Assignment-2

Basic Electrical Engineering

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Name:- Aman Kumar Rajak, Roll no:- 38
                                    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.

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

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

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

2. Explain the term Q-Factor and power Factor

power Factor:-

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

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

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

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

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

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

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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. $V_L = V_C$

$I X_L = I X_C$

2. $X_L = X_C$

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

$\omega^2 = \dfrac{1}{LC}$

$\omega r = \dfrac{1}{\sqrt{LC}}$ (angular resonant frequency)

3. $2\pi f r = \dfrac{1}{\sqrt{LC}}$

$f r = \dfrac{1}{2\pi \sqrt{LC}}$ 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. $I = \dfrac{V}{Z}$

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

7. Power Factor $= 1$

8. Phase angle $0° = \phi$

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

Ans:-

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

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

$di = \dfrac{V_{oo} \sin \omega t \, dt}{L}$

Integrating, $\int di = \int \dfrac{V_{oo} \sin \omega t \, dt}{L}$

$i = \dfrac{V_{oo}}{L} \int \sin \omega t \, dt$

$i = \dfrac{-V_{oo} \cos \omega t}{L \omega}$

$V_{oo} = V_{oo} \sin \omega t$

phasor Diagram :-

$$i = \frac{-V_{om} \sin(\Pi/2 - \omega t)}{L\omega}$$

$$i = \frac{V_{om} \sin(\omega t - \Pi/2)}{L\omega}$$

$$i = I_{om} \sin(\omega t - \Pi/2)$$

where $I_{om} = \dfrac{V_{om}}{L\omega} = \dfrac{V_{om}}{X_L}$

$$X_L = \omega L$$

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

90°
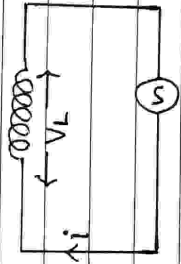
In a pure Capacitive Circuit Current leads the voltage by 90°?

$v = V_{om} \sin \omega t$

$$Q = CV$$

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

$$i = \frac{d \, CV_{om} \sin \omega t}{dt}$$

$$i = CV_{om} \frac{d \, \sin \omega t}{dt}$$

$$i = CV_{om} \cos \omega t \cdot \omega$$

$$i = \omega C V_{om} \sin(\omega t + \Pi/2)$$

$$i = I_{om} \sin(\omega t + \Pi/2)$$

where $I_{om} = \omega C V_{om}$

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

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

phasor Diagram

90°

6. Explain and derive (RMS) value or Average value for a Sine wave.

For complete cycle, Average value is o.

Sinusodial current is given by

$i = I_{00} \sin\theta$

Average value.

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

$$i_{avg} = \int_0^\pi \frac{I_{00} \sin\theta \, d\theta}{\pi}$$

$$= \frac{I_{00}}{\pi} \int_0^\pi \sin\theta \, d\theta$$

$$= \frac{-I_{00}}{\pi} \Big[\cos\theta\Big]_0^\pi$$

$$= \frac{-I_{00}}{\pi} \Big[\cos\pi - \cos 0\Big]$$

$$= \frac{-I_{00}}{\pi}[-1-1] \implies \frac{2 I_{00}}{\pi}$$

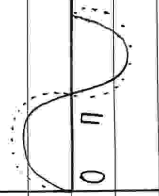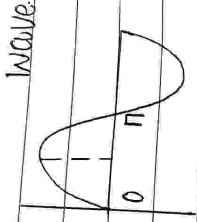$$= \frac{2 I_{00}}{\pi} = 0.707 I_{00} \quad 0.637 I_{00}$$

RMS value :-

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

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

$$= \sqrt{\frac{1}{\pi}\int_0^\pi I_{00}^2 \sin^2\theta \, d\theta}$$

$$= \sqrt{\frac{I_{00}^2}{\pi}\int_0^\pi \sin^2\theta \, d\theta}$$

$$= \sqrt{\frac{I_{00}^2}{\pi}\int_0^\pi \sin^2\theta \, d\theta}$$

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

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

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

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

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

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

$$I_{rms} = \sqrt{\frac{I_{00}^2}{\pi} \times \frac{\pi}{2}}$$

$$= \frac{I_{00}}{\sqrt{2}} = 0.707 \, I_{00}$$

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.

$$i = I_m \sin\theta$$

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

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

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

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

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

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

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

RMS value :-

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

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

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

Form factor = 1.1

Peak factor = 1.414

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

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

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

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

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

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

For Full wave Rectified current

$$i = I_{max}\sin\theta$$

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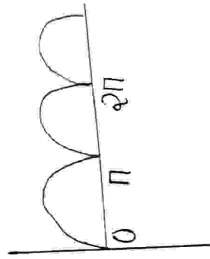
$$= \frac{\int_0^\pi i \, d\theta}{2\pi}$$

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

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

$$= \frac{I_{max}}{2\pi} \left[\cos\theta\right]_0^\pi$$

$$= -\frac{I_{max}}{2\pi} \left[-2\right] \Rightarrow \frac{2 I_{max}}{2\pi} \Rightarrow \frac{I_{max}}{\pi}$$

$$i^2 = I_{00}^2 \sin^2\theta$$

RMS:- $I_{00rms} = \sqrt{\dfrac{\int_0^{\Pi} i^2\, d\theta + \int_{\Pi}^{2\Pi} 0\, d\theta}{2\Pi}}$

$$= \sqrt{\dfrac{\int_0^{\Pi} I_{00}^2 \sin^2\theta\, d\theta + 0}{2\Pi}}$$

$$= \sqrt{\dfrac{I_{00}^2 \int_0^{\Pi} \sin^2\theta\, d\theta}{2\Pi}}$$

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

$$= \sqrt{\dfrac{I_{00}^2 \times \Pi}{2\Pi}} = \dfrac{I_{00}}{\sqrt{2}}$$

Peak factor = $\sqrt{2}$

Form factor = 1.57 power

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

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

(4) Instantaneous value at $f = 3\, ms$.

(1) $i = I_{00} \sin\omega t$

$i = 142.42 \sin 628 t$

maximum value of current = 142.42 Amp.

$\omega = 2\Pi f$

$628 = 2\Pi f$

$f = \dfrac{628}{2\Pi} = 100\, hz$

(2)

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

(4):−

$i = 142.42 \sin 628 t$

$i = 142.42 \sin 628 \times 0.003$

$= 142.42 \sin 1.884$

$= 142.42 \times 0.033$

$= 0.42726 \text{ Amp.}$

1. What do you mean by Series resonance?

Series Resonance

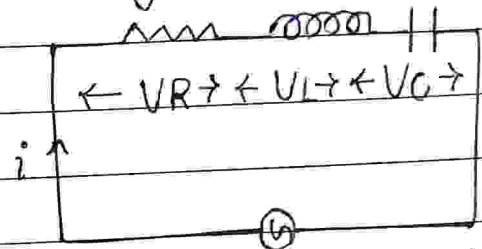A series RLC AC circuit is said to be in resonance when circuit power factor is unity.

Consider a Series RLC circuit as shown in Fig. the circuit impedance is given by

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

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

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.

$$Fr = \frac{1}{2\pi\sqrt{LC}} \quad hz$$

10. Explain RL circuit.

RL series AC circuit

Let V = RMS value of applied voltage

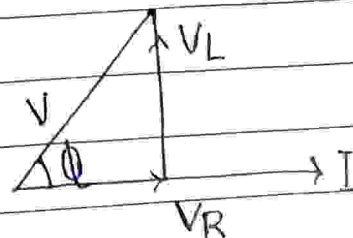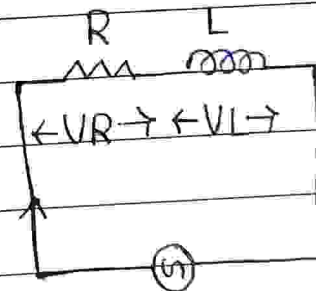I = RMS value of circuit current

$$V_R = IR$$
$$V_L = IX_L$$

phaser 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

Galled impedence of a circuit.

repsesent by z and measured in Ω therefore $I = V/z$

$$V = Iz$$