Multiple Choice Questions (MCQs)

1. A light bulb is rated at 100 W for a 220 V ac supply. The resistance of the bulb is
(a) 284 Ω (b) 384 Ω
(c) 484 Ω (d) 584 Ω

2. In an ac circuit, V and I are given by
$V = 150\sin(150t)$ volt and $I = 150\sin\left(150t + \frac{\pi}{3}\right)$ ampere. The apparent power in the circuit is
(a) 106 W (b) 150 W
(c) 11250 W (d) zero

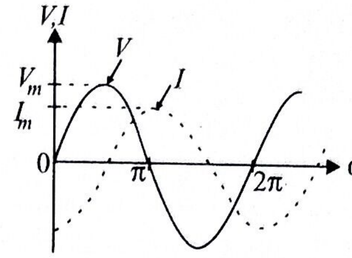
3. In the case of an inductor
(a) voltage lags the current by $\frac{\pi}{2}$
(b) voltage leads the current by $\frac{\pi}{2}$
(c) voltage leads the current by $\frac{\pi}{3}$
(d) voltage leads the current by $\frac{\pi}{4}$.

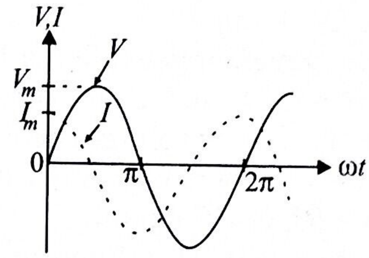
4. An inductor of 30 mH is connected to a 220 V, 100 Hz ac source. The inductive reactance is
(a) 10.58 Ω (b) 12.64 Ω
(c) 18.85 Ω (d) 22.67 Ω

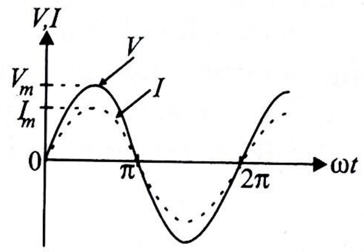
5. A fully charged capacitor C with initial charge Q_0 is connected to a coil of self inductance L at $t = 0$. The time at which the energy is stored equally between the electric and the magnetic field is
(a) $\frac{\pi}{4}\sqrt{LC}$ (b) $2\pi\sqrt{LC}$
(c) $\sqrt{LC}$ (d) $\pi\sqrt{LC}$

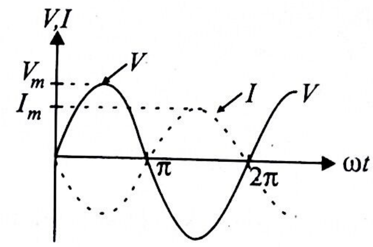
6. An LCR series circuit is under resonance. If I_m is current amplitude, V_m is voltage amplitude, R is the resistance, Z is the impedance, X_L is the inductive reactance and X_C is the capacitive reactance, then
(a) $I_m = \frac{Z}{V_m}$ (b) $I_m = \frac{V_m}{X_L}$
(c) $I_m = \frac{V_m}{X_C}$ (d) $I_m = \frac{V_m}{R}$

7. The phase relationship between current and voltage in a pure resistive circuit is best represented by

(a)


(b)


(c)


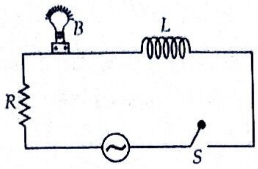
(d)


8. At resonant frequency the current amplitude in series LCR circuit is
(a) maximum (b) minimum
(c) zero (d) infinity.

9. A 0.2 kΩ resistor and 15 μF capacitor are connected in series to a 220 V, 50 Hz ac source. The impedance of the circuit is
(a) 250 Ω (b) 268 Ω
(c) 29.15 Ω (d) 291.5 Ω

10. A sinusoidal voltage of peak value 293 V and frequency 50 Hz is applied to a series LCR circuit in which $R = 6$ Ω, $L = 25$ mH and $C = 750$ μF. The impedance of the circuit is
(a) 7.0 Ω (b) 8.9 Ω
(c) 9.9 Ω (d) 10.0 Ω

11. Switch S is closed at $t = 0$. After sufficiently long time, an iron rod is inserted into the inductor L.
Then, the light bulb

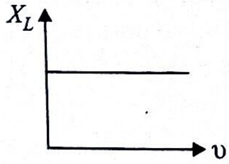


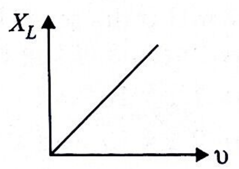
(a) glows more brightly
(b) gets dimmer
(c) glows with the same brightness
(d) gets momentarily dimmer and then glows more brightly.

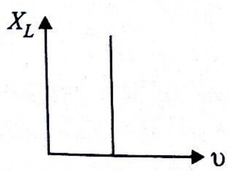
12. In a series LCR circuit having $L = 30$ mH, $R = 8\ \Omega$ and the resonant frequency is 50 Hz. The quality factor of the circuit is
(a) 0.118 (b) 11.8
(c) 118 (d) 1.18

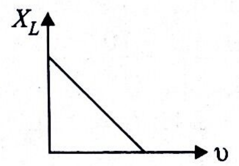
13. Alternating voltage (V) is represented by the equation
(a) $V(t) = V_m e^{\omega t}$ (b) $V(t) = V_m \sin\omega t$
(c) $V(t) = V_m \cot\omega t$ (d) $V(t) = V_m \tan\omega t$
where V_m is the peak voltage.

14. Which of the following graphs represents the correct variation of inductive reactance X_L with frequency υ?

(a)


(b)


(c)


(d)


15. A 44 mH inductor is connected to 220 V, 50 Hz ac supply. The rms value of the current in the circuit is
(a) 12.8 A (b) 13.6 A
(c) 15.9 A (d) 19.5 A

16. The output of a step-down transformer is measured to be 24 V when connected to a 12 watt light bulb. The value of the peak current is
(a) $\frac{1}{\sqrt{2}}$ A (b) $\sqrt{2}$ A
(c) 2 A (d) $2\sqrt{2}$ A

17. Which of the following combinations should be selected for better tuning of an LCR circuit used for communication?
(a) $R = 20\ \Omega$, $L = 1.5$ H, $C = 35\ \mu$F
(b) $R = 25\ \Omega$, $L = 2.5$ H, $C = 45\ \mu$F
(c) $R = 15\ \Omega$, $L = 3.5$ H, $C = 30\ \mu$F
(d) $R = 25\ \Omega$, $L = 1.5$ H, $C = 45\ \mu$F

18. A 30 μF capacitor is connected to a 150 V, 60 Hz ac supply. The rms value of current in the circuit is
(a) 17 A (b) 1.7 A
(c) 1.7 mA (d) 2.7 A

19. The rms value of current in an ac circuit is 25 A, then peak current is
(a) 35.36 mA (b) 35.36 A
(c) 3.536 A (d) 49.38 A

20. The resonant frequency of a series LCR circuit with $L = 2.0$ H, $C = 32\ \mu$F and $R = 10\ \Omega$ is
(a) 20 Hz (b) 30 Hz
(c) 40 Hz (d) 50 Hz

21. A 60 μF capacitor is connected to a 110 V (rms), 60 Hz ac supply. The rms value of current in the circuit is
(a) 1.49 A (b) 14.9 A
(c) 2.49 A (d) 24.9 A

22. When a voltage measuring device is connected to ac mains, the meter shows the steady input voltage of 220 V. This means
(a) input voltage cannot be ac voltage, but a dc voltage
(b) maximum input voltage is 220 V
(c) the meter reads not V but $\langle V^2 \rangle$ and is calibrated to read $\sqrt{\langle V^2 \rangle}$.
(d) the pointer of the meter is stuck by some mechanical defect.

23. In series LCR circuit, the phase angle between supply voltage and current is
(a) $\tan\phi = \frac{X_L - X_C}{R}$ (b) $\tan\phi = \frac{R}{X_L - X_C}$
(c) $\tan\phi = \frac{R}{X_L + X_C}$ (d) $\tan\phi = \frac{X_L + X_C}{R}$

24. A series LCR circuit with $R = 22\ \Omega$, $L = 1.5$ H and $C = 40\ \mu$F is connected to a variable frequency 220 V ac supply. When the frequency of the supply equals the natural frequency of the circuit, what is the average power transferred to the circuit in one complete cycle?
(a) 2000 W (b) 2200 W
(c) 2400 W (d) 2500 W

25. In an alternating current circuit consisting of elements in series, the current increases on increasing the frequency of supply. Which of the following elements are likely to constitute the circuit?
(a) Only resistor.
(b) Resistor and an inductor.
(c) Resistor and a capacitor.
(d) Only an inductor.

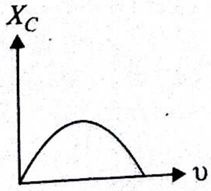
26. When an ac voltage of 220 V is applied to the capacitor C, then
(a) the maximum voltage between plates is 220 V
(b) the current is in phase with the applied voltage
(c) the charge on the plate is not in phase with the applied voltage
(d) the current developed leads the applied voltage by a phase angle of 90°.

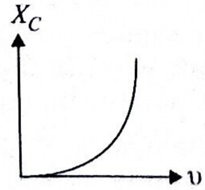
27. The LC parallel resonant circuit
(a) has a very high impedance
(b) has a very high current
(c) acts as resistance of very low value
(d) has zero impedance

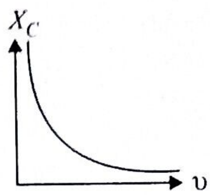
28. A capacitor and an inductance coil are connected in separate AC circuits with a bulb glowing in both the circuits. The bulb glows more brightly when
(a) an iron rod is introduced into the inductance coil
(b) the number of turns in the inductance coil is increased
(c) separation between the plates of the capacitor is increased.
(d) a dielectric is introduced into the gap between the plates of the capacitor.

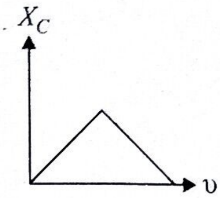
29. Quantity that remains unchanged in a transformer is
(a) voltage
(b) current
(c) frequency
(d) none of these.

30. Which of the following graphs represents the correct variation of capacitive reactance X_C with frequency υ ?

(a) 

(b) 

(c) 

(d) 

31. The loss of energy in the form of heat in the iron core of a transformer is
(a) iron loss
(b) copper loss
(c) mechanical loss
(d) none of these

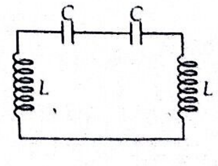
32. An alternating current generator has an internal resistance R_g and an internal reactance X_g. It is used to supply power to a passive load consisting of a resistance R_g and a reactance X_L. For maximum power to be delivered from the generator to the load, the value of X_L should be equal to
(a) zero
(b) X_g
(c) $-X_g$
(d) R_g

33. An inductor of reactance 1 Ω and a resistor of 2 Ω are connected in series to the terminals of a 6 V (rms) ac source. The average power in the circuit is
(a) 8 W
(b) 12 W
(c) 14.4 W
(d) 18 W

34. A charged 30 μF capacitor is connected to a 27 mH inductor. The angular frequency of free oscillations of the circuit is
(a) 1.1×10^3 rad s^{-1}
(b) 2.1×10^3 rad s^{-1}
(c) 3.1×10^3 rad s^{-1}
(d) 4.1×10^3 rad s^{-1}

35. The Q factor of a series LCR circuit with $L = 2$ H, $C = 32$ μF and $R = 10$ Ω is
(a) 15
(b) 20
(c) 25
(d) 30

36. The natural frequency of the circuit shown in figure is



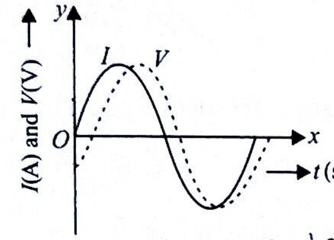
(a) $\frac{1}{2\pi\sqrt{LC}}$
(b) $\frac{1}{2\pi\sqrt{2LC}}$
(c) $\frac{2}{2\pi\sqrt{LC}}$
(d) zero

37. A circuit is made up of a resistance 1 Ω and inductance 0.01 H. An alternating voltage of 200 V at 50 Hz is connected, then the phase difference between the current and the voltage in the circuit is

(a) $\tan^{-1}(\pi)$ (b) $\tan^{-1}\left(\frac{\pi}{2}\right)$

(c) $\tan^{-1}\left(\frac{\pi}{4}\right)$ (d) $\tan^{-1}\left(\frac{\pi}{3}\right)$

38. When an ac source of voltage $V = V_0 \sin 100t$ is connected across a circuit, the phase difference between the voltage V and current I in the circuit is observed to be $\pi/4$, as shown in figure. If the circuit consists possibly only of RC or RL or LC in series, find possible values of two elements.



(a) $R = 1$ kΩ, $C = 10$ μF

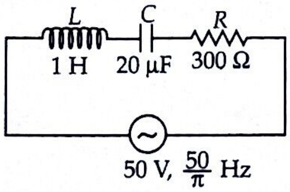
(b) $R = 1$ kΩ, $C = 1$ μF

(c) $R = 1$ kΩ, $L = 10$ mH

(d) $R = 10$ kΩ, $L = 10$ mH

$X_C = R$

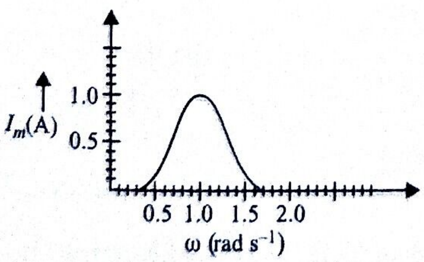
39. In the series LCR circuit shown, the impedance is



(a) 200 Ω (b) 100 Ω

(c) 300 Ω (d) 500 Ω

40. In a series LCR circuit, the plot of I_m versus ω is shown in the figure. The bandwidth of this plot will be



(a) zero (b) 0.1 rad s^{-1}

(c) 0.2 rad s^{-1} (d) 0.4 rad s^{-1}

41. The line that draws power supply to your house from street has

(a) $220\sqrt{2}$ V average voltage.

(b) 220 V average voltage.

(c) voltage and current out of phase by $\pi/2$.

(d) voltage and current possibly differing in phase ϕ such that $|\phi| < \frac{\pi}{2}$.

42. An alternating current of rms value 10 A is passed through a 12 Ω resistor. The maximum potential difference across the resistor is

(a) 20 V (b) 90 V

(c) 169.68 V (d) none of these

43. 200 V ac source is fed to series LCR circuit having $X_L = 50$ Ω, $X_C = 50$ Ω and $R = 25$ Ω. Potential drop across the inductor is

(a) 100 V (b) 200 V

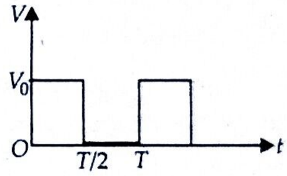
(c) 400 V (d) 10 V

44. A 100 μF capacitor in series with a 40 Ω resistor is connected to a 100 V, 60 Hz supply. The maximum current in the circuit is

(a) 2.65 A (b) 2.75 A

(c) 2.85 A (d) 2.95 A

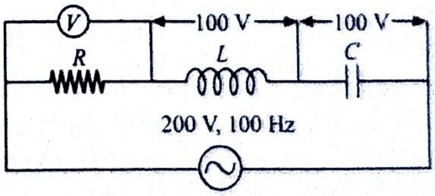
45. The rms value of potential difference V shown in the figure is



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

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

46. In the circuit shown in figure, what will be the reading of the voltmeter?



(a) 300 V (b) 900 V

(c) 200 V (d) 400 V

47. A transformer is used to light 140 W, 24 V lamp from a 240 V ac mains. If the main current is 0.7 A, the efficiency of the transformer is

(a) 63.8% (b) 74%

(c) 83.3% (d) 48%

48. The 220 V AC line voltage that we receive in our homes is

(a) rms value (b) peak value

(c) average value (d) none of these

49. An alternating current in a circuit is given by $I = 20 \sin(100\pi t + 0.05\pi)$ A. The rms value and the frequency of current respectively are
(a) 10 A and 100 Hz (b) 10 A and 50 Hz
(c) $10\sqrt{2}$ A and 50 Hz (d) $10\sqrt{2}$ A and 100 Hz

50. A bulb of resistance 280 Ω is supplied with a 200 V AC supply. What is peak current?
(a) Nearly 1 A (b) Nearly 2 A
(c) Nearly 1.4 A (d) Nearly 2.8 A

51. A capacitor of capacity C has reactance X. If the capacitance and frequency become double, then reactance will be
(a) $4X$ (b) $\frac{X}{2}$
(c) $\frac{X}{4}$ (d) $2X$

52. When the frequency of the AC voltage applied to a series LCR circuit is gradually increased from a low value, the impedance of the circuit
(a) monotonically increases
(b) first increases and then decreases
(c) first decreases and then increases
(d) monotonically decreases

53. A series LCR circuit is connected to an AC source and is showing resonance. Then
(a) $V_R = 0$ (b) $V_L = V_R$
(c) $V_C = V_R$ (d) $V_L = V_C$

54. An LCR circuit contains $R = 50\ \Omega$, $L = 1$ mH and $C = 0.1\ \mu$F. The impedance of the circuit will be minimum for a frequency of
(a) $\frac{10^5}{2\pi}$ Hz (b) $\frac{10^6}{2\pi}$ Hz
(c) $2\pi \times 10^5$ Hz (d) $2\pi \times 10^6$ Hz

55. A 50 volt AC is applied across an RC (series) network. The rms voltage across the resistance is 40 volt, then the potential across the capacitance would be
(a) 10 V (b) 20 V
(c) 30 V (d) 40 V

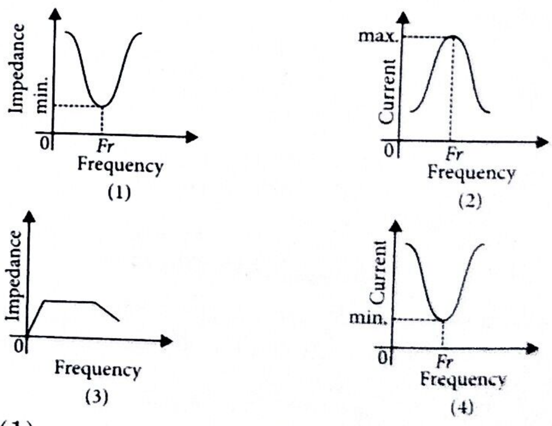
56. The turn ratio of a transformer is 1 : 2. An electrolytic DC cell of emf 2 volt is connected to its primary. The output voltage is
(a) 2 V (b) 0 V
(c) 1 V (d) 3 V

57. In step-up transformer, relation between number of turns in primary (N_P) and number of turns in secondary (N_S) coils is
(a) N_S is greater than N_P
(b) N_P is greater than N_S
(c) N_S is equal to N_P
(d) $N_P = 2N_S$

58. A charged capacitor $C = 30\ \mu$F is connected to an inductor $L = 27$ mH. The angular frequency of their oscillations is
(a) 9.1×10^3 (b) 3.0×10^3
(c) 1.1×10^3 (d) 0.3×10^3

59. The resonance frequency of the tank circuit of an oscillator when $L = \frac{10}{\pi^2}$ mH and $C = 0.04\ \mu$F are connected in parallel is
(a) 250 kHz (b) 25 kHz
(c) 2.5 kHz (d) 25 MHz

60. Out of the following graphs, which graph shows the correct relation (graphical representation) for LC parallel resonant circuit?



(a) (1) (b) (2)
(c) (3) (d) (4)

Case Based MCQs

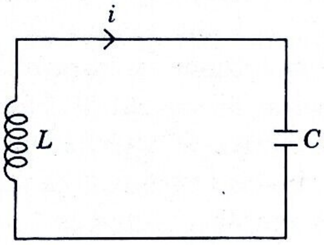
Case I : Read the passage given below and answer the following questions from 61 to 65.

LC Circuit

An LC circuit also called a resonant circuit, tank circuit or tuned circuit is an electric circuit consisting of an inductor represented by the letter L and a capacitor, represented by the letter C connected together. An LC circuit is an idealized model since it assumes there is no dissipation of energy due to resistance.

An LC circuit contains a 20 mH inductor and a 50 μF capacitor with an initial charge of 10 mC.

The resistance of the circuit is negligible. Let the instant the circuit is closed be $t = 0$.



61. The total energy stored initially is

(a) 5 J (b) 3 J
(c) 10 J (d) 1 J

62. The natural frequency of the circuit is

(a) 159.24 Hz (b) 200.12 Hz
(c) 110.25 Hz (d) 95 Hz

63. At what time is the energy stored completely electrical?

(a) $T, 5T, 9T$ (b) $\frac{T}{2}, \frac{5T}{2}, \frac{9T}{2}$
(c) $0, T, 2T, 3T$ (d) $0, \frac{T}{2}, T, \frac{3T}{2}$

64. At what time is the energy stored completely magnetic?

(a) $\frac{T}{2}, \frac{3T}{2}, \frac{T}{4}$ (b) $\frac{T}{3}, \frac{T}{9}, \frac{T}{12}$
(c) $0, 2T, 3T$ (d) $\frac{T}{4}, \frac{3T}{4}, \frac{5T}{4}$

65. The value of X_L is

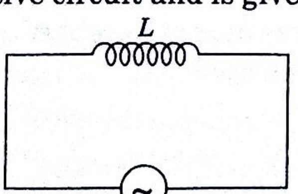
(a) 20 Ω (b) 40 Ω
(c) 60 Ω (d) 50 Ω

Case II : Read the passage given below and answer the following questions from 66 to 70.

AC Voltage Applied to an Inductor

Let a source of alternating e.m.f. $E = E_0 \sin\omega t$ be connected to a circuit containing a pure inductance L. If I is the value of instantaneous current in the circuit, then $I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$.

The inductive reactance limits the current in a purely inductive circuit and is given by $X_L = \omega L$.



66. A 100 hertz a.c. is flowing in a 14 mH coil. The reactance is

(a) 15 Ω (b) 7.5 Ω
(c) 8.8 Ω (d) 10 Ω

67. In a pure inductive circuit, resistance to the flow of current is offered by

(a) resistor
(b) inductor
(c) capacitor
(d) resistor and inductor.

68. In a inductive circuit, by what value of phase angle does alternating current lags behind e.m.f.?

(a) 45° (b) 90°
(c) 120° (d) 75°

69. How much inductance should be connected to 200 V, 50 Hz a.c. supply so that a maximum current of 0.9 A flows through it?

(a) 5 H (b) 1 H
(c) 10 H (d) 4.5 H

70. The maximum value of current when inductance of 2 H is connected to 150 volt, 50 Hz supply is

(a) 0.337 A (b) 0.721 A
(c) 1.521 A (d) 2.522 A

Case III : Read the passage given below and answer the following questions from 71 to 75.

Transformer

A transformer is essentially an a.c. device. It cannot work on d.c. It changes alternating voltages or currents. It does not affect the frequency of a.c. It is based on the phenomenon of mutual induction. A transformer essentially consists of two coils of insulated copper wire having different number of turns and wound on the same soft iron core.

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

71. The value of voltage across the secondary coil is

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

72. The value of current in the bulb is

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

73. The value of current in primary coil is

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

74. Power in primary coil is

(a) 20 W (b) 5 W

(c) 10 W (d) 15 W

75. Power in secondary coil is

(a) 15 W (b) 20 W

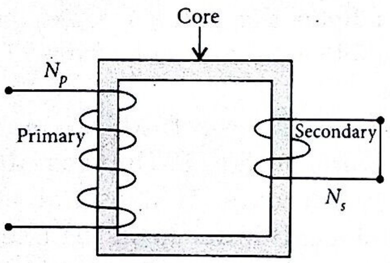
(c) 7 W (d) 8 W

Case IV : Read the passage given below and answer the following questions from 76 to 80.

Step-down Transformer in the Transmission of Electric Power

Step-down transformers are used to decrease or step-down voltages. These are used when voltages need to be lowered for use in homes and factories.

A small town with a demand of 800 kW of electric power at 220 V is situated 15 km away from an electric plant generating power at 440 V. The resistance of the two wire line carrying power is 0.5 Ω per km. The town gets power from the line through a 4000 - 220 V step-down transformer at a sub-station in the town.



76. The value of total resistance of the wires is

(a) 25 Ω (b) 30 Ω

(c) 35 Ω (d) 15 Ω

77. The line power loss in the form of heat is

(a) 550 kW (b) 650 kW

(c) 600 kW (d) 700 kW

78. How much power must the plant supply, assuming there is negligible power loss due to leakage?

(a) 600 kW (b) 1600 kW

(c) 500 W (d) 1400 kW

79. The voltage drop in the power line is

(a) 1700 V (b) 3000 V

(c) 2000 V (d) 2800 V

80. The total value of voltage transmitted from the plant is

(a) 500 V (b) 4000 V

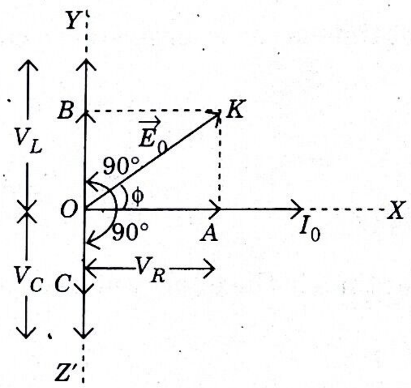
(c) 3000 V (d) 7000 V

Case V : Read the passage given below and answer the following questions from 81 to 85.

LCR Circuit

When a pure resistance R, pure inductor L and an ideal capacitor of capacitance C is connected in series to a source of alternating e.m.f., then current at any instant through the three elements has the same amplitude and is represented as $I = I_0 \sin\omega t$. However, voltage across each element has a different phase relationship with the current as shown in graph.

The effective resistance of RLC circuit is called impedance (Z) of the circuit and the voltage leads the current by a phase angle ϕ.



A resistor of 12 Ω, a capacitor of reactance 14 Ω and a pure inductor of inductance 0.1 H are joined in series and placed across 200 V, 50 Hz a.c. supply.

81. The value of inductive reactance is

(a) 15 Ω (b) 31.4 Ω

(c) 20 Ω (d) 30 Ω

82. The value of impedance is

(a) 20 Ω (b) 15 Ω

(c) 30 Ω (d) 21.13 Ω

83. What is the value of current in the circuit?

(a) 5 A (b) 15 A

(c) 10 A (d) 9.46 A

84. What is the value of the phase angle between current and voltage?

(a) 53°9′ (b) 63°9′

(c) 55°4′ (d) 50°

85. From graph, which one is true from following?

(a) $V_L \geq V_C$ (b) $V_L < V_C$

(c) $V_L > V_C$ (d) $V_L = V_C$

Assertion & Reasoning Based MCQs

For question numbers 86-100, two statements are given-one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.

(a) *Both A and R are true and R is the correct explanation of A*

(b) *Both A and R are true but R is NOT the correct explanation of A*

(c) *A is true but R is false*

(d) *A is false and R is also false*

86. **Assertion (A) :** Long distance transmission of A.C. is carried out at extremely high voltage.

Reason (R) : For large distance, voltage has to be large.

87. **Assertion (A) :** An electric lamp connected in series with a variable capacitor and A.C. source, its brightness increases with increase in capacitance.

Reason (R) : Capacitive reactance decreases with increase in capacitance of capacitor.

88. **Assertion (A) :** A transformer cannot work on D.C. supply.

Reason (R) : D.C. changes neither in magnitude nor in direction.

89. **Assertion (A) :** Step-down transformer increases the current.

Reason (R) : Transformer obeys the law of conservation of energy.

90. **Assertion (A) :** Soft iron is used as a core of transformer.

Reason (R) : Area of hysteresis loop for soft iron is small.

91. **Assertion (A) :** The core of transformer is made laminated in order to increase the eddy currents.

Reason (R) : The sensitivity of transformer increases with increase in the eddy currents.

92. **Assertion (A) :** The alternating current lags behind the e.m.f. by a phase angle of $\pi/2$, when A.C. flows through an inductor.

Reason (R) : The inductive reactance increases as the frequency of A.C. source decreases.

93. **Assertion (A) :** Capacitor serves as a block for D.C. and offers an easy path to A.C.

Reason (R) : Capacitive reactance is inversely proportional to frequency.

94. **Assertion (A) :** When capacitive reactance is smaller than the inductive reactance in *LCR* series circuit, e.m.f. leads the current.

Reason (R) : The phase angle is the angle between the alternating e.m.f. and alternating current of the circuit.

95. **Assertion (A) :** At resonance, *LCR* series circuit have a maximum current.

Reason (R) : At resonance, in *LCR* series circuit, the current and e.m.f are in phase with each other.

96. **Assertion (A) :** A bulb connected in series with a solenoid is connected to A.C. source. If a soft iron core is introduced in the solenoid, the bulb will glow brighter.

Reason (R) : On introducing soft iron core in the solenoid, the inductance decreases.

97. **Assertion (A) :** An electric heater is heated first by direct and then by alternating currents. For both the currents, the potential difference across the ends of the heater is the same. The rate of production of heat will be different in two cases.

Reason (R) : The resistance of a coil in alternating current will be more than the resistance of a coil in direct current, hence heat produced in case of direct current will be low.

98. **Assertion (A) :** An alternating current shows magnetic effect.

Reason (R) : Magnitude of alternating current varies with time.

99. **Assertion (A) :** We use a thick wire in the secondary coil of a step down transformer to reduce the production of heat.

Reason (R) : When the plane of the armature is parallel to the line of force of magnetic field, the magnitude of induced e.m.f. is maximum.

100. **Assertion (A) :** An inductance and a resistance are connected in series with an A.C. circuit. In this circuit the current and the potential difference across the resistance lags behind potential difference across the inductance by an angle $\pi/2$.

Reason (R) : In *L-R* circuit voltage leads the current by phase angle which depends on the value of inductance and resistance both.

ANSWERS

1. (c) : Here, $P = 100$ W, $V_{rms} = 220$ V
Resistance of the bulb is

$$R = \frac{V^2_{rms}}{P} = \frac{(220)^2}{100} = 484\ \Omega$$

2. (c) : Compare $V = 150\sin(150t)$ with $V = V_0\sin\omega t$, we get

$V_0 = 150$ V

Compare $I = 150\sin\left(150t + \frac{\pi}{3}\right)$ with

$I = I_0\sin(\omega t + \phi)$, we get $I_0 = 150$ A

Apparent power,

$$P = V_{rms}I_{rms} = \frac{1}{2}V_0I_0 = \frac{1}{2}\times 150\times 150$$

$= 11250$ W

3. (b) : In an inductor voltage leads the current by $\frac{\pi}{2}$ or current lags the voltage by $\frac{\pi}{2}$.

4. (c) : Here, $L = 30$ mH $= 30\times 10^{-3}$ H
$V_{rms} = 220$ V, $\upsilon = 100$ Hz
Inductive reactance,
$X_L = 2\pi\upsilon L$
$= 2\times 3.14\times 100\times 30\times 10^{-3} = 18.85\ \Omega$

5. (a) : As $\omega^2 = \frac{1}{LC}$ or $\omega = \frac{1}{\sqrt{LC}}$

Maximum energy stored in capacitor $= \frac{1}{2}\frac{Q_0^2}{C}$

Let at any instant t, the energy be stored equally between electric and magnetic field. Then energy stored in electric field at instant t is

$$\frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}\left[\frac{1}{2}\frac{Q_0^2}{C}\right]$$

or $Q^2 = \frac{Q_0^2}{2}$ or $Q = \frac{Q_0}{\sqrt{2}}$ or $Q_0\cos\omega t = \frac{Q_0}{\sqrt{2}}$

or $\omega t = \frac{\pi}{4}$ or $t = \frac{\pi}{4\omega} = \frac{\pi}{4\times(1/\sqrt{LC})} = \frac{\pi\sqrt{LC}}{4}$

6. (d) : Impedance of the circuit,

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

At resonance, $X_L = X_C$
$\therefore\ Z = R$

$$\therefore\ I_m = \frac{V_m}{Z} = \frac{V_m}{R}.$$

7. (c) : In the pure resistive circuit current and voltage both are in phase. Hence graph (c) is correct.

8. (a)

9. (d) : Here, $R = 0.2$ kΩ $= 200\ \Omega$
$C = 15\ \mu$F $= 15\times 10^{-6}$ F
$V_{rms} = 220$ V, $\upsilon = 50$ Hz

Capacitive reactance, $X_C = \frac{1}{2\pi\upsilon C}$

$$= \frac{1}{2\times 3.14\times 50\times 15\times 10^{-6}} = 212\ \Omega$$

The impedance of the RC circuit is
$Z = \sqrt{R^2 + X_C^2}$

$$= \sqrt{(200)^2 + (212)^2} = 291.5\ \Omega$$

10. (a) : Here, $R = 6\ \Omega$, $L = 25$ mH $= 25\times 10^{-3}$ H,
$C = 750\ \mu$F $= 750\times 10^{-6}$ F, $\upsilon = 50$ Hz

$X_L = 2\pi\upsilon L = 2\times 3.14\times 50\times 25\times 10^{-3} = 7.85\ \Omega$

$$X_C = \frac{1}{2\pi\upsilon C} = \frac{1}{2\times 3.14\times 50\times 750\times 10^{-6}} = 4.25\ \Omega$$

$\therefore\ X_L - X_C = 7.85 - 4.25 = 3.6\ \Omega$

Impedence of the series LCR circuit is

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$\therefore\ Z = \sqrt{(6)^2 + (3.6)^2} = \sqrt{36 + 12.96} = 7.0\ \Omega$$

11. (b) : As the rod is inserted, inductance increases and hence the voltage across inductor increases. This causes a drop in the voltage across the bulb and hence it gets dimmer.

12. (d) : Here, $L = 30$ mH $= 30\times 10^{-3}$ H, $R = 8\ \Omega$, $\upsilon_r = 50$ Hz
As $\omega_r = 2\pi\upsilon_r = 2\times 3.14\times 50 = 314$ Hz

$\therefore$ Quality factor, $Q = \frac{\omega_r L}{R} = \frac{314\times 30\times 10^{-3}}{8} = 1.18$

13. (b) : The equation of alternating voltage is
$V(t) = V_m\sin\omega t$

14. (b) : Inductive reactance, $X_L = \omega L = 2\pi\upsilon L$
$\Rightarrow X_L \propto \upsilon$
Hence, inductive reactance increases linearly with frequency.

15. (c) : Here, $L = 44$ mH $= 44\times 10^{-3}$ H
$V_{rms} = 220$ V, $\upsilon = 50$ Hz
The inductive reactance is
$X_L = \omega L = 2\pi\upsilon L = 2\times 3.14\times 50\times 44\times 10^{-3} = 13.82\ \Omega$

$$\therefore\ I_{rms} = \frac{V_{rms}}{X_L} = \frac{220}{13.82} = 15.9\ \text{A}$$

16. (a) : Here, $V_s = 24$ V, $P_s = 12$ W

$$I_s = \frac{P_s}{V_s} = \frac{12}{24} = 0.5\ \text{A}$$

$$I_m = \sqrt{2}\,I_s = \sqrt{2}\times 0.5 = \frac{1}{\sqrt{2}}\ \text{A}$$

17. (c) : For better tuning of an LCR circuit used for communication the circuit should possess high quality factor of resonance.

i.e., $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$ should be high.

For it R should be low, L should be high and C should be low, therefore combination in option (c) is correct.

18. (b) : Here, $C = 30\ \mu F = 30 \times 10^{-6}$ F

$V_{rms} = 150$ V, $\upsilon = 60$ Hz

Capacitive reactance

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi\upsilon C} = \frac{1}{2\times3.14\times60\times30\times10^{-6}} = 88.46\ \Omega$$

$$I_{rms} = \frac{V_{rms}}{X_C} = \frac{150}{88.46} = 1.7\ \text{A}$$

19. (b) : Here, $I_{rms} = 25$ A

$\therefore\ I_m = \sqrt{2}\,I_{rms} = \sqrt{2}\times 25 = 35.36$ A.

20. (a) : Here, $L = 2$ H, $C = 32\ \mu F = 32 \times 10^{-6}$ F

$R = 10\ \Omega$

$$\therefore\ \omega_r = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2\times32\times10^{-6}}}$$

$$= \frac{10^3}{\sqrt{64}} = \frac{10^3}{8} = 125\ \text{rad s}^{-1}$$

$$\upsilon_r = \frac{\omega_r}{2\pi} = \frac{125}{2\times3.14} = 20\ \text{Hz}$$

21. (c) : Here, $C = 60\ \mu F = 60 \times 10^{-6}$ F

$V_{rms} = 110$ V, $\upsilon = 60$ Hz

$$\therefore\ I_{rms} = \frac{V_{rms}}{X_C} = \frac{V_{rms}}{1/2\pi\upsilon C}$$

$$= 2\pi\upsilon C\,V_{rms}$$

$$= 2 \times 3.14 \times 60 \times 60 \times 10^{-6} \times 110 = 2.49\ \text{A}$$

22. (c) : The voltmeter connected to ac mains is calibrated to read root mean square value or virtual value of ac voltage.

23. (a)

24. (b) : When the frequency of the supply equals to the natural frequency of circuit, resonance occurs.

$\therefore\ Z = R = 22\ \Omega$

and $I_{rms} = \frac{V_{rms}}{Z} = \frac{220}{22} = 10$ A

Average power transferred per cycle,

$$P = V_{rms}\,I_{rms}\,\frac{R}{Z} = 220 \times 10 \times 1 = 2200\ \text{W}$$

25. (c) : Reactance of a capacitor, $X_C = \frac{1}{\omega C} = \frac{1}{2\pi\upsilon C}$

As frequency increases, X_C decreases and therefore current increases. As R does not vary with frequency, therefore, likely elements constituting the circuit may be capacitor and resistor.

26. (d) : When an ac voltage of 220 V is applied to a capacitor C, the charge on the plates is in phase with the applied voltage.

As the circuit is pure capacitive so, the current developed leads the applied voltage by a phase angle of 90°.

27. (a) : The LC parallel resonant circuit has a very high impedance, hence a very low current.

28. (d)

29. (c) : A transformer does not change the frequency of ac.

30. (c) : Capacitive reactance, $X_C = \frac{1}{\omega C} = \frac{1}{2\pi\upsilon C}$

$\Rightarrow\ X_C \propto \frac{1}{\upsilon}$

With increase in frequency, X_C decreases.

Hence, option (c) represents the correct graph.

31. (a) : Iron loss is the energy loss in the form of heat due to the formation of eddy currents in the iron core of the transformer.

32. (c) : For maximum power to be delivered from the generator to the load, the total reactance must vanish.

i.e., $X_L + X_g = 0$ or $X_L = -X_g$

33. (c) : Here, $X_L = 1\ \Omega$, $R = 2\ \Omega$, $V_{rms} = 6$ V

Impedance of the circuit

$$Z = \sqrt{X_L^2 + R^2} = \sqrt{(1)^2 + (2)^2} = \sqrt{5}\ \Omega$$

$$I_{rms} = \frac{V_{rms}}{Z} = \frac{6}{\sqrt{5}}\ \text{A}$$

Average power, $P = V_{rms}\,I_{rms}\,\frac{R}{Z}$

$$= 6 \times \frac{6}{\sqrt{5}} \times \frac{2}{\sqrt{5}} = \frac{72}{5} = 14.4\ \text{W}$$

34. (a) : Here, $C = 30\ \mu F = 30 \times 10^{-6}$ F

$L = 27$ mH $= 27 \times 10^{-3}$ H

$$\therefore\ \omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{27\times10^{-3}\times30\times10^{-6}}} = \frac{1}{\sqrt{81\times10^{-8}}}$$

$$= \frac{10^4}{9} = 1.1\times10^3\ \text{rad s}^{-1}$$

35. (c) : Here, $L = 2$ H, $C = 32\ \mu F = 32 \times 10^{-6}$ F,

$R = 10\ \Omega$

$\therefore$ Resonance frequency, $\omega_r = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{2\times32\times10^{-6}}}$

$$= \frac{10^3}{8}\ \text{rad s}^{-1}$$

Quality factor $= \frac{\omega_r L}{R} = \frac{10^3\times2}{8\times10} = 25$

36. (a) : In the given circuit, two capacitors are in series and so are the two inductors. So, their equivalent capacitance and inductance are

$$\frac{1}{C_s} = \frac{1}{C} + \frac{1}{C} = \frac{2}{C}\ \text{or}\ C_s = \frac{C}{2}\ \text{and}\ L_s = L + L = 2L$$

$\therefore$ The natural frequency of the circuit is

$$\upsilon = \frac{1}{2\pi\sqrt{L_s C_s}} = \frac{1}{2\pi\sqrt{(2L)\left(\frac{C}{2}\right)}} = \frac{1}{2\pi\sqrt{LC}}$$

37. (a) : $\tan\phi = \left(\frac{X_L}{R}\right)$

$X_L = \omega L = (2\pi\upsilon L) = (2\pi)(50)(0.01) = \pi\ \Omega$

Also, $R = 1\ \Omega$

$\therefore\quad \phi = \tan^{-1}(\pi)$

38. (a) : Figure given in the question shows that current I leads the voltage V by a phase angle $\pi/4$. Therefore, the circuit can be RC circuit alone.

$$\tan\phi = \frac{X_C}{R} = \frac{1}{\omega CR} \qquad \left(\because X_C = \frac{1}{\omega C}\right)$$

$$\tan\frac{\pi}{4} = \frac{1}{\omega CR}$$

$$1 = \frac{1}{\omega CR} \qquad \text{...(i)}$$

From $V = V_0 \sin 100t$, we get

$\omega = 100$ rad s^{-1}

$$\therefore\ CR = \frac{1}{\omega} = \frac{1}{100} \qquad \text{(Using (i))}$$

When $R = 1$ k$\Omega = 10^3\ \Omega$

$$C = \frac{1}{10^5} = 10^{-5}\ \text{F} = 10\ \mu\text{F}$$

39. (d) : Here, $L = 1$ H, $C = 20\ \mu$F $= 20 \times 10^{-6}$ F

$R = 300\ \Omega,\ \upsilon = \frac{50}{\pi}$ Hz

The inductive reactance is

$$X_L = 2\pi\upsilon L = 2 \times \pi \times \frac{50}{\pi} \times 1 = 100\ \Omega$$

The capacitive reactance is

$$X_C = \frac{1}{2\pi\upsilon C} = \frac{1}{2 \times \pi \times \frac{50}{\pi} \times 20 \times 10^{-6}} = 500\ \Omega$$

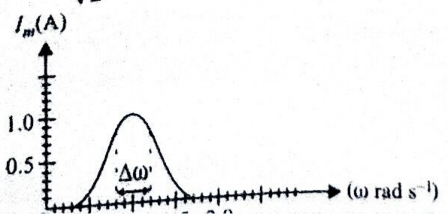
The impedance of the series LCR circuit is

$$Z = \sqrt{R^2 + (X_C - X_L)^2}$$

$$= \sqrt{(300)^2 + (500 - 100)^2}$$

$$= \sqrt{(300)^2 + (400)^2} = 500\ \Omega$$

40. (d) : Bandwidth is the frequency range at which current amplitude $I_m = \frac{1}{\sqrt{2}} I_{max} = 0.7 I_{max}$.



From figure,

Band width $\Delta\omega = 1.2 - 0.8 = 0.4$ rad s^{-1}

41. (d) : As the line has some resistance ($R \neq 0$), voltage and current differ in phase ϕ such that $|\phi| < \frac{\pi}{2}$.

42. (c) : Here, $I_{rms} = 10$ A, $R = 12\ \Omega$

The maximum current $I_m = \sqrt{2} I_{rms} = \sqrt{2}(10) = 10\sqrt{2}$ A

Maximum potential difference is $V_m = I_m R$

$= 10\sqrt{2} \times 12 = 169.68$ V

43. (c) : Here, $V_{rms} = 200$ V

$X_L = 50\ \Omega$, $X_C = 50\ \Omega$, $R = 25\ \Omega$

Impedance of the circuit,

$$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{25^2 + (50 - 50)^2} = 25\ \Omega$$

Current in the circuit,

$$I_{rms} = \frac{V_{rms}}{Z} = \frac{200\ \text{V}}{25\ \Omega} = 8\ \text{A}$$

Voltage drop across the inductor is

$V_L = I_{rms} X_L = 8$ A $\times$ 50 Ω = 400 V

44. (d) : Here, $C = 100\ \mu$F $= 100 \times 10^{-6}$ F $= 10^{-4}$ F, $R = 40\ \Omega$,

$V_{rms} = 100$ V, $\upsilon = 60$ Hz

$\therefore\quad V_0 = \sqrt{2}\, V_{rms} = 100\sqrt{2}$ V

In series RC circuit,

$$Z = \sqrt{R^2 + X_C^2} = \sqrt{R^2 + \frac{1}{\omega^2 C^2}}$$

$$= \frac{1}{\sqrt{R^2 + \frac{1}{4\pi^2\upsilon^2 C^2}}} \qquad [\because \omega = 2\pi\upsilon]$$

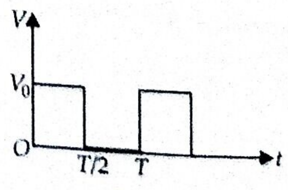
Maximum current in the circuit,

$$I_0 = \frac{V_0}{Z} = \frac{V_0}{\sqrt{R^2 + \frac{1}{4\pi^2\upsilon^2 C^2}}}$$

$$= \frac{100\sqrt{2}}{\sqrt{(40)^2 + \frac{1}{4 \times (3.14)^2 \times (60)^2 \times (10^{-4})^2}}}$$

$$= \frac{100\sqrt{2}}{48} = 2.95\ \text{A}$$

45. (c) :



$V = V_0$ for $0 \le t \le \frac{T}{2}$

$V = 0$ for $\frac{T}{2} \le t \le T$

$$V_{rms} = \left[\frac{\int_0^T V^2\,dt}{\int_0^T dt}\right]^{1/2} = \left[\frac{\int_0^{T/2} V_0^2\,dt + \int_{T/2}^{T}(0)\,dt}{\int_0^T dt}\right]^{1/2}$$

$$= \left[\frac{V_0^2}{T}[t]_0^{T/2}\right]^{1/2} = \left[\frac{V_0^2}{T}\left(\frac{T}{2}\right)\right]^{1/2} = \left[\frac{V_0^2}{2}\right]^{1/2}$$

$$V_{rms} = \frac{V_0}{\sqrt{2}}$$

46. (c) : Here, $V_L = V_C = 100$ V, $V = 200$ V

As $V = \sqrt{V_R^2 + (V_L - V_C)^2}$

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

or $V_R = 200$ V

47. (c) : Output power = 140 W
Input power = 240 × 0.7 = 168 W

$$\text{Efficiency} = \frac{\text{output power}}{\text{input power}} \times 100 = \frac{140}{168} \times 100 = 83.3\%$$

48. (a) : The 220 V, ac line voltage that we receive in our homes is an rms value.

49. (c) : Given, $I = 20\sin(100\pi t + 0.05\pi)$ A
Comparing with standard equation, we get
$I_0 = 20$ A and $\omega = 100\pi$ rad s^{-1}

$$\therefore\ I_{rms} = \frac{I_0}{\sqrt{2}} = \frac{20}{\sqrt{2}} = 10\sqrt{2}\text{ A}$$

Now $\omega = 100\pi$, $2\pi\upsilon = 100\pi$, $\upsilon = 50$ Hz

50. (a) : Here, $R = 280\ \Omega$, $V_{rms} = 200$ V

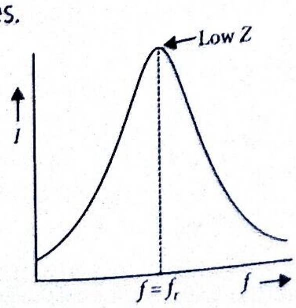
Peak voltage, $V_0 = V_{rms}\sqrt{2} = 200\sqrt{2}$

$$\text{Peak current, } I_0 = \frac{V_0}{R} = \frac{200\sqrt{2}\text{ V}}{280\ \Omega} \approx 1\text{ A}$$

51. (c) : $X_C = \dfrac{1}{\omega C} = \dfrac{1}{(2\pi\upsilon)C}$

$$\therefore\ \frac{X_{C_2}}{X_{C_1}} = \frac{\upsilon_1 C_1}{\upsilon_2 C_2} = \frac{1}{2}\cdot\frac{1}{2} = \frac{1}{4}\quad \therefore\ 2X_{C_2} = \frac{X_{C_1}}{4} = \frac{X}{4}$$

52. (c) : From the graph, we concluded that with the increase in frequency, the current increases, attains a maximum value ($f = f_r$) and then decreases. It implies that the impedance first decreases, becomes minimum for maximum value of current and then increases.



53. (d) : At resonance, voltage across inductor = voltage across capacitor *i.e.*, $V_L = V_C$.

54. (a) : The impedance of the LCR circuit will be minimum for a resonant frequency υ_r.

$$\upsilon_r = \frac{1}{2\pi\sqrt{LC}}$$

Here, $L = 1$ mH $= 1 \times 10^{-3}$ H, $C = 0.1\ \mu$F $= 0.1 \times 10^{-6}$ F

$$\therefore\ \upsilon_r = \frac{1}{2\pi\sqrt{(1\times10^{-3}\text{ H})(0.1\times10^{-6}\text{ F})}} = \frac{10^5}{2\pi}\text{ Hz}$$

55. (c) : $V_{RC} = \sqrt{V_R^2 + V_C^2}\quad \therefore\ 50 = \sqrt{40^2 + V_C^2}$

$50^2 = 40^2 + V_C^2 \Rightarrow V_C^2 = 50^2 - 40^2 = 900$

$\therefore\ V_C = 30$ V

56. (b)

57. (a)

58. (c) : Here, $C = 30\ \mu$F $= 30 \times 10^{-6}$ F,
$L = 27$ mH $= 27 \times 10^{-3}$ H

$$\text{The angular frequency, } \omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{27\times10^{-3}\times30\times10^{-6}}}$$

$$= \frac{1}{9\times10^{-4}} = 1.1\times10^3\text{ rad s}^{-1}$$

59. (b): $f = \dfrac{1}{2\pi}\sqrt{\dfrac{1}{LC}} = 25\times10^3$ Hz

60. (d) : At parallel resonance, L and C are connected in parallel combination and current is minimum.

61. (d) : Energy, $E = \dfrac{1}{2}\dfrac{Q^2}{C} = \dfrac{(10\times10^{-3})^2}{2\times50\times10^{-6}} = 1$ J

62. (a) : Frequency, $\upsilon = \dfrac{1}{2\pi\sqrt{LC}}$

$$= \frac{1}{2\pi\sqrt{20\times10^{-3}\times50\times10^{-6}}} = \frac{10^3}{2\pi} = 159.24\text{ Hz}$$

63. (d) : Total time period, $T = \dfrac{1}{\upsilon} = \dfrac{1}{159.24} = 6.28$ ms

Total charge on capacitor at time t, $Q' = Q\cos\dfrac{2\pi}{T}t$

For energy stored is electrical, we can write $Q' = \pm Q$.
Hence, energy stored in the capacitor is completely electrical at, $t = 0, \dfrac{T}{2}, T, \dfrac{3T}{2}, \ldots..$

64. (d) : Magnetic energy is maximum when electrical energy is equal to zero.

Hence $t = \dfrac{T}{4}, \dfrac{3T}{4}, \dfrac{5T}{4}, \ldots\ldots.$

65. (a) : $X_L = \omega L = 2\pi\upsilon L = 2 \times 3.14 \times 159.24 \times 20 \times 10^{-3}$

$\Rightarrow X_L = 20\ \Omega$

66. (c) : Inductive reactance,
$X_L = \omega L = 2\pi\upsilon L = 2\pi \times 100 \times 14 \times 10^{-3}$
$X_L = 8.8\ \Omega$

67. (b)

68. (b) : In an inductor voltage leads the current by $\frac{\pi}{2}$ or current lags the voltage by $\frac{\pi}{2}$.

69. (b) : The current in the inductor coil is given by

$$I_0 = \frac{E_0}{X_L} = \frac{\sqrt{2}E_v}{2\pi\upsilon L}$$

$$L = \frac{\sqrt{2}E_v}{2\pi\upsilon I_0} = \frac{1.414 \times 200}{2 \times 3.14 \times 50 \times 0.9} = 1\ \text{H}$$

70. (a) : Inductive reactance,
$X_L = \omega L = 2\pi\upsilon L = 2 \times 3.14 \times 50 \times 2 = 628\ \Omega$

$$I_0 = \frac{E_0}{X_L} \Rightarrow I_0 = \frac{\sqrt{2} \times E_v}{X_L} = \frac{\sqrt{2} \times 150}{628} = 0.337\ \text{A}$$

71. (c) : As $\frac{E_s}{E_p} = \frac{n_s}{n_p} \Rightarrow E_s = E_p \cdot \frac{n_s}{n_p}$

$$= \frac{120 \times 50}{2000} = 3\ \text{V}$$

72. (d) : $I_s = \frac{E_s}{R} \Rightarrow I_s = \frac{3}{0.6} = 5\ \text{A}$

73. (a) : As $\frac{I_p}{I_s} = \frac{E_s}{E_p}$

$$\Rightarrow I_p = \frac{E_s}{E_p} \times I_s = \frac{3}{120} \times 5 = 0.125\ \text{A}$$

74. (d) : Power in primary, $P_p = E_p \times I_p = 120 \times 0.125$
$= 15\ \text{W}$

75. (a) : Power in secondary coil, $P_s = E_s \times I_s = 3 \times 5$
$= 15\ \text{W}$

76. (d) : Resistance of the two wire lines carrying power = 0.5 Ω/km
Total resistance = (15 + 15)0.5 = 15 Ω

77. (c) : Line power loss = I^2R
RMS current in the coil,

$$I = \frac{P}{V_1} = \frac{800 \times 10^3}{4000} = 200\ \text{A}$$

∴ Power loss = $(200)^2 \times 15 = 600$ kW

78. (d) : Assuming that the power loss is negligible due to the leakage of the current.
The total power supplied by the plant
= 800 kW + 600 kW = 1400 kW

79. (b) : Voltage drop in the power line = IR
= 200 × 15 = 3000 V

80. (d) : Total voltage transmitted from the plant
= 3000 V + 4000 V = 7000 V

81. (b) : Given : $R = 12\ \Omega$, $X_C = 14\ \Omega$, $L = 0.1$ H
$X_L = \omega L = 2\pi\upsilon L = 2 \times 3.14 \times 50 \times 0.1 = 31.4\ \Omega$

82. (d) : Impedance, $Z = \sqrt{R^2 + (X_L - X_C)^2}$

$$= \sqrt{(12)^2 + (31.4 - 14)^2} = 21.13\ \Omega$$

83. (d) : $I_v = \frac{E_v}{Z} = \frac{200\ \text{V}}{21.13} = 9.46\ \text{A}$

84. (c) : $\tan\phi = \frac{X_L - X_C}{R} = \frac{31.4 - 14}{12} = 1.45$

$\phi = \tan^{-1}(1.45) = 55°4'$

85. (c)

86. (c) : The transmission is done at high voltage due to which current through the wire is reduced. By reduction in current corresponding dissipation of energy is also reduced (as $H \propto I^2R$). If transmission is done at low voltage then we have to use thick wire in order to reduce the dissipation of energy. This increase the cost of transmission lines wires. In order to reduce both energy dissipation and cost of transmission wire, transmission is done at high voltage by using step-up transformers.

87. (a) : Capacitive reactance $X_C = \frac{1}{\omega C}$. When capacitance C increases, the capacitive reactance decreases. Due to decrease in its values, the current in the circuit will increase $\left(I = \frac{E}{\sqrt{R^2 + X_C^2}}\right)$ and hence brightness of source (or electric lamp) will also increases.

88. (a) : Transformer works on the principle of mutual induction *i.e.*, if two coils are inductively coupled and when current or magnetic flux is changed through one of the two coils, then induced e.m.f. is produced in the other coil. So whenever there is change in current or magnetic flux, only then e.m.f. is induced. But in case of D.C. current or voltage, e.m.f. is not induced because it remain constant throughout and never changes its direction and magnitude. Therefore transformer cannot work when D.C. is applied.

89. (b) : If there is no loss of energy in transformer, then instantaneous output power is equal to instantaneous input power. From this we get $\frac{e_s}{e_p} = \frac{I_p}{I_s}$.

So in step up transformer voltage increases by decreasing the current. Similarly, step-down transformer decreases the voltage by increasing current. Therefore transformer simply transforms the voltage and current, obeying the law of conservation of energy.

90. (a) : The alternating current flowing through the coils, magnetises and demagnetises the iron core again and again over complete cycles. During each cycle of magnetisation, some energy is lost due to hysteresis, the energy lost during a cycle of magnetisation being equal to area of hysteresis loop (in magnitude). Energy loss can be reduce by selecting the material core, which has narrow hysteresis loop, that is why soft iron core is used.

91. (d) : Eddy current is produced in the iron core due to induced e.m.f. Since resistance of the iron core is quite small, the magnitude of eddy currents is quite large. As a result, large amount of heat is produced. To avoid it, a laminated core is used in a transformer. In laminated core iron stripes are quite thin and each strip possesses very large resistance, the magnitude of eddy currents produced is quite small and hence only a small amount of heat is produced.

92. (c) : When pure inductor is connected to source of an alternating emf, then instantaneous value of alternating emf is given by $E = E_0 \sin\omega t$, and corresponding alternating current is given by $I = I_0 \sin(\omega t - \pi/2)$. From these two equations, it follows that alternating current lags behind e.m.f. by a phase angle of $\pi/2$. The inductive reactance,

$X_L = \omega L = 2\pi f L$, so when frequency increases correspondingly inductive reactance also increases.

93. (a) : The capacitive reactance of capacitor is given by

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}.$$

So this is infinite for D.C. ($f = 0$) and has a finite value for ...refore a capacitor blocks D.C. and offers an easy pa... .C.

94. (b) ...he phase angle for the LCR series circuit is given by $\tan\theta = \frac{X_L - X_C}{R} = \frac{\omega L - 1/\omega C}{R}$

where X_L, X_C are inductive reactance a... ...e reactance respectively. When $X_L > X_C$ then ta... *i.e.* θ is positive (between 0 and $\pi/2$). Hence em... ...s the current.

95. (b) : At resonance $X_L = X_C$ or $\omega L = \frac{1}{\omega C}$. Because of this impedance of LCR series circuit become equal to resistance of circuit $\left(Z = \sqrt{R^2 + (X_L - X_C)^2}\right)$. Therefore from $I = \frac{E}{Z} = \frac{E}{R}$, at resonance, current in LCR series circuit is maximum. Correspondingly phase angle is also equal to zero. Therefore emf and current are in phase in LCR series circuit.

96. (d) : On introducing soft iron core, the bulb will glow dimmer. This is because on introducing soft iron core in the solenoid, its inductance L increases, the inductive reactance, $X_L = \omega L$ increases and hence the current through the bulb decreases.

97. (a) : The element of the heater is in the form of a coil so that it has inductance L also besides the resistance R. So, for the alternating current, the effective resistance of the heater would be $\sqrt{R^2 + (\omega L)^2}$ which is larger than the resistance R for the direct current. Hence on heating by alternating current, heat produced per second would be less.
($H = V^2/R$ and V is same in both the cases).

98. (b) : Like direct current, an alternating current also produces magnetic field. But the magnitude and direction of the field goes on changing continuously with time.

99. (b) : A step-down transformer converts electrical energy from a high voltage to one at a low voltage. Accordingly the current in the secondary will be larger than that in the primary. In order to produce less heat in the secondary, we use a wire of lesser resistance i.e. thick wire. We also know that when the plane of the armature is parallel to the lines of force of magnetic field, the rate of change of magnetic flux linked with it is maximum. Therefore the e.m.f. induced in the armature in this orientation is maximum.

100.(b) : As both the inductance and resistance are joined in series, hence current through both will be same. But in case of resistance, both the current and potential vary simultaneously, hence they are in same phase. While in case of an inductance when current is zero, potential difference across it is maximum and when current reaches maximum (at $\omega t = \pi/2$), potential difference across it becomes zero *i.e.*, potential difference leads the current by $\pi/2$ or current lags behind the potential difference by $\pi/2$. Phase angle in case of LR circuit is given as $\phi = \tan^{-1}\left(\frac{\omega L}{R}\right)$.

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