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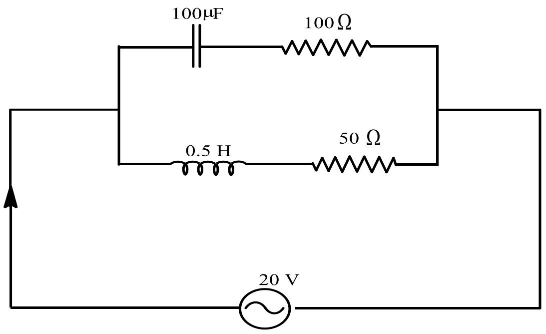
Date : 28.03.2025
Time : 01:17:24
Marks : 86

TEST ID: 36
PHYSICS

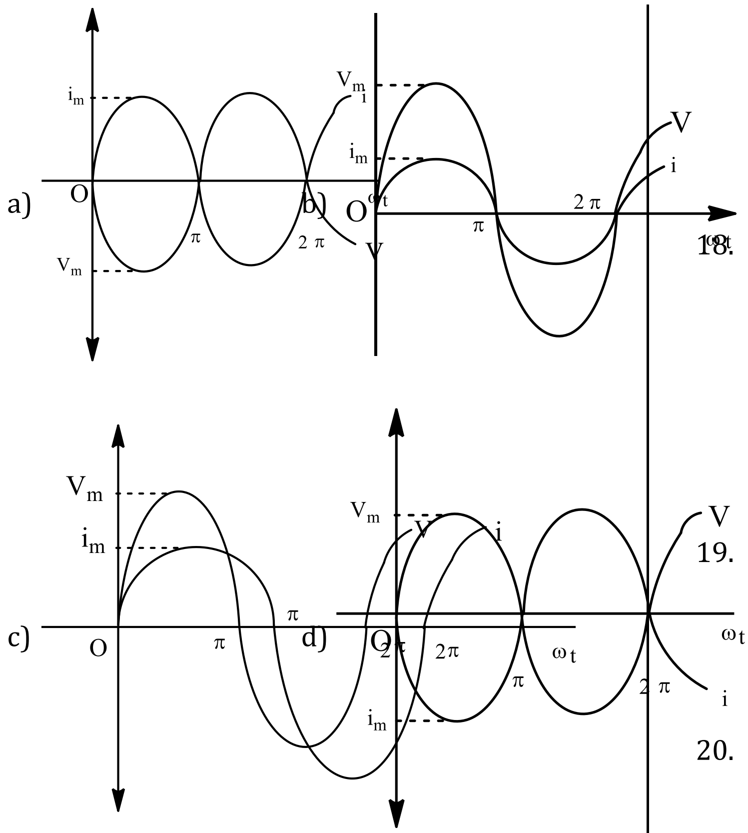
13.AC CIRCUITS

Single Correct Answer Type

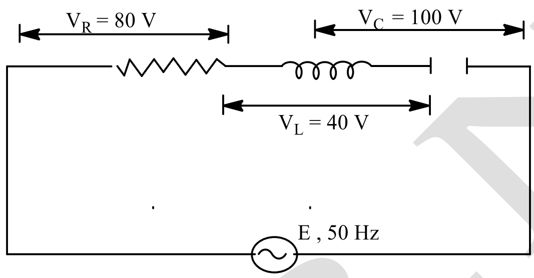
1. In a series $L - C - R$ circuit, $R = 300\ \Omega, L = 0.9\text{H}, C = 2\mu\text{F}, \omega = 1000$ rad/s. The impedance of the circuit is
   a) $500\ \Omega$ b) $1300\ \Omega$
   c) $400\ \Omega$ d) $900\ \Omega$
2. In non-resonant circuit, what will be the nature of the circuit for frequencies higher than the resonant frequency?
   a) Resistive b) Capacitive
   c) Inductive d) None of these
3. In series L-C-R circuit, the capacitance is changed from C to 2 C. The inductance should be changed from L to .. to obtain same resonance frequency.
   a) 4L b) L/2
   c) L/4 d) 2L
4. An AC circuit contains resistance of 12Ω and inductive reactance 5Ω. The phase angle between current and potential difference, will be
   a) $\sin^{-1}\left(\frac{12}{13}\right)$ b) $\cos^{-1}\left(\frac{5}{12}\right)$
   c) $\sin^{-1}\left(\frac{5}{12}\right)$ d) $\cos^{-1}\left(\frac{12}{13}\right)$
5. A 10 μF capacitor is charged to 25 V of potential. The battery is then disconnected and a pure 100 mH coil is connected across the capacitor, so that $L - C$ oscillations are set up. The maximum current in the coil is
   a) 0.25 A b) 0.01 A
   c) 2.5 A d) 1.6 A
6. The rms value of current i_{rms} is
   a) $\frac{i_0}{2\pi}$ b) $\frac{i_0}{\sqrt{2}}$
   c) $\frac{2i_0}{\pi}$ d) $\sqrt{2}i_0$ (where, i_0 is the value of peak current)
7. An AC source is $120\text{ V} - 60\text{ Hz}$. The value of voltage after $\frac{1}{720}$ s from start will be
   a) 20.2 V b) 42.4 V
   c) 84.8 V d) 106.8 V
8. In a series resonant $R - L - C$ circuit, the voltage across R is 100 V and the value of $R = 1000\ \Omega$. The capacitance of the capacitor is 2×10^{-6} F, angular frequency of AC is 200 rad s^{-1}. Then, the potential difference across the inductance coil is
   a) 100 V b) 40 v
   c) 250 V d) 400 V
9. In an $L - C - R$ ciruit, if V is the effective value of the applied voltage, V_R is the voltage across R, V_L is the effective voltage across L, V_C is the effective voltage across C, then
   a) $V = V_R + V_L + V_C$ b) $V^2 = V_R^2 + V_L^2 + V_C^2$
   c) $V^2 = V_R^2 + (V_L - V_C)^2$ d) $V^2 = V_L^2 + (V_R - V_C)^2$
10. A pure inductor of inductance 25.0 mH is connected to a source of 220 V. Find the inductive reactance, if the frequency of the source is 50 Hz.
    a) $785\ \Omega$ b) $6.50\ \Omega$
    c) $7.85\ \Omega$ d) $8.75\ \Omega$
11. In the given circuit, the AC source has $\omega = 100$ rad/s. Considering the inductor and capacitor to be ideal, the correct choice(s) is (are)



    a) The current through the circuit = 0.3 A b) The current through the circuit $= 0.3\sqrt{2}$ A
    c) The voltage across $100\ \Omega$ resistor $= 30\sqrt{2}$ V d) The voltage across $50\ \Omega$ resistor = 10 V
12. Which of the following is the graphical representation of alternating current and voltage for a purely resistive circuit



13. The value of alternating emf E in the given circuit will be



a) 220 V b) 140 V
c) 100 V d) 20 V

14. An alternating current is given by the equation $i = i_1 \cos \omega t + i_2 \sin \omega t$. The rms current is given by
a) $\frac{1}{\sqrt{2}}(i_1 + i_2)$ b) $\frac{1}{\sqrt{2}}(i_1 + i_2)^2$
c) $\frac{1}{\sqrt{2}}(i_1^2 + i_2^2)^{1/2}$ d) $\frac{1}{2}(i_1^2 + i_2^2)^{1/2}$

15. For high frequency ,capacitor offers
a) more resistance b) less resistance
c) zero resistance d) None of these

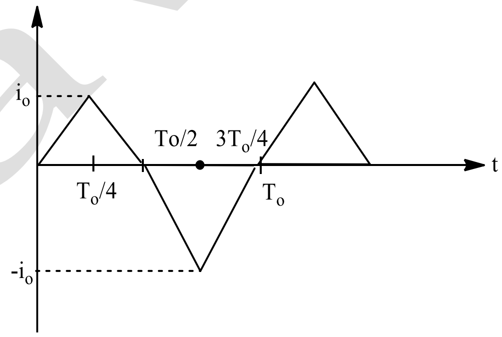
16. A generator produces a voltage that is given by $V = 240 \sin 120\, t$, where t is in second. The frequency and rms voltage are
a) 60 Hz and 240 V b) 19 Hz and 120 V
c) 19 Hz and 170 V d) 754 Hz and 70 V

17. 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) $\frac{1}{60\pi}$

18. A coil of 0.01 H inductance and 1Ω resistance is connected to 200 V, 50 Hz AC supply. The impedance of the circuit and time lag between maximum alternating voltage and current would be
a) 3.3 Ω and $\frac{1}{250}$ s b) 3.9 kΩ and $\frac{1}{160}$ s
c) 4.2 kΩ and $\frac{1}{100}$ s d) 2.8 kΩ and $\frac{1}{120}$ s

19. If an AC main supply is given to be 220 V. What would be the average emf during a positive half cycle?
a) 198 V b) 386 V
c) 256 V d) None of these

20. The average current in terms of i_0 for the waveform shown is



a) i_0 b) $\frac{i_0}{3}$
c) $\frac{i_0}{2}$ d) $\frac{i_0}{4}$

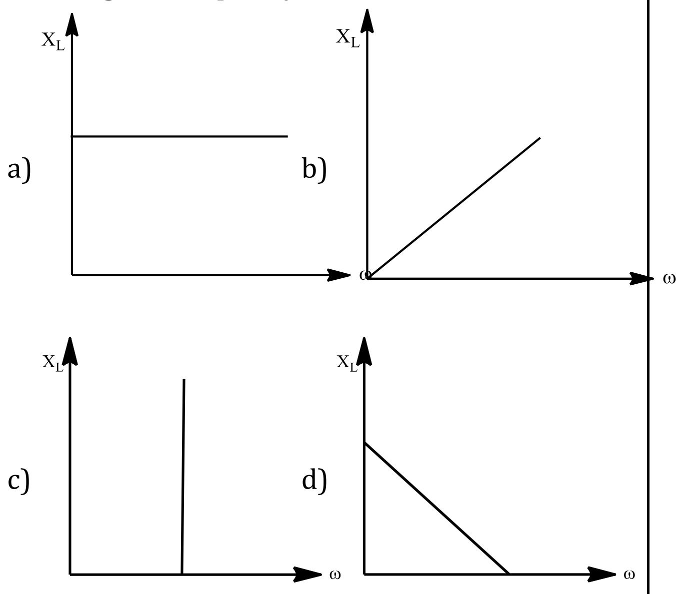
21. A charged 30μF capacitor is connected to a 27 mH inductor. What is the angular frequency of free oscillations of the circuit?
a) $1.1\ s^{-1}$ b) $1.1 \times 10^3\ s^{-1}$
c) $1\ s^{-1}$ d) $1 \times 10^{-3}\ s^{-1}$

22. What is the value of inductance L for which the current is a maximum in a series $L - C - R$ circuit with $C = 10\mu F$ and $\omega = 1000\ s^{-1}$?
a) 100mH b) 1mH
c) Cannot be calculated unless R is known d) 10mH

23. An alternating voltage, $V = 200\sqrt{2} \sin(100\, t)$ is connected to a 1μF, capacitor through an AC ammeter. The reading of the ammeter shall be
a) 10 mA b) 20 mA
c) 40 mA d) 80 mA

24. Which of the following graphs represents the correct variation of inductive reactance X_L

with angular frequency ω?



25. When an alternating voltage source of $V = 200\sin\left(100\pi t - \frac{\pi}{3}\right)$ is applied to a pure capacitor of capacitance 2μF, then the instantaneous value of current through the capacitor is

a) $200\sin\left(100\pi t + \frac{\pi}{6}\right)$ b) $0.04\pi\sin\left(100\pi t + \frac{\pi}{6}\right)$

c) $200\sin\left(100\pi t - \frac{\pi}{6}\right)$ d) $0.04\pi\sin\left(100\pi t - \frac{\pi}{6}\right)$

26. An inductance of negligible resistance, whose reactance is 120 Ω at 200 Hz is connected to a 240 V, 60 Hz, power line. The current in the inductor is

a) 6.66 A b) 6.60 A
c) 5.45 A d) 54.5 A

27. The current in the series $L - C - R$ circuit is

a) $i = i_m\sin(\omega t + \phi)$ b) $i = \frac{V_m}{\sqrt{R^2 + (X_C - X_L)^2}}\sin(\omega t + \phi)$
c) $i = 2i_m\cos(\omega t + \phi)$ d) Both (a) and (b)

28. A coil of inductive reactance 31 Ω has a resistance of 8 Ω. It is placed in series with a condenser of capacitive reactance 25 Ω. The combination is connected to an AC source of 110 V. The power factor of the circuit is

a) 0.56 b) 0.64
c) 0.80 d) 0.33

29. An alternating voltage $V = 200\sqrt{2}\sin(100\,t)$ volt is connected to 1μF capacitor through AC ammeter. The reading of ammeter is

a) 5 mA b) 10 mA
c) 15 mA d) 20 mA

30. The rms current in the circuit containing a pure inductor of 40 mH, connected to a source 200 V, 50 Hz is

a) 25 A b) 16 A
c) 11 A d) 28 A

31. 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

32. A resistance of 200Ω and capacitor of 15μF are connected in series to a 220 V, 50 Hz AC source. The voltage (rms) across the resistor and capacitor is that

a) 151 V, 160.4 V b) 150 V, 100.3 V
c) 220 V, 91.8 V d) 145 V, 311.3 V

33. A 1.5 mH inductor in an $L - C$ circuit stores a maximum energy of 30ωJ. The rms value of current in the circuit is

a) $\frac{1}{\sqrt{2}} \times 10^{-1}$ A b) $\sqrt{2} \times 10^{-2}$ A
c) $\frac{1}{\sqrt{2}} \times 10^{-2}$ A d) $\sqrt{2} \times 10^{-1}$ A

34. A coil of self-inductance L is connected in series with a bulb B and an AC source. Brightness of the bulb decreases when

a) frequency of the AC source is decreased
b) number of turns in the coil is reduced
c) a capacitance of reactance $X_C - X_L$ is included in the same circuit
d) an iron rod is inserted in the coil

35. The peak value of alternating current is $5\sqrt{2}$ A. The root-mean-square value of current will be

a) 5 A b) 2.5 A
c) $5\sqrt{2}$ A d) None of these

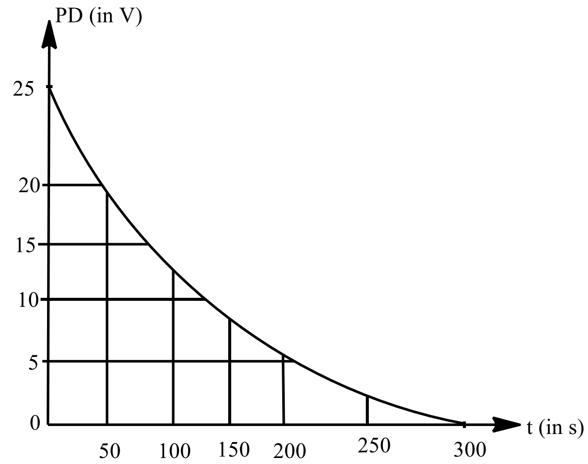
36. In an AC circuit, the current lags behind the voltage by $\pi/3$. The components of the circuit are

a) R and L b) L and C
c) R and C d) only R

37. An alternating voltage (in volts) given by $V = 200\sqrt{2}\sin(100t)$ is connected to a 1μF capacitor through an AC ammeter. The reading of the ammeter will be

a) 10 mA b) 20 mA
c) 40 mA d) 80 mA

38. Figure shows an experimental plot for discharging of a capacitor in an R − C circuit. The time constant τ of this circuit lies between



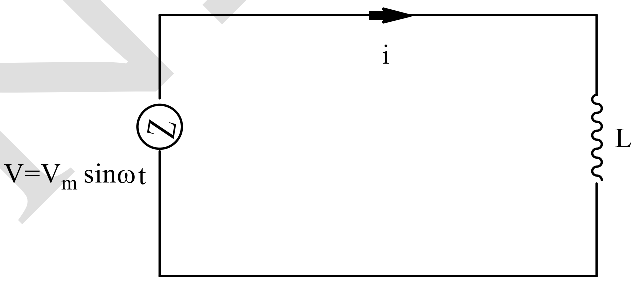
a) 150 s and 200 s b) 0 s and 50 s
c) 50 s and 100 s d) 100 s and 150 s

39. The instantaneous values of current and voltage in an AC circuit are given by
$i = 6\sin\left(100\,\pi t + \frac{\pi}{4}\right)$, $V = 5\sin\left(100\,\pi t - \frac{\pi}{4}\right)$, then
a) current leads the voltage by 45° b) voltage leads the current by 90°
c) current leads the voltage by 90° d) voltage leads the current by 45°

40. The maximum value of AC in a circuit is 707 V. Its rms value is
a) 70.7 V b) 100 V
c) 500 V d) 707 V

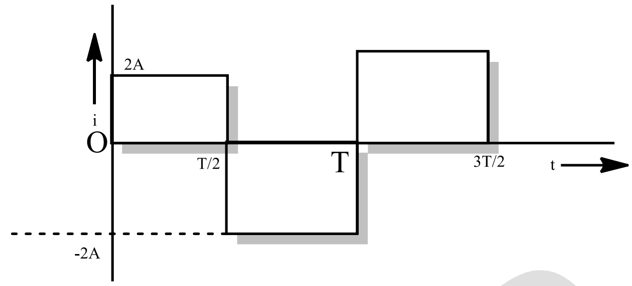
41. An alternating voltage $V(t) = 220\sin 100\pi t$ volt is applied to a purely resistive load of 50Ω. The time taken for the current to rise from half of the peak value to the peak value is
a) 5 ms b) 2.2 ms
c) 7.2 ms d) 3.3 ms

42. When an alternating voltage is applied to an inductor as shown in the figure, then



a) $V + L\frac{di}{dt} = 0$ b) $V - L\frac{di}{dt} = 0$
c) $L + V\frac{di}{dt} = 0$ d) $L - V\frac{di}{dt} = 0$

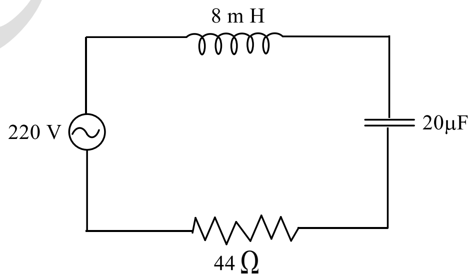
43. The r m s value of the alternating current shown in figure is



a) 2A b) -2A
c) 4A d) 1A

44. Alternating current of peak value $\left(\frac{2}{\pi}\right)$ ampere flows through the primary coil of the transformer. The coefficient of mutual inductance between primary and secondary coil is 1H. The peak emf induced in secondary coil is (frequency of AC = 50 Hz)
a) 100 V b) 200 v
c) 300 V d) 400 V

45. For the series L-C-R circuit shown in the figure, what is the angular resonant frequency and amplitude of the current at the resonating frequency?



a) 2500 $rads^{-1}$ and $5\sqrt{2}$ A b) 2500 $rads^{-1}$ and 5 A
c) 2500 $rads^{-1}$ and $\frac{5}{\sqrt{2}}$ A d) 25 $rads^{-1}$ and $5\sqrt{2}$ A

46. If reading of an ammeter is 10 A, the peak value of current is
a) $\frac{10}{\sqrt{2}}$ A b) $\frac{5}{\sqrt{2}}$ A
c) $20\sqrt{2}$ A d) $10\sqrt{2}$ A

47. In an L-C circuit, angular frequency at resonance is ω. What will be the new angular frequency when inductor's inductance is made two times and capacitor's capacitance is made four times?
a) $\frac{\omega}{2\sqrt{2}}$ b) $\frac{\omega}{\sqrt{2}}$
c) 2ω d) $\frac{2\omega}{\sqrt{2}}$

48. To express AC power in the same form as DC

power, a special value of current is defined and used, is called

a) root-mean-square current (i_{rms}) b) effective current
c) induced current d) Both (a) and (b)

49. Alternating current cannot be measured by DC ammeter because

a) AC cannot pass through DC ammeter b) AC changes direction
c) average value of current for complete cycle is zero d) DC ammeter will get damaged

50. The frequency of an alternating voltage is 50 cycles/s and its amplitude is 120 V. Then, the rms value of voltage is

a) 101.3 V b) 84.8 V
c) 70.7 V d) 56.5 V

51. The impedance of a circuit, when a resistance R and an inductor of inductance are connected in series in an AC circuit of frequency f, is

a) $\sqrt{R + 2\pi^2 f^2 L^2}$ b) $\sqrt{R + 4\pi^2 f^2 L^2}$
c) $\sqrt{R^2 + 4\pi^2 f^2 L^2}$ d) $\sqrt{R^2 + 2\pi^2 f^2 L^2}$

52. A charged 40 μF capacitor is connected to a 16 mH inductor. What is the angular frequency of free oscillations of the circuit?

a) 1.1 s b) $1.25 \times 10^3\ s^{-1}$
c) $2 \times 10^3\ s^{-1}$ d) $2.5 \times 10^3\ s^{-1}$

53. Which of the following represents the value of voltage and current at that instant?

a) $V_m \sin \omega t$, $i_m \sin \omega t$ b) $V_m \cos \omega t$, $i_m \cos \omega t$
c) $-V_m \sin \omega t$, $-i_m \sin \omega$ d) $-V_m \cos \omega t$, $-i_m \cos \omega$

54. Which current do not change direction with time?

a) DC current b) AC current
c) Both (a) and (b) d) Neither (a) nor (b)

55. The reactance of a coil when used in the AC power supply (220 V, 50 cycle s^{-1}) is 50 Ω. The inductance of the coil is nearly

a) 0.16 H b) 0.22 H
c) 2.2 H d) 1.6 H

56. AC measuring instruments measures

a) peak value b) rms value
c) any value d) average value

57. An alternating voltage $E = 200\sqrt{2}\sin(100\ t)$ is connected to 1μF capacitor through AC ammeter. The reading of ammeter shall be

a) 10 mA b) 20 mA
c) 40 mA d) 80 mA

58. The natural frequency of an $L - C$ circuit is 125000 cycle/s. Then, the capacitor C is replaced by another capacitor with a dielectric medium of dielectric constant K. In this case, the frequency decreases by 25 kHz. The value of K is

a) 3.0 b) 2.1
c) 1.56 d) 1.7

59. If the power factor changes from $\frac{1}{2}$ to $\frac{1}{4}$, then what is the increase in impedance in AC?

a) 20% b) 50%
c) 25% d) 100%

60. The maximum voltage in DC circuit is 282 V. The effective voltage in AC circuit will be

a) 200 V b) 300 V
c) 400 V d) 564 V

61. An alternating emf of 0.2 V is applied across an $L - C - R$ series circuit having $R = 4\Omega$, $C = 80\mu F$ and $= 200$ mH. At resonance the voltage drop across the inductor is

a) 10 V b) 2.5 V
c) 1 V d) 5 V

62. If the inductance and capacitance are both doubled in L-C-R circuit, the resonant frequency of the circuit will

a) decrease to one-half the original value b) decrease to one-fourth the original value
c) increase to twice the original value d) decrease to twice the original value

63. If the frequency is doubled, what happen to the capacitive reactance and the current?

a) Capacitive reactance is halved, the current is doubled b) Capacitive reactance is doubled, the current is halved
c) Capacitive reactance and the current are halved d) Capacitive reactance and the current are doubled

64. In an AC circuit, $i = 100 \sin 200\,\pi t$. The time required for the current to achieve its peak value will be

a) $\frac{1}{100}$ s b) $\frac{1}{200}$ s
c) $\frac{1}{300}$ s d) $\frac{1}{400}$ s

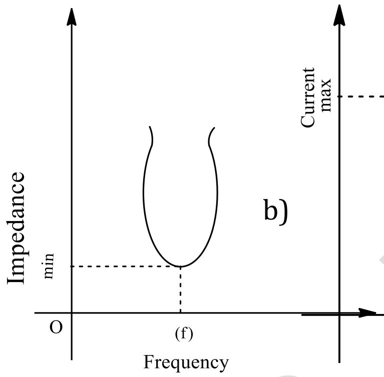
65. In an electrical circuit R, L, C and an AC voltage source all connected in series. When L is removed from the circuit, the phase difference between the voltage and the current in the circuit is $\frac{\pi}{3}$. If instead C is removed from the circuit, the phase difference is again $\frac{\pi}{3}$. The power factor of the circuit is

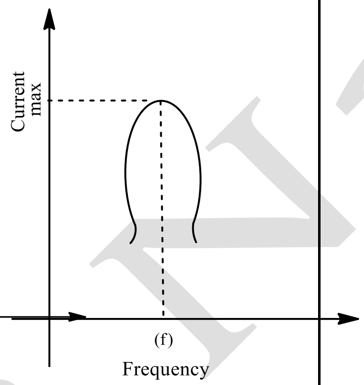
a) $\frac{1}{2}$ b) $\frac{1}{\sqrt{2}}$
c) 1 d) $\frac{\sqrt{3}}{2}$

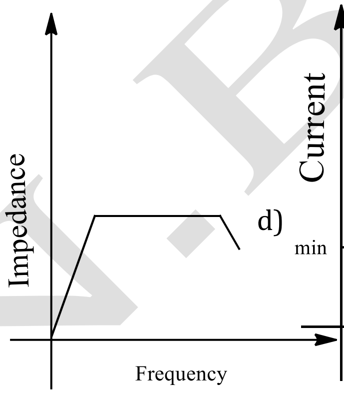
66. in L-C-R circuit, power factor at resonance is
a) less than one b) greater than one
c) unity d) Can't predicted

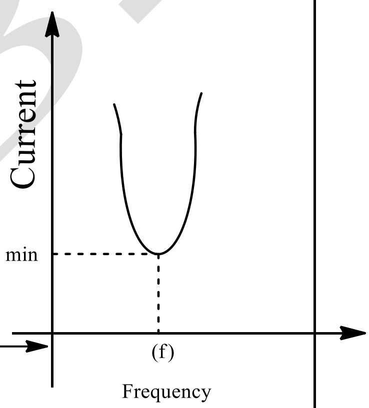
67. Same current is flowing in two AC circuit, First contains only inductance and second contains only capacitance. If frequency of AC is increased for both, the current will
a) increase in first circuit and decrease in second b) increase in both circuits
c) decrease in both circuits d) decrease in first circuit and increase in second

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

a) 

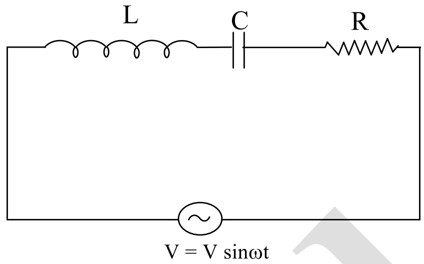
b) 

c) 

d) 

69. In a $L - R$ circuit of 3 mH inductance and 4Ω resistance, emf $E = (4 \cos 1000t)V$ is applied. The amplitude of current is
a) 0.8 A b) $\frac{4}{7}$ A
c) 1 A d) $\frac{4}{\sqrt{7}}$ A

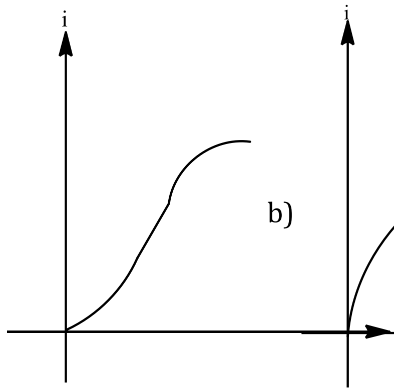
70. For the $L - C - R$ circuit shown here, the current is observed to lead the applied voltage. An additional capacitor C', when joined with the capacitor C present in the circuit, makes the power factor of the circuit unity. The capacitor C' must have been connected in

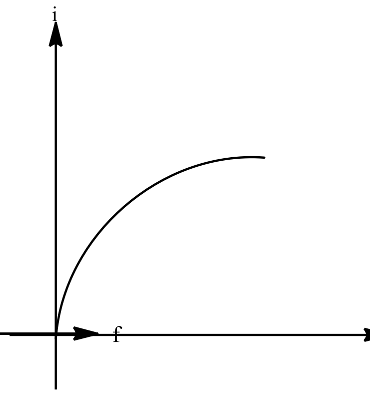


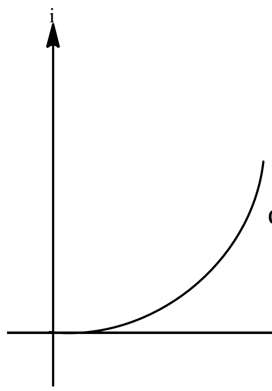
a) series with C and has a magnitude $\frac{C}{(\omega^2LC-1)}$
b) series with C and has a magnitude $\frac{(1-\omega^2LC)}{\omega^2L}$
c) parallel with C and has a magnitude $\frac{(1-\omega^2LC)}{\omega^2L}$
d) parallel with C and has a magnitude $\frac{C}{(\omega^2LC-1)}$

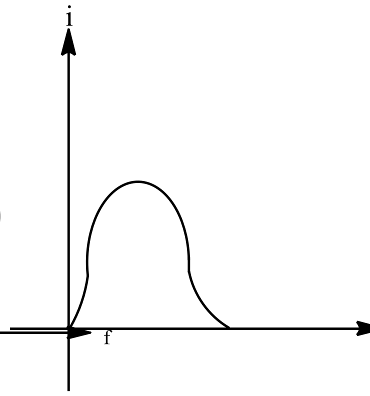
71. A $15.0\ \mu F$ capacitor is connected to a 220 V, 50 Hz source. The capacitive reactance is
a) $220\ \Omega$ b) $215\ \Omega$
c) $212\ \Omega$ d) $204\ \Omega$

72. An AC circuit of variable frequency f is connected to an L-C-R series circuit. Which one of the graphs in the figure, represents the variation of current i in the circuit with frequency?

a) 

b) 

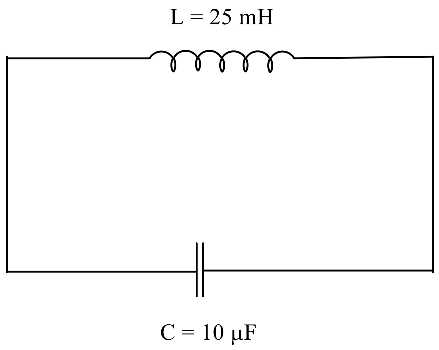
c) 

d) 

73. When a capacitor of 36μF is connected to a 240 V, 50 Hz supply the currents (rms and peak) in the circuit are

a) 1.47 A, 2.04 A　b) 1.95 A, 2.73 A
c) 2.73 A, 3.85 A　d) 2.4 A, 1.08 A

74. If maximum energy is stored in a capacitor at t=0, then find the time after which, current in the circuit will be maximum?



a) $\frac{\pi}{2}$ ms　b) $\frac{\pi}{4}$ ms
c) πms　d) 2 ms

75. In terms of q, the voltage equation for series L − C − R circuit is given by

a) $L\frac{dq}{dt} + R\frac{dq}{dt} + \frac{q}{C} = V_m \sin \omega t$　b) $L\frac{d^2q}{dt^2} + R\frac{dq}{dt} + \frac{q}{C} = V_m \sin \omega t$
c) $L\frac{d^2q}{dt} - R\frac{dq}{dt} + \frac{q}{C} = V_m \sin \omega t$　d) $L\frac{d^2q}{dt} - R\frac{dq}{dt} - \frac{q}{C} = V_m \sin \omega t$

76. A coil has inductance 2 H. The ratio of its reactance, when it is connected first to an AC source and then to DC source, is

a) zero　b) 1
c) less than 1　d) infinity

77. The instantaneous voltage through a device of impedance 20Ω is V = 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

78. The average value of AC voltage given by $V = V_m \sin \omega t$ over time interval $t = 0$ to $t = \frac{\pi}{\omega}$ is

a) 0　b) $\frac{2V_m}{\pi}$
c) $\frac{V_m}{\pi}$　d) V_m

79. The peak value of AC voltage on a 220 V mains is

a) $240\sqrt{2}$ V　b) $230\sqrt{2}$ V
c) $220\sqrt{2}$ V　d) $200\sqrt{2}$ V

80. A capacitor 50μF is connected to a power source V = 220 sin 50t (V in volt, t in second). The value of rms current (in ampere) is

a) $\frac{\sqrt{2}}{0.55}$ A　b) 0.55 A
c) $\sqrt{2}$ A　d) $\frac{0.55}{\sqrt{2}}$ A

81. A resistance of 20Ω is connected to a source of an alternating potential, V = 220 sin(100π t). The time taken by current to change from its peak value to rms value is

a) 0.2 s　b) 0.25 s
c) 25×10^{-3} s　d) 2.5×10^{-3} s

82. The electric mains in the house is marked 220 V, 50 Hz. Write down the equation for instantaneous voltage.

a) 3.1 sin(100π)t　b) 31.1 cos(100π)t
c) 311.1 sin(100π)t　d) 311.1 cos(100π)t

83. A bulb is connected first with DC and then AC of same voltage, then it will shine brightly with

a) AC　b) DC
c) brightness will be in ratio 1/1.4　d) equally with both AC and DC supply

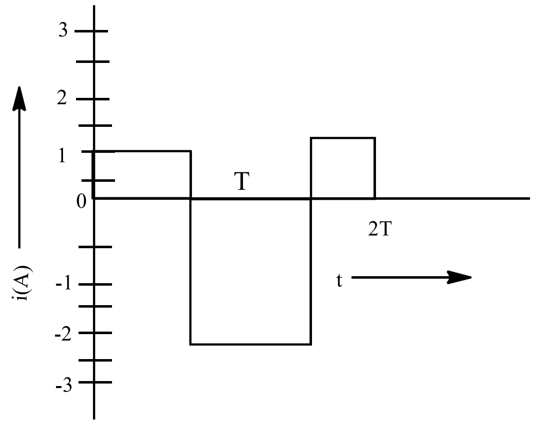
84. An L − C circuit contains 10 mH inductor and a 25 μF capacitor. The ratio of the time periods for the energy to be completely magnetic, is

a) 0, 1.57, 4.71　b) 1.57, 3.14, 4.71
c) 1.57, 4.71, 7.85　d) None of the above

85. In a circuit, the current lags behind the voltage by a phase difference of π /2, the circuit will contain which of the following?

a) only R　b) only C
c) R and C　d) only L

86. The alternating current in a circuit is described by graph shown in figure. The rms current obtained from graph would be



a) 1.4 A　b) 2.2 A
c) 1.9 A　d) 2.6 A

N.B.Navale

Date : 28.03.2025 **TEST ID: 36**
Time : 01:17:24 **PHYSICS**
Marks : 86

13.AC CIRCUITS

: ANSWER KEY :

1)	a	2)	c	3)	b	4)	d
5)	a	6)	b	7)	c	8)	c
9)	c	10)	c	11)	a	12)	b
13)	c	14)	c	15)	b	16)	c
17)	b	18)	a	19)	a	20)	c
21)	b	22)	a	23)	b	24)	b
25)	b	26)	a	27)	d	28)	c
29)	d	30)	b	31)	d	32)	a
33)	d	34)	d	35)	a	36)	a
37)	b	38)	d	39)	c	40)	c
41)	d	42)	b	43)	a	44)	b
45)	a	46)	d	47)	a	48)	d
49)	c	50)	b	51)	c	52)	b
53)	a	54)	a	55)	a	56)	b
57)	b	58)	c	59)	d	60)	a
61)	b	62)	a	63)	a	64)	d
65)	c	66)	c	67)	d	68)	d
69)	a	70)	c	71)	c	72)	d
73)	c	74)	b	75)	b	76)	d
77)	b	78)	b	79)	c	80)	b
81)	d	82)	c	83)	d	84)	b
85)	d	86)	a				

N.B.Navale

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TEST ID: 36
PHYSICS

13.AC CIRCUITS

: HINTS AND SOLUTIONS :

Single Correct Answer Type

1 **(a)**

Impedance for series $L - C - R$ circuit is given by

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

Given, resistance, $R = 300\ \Omega$, inductance, $L = 0.9H$,
capacitance, $C = 2\mu F = 2 \times 10^{-6}$ F and angular frequency, $\omega = 1000$ rad/s.
Substituting the given values in the above equation, we get

$\Rightarrow$ z

$$= \sqrt{300^2 + \left(1000 \times 0.9 - \frac{1}{1000 \times 2 \times 10^{-6}}\right)^2}$$

$\Rightarrow\ z = \sqrt{90000 + (900 - 500)^2}$

$\Rightarrow\ z = \sqrt{250000} = 500\Omega$

Hence, the impedance of $L - C - R$ circuit is 500Ω.

2 **(c)**

At resonant frequency, $X_L = X_C$ $\left(\because \omega L = \frac{1}{\omega C}\right)$

The frequencies are higher than resonance frequencies.

$X_L > X_C$

i.e., behavior is inductive.

3 **(b)**

At resonance, $X_L = X_C$

i. e. $\omega_r L = \dfrac{1}{\omega_r C}$

or $\omega_r = \dfrac{1}{\sqrt{LC}}$

or $2\pi v_r = \dfrac{1}{\sqrt{LC}}$

or $v_r = \dfrac{1}{2\pi\sqrt{LC}}$

or LC = constant (as V remain same)

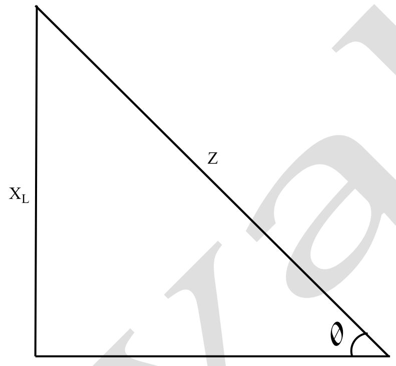
$\therefore \frac{L_2}{L_1} = \frac{C_1}{C_2}$ or $\frac{L_2}{L} = \frac{C}{2C}$ or $L_2 = \frac{L}{2}$

4 **(d)**

Given, $R = 12\ \Omega$ and $X_L = 5\Omega$

$\therefore$ Impedance, $Z = \sqrt{(12)^2 + (5)^2} = 13\Omega$

The impedance triangle is as shown below



From this triangle, $\cos\theta = \frac{R}{Z}$

$\Rightarrow \theta = \cos^{-}\left(\frac{R}{Z}\right)$

$= \cos^{-1}\left(\frac{12}{13}\right)$

5 **(a)**

For $L - C$ oscillations,
Energy stored in inductor = Energy stored in capacitor

$\frac{1}{2}Li_m^2 = \frac{1}{2}CV_m^2$

Given, $V_m = 25$ V, $C = 10\mu F = 10^{-5}$ F

and $L = 100mH = 10^{-1}H$

or $i_m = V_m\sqrt{\frac{C}{L}} = 25\sqrt{\frac{10^{-5}}{10^{-1}}}$

$= 25 \times 10^{-2}$ A $= 0.25$ A

6 **(b)**

The value of current, $i_{ms} = \frac{i_0}{\sqrt{2}}$

7 **(c)**

$V = V_0 \sin\omega t = V_{rms}\sqrt{2}\sin\omega t$

Aftert $= \dfrac{1}{720}$ s,

$V = 120\sqrt{2}\sin 2\pi vt$

$= 120\sqrt{2}\sin 2\pi \times 60 \times \dfrac{1}{720}$

$= 120\sqrt{2}\sin\dfrac{\pi}{6} = 120\sqrt{2} \times \dfrac{1}{2}$

$= 60\sqrt{2} = 84.8\text{ V}$

8 **(c)**

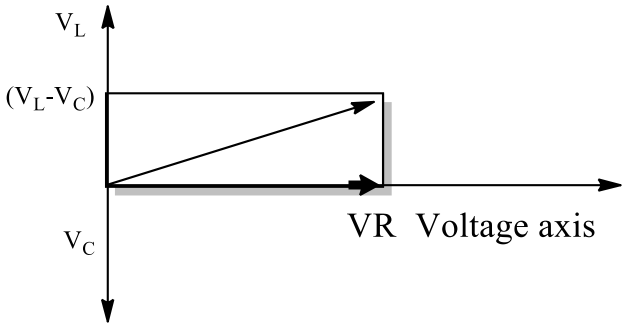
The current in the circuit, $i = \frac{V_R}{R} = \frac{100}{1000} = 0.1\text{ A}$

At resonance, $V_L = V_C = iX_C = \frac{i}{\omega C}$

$= \dfrac{0.1}{200 \times 2 \times 10^{-6}} = 250\text{ V}$

9 **(c)**

Phasor diagram of R-L-C series circuit is shown in figure



$V^2 = V_R^2 + (V_L - V_C)^2$

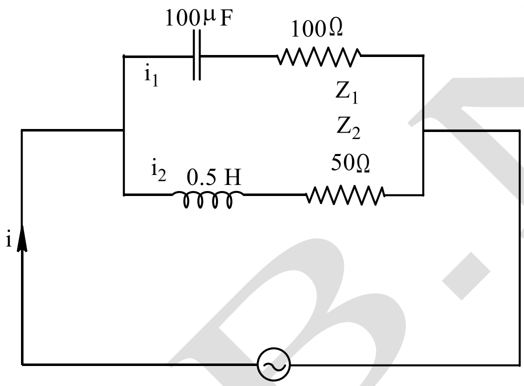
10 **(c)**

Given, $L = 25\text{ mH} = 25 \times 10^{-3}\text{H}$ and $v = 50\text{ Hz}$

The inductive reactance,

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

11 **(a)**



Circuit 1 $X_C = \frac{1}{\omega C} = \frac{1}{100 \times 100 \times 10^{-6}} = 100\Omega$

$\therefore\ Z_1 = \sqrt{(100)^2 + (100)^2} = 100\sqrt{2}\ \Omega$

$\phi_1 = \cos^{-1}\left(\dfrac{R_1}{Z_1}\right)$

$= \cos^{-1}\left(\dfrac{100}{100\sqrt{2}}\right) = \cos^{-1}\left(\dfrac{1}{\sqrt{2}}\right)$

$= 45°$

In this circuit, current leads the voltage,

$i_1 = \dfrac{V}{Z_1} = \dfrac{20}{100\sqrt{2}} = \dfrac{1}{5\sqrt{2}}\text{ A}$

$V_{100\Omega} = (100)i_1 = (100)\dfrac{1}{5\sqrt{2}} = 10\sqrt{2}\text{ V}$

Circuit 2 $X_L = \omega L = (100)(0.5) = 50\Omega$

$Z_2 = \sqrt{(50)^2 + (50)^2} = 50\sqrt{2}\Omega$

$\phi_2 = \cos^{-1}\left(\dfrac{R_2}{Z_2}\right) = \cos^{-1}\dfrac{50}{50\sqrt{2}} = \cos^{-1}\dfrac{1}{\sqrt{2}} = 45°$

In this circuit, voltage leads the current,

$i_2 = \dfrac{V}{Z_2} = \dfrac{20}{50\sqrt{2}} = \dfrac{\sqrt{2}}{5}\text{ A}$

$V_{50\Omega} = (50)i_2 = 50\left(\dfrac{\sqrt{2}}{5}\right) = 10\sqrt{2}\text{ V}$

Further, I_1 and I_2 have a mutual phase difference of 90°.

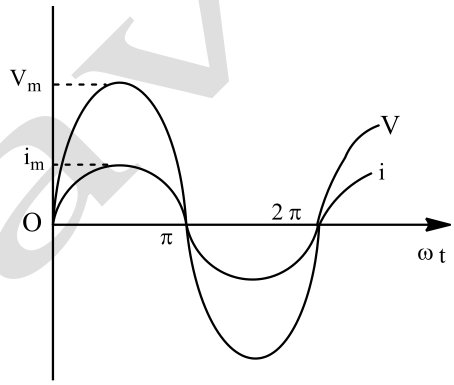
$\therefore\ I = \sqrt{I_1^2 + I_2^2} = \sqrt{\dfrac{1}{50} + \dfrac{4}{50}}$

$I = \dfrac{1}{\sqrt{10}}\text{ A} \approx 0.3\text{ A}$

12 **(b)**

In a purely resistive circuit, the alternating current and voltage are in phase. This means that the maxima, zero and minima occur at the same time, for both quantities.

This can be graphically represented as



13 **(c)**

For series $L - C - R$ circuit,

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

$= \sqrt{(80)^2 + (40 - 100)^2} = 100\text{ V}$

14 **(c)**

Equation of alternating current is given as

$i = i_1 \cos\omega t + i_2 \sin\omega t$ ...(i)

Let, $i_1 = A\sin\phi$ ...(ii)

and $i_2 = A\cos\phi$ ...(iii)

From Eq. (i), we have

$i = A\sin\phi\cos\omega t + A\cos\phi\sin\omega t$

$= A[\cos\omega t\sin\phi + \sin\omega t\cos\phi]$

$i = A\sin(\omega t + \phi)$ ...(iv)

Squaring and adding Eqs. (ii) and (iii), we get

$i_1^2 + i_2^2 = A^2(\sin^2\phi + \cos^2\phi) = A^2 \Rightarrow A = [i_1^2 + i_2^2]^{\frac{1}{2}}$

From Eq. (iv), we get

$i = [i_1^2 + i_2^2]^{\frac{1}{2}}\sin(\omega t + \phi)$ ...(v)

Comparing Eq. (v) with equation, $i = i_m\sin(\omega t + \phi)$, we get

$$i_m = (i_1^2 + i_2^2)^{\frac{1}{2}}$$

$\therefore \quad i_{rms} = \frac{i_m}{\sqrt{2}} = \frac{(i_1^2+i_2^2)^{1/2}}{\sqrt{2}}$

15 **(b)**

For high frequency, capacitor offers less resistance because, $X_C \propto \frac{1}{v}$.

16 **(c)**

Frequency of a generator, i.e.

$$v = \frac{\omega}{2\pi} = \frac{120 \times 7}{2 \times 22} = 19 \text{ Hz}$$

$$v_{rms} = \frac{240}{\sqrt{2}} = 120\sqrt{2} = 169.7 \approx 170 \text{ V}$$

17 **(b)**

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

$$\therefore \tan 45° = L = \frac{R}{\omega} = \frac{100}{2\pi \times 1000} \ (\because \tan 45° = 1)$$

$$L = \frac{1}{20\pi}$$

18 **(a)**

Given, inductance, $L = 0.01\text{H}$, resistance, $R = 1\Omega$, voltage, $V = 200$ Vand frequency, $f = 50$ Hz

Impedance of the circuit,

$$Z = \sqrt{R^2 + X_L^2} = \sqrt{R^2 + (2\pi f L)^2}$$

$$= \sqrt{1^2 + (2 \times 3.14 \times 50 \times 0.01)^2}$$

$$Z = \sqrt{10.86} = 3.3\Omega$$

$$\tan\phi = \frac{\omega L}{R} = \frac{2\pi f L}{R} = \frac{2 \times 3.14 \times 50 \times 0.01}{1}$$

$$= 9.14$$

$$\phi = \tan^{-1}(3.14) = 72°$$

Phase difference, $\phi = \frac{72 \times \pi}{180}$ rad

Time lag between alternating voltage and current,

$$\Delta t = \frac{\phi}{\omega} = \frac{72\pi}{180 \times 2\pi \times 50} = \frac{1}{250} \text{ s}$$

19 **(a)**

The given value of voltage in rms value, is

$$E_{rms} = \frac{E_0}{\sqrt{2}}$$

$$E_0 = E_{rms} \times \sqrt{2} = 220 \times \sqrt{2} = 311 \text{ V}$$

The average emf during positive half cycle is given as

$$E_{av} = \frac{2E_0}{\pi} = \frac{2 \times 311}{3.14} = 198 \text{ V}$$

20 **(c)**

As, $i = 2i_0 \frac{t}{T_0}$, where $0 < t < \frac{T_0}{2}$

and $i = 2i_0\left(\frac{t}{T_0} - 1\right)$, where $\frac{T_0}{2} < t < T_0$

$$\therefore i_{av} = \frac{2}{T}\int_0^{T/2} i\,dt = \frac{2}{T_0}\left[\int_0^{T_0/2} \frac{2i_0 t}{T_0} dt\right]$$

$$= \frac{2}{T_0^2}\left[\frac{2i_0 T_0^2}{2 \times 4}\right] = \frac{i_0}{2}$$

21 **(b)**

Angular frequency of free oscillations of the circuit, i.e.

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(27 \times 10^{-3})(30 \times 10^{-6})}\text{s}^{-1}}$$

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

22 **(a)**

Current in $L - C - R$ series circuit,

$$i = \frac{V}{\sqrt{R^2 + (X_L - X_C)^2}}$$

where, V is rms value of current, R is resistance, X_L is inductive reactance and X_C is capacitive reactance.

For current to be maximum, denominator should be minimum which can be done, if

$X_L = X_C$

This happens in resonance state of the circuit, i.e.

$$\omega L = \frac{1}{\omega C}$$

or $L = \frac{1}{\omega^2 C}$ ...(i)

Given, $\omega = 1000 \text{ s}^{-1}, C = 10\mu\text{F}$

$= 10 \times 10^{-6}$ F

Putting the above values in Eq. (i), we get

$$L = \frac{1}{(1000)^2 \times 10 \times 10^{-6}}$$

$$= 0.1\text{H} = 100\text{mH}$$

23 **(b)**

Given, alternating voltage, $V = 200\sqrt{2}\sin(100t)$ and $C = 1\mu\text{F} = 1 \times 10^{-6}$ F

Comparing the given voltage equation with standard equation $V = V_m \sin\omega t$, we get

$V_m = 200\sqrt{2}$ V and $\omega = \frac{100\text{rad}}{\text{s}}$

Reading of ammeter

$$= i_{rms} = \frac{V_{rms}}{X_C} = \frac{V_m\,\omega C}{\sqrt{2}} \left(\because X_C = \frac{1}{\omega C}\right)$$

$$= \frac{200\sqrt{2} \times 100 \times (1 \times 10^{-6})}{\sqrt{2}}$$

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

24 **(b)**

Inductive reactance, $X_L = \omega L \Rightarrow X_L \propto \omega$

Hence, inductive reactance increases linearly with angular frequency as shown in graph (b).

25 **(b)**

Alternating voltage source applied to capacitor,

$$V = 200\sin\left(100\pi t - \frac{\pi}{3}\right)$$

$\therefore$ Phase, $\phi_1 = \frac{\pi}{3}, V_m = 200$ V and $\omega = 100\pi$ rad/s

Since, alternating current leads by $\frac{\pi}{2}$ angle from alternating voltage in a purely capacitive circuit, hence phase angle of alternating current is

$$\phi_2 = \frac{\pi}{2} - \phi_1 = \frac{\pi}{2} - \frac{\pi}{3} = \frac{\pi}{6}$$

$\therefore$ Instantaneous value of alternating current through the capacitor is $i = i_m \sin(100\pi t + \phi_2)$

$$= V_m \omega C \sin\left(100\pi t + \frac{\pi}{6}\right) \qquad \left(\because i_m = \frac{V_m}{X_C}\right)$$

$$= 200 \times 100\pi \times 2 \times 10^{-6} \sin\left(100\pi t + \frac{\pi}{6}\right)$$

$$[\because C = 2\mu F = 2 \times 10^{-6}\ F]$$

$$= 0.04\pi \sin\left(100\pi t + \frac{\pi}{6}\right)$$

26 **(a)**

The reactance X_L of the inductance at 200 Hz is 120Ω.

As, $X_L = \omega L = 2\pi v \times L$

$$\Rightarrow L = \frac{X_L}{2\pi v} = \frac{120\Omega}{2\pi \times 200\ s^{-1}} = \frac{3}{10\pi} H$$

If X_L' denotes the reactance of the same inductance at 60 Hz, then

$$X_L' = \omega' L = 2\pi v' L$$

$$\Rightarrow X_L' = (2\pi \times 60)\left(\frac{3}{10\pi}\right) = 36\Omega$$

If i_{rms} is the current that flows through the inductance, when connected to 240 V and 60 Hz power line, then

$$i_{rms} = \frac{V_{rms}}{X_L'} = \frac{240\ V}{36\Omega} = 6.66\ A$$

27 **(d)**

Current in the series,

L − C − R circuit is given by $i = \frac{V_m}{Z} \cdot \sin(\omega t + \phi)$

$$i = \frac{V_m}{\sqrt{R^2 + (X_C - X_L)^2}} \sin(\omega t + \phi)$$

and $i = i_m \sin(\omega t + \phi)$

28 **(c)**

Power factor of AC circuit is given by $\cos\phi = \frac{R}{Z}$

...(i)

where, R is the resistance employed and Z is the impedance of the circuit.

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

...(ii)

From Eqs. (i) and (ii), we get

$$\cos\phi = \frac{R}{\sqrt{R^2 + (X_L - X_C)^2}}$$

Given, $R = 8\Omega, X_L = 31\Omega, X_C = 25\Omega$

$$\therefore \cos\phi = \frac{8}{\sqrt{(8)^2 + (31-25)^2}} = \frac{8}{\sqrt{64+36}} = \frac{8}{10}$$

Hence, $\cos\phi = 0.80$

29 **(d)**

Given, $V = 200\sqrt{2}\sin(100t)V$ ...(i)

Capacitance of capacitor, $C = 1\mu F = 1 \times 10^{-6}$ F

The standard equation of voltage of AC is given by

$V = V_0 \sin \omega t$ ...(ii)

On comparing Eqs. (i) and (ii), we get

$V_0 = 200\sqrt{2}$

$\omega = 100$

We know that, $i_{rms} = \frac{V_{rms}}{X_C}$

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

$$i_{rms} = \frac{V_0}{\sqrt{2}X_C}$$

$$i_{rms} = \frac{V_0 \omega C}{\sqrt{2}} \qquad \left(\because X_C = \frac{1}{\omega C}\right)$$

$$i_{rms} = \frac{200 \times \sqrt{2} \times 100 \times 1 \times 10^{-6}}{\sqrt{2}}$$

$$i_{rms} = 20 \times 10^{-3}\ A = 20\ mA$$

30 **(b)**

Given, $L = 40\ mH = 40 \times 10^{-3} H, V = 200$ V and $v = 50$ Hz

The rms current in the circuit is

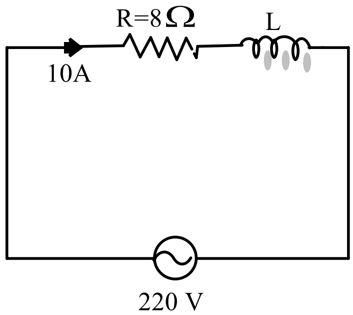
$$i_{rms} = \frac{V}{X_L} = \frac{V}{2\pi v L}$$

$$= \frac{200}{2 \times 3.14 \times 50 \times 40 \times 10^{-3}} \approx 16\ A$$

31 **(d)**

Given, I = 10 A, V = 80 V,

$R = \frac{V}{I} = \frac{80}{10} = 8\Omega$ and $\omega = 50$ Hz



For AC circuit, we have

$$I = \frac{V}{\sqrt{8^2 + X_L^2}}$$

$$\Rightarrow 10 = \frac{220}{\sqrt{64 + X_L^2}}$$

$$\Rightarrow \sqrt{64 + X_L^2} = 22$$

Squaring on both sides, we get

$$64 + X_L^2 = 484$$

$$\Rightarrow X_L^2 = 484 - 64 = 420$$

$X_L = \sqrt{420}$

$\Rightarrow\ 2\pi \times \omega L = \sqrt{420}$

Series inductor on an arc lamp,

$$L = \frac{\sqrt{420}}{(2\pi \times 50)} = 0.065\text{H}$$

32 **(a)**

Since, the current is the same throughout the circuit.

$$i = \frac{V}{Z} = \frac{220}{\sqrt{R^2 + X_C^2}}$$

$$= \frac{220}{\sqrt{200^2 + \left(\frac{1}{2\pi} \times 50 \times 15 \times 10^{-6}\right)^2}} = 0.755 \text{ A}$$

$V_R = iR = (0.755 \text{ A})(200\Omega) = 151 \text{ V}$

$V_C = iX_C = (0.755 \text{ A})(212.5\Omega) = 160.4 \text{ V}$

33 **(d)**

Given, $L = 1.5\text{mH} = 1.5 \times 10^{-3}\text{H}$

$E = 30\mu\text{J} = 3 \times 10^{-5}\text{ J}$

Maximum energy stored in the inductor, $E = \frac{1}{2}Li_m^2$

where, i_m is peak current.

$$\Rightarrow\ i_m = \sqrt{\frac{2E}{L}} = \sqrt{\frac{2 \times 3 \times 10^{-5}}{1.5 \times 10^{-3}}} = 0.2 \text{ A}$$

$$\therefore\ i_{rms} = \frac{i_m}{\sqrt{2}} = \frac{0.2}{\sqrt{2}} = \sqrt{2} \times 10^{-1} \text{ A}$$

34 **(d)**

As, $Z = \sqrt{R^2 + X_L^2} = \sqrt{R^2 + (2\pi fL)^2}$

Also, $i = \frac{V}{Z}$ and $P = i^2R$

When iron rod is inserted, then inductance L of the coil increases which increases impedance Z and consequently, current i and power P of the circuit ' decreases. So, brightness of bulb decreases.

35 **(a)**

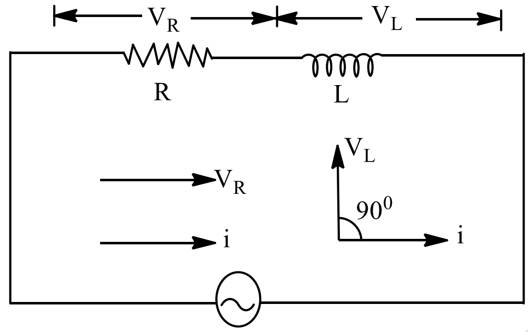
Given, $i_0 = 5\sqrt{2}$ A

Root-mean-square-value of current,

$$i_{rms} = \frac{i_0}{\sqrt{2}} = \frac{5\sqrt{2}}{\sqrt{2}} = 5 \text{ A}$$

36 **(a)**

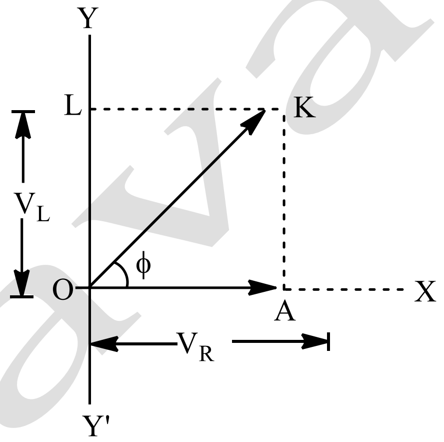
Since, current lags behind the voltage in phase by a constant angle, then circuit must contain R and L.



We find that in $R - L$ circuit, voltage leads the current by a phase angle ϕ, where

$$\tan\phi = \frac{AK}{OA} = \frac{OL}{OA} = \frac{V_L}{V_R} = \frac{i_0X_L}{I_0R}$$

$$\therefore\ \tan\phi = \frac{X_L}{R}$$



37 **(b)**

Given, $V = 200\sqrt{2}\sin(100t)$. Comparing this equation with $V = V_0\sin\omega t$, we have

$V_0 = 200\sqrt{2}$ V and $\omega = 100\text{rad s}^{-1}$

The current in the capacitor,

$$i = \frac{V_{rms}}{Z_C} = V_{rms} \times \omega C \qquad \left(\because Z_C = \frac{1}{\omega C}\right)$$

$$= \frac{V_0}{\sqrt{2}} \times \omega C = \frac{200\sqrt{2}}{\sqrt{2}} \times 100 \times 1 \times 10^{-6}$$

$= 20 \times 10^{-3} \text{ A} = 20 \text{ mA}$

38 **(d)**

As for potential across capacitor in discharging RC circuit $V = V_0e^{-t/\tau}$, when

$$t = \tau, V = V_0e^{-1} = \frac{V_0}{e}$$

$$= \frac{25}{2.718} = 9.2 \text{ V} \quad (\because e = 2.718)$$

Corresponding to $V = 9.2\text{V}$, t lies between 100 s and 150 s.

39 **(c)**

The phase difference between instantaneous value of i and V is

$$\frac{\pi}{4} - \left(-\frac{\pi}{4}\right) = \frac{\pi}{2}$$

Hence, current leads the voltage by 90°.

40 **(c)**

The root-mean-square value (V_{rms}) of alternating voltage is given by

$V_{rms} = \frac{V_0}{\sqrt{2}}$, where V_0 is peak value

Given, $V_0 = 707$ V

$$\therefore\ V_{rms} = \frac{707}{\sqrt{2}} = \frac{707}{1.414} \approx 500 \text{ V}$$

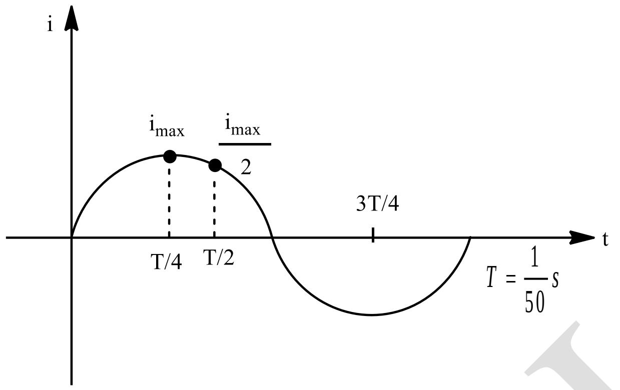
41 **(d)**

In an AC resistive circuit, current and voltage are in phase.

So, $i = \frac{V}{R} \Rightarrow i = \frac{220}{50}\sin(100\pi t)$ ...(i)

$\therefore$ Time period of one complete cycle of current is

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{100\pi} = \frac{1}{50} \text{ s}$$



So, current reaches its maximum value at

$$t_1 = \frac{T}{4} = \frac{1}{200} \text{ s}$$

When current is half of its maximum value, then from Eq. (i), we have

$$i = \frac{i_{max}}{2} = i_{max}\sin(100\pi t_2)$$

$$\Rightarrow \sin(100\pi t_2) = \frac{1}{2} \Rightarrow 100\pi t_2 = \frac{5\pi}{6} \Rightarrow t_2 = \frac{1}{120} \text{ s}$$

So, instantaneous time at which current is half of m : ximum value is $t_2 = \frac{1}{120}$ s

Hence, time duration in which current reaches half of its if orimum value after reaching maximum value is

$$\Delta t = t_2 - t_1 = \frac{1}{120} - \frac{1}{200} = \frac{1}{300} \text{ s} = 3.3 \text{ ms}$$

42 **(b)**

Using Kirchhoff's rule in given figure,

$$V - L\frac{di}{dt} = 0$$

where, the second term is the self induced emf in the inductor and L is the self-inductance of coil.

43 **(a)**

In the given question, there are identical positive and negative half cycles , so the mean value of current is zero for one cycle, but the rms value is not zero . It is calculated as

$$(i^2)_{mean} = \frac{\int_0^T i^2 dt}{\int_0^T dt}$$

$$= \frac{1}{T}\left[\int_0^{T/2} (2)^2 dt + \int_{T/2}^{T} (-2)^2 dt\right]$$

$$= \frac{4}{T}\left(\int_0^{T/2} dt + \int_{T/2}^{T} dt\right) = \frac{4}{T}\left([t]_0^{T/2} + [t]_{T/2}^{T}\right)$$

$$= \frac{4}{T}\left(\frac{T}{2} + T - \frac{T}{2}\right)$$

$$= \frac{4T}{T} = 4$$

$$\therefore i_{rms} = \sqrt{(i^2)_{mean}} = \sqrt{4} = 2 \text{ A}$$

44 **(b)**

According to question, peak value of current,

$$i_0 = \sqrt{2} \times i_{rms} = \frac{2}{\pi} \text{A}$$

Coefficient of mutual inductance = 1H

As we know, induced emf in secondary coil is given by

$\varepsilon_s = M \cdot \frac{di}{dt}$ [where, $i = i_0 \sin \omega t$]

$\varepsilon_s = M\,\omega i_0 \cos(\omega t)$

$= 1 \times 2\pi \times 50 \times \frac{2}{\pi}\cos(2\pi \times 50 \times t)$ ($\because \omega = 2\pi n$)

For $t = 0$, we have

$\varepsilon_s = 4 \times 50 = 200$ V

45 **(a)**

Given, $L = 8\text{mH} = 8 \times 10^{-3}$H,

$C = 20\mu F = 20 \times 10^{-6}$ F, $R = 44\Omega$ and $V_{rms} = 220$ V

Angular resonant frequency of series $L - C - R$ circuit,

$$\omega_0 = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{8 \times 10^{-3} \times 20 \times 10^{-6}}}$$

$= 2500 \text{ rads}^{-1}$

Resonant current $= V_m/R = \frac{V_{rms}\sqrt{2}}{R} = \frac{220\sqrt{2}}{44} = 5\sqrt{2}$ A

46 **(d)**

Ammeter reads the root-mean-square value of current (i_{rms}) which is related to the peak value of current (i_0) by the relation,

$$i_{rms} = \frac{i_0}{\sqrt{2}}$$

$\Rightarrow i_0 = \sqrt{2} \times i_{rms}$

$= \sqrt{2} \times 10 \text{ A} = 10\sqrt{2}$ A

47 **(a)**

$\because$ Angular frequency at resonance, $\omega = \frac{1}{\sqrt{LC}}$ $\cdots$ (i)

According to question, when inductor's inductance is made 2 times and capacitance is 4 times, then

$$\omega' = \frac{1}{\sqrt{2L \times 4C}} = \left(\frac{1}{2\sqrt{2}}\right)\frac{1}{\sqrt{LC}}$$

$$= \frac{\omega}{2\sqrt{2}} \quad \text{[from Eq. (i)]}$$

48 **(d)**

To express an AC power in the same form as DC power ($P = i^2R$), a special value of current is defined and used, it is called root-mean-square (rms) or effective current and is denoted by i_{rms} or i.

49 **(c)**

The full cycle of alternating current consists of two half cycles. For one-half , current is positive and for second-half , current is negative .Therefore ,for an AC cycle, the net value of current average value, Hence, the alternating current cannot be measure by DC ammeter.

50 **(b)**

Amplitude of alternating voltage = Peak voltage $(V_m) = 120$ V, hence rms value of voltage, i.e.

$$V_{rms} = \frac{V_m}{\sqrt{2}} = \frac{120}{1.414} = 84.8 \text{ V}$$

51 **(c)**

In L-R circuit,

$$\text{Impedance, } Z = \sqrt{R^2 + X_L^2}$$

Here, $X_L = \omega L = 2\pi f L$

$$\therefore Z = \sqrt{R^2 + 4\pi^2 f^2 L^2}$$

52 **(b)**

Given, $C = 40\mu F = 40 \times 10^{-6}$ F, and $L = 16mH = 16 \times 10^{-3}$H

Angular frequency of oscillating circuit,

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(16 \times 10^{-3})(40 \times 10^{-6})}}$$

$$= \frac{10^4}{8} = 1.25 \times 10^3 \text{ s}^{-1}$$

53 **(a)**

The value of voltage and current at that instant are $V_m \sin \omega t$ and $i_m \sin \omega t$.

54 **(a)**

DC currents does not change direction with time. But voltages and currents that vary with time are very common.

55 **(a)**

Reactance of the coil or inductive reactance is given as $X_L = \omega L = 2\pi f L$

where, f is frequency.

Given, $X_L = 50\Omega$ and f = 50cps

$$\therefore L = \frac{X_L}{(1)} = \frac{X_L}{2\pi f} = \frac{50}{2\pi \times 50} = \frac{1}{2 \times 314} = 0.16\text{H}$$

56 **(b)**

AC measuring instrument (AC ammeter and voltmeter) always measures rms value.

57 **(b)**

Reading of ammeter

$$= I_{rms} = \frac{E_{rms}}{X_C} = \frac{E_0 \omega C}{\sqrt{2}}$$

$$= \frac{200\sqrt{2} \times 100 \times (1 \times 10^{-6})}{\sqrt{2}}$$

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

58 **(c)**

As natural frequency, i.e. $f = \frac{1}{2\pi\sqrt{LC}}$ or $f \propto \frac{1}{\sqrt{C}}$

When capacitor C is replaced by another capacitor C′ of dielectric constant K, then

$C' = KC$

$$\therefore \frac{f'}{f} = \sqrt{\frac{C}{C'}}$$

$$\Rightarrow \frac{125000 - 25000}{125000} = \sqrt{\frac{C}{KC}}$$

$$\Rightarrow \frac{100}{125} = \frac{1}{\sqrt{K}}$$

$$\Rightarrow K = \left(\frac{125}{100}\right)^2 = 1.56$$

59 **(d)**

Power factor, $\cos\phi = \frac{R}{Z}$

If R is constant, then $\cos\phi \propto \frac{1}{Z}$

$$\therefore \frac{Z_1}{Z_2} = \frac{\cos\phi_2}{\cos\phi_1} = \frac{\frac{1}{4}}{\frac{1}{2}} = \frac{1}{2}$$

$$\Rightarrow Z_2 = 2Z_1$$

$$\therefore \text{Percentage change} = \frac{2Z_1 - Z_1}{Z_1} \times 100 = 100\%$$

60 **(a)**

The effective voltage $= \frac{E_{max}}{\sqrt{2}} = \frac{282}{\sqrt{2}} = 199.4 \text{ V} \simeq 200$ V

61 **(b)**

Given, $V_{rms} = 0.2$ V, $R = 4\Omega$,

$C = 80\ \mu F = 80 \times 10^{-6}$ F

and $L = 200$ mH $= 200 \times 10^{-3}$H

The impedance of the series L − C − R circuit.

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

At resonance, $X_L = X_C \Rightarrow Z = R = 4\Omega$

∴ Voltage drop across inductor,

$(V_{rms})_L = i_{rms} \times X_L = \frac{V_{rms}}{Z} \times \omega L$

$= \frac{V_{rms}}{R} \times \frac{L}{\sqrt{LC}} \quad \left(\because \omega = \frac{1}{\sqrt{LC}}\right)$

$= \frac{V_{rms}}{R} \times \sqrt{\frac{L}{C}} = \frac{0.2}{4} \times \sqrt{\frac{200 \times 10^{-3}}{80 \times 10^{-6}}}$

$= 0.05 \times \sqrt{2500} = 0.05 \times 50 = 2.5$ V

62 **(a)**

The resonant frequency, $v_0 = \frac{1}{2\pi\sqrt{LC}}$

$\Rightarrow v_0 \propto \frac{1}{\sqrt{LC}}$

If inductance and capacitance both are doubled, then

$v_0 = \frac{1}{2}\left(\frac{1}{2\pi\sqrt{LC}}\right)$

So, the resonant frequency will decrease to one-half of the original value.

63 **(a)**

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

$X_C \propto \frac{1}{v}$ ...(i)

Current, $i = \frac{V_{rms}}{X_C} = V_{rms} \cdot \omega C = V_{rms} \cdot 2\pi v C$

$\Rightarrow i \propto v$ ...(ii)

From Eqs. (i) and (ii), we conclude that, if the frequency is doubled, the capacitive reactance is halved and the current is doubled.

64 **(d)**

The current takes $\frac{T}{4}$ seconds to reach the peak value, where T is the time period.

Comparing it with standard equation $i = i_0 \sin \omega t$, we get

$\omega = \frac{2\pi}{T} = 200\pi \Rightarrow T = \frac{1}{100}$ s

$\therefore$ Time required to reach the peak value

$= T/4 = \frac{1}{400}$ s.

65 **(c)**

Here, phase difference in $R - L - C$ series circuit is given as,

$\tan\phi = \frac{X_L - X_C}{R}$

When L is removed, then $\phi = \frac{\pi}{3}$

$\therefore \tan\phi = \frac{X_C}{R} \Rightarrow X_C = R\tan\phi = R\tan\frac{\pi}{3} = \sqrt{3}R$

When C is removed, then ϕ again found to be $\frac{\pi}{3}$.

$\therefore \tan\phi = \frac{X_L}{R} \Rightarrow X_L = R\tan\phi = R\tan\frac{\pi}{3} = \sqrt{3}R$

Hence, power factor, $\cos\phi = \frac{R}{Z} = \frac{R}{\sqrt{(X_L - X_C)^2 + R^2}}$

$= \frac{R}{\sqrt{(\sqrt{3}R - \sqrt{3}R)^2 + R^2}} = \frac{R}{R} = 1$

66 **(c)**

In L-C-R series resonant circuit, $X_L = X_C$

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

$\therefore$ Power factor, $\cos\phi = \frac{R}{Z} = \frac{R}{R} = 1$

Hence, in L-C-R circuit, power factor at resonance is unity.

67 **(d)**

Current corresponding to inductive circuit,

$i = \frac{V}{Z} = \frac{V}{\omega L} \Rightarrow i_{inductive} \propto \frac{1}{\omega}$

...(i)

Similarly, for capacitive circuit $i_{capacitive} \propto \omega$

...(ii)

When frequency of AC is increased,

from Eq.(i), $i_{inductive}$ decreases

from Eq. (ii), $i_{capacitive}$ increases

68 **(d)**

In a parallel resonant circuit, at resonating frequency, the current would be minimum because impedance is maximum.

This is correctly depicted in the graph (d).

69 **(a)**

Given, $E = 4\cos 1000t$ ...(i)

$E = E_0 \cos\omega t$ ...(ii)

From Eqs. (i) and (ii), we get

Peak value of emf, $E_0 = 4$ V

Angular frequency, $\omega = 1000$ Hz

Now, peak value of current is

$i_0 = \frac{E_0}{Z} = \frac{E_0}{\sqrt{R^2 + X_L^2}}$

$= \frac{E_0}{\sqrt{R^2 + \omega^2 L^2}}$

Putting $E_0 = 4\text{ V}, R = 4\Omega, \omega = 1000\text{ Hz}, L = 3\text{mH}$
$= 3 \times 10^{-3}$H

we get, $i_0 = 0.8$ A

70 **(c)**

Power factor of an AC circuit containing L, C and R connected in series is given by

$\cos\phi = \frac{R}{\sqrt{R^2 + \left[\omega L - \frac{1}{\omega C}\right]^2}}$

When an additional capacitance C is joined in parallel with capacitor C, then it makes power factor of circuit unity. i.e.

$\cos\phi = 1 \Rightarrow \frac{R}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega(C+C')}\right)^2}} = 1$

$\Rightarrow \omega L = \frac{1}{\omega(C + C')} \Rightarrow C + C' = \frac{1}{\omega^2 L}$

$\Rightarrow C' = \frac{1 - \omega^2 LC}{\omega^2 L}$

71 **(c)**

Given, $C = 15\mu F = 15 \times 10^{-6}$ F, $V = 220$ V and $v = 50$ Hz

Capacitive reactance, $X_C = \frac{1}{2\pi v C} = \frac{1}{2\pi(50\ Hz)(15\times10^{-6}\ F)} = 212\Omega$

72 **(d)**

The current in an $L - C - R$ circuit is given by

$$i = \frac{V}{\left[R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2\right]^{\frac{1}{2}}}, \text{ where } \omega = 2\pi f$$

Thus, i increases with an increase in ω upto a value given by,

$\omega = \omega_c$, i.e. at $\omega = \omega_c$, we have

$\omega L = \frac{1}{\omega C} \Rightarrow \omega_c = \frac{1}{\sqrt{LC}}$

Hence, $i_{max} = \frac{V}{R}$ at $\omega = \omega_c$

At $\omega > \omega_c$, i again starts decreasing with an increase in ω.

73 **(c)**

Given, $C = 36\mu F = 36 \times 10^{-6}$ F, $V_{rms} = 240$ V and $v = 50$ Hz

Capacitive reactance, $x_C = \frac{1}{2\pi v C} = \frac{1}{2\pi\times50\times36\times10^{-6}} = 88\Omega$

The rms current, $i_{rms} = \frac{V_{rms}}{X_C} = \frac{240\ V}{88\Omega} = 2.73$ A

The peak current, $i_0 = \sqrt{2} i_{rms} = (1.414)(2.73\ A) = 3.85$ A

74 **(b)**

Given, $L = 25mH = 25 \times 10^{-3}H$

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

If T be the time period in $L - C$ oscillation, then

$T = 2\pi\sqrt{LC} = 2\pi\sqrt{25 \times 10^{-3} \times 10^{-5}}$

$= \pi \times 10^{-3}$ s $= \pi$ m $-$ s

Current in the circuit will be maximum, when

$t = \frac{T}{4} = \frac{\pi}{4}$ m $-$ s

75 **(b)**

The voltage equation for the circuit is

$L\frac{di}{dt} + Ri + \frac{q}{C} = V = v_m \sin \omega t$

We know that, $i = dq/dt$. Therefore, $di/dt = d^2q/dt^2$. Thus, in terms of q, the voltage equation becomes

$L\frac{d^2q}{dt^2} + R\frac{dq}{dt} + q/C = V_m \sin \omega t$

76 **(d)**

Given, inductance of a coil, $L = 2H$

Reactance of coil, when it is connected to AC source,

$(X_L)_{AC} = \frac{1}{\omega L}$ (where, ω = angular frequency)

$(X_L)_\omega = \frac{1}{2\omega}$

For DC source, inductor coil behaves as pure conductor. hence $(X_L)_{DC} = 0$.

$\therefore \frac{(X_L)_{AC}}{(X_i)_{DC}} = \frac{\frac{1}{2\omega}}{0} = \infty$(at infinity)

77 **(b)**

The instantaneous voltage through the given device,

$V = 80 \sin 100\pi t$

Comparing the given instantaneous voltage with standard instantaneous voltage

$V = V_0 \sin \omega t$, we get $V_0 = 80$ V

where, V_0 is the peak value of voltage.

Impedance, $Z = 20\Omega$

Peak value of current, $i_0 = \frac{V_0}{Z} = \frac{80}{20} = 4$ A

Effective value of current (root-mean-square value of current)

$i_{rms} = \frac{i_0}{\sqrt{2}} = \frac{4}{\sqrt{2}} = 2\sqrt{2} = 2.828$ A

78 **(b)**

Average voltage,

$$V_{av} = \frac{\int_0^{\pi/\omega} V dt}{\int_0^{\pi/\omega} dt} = \frac{\int_0^{\pi/\omega} V_m \sin \omega t\, dt}{[t]_0^{\pi/\omega}}$$

$$= \frac{V_m \left(\frac{-\cos \omega t}{\omega}\right)_0^{\frac{\pi}{\omega}}}{\frac{\pi}{\omega}}$$

$$= \frac{-V_m}{\pi}(\cos \pi - \cos 0°) = \frac{2V_m}{\pi}$$

79 **(c)**

Here, rms voltage, $V_{rms} = 220$ V

Using the relation, $V_{rms} = \frac{\text{Peak voltage}}{\sqrt{2}} = \frac{V_p}{\sqrt{2}}$

Hence, peak value of AC voltage $V_P = 220\sqrt{2}$V

80 **(b)**

Given, $C = 50\ \mu F = 50 \times 10^{-6}$ F

$V = 220 \sin (50t)$ ...(i)

But we know that,

$V = V_0 \sin \omega t$ ...(ii)

On comparing Eqs. (i) and (ii), we get

$V_0 = 220$ V, $\omega = 50$ rad/s

The capacitive reactance of the circuit is given by

$X_C = \frac{1}{\omega C} = \frac{1}{50 \times 50 \times 10^{-6}} = 400\Omega$

The peak and the rms values of current in the circuit are given as,

$i_0 = \frac{V_0}{X_C} = \frac{220}{400} = \frac{11}{20} = 0.55$ A

81 **(d)**

Since, alternating voltage, $V = 220\sin(100\pi t)$ is connected with 20Ω resistor only, hence equation of alternating current is

$i = i_m \sin(100\pi t)$

Peak value to rms value means current becomes $1/\sqrt{2}$ times.

If t be the time taken by current to change from its peak value to rms value, then from equation of current,

$i = i_m \sin(100\pi t)$

$\frac{i_m}{\sqrt{2}} = i_m \sin(100\pi t)$

$\Rightarrow \frac{1}{\sqrt{2}} = \sin(100\pi t)$

$\Rightarrow \sin\left(\frac{\pi}{4}\right) = \sin(100\pi t)$

$\Rightarrow \frac{\pi}{4} = 100\pi t \Rightarrow t = \frac{1}{400}\text{ s} = 2.5 \times 10^{-3}\text{ s}$

82 **(c)**

Given, $V_{rms} = 220$ V, $v = 50$ Hz

As, $V_{rms} = \frac{V_m}{\sqrt{2}}$

$\Rightarrow V_m = V_{rms}\sqrt{2}$

$= (220\text{ V})(1.414) = 311.1$ V

Further, $\omega = 2\pi v = 2\pi \times 50 = 100\,\pi\text{ rads}^{-1}$

Thus, the equation for the instantaneous voltage is given as

$V = V_m \sin\omega t = 311.1\sin(100\pi)t$.

83 **(d)**

As power consumption, i.e. $P = VI \Rightarrow P = \frac{V^2}{R}$

So, brightness $\propto P_{consumed} \propto \frac{1}{R}$ for bulb, $R_{AC} = R_{DC}$.

So, brightness will be equal in both the cases.

84 **(b)**

When resistance R of the circuit is negligible,

$v = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{10^{-2} \times 25 \times 10^{-6}}}$

$= \frac{10^4}{10\pi} = \frac{10^3}{\pi}$

Thus, the time period, $T = \frac{1}{v} = \frac{\pi}{10^3}\text{ s} = \pi\text{ms}$

Thus, for the energy to be completely magnetic,

$t = \frac{T}{2}, T, \frac{3T}{2}, \ldots \ldots = \frac{\pi}{2}, \pi, \frac{3\pi}{2} \ldots \ldots \text{ms}$

$= 1.57, 3.14, 4.71 \ldots \text{ms}$

85 **(d)**

When a circuit contains inductance only, then the current lags behind the voltage by the phase difference of $\frac{\pi}{2}$ or 90°

While in a purely capacitive circuit, the current leads the voltage by a phase angle of $\frac{\pi}{2}$ or 90°.

In a purely resistive circuit, current is in-phase with the applied voltage.

86 **(a)**

$i_{rms} = \sqrt{\frac{i_1^2 + i_2^2 + i_3^2}{3}} = \sqrt{\frac{1^2 + 2^2 + 1^2}{3}}$

$= \sqrt{\frac{6}{3}} = \sqrt{2} = 1.41$ A

$\simeq 1.4$ A