O P JINDAL SCHOOL, SAVITRINAGAR

ASSIGNMENT

CLASS XII PHYSICS

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21 In a series *LCR* circuit, X_L, X_C and *R* are the inductive reactance, capacitive reactance and resistance respectively at a certain frequency *f*. If the frequency of ac is doubled, what will be the values of reactances and resistance of the circuit? 1

ANS: Resistance *R* remains unchanged; X_L will be doubled and X_C will be halved.

22 In a series *L*-*R* circuit, $X_L = R$ and power factor of the circuit is P_1. When a capacitor with capacitance *C* such that $X_L = X_C$ is put in series, the power factor becomes P_2. Find P_1/P_2. 1

ANS: $1 : \sqrt{2}$

23 How does an inductor behave in an ac circuit at very high frequency? 1

ANS: * $X_L = 2\pi\nu L$, on increasing *n*, X_L also increases.
Hence, the inductor behaves as a bad conductor as the inductive reactance of it is also very high at very high frequency.

24 Why are the divisions marked on the scale of an ac ammeter not equally spaced? 1

ANS: Because an ac ammeter is based on the heating effect of current and heat produced, i.e. $H \propto I^2$.

25 What is the average value of ac over a cycle? 1

ANS: Zero. Because the ac is positive during one half cycle and equally negative during the other half cycle.

26 Show that the current leads the voltage in phase by π/2 in an ac circuit containing an ideal capacitor. 1

ANS:

Consider that an applied ac voltage is

$$V = V_m \sin \omega t \qquad \ldots(i)$$

Let q be the charge on the capacitor at any instant of time t. The instantaneous value of potential difference would be

$$V = \frac{q}{C} \quad \Rightarrow \quad q = CV$$

$$\therefore \qquad q = CV_m \sin \omega t \qquad \ldots(ii)$$

Differentiating equation (ii) w.r.t t, we get

$$\frac{dq}{dt} = C\omega V_m \cos \omega t \quad \Rightarrow \quad i = \frac{V_m}{\left(\frac{1}{C\omega}\right)} \sin (\omega t + \pi/2)$$

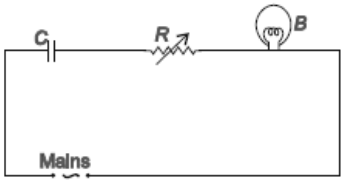
$$\therefore \qquad i = i_m \sin (\omega t + \pi/2) \qquad \ldots(iii)$$

where $i_m = \frac{V_m}{X_C}$; $X_C = \frac{1}{C\omega}$

X_C is called the capacitive reactance of the circuit.

From equations (i) and (iii), we conclude that the current leads the voltage by a phase angle $\pi/2$.

27 A capacitor C, a variable resistor R and a bulb B are connected in series to the ac mains in 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? 1



ANS: It is a CR circuit connected with ac mains where the inductance of bulb remains constant. The current is

$$i = \frac{E}{Z} = \frac{E}{\sqrt{R^2 + X_C^2}}$$ (i) If slab is inserted between the plates, capacitance will increase and as $X_C = \frac{1}{2\pi fC}$, X_C will decrease so Z will decrease making the current in bulb more and hence, the bulb will shine brighter.

(ii) If R is increased, Z will increase making the current less and again the bulb will glow dimly.

28 Determine the average value of a.c over a (i) half cycle and (ii) full cycle. 1

ANS:

(*i*) Let a small amount of charge dq flows through an ac circuit for a small time duration dt, such that the current is given by

$$I = \frac{dq}{dt} \Rightarrow dq = Idt, \quad \text{where } I = I_m \sin \omega t$$

$\therefore$ net charge (q) flowing in the time interval $t = 0$ to $t = \frac{\pi}{\omega} = \left[\frac{T}{2}\right]$ is given by

$$q = \int dq = \int_{t=0}^{t=\frac{\pi}{\omega}} I_m \sin \omega t = I_m \left[\frac{-\cos \omega t}{\omega}\right]_0^{\pi/\omega} = \frac{-I_m}{\omega}\left[\cos \omega \cdot \frac{\pi}{\omega} - \cos 0\right]$$

$$q = \frac{-I_m \cdot T}{2\pi}[-1-1] = \frac{2I_m}{2\pi}.T \qquad \ldots(a)$$

If I_{av} is the steady current passing through the same circuit for the same time interval $\frac{T}{2}$, sending the same amount of charge through the circuit, then

$$q = I_{av}\frac{T}{2} \qquad (b)$$

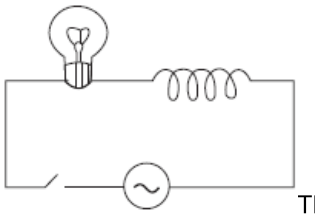
From equations (a) and (b) $I_{av} = \frac{2}{\pi}.I_m$

(*ii*) For a complete cycle, $I_{av} = 0$.

29 An electric heater is heated first using dc and then using ac such that the potential difference across the heater is same in both cases. In which case is more heat produced? 1

ANS: The impedance of the heater coil is greater than the resistance for the same applied voltage, the more current flows through the heater in case of dc. Hence, the more heat is produced in case of dc.

30 A light bulb and an open coil inductor are connected to an ac source through a key as shown in the figure. 1



The switch is closed and after sometime, an iron rod is inserted into the interior of the inductor. The glow of the light bulb (a) increases; (b) decreases; (c) is unchanged, as the iron rod is inserted. Give your answer with reason. What will be your answer if ac source is replaced by a dc source?

ANS: When an iron core is inserted, it gets magnetised and the magnetic field inside the coil increases. The inductance of the coil increases. Consequently, the inductive reactance of the coil increases.
A large fraction of the applied ac voltage appears across the inductor and the voltage across the bulb decreases. Thus, the glow of the bulb decreases. In case of a dc source, the glow of the bulb does not change.