source. If the voltage across the resistor is 12 V, the voltage across the inductor will be:

(A) 6 V
(B) 8 V
(C) 10 V
(D) 16 V

[2026 • Set 55-1-2]

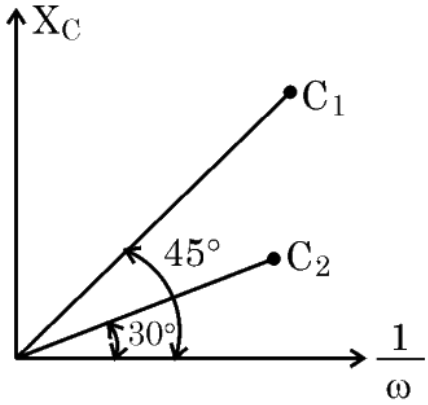
Q3. A series LCR circuit with $R = 3\,\Omega$, $X_L = 4\,\Omega$, $X_C = 8\,\Omega$ is connected to a 220 V, 50 Hz ac

source. The power factor for the circuit is:

(A) 0.30
(B) 0.45
(C) 0.50
(D) 0.60

[2026 • Set 55-1-3]

Q4. The figure shows the variation of capacitive reactance (X_C) of two ideal capacitors of capacitances C_1 and C_2 with the reciprocal of angular frequency $(1/\omega)$ of ac source. The value of C_1/C_2 is:



(A) 5
(B) 2
(C) $\sqrt{3}$
(D) $\frac{1}{\sqrt{3}}$

[2026 • Set 55-2-1]

Q5. An ac voltage is given as $v = 14\ \sin(314\,t)$ V. The average and the effective value of the voltage (in V) over a cycle are respectively:

(A) 14 and 7
(B) 10 and 14
(C) 0 and 10
(D) 10 and 0

[2026 • Set 55-4-1]

Q6. The rms and the average value of an ac voltage $V = V_0 \sin \omega t$ volt over a cycle respectively will be:

(A) $\frac{V_0}{\sqrt{2}}, \frac{V_0}{2}$
(B) $\frac{V_0}{\pi}, \frac{V_0}{2}$
(C) $\frac{V_0}{\sqrt{2}}, 0$

(D) $V_0,\ \dfrac{V_0}{2}$

[2026 • Set 55-5-1]

Q7. Which of the following statements is not true for electric energy in ac form compared to that in dc form?

(A) Production of ac is economical.

(B) ac can be easily and efficiently converted from one voltage to the other.

(C) ac can be transmitted economically over long distances.

(D) ac is less dangerous.

[2026 • Set 55-5-1]

Q8. A voltage $v = v_0 \sin \omega t$ applied to a circuit drives a current $i = i_0 \sin(\omega t + \phi)$ in the circuit. The average power consumed in the circuit over a cycle is:

(A) Zero

(B) $i_0\, v_0 \cos \phi$

(C) $\dfrac{i_0\, v_0}{2}$

(D) $\dfrac{i_0\, v_0}{2} \cos \phi$

[2025 • Set 55-1-1]

Q9. The ratio of the number of turns of the primary to the secondary coils in an ideal transformer is $20 : 1$. If $240\,\text{V}$ ac is applied from a source to the primary coil of transformer and a $6.0\,\Omega$ resistor is connected across the output terminals, then current drawn by the transformer from the source will be:

(A) $4.0\,\text{A}$

(B) $3.8\,\text{A}$

(C) $0.9\,\text{A}$

(D) $0.10\,\text{A}$

[2025 • Set 55-1-3]

Q10. Assertion (A): In an ideal step-down transformer, the electrical energy is not lost. Reason (R): In a step-down transformer, voltage decreases but the current increases.

(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).

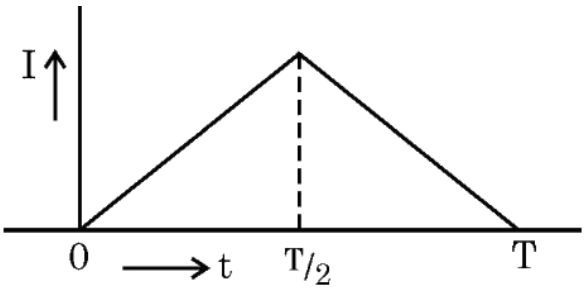
(C) Assertion (A) is true but Reason (R) is false.

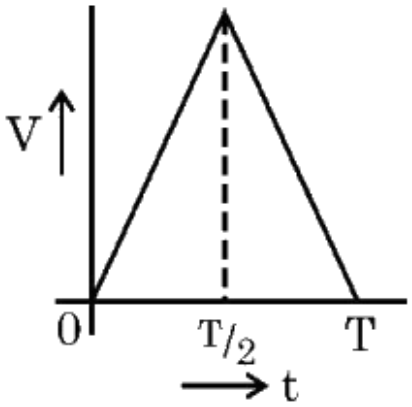
(D) Both Assertion (A) and Reason (R) are false.

[2025 • Set 55-2-1]

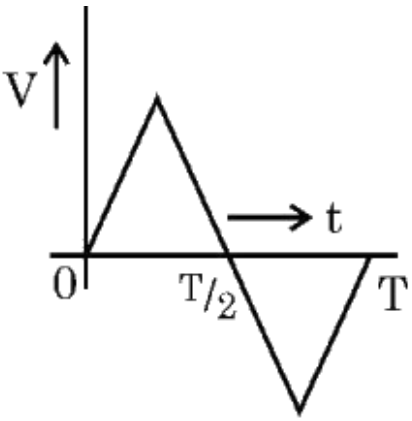
Q11. The alternating current I in an inductor is observed to vary with time t as shown in the

graph for a cycle. Which one of the following graphs is the correct representation of wave form of voltage V with time t?

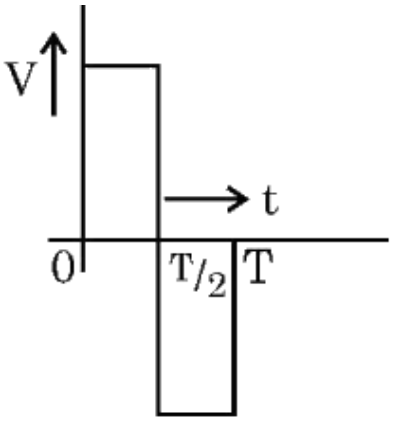




(A)

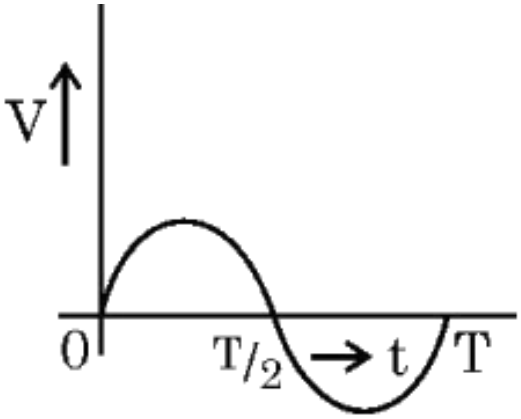


(B)



(C)

(D)



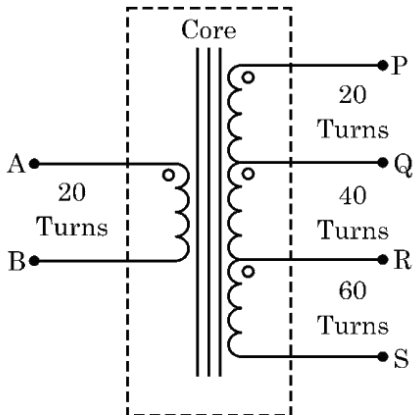
[2025 • Set 55-2-1]

Q12. A transformer is connected to a 200 V ac source. The transformer supplies 3000 V to a device. If the number of turns in the primary coil is 450, then the number of turns in its secondary coil is

(A) 30
(B) 450
(C) 4500
(D) 6750

[2025 • Set 55-2-1]

Q13. The number of turns between different pairs of output terminals are shown for a step-up transformer. Input voltage of 20 V is applied between A and B. Between which two terminals will the output be 120 V?



(A) P and Q
(B) Q and S
(C) P and R
(D) P and S

[2025 • Set 55-2-3]

Q14. Assertion (A): A series LCR circuit behaves as a pure resistive circuit at resonance. Reason

(R): At resonance, $X_L = X_C$ gives $\omega = \dfrac{1}{\sqrt{LC}}$.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Both Assertion (A) and Reason (R) are false.

[2025 • Set 55-4-1]

Q15. An ammeter connected in series in an ac circuit reads $10\,\text{A}$. The maximum value of current at any instant in the circuit is :

(A) $10\sqrt{2}\,\text{A}$

(B) $\dfrac{2}{\sqrt{2}}\,\text{A}$

(C) $\dfrac{10}{\pi}\,\text{A}$

(D) $\dfrac{10}{2}\,\text{A}$

[2025 • Set 55-4-1]

Q16. A transformer is a device used for converting:

(A) high ac voltage and large ac current to low ac voltage and small ac current

(B) high ac voltage and small ac current to low ac voltage and small ac current

(C) low ac voltage and large ac current to high ac voltage and small ac current

(D) low ac voltage and small ac current to high ac voltage and large ac current

[2025 • Set 55-5-2]

Q17. A capacitor of capacitance C has reactance X in an ac circuit. If the capacitance and the frequency of the applied voltage are doubled, the new reactance will become:

(A) $4X$

(B) $2X$

(C) $\dfrac{X}{2}$

(D) $\dfrac{X}{4}$

[2025 • Set 55-5-3]

Q18. An ac source is connected to a resistor and an inductor in series. The voltage across the resistor and inductor are $8\,\text{V}$ and $6\,\text{V}$ respectively. The voltage of the source is:

(A) $10\,\text{V}$

(B) $12\,\text{V}$

(C) $14\,\text{V}$

(D) $16\,\text{V}$

[2025 • Set 55-6-1]

Q19. An alternating current is given by $I = I_0 \cos(100\pi)t$. The least time the current takes to decrease from its maximum value to zero will be:

(A) $\left(\frac{1}{50}\right)$ s

(B) $\left(\frac{1}{100}\right)$ s

(C) $\left(\frac{1}{200}\right)$ s

(D) $\left(\frac{1}{400}\right)$ s

[2025 • Set 55-7-1]

Q20. A capacitor and an inductor are connected in series across an ac source of voltage of variable frequency. The frequency is increased continuously. The nature of the circuit before and after the resonance will be:

(A) inductive only

(B) capacitive only

(C) capacitive and inductive respectively

(D) inductive and capacitive respectively

[2025 • Set 55-7-1]

Q21. When does an inductor act as a conductor in a circuit? Give reason for it.

[2024 • Set 55-1-1]

Q22. A step-up transformer converts a low voltage into high voltage. Does it violate the principle of conservation of energy? Explain.

[2024 • Set 55-1-1]

Q23. The reactance of a capacitor of capacitance C connected to an ac source of frequency ω is X. If the capacitance of the capacitor is doubled and the frequency of the source is tripled, the reactance will become:

(A) $\frac{X}{6}$

(B) $6X$

(C) $\frac{X}{2}$

(D) $\frac{X}{3}$

[2024 • Set 55-1-1]

Q24. The primary and secondary coils of a transformer have 500 turns and 5000 turns respectively. The primary coil is connected to an ac source of $220\,\text{V} - 50\,\text{Hz}$. The output across the secondary coil is:

(A) $220\,\text{V} - 50\,\text{Hz}$
(B) $1100\,\text{V} - 50\,\text{Hz}$
(C) $2200\,\text{V} - 5\,\text{Hz}$
(D) $2200\,\text{V} - 50\,\text{Hz}$

[2024 • Set 55-1-3]

Q25. Which of the following quantity/quantities remains same in primary and secondary coils of an ideal transformer? Current, Voltage, Power, Magnetic flux

(A) Current only
(B) Voltage only
(C) Power only
(D) Magnetic flux and Power both

[2024 • Set 55-2-1]

Q26. A resistor and an ideal inductor are connected in series to a $100\sqrt{2}\,V$, 50 Hz ac source. When a voltmeter is connected across the resistor or the inductor, it shows the same reading. The reading of the voltmeter is:

(A) $100\sqrt{2}\,V$
(B) $100\,V$
(C) $50\sqrt{2}\,V$
(D) $50\,V$

[2024 • Set 55-2-1]

Q27. A series LCR circuit ($L = 2\,mH$, $C = 0.2\,\mu F$ and $R = 30\,\Omega$) is connected to an ac source of variable frequency. The impedance of this circuit will be minimum at a frequency of:

(A) $\frac{10^5}{4\pi}\,Hz$
(B) $\frac{10^5}{2\pi}\,Hz$
(C) $\frac{10^4}{4\pi}\,Hz$
(D) $\frac{10^4}{2\pi}\,Hz$

[2024 • Set 55-2-2]

Q28. In an ac circuit, the instantaneous values of current (in A) and voltage (in V) are $I = 5\sin\omega t$ and $E = 200\cos\left(\omega t + \frac{\pi}{3}\right)$ respectively. The phase difference between voltage and current at any instant is:

(A) $\frac{5\pi}{6}$
(B) $\frac{5\pi}{12}$
(C) $\frac{5\pi}{2}$

(D) $\frac{3\pi}{2}$

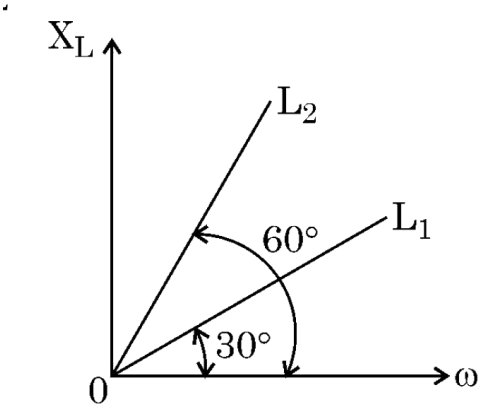
[2024 • Set 55-2-3]

Q29. The average value of the alternating voltage $v = (157\text{ V})\sin\omega t$ over its first half-cycle is:

(A) 157 V
(B) $\frac{157}{\sqrt{2}}$ V
(C) 78.5 V
(D) 100 V

[2024 • Set 55-3-3]

Q30. Figure shows the variation of inductive reactance X_L of two ideal inductors of inductance L_1 and L_2 with angular frequency ω. The value of $\frac{L_1}{L_2}$ is



(A) $\sqrt{3}$
(B) $\frac{1}{\sqrt{3}}$
(C) 3
(D) $\frac{1}{3}$

[2024 • Set 55-4-1]

Q31. An ac source $V = 282\sin(100t)$ volt is connected across a $1\,\mu$F capacitor. The rms value of current in the circuit will be (take $\sqrt{2} = 1.41$)

(A) 10 mA
(B) 20 mA
(C) 40 mA
(D) 80 mA

[2024 • Set 55-4-2]

Q32. The r.m.s. value of a current given by $i = (i_1\cos\omega t + i_2\sin\omega t)$ is

(A) $\frac{1}{\sqrt{2}}(i_1 + i_2)$

(B) $\frac{1}{\sqrt{2}}(i_1 - i_2)$
(C) $\frac{1}{\sqrt{2}}\sqrt{i_1^2 + i_2^2}$
(D) $\frac{1}{2}(i_1^2 + i_2^2)$

[2024 • Set 55-4-3]

Q33. An ac voltage is applied across an ideal inductor. The current in it:
(A) leads the voltage by $\left(\frac{1}{2}\right)$ cycle.
(B) lags the voltage by $\left(\frac{1}{2}\right)$ cycle.
(C) leads the voltage by $\left(\frac{1}{4}\right)$ cycle.
(D) lags the voltage by $\left(\frac{1}{4}\right)$ cycle.

[2024 • Set 55-5-2]

Q34. A voltage signal is described by: $v = V_0$ for $0 \leq t \leq \frac{T}{2}$ and $v = 0$ for $\frac{T}{2} \leq t \leq T$ for a cycle. Its rms value is:
(A) $\frac{V_0}{\sqrt{2}}$
(B) V_0
(C) $\frac{V_0}{2}$
(D) $\sqrt{2}\,V_0$

[2023 • Set 55-3-1]

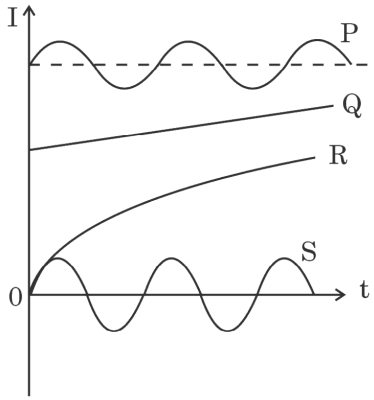
Q35. An inductor, a capacitor and a resistor are connected in series across an ac source of voltage. If the frequency of the source is decreased gradually, the reactance of:
(A) both the inductor and the capacitor decreases.
(B) inductor decreases and the capacitor increases.
(C) both the inductor and the capacitor increases.
(D) inductor increases and the capacitor decreases.

[2023 • Set 55-3-1]

Q36. 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 $I = I_0 \sin\left(\omega t + \frac{\pi}{4}\right)$. 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 $X_C = R$

[2023 • Set 55-4-1]

Q37. 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

[2023 • Set 55-4-1]

Q38. Which of the following statements about a series LCR circuit connected to an ac source is correct?

(A) If the frequency of the source is increased, the impedance of the circuit first decreases and then increases.
(B) If the net reactance $(X_L - X_C)$ of circuit becomes equal to its resistance, then the current leads the voltage by $45°$.
(C) At resonance, the voltage drop across the inductor is more than that across the capacitor.
(D) At resonance, the voltage drop across the capacitor is more than that across the inductor.

[2023 • Set 55-5-1]

Q39. An ideal inductor is connected across an AC source of voltage. The current in the circuit

(A) is ahead of the voltage in phase by π.
(B) lags voltage in phase by π.
(C) is ahead of voltage in phase by $\pi/2$.
(D) lags voltage in phase by $\pi/2$.

[2023 • Set 55-5-2]

Q40. What is the ratio of inductive and capacitive reactance in an ac circuit?

(A) $\omega^2 LC$

(B) LC^2
(C) $\dfrac{L}{C}$
(D) $\omega^2 L$

[2023 • Set 55-5-3]

Q41. An alternating current $I = (10\,\text{A})\,\sin(100\,\pi t)$ is passed through a resistor of $20\,\Omega$. What is the average power consumed by the resistor over a complete cycle?

[2021]

Q42. What is the impedance of a capacitor of capacitance C in an ac circuit using source of frequency n Hz?

OR

What is the value of impedance of a resonant series LCR circuit?

[2020 • Set 55-2-1]

Q43. An ac is passed through a series LCR circuit. What is the impedance of the circuit at resonance?

[2020 • Set 55-3-1]

Q44. In an ac circuit, the applied voltage and flowing current are $E = E_0 \sin\omega t$ and $I = I_0 \sin\left(\omega t + \dfrac{\pi}{2}\right)$ respectively. What is the average power consumed in one cycle in this circuit?

OR

What happens when a block of metal is kept in a varying magnetic field?

[2020 • Set 55-3-1]

Q45. A circuit element is connected across an ac source. It is observed that the voltage across the element leads the current flowing through it by a phase angle $\dfrac{\pi}{2}$. Identify the circuit element.

[2020 • Set 55-3-2]

Q46. Write the impedance of a series LCR resonant circuit in terms of L, C and R.

[2020 • Set 55-3-2]

Q47. What is the value of power factor of a series LCR circuit at resonance?

[2020 • Set 55-3-3]

Q48. The selectivity of a series LCR a.c. circuit is large, when
(A) L is large and R is large

(B) L is small and R is small
(C) L is large and R is small
(D) $L = R$

[2020 • Set 55-5-1]

Q49. An a.c. source of voltage $V = V_0 \sin \omega t$ is connected to an ideal inductor. Draw graphs of voltage V and current i versus ωt.

[2016]

Q50. Explain why current flows through an ideal capacitor when it is connected to an a.c. source but not when it is connected to a d.c. source in a steady state.

[2016]

Q51. Draw a graph to show variation of capacitive-reactance with frequency in an a.c. circuit.

[2015]

Q52. Define capacitor reactance. Write its S.I. units.

[2015]

Q53. Why is the use of a.c. voltage preferred over d.c. voltage ? Give two reasons.

[2014]

Q54. Mention the two characteristic properties of the material suitable for making core of a transformer.

[2012]

Q55. Define the term wattless current.

[2011 • Set 55-1-1]

Q56. The peak value of e.m.f. in a.c. is E_0. Write its (i) rms and (ii) average value over a complete cycle.

[2011 • Set 55-2-1]

Q57. In a series LCR circuit, the voltages across an inductor, a capacitor and a resistor are 30 V, 30 V and 60 V respectively. What is the phase difference between the applied voltage and the current in the circuit?

[2007]

Q58. The power factor of an a.c. circuit is 0.5. What will be the phase difference between voltage and current in this circuit?

[2005]

2-Mark Questions (19 questions · Section B · VSA)

Q1. A resistor and a capacitor are connected in series to an ac source $v = v_m \sin \omega t$. Derive an expression for the impedance of the circuit.

[2024 • Set 55-1-1]

Q2. An electric lamp is designed to operate at $110\,\text{V}$ dc and $11\,\text{A}$ current. If the lamp is operated on $220\,\text{V}$, $50\,\text{Hz}$ ac source with a coil in series, then find the inductance of the coil.

[2024 • Set 55-1-1]

Q3. Draw a labelled diagram of a step-up transformer and describe its working principle. Explain any three causes for energy losses in a real transformer.

[2024 • Set 55-1-1]

Q4. A step-up transformer has 200 and 3000 turns in its primary and secondary coils respectively. The input voltage given to the primary coil is $90\,\text{V}$. Calculate: (1) The output voltage across the secondary coil (2) The current in the primary coil if the current in the secondary coil is $2.0\,\text{A}$.

[2024 • Set 55-1-1]

Q5. (a) Explain the term 'sharpness of resonance' in ac circuit.

(b) In a series LCR circuit, $V_L = V_C \neq V_R$. What is the value of power factor for this circuit?

OR

An ac source of emf $V = V_0 \sin \omega t$ is connected to a capacitor of capacitance C. Deduce the expression for the current (I) flowing in it. Plot the graph of (i) V vs. ωt, and (ii) I vs. ωt.

[2020 • Set 55-2-1]

Q6. A resistor R and an inductor L are connected in series to a source of voltage $V = V_0 \sin \omega t$. The voltage is found to lead current in phase by $\pi/4$. If the inductor is replaced by a capacitor C, the voltage lags behind current in phase by $\pi/4$. When L, C and R are connected in series with the same source, find the:

(i) average power dissipated and

(ii) instantaneous current in the circuit.

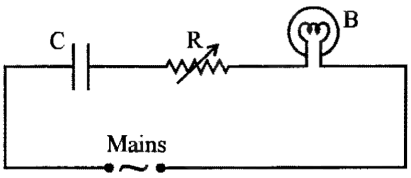
[2020 • Set 55-4-1]

Q7. A light bulb and a solenoid are connected in series across an ac source of voltage. Explain,

how the glow of the light bulb will be affected when an iron rod is inserted in the solenoid.

[2017]

Q8. 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 ?



[2014]

Q9. State the underlying principle of a transformer. How is the large scale transmission of electric energy over long distances done with the use of transformers?

[2012]

Q10. A light bulb is rated 100 W for 220 V ac supply of 50 Hz. Calculate

(i) the resistance of the bulb;

(ii) the rms current through the bulb.

OR

An alternating voltage given by $V = 140 \sin 314t$ is connected across a pure resistor of $50\,\Omega$. Find

(i) the frequency of the source.

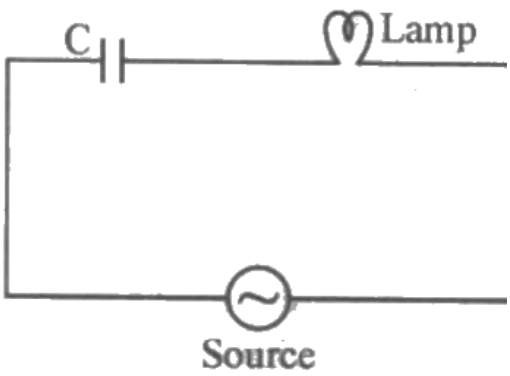
(ii) the rms current through the resistor.

[2012]

Q11. Calculate the quality factor of a series LCR circuit with $L = 2.0\,\text{H}$, $C = 2\,\mu\text{F}$ and $R = 10\,\Omega$. Mention the significance of quality factor in LCR circuit.

[2012]

Q12. An electric lamp having coil of negligible inductance connected in series with a capacitor and an AC source is glowing with certain brightness. How does the brightness of the lamp change on reducing the (i) capacitance, and (ii) the frequency? Justify your answer.



[2010]

Q13. Prove that an ideal capacitor, in an a.c. circuit does not dissipate power.

[2008]

Q14. Derive an expression for the impedance of an a.c. circuit consisting of an inductor and a resistor.

[2008]

Q15. Distinguish between the terms 'average value' and 'rms value' of an alternating current. The instantaneous current from an a.c. source is $I = 5\sin(314\,t)$ ampere. What are the average and rms values of the current?

[2007]

Q16. Calculate the current drawn by the primary of a transformer which steps down 200 V to 20 V to operate a device of resistance 20 Ω. Assume the efficiency of the transformer to be 80%.

[2007]

Q17. An a.c. voltage of 100 V, 50 Hz is connected across a 20 ohm resistor and 2 mH inductor in series. Calculate (i) impedance of the circuit, (ii) rms current in the circuit.

[2007]

Q18. **(i)** Draw the graphs showing variation of inductive reactance and capacitive reactance with frequency of applied a.c. source.

(ii) Can the voltage drop across the inductor or the capacitor in a series LCR circuit be greater than the applied voltage of the a.c. source? Justify your answer.

[2005]

Q19. An a.c. voltage $E = E_0 \sin \omega t$ is applied across an inductor L. Obtain an expression for current I.

[2003]

3-Mark Questions (56 questions · Section C · SA)

Q1. (a) Discuss the behaviour of an inductor connected to (i) a dc source, and (ii) a high frequency ac source.

(b) What is the phase relation between current and voltage in an ideal inductor connected to an ac source? Draw a phasor diagram for the circuit.

[2026 • Set 55-3-1]

Q2. A series combination of circuit elements X and Y is connected across an ac source. It is found that the voltage is ahead of current in phase by $\frac{\pi}{4}$ radian. When element Y is replaced by element Z, the current leads the voltage by $\frac{\pi}{4}$ radian.

(a) Identify the elements X, Y and Z.

(b) What will the phase angle and power factor for the circuit be if X, Y and Z were connected in series across the same ac source? What can you say about the current that flows in the circuit in this case?

[2026 • Set 55-3-2]

Q3. (a) Differentiate between inductive reactance, capacitive reactance and impedance of an ac circuit.

(b) An ideal inductor and an ideal capacitor are connected in series across an ac voltage. Plot a graph showing variation of net reactance of the circuit with frequency of the applied ac voltage.

[2026 • Set 55-5-2]

Q4. (a) Can a transformer step up or step down dc power supply?

(b) Can a step up transformer work as a step down transformer?

(c) Does a step up transformer contradict the principle of conservation of energy? Justify your answer.

[2026 • Set 55-5-3]

Q5. An ac source of voltage $v = v_m \sin \omega t$ is connected to a series combination of LCR circuit. Draw the phasor diagram. Using it obtain an expression for the impedance of the circuit and the phase difference between applied voltage and the current.

[2025 • Set 55-1-3]

Q6. Differentiate between the peak value and root mean square value of an alternating current. Derive the expression for the root mean square value of alternating current, in terms of its peak value.

[2025 • Set 55-2-2]

Q7. **(a)** ac voltage of frequency ω is applied across a series LCR circuit. Draw the phasor diagram and obtain the impedance of the circuit.

(b) Discuss 'resonance' in a series LCR circuit and write the expression for resonant frequency.

[2025 • Set 55-2-3]

Q8. An ac source of voltage $V = V_0 \sin \omega t$ is connected to a circuit element X. It is observed that the current flowing through X varies as $I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$.

(a) Identify the element X and write the expression for its reactance.

(b) Plot a graph to show the variation of reactance of the element with the frequency of the applied voltage.

(c) Draw plots showing the variation of voltage and current with time over one cycle of applied ac.

[2025 • Set 55-7-3]

Q9. An inductor, a capacitor and a resistor are connected in series with an ac source $v = v_m \sin \omega t$. Derive an expression for the average power dissipated in the circuit. Also obtain the expression for the resonant frequency of the circuit.

[2024 • Set 55-1-1]

Q10. **(a)** Draw the graphs showing the variation of the following with the frequency of ac source in a circuit: (i) Resistance (ii) Capacitive reactance (iii) Inductive reactance

(b) Can the voltage drop across the inductor or the capacitor in a series LCR circuit be greater than the applied voltage of the ac source? Justify your answer.

[2024 • Set 55-1-3]

Q11. An ac voltage $v_i = 140 \sin(100\pi t)\ V$ is applied to the primary coil having 200 turns, of an ideal transformer and it supplies a power of 5 kW. If the secondary coil has 1000 turns, find:

(a) the output voltage,

(b) the instantaneous voltage across the secondary coil, and

(c) the current in the secondary coil. (Take $\sqrt{2} = 1.4$)

[2024 • Set 55-2-3]

Q12. A sinusoidal voltage is applied to an electric circuit containing a circuit element 'X' in which the current leads the voltage by $\frac{\pi}{2}$.

(a) Identify the circuit element in the circuit.

(b) Write the formula for its reactance.

(c) Show graphically the variation of this reactance with frequency of ac voltage.

(d) Explain the behaviour of this element when it is used in (i) an ac circuit, and (ii) a dc circuit.

[2024 • Set 55-3-1]

Q13. Distinguish between reactance and impedance of an ac circuit. Show that an ideal inductor in an ac circuit does not dissipate any power.

[2024 • Set 55-3-2]

Q14. How does the resistance differ from impedance? With the help of a suitable phasor diagram, obtain an expression for impedance of a series LCR circuit, connected to a source $v = v_m \sin \omega t$.

[2023 • Set 55-1-1]

Q15. Find the condition for resonance in a series LCR circuit connected to a source $v = v_m \sin \omega t$, where ω can be varied. Give the factors on which the resonant frequency of a series LCR circuit depends. Plot a graph showing the variation of electric current with frequency in a series LCR circuit.

[2023 • Set 55-1-1]

Q16. The primary and the secondary coils of an ideal step-down transformer consist of 650 and 25 turns respectively. When the primary coil of this transformer is connected to 240 V mains, the current in the primary coil is 1.5 A. Calculate:

(a) the voltage across the secondary coil

(b) the current in the secondary coil

(c) the average power delivered to the output circuit

[2023 • Set 55-1-2]

Q17. An ac voltage $v = v_m \sin \omega t$ ($v_m = 310$ V and $f = 50$ Hz) is connected to a pure capacitor of capacitance $15\,\mu$F. Calculate (i) the reactance of the capacitor, and (ii) the amplitude of the current. Write the expression of current through the capacitor as a function of time.

[2023 • Set 55-1-3]

Q18. A series CR circuit with $R = 200\ \Omega$ and $C = (50/\pi)\ \mu$F is connected across an ac source of peak voltage $\varepsilon_0 = 100$ V and frequency $\nu = 50$ Hz. Calculate

(a) impedance of the circuit (Z),

(b) phase angle (φ), and

(c) voltage across the resistor.

[2023 • Set 55-2-1]

Q19. A series RL circuit with $R = 10\ \Omega$ and $L = \left(\frac{100}{\pi}\right)$ mH is connected to an ac source of voltage $V = 141\ \sin(100\pi t)$, where V is in volts and t is in seconds. Calculate

(a) impedance of the circuit

(b) phase angle, and

(c) voltage drop across the inductor.

[2023 • Set 55-2-2]

Q20. A resistor of $50\ \Omega$, a capacitor of $\left(\frac{25}{\pi}\right)\ \mu$F and an inductor of $\left(\frac{4}{\pi}\right)$ H are connected in series across an ac source whose voltage (in volt) is given by $V = 70\ \sin(100\pi t)$. Calculate:

(a) the net reactance of the circuit,

(b) the impedance of the circuit,

(c) the effective value of current in the circuit.

[2023 • Set 55-2-3]

Q21. (a) An ac source $V = V_m \sin\omega t$ is connected across an ideal capacitor. Derive the expression for the (i) current flowing in the circuit, and (ii) reactance of the capacitor. Plot a graph of current i versus ωt.

OR

(b) A series combination of an inductor L, a capacitor C and a resistor R is connected across an ac source of voltage in a circuit. Obtain an expression for the average power consumed by the circuit. Find power factor for (i) purely inductive circuit, and (ii) purely resistive circuit.

[2023 • Set 55-3-1]

Q22. (a) A resistor of 30 Ω and a capacitor of $\frac{250}{\pi}\ \mu F$ 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.

OR

(b) A series LCR circuit with $R = 20\,\Omega$, $L = 2$ H and $C = 50\,\mu F$ is connected to a 200 volts ac source of variable frequency. What is (i) the amplitude of the current, and (ii)

the average power transferred to the circuit in one complete cycle, at resonance? (iii) Calculate the potential drop across the capacitor.

[2023 • Set 55-4-1]

Q23. An alternating voltage of 220 V is applied across a device X. A current of 0.22 A flows in the circuit and it lags behind the applied voltage in phase by $\pi/2$ radian. When the same voltage is applied across another device Y, the current in the circuit remains the same and it is in phase with the applied voltage.

(i) Name the devices X and Y and,

(ii) Calculate the current flowing in the circuit when the same voltage is applied across the series combination of X and Y.

[2023 • Set 55-5-1]

Q24. A current of 1A flows through a coil when it is connected across a DC battery of 100 V. If DC battery is replaced by an AC source of 100 V and angular frequency 100 rad s^{-1}, the current reduces to 0.5 A. Find

(i) impedance of the circuit.

(ii) self-inductance of coil.

(iii) phase difference between the voltage and the current.

[2023 • Set 55-5-2]

Q25. The primary coil having N_p turns of an ideal transformer is supplied with an alternating voltage V_p. Obtain an expression for the voltage V_s induced in its secondary coil having N_s turns. Mention two main sources of power loss in real transformers.

[2023 • Set 55-5-2]

Q26. An alternating current $I = 14\sin(100\pi t)$ A passes through a series combination of a resistor of $30\,\Omega$ and an inductor of $\left(\frac{2}{5\pi}\right)$ H. Taking $\sqrt{2} = 1.4$, calculate the

(i) rms value of the voltage drops across the resistor and the inductor, and

(ii) power factor of the circuit.

[2023 • Set 55-5-3]

Q27. (i) In an LCR series circuit connected to an ac source, the voltage and the current are in the same phase. If the capacitor is filled with a dielectric, will the current lead or lag behind or remain in phase with the voltage? Explain.

(ii) In the circuit, why is the rms value of net voltage not equal to the sum of voltage drops across individual elements?

(iii) Draw a graph showing variation of the impedance of the circuit with the frequency of the applied voltage.

[2021]

Q28. **(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?

(ii) We cannot step up a dc voltage using a transformer. Why?

(iii) On what principle does a metal detector work?

[2021]

Q29. A resistance R and a capacitor C are connected in series to a source $V = V_0 \sin \omega t$. Find:

(a) The peak value of the voltage across the (i) resistance and (ii) capacitor.

(b) The phase difference between the applied voltage and current. Which of them is ahead?

[2020 • Set 55-1-1]

Q30. A resistor R and an inductor L are connected in series to a source $V = V_0 \sin \omega t$. Find the

(a) peak value of the voltage drops across R and across L,

(b) phase difference between the applied voltage and current. Which of them is ahead?

[2020 • Set 55-1-2]

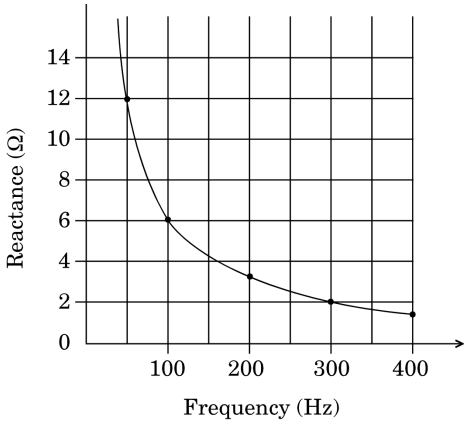
Q31. A resistance R and a capacitor C are connected in series to an ac source $V = V_0 \sin \omega t$.

(a) Obtain the expression for the instantaneous current (I) in the circuit.

(b) Show graphically variations of V and I as a function of ωt.

[2020 • Set 55-1-3]

Q32. 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.

[2020 • Set 55-2-1]

Q33. A series LCR ac circuit has $L = 2.0\,\text{H}$, $C = 32\,\mu\text{F}$ and $R = 10\,\Omega$.

(a) At what angular frequency of ac will it resonate?

(b) Calculate the Q value of the circuit.

OR

An ideal inductor of $5\,\text{H}$ inductance is connected to a $200\,\text{V}$, $50\,\text{Hz}$ ac supply.

(a) Calculate the rms and peak value of current in the inductor.

(b) What is the phase difference between current through the inductor and the applied voltage? How will it change if a small resistance is connected in series with this inductor in the circuit?

[2020 • Set 55-3-1]

Q34. Explain with the help of a diagram, the working of a step-down transformer. Why is a laminated iron core used in a transformer?

[2020 • Set 55-4-1]

Q35. Explain the principle of the device with diagram, which is used to provide electricity at the proper voltage for household purposes. Briefly discuss loss of energy in it due to flux leakage and its minimization.

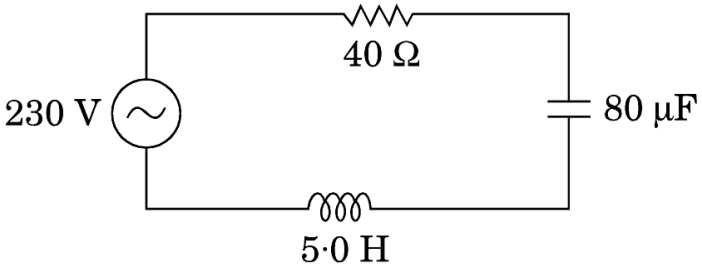
[2020 • Set 55-4-2]

Q36. A capacitor (C) and resistor (R) are connected in series with an ac source of voltage of frequency $50\,\text{Hz}$. The potential difference across C and R are respectively $120\,\text{V}$, $90\,\text{V}$,

and the current in the circuit is $3\,A$. Calculate (i) the impedance of the circuit (ii) the value of the inductance, which when connected in series with C and R will make the power factor of the circuit unity.

OR

The figure shows a series LCR circuit connected to a variable frequency $230\,V$ source.



(a) Determine the source frequency which drives the circuit in resonance.

(b) Calculate the impedance of the circuit and amplitude of current at resonance.

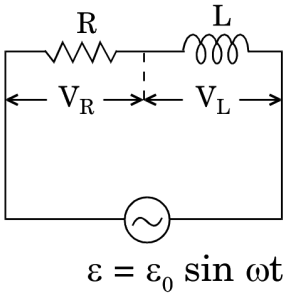
(c) Show that potential drop across LC combination is zero at resonating frequency.

[2019 • Set 55-2-1]

Q37. (a) An ac circuit as shown in the figure has an inductor of inductance L and a resistor of resistance R connected in series. Using the phasor diagram, explain why the voltage in the circuit will lead the current in phase.

(b) The potential difference across the resistor is $160\,V$ and that across the inductor is $120\,V$. Find the effective value of the applied voltage. If the effective current in the circuit be $1.0\,A$, calculate the total impedance of the circuit.

(c) What will be the potential difference in the circuit when direct current is passed through the circuit?



OR

An ac circuit consists of a series combination of circuit elements X and Y. The current is ahead of the voltage in phase by $\frac{\pi}{4}$. If element X is a pure resistor of $100\,\Omega$,

(a) name the circuit element Y.

(b) calculate the rms value of current, if rms value of voltage is 141 V.

(c) what will happen if the ac source is replaced by a dc source?

[2019 • Set 55-3-1]

Q38. A voltage $v = v_m \sin \omega t$ applied to a series LCR circuit, drives a current in the circuit given $i = i_m \sin(\omega t + \phi)$. Deduce the expression for the instantaneous power supplied by the source. Hence, obtain the expression for the average power. Define the terms 'power factor' and 'wattless current', giving the examples where power factor is maximum and the circuit where there is wattless current.

[2019 • Set 55-5-1]

Q39. Given three elements X, Y and Z to be connected across an ac source. With only X connected across the ac source, voltage and current are found to be in the same phase. With only element Y in the circuit, the voltage lags behind the current in phase by $\pi/2$ while with the element Z in the circuit, the voltage leads the current in phase by $\pi/2$.

(a) Identify the elements X, Y and Z.

(b) When all these elements are connected in series across the same source, (i) determine the power factor, and (ii) find out the condition when the circuit is in resonant state.

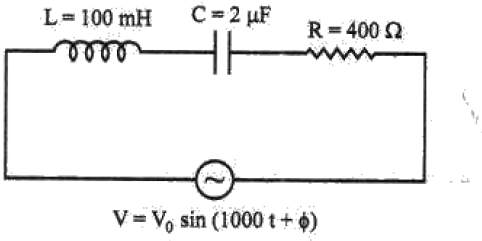
[2019 • Set 55-5-2]

Q40. Draw the phasor diagram of a series LCR connected across an ac source $V = V_m \sin \omega t$. Hence, derive the expression for the impedance of the circuit. Obtain the conditions for the phase angle under which the current is (i) maximum, and (ii) minimum.

[2019 • Set 55-5-3]

Q41. **(i)** Find the value of the phase difference between the current and the voltage in the series LCR circuit shown below. Which one leads in phase: current or voltage?

(ii) Without making any other change, find the value of the additional capacitor C_1, to be connected in parallel with the capacitor C, in order to make the power factor of the circuit unity.



[2017]

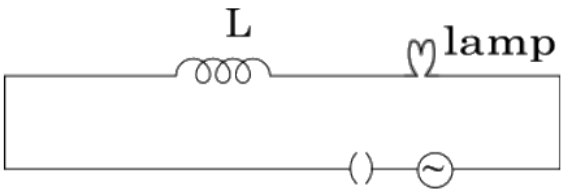
Q42. A source of ac voltage $v = v_0 \sin \omega t$ is connected across a pure inductor of inductance L. Derive the expressions for the instantaneous current in the circuit. Show that average

power dissipated in the circuit is zero.

[2017]

Q43. **(i)** When an AC source is connected to an ideal inductor show that the average power supplied by the source over a complete cycle is zero.

(ii) A lamp is connected in series with an inductor and an AC source. What happens to the brightness of the lamp when the key is plugged in and an iron rod is inserted inside the inductor? Explain.



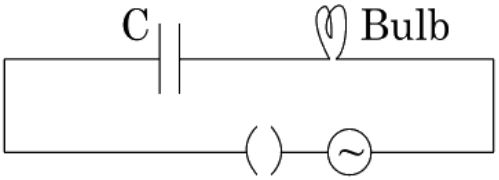
[2016]

Q44. Draw a schematic arrangement for winding of primary and secondary coils in a transformer with the two coils on separate limbs of the core. State its underlying principle and find the relation between the primary and secondary voltages in terms of the number of turns of the primary and secondary windings. How are the currents in the primary and secondary coils related to the voltages in the case of an ideal transformer?

[2016]

Q45. **(i)** When an AC source is connected to an ideal capacitor, show that the average power supplied by the source over a complete cycle is zero.

(ii) A bulb is connected in series with a variable capacitor and an A.C. source as shown. What happens to the brightness of the bulb when the key is plugged in and capacitance of the capacitor is gradually reduced?



[2016]

Q46. A capacitor of unknown capacitance, a resistor of $100\ \Omega$ and an inductor of self inductance $L = (4/\pi^2)$ henry are connected in series to an ac source of 200 V and 50 Hz. Calculate the value of the capacitance and impedance of the circuit when the current is in phase with the voltage. Calculate the power dissipated in the circuit.

[2016]

Q47. A series LCR circuit is connected across an a.c. source of variable angular frequency 'ω'.

Plot a graph showing variation of current 'i' as a function of 'ω' for two resistances R_1 and R_2 ($R_1 > R_2$). Answer the following questions using this graph:

(a) In which case is the resonance sharper and why?

(b) In which case is the power dissipation more and why?

[2015]

Q48. An inductor L of inductance X_L is connected in series with a bulb B and an ac source. How would brightness of the bulb change when (i) number of turns in the inductor is reduced, (ii) an iron rod is inserted in the inductor and (iii) a capacitor of reactance $X_C = X_L$ is inserted in series in the circuit. Justify your answer in each case.

[2015]

Q49. A voltage $V = V_0 \sin \omega t$ is applied to a series LCR circuit. Derive the expression for the average power dissipated over a cycle. Under what condition is (i) no power dissipated even though the current flows through the circuit, (ii) maximum power dissipated in the circuit ?

[2014]

Q50. In a series LCR circuit connected to an ac source of variable frequency and voltage $v = v_m \sin \omega t$, draw a plot showing the variation of current (I) with angular frequency (ω) for two different values of resistance R_1 and R_2 $(R_1 > R_2)$. Write the condition under which the phenomenon of resonance occurs. For which value of the resistance out of the two curves, a sharper resonance is produced? Define Q-factor of the circuit and give its significance.

[2013]

Q51. A series LCR circuit is connected to an ac source. Using the phasor diagram, derive the expression for the impedance of the circuit. Plot a graph to show the variation of current with frequency of the source, explaining the nature of its variation.

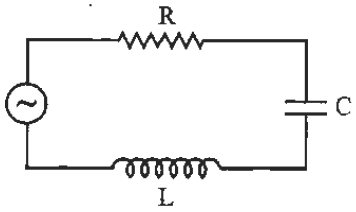
[2012]

Q52. The figure shows a series LCR circuit with $L = 5.0\,\text{H}$, $C = 80\,\mu\text{F}$, $R = 40\,\Omega$ connected to a variable frequency $240\,\text{V}$ source. Calculate

(i) The angular frequency of the source which drives the circuit at resonance.

(ii) The current at the resonating frequency.

(iii) The rms potential drop across the capacitor at resonance.



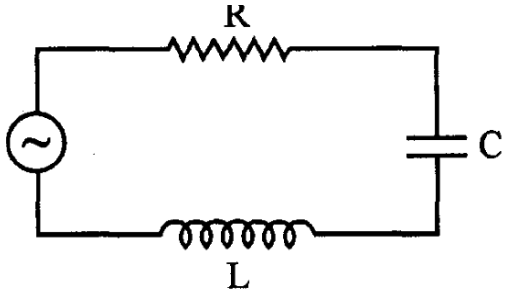
[2012]

Q53. A series LCR circuit with $L = 4.0\,\text{H}$, $C = 100\,\mu\text{F}$ and $R = 60\,\Omega$ is connected to a variable frequency $240\,\text{V}$ source as shown. Calculate:

(i) the angular frequency of the source which drives the circuit at resonance;

(ii) the current at the resonating frequency;

(iii) the rms potential drop across the inductor at resonance.



[2012]

Q54. An inductor $200\ mH$, capacitor $500\ \mu F$, resistor $10\ \Omega$ are connected in series with a $100\ V$, variable frequency a.c. source. Calculate the

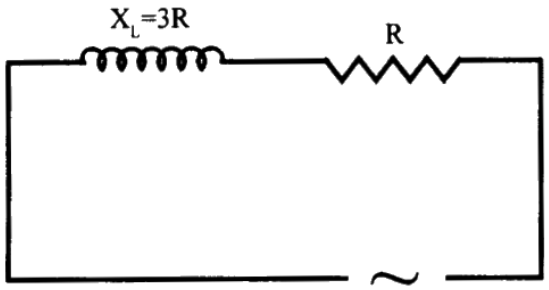
(i) frequency at which the power factor of the source is unity

(ii) current amplitude at this frequency

(iii) Q-factor

[2008]

Q55. Given below are two electric circuits A and B.



Calculate the ratio of power factor of the circuit B to the power factor of circuit A.

[2007]

Q56. In a series R-C circuit, $R = 30\,\Omega$, $C = 0.25\,\mu$F, $V = 100$ V and $\omega = 10{,}000$ radian/second. Find the current in the circuit and calculate the voltage across the resistor and the capacitor. Is the algebraic sum of these voltages more than the source voltage? If yes, resolve the paradox.

[2004]

4-Mark Questions (3 questions · Section D · Case Study)

Q1. The teachers of Geeta's school took the students on a study trip to a power generating station, located nearly 200 km away from the city. The teacher explained that electrical energy is transmitted over such a long distance to their city, in the form of alternating current (ac) raised to a high voltage. At the receiving end in the city, the voltage is reduced to operate the devices. As a result, the power loss is reduced. Geeta listened to the teacher and asked questions about how the ac is converted to a higher or lower voltage.

(a) Name the device used to change the alternating voltage to a higher or lower value. State one cause for power dissipation in this device.

(b) Explain with an example, how power loss is reduced if the energy is transmitted over long distances as an alternating current rather than a direct current.

(c) Write two values each shown by the teachers and Geeta.

[2018]

Q2. Shiv had a high tension tower erected on his farm land. He kept complaining to the authorities to remove it since it occupied a large portion of his land. His uncle, who was a teacher, explained to him the need for erecting these towers for efficient transmission of power. As Shiv got convinced and realized its significance, he stopped complaining. Based on the above paragraph, answer the following questions:

(a) Why is it necessary to transport power at high voltages?

(b) 'A low power factor implies large power loss'. Explain.

(c) Write the two values displayed by Shiv and his Uncle.

[2016]

Q3. During a thunderstorm the 'live' wire of the transmission line fell down on the ground. A group of boys passing through noticed it and some of them wanted to place the wire by the side. As they were approaching the wire and trying to lift it, Hari noticed it and immediately pushed them away to prevent them from touching the wire. Two of them got hurt in the process. Hari took them to a doctor to get medical aid. Based on the above paragraph, answer the following:

(a) Write two values which Hari displayed during the incident.

(b) Why is it that a bird can sit over a suspended 'live' wire without any harm whereas touching it on the ground can give a fatal shock?

(c) The electric power from a power plant is set up to a very high voltage before transmitting it to distant consumers. Write the reason for it.

[2016]

5-Mark Questions (34 questions · Section E · Long Answer)

Q1. (a) A series combination of L, C and R is connected to an a.c. source. Using a phasor diagram, derive an expression for the impedance of the circuit and phase difference between V and I.

[2026 • Set 55-2-1]

Q2. (b) Under what conditions: (i) the impedance of the circuit is minimum? (ii) wattless current flows in the circuit?

[2026 • Set 55-2-1]

Q3. (i) A light bulb and an open coil inductor are connected in series across an ac source of variable frequency. How will the glow of the bulb be affected when: (I) an iron bar is inserted inside the coil, and (II) the frequency of the source is decreased? Justify your answers. Assume that in each above case other factors remain unchanged.

[2026 • Set 55-3-1]

Q4. (ii) An ac voltage $V = 280\sin(100\pi t)$ volt is connected across a series LCR circuit in which $R = 400\ \Omega$, $L = \frac{5}{\pi}$ H and $C = \frac{1}{\pi}\ \mu$F. Taking $\sqrt{2} = 1{\cdot}4$, calculate: (I) impedance of the circuit. (II) rms value of current that flows in the circuit. (III) power factor of the circuit.

[2026 • Set 55-3-1]

Q5. (a) (i) Define the terms (I) resonant frequency, and (II) power factor of a series LCR circuit. For what value of the power factor will the power dissipated in the circuit be maximum? (ii) An inductor of 5 H, a capacitor of 50 μF and a resistor of 400 Ω are connected in series across an ac voltage $v = 140\sin(100\pi t)$ V. Calculate: (I) impedance of the circuit, and (II) rms value of current that flows in the circuit. (Take $\sqrt{2} = 1 \cdot 4$)

OR

(b) (i) Draw a labelled diagram of a step-up transformer. Obtain the ratio of secondary voltage to primary voltage in terms of number of turns in the two coils. (ii) The number of turns in the primary and the secondary coil of an ideal transformer are 100 and 5000 respectively. If 3·3 kW power is supplied to the transformer at 220

V, find (I) current in the primary coil, and (II) output voltage.

[2026 • Set 55-4-1]

Q6. (a) (i) Write the principle of working of an ac generator. Draw its labelled diagram and explain its working. (ii) A resistor of $400\,\Omega$, an inductor of $\left(\frac{2}{\pi}\right)$ H and a capacitor of $\left(\frac{50}{\pi}\right)$ μF are joined in series across an ac source $v = 140\sin(100\pi)t$ V. Find the rms voltages across these three circuit elements. The algebraic sum of these voltages is more than the rms voltage of source. Explain.

OR

(b) (i) Write the principle of working of a transformer. With the help of a labelled diagram, explain the working of a step-up transformer. (ii) An ideal transformer is designed to convert 50 V into 250 V. It draws 200 W power from an ac source whose instantaneous voltage is given by $v_i = 20\sin(100\pi)t$ V. Find: (I) rms value of input current. (II) expression for instantaneous output voltage. (III) expression for instantaneous output current.

[2025 • Set 55-6-1]

Q7. (i) Mention the factors on which the resonant frequency of a series LCR circuit depends. Plot a graph showing variation of impedance of a series LCR circuit with the frequency of the applied a.c. source.

(ii) With the help of a suitable diagram, explain the working of a step-up transformer.

(iii) Write two causes of energy loss in a real transformer.

[2024 • Set 55-4-1]

Q8. (i) You are given three circuit elements X, Y and Z. They are connected one by one across a given ac source. It is found that V and I are in phase for element X. V leads I by $\left(\frac{\pi}{2}\right)$ for element Y while I leads V by $\left(\frac{\pi}{2}\right)$ for element Z. Identify elements X, Y and Z.

(ii) Establish the expression for impedance of circuit when elements X, Y and Z are connected in series to an ac source. Show the variation of current in the circuit with the frequency of the applied ac source.

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

[2024 • Set 55-5-1]

Q9. (i) Describe the construction and working of a transformer and hence obtain the relation for $\left(\frac{V_s}{V_p}\right)$ in terms of number of turns of primary and secondary.

(ii) Discuss four main causes of energy loss in a real transformer.

[2024 • Set 55-5-1]

Q10. With the help of a labelled diagram, explain the working of a step-up transformer. Give reasons to explain the following:

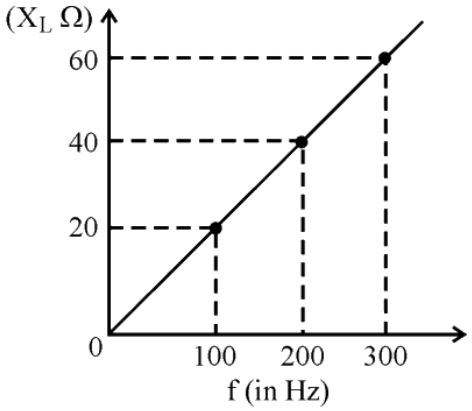
(i) The core of the transformer is laminated.

(ii) Thick copper wire is used in windings.

[2020 • Set 55-1-1]

Q11. (a) Show that an ideal inductor does not dissipate power in an ac circuit.

(b) The variation of inductive reactance (X_L) of an inductor with the frequency (f) of the ac source of 100 V and variable frequency is shown in the fig.



(i) Calculate the self-inductance of the inductor. (ii) When this inductor is used in series with a capacitor of unknown value and a resistor of $10\,\Omega$ at $300\,s^{-1}$, maximum power dissipation occurs in the circuit. Calculate the capacitance of the capacitor.

OR

(a) A conductor of length l is rotated about one of its ends at a constant angular speed ω in a plane perpendicular to a uniform magnetic field B. Plot graphs to show variations of the emf induced across the ends of the conductor with (i) angular speed ω and (ii) length of the conductor l.

(b) Two concentric circular loops of radius 1 cm and 20 cm are placed coaxially. (i) Find mutual inductance of the arrangement. (ii) If the current passed through the outer loop is changed at a rate of 5 A/ms, find the emf induced in the inner loop. Assume the magnetic field on the inner loop to be uniform.

[2020 • Set 55-5-1]

Q12. In a series LCR circuit connected across an ac source of variable frequency, obtain the expression for its impedance and draw a plot showing its variation with frequency of the

ac source.

[2019 • Set 55-1-1]

Q13. What is the phase difference between the voltages across inductor and the capacitor at resonance in the LCR circuit?

[2019 • Set 55-1-1]

Q14. When an inductor is connected to a $200\,V$ dc voltage, a current of $1\,A$ flows through it. When the same inductor is connected to a $200\,V$, $50\,Hz$ ac source, only $0.5\,A$ current flows. Explain, why? Also, calculate the self inductance of the inductor.

[2019 • Set 55-1-1]

Q15. Draw the diagram of a device which is used to decrease high ac voltage into a low ac voltage and state its working principle. Write four sources of energy loss in this device.

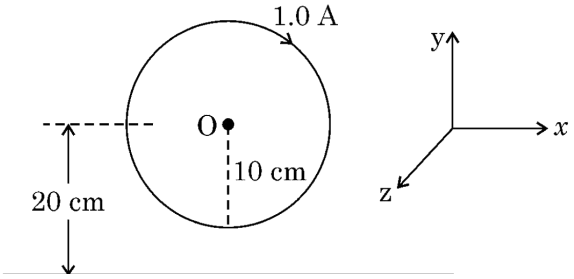
[2019 • Set 55-1-1]

Q16. A small town with a demand of $1200\,kW$ of electric power at $220\,V$ is situated $20\,km$ away from an electric plant generating power at $440\,V$. The resistance of the two wire line carrying power is $0.5\,\Omega$ per km. The town gets the power from the line through a 4000-$220\,V$ step-down transformer at a sub-station in the town. Estimate the line power loss in the form of heat.

[2019 • Set 55-1-1]

Q17. (a) What do you understand by 'sharpness of resonance' for a series LCR resonant circuit? How is it related with the quality factor 'Q' of the circuit? Using the graphs given in the diagram, explain the factors which affect it. For which graph is the resistance (R) minimum?

(b) A $2\,\mu F$ capacitor, $100\,\Omega$ resistor and $8\,H$ inductor are connected in series with an ac source. Find the frequency of the ac source for which the current drawn in the circuit is maximum. If the peak value of emf of the source is $200\,V$, calculate the (i) maximum current, and (ii) inductive and capacitive reactance of the circuit at resonance.



OR

(a) Draw a schematic diagram of an ac generator. Explain its working and obtain the expression for the instantaneous value of the emf in terms of the magnetic field B,

number of turns N of the coil of area A rotating with angular frequency ω. Show how an alternating emf is generated by a loop of wire rotating in a magnetic field.

(b) A circular coil of radius $10\,\text{cm}$ and 20 turns is rotated about its vertical diameter with angular speed of $50\,\text{rad s}^{-1}$ in a uniform horizontal magnetic field of $3.0 \times 10^{-2}\,\text{T}$. (i) Calculate the maximum and average emf induced in the coil. (ii) If the coil forms a closed loop of resistance $10\,\Omega$, calculate the maximum current in the coil and the average power loss due to Joule heating.

[2019 • Set 55-4-1]

Q18. A device X is connected across an ac source of voltage $V = V_0 \sin \omega t$. The current through X is given as $I = I_0 \sin\left(\omega t + \frac{\pi}{2}\right)$.

(a) Identify the device X and write the expression for its reactance.

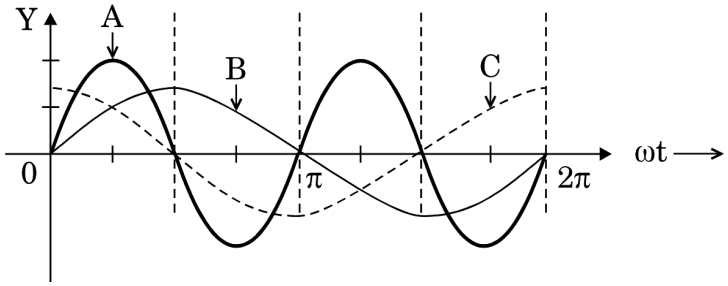
(b) Draw graphs showing variation of voltage and current with time over one cycle of ac, for X.

(c) How does the reactance of the device X vary with frequency of the ac ? Show this variation graphically.

(d) Draw the phasor diagram for the device X.

[2018]

Q19. A device X is connected to an ac source $V = V_0 \sin \omega t$. The variation of voltage, current and power in one cycle is shown in the following graph:



(a) Identify the device 'X'.

(b) Which of the curves A, B and C represent the voltage, current and the power consumed in the circuit? Justify your answer.

(c) How does its impedance vary with frequency of the ac source? Show graphically.

(d) Obtain an expression for the current in the circuit and its phase relation with ac voltage.

[2017]

Q20. (i) Draw a labelled diagram of a step-down transformer. State the principle of its working.

(ii) Express the turn ratio in terms of voltages.

(iii) Find the ratio of primary and secondary currents in terms of turn ratio in an ideal transformer.

(iv) How much current is drawn by the primary of a transformer connected to 220 V supply when it delivers power to a 110 V $-$ 550 W refrigerator?

OR

(a) Explain the meaning of the term mutual inductance. Consider two concentric circular coils, one of radius r_1 and the other of radius r_2 $(r_1 < r_2)$ placed coaxially with centres coinciding with each other. Obtain the expression for the mutual inductance of the arrangement.

(b) A rectangular coil of area A, having number of turns N is rotated at f revolutions per second in a uniform magnetic field B, the field being perpendicular to the coil. Prove that the maximum emf induced in the coil is $2\pi fNBA$.

[2016]

Q21. In a series LCR circuit connected to an a.c. source of voltage $v = v_m \sin \omega t$, use phasor diagram to derive an expression for the current in the circuit. Hence obtain the expression for the power dissipated in the circuit. Show that power dissipated at resonance is maximum.

[2016]

Q22. (a) Show that in an a.c. circuit containing a pure inductor, the voltage is ahead of current by $\pi/2$ in phase.

(b) A horizontal straight wire of length L extending from east to west is falling with speed v at right angles to the horizontal component of Earth's magnetic field B. (i) Write the expression for the instantaneous value of the e.m.f. induced in the wire. (ii) What is the direction of the e.m.f.? (iii) Which end of the wire is at the higher potential?

[2011]

Q23. (i) With the help of a labelled diagram, describe briefly the underlying principle and working of a step up transformer.

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

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

[2011 • Set 55-1-1]

Q24. Derive an expression for the impedance of a series LCR circuit connected to an AC supply of variable frequency. Plot a graph showing variation of current with the frequency of the

applied voltage. Explain briefly how the phenomenon of resonance in the circuit can be used in the tuning mechanism of a radio or a TV set.

[2011 • Set 55-1-1]

Q25. (a) An alternating voltage $v = v_m \sin \omega t$ applied to a series LCR circuit drives a current given by $i = i_m \sin(\omega t + \phi)$. Deduce an expression for the average power dissipated over a cycle.

(b) For circuits used for transporting electric power, a low power factor implies large power loss in transmission. Explain.

(c) Determine the current and quality factor at resonance for a series LCR circuit with $L = 1.00\,\text{mH}$, $C = 1.00\,\text{nF}$ and $R = 100\,\Omega$ connected to an a.c. source having peak voltage of 100 V.

[2011 • Set 55-2-1]

Q26. A series LCR circuit is connected to an ac source having voltage $v = v_m \sin \omega t$. Derive the expression for the instantaneous current I and its phase relationship to the applied voltage. Obtain the condition for resonance to occur. Define 'power factor'. State the conditions under which it is (i) maximum and (ii) minimum.

[2010]

Q27. (a) Derive an expression for the average power consumed in a series LCR circuit connected to a.c. source in which the phase difference between the voltage and the current in the circuit is ϕ.

(b) Define the quality factor in an a.c. circuit. Why should the quality factor have high value in receiving circuits? Name the factors on which it depends.

[2009]

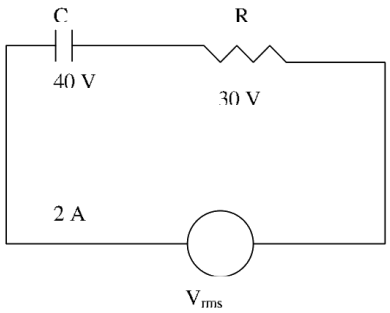
Q28. (a) Derive the relationship between the peak and the rms value of current in an a.c. circuit.

(b) Describe briefly, with the help of a labelled diagram, working of a step-up transformer.

(c) A step-up transformer converts a low voltage into high voltage. Does it not violate the principle of conservation of energy? Explain.

[2009]

Q29. State the condition for resonance to occur in a series LCR a.c circuit and derive an expression for the resonant frequency. Draw a plot showing the variation of the peak current (i_m) with frequency of the a.c source used. Define the quality factor, Q of the circuit. Calculate the (i) impedance, (ii) wattless current of the given a.c circuit.



[2008]

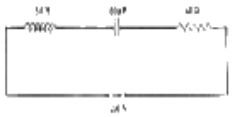
Q30. Draw a labeled circuit arrangement showing the windings of primary and secondary coil in a transformer. Explain the underlying principle and working of a step-up transformer. Write any two major sources of energy loss in this device. How much current is drawn by the primary coil of a transformer which steps down $220\ V$ to $22\ V$ to operate a device with an impedance of $220\ ohm$?

[2008]

Q31. Explain the term 'inductive reactance'. Show graphically the variation of inductive reactance with frequency of the applied alternating voltage. An a.c. voltage $E = E_0 \sin \omega t$ is applied across a pure inductor of inductance L. Show mathematically that the current flowing through it lags behind the applied voltage by a phase angle of $\pi/2$.

[2007]

Q32. The given circuit diagram shows a series LCR circuit connected to a variable frequency 230 V source:



(a) Determine the source frequency which drives the circuit in resonance.

(b) Obtain the impedance of the circuit and the amplitude of current at the resonating frequency.

(c) Determine the rms potential drops across the three elements of the circuit.

(d) How do you explain the observation that the algebraic sum of the voltages across the three elements obtained in (c) is greater than the supplied voltage?

[2006]

Q33. The primary coil of an ideal step-up transformer has 100 turns and the transformation ratio is also 100. The input voltage and power are 220 V and 1100 W respectively. Calculate:

(i) number of turns in the secondary

(ii) the current in the primary

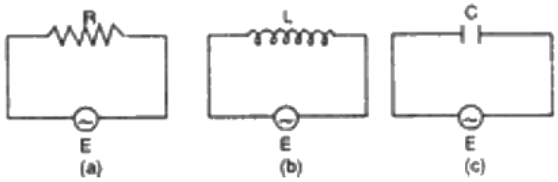
(iii) voltage across the secondary

(iv) the current in the secondary

(v) power in the secondary

[2006]

Q34. What is a choke coil? Why is it preferred to resistance in a.c. circuits? In figures (a), (b) and (c) are shown three a.c. circuits with equal currents. If the frequency of e.m.f. be increased, then what will be the effect on the currents flowing in them? Explain with reason.



[2003]