**16.1** An alternating current is represented by the equation $I = 20 \sin 100\pi t$. Compute its frequency and the maximum and rms values of current.

**Solution:** The standard equation for A.C is

$$I = I_o \sin(2\pi f)t \quad \text{——— (1)}$$

The given equation is

$$I = 20 \sin(100\pi)t \quad \text{——— (2)}$$

(a) **Frequency**

Comparing eq (1) and (2)

$$2\pi f = 100\pi$$

$$f = \frac{100\pi}{2\pi}$$

$$\boxed{f = 50\ Hz}$$

(b) **Maximum Current**

Again by comparing (1) and (2)

$$\boxed{I_o = 20\ A}$$

(c) **rms value of current**

As $I_{rms} = \frac{I_o}{\sqrt{2}} = 0.707\ I_o$

$$I_{rms} = 0.707 \times 20\ A$$

$$\boxed{I_{rms} = 14\ A}$$

**16.2** A sinosoidal A.C. has a maximum value of 15 A. What are its rms values? If the time is recorded from the instant the current is zero and is becoming positive, what is the instantaneous value of the current after $\frac{1}{300}$ s given the frequency is 50 Hz?

**Solution** $I_o = 15A$, $t = \frac{1}{300}$ s, $f = 50\ Hz$

**rms-value.** $I_{rms} = ?$, $I = ?$

$$I_{rms} = \frac{I_o}{\sqrt{2}} = 0.707\ I_o$$

$$I_{rms} = 0.707 \times 15A$$

$$\boxed{I_{rms} = 10.6\ A}$$

**Instantaneous Value of Current**

$$I = I_o \sin \omega t = I_o \sin 2\pi f t$$

$$I = 15A \sin(2\pi \times 50 \times \frac{1}{300})$$

$$I = 15A \sin(\pi/3) = 15A \sin(180/3) = 15A \sin 60^\circ$$

$$I = 15A \times 0.866 = 12.96A$$

$$\boxed{I = 13.0 A}$$

**16.3** :- Find the value of the current and inductive reactance when A.C. voltage of 220V at 50 Hz is passed through an inductor of 10 H.

**Solution** :- $V = 220V$ , $f = 50\ Hz$ , $L = 10H$

$I = ?$ $X_L = ?$

Inductive Reactance.

$$X_L = \omega L = 2\pi f L$$

$$X_L = 2 \times 3.14 \times 50\ Hz \times 10H$$

$$X_L = 3140\ \Omega$$

Current -

$$I = \frac{V}{X_L} = \frac{220V}{3140\Omega}$$

$$I = 0.07 A$$

**16.4** :- A circuit has an inductance of $\frac{1}{\pi}$ H and resistance of 2000 Ω. A 50 Hz A.C. is supplied to it. Calculate the reactance and impedance offered by the circuit.

**Solution** :- $L = \frac{1}{\pi} H$ , $R = 2000\Omega$ , $f = 50\ Hz$

$X_L = ?$ $Z = ?$

**Reactance** $X_L = \omega L = 2\pi f L$

$$X_L = 2 \times \cancel{3.14} \times 50\ Hz \times \frac{1}{\cancel{3.14}} H$$

$$X_L = 100\ \Omega$$

**Impedance**

$$Z = \sqrt{R^2 + (X_L)^2} = \sqrt{(2000)^2 + (100)^2}\ \Omega$$

$$Z = 2002.5\ \Omega$$

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As $V = IZ$

$$I = \frac{V}{Z} = \frac{240\,V}{20.3214\,\Omega} = 11.81\,A$$

Now

$$\theta = \tan^{-1}\left(\frac{X_L}{R}\right) = \tan^{-1}\left(\frac{3.6}{20}\right) = 10.20^\circ$$

$$\text{Power Dissipated} = P = VI\cos\theta$$

$$= 240\,V \times 11.81\,A \cos 10.20^\circ$$

$$P = 2789.6\,W$$

**16.7** Find the value of the current flowing through a capacitance $0.5\,\mu F$ when connected to a source of $150\,V$ at $50\,Hz$.

**Solution :-** $C = 0.5 \times 10^{-6}\,F$, $V = 150\,V$, $f = 50\,Hz$.

$I = ?$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = \frac{1}{2 \times 3.14 \times 50\,s^{-1} \times 0.5 \times 10^{-6}\,F}$$

$$X_C = 6369.4\,\Omega$$

then $\quad \text{Current} = I = \dfrac{V}{X_C}$

$$I = 0.024\,A$$

**16.8** An alternating source of emf 12 V and frequency 50 Hz is applied to a capacitor of capacitance $3\,\mu F$ in series with a resistor of resistance $1\,\Omega$. Calculate the phase angle.

**Solution :-** $V = 12\,V$, $f = 50\,Hz$, $C = 3 \times 10^{-6}\,F$, $R = 1\,\Omega$

$\theta = ?$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = \frac{1}{2 \times 3.14 \times 50\,s^{-1} \times 3 \times 10^{-6}\,F} = \frac{10^6}{942}$$

$$X_C = 1062.89\,\Omega$$

$$\theta = \tan^{-1}\left(\frac{X_C}{R}\right) = \tan^{-1}\left(\frac{1062.89\,\Omega}{1\,\Omega}\right)$$

$$\theta = 89.9^\circ$$

**16.9** What is the resonating frequency of a circuit which includes a coil of inductance 2.5 H and a capacitance $40\,\mu F$?

$L = 2.5\,H$, $C = 40 \times 10^{-6}\,F$

$$f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2 \times 3.14 \times \sqrt{2.5\,H \times 40 \times 10^{-6}\,F}} = 15.9\,Hz$$

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**16.10** An inductor of inductance $150\mu H$ is connected in parallel with a variable capacitor whose capacitance can be changed from $500pF$ to $20pF$. Calculate the maximum and minimum frequency for which the circuit can be tuned.

**Solution**

$L = 150\mu H = 150\times10^{-6}\,H$

$C_1 = 500pF = 500\times10^{-12}\,F$

$C_2 = 20pF = 20\times10^{-12}\,F$

As resonating frequency $= f = \dfrac{1}{2\pi\sqrt{LC}}$ $\quad f \propto \dfrac{1}{\sqrt{C}}$

So $\quad f_{min.} = \dfrac{1}{2\pi\sqrt{LC_1}} = \dfrac{1}{2\times3.14\times\sqrt{150\times10^{-6}H\times500\times10^{-12}F}}$

$f_{min.} = 0.58\times10^{6}\,Hz = 0.58\,MHz$

and

$f_{max.} = \dfrac{1}{2\pi\sqrt{LC_2}} = \dfrac{1}{2\times3.14\times\sqrt{150\times10^{-6}H\times20\times10^{-12}F}}$

$f_{max} = 2.91\times10^{6}\,Hz = 2.91\,MHz$

Therefore $\quad \boxed{f_{max.} = 2.91\,MHz}$

and $\quad \boxed{f_{min} = 0.58\,MHz}$