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Section:- A

1. Explain Form Factor And peak Factor

(a) Form Factor:-
The ratio of RMs value to the average value of an alternating quantity is known as Form Factor.

$$\text{Form Factor} = \frac{\text{R.M.S value}}{\text{Average value}}$$

(b) Peak Factor:-
The ratio of Maximum value to RMS value of an alternating quantity is known as peak Factor.

$$\text{peak Factor} = \frac{\text{Maximum value}}{\text{RMS value}}$$

2. Explain the term Q-Factor and power Factor

power Factor:-

(1) The angle of cosine between resultant voltage and resultant current.

$$P.F = \cos\phi \; \{0 \le P.F \le 1\}$$

(2) $P.F = \dfrac{\text{True power}}{\text{Apparent power}}$

(3) $P.F = \cos\phi = \dfrac{R}{Z}$

Quality Factor:- $Q = 2\pi \times \dfrac{\text{Maximum energy stored}}{\text{Energy dissipated per cycle}}$

$$Q = \frac{\omega L}{R} = \frac{1}{\omega_r C R}$$

3. Explain Active, Reactive and Apparent power.

1:- Apparent power - the total power that appear to be transfer between the source and load is called Apparent power.

2:- True power - the power which is actually consumed in the circuit is called true power.

3:- Reactive power - the component of apparent power which is neither consume nor any useful work in the circuit is called Reactive power.

4. List the various effect of series Resonance

1. $V_L = V_C$

$IX_L = IX_C$

2. $X_L = X_C$

$\omega L = \frac{1}{\omega C}$

$\omega_r^2 = \frac{1}{LC}$

$\omega_r = \frac{1}{\sqrt{LC}}$

$2\pi f_r = \frac{1}{\sqrt{LC}}$ (angular resonant Frequency)

3. $f_r = \frac{1}{2\pi\sqrt{LC}}$ hz (Resonant Frequency)

4. $V = V_R$ (pure resistive in nature)

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

$Z_{min} = R$

6. $I = \frac{V}{Z}$

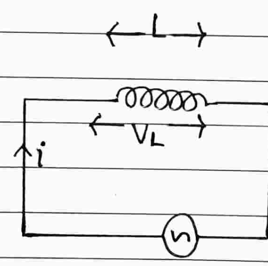
$I_{max} = \frac{V}{R}$

7. power Factor = 1

8. phase angle $0° = \phi$

5. prove that in a purely inductive circuit current lags the voltage by 90°.

Ans:-



$V_L = L\frac{di}{dt}$

$di = \frac{V_L\,dt}{L}$

$V = V_m \sin\omega t$

$di = \frac{V_m \sin\omega t\,dt}{L}$

Integrating, $\int di = \int \frac{V_m \sin\omega t\,dt}{L}$

$i = \frac{V_m}{L}\int \sin\omega t\,dt$

$i = -\frac{V_m}{L\omega}\cos\omega t$

$$i = \frac{-V_m}{L\omega} \sin(\pi/2 - \omega t)$$

$$i = \frac{V_m}{L\omega} \sin(\omega t - \pi/2)$$

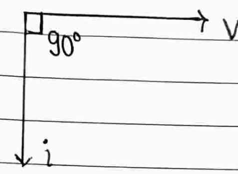
$$i = I_m \sin(\omega t - \pi/2)$$

where $I_m = \frac{V_m}{L\omega} = \frac{V_m}{X_L}$

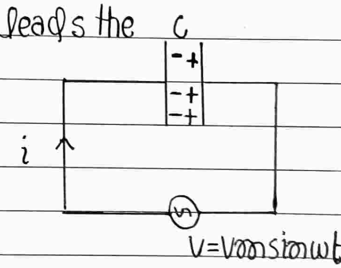
$X_L = \omega L$

$X_L = 2\pi f L$ $\quad X_L \propto f$.

phasor Diagram:-



In a pure capacitive circuit current leads the voltage by 90°?



$Q = CV$

$$i = \frac{dQ}{dt}$$

$$i = \frac{d}{dt} CV_m \sin\omega t$$

$$i = CV_m \frac{d}{dt} \sin\omega t$$

$i = CV_m \cos\omega t \cdot \omega$

$i = \omega C V_m \sin(\omega t + \pi/2)$

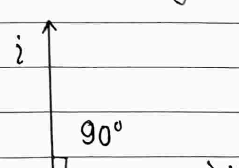
$i = I_m \sin(\omega t + \pi/2)$

where $I_m = \omega C V_m$

$X_C = 1/\omega C$

$$X_C = \frac{1}{2\pi f C} \quad X_C \propto \frac{1}{f}.$$

phasor Diagram

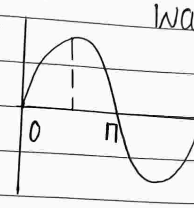


6. Explain and drive (RMS) value or Average value for a sine wave.

For complete cycle, Average value is 0.

Sinusodial current is given by

$i = I_m \sin\theta$



Average value,

$$i = \int_0^{\pi} \frac{i\,d\theta}{\pi}$$

$$i_{avg} = \int_0^{\pi} \frac{I_m \sin\theta\, d\theta}{\pi}$$

$$= \frac{I_m}{\pi} \int_0^{\pi} \sin\theta\, d\theta$$

$$= -\frac{I_m}{\pi} \left[\cos\theta\right]_0^{\pi}$$

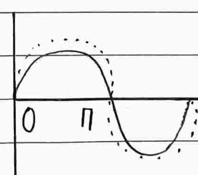
$$= -\frac{I_m}{\pi} \left[\cos\pi - \cos 0\right]$$

$$= -\frac{I_m}{\pi} \left[-1-1\right] \Rightarrow \frac{2I_m}{\pi} = \cancel{0.707 I_m}\ 0.637\, I_m$$

RMS value :-

$$i^2 = I^2 \sin^2\theta$$

$$I_{rms} = \sqrt{\int_0^{\pi} \frac{i^2\, d\theta}{\pi}}$$



$$= \sqrt{\frac{1}{\pi} \int_0^{\pi} I_m^2 \sin^2\theta\, d\theta}$$

$$= \sqrt{\frac{I_m^2}{\pi} \int_0^{\pi} \sin^2\theta\, d\theta}$$

$$= \sqrt{\frac{I_m^2}{\pi} \int_0^{\pi} \sin^2\theta\, d\theta}.$$

$$\int_0^{\pi} \sin^2\theta \, d\theta$$

$$= \int_0^{\pi} \frac{1-\cos 2\theta}{2} \, d\theta$$

$$= \int_0^{\pi} \frac{d\theta}{2} - \int_0^{\pi} \frac{\cos 2\theta}{2} \, d\theta$$

$$= \frac{\pi}{2} - \frac{1}{4}[\sin 2\theta]_0^{\pi}$$

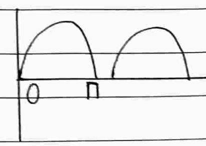
$$= \frac{\pi}{2} - 0$$

$$I_{rms} = \sqrt{\frac{I_m^2}{\pi} \times \frac{\pi}{2}}$$

$$= \frac{I_m}{\sqrt{2}} = 0.707 \, I_m$$

7. Find the average value, RMS value, form Factor & peak Factor for a half wave and Full Wave rectified current

For half wave Rectified Current



$i = I_m \sin\theta$

$I_{avg} = \dfrac{\int_0^{\pi} i\,d\theta}{\pi}$

$= \dfrac{1}{\pi}\int_0^{\pi} I_m \sin\theta\, d\theta$

$= \dfrac{I_m}{\pi}\int_0^{\pi} \sin\theta\, d\theta$

$= -\dfrac{I_m}{\pi}\left[\cos\theta\right]_0^{\pi}$

$= -\dfrac{I_m}{\pi}\left[\cos\pi - \cos 0\right]$

$= -\dfrac{I_m}{\pi}(-2)$

$= \dfrac{2I_m}{\pi}$

Form factor = 1.1
Peak factor = 1.414

RMS value :-

$i^2 = I_m^2 \sin^2\theta$

$I_{rms} = \sqrt{\dfrac{\int_0^{\pi} i^2\, d\theta}{\pi}}$

$= \sqrt{\dfrac{I_m^2}{\pi}\int_0^{\pi} \sin^2\theta\, d\theta}$

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$$\int_0^{\pi} \sin^2\theta \, d\theta$$

$$\int_0^{\pi} \frac{1-\cos 2\theta}{2} \, d\theta$$

$$= \frac{\pi}{2} - 0$$

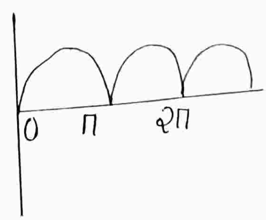
$$I_{rms} = \sqrt{\frac{I_m^2}{\pi} \times \frac{\pi}{2}}$$

$$I_{rms} = \frac{I_m}{\sqrt{2}}$$

<u>For Fullwave Rectified current</u>

$$i = I_m \sin\theta$$

$$I_{avg} = \frac{\int_0^{\pi} i \, d\theta + \int_{\pi}^{2\pi} 0 \, d\theta}{2\pi}$$



$$= \int_0^{\pi} \frac{i \, d\theta}{2\pi}$$

$$= \frac{1}{2\pi} \int_0^{\pi} I_m \sin\theta \, d\theta$$

$$= \frac{I_m}{2\pi} \int_0^{\pi} \sin\theta \, d\theta$$

$$= -\frac{I_m}{2\pi} [\cos\theta]_0^{\pi}$$

$$= -\frac{I_m}{2\pi} [-2] \Rightarrow \frac{2 I_m}{2\pi} \rightarrow \frac{I_m}{\pi}$$

$i^2 = I_m^2 \sin^2\theta$

RMS :- $I_{rms} = \sqrt{\dfrac{\int_0^{\pi} i^2 \, d\theta + \int_{\pi}^{2\pi} 0 \, d\theta}{2\pi}}$

$= \sqrt{\dfrac{I_m^2}{2\pi} \int_0^{\pi} \sin^2\theta \, d\theta + 0}$

$=$ Now, $\int_0^{\pi} \sin^2\theta \, d\theta = \dfrac{\pi}{2}$

$\sqrt{\dfrac{I_m^2}{2\pi} \times \dfrac{\pi}{2}} = \dfrac{I_m}{2}$

Peak factor $= \sqrt{2}$

Form factor $= 1.57$

~~power~~

8. The equation of an alternating current $i = 142.42 \sin 628t$ determine

(1) maximum value (2) Frequency (3) Time period

(4) Instantaneous value at $t = 3$ ms.

$i = I_m \sin \omega t$

$i = 142.42 \sin 628t$

(1) maximum value of current $= 142.42$ Amp.

$\omega = 2\pi f$

$628 = 2\pi f$

(2) $f = \dfrac{628}{2\pi} = 100$ hz

$f = \dfrac{1}{T}$

(3) $T = 1/f = \dfrac{1}{100} = 0.01$ sec

(4):- $i = 142.42 \sin 628t$

$i = 142.42 \sin 628 \times 0.003$

$= 142.42 \sin 1.884$

$= 142.42 \times 0.032$

$= 0.42726$ Amp.

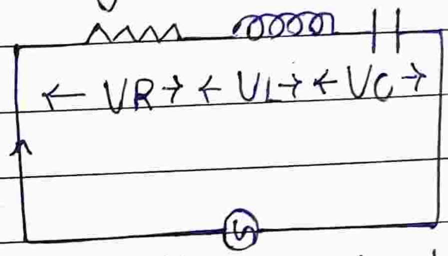
9. What do you mean by series resonance?

Series Resonance

A series RLC AC circuit is said to be in resonance when circuit power factor is unity.

Consider a series RLC circuit as shown in Fig.

the circuit impeadence is given by



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

$$I = \frac{V}{\sqrt{R^2 + (X_L - X_C)^2}}$$

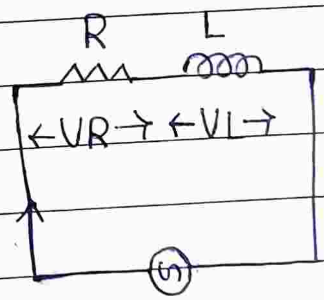
Vm sinωt

Resonance will occur in this circuit when circuit power factor is unity and this will happen when $X_L = X_C$

Regardless of the value of inductance L and capacitance C there is one frequency at which $X_L = X_C$ and is called resonant frequency and given by Fr at series resonance.

$$F_r = \frac{1}{2\pi\sqrt{LC}} \text{ hz}$$

10. Explain RL circuit.



RL series AC circuit

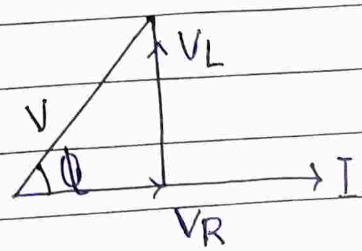
let V = RMS value of applied voltage

I = RMS value of circuit current

$V_R = IR$

$V_L = IX_L$

phasor diagram



$$V^2 = V_R^2 + V_L^2$$

$$V^2 = (IR)^2 + (IX_L)^2$$

$$V^2 = I^2(R^2 + X_L^2)$$

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$$\frac{V^2}{I^2} = (R^2 + X_L^2)$$

$$\frac{V}{I} = \sqrt{R^2 + X_L^2}$$

the quantity $\sqrt{R^2 + X_L^2}$ offers opposition to current flow and called impedence of a circuit. represent by z and measured in 0 therefore $I = V/z$

$$V = IZ$$

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