PRACTICE EXERCISES

SINGLE CORRECT CHOICE TYPE QUESTIONS

This section contains Single Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

1. An alternating voltage $V = 200\sqrt{2}\sin(100t)$, where V is in volt and t in seconds, is connected to a series combination of $1\ \mu F$ capacitor and $10\ k\Omega$ resistor through an ac ammeter. The reading of the ammeter will be

(A) $\sqrt{2}$ mA (B) $10\sqrt{2}$ mA

(C) 2 mA (D) 20 mA

2. An LCR series circuit containing a resistance of $120\ \Omega$ has angular resonance frequency 4×10^5 rads^{-1}. At resonance the voltage across resistance and inductance are 60 V and 40 V respectively. The values of L and C are

(A) 0.2 mH, $\frac{1}{32}\ \mu F$ (B) 0.4 mH, $\frac{1}{16}\ \mu F$

(C) 0.2 mH, $\frac{1}{16}\ \mu F$ (D) 0.4 mH, $\frac{1}{32}\ \mu F$

3. 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%

4. In an AC circuit, twice the impedance is $\sqrt{3}$ times the reactance, then the phase angle is

(A) 60° (B) 30°

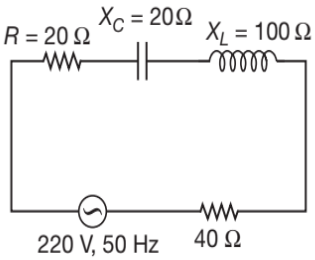
(C) ZERO (D) $\phi = \sin^{-1}\left(\frac{1}{\sqrt{3}}\right)$

5. An alternating voltage, given by $V = 300\sqrt{2}\sin(50t)$ is connected across a $1\ \mu F$ capacitor through an AC ammeter. The reading of the ammeter is

(A) 10 mA (B) 15 mA

(C) 40 mA (D) 100 mA

6. The power factor of the circuit shown in the figure is



(A) 0.2 (B) 0.4

(C) 0.6 (D) 0.8

7. If L and R be the inductance and resistance respectively for an ideal choke coil, then identify the correct statement.

(A) L is very high compared to R

(B) R is very high compared to L

(C) Both L and R are high

(D) Both L and R are low

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

(A) 2.5 pF (B) 5.0 pF

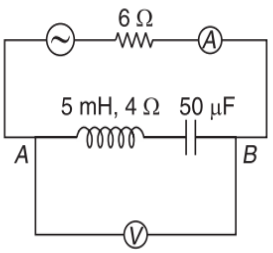
(C) 25 pF (D) 50 pF

9. In PROBLEM 8, the current at resonance is

(A) $1\ \mu A$ (B) $1.5\ \mu A$

(C) $2\ \mu A$ (D) $4\ \mu A$

10. An AC source of voltage $V = 20\cos(2000t)$ having negligible resistance is applied across the circuit shown in Figure. The voltmeter and ammeter readings are



(A) 0 V, 2 A (B) 0 V, 1.4 A

(C) 5.6 V, 1.4 A (D) 8 V, 2 A

11. When 100 V dc is applied across a coil, a current of 1 A flows through it. When 100 V ac of 50 Hz is applied across the same coil, only 0.5 A flows. The resistance and inductance of the coil are $(\text{Take } \pi^2 = 10)$

(A) $50\ \Omega$, 0.3 H (B) $50\ \Omega$, $\sqrt{0.3}$ H

(C) $100\ \Omega$, 0.3 H (D) $100\ \Omega$, $\sqrt{0.3}$ H

12. A generator produces a time varying voltage given by $V = 240\sin 120t$, where t is in second. The rms voltage and frequency are
(A) 170 V and 19 Hz (B) 240 V and 60 Hz
(C) 170 V and 60 Hz (D) 120 V and 19 Hz

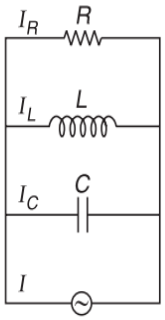
13. Two coils A and B are connected in series across a 240 V, 50 Hz supply. The resistance of A is 5 Ω and the inductance of B is 0.02 H. The power consumed is 3 kW and the power factor is 0.75. The impedance of the circuit is
(A) 0.144 Ω (B) 1.44 Ω
(C) 14.4 Ω (D) 144 Ω

14. In PROBLEM 13, the resistance of the coil B is
(A) 0.58 Ω (B) 5.8 Ω
(C) 1.16 Ω (D) 11.6 Ω

15. In PROBLEM 13, the inductance of coil A is
(A) 0.01 H (B) 0.02 H
(C) 0.03 H (D) 0.04 H

16. Two coils have mutual inductance 0.005 H. The current changes in the first coil according to equation $I = I_0 \sin\omega t$ where $I_0 = 10$ A and $\omega = 100\pi$ rads^{-1}. The maximum value of emf in the second coil (in volt) is
(A) 2π (B) 5π
(C) π (D) 4π

17. In a parallel LCR circuit as shown in Figure.



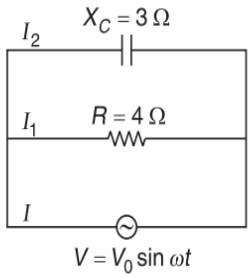
If I_R, I_L, I_C and I represent the rms values of current flowing through resistor, inductor, capacitor and the source respectively, then select the correct option.
(A) $I = I_R + I_L + I_C$
(B) $I = I_R + I_L - I_C$
(C) $I = \sqrt{I_R^2 + I_L^2 + I_C^2}$
(D) I_L or I_C may be greater than I

18. An LCR series circuit contains $L = 8$ H, $C = 0.5$ μF and $R = 100$ Ω. The resonant frequency of the circuit is
(A) $\frac{1000}{\pi}$ Hz (B) $\frac{500}{\pi}$ Hz
(C) $\frac{250}{\pi}$ Hz (D) $\frac{125}{\pi}$ Hz

19. In a series LCR circuit connected across an ac input, the current in the circuit will
(A) decrease if R is increased
(B) decrease if L is increased
(C) increase if C is increased
(D) decrease if C is increased

20. An inductive coil has a resistance of 100 Ω. When an ac signal of frequency 1000 Hz is applied to the coil, the voltage leads the current by 45°. The inductance of the coil is
(A) $\frac{1}{10\pi}$ (B) $\frac{1}{20\pi}$
(C) $\frac{1}{40\pi}$ (D) $\frac{1}{60\pi}$

21. A capacitor and resistor are connected with an AC source as shown in Figure.



The capacitive reactance is 3 Ω and the resistance of resistor is 4 Ω. The phase difference between currents I and I_1 is
Given that $\sin^{-1}\left(\frac{3}{5}\right) = 37°$
(A) 90° (B) ZERO
(C) 53° (D) 37°

22. An ideal inductor takes a current of 10 A when connected to a 125 V, 50 Hz ac supply. A pure resistor across the same source takes 12.5 A. If the two are connected in series across a $100\sqrt{2}$ V, 40 Hz supply, the current through the circuit will be
(A) 10 A (B) 12.5 A
(C) 20 A (D) 25 A

23. Voltage applied to an AC circuit and the current flowing in it are respectively given by

$V = 200\sqrt{2}\sin\left(\omega t + \frac{\pi}{4}\right)$ and

$i = -\sqrt{2}\cos\left(\omega t + \frac{\pi}{4}\right)$

The power consumed in the circuit is

(A) 200 W (B) 400 W

(C) $200\sqrt{2}$ W (D) None of these

24. If $E = 8\sin(\omega t) + 6\sin(2\omega t)$, then the rms values is

(A) $5\sqrt{2}$ V (B) $7\sqrt{2}$ V

(C) 10 V (D) $10\sqrt{2}$ V

25. An AC voltage is applied across a series combination of L and R. If the voltage drop across the resistor and inductor are 20 V and 15 V respectively, then applied peak voltage is

(A) 25 V (B) 35 V

(C) $25\sqrt{2}$ V (D) $5\sqrt{7}$ V

26. The number of turns of primary and secondary coils of a transformer are 5 and 10 respectively and the mutual inductance of the transformer is 25 H. If the number of turns in the primary and secondary are made 10 and 5 respectively, then the mutual inductance of the transformer will be

(A) 6.25 H (B) 12.5 H

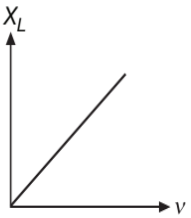
(C) 25 H (D) 50 H

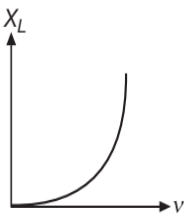
27. An ideal transformer is used to step up an alternating emf 220 V to 4.4 kV to transmit 6.6 kW power. The current rating the secondary is

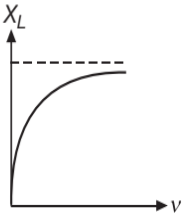
(A) 30 A (B) 3 A

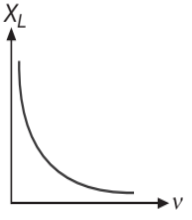
(C) 1.5 A (D) 1 A

28. Which one of the following represents the variation of inductive reactance (X_L) with the frequency of the voltage source?

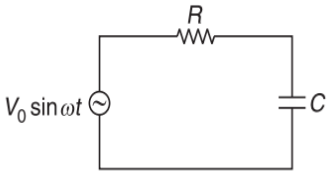
(A) 

(B) 

(C) 

(D) 

29. An AC voltage source $V = V_0 \sin \omega t$ is connected across resistance R and capacitance C as shown in Figure.



It is given that the resistance R equals the capacitive reactance and the peak current is I_0. If the angular frequency of the voltage source is changed to $\frac{\omega}{\sqrt{3}}$, then the new peak current in the circuit is

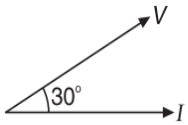
(A) $\frac{I_0}{2}$ (B) $\frac{I_0}{\sqrt{2}}$

(C) $\frac{I_0}{\sqrt{3}}$ (D) $\frac{I_0}{3}$

30. If resistance in an ac circuit is increased, then its power factor

(A) decreases
(B) increases
(C) remains same
(D) decreases and becomes zero

31. Phasor diagram of a series AC circuit is shown in Figure. Then the circuit

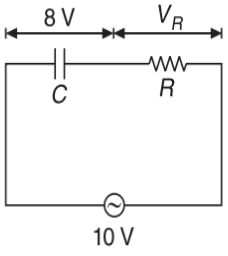


(A) must be containing resistor and capacitor only.
(B) must be containing resistor and inductor only
(C) must be containing all three elements L, C and R
(D) cannot have only capacitor and inductor

32. Hot wire ammeters can be used for measuring

(A) alternating current only
(B) direct current only
(C) both alternating and direct current
(D) neither alternating nor direct current

33. In a series CR circuit shown in Figure, the applied voltage is 10 V and the voltage across capacitor is found to be 8 V. The voltage across R and the phase difference between current and the applied voltage will respectively be



(A) $6\text{ V}, \tan^{-1}\left(\frac{4}{3}\right)$ (B) $3\text{ V}, \tan^{-1}\left(\frac{3}{4}\right)$

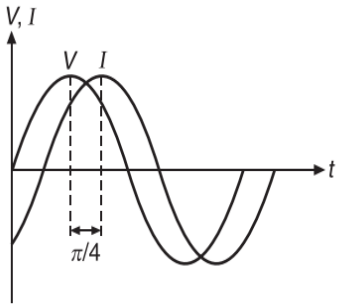
(C) $6\text{ V}, \tan^{-1}\left(\frac{3}{4}\right)$ (D) None of these

34. An inductance, a capacitance and a resistance are connected in series across a source of alternating voltage. At resonance, the applied voltage and the current flowing through the circuit will have a phase difference of

(A) $\frac{\pi}{4}$ (B) ZERO

(C) π (D) $\frac{\pi}{2}$

35. An AC voltage $V = V_0 \sin 100t$ is applied to the circuit for which the phase difference between current and voltage is found to be $\frac{\pi}{4}$. The best suitable combination for satisfying the given condition is



(A) $R = 100\ \Omega$, $C = 1\ \mu\text{F}$

(B) $R = 1\ \text{k}\Omega$, $C = 10\ \mu\text{F}$

(C) $R = 10\ \text{k}\Omega$, $L = 1\ \text{H}$

(D) $R = 1\ \text{k}\Omega$, $L = 10\ \text{H}$

36. The average emf during the positive half cycle of an a.c. supply of peak value E_0 is

(A) $\frac{E_0}{\pi}$ (B) $\frac{E_0}{\sqrt{2}\pi}$

(C) $\frac{E_0}{2\pi}$ (D) $\frac{2E_0}{\pi}$

37. When an alternating voltage of 220 V is applied across a device P, a current of 0.25 A flows through the circuit and it leads the applied voltage by an angle $\frac{\pi}{2}$ radian. When the same voltage source is connected across another device Q, the same current is observed in the circuit but in phase with the applied voltage. What is the current when the same source is connected across a series combination of P and Q?

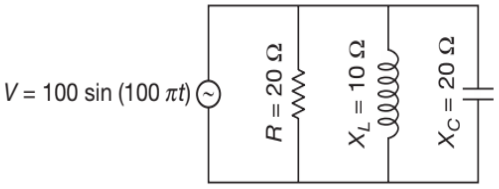
(A) $\frac{1}{4\sqrt{2}}$ A lagging in phase by $\frac{\pi}{4}$ with voltage

(B) $\frac{1}{4\sqrt{2}}$ A leading in phase by $\frac{\pi}{4}$ with voltage

(C) $\frac{1}{\sqrt{2}}$ A leading in phase by $\frac{\pi}{4}$ with voltage

(D) $\frac{1}{4\sqrt{2}}$ A leading in phase by $\frac{\pi}{2}$ with voltage

38. 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

39. In a step-down transformer the input voltage is 22 kV and the output voltage 550 V. The ratio of the number of turns in the secondary to that in the primary

(A) 1 : 20 (B) 20 : 1

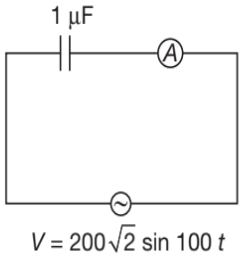
(C) 1 : 40 (D) 40 : 1

40. In an LCR series 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) $\frac{L}{4}$ (D) $4L$

41. In the circuit shown in Figure, the reading of the AC ammeter is



(A) $20\sqrt{2}$ mA (B) $40\sqrt{2}$ mA

(C) 20 mA (D) 40 mA

42. An ideal transformer steps down 220 V to 22 V in order to operate a device with an impedance of 220 Ω. The current in the primary is

(A) 0.01 A (B) 0.1 A

(C) 0.5 A (D) 1.0 A

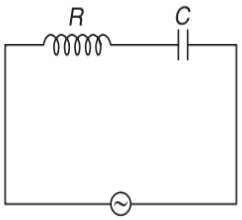
43. The frequency of an alternating current is 50 Hz. The minimum time taken by it in reaching from zero to peak value is

(A) 5 ms (B) 10 ms
(C) 20 ms (D) 50 ms

44. In a noiseless transformer an alternating current of 2 A is flowing in the primary coil. The number of turns in the primary and secondary coil are 100 and 20 respectively. The value of the current in the secondary coil is

(A) 0.08 A (B) 0.4 A
(C) 5 A (D) 10 A

45. A 50 Hz AC source of 20 V is connected across R and C as shown in Figure. If the voltage across R is 12 V, then the voltage across C is



(A) 8 V (B) 16 V
(C) 10 V (D) 14 V

46. If ϕ is phase difference between current and voltage, the wattless component of current is

(A) $I\cos\phi$ (B) $I\sin\phi$
(C) $I\tan\phi$ (D) $I\cos^2\phi$

47. In a series LCR circuit, current in the circuit is 11 A when the applied voltage is 220 V. Voltage across the capacitor is 200 V. If the value of resistor is 20 Ω, then the voltage across the unknown inductor is

(A) ZERO (B) 200 V
(C) 20 V (D) None of these

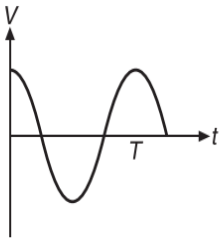
48. A steady potential difference of 10 V produces heat at a rate x in a resistor. The peak value of the alternating voltage which will produce heat at a rate $\frac{x}{2}$ in the same resistor is

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

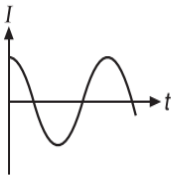
49. A coil, a capacitor and an AC source of rms voltage 24 V are connected in series. By varying the frequency of the source, a maximum rms current of 6 A is observed. If coil is connected to a DC battery of emf 12 V and internal resistance 4 Ω, then current through it in steady state is

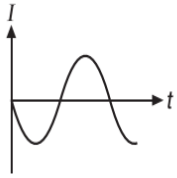
(A) 2.4 A (B) 1.8 A
(C) 1.5 A (D) 1.2 A

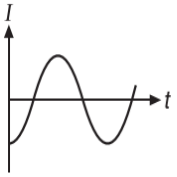
50. The voltage across a pure inductor is represented by the graph shown in Figure.

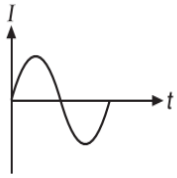


Which one of the following diagrams will represent the current?

(A) 

(B) 

(C) 

(D) 

51. An alternating voltage is applied across the series combination of resistor and an inductor. If the applied voltage is $V = 220\sin 120t$ and current flowing in the circuit is $I = 4\sin(120t - 60°)$. The power consumed in the circuit is

(A) ZERO (B) 100 W
(C) 220 W (D) 440 W

52. A resistance R, an inductance L and a capacitance C are connected in series across an ac source of angular frequency ω. If the resonant frequency is ω_0 then the current will lag behind the voltage if

(A) $\omega < \omega_0$ (B) $\omega > \omega_0$
(C) $\omega = \omega_0$ (D) $\omega = 0$

53. The impedance of a circuit consists of 3 Ω resistance and 4 Ω reactance. The power factor of the circuit is

(A) 0.4 (B) 0.6
(C) 0.8 (D) 1.0

54. In series LCR circuit, voltage drop across resistance is 8 V, across inductor is 6 V and across capacitor is 12 V. Then,

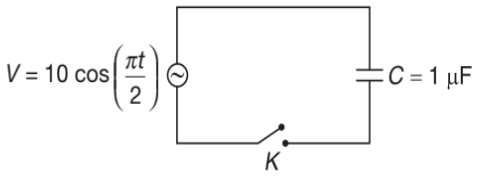
(A) voltage of the source will be leading in the circuit.
(B) voltage drop across each element will be less than the applied voltage.
(C) power factor of the circuit will be $\frac{3}{4}$.
(D) current leads the voltage.

55. An ideal inductor of $\left(\frac{1}{\pi}\right)$ H is connected in series with a 300 Ω resistor. If a 20 V, 200 Hz ac source is connected across the combination, the phase difference between the voltage and the current is

(A) $\tan^{-1}\left(\frac{5}{4}\right)$ (B) $\tan^{-1}\left(\frac{4}{5}\right)$

(C) $\tan^{-1}\left(\frac{3}{4}\right)$ (D) $\tan^{-1}\left(\frac{4}{3}\right)$

56. An AC voltage source described by $V = 10\cos\left(\frac{\pi t}{2}\right)$ is connected to a 1 μF capacitor as shown in Figure. The key K is closed at $t = 0$. The time $(t > 0)$ after which the magnitude of current i reaches its maximum value for the first time is



(A) 1 s (B) 2 s

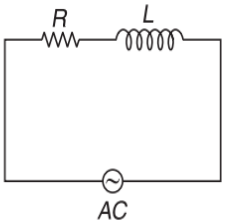
(C) 3 s (D) 4 s

57. A low-loss transformer has 230 V applied to the primary and gives 4.6 V in the secondary. The secondary is connected to a load which draws 5 A of current. The current (in ampere) in the primary is

(A) 0.1 (B) 1.0

(C) 10 (D) 250

58. A circuit contains resistance R and an inductance L in series. An alternating voltage $V = V_0 \sin \omega t$ is applied across it. The currents in R and L respectively will be



(A) $I_R = I_0 \cos \omega t$, $I_L = I_0 \cos \omega t$

(B) $I_R = -I_0 \sin \omega t$, $I_L = I_0 \cos \omega t$

(C) $I_R = I_0 \sin \omega t$, $I_L = -I_0 \cos \omega t$

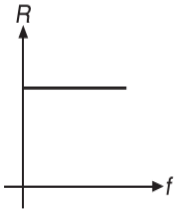
(D) $I_R = I_0 \sin \omega t$, $I_L = I_0 \cos \omega t$

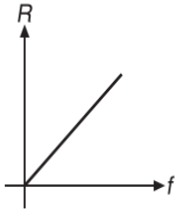
59. The rate of heat production in a resistor due to an alternating current of rms value 10 A is same as that due to a direct current of

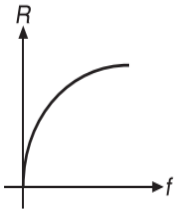
(A) 10 A (B) $\frac{10}{\sqrt{2}}$ A

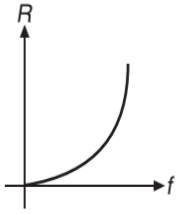
(C) $10\sqrt{2}$ A (D) 5 A

60. The correct variation of resistance R with frequency f is given by

(A) 

(B) 

(C) 

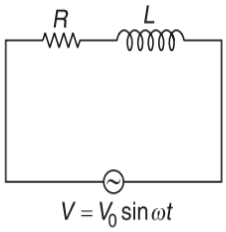
(D) 

61. A 220 V main supply is connected to a resistance of 100 kΩ. The effective current is

(A) 2.2 mA (B) $2.2\sqrt{2}$ mA

(C) $\frac{2.2}{\sqrt{2}}$ mA (D) None of the above

62. The power consumed in the circuit shown in Figure, is



(A) ZERO (B) $\frac{V_0^2}{2R}$

(C) $\frac{V_0^2 R}{2(R^2 + \omega^2 L^2)}$ (D) $\frac{V_0^2 R}{2\sqrt{R^2 + \omega^2 L^2}}$

63. In a transformer, N_P and N_S are 1000 and 3000 respectively. If the primary is connected across 80 V A.C., the potential difference across each turn of the secondary will be

(A) 240 V (B) 0.24 V

(C) 0.8 V (D) 0.08 V

64. 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

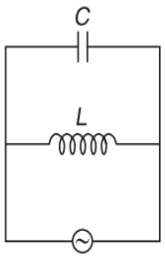
65. An LCR series circuit has a maximum current of 5 A. If $L = 0.5$ H and $C = 8\ \mu$F, then the angular frequency of AC voltage is

(A) 500 rads^{-1} (B) 5000 rads^{-1}
(C) 400 rads^{-1} (D) 250 rads^{-1}

66. The electric current in a circuit is given by $I = 4t$, where, t is in second and I in ampere. The rms current for the period $t = 0$ to $t = 2$ s is

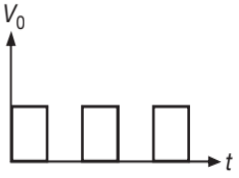
(A) 3 A (B) 4 A
(C) $\frac{8}{\sqrt{3}}$ A (D) $8\sqrt{3}$ A

67. In the AC network shown in Figure, the respective rms current flowing through the inductor and capacitor are 0.6 A and 0.8 A. The current supplied by the ac source is



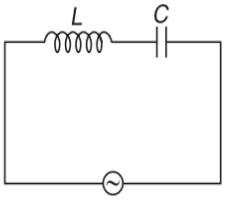
(A) 1.0 A (B) 1.4 A
(C) 0.2 A (D) 2.2 A

68. The rms value of the potential difference shown is



(A) V_0 (B) $\frac{V_0}{\sqrt{2}}$
(C) $\frac{V_0}{2}$ (D) $2V_0$

69. In a series LC circuit, the applied voltage is V_0. If ω is very low, then the voltage drop across the inductor V_L and capacitor V_C are

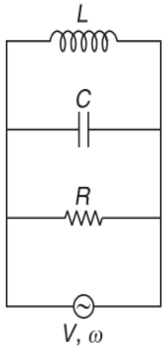


(A) $V_L = \frac{V_0}{2}$, $V_C = \frac{V_0}{2}$ (B) $V_L = 0$, $V_C = V_0$
(C) $V_L = V_0$, $V_C = 0$ (D) $V_L = -V_C = \frac{V_0}{2}$

70. In a step-up transformer, the turns ratio of primary and secondary is 1 : 2. A Laclanche cell of emf 1.5 V is connected across the primary. The voltage developed across the secondary would be

(A) ZERO (B) 3.0 V
(C) 1.5 V (D) 0.75 V

71. An AC source of peak value V_0 and angular frequency ω is applied across an LCR parallel circuit shown in Figure. The peak value of current through the AC source is



(A) $\frac{V_0}{\sqrt{\frac{1}{R^2}+\left(\omega L-\frac{1}{\omega C}\right)^2}}$ (B) $V_0\sqrt{\frac{1}{R^2}+\left(\omega C-\frac{1}{\omega L}\right)^2}$

(C) $\frac{V_0}{\sqrt{R^2+\left(\omega L-\frac{1}{\omega C}\right)^2}}$ (D) $V_0\left(\frac{1}{R}+\omega C-\frac{1}{\omega L}\right)$

72. An inductor of 1 H is connected across a 220 V, 50 Hz supply. The peak value of the current is approximately

(A) 0.5 A (B) 0.7 A
(C) 1 A (D) 1.4 A

73. If a current $I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$ flows in a circuit across which an alternating potential $E = E_0 \sin \omega t$ has been applied, then the power consumed in the circuit is

(A) $\frac{E_0 I_0}{\sqrt{2}}$ (B) $\frac{E_0 I_0}{2}$
(C) $\frac{EI}{\sqrt{2}}$ (D) ZERO

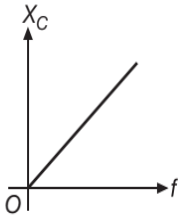
74. A steady current of magnitude I and an AC current of peak value I are allowed to pass through identical resistors for the same time. The ratio of heat produced in the two resistors will be

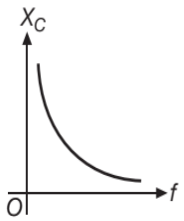
(A) 2 : 1 (B) 1 : 2
(C) 1 : 1 (D) None of these

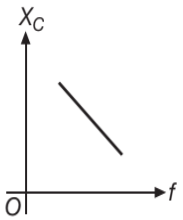
75. An AC source producing emf $V = V_0[\sin(\omega t) + \sin(2\omega t)]$ is connected in series with a capacitor and a resistor. The current found in the circuit is $I = I_1 \sin(\omega t + \phi_1) + I_2 \sin(2\omega t + \phi_2)$. Then, we have

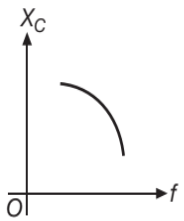
(A) $I_1 = I_2$ (B) $I_1 = \frac{I_2}{2}$
(C) $I_1 < I_2$ (D) $I_1 > I_2$

76. Identify the graph which correctly represents the variation of capacitive reactance X_C with frequency

(A) 

(B) 

(C) 

(D) 

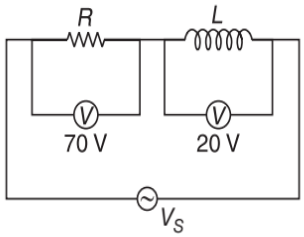
77. An LCR series circuit consists of a resistance of $10\ \Omega$, a capacitance of reactance $60\ \Omega$ and an inductor coil. The circuit is found to resonate when put across a 300 V, 100 Hz supply. The inductance of the coil is $(\text{Take } \pi = 3)$.

(A) 0.1 H (B) 0.01 H
(C) 0.2 H (D) 0.02 H

78. In PROBLEM 77, the current in the circuit at resonance is

(A) 10 A (B) 15 A
(C) 30 A (D) 60 A

79. The figure shows an AC circuit with resistance R, inductance L and source voltage V_s. Then,



(A) the source voltage $V_s = 72.8$ V
(B) the phase angle between current and source voltage is $\tan^{-1}\left(\frac{7}{2}\right)$
(C) Both (A) and (B) are correct
(D) Both (A) and (B) are wrong

80. A $60\ \mu$F capacitor, 0.3 H inductor and a $50\ \Omega$ resistor are connected in series with a 120 V, 60 Hz source. The current in the circuit approximately is

(A) 1.5 A (B) 2 A
(C) 3 A (D) 4 A

81. In PROBLEM 80, the power dissipated is

(A) 178 W (B) 89 W
(C) 56.25 W (D) 112.5 W

82. In an ac circuit, the rms value of the current, I_{rms}, is related to the peak current I_0 as

(A) $I_{rms} = \frac{I_0}{\pi}$ (B) $I_{rms} = \frac{I_0}{\sqrt{2}}$
(C) $I_{rms} = \sqrt{2} I_0$ (D) $I_{rms} = \pi I_0$

83. An alternating emf given by $V = V_0 \sin(\omega t)$ has peak value 10 V and frequency 50 Hz. The instantaneous emf at $t = \frac{1}{600}$ s is

(A) 10 V (B) $5\sqrt{3}$ V
(C) 5 V (D) 1 V

84. A step-up transformer connected to 220 V ac line is to supply 22 kV for a neon sign in secondary circuit. In primary circuit, a fuse wire is connected which is to blow when the current in the secondary circuit exceeds 10 mA. The turn ratio of the transformer is

(A) 50 (B) 100
(C) 150 (D) 200

85. A complex current wave function is represented by the equation is given by $i = (6 + 5\sin 100\omega t)$ A. Its average value over one time period is

(A) 12 A (B) 6 A
(C) $\sqrt{61}$ A (D) Zero

86. In an ac circuit $V(\text{in volt}) = 100\sin(100t)$ and $I(\text{in mA}) = 100\sin\left(100t + \frac{\pi}{3}\right)$. The power dissipated in the circuit is

(A) 10^4 W (B) 10 W
(C) 2.5 W (D) 5 W

MULTIPLE CORRECT CHOICE TYPE QUESTIONS

This section contains Multiple Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONE OR MORE is/are correct.

1. In an LCR circuit, the resistance R, inductance L and capacitance C are connected in series. An ac voltage $V = V_0 \sin(\omega t)$ is fed to this circuit. The frequency ω of the source can be varied, theoretically from zero (i.e. extremely small values) to infinity (i.e. extremely large values). If $\langle P \rangle$ is the average power consumed in the circuit, then select the correct statement(s).

(A) $\langle P \rangle \approx 0$ for $\omega_0 \to \infty$

(B) $\langle P \rangle$ is independent of ω.

(C) $\langle P \rangle = \frac{V_0^2}{2R}$ for $\omega^2 LC = 1$

(D) $\langle P \rangle = \frac{V_0^2}{4R}$ for frequencies that differ in value by $\frac{R}{L}$

2. In an AC circuit, the power factor

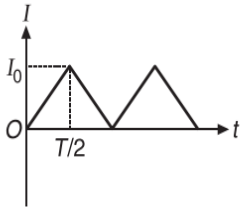
(A) is unity when the circuit is purely resistive.

(B) is unity when the circuit is purely inductive.

(C) is zero when the circuit is purely capacitive.

(D) is 0.5 when the difference of inductive reactance and capacitive reactance is 1.732 times the resistance.

3. The current in a certain circuit varies with time as shown. The peak value of current is I_0. If i_v and i_m represent the virtual (rms) and mean value of current for a complete cycle respectively, then



(A) $i_m = \frac{2i_0}{\pi}$ (B) $i_m = \frac{i_0}{2}$

(C) $i_{rms} = \frac{i_0}{\sqrt{3}}$ (D) $i_{rms} = \frac{i_0}{\sqrt{2}}$

4. A tube light of 60 V, 60 W rating is connected across an AC source of 100 V and 50 Hz frequency. Then

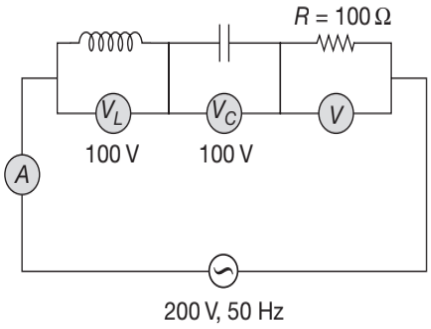
(A) an inductance of $\frac{4}{5\pi}$ H may be connected in series.

(B) a capacitor of $\frac{250}{\pi}$ μF may be connected in series to it.

(C) an inductor of $\frac{2}{5\pi}$ H may be connected in series

(D) a resistance of 40 Ω may be connected in series

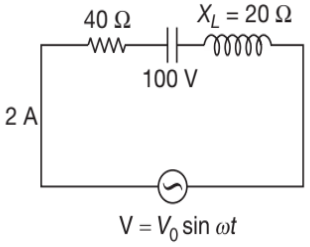
5. In the circuit shown if V_R and A be the readings of the voltmeter and ammeter, then



(A) $V_R = 300$ V (B) $A = 1$ A

(C) $V_R = 200$ V (D) $A = 2$ A

6. For the circuit shown in Figure, labelled with the specific values, select the correct statements.



(A) The voltage across the resistor is 80 V

(B) The capacitive reactance is 50 Ω

(C) The voltage across the inductor is 40 V

(D) The peak value of the applied voltage is 100 V

7. During resonance, in a series LCR circuit, the power

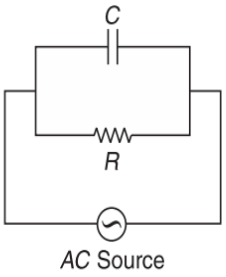
(A) factor is one

(B) factor is zero

(C) consumed across inductor is zero

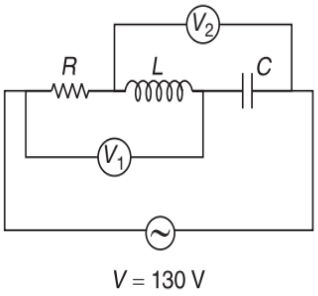
(D) consumed across resistor is $\frac{I_0^2 R}{2}$

8. A 200 V, 5kHz AC source is applied to the circuit having a capacitor $C = \frac{1}{\pi}$ μF and a resistor $R = 100$ Ω as shown in Figure. Then, select the correct statement(s).



(A) The current through the resistor is 2 A
(B) The current through the capacitor is 0.126 A
(C) Total current supplied by ac source is ≈ 0.283 A
(D) Current in both the branches is same

9. In a series LCR circuit shown in Figure, the readings of voltmeters V_1 and V_2 are 100 V and 120 V. Select the correct statement(s).



(A) Voltage across resistor, inductor and capacitor are 50 V, 86.6 V and 206.6 V respectively.
(B) Voltage across resistor, inductor and capacitor are 10 V, 90 V and 30 V respectively.
(C) Power factor of the circuit is $\frac{5}{13}$.
(D) Circuit is capacitive in nature.

10. In a series *LCR* circuit, the rms voltage supply is 170 V. If V_R, V_L and V_C represent the rms voltage drop across resistor, inductor and capacitor, then
(A) $V_R \le 170$ V (always)
(B) $V_L \le 170$ V (always)
(C) V_L or V_C may be greater than 170 V
(D) $|V_L - V_C| < 170$

11. In an AC series circuit, $R = 20\ \Omega$, $X_L = 20\ \Omega$ and $X_C = 40\ \Omega$. Then, select the correct option(s).
(A) The given values are at frequency less than the resonance frequency.
(B) The given values are at frequency more than the resonance frequency.
(C) If frequency is increased from the given value, impedance of the circuit will decrease.
(D) If frequency is increased from the given value, current in the circuit may increase or decrease.

12. Consider three *LC* circuits, first with capacitance *C*, inductance *L*, second with capacitance $\frac{C}{2}$, inductance 2*L* and third with capacitance 2*C*, inductance $\frac{L}{2}$. All the three capacitors are charged to the same potential *V* and then made to oscillate. The respective frequencies of the circuits are f_1, f_2 and f_3. Also the currents in the circuits have respective maximum values I_1, I_2 and I_3. Then
(A) $f_1 = f_2 = f_3$ (B) $f_1 = f_2 = \frac{f_3}{\sqrt{2}}$
(C) $I_1 = I_2 < I_3$ (D) $I_2 < I_1 < I_3$

13. Current in an *AC* circuit is given by $i = 3\sin\omega t + 4\cos\omega t$, then
(A) rms value of current is $2.5\sqrt{2}$ A
(B) mean value of this current in positive one-half period will be 3.2 A
(C) if voltage applied is $V = V_0 \sin\omega t$, then the circuit may contain resistance and capacitance
(D) if voltage applied is $V = V_0 \cos\omega t$, then the circuit may contain resistance and inductance only

14. In an AC series circuit, $R = 10\ \Omega$, $X_L = 20\ \Omega$ and $X_C = 10\ \Omega$. Then, select the correct option(s).
(A) Voltage function will lead the current function.
(B) Total impedance of the circuit is $10\sqrt{2}\ \Omega$.
(C) Phase angle between voltage function and current function is $45°$.
(D) Power factor of circuit is $\frac{1}{\sqrt{2}}$.

REASONING BASED QUESTIONS

This section contains Reasoning type questions, each having four choices (A), (B), (C) and (D) out of which ONLY ONE is correct. Each question contains STATEMENT 1 and STATEMENT 2. You have to mark your answer as

Bubble (A) If both statements are TRUE and STATEMENT 2 is the correct explanation of STATEMENT 1.
Bubble (B) If both statements are TRUE but STATEMENT 2 is not the correct explanation of STATEMENT 1.
Bubble (C) If STATEMENT 1 is TRUE and STATEMENT 2 is FALSE.
Bubble (D) If STATEMENT 1 is FALSE but STATEMENT 2 is TRUE.

1. **Statement-1:** In series *LCR* circuit resonance can take place.
Statement-2: Resonance takes if inductive and capacitive reactance are equal.

2. **Statement-1:** AC source is connected across a circuit. Power dissipated in circuit is P. The power is dissipated only across resistance.
Statement-2: Inductor and capacitor will not consume any power in AC circuit.

3. **Statement-1:** In a LC circuit, the charge on the capacitor oscillates simple harmonically.
Statement-2: The total energy in a LC circuit is a constant.

4. **Statement-1:** Average value of a.c. over a complete cycle is always zero.
Statement-2: Average value of a.c. is always defined over half cycle.

5. **Statement-1:** Capacitor serves as a block for d.c. and offers an easy path to a.c.
Statement-2: Capacitive reactance is inversely proportional to frequency.

6. **Statement-1:** When frequency is greater than resonance frequency in a series LCR circuit, it will be an inductive circuit.
Statement-2: Resultant voltage will lead the current.

7. **Statement-1:** A capacitor blocks direct current in the steady state.
Statement-2: The capacitive reactance of the capacitor is inversely proportional to frequency f of the source of emf.

8. **Statement-1:** In the purely resistive element of a series LCR AC circuit, the maximum value of r.m.s. current increases with increase in the angular frequency of the applied e.m.f.
Statement-2: $I_{max}=\frac{E_{max}}{Z}$, $Z=\sqrt{R^2+\left(\omega L-\frac{1}{\omega C}\right)^2}$, where I_{max} is the peak current in a cycle.

LINKED COMPREHENSION TYPE QUESTIONS

This section contains Linked Comprehension Type Questions or Paragraph based Questions. Each set consists of a Paragraph followed by questions. Each question has four choices (A), (B), (C) and (D), out of which only one is correct (For the sake of competitiveness there may be a few questions that may have more than one correct options).

Comprehension I

A $25\ \mu F$ capacitor, a 0.10 H inductor and a $25\ \Omega$ resistor are connected in series with an AC source whose emf is given by $E=310\sin(314t)$ volt. Based on the above facts, answer the following questions.

1. The frequency of the emf is
(A) 25 cps (B) 50 cps
(C) 75 cps (D) 100 cps

2. The reactance of the circuit is
(A) $95.9\ \Omega$ (B) $65.7\ \Omega$
(C) $127.3\ \Omega$ (D) $31.4\ \Omega$

3. The impedance of the circuit is
(A) $79.1\ \Omega$ (B) $89.1\ \Omega$
(C) $99.1\ \Omega$ (D) $100.1\ \Omega$

4. The current in the circuit is
(A) 1.21 A (B) 2.21 A
(C) 3.21 A (D) 4.21 A

5. The phase angle of the current by which it leads the applied emf is
(A) 75.4° (B) 30°
(C) 60° (D) 90°

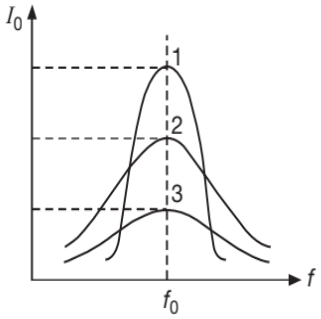
6. The expression for the instantaneous value of current in the circuit is
(A) $3.13\sin(314t+1.32)$ (B) 2 A
(C) $3.13\cos(314t+1.32)$ (D) $\sqrt{2}\,A$

7. The effective voltages across the capacitor, the inductor and the resistor are
(A) 281.3 V, 69.4 V, 55.3 V
(B) 0, 0, 0
(C) 3 V, 2 V, 6 V
(D) None of these

8. The value of inductance that will make the impedance of circuit to be minimum is
(A) 0.11 H (B) 0.21 H
(C) 0.31 H (D) 0.41 H

Comprehension 2

The figure represents variation of peak current I_0 with applied frequency f of the AC source of three different LCR circuits having different resistances. The value of inductance L and capacitance C are same for all the three circuits. Based on the above facts, answer the following questions.



9. If R_1, R_2 and R_3 be the resistance of circuit 1, 2 and 3 respectively, then

(A) $R_1 > R_2 > R_3$ (B) $R_1 < R_2 < R_3$

(C) $R_1 > R_2 = R_3$ (D) $R_1 = R_2 = R_3$

10. If $R_1 = 1\,\Omega$, $R_2 = 5\,\Omega$, $R_3 = 10\,\Omega$ and $L = \frac{900}{\pi}$ mH, $C = \frac{40}{\pi}\,\mu$F, then the value of f_0 is

(A) 250 Hz (B) 125 Hz

(C) $\frac{250}{6}$ Hz (D) $\frac{250}{3}$ Hz

11. A capacitor of capacitance C is charged to a potential V and then connected to an inductor of inductance L in a closed circuit. Choose the correct statement

(A) There is no current in the circuit, initially

(B) The current will flow through circuit until the capacitor gets fully discharged

(C) The current in the circuit will be very high since there is no resistance in the circuit

(D) There will always be flow of current in the circuit

12. In context to Question No. 37, the maximum current that flows through the inductor is

(A) $V\sqrt{\frac{C}{L}}$

(B) $V\sqrt{\frac{L}{C}}$

(C) $\frac{1}{2\pi}V\sqrt{\frac{C}{L}}$

(D) There is no flow of current

13. In context to Question No. 31, the frequency with which energy oscillates between Electric Field Energy and Magnetic Field Energy is

(A) $\frac{1}{4\pi\sqrt{LC}}$

(B) $\frac{1}{\pi\sqrt{LC}}$

(C) $\frac{1}{2\pi\sqrt{LC}}$

(D) the energy in the electric field does not oscillate

Comprehension 3

A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series LCR circuit in which $R = 3\,\Omega$, $L = 25.48$ mH, $C = 796\,\mu$F. Based on the above facts, answer the following questions.

14. The rms voltage is

(A) 50 V (B) 100 V

(C) 200 V (D) 250 V

15. X_L is

(A) 2 Ω (B) 4 Ω

(C) 6 Ω (D) 8 Ω

16. X_C is

(A) 2 Ω (B) 4 Ω

(C) 6 Ω (D) 8 Ω

17. Z is

(A) 2 Ω (B) 3 Ω

(C) 4 Ω (D) 5 Ω

18. The peak current is

(A) 56.6 A (B) 26.6 A

(C) 16.2 A (D) 7.2 A

19. The phase angle is

(A) 43.13° (B) 53.13°

(C) 60° (D) 90°

20. The rms current is

(A) 10 A (B) 20 A

(C) 30 A (D) 40 A

21. The rms voltage across capacitor is

(A) 120 V (B) 160 V

(C) 320 V (D) 0 V

22. The rms voltage across inductor is

(A) 120 V (B) 160 V

(C) 320 V (D) 0 V

23. The rms voltage across resistor is
(A) 120 V (B) 160 V
(C) 320 V (D) 0 V

24. The power dissipated in the circuit is
(A) 4800 W (B) 240 W
(C) 120 W (D) 12 W

25. The power factor is
(A) 0.1 (B) 0.4
(C) 0.5 (D) 0.6

26. The power input is
(A) 4800 W (B) 240 W
(C) 120 W (D) 12 W

27. The resonance frequency is
(A) 35.4 Hz (B) 45 Hz
(C) 50 Hz (D) 60 Hz

28. Value of Z at resonance is
(A) 1 Ω (B) 2 Ω
(C) 3 Ω (D) 4 Ω

29. Current at resonance is
(A) 66.67 A (B) 1 A
(C) 0 A (D) ∞

30. The power consumed at resonance is
(A) 13.33 kW (B) 23.33 kW
(C) 4 kW (D) 7 kW

Comprehension 4

In an AC series RC circuit, the voltage applied V and the current I are given by

$$V(t)=170\sin\left(6280t+\frac{\pi}{3}\right)\text{ V}$$

$$I(t)=8.5\sin\left(6280t+\frac{\pi}{2}\right)\text{ A}$$

31. The resistance of the circuit is
(A) 10.32 Ω (B) 17.32 Ω
(C) 6.32 Ω (D) 25.32 Ω

32. The capacitance of the circuit will be
(A) 15.92 μΩ (B) 10.92 μΩ
(C) 13 μΩ (D) 50.92 μΩ

33. The power factor will be given by
(A) $\sqrt{3}$ (B) $\frac{1}{\sqrt{2}}$
(C) $\frac{\sqrt{3}}{2}$ (D) $\frac{1}{2}$

Comprehension 5

A series LCR circuit with $L=0.12$ H, $C=480$ nF, $R=23$ Ω is connected to a 230 V variable frequency supply. Based on the above facts, answer the following questions.

34. The source frequency for which current amplitude is maximum is
(A) 263 Hz (B) 363 Hz
(C) 463 Hz (D) 663 Hz

35. The current amplitude is
(A) 7.1 A (B) 8.1 A
(C) 11.1 A (D) 14.1 A

36. What is the source frequency for which average power absorbed by the circuit is maximum?
(A) 263 Hz (B) 363 Hz
(C) 463 Hz (D) 663 Hz

37. The maximum average power is
(A) 186 W (B) 1186 W
(C) 2286 W (D) 3386 W

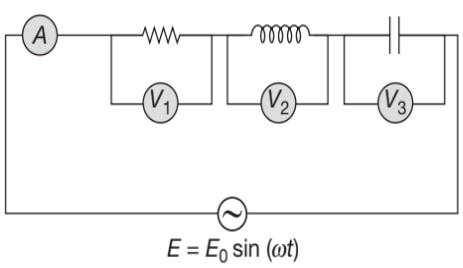
38. The frequencies of the source for which the power transferred to the circuit is half the power at resonant frequency are
(A) 648 Hz, 678 Hz (B) 630 Hz, 640 Hz
(C) 330 Hz, 440 Hz (D) 1 Hz, 2 Hz

39. The current amplitude at half the peak power points is
(A) 2 A (B) 6 A
(C) 8 A (D) 10 A

40. The Q-factor of the circuit is
(A) 21.7 (B) 11.7
(C) 9.7 (D) 7.7

Comprehension 6

For the circuit shown in figure a voltage of $E=E_0\sin(\omega t)$ is applied. The voltmeter readings are V_1 = 100 V, V_2 = 125 V, V_3 = 150 V and ammeter reading is 5 A.



41. The net impedance of circuit is
(A) $5\sqrt{37}$ Ω (B) $5\sqrt{26}$ Ω
(C) $5\sqrt{17}$ Ω (D) $5\sqrt{29}$ Ω

42. The power factor of circuit is

(A) $\frac{4}{\sqrt{17}}$ (B) $\frac{4}{\sqrt{29}}$

(C) $\frac{4}{\sqrt{26}}$ (D) $\frac{4}{\sqrt{37}}$

43. The value of E_0 is

(A) $25\sqrt{17}$ V (B) $20\sqrt{17}$ V

(C) $20\sqrt{34}$ V (D) $25\sqrt{34}$ V

Comprehension 7

A circuit containing a 80 mH inductor and a 60 μF capacitor in series is connected to a 230 volt, 50 Hz supply. The resistance of the circuit is negligible. Based on the above facts, answer the following questions.

44. The current amplitude is

(A) 7.6 A (B) 8.6 A

(C) 9.6 A (D) 11.6 A

45. The rms value of current is

(A) 5.2 A (B) 6.2 A

(C) 7.2 A (D) 8.2 A

46. The rms value of potential drop across inductor is

(A) 106 V (B) 206 V

(C) 306 V (D) 406 V

47. The rms value of potential drop across capacitor is

(A) 135.3 V (B) 235.3 V

(C) 335.3 V (D) 435.3 V

48. The applied rms voltage is

(A) 229.3 V (B) 119.3 V

(C) 19.3 V (D) 9.3 V

49. The average power transferred to the inductor is

(A) 0 W (B) 1 W

(C) 4 W (D) 19.7 W

50. The average power transferred to the capacitor is

(A) 0 W (B) 1 W

(C) 4 W (D) 19.7 W

51. The total average power absorbed by the circuit is

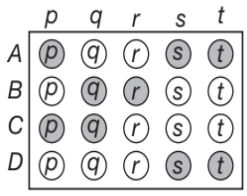
(A) 0 W (B) 1 W

(C) 4 W (D) 19.7 W

MATRIX MATCH/COLUMN MATCH TYPE QUESTIONS

Each question in this section contains statements given in two columns, which have to be matched. The statements in **COLUMN-I** are labelled A, B, C and D, while the statements in **COLUMN-II** are labelled p, q, r, s (and t). Any given statement in **COLUMN-I** can have correct matching with **ONE OR MORE** statement(s) in **COLUMN-II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following examples:

If the correct matches are A → p, s and t; B → q and r; C → p and q; and D → s and t; then the correct darkening of bubbles will look like the following:

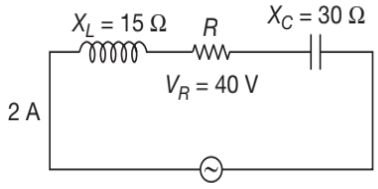


1. An LCR series circuit has a current which lag behind the applied voltage by ϕ. The voltage across the inductance has a maximum value equal to twice the maximum of the voltage across the capacitor. $E_L = 30\sin(100t)$. If $R = 20\ \Omega$, then match the items given in **COLUMN-I** with that in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) Reactance of capacitor if $\phi = 45°$.	(p) 120 Ω
(B) Reactance of inductor if $\phi = 45°$.	(q) $20\sqrt{3}$ Ω
(C) Impedance of circuit if $\phi = 45°$.	(r) 20 Ω
(D) Reactance of circuit if $\phi = 60°$.	(s) 40 Ω
	(t) $20\sqrt{2}$ Ω

(*Continued*)

2. For the circuit shown, match descriptions in **COLUMN-I** with the respective values in SI units given in **COLUMN-II**.



COLUMN-I	COLUMN-II
(A) The resistance is	(p) 20
(B) Voltage across the capacitor	(q) 30
(C) Voltage across the inductor	(r) 50
(D) Applied voltage	(s) 60

3. Match the elements given in **COLUMN-I**, with their respective current phase relation given in **COLUMN-II** for an AC input applied across each element or the combination of elements.

COLUMN-I	COLUMN-II
(A) Ideal capacitor	(p) current leads voltage
(B) Non ideal inductor	(q) voltage leads current
(C) LCR circuit for the minimum impedance	(r) $\phi = 90°$
(D) Non ideal capacitor	(s) $\phi = 0°$

4. For a series LCR circuit connected to an AC source, match the variations in **COLUMN-I** to the effects in **COLUMN-II.**

COLUMN-I	COLUMN-II
(A) If resistance is increased	(p) current will increase
(B) If capacitance is increased	(q) current will decrease
(C) If inductance is increased	(r) current may increase or decrease
(D) If frequency is increased	(s) power may decrease or increase

5. An AC voltage $V = V_0 \sin \omega t$ is applied across a circuit. Corresponding to this applied voltage, match the currents in **COLUMN-I** to the respective circuit combinations in **COLUMN-II**.

COLUMN-I	COLUMN-II
(A) $I = I_0 \sin \omega t$	(p) only R circuit
(B) $I = -I_0 \cos \omega t$	(q) only L circuit
(C) $I = I_0 \sin\left(\omega t + \frac{\pi}{6}\right)$	(r) may be CR circuit
(D) $I = I_0 \sin\left(\omega t - \frac{\pi}{3}\right)$	(s) may be LR circuit
	(t) may be LCR circuit

INTEGER/NUMERICAL ANSWER TYPE QUESTIONS

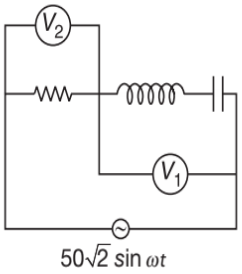
In this section, the answer to each question is a numerical value obtained after doing series of calculations based on the data given in the question(s).

1. In a series LCR circuit where $R = 300\ \Omega$, $L = 0.8$ H, and $C = 0.04\ \mu$F, the source has voltage amplitude $V = 300$ V and a frequency equal to the resonance frequency of the circuit.
   (a) What is the power factor?
   (b) What is the average power delivered, in watt, by the source?
   (c) The capacitor is replaced by one with $C = 0.08\ \mu$F, and the source frequency is adjusted to the new resonance value. What is then the average power delivered, in watt, by the source?

2. Consider a series LR circuit in which $L = \frac{1}{\pi} H$ and resistance $R = 100\ \Omega$. When the circuit is connected to a 220 V, 50 Hz a.c. source, calculate the current drawn in ampere from the source.

3. A current of 4 A flows in a coil when connected to a 12 V dc source. If the same coil is connected to a 12 V, 50 rads^{-1} ac source, a current of 2.4 A flows in the circuit. Determine the inductance of the coil in millihenry. Also find the power developed in the circuit, closest to two-digit integer in watt, if a 2500 μF capacitor is connected in series with the coil.

4. In the circuit shown, the reading of voltmeter V_1 is 40 V. Calculate the reading of voltmeter V_2 in volt.



5. A fixed inductance $L = 2\ \mu$H is used in series with a variable capacitor in the tuning section of a radiotelephone on a ship. What capacitance, in pF, tunes the circuit to the signal from a transmitter broadcasting at 5 MHz ? Take $\pi^2 \cong 10$.

6. A series LCR circuit having a resistance of $100\sqrt{5}\ \Omega$ is connected to a 200 V ac source. When the capacitor is removed from the circuit, the current lags behind voltage by $45°$. When the inductor is removed from the circuit keeping the capacitor and resistor in the circuit, the current leads the voltage by an angle of $\tan^{-1}\left(\frac{1}{2}\right)$. Calculate the current (in ampere) in the LCR circuit and the average power dissipated (in watt) in LCR circuit.

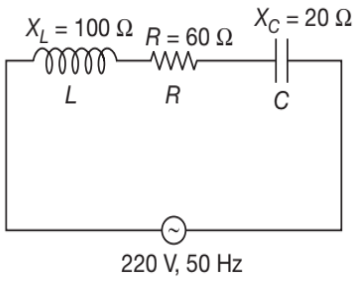
7. For a series LCR circuit with $L = 2$ H, $C = 1\ \mu$F and $R = 1\ \text{k}\Omega$, connected across an ac input given by $V = 100\sqrt{2}\sin(1000t)$ V, find the voltage across L, C and R, rounded off to the nearest integer, in volt.

8. A coil of inductance 0.4 mH is connected to a capacitor of capacitance 400 pF. The wave length for which this circuit is tuned is found to be $(*)\pi$, where $*$ is not readable. Calculate $*$.

9. A $10\ \Omega$ resistor, 10 mH inductor and $100\ \mu$F capacitor are connected in series to a 50 V (rms) source having variable frequency. Find the energy, in millijoule, that is delivered to the circuit during one period if the operating frequency is twice the resonance frequency.

10. When a coil is connected to a 100 V DC supply, the current in it is 2 A. When the same coil is connected to an AC source $V = 100\sqrt{2}\sin\omega t$, the current is 1 A. Find the inductive reactance (in ohm) used in the circuit.

11. For the circuit shown in Figure, calculate the power factor.



12. A series LCR circuit having resistor of $120\ \Omega$ has a resonant frequency of 4000 rads^{-1}. At resonance, the voltage across resistance and inductance is 60 V and 40 V respectively. Calculate the value of inductance (in millihenry) and capacitance (in microfarad) in the circuit.

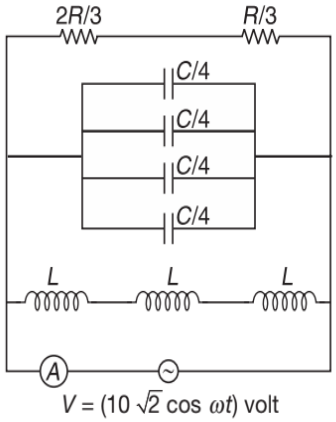
13. A $12\ \Omega$ resistor and an inductor of inductance $\frac{0.05}{\pi}$ H having negligible resistance are connected in series. Across the end of this circuit a 130 V, 50 Hz ac source is connected. Calculate the current (in ampere) in the circuit, the potential difference across resistance and inductance in volt.

14. A series LCR circuit is connected across an ac source $E = 10\sin\left(100\pi t - \frac{\pi}{6}\right)$ and the current in the circuit is observed to be $I = 2\sin\left(100\pi t + \frac{\pi}{12}\right)$. Calculate the average power (in watt) dissipated in the circuit.

15. Calculate the capacitance of the capacitor (in microfarad) required to be connected in series with a 30 V, 10 W bulb to run it when connected across a 220 V, 50 Hz ac.

16. A light bulb has the rating 200 W, 220 V. Find the resistance of the bulb (in ohm) and the rms value of current flowing through the bulb (in ampere).

17. In the circuit shown, reactance of each capacitor is $4R$ and that of each inductor is $\frac{R}{3}$. If $R = 5\ \Omega$ then calculate the reading of ammeter, in ampere.



18. A capacitor, a resistor and a 40 mH inductor is connected in series to an ac source of frequency 50 Hz. Calculate the capacitance of the capacitor in μF, if the current is in phase with the voltage.

ARCHIVE: JEE MAIN

1. **[Online April 2019]**
An alternating voltage $V(t) = 220\sin(100\pi t)$ volt is applied to a purely resistive load of 50 Ω. The time taken for the current to rise from half of the peak value to the peak value is

(A) 2.2 ms (B) 7.2 ms
(C) 5 ms (D) 3.3 ms

2. **[Online April 2019]**
A circuit connected to an ac source of emf $e = e_0\sin(100t)$ with t in seconds, gives a phase difference of $\frac{\pi}{4}$ between the emf e and current i. Which of the following circuits will exhibit this?

(A) RL circuit with $R = 1\ \text{k}\Omega$ and $L = 10$ mH
(B) RL circuit with $R = 1\ \text{k}\Omega$ and $L = 1$ mH
(C) RC circuit with $R = 1\ \text{k}\Omega$ and $C = 10\ \mu$F
(D) RC circuit with $R = 1\ \text{k}\Omega$ and $C = 1\ \mu$F

3. **[Online April 2019]**
One kg of water, at 20 °C, is heated in an electric kettle whose heating element has a mean (temperature averaged) resistance of 20 Ω. The rms voltage in the mains is 200 V. Ignoring heat loss from the kettle, time taken for water to evaporate fully, is close to

[Specific heat of water $= 4200\ \text{Jkg}^{-1}\ ^\circ\text{C}^{-1}$, Latent heat of water $= 2260\ \text{kJkg}^{-1}$]

(A) 16 minute (B) 3 minute
(C) 22 minute (D) 10 minute

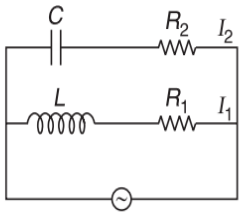
4. **[Online January 2019]**
A series AC circuit containing an inductor (20 mH), a capacitor (120 μF) and a resistor (60 Ω) is driven by an AC source of $\frac{24\ \text{V}}{50\ \text{Hz}}$. The energy dissipated in the circuit in 60 s is

(A) 5.65×10^2 J (B) 5.17×10^2 J
(C) 2.26×10^3 J (D) 3.39×10^3 J

5. **[Online January 2019]**
A power transmission line feeds input power at 2300 V to a step-down transformer with its primary windings having 4000 turns. The output power is delivered at 230 V by the transformer. If the current in the primary winding of the transformer is 5 A and its efficiency is 90%, the output current would be

(A) 25 A (B) 50 A
(C) 45 A (D) 35 A

6. **[Online January 2019]**
In the circuit shown $C = \frac{\sqrt{3}}{2}\ \mu$F, $R_2 = 20\ \Omega$, $L = \frac{\sqrt{3}}{10}$ H and $R_1 = 10\ \Omega$. Current in L-R_1 path is I_1 and in C-R_2 path it is I_2. The voltage of AC source is given by $V = 200\sqrt{2}\sin(100t)$ volt. The phase difference between I_1 and I_2 is



(A) 0° (B) 60°
(C) 30° (D) 90°

7. **[2018]**
In an ac circuit, the instantaneous emf and current are given by $e = 100\sin 30t$, $i = 20\sin\left(30t - \frac{\pi}{4}\right)$. In one cycle of ac, the average power consumed by the circuit and the wattless current are, respectively

(A) $50, 10$ (B) $\frac{1000}{\sqrt{2}}, 10$

(C) $\frac{50}{\sqrt{2}}, 0$ (D) $50, 0$

8. [2018]

For an RLC circuit driven with voltage of amplitude v_m and frequency $\omega_0 = \frac{1}{\sqrt{LC}}$ the current exhibits resonance. The quality factor, Q is given by

(A) $\frac{\omega_0 L}{R}$ (B) $\frac{\omega_0 R}{L}$

(C) $\frac{R}{\omega_0 C}$ (D) $\frac{CR}{\omega_0}$

9. [Online 2018]

An ideal capacitor of capacitance $0.2\ \mu F$ is charged to a potential difference of $10\ V$. The charging battery is then disconnected. The capacitor is then connected to an ideal inductor of self-inductance $0.5\ mH$. The current at a time when the potential difference across the capacitor is $5\ V$, is

(A) 0.34 A (B) 0.17 A

(B) 0.25 A (C) 0.15 A

10. [Online 2018]

A power transmission line feeds input power at $2300\ V$ to a step down transformer with its primary windings having 4000 turns, giving the output power at $230\ V$. If the current in the primary of the transformer is $5\ A$ and its efficiency is 90%, the output current would be

(A) 50 A (B) 25 A

(C) 45 A (D) 20 A

11. [Online 2017]

A sinusoidal voltage of peak value $283\ V$ and angular frequency $320\ s^{-1}$ is applied to a series LCR circuit. Given that $R = 5\ \Omega$, $L = 25\ mH$ and $C = 1000\ \mu F$. The total impedance and phase difference between the voltage across the source and the current will respectively be

(A) $10\ \Omega$ and $\tan^{-1}\left(\frac{5}{3}\right)$ (B) $10\ \Omega$ and $\tan^{-1}\left(\frac{8}{3}\right)$

(C) $7\ \Omega$ and $\tan^{-1}\left(\frac{5}{3}\right)$ (D) $7\ \Omega$ and $45°$

12. [2016]

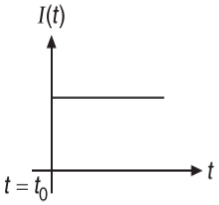
An arc lamp requires a direct current of $10\ A$ at $80\ V$ to function. If it is connected to a $220\ V$ (rms), $50\ Hz$ ac supply, the series inductor needed for it to work is close to

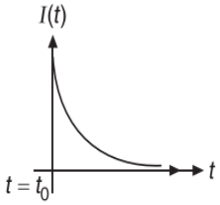
(A) 80 H (B) 0.08 H

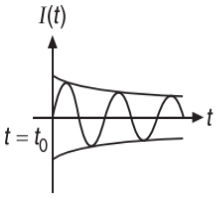
(C) 0.044 H (D) 0.065 H

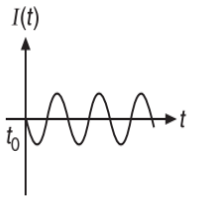
13. [Online 2016]

A series LR circuit is connected to a voltage source with $V(t) = V_0 \sin \omega t$. After very large time, current $I(t)$ behaves as $\left(t_0 \gg \frac{L}{R}\right)$

(A) 

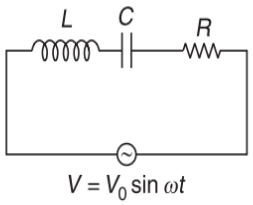
(B) 

(C) 

(D) 

14. [Online 2015]

For the LCR circuit, shown here, the current is observed to lead the applied voltage. An additional capacitor C', when joined with the capacitor C present in the circuit, makes the power factor of the circuit unity. The capacitor C', must have been connected in



(A) series with C and has a magnitude $\frac{1-\omega^2 LC}{\omega^2 L}$

(B) series with C and has a magnitude $\frac{C}{(\omega^2 LC - 1)}$

(C) parallel with C and has a magnitude $\frac{C}{(\omega^2 LC - 1)}$

(D) parallel with C and has a magnitude $\frac{1-\omega^2 LC}{\omega^2 L}$.

15. [2010]

In a series LCR circuit $R = 200\ \Omega$ and the voltage and the frequency of the main supply is $220\ V$ 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) 242 W (B) 305 W

(C) 210 W (D) ZERO W

ARCHIVE: JEE ADVANCED

Single Correct Choice Type Problems

This section contains Single Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONLY ONE is correct.

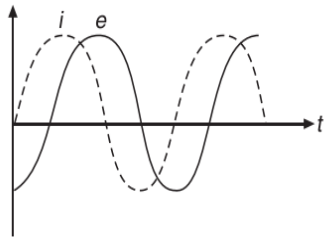
1. [IIT-JEE 2010]

An AC voltage source of variable angular frequency ω and fixed amplitude V connected in series with a capacitance C and an electric bulb of resistance R (inductance zero). When ω is increased

(A) the bulb glows dimmer
(B) the bulb glows brighter
(C) total impedance of the circuit is unchanged
(D) total impedance of the circuit increases

2. [IIT-JEE 2003]

When an AC source of emf $e = E_0 \sin(100t)$ is connected across a circuit, the phase difference between the emf e and the current i in the circuit is observed to be $\frac{\pi}{4}$, as shown in Figure. If the circuit consists possibly only of R-C or R-L or L-C in series, find the relationship between the two elements



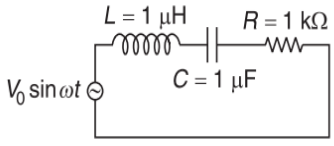
(A) $R = 1\ \text{k}\Omega, C = 10\ \mu\text{F}$ (B) $R = 1\ \text{k}\Omega, C = 1\ \mu\text{F}$
(C) $R = 1\ \text{k}\Omega, L = 10\ \text{H}$ (D) $R = 1\ \text{k}\Omega, L = 1\ \text{H}$

Multiple Correct Choice Type Problems

This section contains Multiple Correct Choice Type Questions. Each question has four choices (A), (B), (C) and (D), out of which ONE OR MORE is/are correct.

1. [JEE (Advanced) 2017]

In the circuit shown, $L = 1\ \mu\text{H}$, $C = 1\ \mu\text{F}$ and $R = 1\ \text{k}\Omega$. They are connected in series with an AC source $V = V_0 \sin \omega t$ as shown. Which of the following options is/are correct?



(A) At $\omega \sim 0$, the current flowing through the circuit becomes nearly zero
(B) The frequency at which the current will be in phase with the voltage is independent of R
(C) The current will be in phase with the voltage if $\omega = 10^4\ \text{rads}^{-1}$
(D) At $\omega \gg 10^6\ \text{rads}^{-1}$, the circuit behaves like a capacitor

2. [JEE (Advanced) 2017]

The instantaneous voltages at three terminals marked X, Y and Z are given by $V_X = V_0 \sin \omega t$,

$$V_Y = V_0 \sin\left(\omega t + \frac{2\pi}{3}\right) \text{ and } V_Z = V_0 \sin\left(\omega t + \frac{4\pi}{3}\right).$$

An ideal voltmeter is configured to read rms value of the potential difference between its terminals. It is connected between points X and Y and then between Y and Z. The reading(s) of the voltmeter will be

(A) $(V_{YZ})_{\text{rms}} = V_0\sqrt{\frac{1}{2}}$

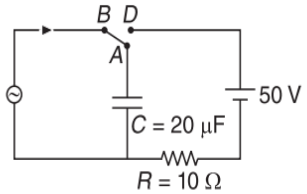
(B) $(V_{XY})_{\text{rms}} = V_0\sqrt{\frac{3}{2}}$

(C) independent of the choice of the two terminals

(D) $(V_{XY})_{\text{rms}} = V_0$

3. [JEE (Advanced) 2014]

At time $t = 0$, terminal A in the circuit shown in the figure is connected to B by a key and an alternating current $I(t) = I_0 \cos(\omega t)$, with $I_0 = 1$ A and $\omega = 500\ \text{rads}^{-1}$ starts flowing in it with the initial direction shown in the Figure. At $t = \frac{7\pi}{6\omega}$, the key is switched from B to D. Now onwards only A and D are connected. A total charge Q flows from the battery to charge the capacitor fully. If $C = 20\ \mu\text{F}$, $R = 10\ \Omega$ and the battery is ideal with emf of 50 V, identify the correct statement(s).



(A) Magnitude of the maximum charge on the capacitor before $t = \frac{7\pi}{6\omega}$ is 1×10^{-3} C

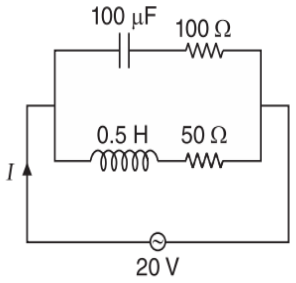
(B) The current in the left part of the circuit just before $t = \frac{7\pi}{6\omega}$ is clockwise

(C) Immediately after A is connected to D, the current in R is 10 A

(D) $Q = 2 \times 10^{-3}$ C

4. [IIT-JEE 2012]

In the given circuit, the AC source has $\omega = 100$ rads^{-1}. Considering the inductor and capacitor to be ideal, the correct choice(s) is(are)



(A) the current through the circuit, I is 0.3 A

(B) the current through the circuit, I is $0.3\sqrt{2}$ A

(C) the voltage across 100 Ω resistor $= 10\sqrt{2}$ V

(D) the voltage across 50 Ω resistor $= 10$ V

5. [IIT-JEE 2011]

A series R-C circuit is connected to AC voltage source. Consider two cases; (A) when C is without a dielectric medium and (B) when C is filled with dielectric of constant 4. The current I_R through the resistor and voltage V_C across the capacitor are compared in the two cases. Which of the following is/are true?

(A) $I_R^A > I_R^B$ (B) $I_R^A < I_R^B$

(C) $V_C^A > V_C^B$ (D) $V_C^A < V_C^B$

Linked Comprehension Type Questions

This section contains Linked Comprehension Type Questions or Paragraph based Questions. Each set consists of a Paragraph followed by questions. Each question has four choices (A), (B), (C) and (D), out of which only one is correct. (For the sake of competitiveness there may be a few questions that may have more than one correct options)

Comprehension 1

A thermal power plant produces electric power of 600 kW at 4000 V, which is to be transported to a place 20 km away from the power plant for consumers' usage. It can be transported either directly with a cable of large current carrying capacity or by using a combination of step-up and step-down transformers at the two ends. The drawback of the direct transmission is the large energy dissipation. In the method using transformers, the dissipation is much smaller. In this method, a step-up transformer is used at the plant side so that the current is reduced to a smaller value. At the consumers' end, a step-down transformer is used to supply power to the consumers at the specified lower voltage. It is reasonable to assume that the power cable is purely resistive and the transformers are ideal with a power factor unity. All the current and voltages mentioned are rms values.

1. [JEE (Advanced) 2013]

If the direct transmission method with a cable of resistance 0.4 Ω km^{-1} is used, the power dissipation (in %) during transmission is

(A) 20 (B) 30

(C) 40 (D) 50

2. [JEE (Advanced) 2013]

In the method using the transformers, assume that the ratio of the number of turns in the primary to that in the secondary in the step-up transformer is 1 : 10. If the power to the consumers has to be supplied at 200 V, the ratio of the number of turns in the primary to that in the secondary in the step-down transformer is

(A) 200 : 1 (B) 150 : 1

(C) 100 : 1 (D) 50 : 1

Matrix Match/Column Match Type Questions

Each question in this section contains statements given in two columns, which have to be matched. The statements in **COLUMN-I** are labelled A, B, C and D, while the statements in **COLUMN-II** are labelled p, q, r, s (and t). Any given statement in **COLUMN-I** can have correct matching with **ONE OR MORE** statement(s) in **COLUMN-II**. The appropriate bubbles corresponding to the answers to these questions have to be darkened as illustrated in the following examples:

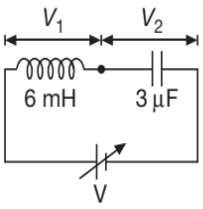
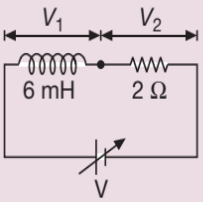
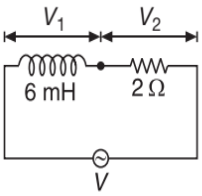
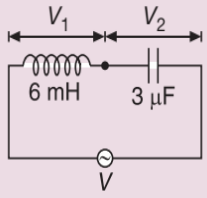
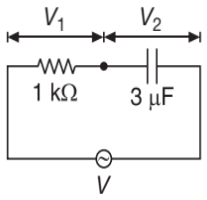
If the correct matches are A → p, s and t; B → q and r; C → p and q; and D → s and t; then the correct darkening of bubbles will look like the following:

	p	q	r	s	t
A	●	○	○	●	●
B	○	●	●	○	○
C	●	●	○	○	○
D	○	○	○	●	●

1. [IIT-JEE 2010]

You are given many resistances, capacitors and inductors. These are connected to a variable DC voltage source (the first two circuits) or an AC voltage source

of 50 Hz frequency (the next three circuits) in different ways as shown in **COLUMN II.** When a current I (steady state for DC or rms for AC) flows through the circuit, the corresponding voltage V_1 and V_2 (indicated in circuits) are related as shown in **COLUMN I.**

COLUMN-I	COLUMN-II
(A) $I \neq 0, V_1$ is proportional to I	(p) 
(B) $I \neq 0, V_2 > V_1$	(q) 
(C) $V_1 = 0, V_2 = V$	(r) 
(D) $I \neq 0, V_2$ is proportional to I	(s) 
	(t) 

(*Continued*)

Integer/Numerical Answer Type Questions

(In this section, the answer to each question is a numerical value obtained after series of calculations based on the data provided in the question(s)).

1. [IIT-JEE 2011]

A series RC combination is connected to an ac voltage of angular frequency $\omega = 500$ rads^{-1}. If the impedance of the RC circuit is $R\sqrt{1.25}$, the time constant (in millisecond) of the circuit is

ANSWER KEYS–TEST YOUR CONCEPTS AND PRACTICE EXERCISES

Test Your Concepts-I (Based on AC)

2. 162 V

3. $I_{rms} = \frac{2k}{\sqrt{3}}$

4. $\frac{E_0}{\sqrt{2}}$

5. $V_{rms} = \sqrt{V_0^2 + \frac{V_1^2}{2}}$

6. (a) $I = (2\times10^{-2}\text{ A})\sin\left((10^3\text{ rads}^{-1})t\right)$

(b) $4\times10^3\ \Omega$

(c) $V_L = 80\sin\left\{(10^3\text{ rads}^{-1})t + \frac{\pi}{2}\right\}$ V

7. 72.3°, 60.67 A

8. (a) $\frac{1}{60}$ s, 377 rads^{-1}, 15.08 Ω, 25.05 Ω, 37°

(b) 6 A, 120 V, 90.5 V

9. 48.4 mH, 11 Ω
In case of ac, power loss in choke is zero.
In case of dc, the loss in additional resistance R' is 1100 W

10. (a) $I = 8.33\times10^{-3}\cos\left[(950\text{ rads}^{-1})t\right]$

(b) 760 Ω

(c) $V_L = -(6.33\text{ V})\sin\left((950\text{ rads}^{-1})t\right)$

11. (a) 326 mA

(b) 35.3°, voltage lagging behind current

(c) $V_R = 97.8$ V, $V_L = 32.6$ V, $V_C = 102$ V

12. (a) 628 Ω

(b) 6.37 mH

(c) 1.6 kΩ

(d) 1.6 mF

13. (a) 110.08 W

(b) 220 W

14. $20\ A, \frac{\pi}{4}$

15. $3R$

16. (a) 224 rads^{-1}

(b) 500 W

(c) 226 rads^{-1}, 221 rads^{-1}

17. (a) 1 kHz

(b) $\frac{\sqrt{3}}{2}$

(c) $R = 17.32\ \Omega$, $C = 16\ \mu$F

18. (a) 7.96×10^4 Hz

(b) $3.2\times10^6\ \Omega$

19. (a) 62.5 pF

(b) 84 mm

(c) 2.51 Ω

20. f_0

Test Your Concepts-II (Based on Transformer)

1. ZERO

2. (a) 83.3

(b) 54 mA

(c) 185 kΩ

3. 125 V

4. (a) 30 kW

(b) 6×10^{-3}

Single Correct Choice Type Questions

1. B	**2.** A	**3.** B	**4.** A	**5.** B	**6.** C	**7.** A	**8.** A	**9.** C	**10.** C
11. D	**12.** A	**13.** C	**14.** B	**15.** B	**16.** B	**17.** D	**18.** C	**19.** A	**20.** B
21. C	**22.** A	**23.** D	**24.** A	**25.** C	**26.** C	**27.** C	**28.** A	**29.** B	**30.** B
31. D	**32.** C	**33.** A	**34.** B	**35.** B	**36.** D	**37.** B	**38.** D	**39.** C	**40.** C
41. C	**42.** A	**43.** A	**44.** D	**45.** B	**46.** B	**47.** B	**48.** C	**49.** C	**50.** B

51. C	52. B	53. B	54. D	55. D	56. A	57. A	58. C	59. A	60. A
61. A	62. C	63. D	64. B	65. A	66. C	67. C	68. B	69. B	70. A
71. B	72. C	73. D	74. A	75. C	76. B	77. A	78. C	79. A	80. A
81. D	82. B	83. C	84. B	85. B	86. C				

Multiple Correct Choice Type Questions

1. A, C, D	2. A, C, D	3. B, C	4. A, D	5. C, D
6. A, B, C	7. A, C, D	8. A, C, D	9. A, C, D	10. A, C, D
11. A, C, D	12. A, D	13. A, B, C, D	14. A, B, C, D	

Reasoning Based Questions

1. A	2. A	3. B	4. B	5. A	6. A	7. A	8. D

Linked Comprehension Type Questions

1. B	2. A	3. C	4. B	5. A	6. A	7. A	8. D	9. B	10. D
11. D	12. A	13. C	14. C	15. D	16. B	17. D	18. A	19. B	20. D
21. B	22. C	23. A	24. A	25. D	26. A	27. A	28. C	29. A	30. A
31. B	32. A	33. C	34. D	35. D	36. D	37. C	38. A	39. D	40. A
41. C	42. A	43. D	44. D	45. D	46. B	47. D	48. A	49. A	50. A
51. A									

Matrix Match/Column Match Type Questions

1. A → (r)	B → (s)	C → (t)	D → (q)
2. A → (q)	B → (p)	C → (r)	D → (s)
3. A → (r)	B → (q)	C → (s)	D → (p)
4. A → (q, s)	B → (r, s)	C → (r, s)	D → (r, s)
5. A → (p, t)	B → (q)	C → (r, t)	D → (s, t)

Integer/Numerical Answer Type Questions

1. (a) 1, (b) 150, (c) 150		2. 1.56	3. 17	4. 30
5. 500	6. 0.8, 143	7. Voltage across L, C, R (in volt) is 141, 71, 71		8. 240
9. 242	10. 87	11. 0.6	12. 20, 3.125	13. 10, 120, 50
14. 7	15. 4.8	16. 242, 0.9	17. 2	18. 250

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1. D	2. C	3. C	4. B	5. C	6. *	7. B	8. A	9. B	10. C
11. D	12. D	13. D	14. D	15. A					

* No given option is correct

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Single Correct Choice Type Problems

1. B **2.** A

Multiple Correct Choice Type Problems

1. A, B **2.** B, C **3.** C, D **4.** A, C **5.** B, C

Linked Comprehension Type Questions

1. B **2.** A

Matrix Match/Column Match Type Questions

1. A → (r, s, t) B → (q, r, s, t) C → (q, p) D → (q, r, s, t)

Integer/Numerical Answer Type Questions

1. 4