ALTERNATING CURRENT

1. A resistance of 20 Ω is connected to a source of 110 V, 50 Hz alternating current. Find
   a) the rms current
   b) the maximum instantaneous current in the resistor and
   c) the time taken by current to change from its maximum value to the rms value.

   Answer : a) 5.5 A; b) 7.8 A; c) 2.5 ms.

2. The electric current in a circuit is given by $i = i_0\left(t/\tau\right)$ for some time. Calculate the rms current for the period $t = 0$ to $t = \tau$.

   Answer : $i_0/\sqrt{3}$

3. A capacitor of capacitance 100 μF and a coil of resistance 50 Ω and inductance 0.5 H are connected in series with a 110 V, 50 H ac source. Find the rms value of the current.

   Answer : 0.82 A

4. A series ac circuit contains an inductor of inductance 20 mH, a capacitor 100 μF and a resistance 50 Ω. The circuit is connected to ac source of 12 V, 50 Hz. Find the energy dissipated in the circuit in 1000 s.

   Answer : 2.3 kJ.

5. An electric bulb is designed to consume 55 W when operated at 110 volts. It is connected to a 220 V, 50 Hz line through a choke coil in series. What should be the inductance of the coil for which the bulb gets correct voltage?

   Answer :

6. In a series *LCR* circuit with an ac source R = 300 Ω, C = 20 μF, L = 1.0 Henry, $E_{rms} = 50$ V and $f = \dfrac{50}{\pi}$ Hz. Find
   a) the rms current in the circuit and
   b) the rms potential differences across the capacitor, the resistor and the inductor.

   Answer :

7. A circuit has a coil of resistance 50 Ω and inductance $3/\pi$ Henry. It is connected in series with a condenser of $\dfrac{40}{\pi}$ μF and ac supply voltage of 200 V and 50 Hz. Calculate
   a) the impedance of the circuit,
   b) the p.d. across inductance coil and condenser.

   Answer :

8. An inductor $2/\pi$ Henry, a capacitor $\dfrac{100}{\pi}$ μF and a resistor 75 Ω are connected in series across a source of emf $V = 10\sin\left(100\pi t\right)$.
   a) find the impedance of the circuit.
   b) find the energy dissipated in the circuit in 20 minutes.

   Answer :

9. A series circuit consists of a resistance, inductance and capacitance. The applied voltage and the current at any instant are given by

   $$E = 100\pi\cos\left(5000t - 10^\circ\right) \text{ and } \quad i = 5\cos\left(5000t - 370^\circ\right)$$

The inductance is 0.01 Henry. Calculate the value of capacitance and resistance.

Answer :

10. An inductance of 2.0 H, a capacitance of 18 μF and a resistance of 10 kΩ are connected to an ac source of 20 V with adjustable frequency
a) What frequency should be chosen to maximise the current (rms) in the circuit?
b) What is the value of this maximum current (rms)?

Answer :

11. An inductor-coil a capacitor and an ac source of rms voltage 24 V are connected in series. When the frequency of the source is varied a maximum rms current of 6.0 A is observed. If this inductor coil is connected to a battery of emf 12 V and internal resistance 4.0 Ω, what will be energy stored in the inductor?

Answer :

12. A wave of wavelength 300 metre can be transmitted by a transmission centre. A condenser of capacity 2.5 μF is available. Calculate the inductance of the required coil for a resonant circuit. (Take $\pi = \sqrt{10}$).

Answer :

13. A coil has a resistance of 10 Ω and an inductance of 0.4 H. It is connected to an ac source of 6.5 V, 60 rad/s. Find the average power consumed in the circuit.

Answer : $5/8$ W.

14. An electric bulb is designed to consume 55 W when operated at 110 V. It is connected to a 220 V, 50 Hz line through a choke coil in series. What should be the inductance of the coil for which the bulb gets correct voltage?

Answer : 1.2 H

15. In a series *LCR* circuit with R = 300 Ω, C = 20 μF and L = 1 H is connected to an ac source of 50 V, 100 rad/s. Find
a) the rms current in the circuit,
b) the rms value of potential difference across the capacitor, resistor and inductor
c) average electric field energy stored in the capacitor
d) average magnetic field energy stored in the inductor

Answer : a) 0.1 A; b) 50 V, 30V, 10 V; c) 25 mJ, 5 mJ

16. An inductor coil a capacitor and an ac source of variable frequency and rms voltage 24 V are connected in series. When frequency of the source is varied a maximum rms current of 6.0 A is observed. If this inductor coil is connected to a battery of emf 12 V and internal resistance 4 Ω, what current will flow through the coil?

Answer : 1.5 A.

17. 200 km long telegraph wire has a capacity of 0.014 μF/km. If it carries an alternating current of 5,000 Hz, find the inductance of an inductor required to be connected in series for the minimum impedance of the line.

Answer : 360 μH.

18. A 100 V ac source of frequency 500 Hz is connected to a *LCR* circuit with L = 8.1 mH, C = 12.5 μF and R = 10 Ω, all connected in series. Find the potential difference across the resistance.

Answer : 100 V.

19. A series *LCR* circuit with 100 Ω resistance is connected to an ac source of 200 V and angular frequency 300 rad/s. When only capacitance is removed, the current lags behind voltage by 60°, when only inductance is removed, the current leads voltage by 60°. Calculate the current in *LCR* circuit. Also find the power dissipated in the circuit.

Answer : 2 amp, 400 W.

20. 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 rad/s ac source, a current of 2.4 amp flows in the

circuit. Determine the inductance of the coil. Also find the power developed in the circuit if a 2.5 mF capacitor is connected in series with the coil.

Answer : 80 mH, 17.28 W.

21. A *LCR* circuit has L = 10 mH, R = 3 Ω and C = 1 μF connected in series to a source of $V = 15\cos(\omega t)$ volts. Calculate the current amplitude and average power dissipated per cycle at a frequency that is 10% lower than the resonant frequency.

Answer : 0.7 amp, 0.74 W.

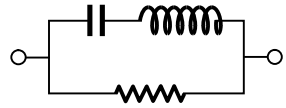
22. The current in an ideal coil of self inductance 2.0 H is increasing according to $i = 2\sin t^2$ amp. Find the amount of energy spent by source during the period when the current changes from zero to 2 amp.

Answer : 4 J.

23. A 750 Hz, 20 V source is connected to a resistance of 100 Ω, an inductance of 0.1803 H and a capacitance of 10 μF all in series. Calculate the time in which the resistance (thermal capacity = 2 J/°C) will get heated by 10 °C.

Answer : 348 s.

24. A box contains *L*, *C* and *R*. When 250 V dc is applied to the terminals of the box, a current of 1.0 amp, flows in the circuit. When an ac source of 250 V rms at 2250 rad/s is connected, a current of 1.25 amp rms flows. It is observed that the current rises with frequency and becomes maximum at 4500 rad/s. Find the values of *L*, *C* and *R*. Also draw the circuit diagram.

Answer : $\frac{4}{81}$ H, 1 μF, 250 Ω, 

25. A series *LCR* circuit containing a resistance of 120 Ω has angular frequency of resonance as 4×10^5 rad/s. At resonance the voltage across resistance and inductor are 60 V and 40 V respectively. Find the value of *L* and *C*. At what frequency the current in the circuit lags the voltage by 45°?

Answer : 0.2 mH, $\frac{1}{32}$ μF, 8×10^5 rad/s.

26. A choke coil is needed to operate an arc lamp at 160 V (rms) and 50 Hz. The arc lamp has an effective resistance of 5 W when running at 10 A (rms). Calculate the inductance of the choke coil. If the same arc lamp is to be operated on 160 V dc, find the additional resistance is required to be connected in series. Find the % loss of power in dc circuit.

Answer : 50 mH, 11 Ω, 68.75 %

27. A box *P* and a coil *Q* are connected in series with an ac source of variable frequency. The emf of source is constant at 10 V. Box *P* contains a capacitance of 1 μF in series with a resistance of 32 Ω. Coil *Q* has a self inductance 4.9 mH and a resistance of 68 Ω. The frequency of source is adjusted so that the maximum current flows in *P* and *Q*. Find the impedance of *P* and *Q* at this frequency. Also find the voltage across *P* and *Q* respectively.

Answer : 76 Ω, 98 Ω, 7.6 V, 9.8 V.

28. An inductor 20 mH, a capacitor 100 μF and a resistor 50 Ω are connected in series across a source of emf $V = 10\sin(100\pi t)$. Find the energy dissipated in the circuit in 20 minute. If resistance is removed from the circuit and the value of inductance is doubled, then find the current as a function of time in the new circuit.

Answer : 952 J, $i = 0.52\cos(100\pi t)$

29. In a series resonance *LC* circuit of resonance frequency 20 k Hz, the inductance of the inductor is π m H. Find the current through the circuit if an ac voltage 90 V, 10 k Hz is applied to it. (Take $\pi = \sqrt{10}$)

Answer : 0.15 amp

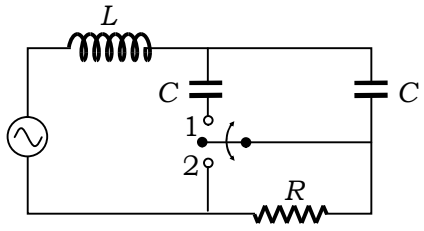
30. 250 V, 100 W bulb is to be operated by a 300 V ac supply. Find the series resistance required for the proper operation of the bulb. When the resistance is replaced by an inductor of inductance of $\frac{50}{\pi}$ mH, the bulb still operates properly. Find the frequency of the ac source. Also find the percentage saving on power in replacing resistance by inductor.

Answer : 125 Ω, 4146 Hz, $\frac{50}{3}$ %

31. The power factor of an *LR* circuit connected across 240 V, 50 Hz ac power supply is 0.6. Circuit generates 120 W of heat. Find the capacitance required to be connected in series to change the power factor to unity. What is the new rate of generation of heat.

Answer : 13.8 μF, $\frac{1000}{3}$ W

32. The ac generator in figure supplies 150 $V_{(max)}$ at 50 Hz. With the switch open as in the diagram, the resulting current leads the generator emf by 60°. With the switch in position 1, the current lags the generator emf by 30°. When the switch is in position 2, the maximum current is 3 A. Then the value of *R* is



Answer :