ALTERNATING CURRENT

FACT/DEFINITION TYPE QUESTIONS

1. In general in an alternating current circuit
(a) the average value of current is zero
(b) the average value of square of the current is zero
(c) average power dissipation is zero
(d) the phase difference between voltage and current is zero

2. The frequency of A.C. mains in India is
(a) 30 c/s (b) 50 c/s
(c) 60 c/s (d) 120 c/s

3. A.C. power is transmitted from a power house at a high voltage as
(a) the rate of transmission is faster at high voltages
(b) it is more economical due to less power loss
(c) power cannot be transmitted at low voltages
(d) a precaution against theft of transmission lines

4. The electric mains supply in our homes and offices is a voltage that varies like a *sine* function with time such a voltage is called ... *A*... and the current driven by it in a circuit is called the ... *B*... Here, *A* and *B* refer to
(a) DC voltage, AC current
(b) AC voltage, DC current
(c) AC voltage, DC voltage
(d) AC voltage, AC current

5. Alternating currents can be produced by a
(a) dynamo (b) choke coil
(c) transformer (d) electric motor

6. The alternating current of equivalent value of $\frac{I_0}{\sqrt{2}}$ is
(a) peak current (b) r.m.s. current
(c) D.C. current (d) all of these

7. The alternating e.m.f. of $e = e_0 \sin \omega t$ is applied across capacitor C. The current through the circuit is given by
(a) $I = I_0 \sin \omega t$ (b) $I = I_0 \sin\left(\omega t + \frac{\pi}{2}\right)$
(c) $I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$ (d) $I = I_0 \sin(\omega t - \pi)$

8. The peak value of the a.c. current flowing throw a resistor is given by
(a) $I_0 = e_0/R$ (b) $I = e/R$
(c) $I_0 = e_0$ (d) $I_0 = R/e_0$

9. The alternating current can be measured with the help of
(a) hot wire ammeter
(b) hot wire voltmeter
(c) moving magnet galvanometer
(d) suspended coil type galvanometer

10. Alternating current can not be measured by D.C. ammeter, because
(a) A. C. is virtual
(b) A. C. changes its direction
(c) A. C. can not pass through D.C. ammeter
(d) average value of A. C for complete cycle is zero

11. The heat produced in a given resistance in a given time by the sinusoidal current $I_0 \sin \omega t$ will be the same as that of a steady current of magnitude nearly
(a) $0.71\, I_0$ (b) $1.412\, I_0$
(c) I_0 (d) $\sqrt{I_0}$

12. In an a.c. circuit, the r.m.s. value of current, I_{rms} is related to the peak current, I_0 by the relation
(a) $I_{rms} = \sqrt{2}\, I_0$ (b) $I_{rms} = \pi I_0$
(c) $I_{rms} = \frac{1}{\pi} I_0$ (d) $I_{rms} = \frac{1}{\sqrt{2}} I_0$

13. The ratio of mean value over half cycle to r.m.s. value of A.C. is
(a) $2 : \pi$ (b) $2\sqrt{2} : \pi$
(c) $\sqrt{2} : \pi$ (d) $\sqrt{2} : 1$

14. An A.C. source is connected to a resistive circuit. Which of the following is true?
(a) Current leads ahead of voltage in phase
(b) Current lags behind voltage in phase
(c) Current and voltage are in same phase
(d) Any of the above may be true depending upon the value of resistance.

15. In which of the following circuits the maximum power dissipation is observed?
(a) Pure capacitive circuit (b) Pure inductive circuit
(c) Pure resistive circuit (d) None of these

16. With increase in frequency of an A.C. supply, the inductive reactance
(a) decreases
(b) increases directly with frequency
(c) increases as square of frequency
(d) decreases inversely with frequency

17. The average power dissipated in a pure inductance is
(a) $\frac{1}{2}LI^2$ (b) LI^2
(c) $LI^2/4$ (d) zero

18. If a current I given by $I = I_0 \sin(\omega t - \pi/2)$ flows in inductance in an A.C. circuit across which an A.C. potential $E = E_0 \sin \omega t$ has been applied, then power consumption P in the circuit will be
(a) $P = E_0 I_0/\sqrt{2}$ (b) $P = EI/\sqrt{2}$
(c) $P = E_0 I_0/2$ (d) zero

19. 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 $\frac{\pi}{4}$

20. If the frequency of an A.C. is made 4 times of its initial value, the inductive reactance will
(a) be 4 times (b) be 2 times
(c) be half (d) remain the same

21. An inductance L having a resistance R is connected to an alternating source of angular frequency ω. The Quality factor Q of inductance is
(a) $R/\omega L$ (b) $(\omega L/R)^2$
(c) $(R/\omega L)^{1/2}$ (d) $\omega L/R$

22. A capacitor acts as an infinite resistance for
(a) DC (b) AC
(c) DC as well as AC (d) neither AC nor DC

23. The capacitive reactance in an A.C. circuit is
(a) effective resistance due to capacity
(b) effective wattage
(c) effective voltage
(d) None of these

24. Of the following about capacitive reactance which is correct?
(a) The reactance of the capacitor is directly proportional to its ability to store charge
(b) Capacitive reactance is inversely proportional to the frequency of the current
(c) Capacitive reactance is measured in farad
(d) The reactance of a capacitor in an A.C. circuit is similar to the resistance of a capacitor in a D.C. circuit

25. Phase difference between voltage and current in a capacitor in an ac circuit is
(a) π (b) $\pi/2$
(c) 0 (d) $\pi/3$

26. A capacitor has capacitance C and reactance X, if capacitance and frequency become double, then reactance will be
(a) 4X (b) X/2
(c) X/4 (d) 2X

27. 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 votage.
(d) power delivered to the capacitor per cycle is zero.

28. In LCR circuit if resistance increases quality factor
(a) increases finitely (b) decreases finitely
(c) remains constant (d) None of these

29. An inductor, a resistor and a capacitor are joined in series with an AC source. As the frequency of the source is slightly increased from a very low value, the reactance of the
(a) inductor increases (b) resistor increases
(c) capacitor increases (d) circuit increases

30. With increase in frequency of an A.C. supply, the impedance of an L-C-R series circuit
(a) remains constant
(b) increases
(c) decreases
(d) decreases at first, becomes minimum and then increases.

31. If an LCR series circuit is connected to an ac source, then at resonance the voltage across
(a) R is zero
(b) R equals the applied voltage
(c) C is zero
(d) L equals the applied voltage

32. The current leads the voltage by an angle ϕ which is given by
(a) $\tan^{-1}\left(\frac{1}{\omega CR}\right)$ (b) $\tan^{-1}(\omega CR)$
(c) $\tan^{-1}\left(\frac{\omega C}{R}\right)$ (d) $\tan^{-1}\left(\frac{R}{\omega C}\right)$

33. In an L.C.R. series a.c. circuit, the current
(a) is always in phase with the voltage
(b) always lags the generator voltage
(c) always leads the generator voltage
(d) None of these

34. An LCR series circuit, connected to a source E, is at resonance. Then the voltage across
(a) R is zero (b) R equals applied voltage
(c) C is zero (d) L equals applied voltage

35. In a series resonant circuit, having L,C and R as its elements, the resonant current is i. The power dissipated in circuit at resonance is

(a) $\frac{i^2R}{(\omega L - 1/\omega C)}$ (b) zero

(c) $i^2 \omega L$ (d) $i^2 R$.

Whereas ω is angular resonant frequency

36. At resonance frequency the impedance in series *LCR* circuit is
(a) maximum (b) minimum
(c) zero (d) infinity

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

38. In tuning, we vary the capacitance of a capacitor in the tunning circuit such that the resonant frequency of the circuit becomes nearly equal to the frequency of the radio signal received. When this happens, the ...*A*... with the frequency of the signal of the particular radio station in the circuit is maximum. Here *A* refers to
(a) resonant frequency
(b) impedance
(c) amplitude of the current
(d) reactance

39. The power factor in a circuit connected to an A.C. The value of power factor is
(a) unity when the circuit contains an ideal inductance only
(b) unity when the circuit contains an ideal resistance only
(c) zero when the circuit contains an ideal resistance only
(d) unity when the circuit contains an ideal capacitance only

40. Current in a circuit is wattless if
(a) inductance in the circuit is zero
(b) resistance in the circuit is zero
(c) current is alternating
(d) resistance and inductance both are zero

41. Power factor is one for
(a) pure inductor
(b) pure capacitor
(c) pure resistor
(d) either an inductor or a capacitor.

42. The impedance of a LCR series circuit is

(a) $\sqrt{R^2 + (X_L - X_C)^2}$ (b) $\sqrt{R^2 + (X_L + X_C)^2}$

(c) $\sqrt{R + (X_L + X_C)^2}$ (d) $\sqrt{X_L - X_C + R}$

43. An A. C. of frequency f is flowing in a circuit containing a resistance R and capacitance C in series. The impedance of the circuit is equal to
(a) R + f (b) R + 2πfC

(c) $R + \frac{1}{2\pi fC}$ (d) $\sqrt{R^2 + X_C^2}$

44. Power factor of the A. C. circuit varies between
(a) 0 to 0.5 (b) 0.5 to 1
(c) 0 to 1 (d) 1 to 2

45. The graph between inductive reactance and frequency is
(a) parabola (b) straight line
(c) hyperbola (d) an arc of a circle

46. For minimum dissipation of energy in the circuit the power factor should be
(a) large (b) small
(c) moderate (d) can not say

47. The inductive reactance of an inductor of inductance L is

(a) $\frac{1}{2\pi fC}$ (b) $\frac{1}{2\pi fL}$

(c) 2πfC (d) 2πfL

48. The opposition offered by ohmic and non ohmic components is
(a) inductive reactance (b) capacitive reactance
(c) impedance (d) all of these

49. The average power dissipated in an A.C. circuit containing a resistance alone is
(a) $e_{rms} I_{rms}$ (b) $e_{rms} I_{rms} \cos\phi$
(d) 0 (d) none of these

50. The product $e_{rms} I_{rms}$ is called as
(a) true power (b) apparent power
(c) power factor (d) Q factor

51. Power in an A.C. circuit is rated per second at which
(a) charge flows (b) work is done
(c) energy is spent (d) current alternates

52. In an a.c. circuit with phase voltage V and current I, the power dissipated is

(a) $\frac{VI}{2}$ (b) $\frac{VI}{\sqrt{2}}$

(c) VI (d) VI cos θ

53. The sinusoidal A.C. current flows through a resistor of resistance R. If the peak current is I_p, then power dissipated is

(a) $I_p^2 R \cos\theta$ (b) $\frac{1}{2} I_p^2 R$

(c) $\frac{4}{\pi} I_p^2 R$ (d) $\frac{1}{\pi^2} I_p^2 R$

54. The power factor of an AC circuit having resistance (R) and inductance (L) connected in series and an angular velocity ω is
(a) R/ωL (b) $R/(R^2\omega^2L^2)$
(c) ωL/R (d) $R/(R^2\omega^2L^2)^{1/2}$

55. The transformer voltage induced in the secondary coil of a transformer is mainly due to
(a) a varying electric field
(b) a varying magnetic field
(c) the vibrations of the primary coil
(d) the iron core of the transformer

56. A transformer is employed to
(a) convert A.C. into D.C.
(b) convert D.C. into A.C.
(c) obtain a suitable A.C. voltage
(d) obtain a suitable D.C. voltage

57. Transformers are used
(a) in DC circuit only
(b) in AC circuits only
(c) in both DC and AC circuits
(d) neither in DC nor in AC circuits

58. 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

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

60. Eddy currents in the core of transformer can't be developed by
(a) increasing the number of turns in secondary coil
(b) taking laminated transformer
(c) making step down transformer
(d) using a weak a.c. at high potential

61. The core of transformer is laminated to reduce
(a) flux leakage (b) hysteresis
(c) copper loss (d) eddy current

62. A transformer is based on the principle of
(a) mutual induction (b) self induction
(c) Ampere's law (d) X-ray crystallography

63. The transformation ratio in the step-up transformer is
(a) one
(b) greater than one
(c) less than one
(d) the ratio greater or less than one depends on the other factor

64. The parallel combination of inductor and capacitor is called as
(a) rectifier circuit (b) tank circuit
(c) acceptor circuit (d) filter circuit

STATEMENT TYPE QUESTIONS

65. Consider the following statements and then select the correct statements.
I. Most of the electrical device we use require AC voltage.
II. Most of the electrical energy sold by power companies is transmitted and distributed as alternating current.
III. AC voltage can be easily and efficiently converted from one to the other by means of transformers.
(a) I is correct, II and III are incorrect
(b) I III are correct, II is incorrect
(c) I II are correct, III is incorrect
(d) I, II and III are correct

66. Which of the following statements is/are correct ?
I. In LCR series ac circuit, as the frequency of the source increases, the impedence of the circuit first decreases and then increases.
II. If the net reactance of an LCR series ac circuit is same as its resistance, then the current lags behind the voltage by 45°.
III. Below resonance, voltage leads the current while above it, current leads the voltage.
(a) I only (b) II only
(c) I and III (d) I and II

67. An alternating voltage of frequency ω is induced in electric circuit consisting of an inductance L and capacitance C, connected in parallel. Then across the inductance coil the
I. current is maximum when $\omega^2 = 1/(LC)$
II. current is minimum when $\omega^2 = 1/(LC)$
III. voltage is minimum when $\omega^2 = 1/(LC)$
IV. voltage is maximum when $\omega^2 = 1/(LC)$
Which of the above statements are correct?
(a) I and III (b) I and IV
(c) II and III (d) II and IV

68. Which of the following statements are correct ?
I. If the resonance is less sharp, not only is the maximum current less, the circuit is close to resonance for a larger range $\Delta\omega$ of frequencies and the tuning of the circuit will not be good.
II. Less sharp the resonance less is the selectivity of the circuit or *vice–versa*.
III. If quality factor is large, i.e., R is low or L is large, the circuit is more selective.
(a) I and II only (b) II and III only
(c) I and III only (d) I, II and III

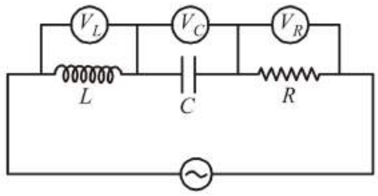
MATCHING TYPE QUESTIONS

69. Match Columns I and II.

Column I	**Column II**
(A) RL circuit	(1) Leading quantity - current
(B) RC circuit	(2) Leading quantity - voltage
(C) Inductive circuit	(3) Phase difference between voltage and current 0°
(D) Resistive circuit	(4) Phase difference between voltage and current 90°

(a) (A) → (2); (B) → (1); (C) → (3); (D) → (4)
(b) (A) → (2); (B) → (2); (C) → (4); (D) → (3)
(c) (A) → (4); (B) → (3); (C) → (2); (D) → (1)
(d) (A) → (2); (B) → (1); (C) → (4); (D) → (3)

70. In an LCR series circuit connected to an ac source, the supply voltage is $V = V_0 \sin\left(100\pi t + \frac{\pi}{6}\right)$. $V_L = 40\ V$, $V_R = 40V$, $Z = 5\Omega$ and $R = 4\Omega$. Then match the column I and II.



	Column I		Column II
(A)	Peak current (in A)	(1)	$10\sqrt{2}$
(B)	V_0 (in volts)	(2)	$50\sqrt{2}$
(C)	Effective value of applied voltage (in volts)	(3)	50
(D)	X_C (in Ω)	(4)	1

(a) (A)→(1); (B)→(2); (C)→(1); (D)→(4)
(b) (A)→(2); (B)→(3); (C)→(1); (D)→(4)
(c) (A)→(4); (B)→(3); (C)→(2); (D)→(1)
(d) (A)→(4); (B)→(1); (C)→(3); (D)→(2)

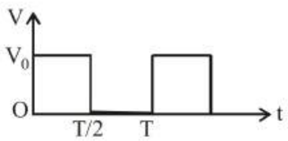
71. In a series LCR circuit, the e.m.f. leads current. Now the driving frequency is decreased slightly. Match columns I and II.

	Column I		Column II
(A)	Current amplitude	(1)	Increases
(B)	Phase constant	(2)	Decreases
(C)	Power developed in resistor	(3)	Remains same
(D)	Impedance	(4)	May increase or decrease

(a) (A)→(1, 2); (B)→(2); (C)→(3, 4); (D)→(1)
(b) (A)→(1); (B)→(2); (C)→(1); (D)→(2)
(c) (A)→(1); (B)→(3); (C)→(1); (D)→(1, 2)
(d) (A)→(2); (B)→(3); (C)→(4); (D)→(1)

DIAGRAM TYPE QUESTIONS

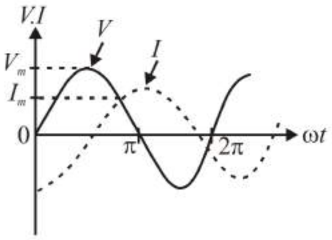
72. The r.m.s. value of potential difference V shown in the figure is

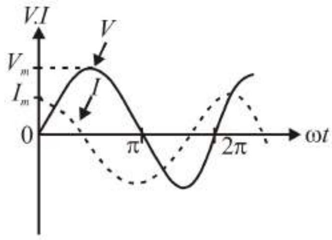


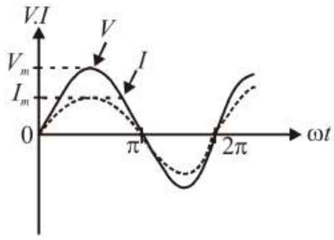
(a) V_0 (b) $V_0/\sqrt{2}$

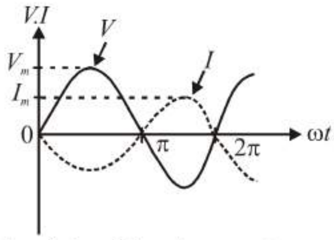
(c) $V_0/2$ (d) $V_0/\sqrt{3}$

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

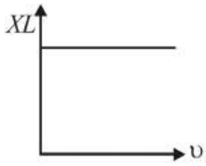
(a)


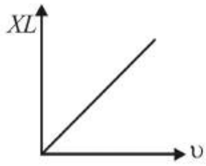
(b)


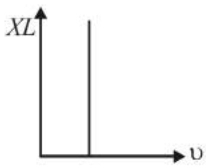
(c)


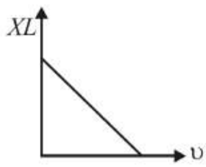
(d)


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

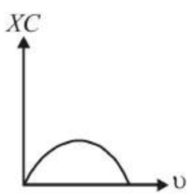
(a)


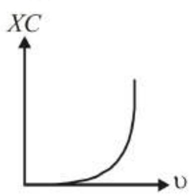
(b)


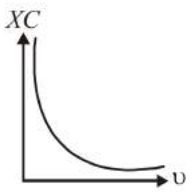
(c)


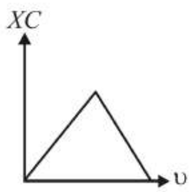
(d)


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

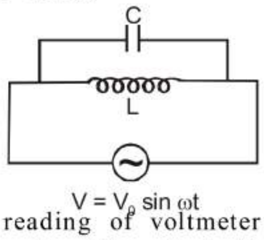
(a)


(b)


(c)


(d)


76. For the circuit shown in the fig., the current through the inductor is 0.9 A while the current through the condenser is 0.4 A. Then



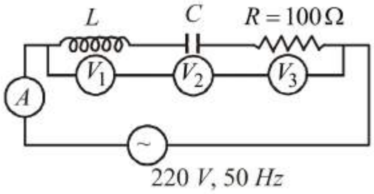
(a) current drawn from source I = 1.13 A

(b) ω = 1/(1.5 LC)

(c) I = 0.5 A

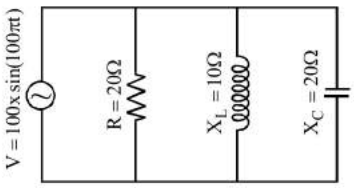
(d) I = 0.6 A

77. In the given circuit the reading of voltmeter V_1 and V_2 are 300 volt each. The reading of the voltmeter V_3 and ammeter A are respectively



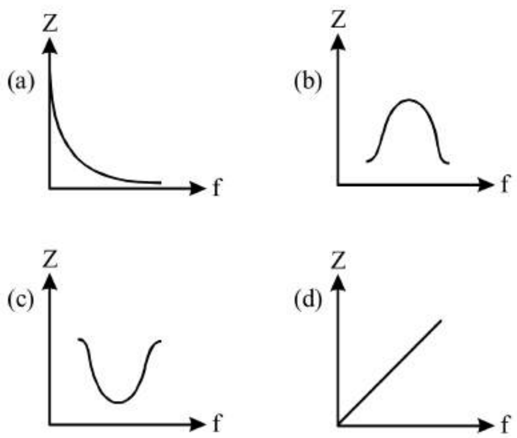
(a) 150 V and 2.2 A
(b) 220 V and 2.0 A
(c) 220 V and 2.0 A
(d) 100 V and 2.0 A

78. In the given circuit, the current drawn from the source is

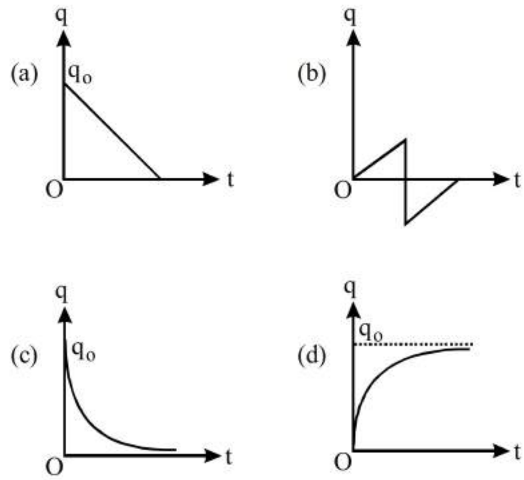


(a) 20 A
(b) 10 A
(c) 5 A
(d) $5\sqrt{2}$ A

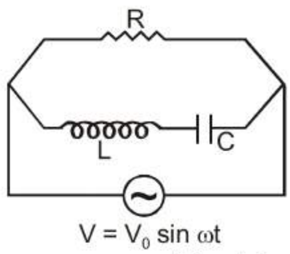
79. Which one of the following curves represents the variation of impedance (Z) with frequency f in series LCR circuit?



80. In LCR series circuit fed by a DC source, how does the amplitude of charge oscillations vary with time during discharge ?



81. The current in resistance R at resonance is



(a) zero
(b) minimum but finite
(c) maximum but finite
(d) infinite

ASSERTION- REASON TYPE QUESTIONS

Directions : Each of these questions contain two statements, Assertion and Reason. Each of these questions also has four alternative choices, only one of which is the correct answer. You have to select one of the codes (a), (b), (c) and (d) given below.

(a) Assertion is correct, reason is correct; reason is a correct explanation for assertion.

(b) Assertion is correct, reason is correct; reason is not a correct explanation for assertion

(c) Assertion is correct, reason is incorrect

(d) Assertion is incorrect, reason is correct.

82. **Assertion :** Average value of ac over a complete cycle is always zero.

Reason: Average value of ac is always defined over half cycle.

83. **Assertion :** The voltage and current in a series AC circuit are given by $V = V_0 \sin\omega t$ and $i = i_0 \cos\omega t$. The power dissipated in the circuit is zero.

Reason : Power in AC circuit is given by $P = \frac{V_0 i_0}{2}\cos\phi$.

84. **Assertion :** The alternating current lags behind the emf by a phase angle of $\frac{\pi}{2}$, when AC flows through an inductor.

Reason : The inductive reactance increases as the frequency of AC source increases.

85. Assertion : The inductive reactance limits amplitude of the current in a purely inductive circuit.
Reason: The inductive reactance is independent of the frequency of the current.

85. **Assertion :** A capacitor blocks direct current in the steady state.
Reason : The capacitive reactance of the capacitor is inversely proportional to frequency f of the source of emf.

87. **Assertion :** A capacitor is connected to a direct current source. Its reactance is infinite.
Reason : Reactance of a capacitor is given by $X_c = \frac{1}{\omega C}$.

88. **Assertion :** In a purely inductive or capacitive circuit, the current is referred to as wattless current.
Reason: No power is dissipated in a purely inductive or capacitive circuit even though a current is flowing in the circuit.

89. **Assertion :** The power in an ac circuit is minimum if the circuit has only a resistor.
Reason: Power of a circuit is independent of the phase angle.

90. **Assertion :** In the purely resistive element of a series LCR, AC circuit the maximum value of rms current increases with increase in the angular frequency of the applied emf.
Reason : $I_{max} = \frac{\varepsilon_{max}}{z}$, $z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$,
where I_{max} is the peak current in a cycle.

91. **Assertion :** When the frequency of the AC source in an LCR circuit equals the resonant frequency, the reactance of the circuit is zero, and so there is no current through the inductor or the capacitor.
Reason : The net current in the inductor and capacitor is zero.

92. **Assertion :** In series LCR resonance circuit, the impedance is equal to the ohmic resistance.
Reason: At resonance, the inductive reactance exceeds the capacitive reactance.

93. **Assertion :** Choke coil is preferred over a resistor to control the current in an AC circuit.
Reason : Power factor of an ideal inductor is zero.

94. **Assertion :** The power is produced when a transformer steps up the voltage.
Reason : In an ideal transformer VI = constant.

95. **Assertion :** A laminated core is used in transformers to increase eddy currents.
Reason: The efficiency of a transformer increases with increase in eddy currents.

CRITICALTHINKING TYPE QUESTIONS

96. Determine the rms value of the emf given by
E (in volt) = 8 sin (ω t) + 6sin (2 ω t)
(a) $5\sqrt{2}$V (b) $7\sqrt{2}$V
(c) 10V (d) $10\sqrt{2}$V

97. The r.m.s value of an a.c. of 50 Hz is 10 amp. The time taken by the alternating current in reaching from zero to maximum value and the peak value of current will be
(a) 2×10^{-2} sec and 14.14 amp
(b) 1×10^{-2} sec and 7.07 amp
(c) 5×10^{-3} sec and 7.07 amp
(d) 5×10^{-3} sec and 14.14 amp

98. The instantaneous voltage through a device of impedance 20 Ω is e = 80 sin 100 πt. The effective value of the current is
(a) 3 A (b) 2.828 A
(c) 1.732 A (d) 4 A

99. The impedance in a circuit containing a resistance of 1 Ω and an inductance of 0.1 H in series, for AC of 50 Hz, is
(a) $100\sqrt{10}\Omega$ (b) $10\sqrt{10}\Omega$
(c) 100Ω (d) $\sqrt{10}\Omega$

100. An ac voltage is applied to a resistance R and an inductor L in series. If R and the inductive reactance are both equal to 3Ω, the phase difference between the applied voltage and the current in the circuit is
(a) π/6 (b) π/4
(c) π/2 (d) zero

101. A coil has resistance 30 ohm and inductive reactance 20 ohm at 50 Hz frequency. If an ac source, of 200 volt, 100 Hz, is connected across the coil, the current in the coil will be
(a) 4.0A (b) 8.0A
(c) $\frac{20}{\sqrt{13}}$A (d) 2.0 A

102. A coil of inductance 300 mH and resistance 2 Ω is connected to a source of voltage 2 V. The current reaches half of its steady state value in
(a) 0.1 s (b) 0.05 s
(c) 0.3 s (d) 0.15 s

103. An inductance of negligible resistance whose reactance is 22 Ω at 200 Hz is connected to 200 volts, 50 Hz power line. The value of inductance is
(a) 0.0175 henry (b) 0.175 henry
(c) 1.75 henry (d) 17.5 henry

104. An inductive circuit contains resistance of 10 ohms and an inductance of 2 henry. If an A.C. voltage of 120 Volts and frequency 60 Hz is applied to this circuit, the current would be nearly
(a) 0.32 A (b) 0.16 A
(c) 0.48 A (d) 0.80 A

105. An inductive coil has a resistance of 100 Ω. When an a.c. signal of requency 1000 Hz is fed to the coil, the applied voltage leads the current by 45°. What is the inductance of the coil ?
(a) 10mH (b) 12mH
(c) 16mH (d) 20mH.

106. In an LR circuit f = 50 Hz, L = 2H, E = 5 volts, R = 1 Ω then energy stored in inductor is
(a) 50 J (b) 25 J
(c) 100 J (d) None of these

107. In an ac circuit an alternating voltage $e = 200\sqrt{2}\ \sin 100t$ volts is connected to a capacitor of capacity 1 μF. The r.m.s. value of the current in the circuit is
(a) 10 mA (b) 100 mA
(c) 200 mA (d) 20 mA

108. An alternating voltage E (in volts) = $200\sqrt{2}\ \sin 100\,t$ is connected to one micro farad capacitor through an a.c. ammeter. The reading of the ammeter shall be
(a) 100 mA (b) 20 mA
(c) 40 mA (d) 80 mA

109. An alternating voltage of 220 V, 50 Hz frequency is applied across a capacitor of capacitance 2 μF. The impedence of the circuit is
(a) $\frac{\pi}{5000}$ (b) $\frac{1000}{\pi}$
(c) 500π (d) $\frac{5000}{\pi}$

110. In an experiment, 200 V A.C. is applied at the ends of an LCR circuit. The circuit consists of an inductive reactance $(X_L) = 50\ \Omega$, capacitive reactance $(X_C) = 50\ \Omega$ and ohmic resistance $(R) = 10\ \Omega$. The impedance of the circuit is
(a) 10Ω (b) 20Ω
(c) 30Ω (d) 40Ω

111. In an electrical circuit *R*, *L*, *C* and an a.c. voltage source are all connected in series. When *L* is removed from the circuit, the phase difference between the voltage the current in the circuit is $\pi/3$. If instead, *C* is removed from the circuit, the phase difference is again $\pi/3$. The power factor of the circuit is
(a) 1/2 (b) $1/\sqrt{2}$
(c) 1 (d) $\sqrt{3}/2$

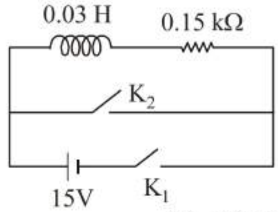
112. In an LCR series a.c. circuit, the voltage across each of the components, L, C and R is 50V. The voltage across the LC combination will be
(a) 100 V (b) $50\sqrt{2}$ V
(c) 50 V (d) 0 V

113. If resistance of 100Ω, and inductance of 0.5 henry and capacitance of 10×10^6 farad are connected in series through 50 Hz A.C. supply, then impedance is
(a) 1.8765 Ω (b) 18.76 Ω
(c) 187.6 Ω (d) 101.3 Ω

114. In an LCR series resonant circuit, the capacitance is changed from C to 4C. For the same resonant frequency, the inductance should be changed from L to
(a) 2L (b) $\frac{L}{2}$
(c) 4L (d) $\frac{L}{4}$

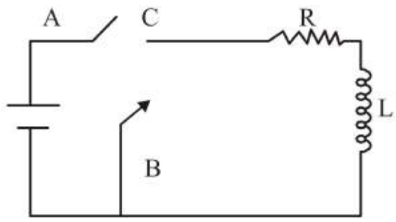
115. An inductor (L = 0.03 H) and a resistor (R = 0.15 kΩ) are connected in series to a battery of 15V EMF in a circuit shown below. The key K_1 has been kept closed for a long time. Then at t = 0, K_1 is opened and key K_2 is closed simultaneously.

At t = 1 ms, the current in the circuit will be : $(e^5 \cong 150)$



(a) 6.7 mA (b) 0.67 mA
(c) 100 mA (d) 67 mA

116. In the circuit shown here, the point 'C' is kept connected to point 'A' till the current flowing through the circuit becomes constant. Afterward, suddenly, point 'C' is disconnected from point 'A' and connected to point 'B' at time t = 0. Ratio of the voltage across resistance and the inductor at t = L/R will be equal to



(a) $\frac{e}{1-e}$ (b) 1
(c) –1 (d) $\frac{1-e}{e}$

117. A series R-C circuit is connected to an alternating voltage source. Consider two situations:
(a) When capacitor is air filled.
(b) When capacitor is mica filled.
Current through resistor is i and voltage across capacitor is V then :
(a) $V_a > V_b$ (b) $i_a > i_b$
(c) $V_a = V_b$ (d) $V_a < V_b$

118. A resistance 'R' draws power 'P' when connected to an AC source. If an inductance is now placed in series with the resistance, such that the impedance of the circuit becomes 'Z', the power drawn will be
(a) $P\sqrt{\frac{R}{Z}}$ (b) $P\left(\frac{R}{Z}\right)$
(c) P (d) $P\left(\frac{R}{Z}\right)^2$

119. In series L-C-R circuit, the voltages across R, L and C are V_R, V_L and V_C respectively. Then the voltage of applied a.c. source must be
(a) $V_R + V_L + V_C$
(b) $\sqrt{[(V_R)^2 + (V_L - V_C)^2]}$
(c) $V_R + V_C - V_L$
(d) $[(V_R + V_L)^2 + (V_C)^2]^{1/2}$

120. In a series resonant LCR circuit, the voltage across R is 100 volts and R = 1 kΩ with C = 2μF. The resonant frequency ω is 200 rad/s. At resonance the voltage across L is

(a) 2.5×10^{-2} V (b) 40 V
(c) 250 V (d) 4×10^{-3} V

121. In series combination of R, L and C with an A.C. source at resonance, if R = 20 ohm, then impedence Z of the combination is

(a) 20 ohm (b) zero
(c) 10 ohm (d) 400 ohm

122. The tuning circuit of a radio receiver has a resistance of 50 Ω, an inductor of 10 mH and a variable capacitor. A 1 MHz radio wave produces a potential difference of 0.1 mV. The values of the capacitor to produce resonance is (Take $\pi^2 = 10$)

(a) 2.5 pF (b) 5.0 pF
(c) 25 pF (d) 50 pF

123. Resonance frequency of LCR series a.c. circuit is f_0. Now the capacitance is made 4 times, then the new resonance frequency will become

(a) $f_0/4$ (b) $2f_0$
(c) f_0 (d) $f_0/2$.

124. In a RLC circuit capacitance is changed from C to 2 C. For the resonant frequency to remain unchanged, the inductance should be changed from L to

(a) 4 L (b) 2 L
(c) L/2 (d) L/4

125. Resonance frequency of LCR series a.c. circuit is f_0. Now the capacitance is made 4 times, then the new resonance frequency will become

(a) $f_0/4$ (b) $2f_0$
(c) f_0 (d) $f_0/2$.

126. In an a.c. circuit the voltage applied is $E = E_0 \sin \omega t$. The resulting current in the circuit is $I = I_0 \sin\left(\omega t + \frac{\pi}{2}\right)$

The power consumption in the circuit is given by

(a) $P = \sqrt{2}E_0I_0$ (b) $P = \frac{E_0I_0}{\sqrt{2}}$

(c) P = zero (d) $P = \frac{E_0I_0}{2}$

127. The instantaneous values of alternating current and voltages in a circuit are given as

$$i = \frac{1}{\sqrt{2}}\sin(100\pi t)\,A$$

$$e = \frac{1}{\sqrt{2}}\sin(100\pi t + \pi/3)\text{ Volt}$$

The average power in Watt consumed in the circuit is

(a) $\frac{1}{4}$ (b) $\frac{\sqrt{3}}{4}$

(c) $\frac{1}{2}$ (d) $\frac{1}{8}$

128. In a series LCR circuit $R = 200\Omega$ and the voltage and the frequency of the main supply is 220V and 50 Hz respectively. On taking out the capacitance from the circuit the current lags behind the voltage by 30°. On taking out the inductor from the circuit the current leads the voltage by 30°. The power dissipated in the LCR circuit is

(a) 305 W (b) 210 W
(c) Zero W (d) 242 W

129. In an A.C. circuit, the current flowing in inductance is $I = 5 \sin(100t - \pi/2)$ amperes and the potential difference is $V = 200 \sin(100t)$ volts. The power consumption is equal to

(a) 1000 watt (b) 40 watt
(c) 20 watt (d) Zero

130. In an a.c. circuit V and **I** are given by

$V = 100 \sin(100t)$ volts

$\mathbf{I} = 100 \sin(100t + \pi/3)$ mA

the power dissipated in the circuit is

(a) 10^4 watt (b) 10 watt
(c) 2.5 watt (d) 5.0 watt

131. An alternating voltage $V = V_0 \sin \omega t$ is applied across a circuit. As a result, a current $I = I_0 \sin(\omega t - \pi/2)$ flows in it. The power consumed per cycle is

(a) zero (b) $0.5\,V_0I_0$
(c) $0.707\,V_0I_0$ (d) $1.414\,V_0I_0$

132. Two coils A and B are connected in series across a 240 V, 50 Hz supply. The resistance of A is 5 Ω and the inductance of B is 0.02 H. The power consumed is 3 kW and the power factor is 0.75. The impedance of the circuit is

(a) 0.144 Ω (b) 1.44 Ω
(c) 14.4 Ω (d) 144 Ω

133. 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) $\pi\sqrt{LC}$

134. 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}

135. The primary winding of transformers has 500 turns whereas its secondary has 5000 turns. The primary is connected to an A.C. supply of 20 V, 50 Hz. The secondary will have an output of

(a) 2V, 5Hz (b) 200 V, 500 Hz
(c) 2V, 50 Hz (d) 200 V, 50Hz

136. A step up transformer operates on a 230 V line and supplies a current of 2 ampere. The ratio of primary and secondary winding is 1:25. The current in primary is
(a) 25 A (b) 50 A
(c) 15 A (d) 12.5 A

137. A 220 volts input is supplied to a transformer. The output circuit draws a current of 2.0 ampere at 440 volts. If the efficiency of the transformer is 80%, the current drawn by the primary windings of the transformer is
(a) 3.6 ampere (b) 2.8 ampere
(c) 2.5 ampere (d) 5.0 ampere

138. In a transformers, number of turns in primary coil are 140 and that in secondary coil are 280. If current in primary coil is 4A, then that in secondary coil is
(a) 4 A (b) 2 A
(c) 6 A (d) 10 A

139. The primary winding of a transformer has 100 turns and its secondary winding has 200 turns. The primary is connected to an A.C. supply of 120 V and the current flowing in it is 10 A. The voltage and the current in the secondary are
(a) 240 V, 5 A (b) 240 V, 10 A
(c) 60 V, 20 A (d) 120 V, 20 A

140. A step down transformer is connected to 2400 volts line and 80 amperes of current is found to flow in output load. The ratio of the turns in primary and secondary coil is 20 : 1. If transformer efficiency is 100%, then the current flowing in the primary coil will be
(a) 1600 amp (b) 20 amp
(c) 4 amp (d) 1.5 amp

141. A step down transformer reduces 220 V to 110 V. The primary draws 5 ampere of current and secondary supplies 9 ampere. The efficiency of transformer is
(a) 20% (b) 44%
(c) 90% (d) 100%

142. A transformer is used to light a 140 W, 24 V bulb from a 240 V a.c. mains. The current in the main cable is 0.7 A. The efficiency of the transformer is
(a) 63.8 % (b) 83.3 %
(c) 16.7 % (d) 36.2 %

143. A transformer has an efficiency of 80%. It works at 4 kW and 100 V. If secondary voltage is 240 V, the current in primary coil is
(a) 0.4 A (b) 4 A
(c) 10 A (d) 40 A

144. The primary of a transformer has 400 turns while the secondary has 2000 turns. If the power output from the secondary at 1000 V is 12 kW, what is the primary voltage?
(a) 200 V (b) 300 V
(c) 400 V (d) 500 V

145. A transformer connected to 220 V mains is used to light a lamp of rating 100 W and 110 V. If the primary current is 0.5 A, the efficiency of the transformer is (approximately)
(a) 60% (b) 35%
(c) 50% (d) 90%

146. A transformer having efficiency of 90% is working on 200V and 3kW power supply. If the current in the secondary coil is 6A, the voltage across the secondary coil and the current in the primary coil respectively are :
(a) 300 V, 15A (b) 450 V, 15A
(c) 450V, 13.5A (d) 600V, 15A

HINTS AND SOLUTIONS

FACT/DEFINITION TYPE QUESTIONS

1. (a)
2. (b) In India the frequency of A.C. current is 50 Hz.
3. (b)
4. (d) The electric mains supply in our homes and offices is a voltage that varies like a *sine* function with time. Such a voltage is called alternating voltage and the current driven by it in a circuit is called the alternating current.

5. (a) 6. (b) 7. (b) 8. (a)
9. (a) 10. (d) 11. (a) 12. (d)

13. (b) We know that $I_{rms} = I_0/\sqrt{2}$ and $I_m = 2I_0/\pi$

$$\therefore \frac{I_m}{I_{rms}} = \frac{2\sqrt{2}}{\pi}$$

14. (c) When resistance is connected to A.C source, then current & voltage are in same phase.
15. (c)
16. (b) $X_L = \omega L \Rightarrow X_L \propto \omega$
17. (d) In case of pure inductance cos ϕ = 0, so no power dissipates.
18. (d) $P = V_{r.m.s.} \times I_{r.m.s.} \times \cos\phi = \frac{1}{2} E_0 \times I_0 \cos \pi/2 = 0$
19. (b) In an inductor voltage leads the current by $\frac{\pi}{2}$ or current lags the voltage by $\frac{\pi}{2}$.
20. (a)
21. (d) $Q = \frac{\text{Potential drop across capacitor or inductor}}{\text{Potential drop across R.}}$

$$= \frac{\omega L}{R}$$

22. (a) X_C(reactance of capacitor) $= \frac{1}{\omega C}$ for D.C.,

$\omega = 0 \Rightarrow X_C = \infty$

23. (a) Capacitive reactance in an A.C circuit is

$X_C = \frac{1}{\omega C}$ ohm, where C is the capacitance of capacitor & $\omega = 2\pi n$ (n is the frequency of A.C source).

24. (b) $X_C = \frac{1}{\omega C} \Rightarrow X_C \propto \frac{1}{\omega}$ for given C.

25. (b) In a capacitive ac circuits, the voltage lags behind the current in phase by $\pi/2$ radian.

26. (c) The reactance of capacitor $X = \frac{1}{\omega C}$ where ω is frequency and C is the capacitance of capacitor.

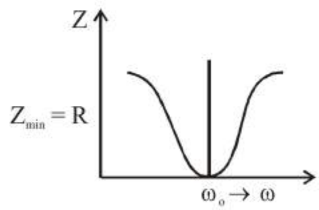
27. (d) When an ac voltage of 220 V is applied to a capacitor *C*, the charge on the plates is in phase with the applied voltage.
As the circuit is pure capacitive so, the current developed leads the applied voltage by a phase angle of 90° Hence, power delivered to the capacitor per cycle is
$P = V_{rms} I_{rms} \cos 90° = 0.$

28. (b)
29. (a) The reactance of inductor, $X_L = \omega L$

The reactance of capacitor, $X_C = \frac{1}{\omega C}$

where $\omega = 2\pi n$ & n is the frequency of A.C source.

30. (d)

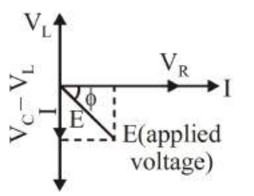


31. (b) In series RLC circuit,

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

And, at resonance, $V_L = V_C$
Hence, $V = V_R$

32. (a)
33. (d)



$$\tan\phi = \frac{V_C - V_L}{V_R} \text{ (if } V_C > V_L)$$

$$= \frac{V_L - V_C}{R} \text{ (if } V_L > V_C)$$

where ϕ is angle between current & applied voltage.

34. (b) Power factor $= \cos\varphi = \frac{R}{Z} = \frac{12}{15} = \frac{4}{5} = 0.8$

35. (d) At resonance wL= 1/wC
and i = E/R , So power dissipated in circuit is $P = i^2R$.

36. (b) At resonance frequency, the inductive and capacitive reactance are equal.
i.e. $X_L = X_C$
$\therefore$ Impedance, $Z = \sqrt{R^2 + (X_L - X_C)^2}$
$= \sqrt{R^2 + 0^2} = R$

37. (a)

38. (c) When this happens the amplitude of the current with the frequency of the signal of the particular radio station in the circuit is maximum.

39. (b) $\cos\phi = \frac{R}{Z}$, where Z is the impedance &
$Z = \sqrt{R^2 + (X_L - X_C)^2}$, if there is only resistance then $Z = R \Rightarrow \cos\phi = 1$

40. (b) If $R = 0 \Rightarrow \cos\phi = 0 \Rightarrow \phi = 90°$ so P =0, in this case power loss is zero & current flowing in the circuit is called wattless current.

41. (c) 42. (a) 43. (d) 44. (c)
45. (b) 46. (a) 47. (d) 48. (c)
49. (a) 50. (b) 51. (b)

52. (d) $P = VI\cos\theta$. So, power dissipation depends upon V and I.

53. (b) The value of r.m.s current is $I_{rms} = \frac{I_P}{\sqrt{2}}$
so power dissipated is $P = I_{rms}^2 R = \frac{1}{2} I_P^2 R$

54. (b) 55. (b) 56. (c) 57. (b)

58. (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.

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

60. (b)

61. (d) The core of a transformer is laminated to reduce eddy current.

62. (a) 63. (b) 64. (b)

STATEMENT TYPE QUESTIONS

65. (d) Most of the electrical devices we use require AC voltage. This is mainly because most of the electrical energy sold by power companies is transmitted and distributed as alternating current. The main reason for preferring use of AC voltage over DC voltage is that Ac voltage can be easily and efficiently converted from one voltage to the other by means of transformers.

66. (d) Option (d) is false because the reason why the voltage leads the current is because $\frac{1}{C\omega} > L\omega$ and if the voltage lags, the inductive reactance is greater than the capacitive reactance.

67. (d)

68. (d) If the resonance is less sharp, not only is the maximum current less, the circuit is close to resonance for larger range $\Delta\omega$ of frequencies and the tuning of the circuit will not be good. So, less sharp the resonance, less is the selectivity of the circuit or vice-versa. If quality factor is large, i.e., R is low or L is large, the circuit is more selective.

MATCHING TYPE QUESTIONS

69. (d) $(A) \to (2)$; $(B) \to (1)$; $(C) \to (4)$; $(D) \to (3)$

70. (a) A-1 : $i_{rms} = \frac{V_R}{R} = \frac{40}{4} = 10A$; $i_0 = \sqrt{2} i_{rms} = 2\sqrt{2}\ A$

B-2; $\therefore V_{rms} = iZ = 10 \times 5 = 50V$; $V_0 = \sqrt{2}\, V_{rms} = 50\sqrt{2}\, V$

C-1 :

D-4 : Now $V^2 = V_R^2 + (V_L - V_C)^2$

or $50^2 = 40^2 + (40 - V_C)^2$

$\therefore V_C = 10V$,

and $X_C = \frac{V_C}{i} = \frac{10}{10} = 1\Omega$

71. (b)

DIAGRAM TYPE QUESTIONS

72. (b) $V_{rms} = \sqrt{\frac{(T/2)V_0^2 + 0}{T}} = \frac{V_0}{\sqrt{2}}$.

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

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

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

$\Rightarrow \quad X_L \propto \frac{1}{\upsilon}$

With increases in frequency, X_C decreases.
Hence, option (c) represents the corrent graph.

76. (c) The current drawn by inductor and capacitor will be in opposite phase. Hence net current drawn from generator
$= I_L - I_C = 0.9 - 0.4 = 0.5$ amp.

77. (b) As $V_L = V_C = 300\ V$, resonance will take place
$\therefore\ V_R = 220\ V$

Current, $I = \frac{220}{100} = 2.2\,A$

$\therefore$ reading of $V_3 = 220\ V$
and reading of $A = 2.2\,A$

78. (d)

79. (c) Impedance at resonant frequency is minimum in series LCR circuit.

So, $Z = \sqrt{R^2 + \left(2\pi fL - \frac{1}{2\pi fC}\right)^2}$

When frequency is increased or decreased, Z increases.

80. (c)

81. (c) At resonance $X_L = X_C \Rightarrow Z = R$ & current is maximum but finite, which is $I_{max} = \frac{E}{R}$, where E is applied voltage.

ASSERTION- REASON TYPE QUESTIONS

82. (b) The means or average value of alternating current or e.m.f during a half cycle is given by
$I_m = 0.636 I_0$ or $E_m = 0.636 E_0$
During the next half cycle, the mean value of ac will be equal in magnitude but opposite in direction. For this reason the average value of ac over a complete cycle is always zero. So the average value is always defined over a half cycle of ac.

83. (a) $V = V_0 \sin \omega t\ i = i_0 \cos \omega t = i_0 \sin(\omega t + \pi/2)$

$\therefore\ \phi = \frac{\pi}{2}$, and $\cos\phi = 0$.

84. (b) In case of inductive circuit emf leads current by $\pi/2$ rad

85. (c) The inductive reactance limits the amplitude of current in a purely inductive circuit in the same way as the resistance limits the current in a purely resistive circuit.
i.e. $I_0 = \frac{\varepsilon_0}{X_L}$

86. (b)

87. (a) As $X_C = \frac{1}{\omega C}$, so for $\omega = 0$, $X_C \to \infty$.

88. (a) In a purely inductive or capacitive circuit, power factor, $\cos\phi = 0$ and no power is dissipated even though a current is flowing in the circuit. In such cases, current is referred to as wattless current.

89. (d) Power in a series ac circuit consisting of L, C and R is given by

$P = I_{rms} V_{rms} \cos\phi$ where $\phi = \tan^{-1}\left(\frac{|X_L - X_C|}{R}\right)$

For a purely resistive circuit $X_L = 0$ and $X_C = 0$
Therefore, $\tan\phi = 0$ or $\phi = 0$ and thereby $\cos\phi = 1$ and $P = IV$.
The power is maximum as $\cos\phi$ is maximum. Power depends on the phase angle through the power factor $\cos\phi$.

90. (c)

91. (d) The currents in capacitor and in inductor are opposite and so net current is zero.

92. (c) In series resonance circuit,
inductive reactance is equal to capacitive reactance.
i.e. $\omega L = \frac{1}{\omega C}$

$\therefore\ Z = \sqrt{R^2 + \left(\omega L = \frac{1}{\omega C}\right)^2} = R$

93. (a)

94. (a) Transformer cannot produce power, but it transfer from primary to secondary.

95. (d) Large eddy currents are produced in non-laminated iron core of the transformer by the induced emf, as the resistance of bulk iron core is very small. By using thin iron sheets as core the resistance is increased. Laminating the core substantially reduces the eddy currents. Eddy current heats up the core of the transformer. More the eddy currents greater is the loss of energy and the efficiency goes down.

CRITICALTHINKING TYPE QUESTIONS

96. (a) $E = 8\sin\omega t + 6\sin 2\omega t$

$\Rightarrow E_{peak} = \sqrt{8^2 + 6^2} = 10\ V$

$E_{rms} = \frac{10}{\sqrt{2}} = 5\sqrt{2}\ V$

97. (d)

98. (b) Given equation, $e = 80 \sin 100\pi t$ ...(i)

Standard equation of instantaneous voltage is given by $e = e_m \sin\omega t$ ...(ii)

Compare (i) and (ii), we get $e_m = 80$ V

where e_m is the voltage amplitude.

Current amplitude $I_m = \frac{e_m}{Z}$ where Z = impendence

$= 80/20 = 4$ A.

$$I_{r.m.s} = \frac{4}{\sqrt{2}} = \frac{4\sqrt{2}}{2} = 2\sqrt{2} = 2.828 \text{ A.}$$

99. (b)

100. (b) The phase difference ϕ is given by

$$\tan\phi = \frac{X_L}{R} = \frac{3}{3} = 1$$

$$\Rightarrow \phi = \frac{\pi}{4}.$$

101. (a) If $\omega = 50 \times 2\pi$ then $\omega L = 20\Omega$

If $\omega' = 100 \times 2\pi$ then $\omega' L = 40\Omega$

Current flowing in the coil is

$$I = \frac{200}{Z} = \frac{200}{\sqrt{R^2 + (\omega' L)^2}} = \frac{200}{\sqrt{(30)^2 + (40)^2}}$$

I = 4A.

102. (a) The charging of inductance given by,

$$i = i_0\left(1 - e^{-\frac{Rt}{L}}\right)$$

$$\frac{i_0}{2} = i_0(1 - e^{-\frac{Rt}{L}}) \Rightarrow e^{-\frac{Rt}{L}} = \frac{1}{2}$$

Taking log on both the sides,

$$-\frac{Rt}{L} = \log 1 - \log 2$$

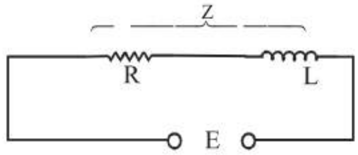
$$\Rightarrow t = \frac{L}{R}\log 2 = \frac{300 \times 10^{-3}}{2} \times 0.69 \Rightarrow t = 0.1 \text{ sec.}$$

103. (a) $X_L = \omega L = 2\pi n L$

$$\therefore L = \frac{X_L}{2\pi n} = \frac{22 \times 7}{2 \times 22 \times 200} H = 0.0175 H$$

104. (b) **105. (c)**

106. (d) $L = 2H, E = 5$ volts, $R = 1\Omega$



Energy in inductor $= \frac{1}{2}LI^2$ $I = \frac{E}{Z}$

$$I = \frac{5}{\sqrt{R^2 + (\omega L)^2}} = \frac{5}{\sqrt{1 + 4\pi^2 \times 50^2 \times 4}}$$

$$= \frac{5}{\sqrt{1 + (200\pi^2)}} = \frac{5}{200\pi}$$

$$\text{Energy} = \frac{1}{2} \times 2 \times \frac{5 \times 5}{200 \times 200\pi^2} = 6.33 \times 10^{-5} \text{ joules}$$

107. (d) $V_{rms} = \frac{200\sqrt{2}}{\sqrt{2}} = 200V$

$$I_{rms} = \frac{V_{rms}}{X_C} = \frac{200}{\frac{1}{100 \times 10^{-6}}}$$

$= 2 \times 10^{-2} = 20$mA

108. (b) $I = \frac{E}{X_C} = E\omega C = \left(\frac{E_0}{\sqrt{2}} \times \omega C\right)$

$$\therefore I = 120 \times \left(\frac{200}{100}\right) = 240V = 20 \times 10^{-3} \text{ amp.}$$

109. (d) Impedence of a capacitor is $X_C = 1/\omega C$

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 50 \times 2 \times 10^{-6}} = \frac{5000}{\pi}.$$

110. (a) Given : Supply voltage $(V_{ac}) = 200$ V

Inductive reactance $(X_L) = 50$ W

Capacitive reactance $(X_C) = 50$ W

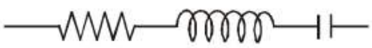
Ohmic resistance (R) = 10 W.

We know that impedance of the LCR circuit

(Z)

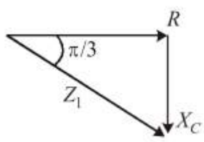
$$= \sqrt{\{(X_L - X_C)^2 + R^2\}} = \sqrt{\{(50-50)^2 + (10)^2\}} = 10\Omega$$

111. (c)



when L is removed from the circuit

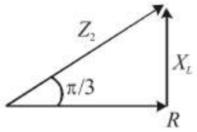
$$\frac{X_C}{R} = \tan\frac{\pi}{3}$$



$$X_C = R\tan\frac{\pi}{3} \quad ....(1)$$

when C is remove from the circuit

$$\frac{X_L}{R} = \tan\frac{\pi}{3}$$



$$X_C = R\tan\frac{\pi}{3} \quad ...(2)$$

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

power factor $\cos\phi = \frac{R}{Z} = 1$

112. (d) Since the phase difference between L & C is π

$\therefore$ net voltage difference across LC $= 50-50 = 0$

113. (c) $Z = \sqrt{R^2+\left(\omega L - \frac{1}{\omega C}\right)^2}$

Here R = 100 W, L = 0.5 henry, C = 10 × 10^6 farad

$\omega = 2\text{ p }\pi = 100\ \pi$.

114. (d) For resonant frequency to remain same

$\sqrt{LC}$ = constant

LC = constant

As, $C \to 4C$

$\therefore\ L \to \frac{L}{4}$

115. (b) $I(0) = \frac{15\times100}{0.15\times10^3} = 0.1A$

$I(\infty) = 0$

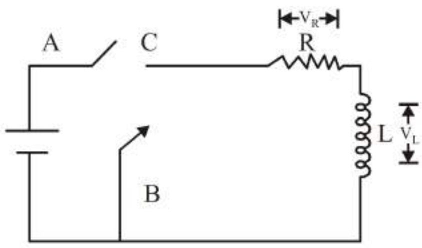
$I(t) = [I(0) - I(\infty)]\ e^{\frac{-t}{L/R}} + i(\infty)$

$I(t) = 0.1\ e^{\frac{-t}{L/R}} = 0.1\ e^{\frac{R}{L}}$

$I(t) = 0.1\ e^{\frac{0.15\times1000}{0.03}} = 0.67mA$

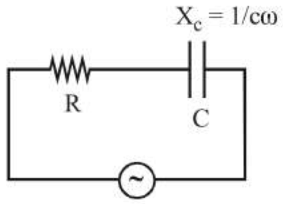
116. (c) Applying Kirchhoff's law of voltage in closed loop

$-V_R - V_C = 0 \Rightarrow \frac{V_R}{V_C} = -1$



117. (a) For series R – C circuit, capacitive reactance,

$$Z_c = \sqrt{R^2+\left(\frac{1}{C\omega}\right)^2}$$



AC Source

$$\text{Current } i = \frac{V}{Z_c} = \frac{V}{\sqrt{R^2+\left(\frac{1}{C\omega}\right)^2}}$$

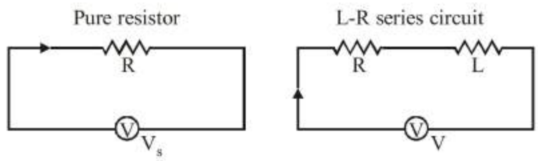
$$V_c = iX_c = \frac{V}{\sqrt{R^2+\left(\frac{1}{C\omega}\right)^2}} \times \frac{1}{C\omega}$$

$$V_c = \frac{V}{\sqrt{(RC\omega)^2+1}}$$

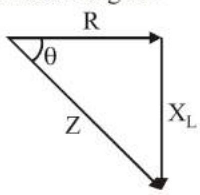
If we fill a di-electric material like mica instead of air then capacitance $C\uparrow \Rightarrow V_c\downarrow$

So, $V_a > V_b$

118. (d)



Phasor diagram



$\cos\theta = \frac{R}{Z}$

Z = impedance

For pure resistor circuit, power

$$P = \frac{V^2}{R} \Rightarrow V^2 = PR$$

For L-R series circuit, power

$$P^1 = \frac{V^2}{Z}\cos\theta = \frac{V^2}{Z}\cdot\frac{R}{Z} = \frac{PR}{Z^2}\cdot R = P\left(\frac{R}{Z}\right)^2$$

119. (b)

120. (c) Across resistor, $I = \frac{V}{R} = \frac{100}{1000} = 0.1$ A

At resonance,

$$X_L = X_C = \frac{1}{\omega C} = \frac{1}{200 \times 2 \times 10^{-6}} = 2500$$

Voltage across L is

$$IX_L = 0.1 \times 2500 = 250\,V$$

121. (a)

122. (a) $L = 10\,mHz = 10^{-2}Hz$

$f = 1MHz = 10^6$ Hz

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

$$f^2 = \frac{1}{4\pi^2 LC}$$

$$\Rightarrow C = \frac{1}{4\pi^2 f^2 L} = \frac{1}{4 \times 10 \times 10^{-2} \times 10^{12}} = \frac{10^{-12}}{4} = 2.5 \text{ pF}$$

123. (d) In LCR series circuit, resonance frequency f_0 is given by

$$L\omega = \frac{1}{C\omega} \Rightarrow \omega^2 = \frac{1}{LC} \quad \therefore \omega = \sqrt{\frac{1}{LC}} = 2\pi f_0$$

$$\therefore f_0 = \frac{1}{2\pi\sqrt{LC}} \quad \text{or} \quad f_0 \alpha \frac{1}{\sqrt{C}}$$

When the capacitance of the circuit is made 4 times, its resonant frequency become f_0'

$$\therefore \frac{f_0'}{f_0} = \frac{\sqrt{C}}{\sqrt{4C}} \quad \text{or} \quad f_0' = \frac{f_0}{2}$$

124. (c) We know that $f = \frac{1}{2\pi\sqrt{(LC)}}$,

when C is doubled, L should be halved so that resonant frequency remains unchanged.

125. (d) In LCR series circuit, resonance frequency f_0 is given by

$$L\omega = \frac{1}{C\omega} \Rightarrow \omega^2 = \frac{1}{LC} \quad \therefore \omega = \sqrt{\frac{1}{LC}} = 2\pi f_0$$

$$\therefore f_0 = \frac{1}{2\pi\sqrt{LC}} \quad \text{or} \quad f_0 \alpha \frac{1}{\sqrt{C}}$$

When the capacitance of the circuit is made 4 times, its resonant frequency become f_0'

$$\therefore \frac{f_0'}{f_0} = \frac{\sqrt{C}}{\sqrt{4C}} \quad \text{or} \quad f_0' = \frac{f_0}{2}$$

126. (c) We know that power consumed in a.c. circuit is given by, $P = E_{rms} \cdot I_{rms} \cos\phi$

Here, $E = E_0 \sin\omega t$

$$I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$$

which implies that the phase difference,

$$\phi = \frac{\pi}{2}$$

$$\therefore P = E_{rms} \cdot I_{rms} \cdot \cos\frac{\pi}{2} = 0 \quad \left(\because \cos\frac{\pi}{2} = 0\right)$$

127. (d) The average power in the circuit where $\cos\phi$ = power factory

$$<P> = V_{rms} \times I_{rms} \cos\phi$$

$$\phi = \pi/3 = \text{phase difference} = \frac{180}{3} = 60$$

$$V_{rms} = \frac{\frac{1}{\sqrt{2}}}{\sqrt{2}} = \frac{1}{2}\text{volt}$$

$$I_{rms} = \frac{\frac{1}{\sqrt{2}}}{\sqrt{2}} = \left(\frac{1}{2}\right)A$$

$$\cos\phi = \cos\frac{\pi}{3} = \frac{1}{2}$$

$$<P> = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{8}W$$

128. (d) When capacitance is taken out, the circuit is LR.

$$\therefore \tan\phi = \frac{\omega L}{R}$$

$$\Rightarrow \omega L = R\tan\phi = 200\times\frac{1}{\sqrt{3}} = \frac{200}{\sqrt{3}}$$

Again, when inductor is taken out, the circuit is CR.

$$\therefore \tan\phi = \frac{1}{\omega CR}$$

$$\Rightarrow \frac{1}{\omega c} = R\tan\phi = 200\times\frac{1}{\sqrt{3}} = \frac{200}{\sqrt{3}}$$

Now, $Z = \sqrt{R^2 + \left(\frac{1}{\omega C} - \omega L\right)^2}$

129. (d) Power, $P = I_{r.m.s} \times V_{r.m.s} \times \cos\phi$

In the given problem, the phase difference between voltage and current is p/2. Hence

$P = I_{r.m.s} \times V_{r.m.s} \times \cos(\pi/2) = 0.$

130. (c) $P = V_{r.m.s} \times I_{r.m.s} \times \cos\phi = \frac{1}{2} V_0 I_0 \cos\phi$

$$= \frac{1}{2} \times 100 \times (100\times10^{-3}) \cos\pi/3 = 2.5\text{ W}$$

131. (a) The phase angle between voltage V and current I is $\pi/2$. Therefore, power factor $\cos\phi = \cos(\pi/2) = 0$. Hence the power consumed is zero.

132. (c) $P = \frac{E_V^2 \cos\phi}{Z}$

$$P = 3000 = \frac{(240)^2(0.75)}{Z} d \quad \Rightarrow Z = 14.4\Omega$$

133. (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 $Q = \frac{Q_0}{\sqrt{2}}$

$$\Rightarrow Q_0 \cos\omega t = \frac{Q_0}{\sqrt{2}}$$

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

$$= \frac{\pi\sqrt{LC}}{4}$$

134. (a) : Here, C 30 μF = 30 × 10^{-6} F,
L = 27 mH = 27 × 10^{-3} H

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

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

135. (d)

136. (b) $\frac{n_p}{n_s} = \frac{E_p}{E_s} = \frac{1}{25}$

$\therefore E_s = 25E_p$

But $E_s I_s = E_p I_p \Rightarrow I_p = \frac{E_s \times I_s}{E_p} \Rightarrow I_p = 50A$

137. (d) $\frac{V_2}{V_1} = 0.8\frac{I_1}{I_2} \Rightarrow \frac{V_2 I_2}{V_1 I_1} = 0.8$

$V_1 = 220\ V, I_2 = 2.0\ A, V_2 = 440\ V$

$$I_1 = \frac{V_2 I_2}{V_1}\times\frac{10}{8} = \frac{440\times2\times10}{220\times8} = 5\ A$$

138. (b)

139. (a) $\frac{E_s}{E_p} = \frac{n_s}{n_p}$ or $E_s = E_p \times \left(\frac{n_s}{n_p}\right)$

$$\therefore E_s = 120\times\left(\frac{200}{100}\right) = 240\text{V}$$

$$\frac{I_p}{I_s} = \frac{n_s}{n_p} \text{ or } I_s = I_p\left(\frac{n_p}{n_s}\right) \quad \therefore I_s = 10\left(\frac{100}{200}\right) = 5\text{ amp}$$

140. (c) $\frac{I_s}{I_p} = \frac{n_p}{n_s}$; $\frac{80}{I_p} = \frac{20}{1}$ or $I_p = 4$ amp.

141. (c) $\eta = \frac{E_S I_S}{E_P I_P}$ $\therefore \eta = \frac{110 \times 9}{220 \times 5} = 0.9 \times 100\% = 90\%$

142. (b) Power of source $= EI = 240 \times 0.7 = 166$

$\Rightarrow$ Efficiency $= \frac{140}{166} \Rightarrow \eta = 83.3\%$

143. (d) As $E_p I_p = P_i$ $\therefore$ $I_p = \frac{P_i}{E_p} = \frac{4000}{100} = 40$ A.

144. (a) $N_P = 400, N_S = 2000$ and $V_S = 1000$ V.

$\frac{V_P}{V_S} = \frac{N_P}{N_S}$ of, $V_P = \frac{V_S \times N_P}{N_S} = \frac{1000 \times 400}{2000} = 200$V.

145. (d) Power in primary of transformer is

$P_P = V_p . I_P = 220 \times 0.5$

$= 110$ W

But power in secondary of transformer is

$Ps = 100$ W

$\therefore \eta = \frac{100}{110} = 0.9 = 90\%$

146. (b) Efficiency $\eta = \frac{V_s I_s}{V_p I_p} \Rightarrow 0.9 = \frac{V_s(6)}{3 \times 10^3}$

$\Rightarrow V_s = 450$ V

As $V_p I_p = 3000$ so

$I_p = \frac{3000}{V_p} = \frac{3000}{200}$ A $= 15$A