PHYSICS

BOOKS - VIKRAM PUBLICATION (ANDHRA PUBLICATION)

ALTERNATING CURRENT

Problems

1. An ideal inductor (no internal resistance for the coil) or 20 mH is connected in series with

an AC ammeter to an AC source whose emf is given by $e = 20\sqrt{2}\sin(200t + \pi/3)V$, where t is in seconds. Find the reading of the ammeter ?

Watch Video Solution

2. The instantaneous current and instantaneous voltage across a series circuit containing resistance and inductance are given by $I = \sqrt{2}\sin(100t - \pi/4)A$ and $v = 40\sin(100t)$ V. Calculate the resistance ?

Watch Video Solution

3. In an AC circuit, a condenser, a resistor and a pure inductor are connected in series across an alternator (AC generator). If the voltages across them are 20 V, 35 V and 20 V respectively, find the voltage supplied by the alternator.

Watch Video Solution

4. An AC circuit contains a resistance R, an inductance L and a capacitance C connected in series across an alternator of constant voltage and variable frequency. At resonant frequency, it is found that the inductive reactance, the capacitive reactance and the resistance are equal and the current in the circuit is i_0. Find the current in the circuit at a frequency twice that of the resonant frequency.

Watch Video Solution

5. A series resonant circuit contains L_1, R_1 and C_1. The resonant frequency is f. Another series resonant circuit contains L_2, R_2 and C_2 . The resonant frequency is also f. If these two circuits are connected in series, calculate the resonant frequency.

View Text Solution

6. In a series LCR circuit $R = 200\Omega$ and the voltage and the frequency of the mains supply is 200 V and 50 Hz respectively. On taking out

the capacitance from the circuit out the capacitance from the circuit the current lags behind the voltage by 45°. On taking out the inductor from the circuit the current leads the voltage by 45°. Calculate the power dissipated in the LCR circuit.

Watch Video Solution

7. The primary of a transformer with primary to secondary turns ratio of 1 : 2, is connected to an alternator of voltage 200 V. A current of

4A is flowing though the primary coil. Assuming that the transformer has no losses, find the secondary voltage and current are respectively.

Watch Video Solution

8. A light bulb is rated at 100W for a 220 V supply. Find

The resistance of the bulb,

View Text Solution

9. A light bulb is rated at 100W for a 220 V supply. Find

The peak voltage of the source,

Watch Video Solution

10. A light bulb is rated at 100W for a 220 V supply. Find

The rms current through the bulb.

Watch Video Solution

11. A pure inductor of 25.0 mH is connected to a source of 220 V. Find the inductive reactance and rms current in the circuit if the frequency of the source is 50 Hz.

Watch Video Solution

12. The instantaneous current and instantaneous voltage across a series circuit containing resistance and inductance are given by $I = \sqrt{2}\sin(100t - \pi/4)A$ and $v = 40\sin(100t)$ V. Calculate the resistance ?

Watch Video Solution

13. In an AC circuit, a condenser, a resistor and a pure inductor are connected in series across an alternator (AC generator). If the voltages across them are 20 V, 35 V and 20 V respectively, find the voltage supplied by the alternator.

Watch Video Solution

14. What is step up transformer ? How it differs from step down transformer ?

Watch Video Solution

Textual Examples

1. A light bulb is rated at 100W for a 220 V supply. Find

The resistance of the bulb

Watch Video Solution

2. A light bulb is rated at 100 W for a 220 V supply. Find

(a) the resistance of the bulb.

(b) the peak voltage of the source

(c) the rms current through the bulb.

Watch Video Solution

3. A light bulb is rated at 100W for a 220 V supply. Find

The rms current through the bulb.

Watch Video Solution

4. A pure inductor of 25.0 mH is connected to a source of 220 V. Find the inductive reactance and rms current in the circuit if the frequency of the source is 50 Hz.

Watch Video Solution

5. A lamp is connected in series with a capacitor. Predict your observations for dc and

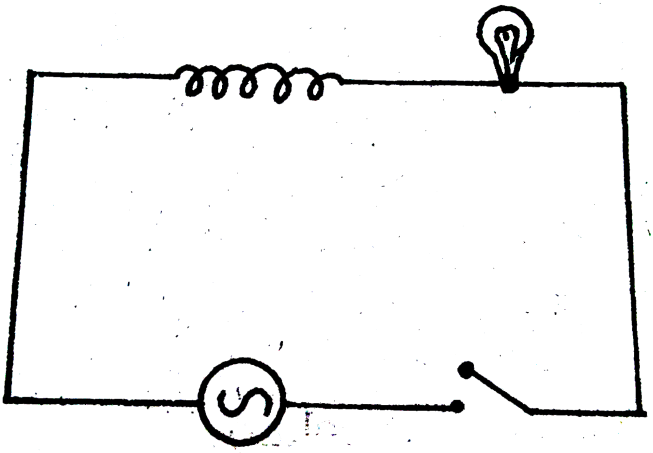
ac connections. What happens in each case if the capacitance of the capacitor is reduced ?

Watch Video Solution

6. A $15.0\mu F$ capacitor is connected to a 220 V, 50 Hz source. Find the capacitive reactance and the current (rms and peak) in the circuit. If the frequency is doubled, what happens to the capacitive reactance and the current ?

Watch Video Solution

7. A light bulb and an open coil inductor are connected to an ac source through a key as shown in the figure.



The switch is closed and after sometime, an iron rod is inserted into interior of the inductor. The glow of the light bulb (a) increases , (b) decreases , (c) is unchanged, as

the iron rod is inserted. Given your answer with reasons.

Watch Video Solution

8. A resistor of 200Ω and a capacitor of $1.50\mu F$ are connected in series to a 220V, 50 Hz ac source.

Calculate the voltage (rms) across the resistor and the capacitor. Is the algebraic sum of these voltages more than the source voltage ? If yes, resolve the paradox.

Watch Video Solution

9. A resistor of 200Ω and a capacitor of $1.50\mu F$ are connected in series to a 220V, 50 Hz ac source.

Calculate the voltage (rms) across the resistor and the capacitor. Is the algebraic sum of these voltages more than the source voltage ? If yes, resolve the paradox.

Watch Video Solution

10. For circuits used for transporting electric power, a low power factor implies large power loss in transmission. Explain.

Watch Video Solution

11. Power factor can often be improved by the use of a capacitor of appropriate capacitance in the circuit. Explain.

View Text Solution

12. A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series LCR circuit in which $R = 3\Omega$. $L = 25.48mH$. And $C = 796\mu F$.

The impedance of the circuit

Watch Video Solution

13. A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series LCR circuit in which $R = 3\Omega$. $L = 25.48mH$. And $C = 796\mu F$.

The phase difference between the voltage across the source and the current

Watch Video Solution

14. A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series LCR circuit in which $R = 3\Omega$. $L = 25.48mH$. And $C = 796\mu F$.

The power dissipated in the circuit

Watch Video Solution

15. A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series LCR circuit in which $R = 3\Omega$. $L = 25.48mH$. And $C = 796\mu F$.

The power factor.

Watch Video Solution

16. A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series LCR circuit in which R = 3 Ω . L = 25.48 m H . And C = 796 μ F .Suppose the frequency of the source

can be varied.

What is the frequency of the source at which resonance occurs ?

 Watch Video Solution

17. A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series LCR circuit in which R = 3 Ω . L = 25.48 m H . And C = 796 μ F .Suppose the frequency of the source in the previous example can be varied.

Calculate the impedance, the current, and the power dissipated at the resonant condition.

Watch Video Solution

18. At an airport, a person is made to walk through the doorway of a metal detector, for security reasons. If she/he is carrying anything made of metal, the metal detector emits a sound. On what principle does this detector work ?

Watch Video Solution

19. Show that in the free oscillations of an LC circuit, the sum of energies stored in the capacitor and the inductor is constant in time.

Watch Video Solution

Very Short Answer Questions

1. A transformer converts 200 V ac into 2000 V ac. Calculate the number of turns in the secondary if the primary has 10 turns.

Watch Video Solution

2. What type of transformer is used in a 6V bed lamp ?

Watch Video Solution

3. What is the phenomenon involved in the working of transformer ?

Watch Video Solution

4. What is transformer ratio ?

Watch Video Solution

5. Write the expression for the reactance of (i) an inductor and (ii) a capacitor.

Watch Video Solution

6. What is the phase difference between A.C emf and current in the following : Pure

resistor, pure inductor and pure capacitor.

Watch Video Solution

7. Define power factor. On which factors does power factor depend ?

Watch Video Solution

8. What is meant by wattless component of current ?

Watch Video Solution

9. When does a LCR series circuit have minimum impedance ?

Watch Video Solution

10. What is the phase difference between voltage and current when the power factor in LCR series circuit is unity ?

Watch Video Solution

Short Answer Questions

1. Obtain an expression for the current through an inductor when an AC emf is applied.

Watch Video Solution

2. Obtain an expression for the current through an inductor when an AC emf is applied.

Watch Video Solution

3. State the principle which a transformer works. Describe the woeking of a transformer with necessary theory.

View Text Solution

Long Answer Questions

1. Obtain on expression for impedance and current in series LCR circuit. Deduce an

expression for the resonating frequency of an LCR series reasonating circuit.

View Text Solution

Textual Exercises

1. A 100Ω resistor is connected to a 220 V. 50 Hz ac supply.

What is the rms value of current in the circuit ?

Watch Video Solution

2. A 100Ω resistor is connected to a 220 V. 50 Hz ac supply.

What is the net power consumed over a full cycle ?

Watch Video Solution

3. The peak voltage of an ac supply is 300 V. What is the rms voltage ?

Watch Video Solution

4. The rms value of current in an ac circuit is 10A. What is the peak current ?

Watch Video Solution

5. A 44 mH inductor is connected to 220 V, 50 Hz ac supply. Determine the rms value of current in the circuit.

Watch Video Solution

6. A $60\mu F$ capacitor is connected to a 110 V, 60 Hz ac supply. Determine the rms value of the current in the circuit.

Watch Video Solution

7. In Exercises 3 and 4, what is the net power absorbed by each circuit over a complete cycle. Explain your answer.

View Text Solution

8. Obtain the resonant frequency ω_r of a series LCR circuit with $L = 2.0H. C = 32\mu F$ and $R = 10\Omega$. What is the Q-value of this circuit ?

Watch Video Solution

9. A charged $30\mu F$ capacitor is connected to a 27 mH inductor. What is the angular frequency of free oscillations of the circuit ?

Watch Video Solution

10. Suppose the initial charge on the capacitor in Exercise 7 is 6mC. What is the total energy at later time ?

View Text Solution

11. A series LCR circuit with $R = 20\Omega, L = 1.5H$ and $C = 35\mu F$ is connected to a variable-frequency 200 V ac supply. When the frequency of the supply equals the natural frequency of the circuit,

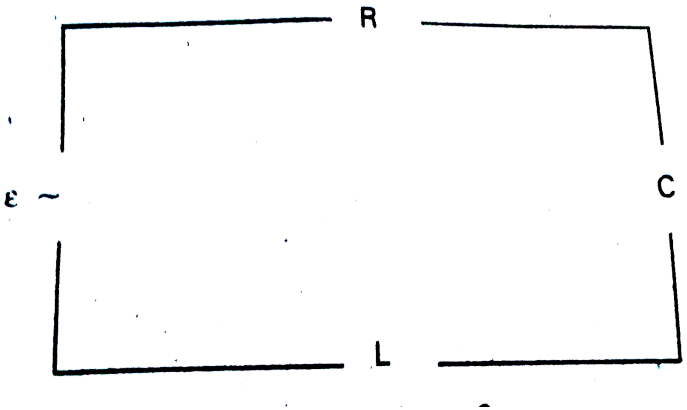
what is the average power transferred to the circuit in one complete cycle ?

Watch Video Solution

12. A radio can tune over the frequency range of a portion of MW broadcast band : (800 kHz to 1200 kHz). If its LC circuit has an effective inductance of 200 μH, what must be the range of its variable capacitor ?

Watch Video Solution

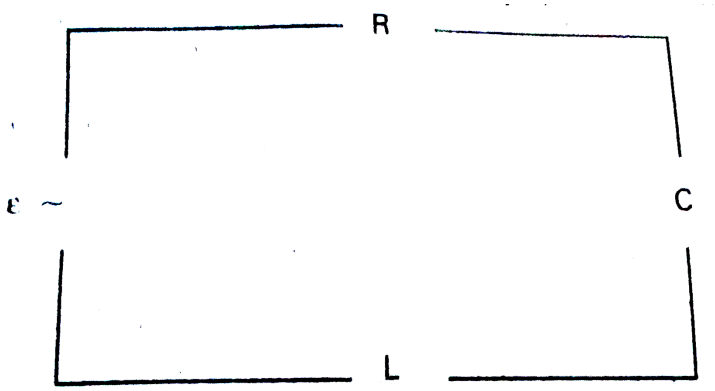
13. Figure shows a series LCR circuit connected to a variable frequency 230 V source. $L = 5.0H, C = 80\mu F, R = 40\Omega.$



Determine the source frequency which drives the circuit in resonance.

Watch Video Solution

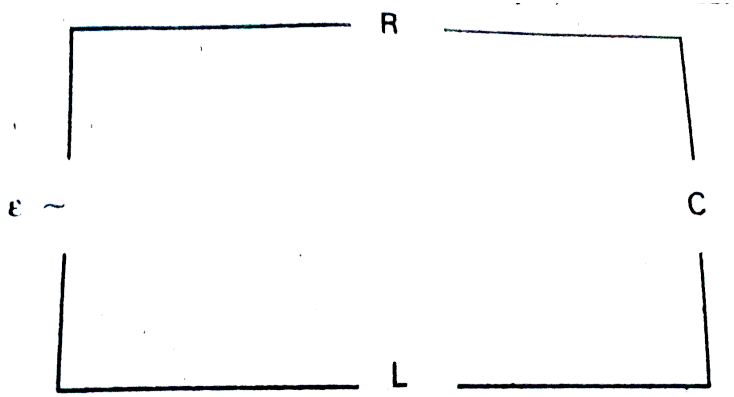
14. Figure shows a series LCR circuit connected to a variable frequency 230 V source. $L = 5.0H, C = 80\mu F, R = 40\Omega.$



Obtain the impedance of the circuit and the amplitude of current at the resonanting frequency.

Watch Video Solution

15. Figure shows a series LCR circuit connected to a variable frequency 230 V source. $L = 5.0H, C = 80\mu F, R = 40\Omega.$



Determine the rms potential drops across the three elements of the circuit. Show that the potential drop across the LC combination is zero at the resonating frequency.

Watch Video Solution

Additional Exercises

1. An LC circuit contains a 20 mH inductor and a $50\mu F$ capacitor with an initial charge of 10 mC. The resistance of circuit is negligible. Let the instant the circuit is closed be t = 0.

What is the total energy stored initially ? Is it conserved during LC oscillations ?

Watch Video Solution

2. An LC circuit contains a 20 mH inductor and a $50\mu F$ capacitor with an initial charge of 10 mC. The resistance of circuit is negligible. Let the instant the circuit is closed be t = 0.

What is the natural frequency of the circuit ?

Watch Video Solution

3. An LC circuit contains a 20 mH inductor and a $50\mu F$ capacitor with an initial charge of 10 mC. The resistance of circuit is negligible. Let the instant the circuit is closed be t = 0.

At what time is the energy stored

(i) Completely electrical (i.e., stored in the capacitor) ?

Watch Video Solution

4. An LC circuit contains a 20 mH inductor and a $50\mu F$ capacitor with an initial charge of 10 mC. The resistance of circuit is negligible. Let the instant the circuit is closed be t = 0.

At what time is the energy stored

(ii) completely magnetic (i.e., stored in the inductor) ?

Watch Video Solution

5. An L-C circuit contains 20 mH inductor and a $50\mu F$ capacitor with an initial charge of 10 mC. The resistance of the circuit is negligible. Let the instant the circuit is closed be t = 0. what is the total energy stored initially ? At what times is the total energy shared equally between the inductor and the capacitor ?

Watch Video Solution

6. An LC circuit contains a 20 mH inductor and a $50\mu F$ capacitor with an initial charge of 10 mC. The resistance of the circuit is negligible. Let the instant the circuit is closed be t = 0.

(a) What is the total energy stored initially ? Is it conserved during the oscillalions?

(b) What is the natural frequency of the circuit?

(c) At what time is the energy stored? (i) Completely electrical ? (ii) Completely

magnetic ?

(d) At what time is the total energy shared equally between the inductor and the capacitor ?

(e) If a resistor is inserted in the circuit, how much energy is eventually dissipated as heat ?

Watch Video Solution

7. A coil of inductance 0.50 H and resistance 100Ω is connected to a 240 V, 50Hz ac supply. what is the maximum current in the coil?

Watch Video Solution

8. A coil of inductance $0.50H$ and resistance 100Ω is connected to a $240V, 50Hz$ ac supply. What are the maximum current in the coil and the time lag between voltage maximum and current maximum?

Watch Video Solution

9. Obtain the answers (a) to (b) in Exercise 13 if the circuit is connected to a high frequency

supply (240 V, 10 kHz). Hence, explain the statement that at very high frequency, an inductor in a circuit nearly amount to an open circuit. How does an inductor behave in a dc circuit after the steady state ?

View Text Solution

10. A $100\mu F$ capacitor in series with a 40Ω resistance is connected to a 110V. 60 Hz supply. What is the maximum current in the circuit ?

Watch Video Solution

11. A $100\mu F$ capacitor in series with a 40Ω resistance is connected to a 110V. 60 Hz supply. What is the time lag between the current maximum and the voltage maximum ?

Watch Video Solution

12. Obtain the answers (a) to (b) in Exercise 15 if the circuit is connected to a 110 V, 12 kHz supply ? Hence, explain the statement that a capacitor is a conductor at very high

frequencies. Compare this behaviour with that of a capacitor in a dc circuit after the steady state.

View Text Solution

13. Keeping the source frequency equal to the resonating frequency of the series LCR circuit, if the three elements L,C and R are arranged in parallel, show that the total current in the parallel LCR circuit is minimum at this frequency. Obtain the current rms value in

each branch of the circuit for the elements and source specified in Exercise 11 for this frequency.

View Text Solution

14. A circuit containing a 80 mH inductor and a $60\mu F$ capacitor in series is connected to a 230 V 50 Hz supply. The resistance of the circuit is negligible.

Obtain the current amplitude and rms values.

Watch Video Solution

15. A circuit containing a 80 mH inductor and a $60\mu F$ capacitor in series is connected to a 230 V 50 Hz supply. The resistance of the circuit is negligible.

Obtain the rms values of protential drops across each element.

Watch Video Solution

16. A circuit containing a 80 mH inductor and a $60\mu F$ capacitor in series is connected to a 230

V 50 Hz supply. The resistance of the circuit is negligible.

What is the average power transferred to the inductor ?

Watch Video Solution

17. A circuit containing a 80 mH inductor and a $60\mu F$ capacitor in series is connected to a 230 V 50 Hz supply. The resistance of the circuit is negligible.

What is the average power transferred to the inductor ?

18. A circuit containing a 80 mH inductor and a $60\mu F$ capacitor in series is connected to a 230 V 50 Hz supply. The resistance of the circuit is negligible.

What is the total average power absorbed by the circuit ? ['Average' implies 'averaged over one cycle']

Watch Video Solution

19. Suppose the circuit in Exercise 18 has a resistance of 15Ω. Obtain the average power transferred to each element of the circuit, and the total power absorbed.

View Text Solution

20. A series LCR circuit with $L = 0.12H, C = 480nF, R = 23\Omega$ is connected to a 230 V variable frequency

supply.

What is the source frequency for which current amplitude is maximum. Obtain this maximum vlaue.

Watch Video Solution

21. A series LCR circuit with $L = 0.12H, C = 480nF, R = 23\Omega$ is connected to a 230 V variable frequency supply.

What is the source frequency for which

average power absorbed by the circuit is maximum. Obtain the value of this maximum power.

Watch Video Solution

22. A series LCR circuit with $L = 0.12H, C = 480pF, R = 23\Omega$ is connected to a 230 V variable frequency supply.

For which frequencies of the source is the power transferred to the circuit half power at

resonant frequency ? What is the current amplitude at these frequencies ?

View Text Solution

23. A series LCR circuit with $L = 0.12H, C = 480nF, R = 23\Omega$ is connected to a 230 V variable frequency supply.

What is the Q - factor of the given circuit ?

Watch Video Solution

24. Obtain the resonant frequency and Q-factor of series LCR circuit with $L = 3.0H, C = 27\mu F,$ and $R = 10.4\Omega.$ It is desired to improved the sharpness of the resonance of the circuit by reducing its 'full width at half maximum' by a factor of2. Suggest a sultable way.

View Text Solution

25. In any ac circuit, is the applied Instantaneous voltage equal to the algebraic

sum of the instantaneous voltages across the series elements of the circuit ? Is the same true for rms voltage ?

Watch Video Solution

26. A capacitor is used in the primary circuit of an induction coil.

View Text Solution

27. An applied voltage signal consists of a superposition of a dc voltage and an ac voltage of high frequency. The circuit consists of an inductor and a capacitor in series. Show that the dc signal will appear across C and the ac signal across L.

View Text Solution

28. A choke coil in series with a lamp is connected to a dc line. The lamp is seen to

shine brightly. Insertion of an Iron core in the choke causes no change in the lamp's brightness. Predict the corresponding observations if the connection is to an ac line.

View Text Solution

29. Why is choke coil needed in the use of fluorescent tubes with ac mains ? Why can we not use an ordinary resistor instead of the choke coil ?

Watch Video Solution

30. A power transmission line feeds input power at 2300 V to a step down trnasformer with it primary windings having 4000 turns. What should be the number of turns in the seconday windings in order to get output power at 230 V?

Watch Video Solution

31. At a hydroelectric power plant, the water pressure head is at a height of 300 m and the

water flow available is $100m^3s^{-1}$. If the turbine generator efficiency is 60%, estimate the electric power available from the plant $(g = 9.8ms^{-2})$.

Watch Video Solution

32. A small town with a demand of 800 kW of power at 220 V is situated 15 km away from an electric plant generating power at 440 V. The resistance of the two wire line carrying power is $0.5\Omega.km^{-1}$. The line gets power from the

line through a 4000-220 V step-down transformer at a substation in the town. Estimate the line power loss in the form of heat?

Watch Video Solution

33. A small town with a demand of 800 kW of electric power at 220 V is situated 15 km away from an electric plant generating power at 440 V. The resistance of the two line wires carrying power is 0.5Ω per km. The town gets

power from the lines through a 4000-220 V step down transformer at a substation in the town.

Estimate the line power loss in the form of heat.

(b) How much power must the plant supply. assuming there is negligible power loss due to leakage?

(c) Characterize the step up transformer at the plant.

Watch Video Solution

34. A small town with a demand of 800 kW of power at 220 V is situated 15 km away from an electric plant generating power at 440 V. The resistance of the two wire line carrying power is $0.5\Omega.km^{-1}$. The line gets power from the line through a 4000-220 V step-down transformer at a substation in the town.

Characterise the step-up transformer at the plant.

Watch Video Solution

35. Do the same exercise as above with the replacement of the earlier transformer by a 40,000-220V step-down transformer (Neglect, as before, leakage losses though this may not be a good assumption any longer because of the very high voltage transmission involved). Hence, explain why high volage transmission is preferred ?

View Text Solution