CLASS 12 PHYSICS PREVIOUS YEAR QUESTIONS
ALTERNATING CURRENT

Question 1. The instantaneous current and voltage of an a.c. circuit are given by i = 10 sin 300 t A and V = 200 sin 300 t V. What is the power dissipation in the circuit? (All India 2008)

Question 2. The instantaneous current and voltage of an a.c. circuit are given by i = 10 sin 314 t A and v = 50 sin 314 t V. What is the power dissipation in the circuit? (All India 2008)

Question 3. The instantaneous current and voltage of an a.c. circuit are given by i = 10 sin 314 tA and v = 50 sin $(314t+\pi 2)$V. (All India 2008)

Question 4. Define the term 'wattless current'. (Delhi 2011)

Question 5. Mention the two characteristic properties of the material suitable for making core of a transformer. (All India 2012)

Question 6. When an ac source is connected across an ideal inductor, show on a graph the nature of variation of the voltage and the current over one complete cycle. (Comptt. Delhi 2012)

Question 7. A heating element is marked 210 V, 630 W. What is the value of the current drawn by the element when connected to a 210 V dc source? (Delhi 2013)

Question 8. A heating element is marked 210 V, 630 W. Find the resistance of the element when connected to a 210 V dc source.

Question 9. Why is the core of a transformer laminated? (Comptt. Delhi 2013)

Question 10. Why is the use of a.c. voltage preferred over d.c. voltage? Give two reasons. (All India 2013)

Question 11. Define capacitor reactance. Write its S.I. units. (Delhi 2015)

Question 12. A variable frequency AC source is connected to a capacitor. Will the displacement current change if the frequency of the AC source is decreased? (Comptt. All India 2015)

Question 13. Plot a graph showing variation of capacitive reactance with the change in the frequency of the AC source. (Comptt. All India 2015)

Question 14. Define 'quality factor' of resonance in series LCR circuit. What is its SI unit? (Delhi 2016)
Answer: Quality factor (Q) is defined as, Q = $\omega_0 LR$
It gives the sharpness of the resonance circuit. It has no SI unit.

Question 15. For an ideal inductor, connected across a sinusoidal ac voltage source, state which one of the following quantity is zero :
(i) Instantaneous power
(ii) Average power over full cycle of the ac voltage source (Comptt. All India 2016)

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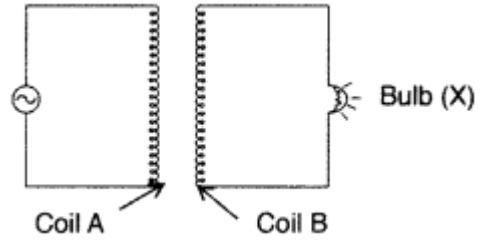
Short Answer Type SA-I

Question 16. Prove that an ideal capacitor in an a.c. circuit does not dissipate power. (Delhi 2008)

Question 17. Prove that an ideal inductor does not dissipate power in an a.c. circuit. (Delhi 2016)

Question 18. Derive an expression for the impedance of an a.c. circuit consisting of an inductor and a resistor. (Delhi 2008)

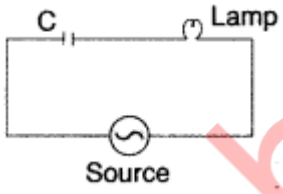
Question 20. The figure given shows an arrangement by which current flows through the bulb (X) connected with coil B, when a.c. is passed through coil A.



(i) Name the phenomenon involved.
(ii) If a copper sheet is inserted in the gap between the coils, explain, how the brightness of the bulb would change. (All India 2008)

Question 21. A 15.0 μF capacitor is connected to 220 V, 50 Hz source. Find the capacitive reactance and the rms current. (All India 2009)

Question 22. An electric lamp having coil of negligible inductance connected in series with a capacitor and an a.c. 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. (Delhi 2009)



Question 23. State the principle of working of a transformer. Can a transformer be used to step up or step down a d.c. voltage? Justify your Answer. (All India 2009)

Question 24. Mention various energy losses in a transformer. (All India 2009)

Question 25. 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? (All India 2012)

Question 26. 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. (All India 2012)

Question 27. A light bulb is rated 200 W for 220 V ac supply of 50 Hz. Calculate
(i) the resistance of the bulb;
(ii) the rms current through the bulb. (All India 2012)

Question 28. A light bulb is rated 150 W for 220 V ac supply of 60 Hz. Calculate
(i) the resistance of the bulb; ,

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(ii) the rms current through the bulb. (All India 2012)

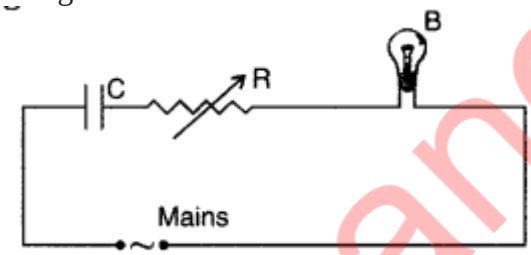
Question 29. An alternating voltage given by V = 140 sin 314 t is connected across a pure resistor of 50 Ω. Find
(i) the frequency of the source.
(ii) the rms current through the resistor. (All India 2012)

Question 30. An alternating voltage given by V = 280 sin 50πt is connected across a pure resistor of 40 Ω. Find
(i) the frequency of the source.
(ii) the rms current through the resistor. (All India 2012)

Question 31. An alternating voltage given by V = 70 sin 100πt is connected across a pure resistor of 25 Ω . Find
(i) the frequency of the source.
(ii) the rms current through the resistor. (All India 2012)

Question 32. A lamp is connected in series with a capacitor. Predict your observation when this combination is connected in turn across
(i) ac source and
(ii) a 'dc' battery. What change would you notice in each case if the capacitance of the capacitor is increased? (Comptt. Delhi 2012)

Question 33. A capacitor 'C', a variable resistor 'R' and a bulb 'B' are connected in series to the ac mains in a 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? (Delhi 2012)
Answer:
(i) Brightness will increase due to increase in capacitance on introducing dielectric slab.
(ii) Brightness will decrease, as the resistance (R) is increased, the potential drop across the bulb will decrease (since both are connected in series).

Question 34. The figure shows a series LCR circuit connected to a variable frequency 200 V source with L = 50 mH, C = 80 μF and R = 40 Ω.
Determine
(i) the source frequency which derives the circuit in resonance;
(ii) the quality factor (Q) of the circuit. (Comptt. All India 2014)

Question 35. The figure shows a series LCR circuit connected to a variable frequency 250 V source with L = 40 mH, C = 100 μF and R = 50 Ω.

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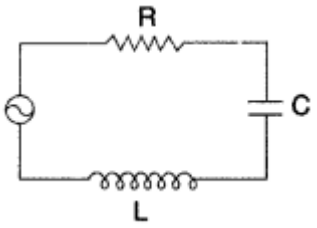
Short Answer Type SA-II

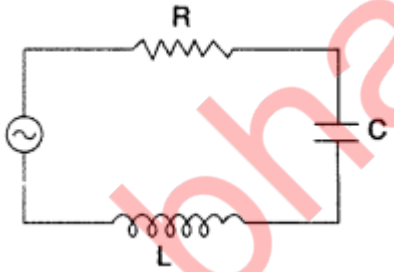
Question 36. An inductor of unknown value, a capacitor of 100 μF and a resistor of 10 Ω are connected in series to a 200 V. 50 Hz a.c. source. It is found that the power factor of the circuit is unity. Calculate the inductance of the inductor and the current amplitude. (Delhi 2008)

Question 37. Two heating elements of resistances R_1 and R_2 when operated at a constant supply of voltage, V, consume powers P_1 and P_2 respectively. Deduce the expressions for the power of their combination when they are, in turn, connected in
(i) series and
(ii) parallel across the same voltage supply. (All India 2008)

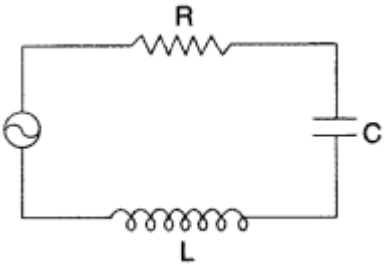
Question 38. The figure shows a series LCR circuit with L = 5.0 H, C = 80 μF, R = 40 Ω connected to a variable frequency 240 V source. Calculate
(i) The angular frequency of the source which drives the circuit at resonance.
(ii) The current at the resonating frequency.
(iii) The rms potential drop across the capacitor at resonance. (Delhi 2008)



Question 39. A series LCR circuit with L = 4.0 H,C = 100 μF and R = 60 Ω. is connected to a variable frequency 240 V source as shown in the figure.
Calculate :
(i) the angular frequency of the source which derives the circuit at resonance;
(ii) the current at the resonating freqency;
(iii) the rms potential drop across the inductor at (Delhi 2008)



Question 40. The figure shows a series LCR circuit with L = 10.0 H, C = 40 μF, R = 60 Ω connected to a variable frequency 240 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 inductor at resonance. (Delhi 2008)

Question 41. A series LCR circuit is connected to an ac source. Using the phasor diagram, derive the

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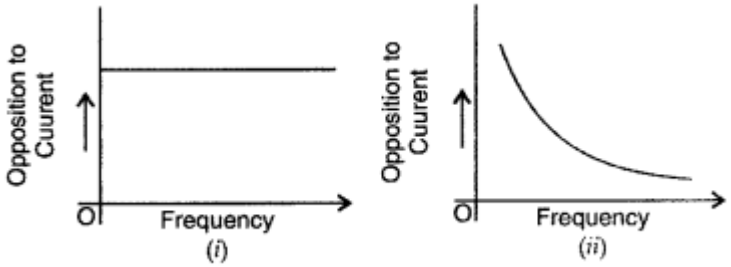
expression for the impedance of the circuit. Plot a graph to show the variation of current with frequency of the source, explaining the nature of its variation. (All India 2008)

Question 42. (a) The graphs
(i) and
(ii) shown in the figure represent variation of opposition offered by the circuit elements, X and Y, respectively to the flow of alternating current vs. the frequency of the applied emf. Identify the elements X and Y.



(b) Write the expression for the impedance offered by the series combination of these two elements connected to an ac source of voltage $V = V_0 \sin \omega t$.
Show on a graph the variation of the voltage and the current with 'out' in the circuit. (Comptt. All India 2008)

Question 43. Draw a sketch showing the basic elements of an a.c. generator. State its principle and explain briefly its working. (Comptt. All India 2008)

Question 44. 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. (Delhi 2013)

Question 45. (i) For a given a.c., $i = i_m \sin \omega t$, show that the average power dissipated in a resistor R over a complete cycle is $\frac{1}{2} i_m^2 R$.
(ii) A light bulb is rated at 100 W for a 220 V a.c. supply. Calculate the resistance of the bulb. (All India 2013)

Question 46. (a) For a given a.c., $i = i_m \sin \omega t$, show that the average power dissipated in a resistor R over complete cycle is $\frac{1}{2} i_m^2 R$.
(b) A light bulb is rated at 125 W for 250 V a.c. supply. Calculate the resistance of the bulb. (All India 2013)

Question 47. (a) When an a.c. source is connected to an ideal capacitor show that the average power supplied by the source over a complete cycle is zero.
(b) A lamp is connected in series with a capacitor. Predict your observations when the system is connected first across a d.c. and then an a.c. source. What happens in each case if the capacitance of the capacitor is reduced? (Comptt. Delhi 2013)

Question 48. A voltage $V = V_0 \sin$ est 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? (All India 2014)

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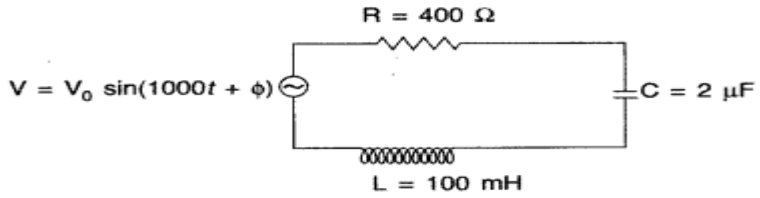
Question 49. An inductor L of inductance X_L is connected in series with a bulb B and an ac source. How would brightness of the bulb change when
(i) number of turns in the inductor is reduced,
(ii) an iron rod is inserted in the inductor and
(iii) a capacitor of reactance $X_C = X_L$ is inserted in series in the circuit. Justify your Answer in each case. (Delhi 2015)

Question 50. (a) Determine the value of phase difference between the current and the voltage in the given series LCR circuit.

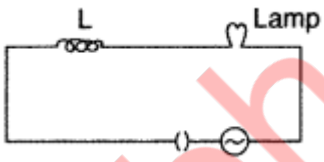


(b) Calculate the value of the additional capacitor which may be joined suitably to the capacitor C that would make the power factor of the circuit unity. (All India 2014)

Question 51. A circuit containing an 80 mH inductor and a 250 μF capacitor in series connected to a 240 V, 100 rad/s supply. The resistance of the circuit is negligible.
(i) Obtain rms value of current. ‘
(ii) What is the total average power consumed by the circuit? (Comptt. Delhi 2014)

Question 52. A source of ac voltage $V = V_0$ sin cat is connected to a series combination of a resistor ‘R’ and a capacitor ‘C’. Draw the phasor diagram and use it to obtain the expression for
(i) impedance of the circuit and
(ii) phase angle. (Comptt. All India 2014)

Question 53. (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.



Question 54. Derive the expression for the average power dissipated in a series LCR circuit for an ac source of a voltage, $v = v_m \sin \omega t$, carrying a current, $i = i_m \sin(\omega t + \phi)$.
Hence define the term “Wattless current”. State under what condition it can be realized in a circuit. (Comptt. Delhi 2014)

Question 55. Obtain the expression for the magnetic energy stored in an ideal inductor of self inductance L when a current I passes through it.
Hence obtain the expression for the energy density of magnetic field B produced in the inductor.

Question 56. The current, in the LCR circuit shown in the figure is observed to lead the voltage in phase. Without making any other change in the circuit, a capacitor, of capacitance C_0, is (appropriately) joined to the capacitor C. This results in making the current, in the ‘modified’ circuit, flow in phase with the applied voltage.

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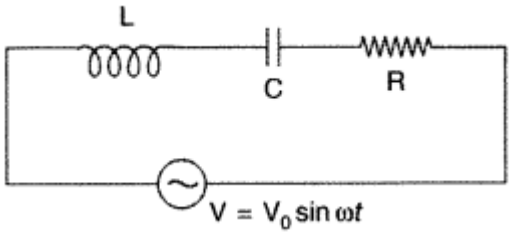
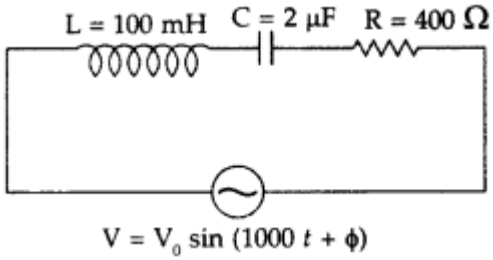


Draw a diagram of the 'modified' circuit and obtain an expression for C_0 in terms of ω, L and C. (Comptt. All India)

Question 57. A 200 mH (pure) inductor, and a 5μF (pure) capacitor, are connected, one by one, across a sinusoidal ac voltage source V = [70.7 sin (1000 t)] voltage. Obtain the expressions for the current in each case. (Comptt. All India 2016)

Question 58. (i) Find the value of the phase difference between the current and the voltage in the series LCR circuit shown here. Which one leads in phase: current or voltage?



(ii) Without making any other change, find the value of the additional capacitor Cv to be connected in parallel with the capacitor C, in order to make the power factor of the circuit unity. (Delhi 2017)

Long Answer Type Questions

Question 59. An a.c. source generating a voltage $v = v_m \sin \omega t$ is connected to a capacitor of capacitance C. Find the expression for the current, i, flowing through it. Plot a graph of v and i versus tat to show that the current is π/2 ahead of the voltage. A resistor of 200Ω and a capacitor of 15.0 μF are connected in series to a 220 V, 50 Hz a.c. source. Calculate the current in the circuit and the rms voltage across the resistor and the capacitor. Is the algebraic sum of these voltages more than the source voltage? If yes, resolve the paradox. (All India 2008)

Question 60. Explain briefly, with the help of a labelled diagram, the basic principle of the working of an a.c. generator.
In an a.c. generator, coil of N turns and area A is rotated at v revolutions per second in a uniform magnetic field B. Write the expression for the emf produced.
A 100-turn coil of area 0.1 m2 rotates at half a revolution per second. It is placed in a magnetic field 0.01 T perpendicular to the axis of rotation of the coil. Calculate the maximum voltage generated in the coil. (All India 2008)

Question 61. (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 0.
(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. (Delhi 2009)

Question 62. (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. A step-up transformer converts a low voltage into high voltage. Does it not violate the principle of conservation

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of energy? Explain. (Delhi 2009)

Question 63. Describe briefly, with the help of a labelled diagram, the basic elements of an a.c. 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. (Delhi 2010)

Question 64.
A series LCR circuit is connected to an a.c. 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. (Delhi 2010)

Question 65. Draw a schematic diagram of a step-up transformer. Explain its working principle. Deduce the expression for the secondary to primary voltage in terms of the number of turns in the two coils. In an ideal transformer, how is this ratio related to the currents in the two coils? How is the transformer used in large scale transmission and distribution of electrical energy over long distances? (All India 2010)

Question 66. (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. (Delhi 2011)

Question 67. 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. (Delhi 2011)

Question 68. State the working of a.c. generator with the help of a labelled diagram.
The coil of an a.c. generator having N turns, each of area A, is rotated with a constant angular velocity to. Deduce the expression for the alternating emf generated in the coil.
What is the source of energy generation in this device? (All India 2011)

Question 69. (a) A voltage $V = V_0 \sin \omega t$ applied to a series LCR circuit drives a current $i = i_0 \sin \omega t$ in the circuit. Deduce the expression for the average power dissipated in the circuit.
(b) For circuits used for transporting electric power, a low power factor implies large power loss in transmission. Explain.
(c) Define the term 'wattless current'. (Comptt. Delhi 2012)

Question 70. (a) An ac source of voltage $v = v_0 \sin \omega t$ is connected across a series combination of an inductor, a capacitor and a resistor. Use the phasor diagram to obtain the expression for
(i) impedance of the circuit and
(ii) phase angle between the voltage and the current.
(b) A capacitor of unknown capacitance, a resistor of 100 Ω and an inductor of self-inductance $L = (4/\pi^2)$ henry are in series connected to an ac source of 200 V and 50 Hz. Calculate the value of the capacitance and the current that flows in the circuit when the current is in phase with the voltage. (Comptt. All India 2012)

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Question 71. (a) Explain with the help of a labelled diagram, the principle and working of a transformer. Deduce the expression for its working formula.
(b) Name any four causes of energy loss in an actual transformer. (Comptt. All India 2012)

Question 72. (a) Draw a schematic sketch of an ac generator describing its basic elements. State briefly its working principle. Show a plot of variation of
(i) Magnetic flux and
(ii) Alternating emf versus time generated by a loop of wire rotating in a magnetic field.
(b) Why is choke coil needed in the use of fluorescent tubes with ac mains? (Delhi 2014)

Question 73. (a) A series LCR circuit is connected to an a.c. source of variable frequency. Draw a suitable phasor diagram to deduce the expressions for the amplitude of the current and phase angle.
(b) Obtain the condition at resonance. Draw a plot showing the variation of current with the frequency of a.c. source for two resistances R_1 and ($R_1 > R_2$). Hence define the quality factor, Q and write its role in the tuning of the circuit. (Comptt. Delhi 2014)

Question 74. (a) Draw a labelled diagram of a.c. generator and state its working principle.
(b) How is magnetic flux linked with the armature coil changed in a generator?
(c) Derive the expression for maximum value of the induced emf and state the rule that gives the direction of the induced emf.
(d) Show the variation of the emf generated
versus time as the armature is rotated with respect to the direction of the magnetic field. (Comptt. Delhi 2014)

Question 75. (a) Draw a schematic arrangement for winding of primary and secondary coil in a transformer when the two coils are wound on top of each other.
(b) State the underlying principle of a transformer and obtain the expression for the ratio of secondary to primary voltage in terms of the
(i) number of secondary and primary windings and
(ii) primary and secondary currents.
(c) Write the main assumption involved in deriving the above relations.
(d) Write any two reasons due to which energy losses may occur in actual transformers. (Comptt. All India 2014)

Question 76. (i) An a.c. source of voltage $V = V_0 \sin \omega t$ is connected to a series combination of L, C and R. Use the phasor diagram to obtain expressions for impedance of the circuit and phase angle between voltage and current. Find the condition when current will be in phase with the voltage. What is the circuit in this condition called?
(ii) In a series LR circuit $X_L = R$ and power factor of the circuit is P_1. When capacitor with capacitance C such that $X_L = X_C$ is put in series, the power factor becomes P_2. Calculate P_1/P_2.

Question 77. (i) Write the function of a transformer. State its principle of working with the help of a diagram. Mention various energy losses in this device.
(ii) The primary coil of an ideal step up transformer has 100 turns and transformation ratio is also 100. The input voltage and power are respectively 220 V and 1100 W. Calculate
(a) number of turns in secondary
(b) current in primary
(c) voltage across secondary
(d) current in secondary
(e) power in secondary (Delhi 2016)

Question 78. (i) Draw a labelled diagram of a step-down transformer. State the priciple 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

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delivers power to a 110V – 550 W refrigerator? (All India 2016)

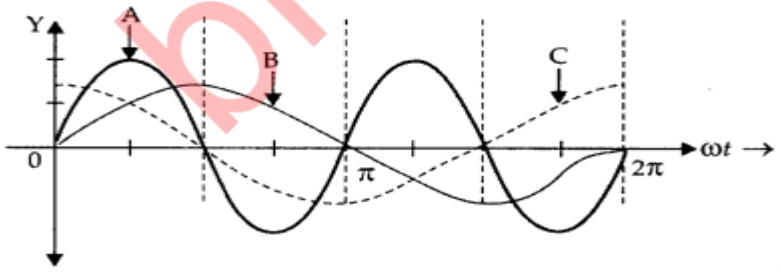
Question 79. Discuss how Faraday's law of e.m. induction is applied in an ac-generator for converting mechanical energy into electrical energy.
Obtain an expression for the instantaneous value of the induced emf in an ac generator. Draw graphs to show the 'phase relationship' between the instantaneous
(i) magnetic flux (ϕ) linked with the coil and
(ii) induced emf (ε) in the coil. ' (Comptt. Delhi 2016)

Question 80. Draw an arrangement for winding of primary and secondary coils in a transformer with two coils on a separate limb of the core.
State the underlying principle of a transformer. Deduce the expression for the ratio of secondary voltage to the primary voltage in terms of the ratio of the number of turns of primary and secondary winding. For an ideal transformer, obtain the ratio of primary and secondary currents in terms of the ratio of the voltages in the secondary and primary voltages.
Write any two reasons for the energy losses which occur in actual transformers. (Comptt. Delhi 2016)

Question 81. (a) Draw a labelled diagram of AC generator. Derive the expression for the instantaneous value of the emf induced in the coil.
(b) A circular coil of cross-sectional area 200 cm^2 and 20 turns is rotated about the vertical diameter with angular speed of 50 rad s^{-1} in a uniform magnetic field of magnitude 3.0×10^{-2} T. Calculate the maximum value of the current in the coil. (Delhi 2017)

Question 82. (a) Draw a labelled diagram of a step-up transformer. Obtain the ratio of secondary to primary voltage in terms of number of turns and currents in the two coils.
(b) A power transmission line feeds input power at 2200 V to a step-down transformer with its primary windings having 3000 turns. Find the number of turns in the secondary to get the power output at 220 V. (Delhi 2017)

Question 83. A device 'X' is connected to an ac source V = V0 sin cot. 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 it 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. (All India 2017).

Question 84. (a) Draw a labelled diagram of an ac generator.
Obtain the expression for the emf induced in the rotating coil of N turns each of cross-sectional area A, in the presence of a magnetic field $B\rightarrow$.
(b) A horizontal conducting rod 10 m long extending from east to west is falling with a speed 5.0 ms^{-1} at right angles to the horizontal component of the Earth's magnetic field, 0.3×10^{-4} Wb m^{-2}. Find the instantaneous value of the emf induced in the rod. (All India 2017)

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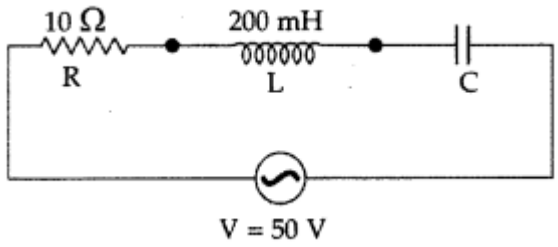
Question 85. In the given circuit, calculate
(a) the capacitance of the capacitor, if the power factor of the circuit is unity,
(b) the Q-factor of this circuit. What is the significance of the Q-factor in a.c. circuit? Given the angular frequency of the a.c. source to be 100/s. Calculate the average power dissipated in the circuit. (Comptt. Delhi 2017)



Question 86. (a) Prove that the current flowing through an ideal inductor connected across a.c. source, lags the voltage in phase by $\pi 2$.
(b) An inductor of self inductance 100 mH, and a bulb are connected in series with a.c. source of rms voltage 10 V, 50 Hz. It is found that effective voltage of the circuit $\pi 4$. Calculate the inductance of the inductor used and average power dissipated in the circuit, if a current of 1 A flows in the circuit. (Comptt. Delhi)

Question 87. (a) Prove that an ideal capacitor in an ac circuit does not dissipate power.
(b) An inductor of 200 mH, capacitor of 400 f and a resistor of 10 Q are connected in series to ac source of 50 V of variable frequency. Calculate the
(i) angular frequency at which maximum power dissipation occurs in the circuit and the corresponding value of the effective current, and
(ii) value of Q-factor in the circuit. (Comptt. All India 2017)

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