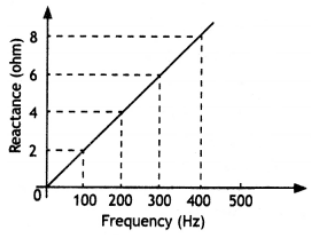
IMPORTANT QUESTIONS CLASS – 12 PHYSICS
CHAPTER – 7 ALTERNATING CURRENT

Question 1.

The figure shows how the reactance of an Inductor varies with frequency. (a) Calculate the value of the Inductance of the Inductor using Information given In the graph. (b) If this Inductor is connected In senes to a resistor of 8 ohms, find what would be the impedance at 300 Hz.



Answer:

(a) We know that $X_L = 2\pi fL$ or $L = XL2\pi f$.

Now slope of the graph is

XLf=8–6400–300=2100 = 0.02

Therefore L is L = XL2πf=0.022×3.14 = 0.0032 H

(b) NowR = 8 ohm, f = 300 Hz, Z = ?

Now Z = R2+X2L–––––––√ . Therefore we have

Z = R2+X2L–––––––√ = (8)2+(6)2––––––––

–√ = 10 Ω

Question 2.

A 25.0 μF capacitor, a 0.10-henry Inductor, and a 25.0-ohm resistor are connected in series with an ac source whose emf is E= 310 s. In 314 t (i) what is the frequency of the .mf? (ii) Calculate (a) the reactance of the circuit (b) the Impedance of the circuit and (C) the current in the circuit.

Answer:

Given C = 25.0 μF, L = 0.10 henry, R = 25.0 ohm, E_0 = 310V,

Comparing with the equation $E = E_0 \sin \omega t$,

we have

(i) ω = 314 or f = 50 Hz

(a) $X_L = 2\pi fL = 2 \times 3.14 \times 50 \times 0.10 = 31.4$ ohm

$X_C = 1/2\pi fC = 127.4$ ohm

Therefore reactance of the circuit is

$X_C - X_L = 127.4 - 31.4 = 96$ ohm

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

Or $Z = \sqrt{(25)^2 + (96)^2} = 99.2$ ohm

(c) The current through the circuit is

$I = \frac{V}{Z} = \frac{310}{\sqrt{2} \times 99.2} = 2.21$ A

Question 3.

A sinusoidal voltage V = 200 sin 314 t Is applied to a resistor of 10 ohms. Calculate (i) rms value of current (ii) rms value of voltage and (iii) power dissipated as heat in watt.

Answer:

V_0 = 200 V, ω = 314 rads^{-1} , V_{rms} = ?, l_{rms} = ?, P = ?

$I_{rms} = \frac{V_{rms}}{R} = \frac{141.4}{10} = 14.14$ A

$P = I_{rms}^2 R = (14.14)^2 \times 10 = 1999.4$ W

Question 4.
Find the inductance of the inductor used in series with a bulb of resistance 10 ohms connected to an ac source of 80 V, 50 Hz. The power factor of the circuit is 0.5. Also, calculate the power dissipation in the circuit.
Answer:
Given R = 10 ohm, V = 80 Hz, f = 50 Hz, cos Φ = 0.5 , L = ?, P = ?
Using the formula
cos Φ = RR2+X2L√
or
$0.25(R^2 + X^2) = R^2$
Or
$O.25X_L^2 = O.75R^2$
or
X_L = 17.32 ohm

Now using $X_L = 2\pi fL$ we have
L = XL2πf=17.322×3.14×50 = 0.055 H

Now Z = R2+X2L−−−−−−−√
= (10)2+(17.32)2−−−−−−−−−−−−−√ = 20 Ω

Now $P_{av} = l_{rms} V_{rms} \cos \Phi$ = V2mZ × cos Φ
or
Pav = (80)22×20 × 0.5 = 160 W

Question 5.
When an alternating voltage of 220 V is applied across a device X, a current of 0.5 A flows through the circuit and Is in phase with the applied voltage. When the same voltage is applied across a device Y, the same current again flows through it, but it leads the voltage by π/2. If element 'X' is a pure resistor of 100 ohms,
(a) name the circuit element 'Y' and
Answer:
The element Y is a capacitor.

(b) calculate the rms value of current, if rms value of voltage is 141 V.
Answer:
The value of Xc is obtained as below

X_C = VI=2200.5 = 440 ohm

Therefore impedance of the circuit
Z = R2+X2C−−−−−−−√=(100)2+(440)2−−−−−−−−−−−√ = 451.2 ohm

Therefore rms value of current V 141
l = VrmsZ=141451.2 = 0.3125 A

Question 6.
When an alternating voltage of 220 V is applied across a device X, a current of 0. 5 A flows through the circuit and is in phase with the applied voltage. When the same voltage is applied across a device V, the same current again flows through it, but it lags the voltage by π/2.
(a) Name the devices X and Y.
Answer:
The element X is a resistor and Y is an inductor.

(b) Calculate the current flowing through the circuit when the same voltage is applied across the series combination of the two devices X and Y.
Answer:
Now both R and XL are the same and are given by
R = X_L = 2200.5 = 440 ohm

Hence impedance of the circuit
Z = R2+X2L−−−−−−−√
= (440)2+(440)2−−−−−−−−−−−√
= 622.2 ohm

Therefore current flowing through the circuit is
l = VZ = 220622.2 = 0.353 A

Question 7.
A 15.0 μF 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?
Answer:
Given C= 15.0 μF= 15 × 10^{-6} F, V= 220 V,
f = 50 HZ, X_C = ? l_m = ?

The capacitive reactance is

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = \frac{1}{2 \times 3.14 \times 50 \times 15 \times 10^{-6}}$$
$$\text{or } X_C = 212\ \Omega$$

Now l_{rms} = VrmsXc=220212 = 1.04 A

Peak value of current
$l_m = 2–√ \times lrms = 1.4.1 \times 1.04 = 1.47$ A

This current oscillates between + 1.47A and –
1.47 A, and is ahead of the voltage by π/2.

If the frequency is doubled, the capacitive reactance is halved and consequently, the current is doubled.

Question 8.
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 mH and C = 796 μF. Find
(a) the impedance of the circuit;
(b) the phase difference between the voltage across the source and the current;
(c) the power dissipated in the circuit; and
(d) the power factor.
Answer:
Given $V_m = 283$ V, f = 50 Hz, R = 3 Ω
L = 25.48 mH, and C = 796 μF.
(a) To find the impedance of the circuit, we first calculate XL and Xc
$X_L = 2\pi fL = 2 \times 3.14 \times 50 \times 25.48 \times 10^{-3} = 8\ \Omega$
$X_C = 12\pi fC$
$= 12 \times 3.14 \times 50 \times 796 \times 10–6 = 4\ \Omega$

Therefore impedance of the circuit is
$Z = R2+(XL–XC)2––––––––––––––√$
$= 32+(8–4)2––––––––––––√$
$= 5\ \Omega$

(b) Phase difference
$\Phi = \tan^{-1}XL–XcR = \tan\text{-}1\ 8–43 = 53.1°$
Since Φ is positive therefore voltage leads current by the above phase.

(c) The power dissipated in the circuit is
$P = V2rmsZ=V2m2Z=(283)22\times5 = 8008.9$ W
(d) power factor = $\cos \Phi = \cos 53.1° = 0.6$

Question 9.
A capacitor and a resistor are connected in series with an ac source. If the potential difference across the C, R is 120 V and 90 V respectively, and if rms current of the circuit is 3 A, calculate the (i) impedance and (ii) power factor of

the circuit.
Answer:
Given V_C = 120 V, V_R = 90 V, f = 3 A. and R = 90/3 = 30 ohm ,

Effective voltage in the circuit
V = V2C+V2R−−−−−−−√=(120)2+(90)2−−−−−−−−−−√= 150 V .
(i) Therefore impedance of the circuit
Z = Vl=1503 = 50 Ω.

(ii) Now power factor of the circuit is
cos Φ = RZ=3050 = 0.6

Question 10.
An inductor 200 mH, a capacitor C, and a resistor 10 ohm are connected in series with 100 V, 50 Hz ac source. If the current and the voltage are in phase with each other, calculate the capacitance of the capacitor.
Answer:
When current and voltage are in phase then $X_L = X_C$

$$\text{or } 2\pi fL = \frac{1}{2\pi fC}$$

$$C = \frac{1}{4\pi^2 f^2 L} = \frac{1}{4 \times (3.14)^2 \times (50)^2 \times 200 \times 10^{-3}}$$

$$= 5.07 \times 10^{-5} \text{ F}$$