Previous Years

Examination Questions

1 Mark Questions

1. A series combination of an inductor (L), a capacitor (C) and a resistor (R) are connected across an AC source of emf of peak value E_0 and angular frequency (ω). Plot a graph to show variation of impedance of the circuit with angular frequency (ω). **Delhi 2020**
2. Define quality factor of resonance in series L-C-R circuit. What is its SI unit? **Delhi 2016**
3. The power factor of an AC circuit is 0.5. What is the phase difference between voltage and current the circuit? **Foreign 2016**
4. Define capacitor reactance. Write its SI unit. **All India 2015**
5. Plot a graph showing variation of capacitive reactance with the change in the frequency of the AC source. **All India 2015C**
6. Why is the use of AC voltage preferred over DC voltage? Give two reasons. **All India 2014**
7. When an AC source is connected across an inductor, show on a graph the nature of variation of the voltage and the current over one complete cycle. **Delhi 2012C**
8. The peak value of emf in AC is E_0. Write its (i) rms (ii) average value over a complete cycle. **Foreign 2011**
9. The current flowing through a pure inductance 2 mH is, $I = (15 \cos 300t)$ A. What is the (i) rms and (ii) average value of current for a complete cycle? **Foreign 2011**
10. Define the term wattless current. **Delhi 2011**
11. A reactive element in an AC circuit causes the current flowing
    (i) to lead in phase by $\pi/2$

(ii) to lag in phase by $\pi/2$ w.r.t. the applied voltage. Identify the element in each case. **Delhi 2010C**

12. Define the term rms value of the current. How is it related to the peak value?

All India 2010C

2 Marks Questions

13. A resistor R and an inductor L are connected in series to a source of voltage $V = V_0 \sin \omega t$. The voltage is found to lead current in phase by $\frac{\pi}{4}$. If the inductor is replaced by a capacitor C, the voltage lags behind current in phase by $\pi / 4$. When L, C and R are connected in series with the same source. Find the

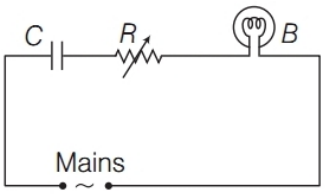
(a) average power dissipated

(b) and instantaneous current in the circuit. **All India 2020**

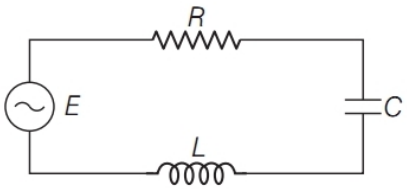
14. A capacitor C, a variable resistor R and a bulb B are connected in series to the AC mains in the circuit as shown. The bulb glows with some brightness. How will the glow of the bulb change if

(i) a dielectric slab is introduced between the plates of the capacitor keeping resistance R to be the same

(ii) the resistance R is increased keeping the same capacitance? **Delhi 2014**



15. The figure shows a series L-C-R circuit connected to a variable frequency 250 V source with $L = 50$ mH, $C = 80\,\mu$F and $R = 40\,\Omega$.

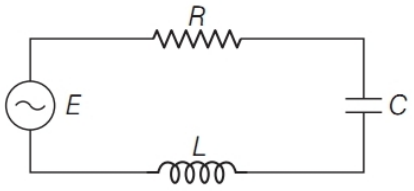


Determine

(i) the source frequency which derives the circuit in resonance.

(ii) the quality factor (Q) of the circuit. **All India 2014C**

16. The figure shows a series L-C-R circuit connected to a variable frequency 250 V source with $L = 40$ mH, $C = 100\,\mu$F and $R = 50\,\Omega$.



Determine

(i) the source frequency which derives the circuit in resonance.

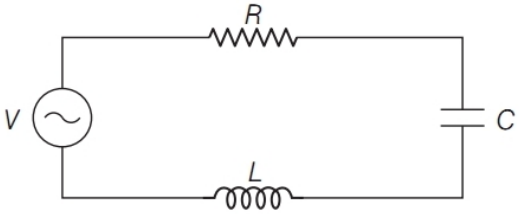
(ii) the quality factor (Q) of the circuit. **All India 2014**

17. The figure shows a series L-C-R circuit connected to a variable frequency 220 V source with $L = 80$ mH, $C = 50\,\mu$F and $R = 60\,\Omega$.

Determine

(i) the source frequency which derives the circuit in resonance.

(ii) the quality factor Q of the circuit. **All India 2014**



18. Show that the current leads the voltage in phase by $\pi/2$ in an AC circuit containing an ideal capacitor. **Foreign 2014**

19. In a series L-C-R circuit, obtain the conditions under which

(i) the impedance of circuit is minimum and

(ii) wattless current flows in the circuit. **Foreign 2014**

20. A series L-C-R circuit is connected to an AC source (200 V, 50 Hz). The voltages across the resistor, capacitor and inductor are respectively, 200 V, 250 V and 250 V.

(i) The algebraic sum of the voltages across the three elements is greater than the voltage of the source. How is this paradox resolved?

(ii) Given the value of the resistance of R is 40 Ω, calculate the current in the circuit. **Foreign 2013**

21. A resistor R and an element X are connected in series to an AC source of voltage. The voltage is found to lead the current in phase by $\pi/4$. If X is replaced by another element Y, the voltage lags behind the current by $\pi/4$.

(i) Identify elements X and Y.

(ii) When both X and Y are connected in series with R to the same source, will the power dissipated in the circuit be maximum or minimum?

Justify your answer. **Foreign 2013**

22. Write the expression for the impedance offered by the series combination of resistor, inductor and capacitor connected to an AC source of voltage $V = V_0 \sin \omega t$. Show on a graph the variation of the voltage and the current with ωt in the circuit. **All India 2012C**

23. A bulb is connected in series with a capacitor. Predict your observation when this combination is connected in turn across

(i) AC source and

(ii) a DC battery. What change would your notice in each case if the capacitance of the capacitor is increased? **Delhi 2012C**

24. Calculate the quality factor of a series L-C-R circuit with $L = 2.0$ H, $C = 2\mu$F and $R = 10\ \Omega$. Mention the significance of quality factor in L-C-R circuit. **Foreign 2012**

25. An alternating voltage given by $V = 140 \sin 314t$ is connected across a pure resistor of 50 Ω. Find

(i) the frequency of the source.

(ii) the rms current through the resistor. **All India 2012**

26. An alternating voltage given by $V = 280 \sin 50\pi t$ is connected across a pure resistor of 40 Ω. Find

(i) the frequency of the source.

(ii) the rms current through the resistor. **All India 2012**

27. An alternating voltage given by $V = 70 \sin 100\pi t$ is connected across a pure resistor of 25 Ω. Find

(i) the frequency of the source.

(ii) the rms current through the resistor. **All India 2012**

28. A light bulb is rated 150 W for 220 V AC supply of 60 Hz. Calculate

(i) the resistance of the bulb

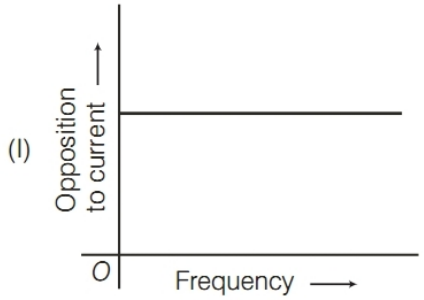
(ii) the rms current through the bulb. **All India 2012**

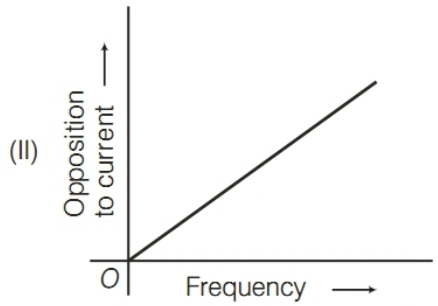
29. Prove that an ideal capacitor in an AC circuit does not dissipate power. **Delhi 2011**

30. (i) The graphs (I) and (II) represent the variation of the opposition offered by the circuit element to the flow of alternating current with frequency of the applied emf. Identify the circuit element corresponding to each graph.

(ii) Write the expression for the impedance offered by the series combination of the above two elements connected across the AC sources.

Which will be ahead in phase in this circuit, voltage or current?





All India 2011C

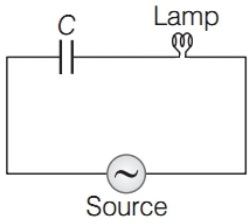
31. (i) An alternating voltage $V = V_m \sin \omega t$ applied to a series L-C-R circuit derives a current given by $I = I_m \sin(\omega t + \phi)$. Deduce an expression for the average power dissipated over a cycle.

(ii) For circuit used for transporting electric power, a low power factor implies large power loss in transmission. Explain. **Foreign 2011**

32. An electric lamp having coil of negligible inductance connected in series with a capacitor and an AC source is glowing with certain brightness.

How does the brightness of the lamp change on reducing the (i) capacitance, and (ii) the frequency ?

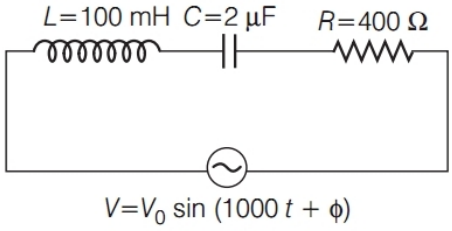
Justify your answer.



Delhi 2010

3 Marks Questions

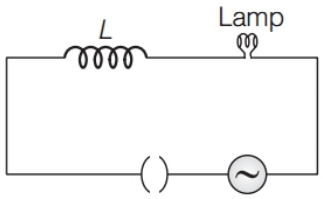
33. (i) Find the value of the phase difference between the current and the voltage in the series L-C-R circuit shown below. Which one leads in phase : current or voltage?



(ii) Without making any other change, find the value of the additional capacitor C', to be connected in parallel with the capacitor C, in order to make the power factor of the circuit unity. **Delhi 2017**

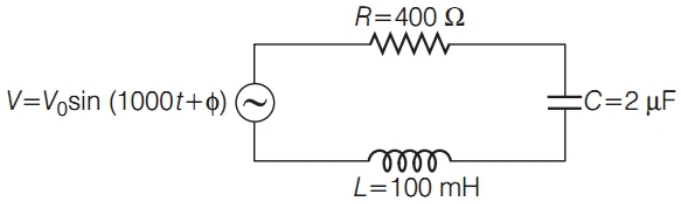
34. (i) When an AC source is connected to an ideal inductor show that the average power supplied by the source over a complete cycle is zero.

(ii) A lamp is connected in series with an inductor and an AC source. What happens to the brightness of the lamp when the key is plugged in and an iron rod is inserted inside the inductor? Explain.



All India 2016

35. Calculate the value of the additional capacitor which may be joined suitably to the capacitor C that would make the power factor of the circuit unity.



All India 2015

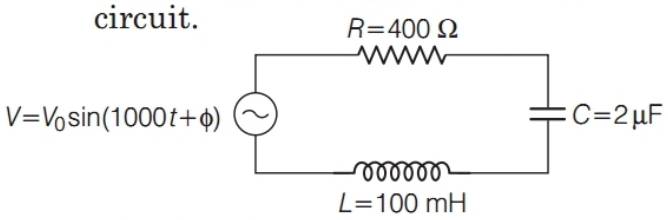
36. A circuit containing an 80 mH inductor and a 250 mF capacitor in series connected to a 240 V, 100 rad/s supply. The resistance of the circuit is negligible.

(i) Obtain rms value of current.

(ii) What is the total average power consumed by the circuit? **Delhi 2015C**

37. A source of AC voltage $V = V_0 \sin \omega t$ is connected to a series combination of a resistor R and a capacitor C. Draw the phasor diagram and use it to obtain the expression for (i) impedance of the circuit and (ii) phase angle. **All India 2015C**

38. (i) Determine the value of phase difference between the current and the voltage in the given series L-C-R circuit.



(ii) Calculate the value of additional capacitor which may be joined suitably to the capacitor C that would make the power factor of the circuit unity. **Delhi 2015**

39. An inductor L of inductance X_L is connected in series with a bulb B and an AC source. How would brightness of the bulb change when (i) number of turn in the inductor is reduced, (ii) an iron rod is inserted in the inductor and (iii) a capacitor of reactance $X_C = X_L$ is inserted in series in the circuit. Justify your answer in each case. **All India 2015**

40. A voltage $V = V_0 \sin \omega t$ is applied to a series L-C-R circuit. Derive the expression for the average power dissipated over a cycle.

Under what condition is (i) no power dissipated even though the current flows through the circuit (ii) maximum power dissipated in the circuit? **All India 2014**

41. In a series L-C-R circuit connected to an AC source of variable frequency and voltage $V = V_m \sin \omega t$, draw a plot showing the variation of current (I) with angular frequency (ω) for two different values of resistance, R_1 and $R_2 (R_1 > R_2)$. Write the condition under which the phenomenon of resonance occurs. For which value of the resistance out of the two curves, a sharper resonance is produced? Define Q-factor of the circuit and give its significance. **Delhi 2013**

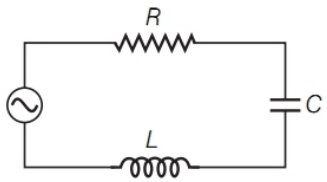
42. (i) For a given AC, $I = I_m \sin \omega t$, show that the average power dissipated in a resistor R over a complete cycle is $\frac{1}{2} I_m^2 R$.

(ii) A light bulb is rated at 100 W for a 220 V AC supply. Calculate the resistance of the bulb. **All India 2013**

43. (i) When an AC source is connected to an ideal capacitor, then show that the average power supplied by the source over a complete cycle is zero.

(ii) A lamp is connected in series with a capacitor. Predict your observations when the system is connected first across a DC and then an AC source. What happens in each case if the capacitance of the capacitor is reduced? **Delhi 2013C**

44. The figure shows a series L-C-R circuit with $L = 10$ H, $C = 40\,\mu$F, $R = 60\,\Omega$ connected to a variable frequency 240 V source. Calculate



(i) the angular frequency of the source which derives the circuit at resonance.

(ii) the current at the resonating frequency.

(iii) the rms potential drop across the inductor at resonance. **Delhi 2012**

45. A series L-C-R circuit is connected to an AC source. Using the phasor diagram, derive the expression for the impedance of the circuit. Plot a graph to show the variation of current with frequency of the source, explaining the nature of its variation. **All India 2012**

46. A series L-C-R circuit is connected to a 220 V variable frequency AC supply. If $L = 20$ mH, $C = (800/\pi^2)\,\mu$F and $R = 110\,\Omega$.

(i) Find the frequency of the source for which average power absorbed by the circuit is maximum.

(ii) Calculate the value of maximum current amplitude. **Delhi 2010C**

47. An AC voltage $V = V_0 \sin \omega t$ is applied across a pure inductor L. Obtain an expression for the current I in the circuit and hence obtain the

(i) inductive reactance of the circuit and

(ii) the phase of the current flowing with respect to the applied voltage.

All India 2010C

48. An AC voltage, $V = V_0 \sin \omega t$ is applied across a pure capacitor, C. Obtain an expression for the current I in the circuit and hence obtain the

(i) capacitive reactance of the circuit and

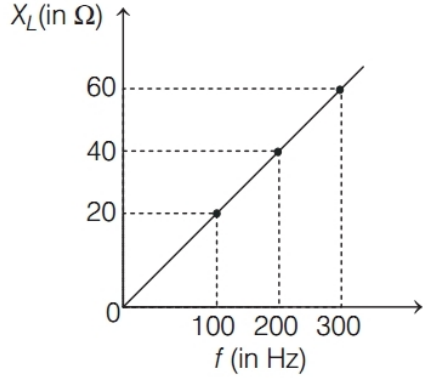
(ii) the phase of the current flowing with respect to the applied voltage.

All India 2010C

5 Marks Questions

49. (i) Show that an ideal inductor does not dissipate power in an AC circuit.

(ii) The variation of inductive reactance (X_L) of an inductor with the frequency (f) of the AC source of 100 V and variable frequency is shown in figure. **Delhi 2020**



(a) Calculate the self-inductance of the inductor.

(b) When this inductor is used in series with a capacitor of unknown value and a resistor of 10 Ω at 300 s^{-1}, maximum power dissipation occurs in the circuit. Calculate the capacitance of the capacitor. **Delhi 2020**

50. (i) In a series L-C-R circuit connected across an AC source of variable frequency, obtain the expression for its impedance and draw a plot showing its variation with frequency of the AC source.

(ii) What is the phase difference between the voltages across inductor and the capacitor at resonance in the L-C-R circuit?

(iii) When an inductor is connected to a 200 V DC voltage, a current of 1 A flows through it. When the same inductor is connected to a 200 V, 50 Hz AC source, only 0.5 A current flows. Explain, why? Also, calculate the self-inductance of the inductor.

Delhi 2019

51. A device X is connected across an AC source of voltage $V = V_0 \sin \omega t$. The current through X is given as $I = I_0 \sin\left(\omega t + \frac{\pi}{2}\right)$.

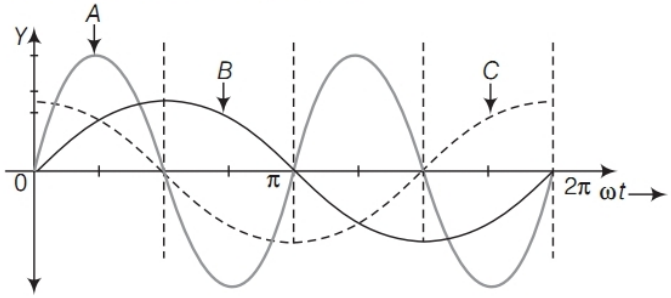
(i) Identify the device X and write the expression for its reactance.

(ii) Draw graphs showing variation of voltage and current with time over one cycle of AC, for X.

(iii) How does the reactance of the device X vary with frequency of the AC? Show this variation graphically.

(iv) Draw the phasor diagram for the device X. **CBSE 2018**

52. A device X is connected to an AC source, $V = V_0 \sin \omega t$. The variation of voltage, current and power in one cycle is shown in the following graph.



(i) Identify the device X.

(ii) Which of the curves A, B and C represent the voltage, current and the power consumed in the circuit? Justify the answer.

(iii) How does its impedance vary with frequency of the AC source? Show graphically.

(iv) Obtain an expression for the current in the circuit and its phase relation with AC voltage. **All India 2017**

53. An AC source of voltage $V = V_0 \sin \omega t$ is connected to a series combination of L, C and R. Use the phasor diagram to obtain expressions for impedance of the circuit and phase angle between voltage and current. Find the condition when current will be in phase with the voltage. What is the circuit in the condition called? **Delhi 2016**

54. A 2 μF capacitor, 100 Ω resistor and 8 H inductor are connected in series with an AC source.

(i) What should be the frequency of the source such that current drawn in the circuit is maximum? What is this frequency called?

(ii) If the peak value of emf of the source is 200 V, find the maximum current.

(iii) Draw a graph showing variation of amplitude of circuit current with changing frequency of applied voltage in a series L-C-R circuit for two different values of resistance R_1 and $R_2 (R_1 > R_2)$.

(iv) Define the term 'Sharpness of Resonance'. Under what condition, does a circuit become more selective? **Foreign 2016**

55. (i) A series L-C-R circuit is connected to an AC source of variable frequency. Draw a suitable phasor diagram to deduce the expressions for the amplitude of the current and phase angle.

(ii) Obtain the condition at resonance. Draw a plot showing the variation of current with the frequency of AC source for two resistances R_1 and $R_2 (R_1 > R_2)$. Hence, define the quality factor Q and write its role in the tuning of the circuit. **Delhi 2014C**

56. (i) An AC source of voltage $V = V_0 \sin \omega t$ is connected across a series combination of an inductor, a capacitor and resistor. Use the phasor diagram to obtain the expression for

(a) impedance of the circuit and

(b) phase angle between the voltage and the current.

(ii) A capacitor of unknown capacitance, a resistor of 100 Ω and an inductor of self inductance $L = (4/\pi^2)$ henry are in series connected to an AC source of 200 V and 50 Hz. Calculate the value of the capacitance and the current that flows in the circuit when the current is in phase with the voltage. **All India 2013C**

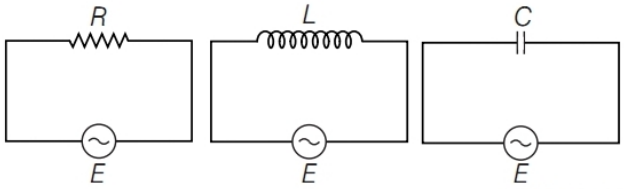
57. A voltage $V = V_0 \sin \omega t$ applied to a series L-C-R circuit drives a current $I = I_0 \sin \omega t$ in the circuit. Deduce the expression for the average power dissipated in the circuit. For circuits used for transporting electric power, a low power factor implies large power loss in transmission. Explain. Define the term 'wattless current'. **Delhi 2012C**

58. Derive an expression for the impedance of a series L-C-R circuit connected to an AC supply of variable frequency. Plot a graph showing variation of current with the frequency of the applied voltage. Explain briefly how the phenomenon of resonance in the circuit can be used in the tuning mechanism of a radio or a TV set? **Delhi 2011**

59. (i) What do you understand by sharpness of resonance in a series L-C-R circuit? Derive an expression for Q-factor of the circuit.

(ii) Three electrical circuits having AC sources of variable frequency are shown in the figures. Initially, the current flowing in each of these is same. If the frequency of the applied AC source is increased, how will the current flowing in these circuits

be affected? Give the reason for your answer.



Delhi 2011C

60. A series L-C-R circuit is connected to an AC source having voltage $V = V_m \sin \omega t$. Derive the expression for the instantaneous current I and its phase relationship to the applied voltage. Obtain the condition for resonance to occur. Define power factor. State the conditions under which it is

(i) maximum and

(ii) minimum. **All India 2010**

61. A resistor of 400 Ω, an inductor of $\frac{5}{\pi}$ H and a capacitor of $\frac{50}{\pi}$ μF are connected in series across a source of alternating voltage of 140 sin 100 πt V. Find the voltage (rms) across the resistor, the inductor and the capacitor. Is the algebraic sum of these voltages more than the source voltage?
If yes, resolve the paradox. **Foreign 2010**
(Given, $\sqrt{2} = 1.414$).