

## UNIT-2

### A.C Circuits

Phase: It is defined as the fraction of times Period alternating quantity from reference point is known as phase.

Phase difference: It is defined as angular displacement between the voltage and current two phasor quantities is known as phase difference.

Phase angle: It is defined as the phase difference between voltage and current is known as phase angle.

Power factor: Power factor is defined as the ratio of active power to apparent power is known as power factor. It is denoted by  $\phi$

$$\phi = \frac{\text{Active power}}{\text{Apparent power}}$$

Form factor: The ratio of RMS value to average value is known as form factor

$$\text{Form factor} = \frac{\text{RMS Value}}{\text{Average Value}} = 1.11$$

R.M.S Value: It is defined as the square root of average value of squares of time period of alternating current in the circuit and phase angle of instant value over one complete cycle.

$$\text{R.M.S. Value} = \frac{1}{T} \int_0^T f(t) \cdot dt$$

**Average Value:** It is defined as the value of direct current which gives total amount of charge to the network in same time and given by alternating current to same electrical network.

$$\text{average value} = \frac{1}{T} \int_0^T f(t) dt$$

**Impedance: ( $Z$ ):** It is defined as the ratio of phasor voltage to phasor current is known as impedance. It is denoted by  $Z$ .  $Z = R + jX_L$

**Admittance ( $Y$ ):** It is denoted by  $Y$ . It is defined as the reciprocal of impedance is known as Admittance ( $Y$ ) or ( $S$ )

$$Y = \frac{1}{R + jX_L}$$

**Susceptance ( $B$ ):** It is imaginary part of Admittance. It is denoted by ' $B$ ' and the units are ( $S$ )

**The Significance of Susceptance:**  
 $\Rightarrow$  It is to predict the nature of electrical circuit ( $C, L$ )

$$B = \pm \frac{X}{R^2 + X^2}$$

**Peak factor:** It is defined as the ratio of Peak value to rms value.

$$\text{Peak factor} = \frac{\text{Peak Value}}{\text{RMS Value}} = 1.34$$



**Resonance:** It is defined as the phenomenon which net reactance of the circuit is zero is known as Resonance.

(or)  
It is defined as inductive reactance is equal to capacitive reactance is known as resonance.

The resonance are classified into two types.

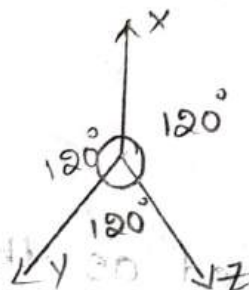
i) Series resonance

ii) Parallel resonance

**Phase Sequence:** The sequence of maximum value by 3- $\phi$  voltage (or) current then the system is known as phase sequence. It is determined the direction of rotation.

**Symmetric Sequence:**

The 3- $\phi$  system if the magnitude and frequency of voltage (or) current are same and which is displayed by angle  $120^\circ$  from each other then the system is called Symmetric Sequence.



**Battery Supply:** If the supply is equal to line to line voltage which are displayed phase angle  $120^\circ$  from each other then the supply is known as battery supply.



Ex:  $V_L \angle 0^\circ$   
 $V_L \angle -120^\circ$   
 $V_L \angle -240^\circ$

Battery load: If the load is equal if the magnitude of impedance which are displayed phase angle and passes the same nature of the load is known as battery load.

Ex:  $Z \angle \phi_1 = Z \angle \phi_2$

Apparent Power: It is defined as the product of rms voltage and current is known as Apparent power.

Apparent power =  $EI$   
 $= E_{rms} \times I_{rms}$

Reactance: The opposition of capacitance (or) Inductance in AC circuit to the flow of current through it is known as Reactance

(or)  
 The Product of RMS Voltage and current and  $\sin \phi$  sign of power factor is known as reactive Power

Reactive power =  $EI \sin \phi$

Form factor: It is defined as the ratio of RMS value to the average value

$\Rightarrow$  form factor is denoted by 'Kf'

$\Rightarrow$  This form factor which is represented for both voltages and current.



$$K_f = \frac{V_{rms}}{V_{avg}} = \frac{0.707 V_m}{0.637 V_m}$$

$$K_f = \frac{0.707}{0.637}$$

$$K_f = 1.11$$

⇒ The form factor for voltage representation is 1.11

⇒ form factor for current representation

$$K_f = \frac{I_{rms}}{I_{avg}} = \frac{0.707 I_m}{0.637 I_m}$$

$$K_f = \frac{0.707}{0.637}$$

$$K_f = 1.11$$

Peak factor: It is defined as the ratio of maximum value of AC quantity to the rms value of an AC quantity.

⇒ Peak factor is denoted by "Kp"

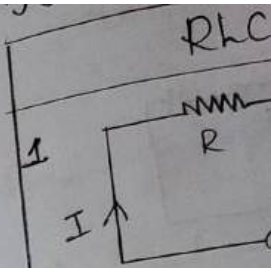
⇒ The peak factor can be represented for both current and voltages.

$$K_p = \frac{\text{Maximum value}}{\text{RMS Value}}$$

$$K_p = \frac{I_m}{0.707 I_m} \Rightarrow K_p = 1.414$$

$$K_p = \frac{V_m}{0.707 V_m}$$

$$K_p = 1.414$$



2 Resonance  
 $f_r =$

3 Quality factor  
 $\frac{1}{R}$

4 Bandwidth

5 Half power  
 $f_1$

ii) upper  
 $f_2$

i) In

$L = 100$

100V

determine  
factor

Sol:

$$K_f = \frac{V_{rms}}{V_{avg}} = \frac{0.707 V_m}{0.637 V_m}$$

$$K_f = \frac{0.707}{0.637}$$

$$K_f = 1.11$$

⇒ The form factor for voltage representation is 1.11

⇒ form factor for current representation

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$$K_p = \frac{V_m}{0.707 V_m}$$

$$K_p = 1.414$$



# Difference between RLC Series and RL (or) LC Series.

RLC	RL
2 Resonant frequency	2 Resonant frequency
$f_r = \frac{1}{2\pi\sqrt{LC}}$	$f_r = \frac{1}{\sqrt{LC}}$
3 Quality factor	3 Quality factor
$\frac{1}{R} \sqrt{\frac{L}{C}}$	$\frac{\omega L}{R}$
4 Band width	4 Band width
$\frac{R}{2\pi L}$	$\frac{R}{L}$
5 Half power frequency	5 Half power frequency
Lower cutt-off frequency	i) Lower cutt off frequency
$f_1 = f_r - \frac{R}{4\pi L}$	$\omega_1 = \frac{-R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}}$
ii) upper cutt off frequency	ii) upper cutt-off frequency
$f_2 = f_r + \frac{R}{4\pi L}$	$\omega_2 = \frac{R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}}$

i) In RLC circuit is consisting of  $R=1k\Omega$ ,  $L=100mH$  and  $C=10\mu F$  with the voltage of  $100V$  is applied across the combination determine the resonance frequency, quality factor and Band width.

Sol: Given

$$R = 1k\Omega = 1000\Omega$$

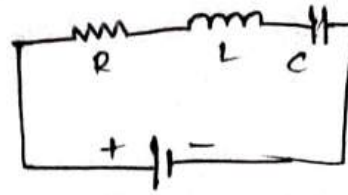
$$L = 100mH = 100 \times 10^{-3} = 0.1$$

$$C = 10 \text{ mF}$$

$$= 10 \times 10^{-6} \text{ F}$$

Resonant frequency

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$



$$= \frac{1}{2 \times 3.14 \sqrt{0.1 \times 10 \times 10^{-6}}}$$

$$= 159.23 \text{ Hz}$$

$$\text{Quality factor} = \frac{1}{R} \times \sqrt{\frac{L}{C}}$$

$$= \frac{1}{1000} \times \sqrt{\frac{0.1}{10 \times 10^{-6}}}$$

$$\boxed{Q_f = 0.1}$$

$$\text{Band width} = \frac{R}{2\pi L} \Rightarrow \frac{1000}{2 \times 3.14 \times 0.1}$$

$$= 1592.35$$

3) An Inductance  $0.5 \text{ H}$ , resistance  $5 \Omega$ , capacitance  $8 \text{ mF}$  across  $220 \text{ V}$  AC supply. calculate the frequency at which circuit resonant and current resonant, Band width and Half power frequency, Voltage capacitance at resonant

Given data

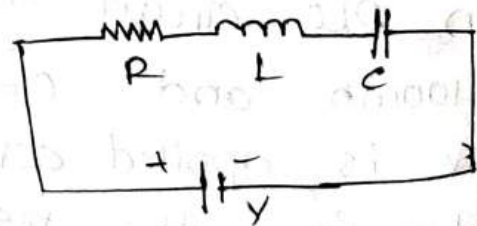
In RLC Series

$$R = 5 \Omega$$

$$C = 8 \times 10^{-6}$$

$$L = 0.5 \text{ H}$$

$$V = 220 \text{ V}$$



Calculate:

$$f_r = ?$$

$$\text{Bandwidth} = ?$$



Half power = ?

current

$$V_c = ?$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$f_r = \frac{1}{2 \times 3.14 \sqrt{0.5 \times 8 \times 10^{-6}}}$$

$$\boxed{f_r = 79.61 \text{ Hz}}$$

$$B = \frac{R}{2\pi L} = \frac{5}{2 \times 3.14 \times 0.5}$$

$$\boxed{B = 1.59}$$

Half power efficiency frequency

Lower cut off frequency

$$f_1 = f_r - \frac{R}{4\pi L}$$

$$f_1 = 79.61 - \frac{5}{4 \times 3.14 \times 0.5}$$

$$\boxed{f_1 = 78.81 \text{ Hz}}$$

Upper cut off frequency

$$f_2 = f_r + \frac{R}{4\pi L}$$

$$f_2 = 79.61 + \frac{5}{4 \times 3.14 \times 0.5}$$

$$\boxed{f_2 = 80.40 \text{ Hz}}$$

Current in resonance

$$\boxed{I = \frac{V}{Z}}$$

$$Z = R + jX_L$$

$$Z = R + j(X_L - X_C)$$

$$Z = R + j(X_L - X_L)$$

$$Z = R$$

$$I = \frac{V}{R}$$

$$I = \frac{220}{5}$$

$$I = 44 \text{ A}$$

$$\begin{bmatrix} X_L - X_C \\ \therefore X_L = X_C \end{bmatrix}$$

Voltage across capacitance

$$V_C = I \times X_C$$

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

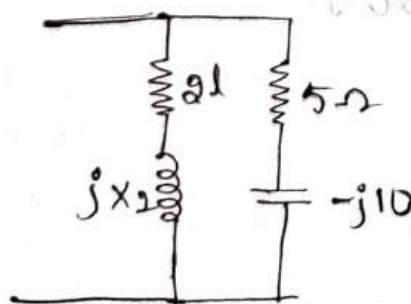
$$V_C = I \times \frac{1}{2\pi \times f \times C}$$

$$V_C = \frac{44}{2 \times 3.14 \times 79.61 \times 8 \times 10^{-6}}$$

$$V_C = 11001.08 \text{ V}$$

H/W

Find the value of L for the circuit shown in fig at the resonant frequency  $\omega = 500 \text{ rad/sec}$ .





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Total admittance of circuit

$$Y_T = Y_L + Y_C$$

$$Y_T = \frac{1}{Z_L} + \frac{1}{Z_C}$$

$$\boxed{Z = R + jX_L} \quad \text{--- ①}$$

$$Z_L = 2 + jX_L \quad \text{--- ①}$$

$$Z_C = 5 - j10 \quad \text{--- ②}$$

Sub ①, ② in ①

$$Y_T = \frac{1}{(2 + jX_L)} + \frac{1}{(5 - j10)} \quad \text{--- ③}$$

Based on ③ multiply & divide  
(2 - jX\_L) and (5 + j10)

$$Y_T = \frac{2 - jX_L}{(2 - jX_L)(2 + jX_L)} + \frac{5 + j10}{(5 + j10)(5 - j10)}$$

$$Y_T = \frac{2 - jX_L}{4 + X_L^2} + \frac{5 + j10}{25 + 100} \quad (V^2 = -1)$$

$$Y_T = \frac{2}{4 + X_L^2} + \frac{5}{125} + \frac{j10^2}{125} - \frac{jX_L}{4 + X_L^2}$$

$$\left( \frac{2}{(4 + X_L^2)} + \frac{1}{25} \right) + j \left( \frac{2}{25} - \frac{X_L}{4 + X_L^2} \right)$$

$$\frac{2}{25} - \frac{X_L}{4 + X_L^2} = 0$$

$$8 + 2X_L^2 - 25X_L = 0$$

$$2X_L^2 - 25X_L + 8 = 0$$

$$ax^2 + bx + c = 0$$

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$a=2, b=-25, c=8$$

$$\frac{-(-25) \pm \sqrt{(-25)^2 - 4(2)(8)}}{2(2)}$$

$$= 25 + \sqrt{561}$$

$$= 12.171$$

$$X_L = \omega \times L$$

$$L = \frac{X_L}{\omega}$$

$$L = \frac{12.17}{500}$$

$$\boxed{L = 24 \text{ mH}}$$

$$L = 0.024 \times 1000$$

$$\boxed{L = 24 \text{ mH}}$$

(or)

$$L = \frac{0.328}{500}$$

$$\boxed{L = 0.64 \text{ mH}}$$

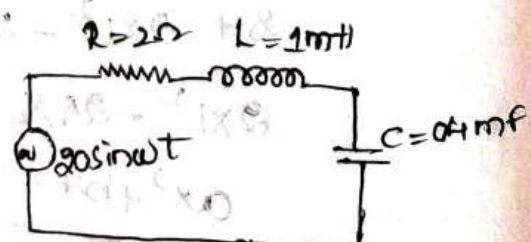
Q) In the circuit shown in fig.  $R=2\Omega$ ,  $L=1\text{mH}$ ,  $C=0.4\mu\text{F}$ , find the resonant frequency, half power frequency, determine the quality factor and Band width amplitude of current at resonant frequency  $\omega_0$ ,  $\omega_1$ ,  $\omega_2$  in the circuit shown in fig.

Given data

$$R=2\Omega$$

$$L=1\text{mH} \Rightarrow 1 \times 10^{-3}\text{H}$$

$$C=0.4\mu\text{F} \Rightarrow 0.4 \times 10^{-6}\text{F}$$





Determine:

$f_r = ?$

$Q.F = ?$

Band width = ?

Half power frequency = ?

Amplitude Current = ?

i) Resonant frequency

$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$= \frac{1}{\sqrt{1 \times 10^{-3} \times 0.4 \times 10^{-6}}}$$

$$= 50,000$$

$$\boxed{\omega_0 = 50K \text{ rad/sec}}$$

ii) Quality factor

$$\frac{\omega_0 \times L}{R}$$

$$= \frac{50,000 \times 1 \times 10^{-3}}{2}$$

$$\boxed{Q.F = 25}$$

iii) Band width

$$\frac{R}{L}$$

$$\frac{2}{1 \times 10^{-3}}$$

$$\boxed{B.W = 2000 \text{ rad/sec}}$$

iv) Half power frequency

Lower power cut off frequency

$$\omega_1 = \frac{-R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{1}{LC}}$$

$$\omega_1 = \frac{-2}{2 \times 1 \times 10^{-3}} + \sqrt{\left(\frac{2}{2 \times 1 \times 10^{-3}}\right)^2 + \frac{1}{1 \times 10^{-3} \times 0.4 \times 10^{-6}}}$$

$$= 49009.99 \text{ rad/sec}$$

$$\boxed{\omega_2 = 49.09 \text{ K rad/sec}}$$

Upper power cut off frequency

$$\omega_2 = \frac{R}{2L} + \sqrt{\left(\frac{R}{2L}\right)^2 + \frac{3}{LC}}$$

$$\omega_2 = \frac{2}{2 \times 10^{-3}} + \sqrt{\left(\frac{2}{2 \times 10^{-3}}\right)^2 + \frac{1}{1 \times 10^{-3} \times 4 \times 10^{-6}}}$$

$$= 51009.99 \text{ rad/sec}$$

$$\boxed{\omega_2 = 51.009 \text{ K rad/sec}}$$

v) Amplitude current

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

$$Z = R + jX_L$$

$$Z = R + j(X_L - X_C)$$

$$Z = R + j(X_L - X_C)$$

$$Z = R$$

$$I = \frac{20}{2}$$

$$\boxed{I = 10 \text{ A}}$$

$$I + \omega_2 = \omega_1 = \omega_2$$

$$I_A = \frac{V_M}{\sqrt{2} \times 2} = \frac{20}{\sqrt{2} \times 2}$$

$$\boxed{I_A = 7.07 \text{ A}}$$



g) calculate the RMS value, Average value, form factor and peak factor for the current over one cycle of an alternating voltage  $V = 200 \sin(314T)$  applied to the resistor of  $20\Omega$  which offers the flow of current in one direction only.

Given data

$$V(t) = 200 \sin(314t)$$

$$V_m = 200V$$

$$R = 20\Omega$$

Determine

RMS value = ?

Average value = ?

form factor = ?

Peak factor = ?

i) RMS value of current

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

$$I_m = \frac{V_m}{R} = \frac{200}{20} = 10A$$

$$I_{rms} = \frac{10}{2}$$

$$\boxed{I_{rms} = 5A}$$

ii) Average value of current

$$I_{rms} = \frac{I_m}{\pi} = \frac{10}{\pi}$$

$$\boxed{I_{rms} = 3.18A}$$

iii) form factor =  $\frac{\text{RMS value}}{\text{Avg value}}$

$$= \frac{5}{3.18}$$

$$\boxed{f.f = 1.57}$$

iv) Peak factor =  $\frac{\text{Peak Value}}{\text{RMS Value}}$

$$\frac{I_m}{I_{rms}} = \frac{10}{5}$$

$$\boxed{P.F = 2}$$

g) Obtain RMS value, Average value, form-factor Peak factor for voltage of symmetrical square wave whose amplitude is 10V and Time period is 40 sec for given data

RMS value

$$= \sqrt{\frac{1}{T} \int_0^T v(t) dt}$$

$$= \sqrt{\frac{1}{40} \int_0^{20} 100 dt + \int_{20}^{40} 100 dt}$$

$$= \sqrt{\frac{1}{40} (100 \times dt)_0^{20} + (100 dt)_{20}^{40}}$$

$$= \sqrt{\frac{1}{40} (100 \times 20 - 100 \times 0) + (100 \times 40 - 100 \times 20)}$$

$$= \sqrt{\frac{1}{40} (2000) + (4000 - 2000)}$$

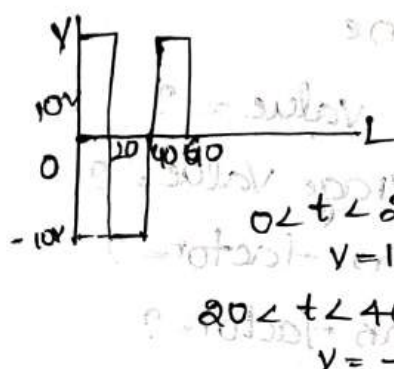
$$\sqrt{\frac{1}{40} (4000)}$$

$$\sqrt{\frac{4000}{40}}$$

$$= \sqrt{100}$$

$$= 10$$

$$\boxed{\text{RMS value} = 10}$$



$$T = 40 \text{ sec}$$

$$A_{avg} = \frac{0.04}{0.04} = \frac{mV}{s} = mV$$

$$\frac{0.1}{0.04} = 2.5 mV$$

$$\boxed{A_{avg} = 2.5 mV}$$

form factor =  $\frac{RMS}{Avg}$

$$\frac{10}{2.5} = \frac{mV}{mV} = 4$$

$$\boxed{A_{avg} = 2.5 mV}$$

ii) Average value

$$= \frac{1}{T} \int_0^T v(t) dt$$

$$= \frac{1}{20} \int_0^{20} 10 dt$$



$$= \frac{1}{20} [10t]_0^{20}$$

$$= \frac{1}{20} [10 \times 20 - 10 \times 0]$$

$$= \frac{200}{20}$$

$$\boxed{\text{Avg value} = 10}$$

$$i) \text{ form factor} = \frac{\text{RMS Value}}{\text{Avg value}}$$

$$= \frac{10}{10}$$

$$\boxed{f.f = 1}$$

$$ii) \text{ Peak factor} = \frac{\text{Peak Value}}{\text{RMS value}}$$

$$= \frac{10}{10}$$

$$\boxed{P.f = 1}$$

g) obtain the RMS value, Average value, form factor, Peak factor of Half wave rectifier sin wave

[When sin waves is mentioned, diagram must be drawn by oneself]

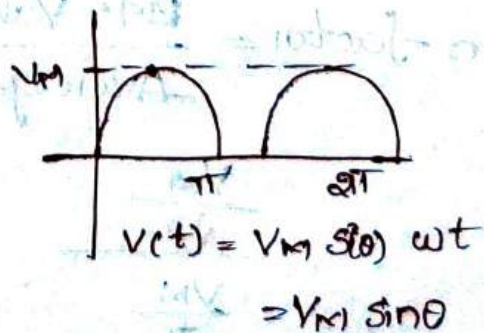
i) RMS Value

$$= \sqrt{\frac{1}{T} \int_0^T V(t)^2 dt}$$

$$= \sqrt{\frac{1}{2\pi} \int_0^{2\pi} (V_m \sin \theta) d\theta}$$

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

$$= \frac{V_m^2}{\pi} \int_0^{\pi} \left( \frac{1 - \cos 2\theta}{2} \right) d\theta$$



$$= \sqrt{\frac{V_m^2}{2\pi} \times (10)_0^\pi}$$

$$= \sqrt{\frac{V_m^2}{2\pi} (\pi - 0)}$$

$$= \sqrt{\frac{V_m^2}{2}}$$

$$\boxed{\text{RMS value} = \frac{V_m}{\sqrt{2}}}$$

$$\text{Average Value} = \frac{1}{T} \int_0^T v(t) dt$$

$$\frac{1}{2\pi} \int_0^\pi V_m \sin \theta d\theta$$

$$\frac{V_m}{2\pi} (-\cos \theta)_0^\pi d\theta$$

$$\frac{V_m}{2\pi} [\cos \pi - \cos 0]$$

$$\frac{V_m}{2\pi} (1+1)$$

$$\frac{V_m}{2\pi} \times 2$$

$$\boxed{\text{Average value} = \frac{V_m}{\pi}}$$

$$\text{Form factor} = \frac{\text{RMS Value}}{\text{Average value}}$$

$$\frac{\frac{V_m}{\sqrt{2}}}{\frac{V_m}{\pi}}$$

$$\frac{V_m}{\pi}$$

$$\frac{1}{\pi} \int_0^\pi V_m \sin \theta d\theta$$

$$\frac{V_m}{\pi} \times \frac{\pi}{V_m}$$

$$\boxed{f = \frac{\pi}{\sqrt{2}}}$$

$$= \frac{V_m}{\sqrt{2}}$$

$$V_m$$

$$\boxed{\text{P.F.}}$$

Formulae:

⇒ Form factor

⇒ Peak factor

⇒ RMS value

⇒ Average value

⇒ RMS value

⇒ Average value



$$= \sqrt{\frac{VM^2}{2\pi} \times (10)_0^\pi}$$

$$= \sqrt{\frac{VM^2}{2\pi} (\pi - 0)}$$

$$= \sqrt{\frac{VM^2}{2}}$$

$$\boxed{\text{RMS value} = \frac{VM}{\sqrt{2}}}$$

a) Average Value =  $\frac{1}{T} \int_0^T v(t) dt$

$$\frac{1}{2\pi} \int_0^\pi VM \sin \theta dt$$

$$\frac{VM}{2\pi} (-\cos \theta)_0^\pi$$

$$\frac{VM}{2\pi} [\cos \pi - \cos 0]$$

$$\frac{VM}{2\pi} (1+1)$$

$$\frac{VM}{2\pi} \times 2$$

$$\boxed{\text{Average value} = \frac{VM}{\pi}}$$

w) Form factor =  $\frac{\text{RMS Value}}{\text{Average value}}$

$$\frac{\frac{VM}{\sqrt{2}}}{\frac{VM}{\pi}}$$

$$\frac{VM}{\pi}$$

$$\frac{1}{\pi} \int_0^\pi VM \sin \theta dt$$

$$\frac{VM}{\sqrt{2}} \times \frac{\pi}{VM}$$

$$\boxed{f.f = \frac{\pi}{\sqrt{2}}}$$

iv) Peak factor =  $\frac{\text{Peak value}}{\text{RMS value}}$

$$= \frac{V_m}{V_m/\sqrt{2}}$$

$$V_m \times \frac{\sqrt{2}}{V_m}$$

$$\boxed{P.F = \sqrt{2}}$$

formuale:

$$\Rightarrow \text{form factor} = \frac{\text{RMS value}}{\text{Average value}}$$

$$\Rightarrow \text{Peak factor} = \frac{\text{Peak value}}{\text{RMS value}}$$

$$\Rightarrow \text{RMS value w.r. to current} \Rightarrow I_{\text{rms}} = \frac{I_m}{\sqrt{2}}$$

$$I_m = \frac{V_m}{R}$$

$$\Rightarrow \text{Average value w.r. to current} \Rightarrow I_{\text{avg}} = \frac{I_m}{\pi}$$

$$\Rightarrow \text{RMS value w.r. to voltage} = \sqrt{\frac{1}{T} \int_0^T v(t)^2 dt}$$

$$\Rightarrow \text{Average value w.r. to voltage} = \frac{1}{T} \int_0^T v(t) dt$$

$$\boxed{I_{\text{avg}} = \frac{I_m}{\pi}}$$

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

$$\boxed{P.F = \sqrt{2}}$$



Q) Obtain the RMS Value Average value form factor and peak factor of full wave rectifier sine wave

RMS Value:

$$= \sqrt{\frac{1}{T} \int_0^T v(t)^2 dt}$$

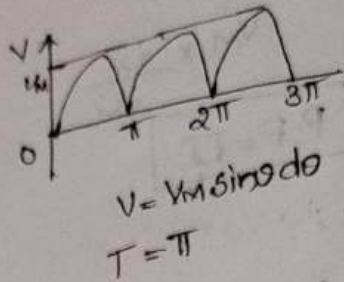
$$= \sqrt{\frac{1}{\pi} \int_0^{\pi} (V_m \sin \theta)^2 d\theta}$$

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

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

$$= \sqrt{\frac{V_m^2}{2\pi} (\pi - 0)}$$

$$\boxed{\text{RMS value} = \frac{V_m}{\sqrt{2}}}$$



ii) Average Value

$$\frac{1}{T} \int_0^T v(t) dt$$

$$\frac{1}{\pi} \int_0^{\pi} V_m \sin \theta d\theta$$

$$\frac{V_m}{\pi} (-\cos \theta)_0^{\pi}$$

$$\frac{V_m}{\pi} (-\cos \pi - (-\cos 0))$$

$$\frac{V_m}{\pi} (1+1)$$

$$\boxed{\text{Average value} = \frac{2V_m}{\pi}}$$

iii) form factor:  
RMS Value  
Average value

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

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

$$\boxed{f.f = 1.57}$$

iv) Peak factor:  $\frac{\text{Peak value}}{\text{RMS value}}$

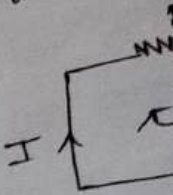
$$= \frac{V_m}{V_m/\sqrt{2}}$$

$$= \sqrt{2}$$

$$\boxed{P.f = 1.414}$$

AC through

Consider a  
an a.c current  
through that P



According to

$$I = V/R$$

But from  
Sub ②

$$I = \frac{V_m}{R}$$

$$I = \left( \frac{V_m}{R} \right)$$

Compare eq

$$I =$$

from eq

we

The m

through

Phasor



§) Obtain the RMS Value Average value form factor rectifier sine wave

RMS Value:

$$= \sqrt{\frac{1}{T} \int_0^T v(t)^2 dt}$$

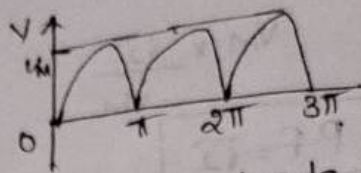
$$= \sqrt{\frac{1}{\pi} \int_0^{\pi} (V_m \sin \theta)^2 d\theta}$$

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

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

$$= \sqrt{\frac{V_m^2}{2\pi} (\pi - 0)}$$

$$\boxed{\text{RMS value} = \frac{V_m}{\sqrt{2}}}$$



$$V = V_m \sin \theta$$

$$T = \pi$$

ii) Average Value

$$\frac{1}{T} \int_0^T v(t) dt$$

$$\frac{1}{\pi} \int_0^{\pi} V_m \sin \theta d\theta$$

$$\frac{V_m}{\pi} (-\cos \theta)_0^{\pi}$$

$$\frac{V_m}{\pi} (-\cos \pi - (-\cos 0))$$

$$\frac{V_m}{\pi} (1+1)$$

$$\boxed{\text{Average value} = \frac{2V_m}{\pi}}$$

iii) form factor:

$$\frac{\text{RMS value}}{\text{Average value}}$$

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

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

$$= 1.57$$

$$\boxed{f.f = 1.57}$$

iv) Peak factor:  $\frac{\text{Peak value}}{\text{RMS value}}$

$$= \frac{V_m}{V_m/\sqrt{2}}$$

$$= \sqrt{2}$$

$$\boxed{P.f = 1.414}$$

AC through p  
Consider  
an a.c current  
through that

$$I = \frac{V}{R}$$

According

$$I = \frac{V}{R}$$

But from

Sub

$$I = \frac{V}{R}$$

$$I = \frac{V}{R}$$

Compare

$$I = \frac{V}{R}$$

from eq

we

The m

through

Phasor

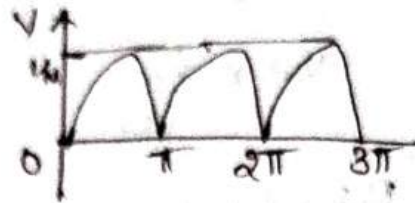


§) Obtain the RMS value, Average value, form factor and peak factor of full wave rectifier sine wave

RMS Value:

$$\begin{aligned}
 &= \sqrt{\frac{1}{T} \int_0^T v(t)^2 dt} \\
 &= \sqrt{\frac{1}{\pi} \int_0^{\pi} (V_m \sin \theta)^2 d\theta} \\
 &= \sqrt{\frac{V_m^2}{\pi} \int_0^{\pi} \sin^2 \theta d\theta} \\
 &= \sqrt{\frac{V_m^2}{\pi} \int_0^{\pi} \frac{1 - \cos 2\theta}{2} d\theta} \\
 &= \sqrt{\frac{V_m^2}{2\pi} (\pi - 0)}
 \end{aligned}$$

$$\boxed{\text{RMS value} = \frac{V_m}{\sqrt{2}}}$$



$$V = V_m \sin \theta$$

$$T = \pi$$

ii) Average Value

$$\begin{aligned}
 &\frac{1}{T} \int_0^T v(t) dt \\
 &= \frac{1}{\pi} \int_0^{\pi} V_m \sin \theta d\theta \\
 &= \frac{V_m}{\pi} (-\cos \theta)_0^{\pi} \\
 &= \frac{V_m}{\pi} (-\cos \pi - (-\cos 0)) \\
 &= \frac{V_m}{\pi} (1 + 1)
 \end{aligned}$$

$$\boxed{\text{Average value} = \frac{2V_m}{\pi}}$$

iii) form factor:

$$\begin{aligned}
 &\frac{\text{RMS Value}}{\text{Average value}} \\
 &= \frac{\frac{V_m}{\sqrt{2}}}{\frac{2V_m}{\pi}} \\
 &= \frac{\pi}{2\sqrt{2}}
 \end{aligned}$$

$$\boxed{f.f = 1.57}$$

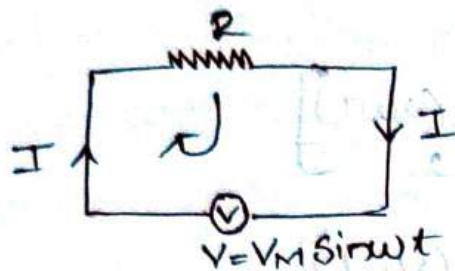
iv) Peak factor:  $\frac{\text{Peak value}}{\text{RMS value}}$

$$\begin{aligned}
 &= \frac{V_m}{V_m/\sqrt{2}} \\
 &= \sqrt{2}
 \end{aligned}$$

$$\boxed{P.f = 1.414}$$

AC through pure Resistance:

Consider a pure resistor (R) through which an a.c current (or) voltage which is passed through that pure resistor



According to the ohm's law

$$I = V/R \text{ --- (1)}$$

But from diagram  $V = V_m \sin \omega t$  --- (2)

Sub (2) in (1)

$$I = \frac{V_m \sin \omega t}{R} \text{ --- (3)}$$

$$I = \left( \frac{V_m}{R} \right) \times \sin \omega t \text{ --- (4)}$$

Compare eq (4) with standard eq

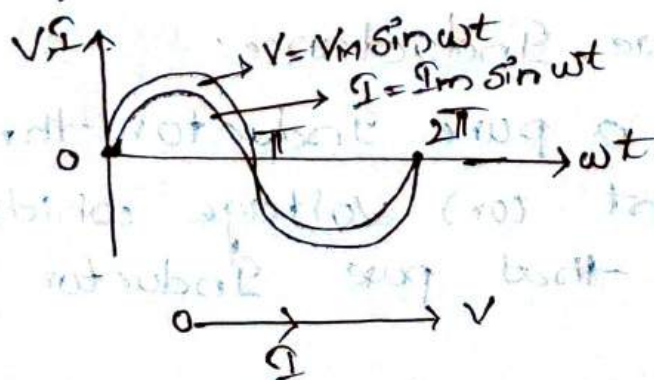
$$I = I_m \sin (\omega t + \phi) \text{ --- (5)}$$

from eq (4) & eq (5)

$$\text{we get } I_m = \frac{V_m}{R} \text{ and } \phi = 0$$

The maximum value of the current flowing through the resistor  $I_m = \frac{V_m}{R}$

Phasor diagram for pure resistance





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The power consumed by the resistor:

$$P = VI$$

from the diagram

$$P = V_m \sin \omega t \times I_m \sin \omega t$$

$$P = V_m I_m \sin^2 \omega t$$

$$P = V_m I_m \left[ \frac{1 - \cos(2\omega t)}{2} \right]$$

$$P = \frac{V_m I_m}{2} [1 - \cos(2\omega t)]$$

$$P = \frac{V_m I_m}{2} - \frac{V_m I_m \cos(2\omega t)}{2} \quad \text{--- (6)}$$

from eq (6) the first component

$$\frac{V_m I_m}{2} = \text{Actual power component}$$

$$\frac{-V_m I_m \cos(2\omega t)}{2} = \text{fluctuating power component}$$

But in the resistor fluctuating power

Component is almost double the cosine value.

Hence, it is considered as zero

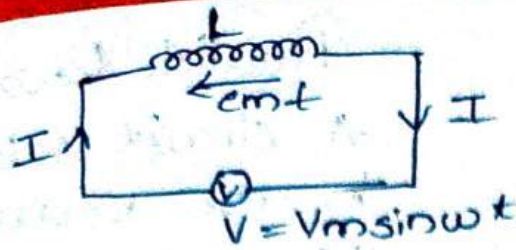
$\therefore$  The total power consumed by the resistor

is  $P = \frac{V_m I_m}{2}$

$$P = \sqrt{\frac{V_m I_m}{2}}$$

Ac through pure Inductance:

consider a pure Inductor through which an A.C current (or) voltage which is passed through that pure Inductor



When the supply voltage, which is given to the inductor a magnetic field which is going to set up around the inductor.

Due to this magnetic field a change flux takes place.

Due to this change in flux an emf will be induced at the inductor that emf is always opposite to that of voltage.

$$V = -e$$

$$e = -L \frac{di}{dt}$$

$$V = -(-L \frac{di}{dt})$$

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

$$V dt = L di$$

$$\text{But } V = V_m \sin \omega t$$

$$V_m \sin \omega t \cdot dt = L di$$

$$di = \frac{V_m}{L} \sin \omega t \cdot dt \quad \text{--- (1)}$$

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

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

$$i = \frac{V_m}{L} \left( \frac{-\cos \omega t}{\omega} \right)$$

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



## Series Resonance

1) A circuit is said to be in series resonance when impedance is minimum (or) when net reactance is zero.

$$\omega L = \frac{1}{\omega C} = 0$$

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

2) The current in the circuit is maximum and is given by  $I_{se} = \left(\frac{V}{R}\right) A$

3) Impedance has resistive part only

4) Power factor of the circuit is unity

5) The Resonant frequency ( $f_r$ ) is given by

$$f_r = \frac{1}{2\pi\sqrt{LC}} \text{ Hz}$$

6) The Voltage across capacitance and inductance are equal in magnitude & 180° out of phase each other

## Parallel Resonance

A circuit said to be in the resonance when I/p admittance is minimum and Input impedance is maximum.

The current in the circuit is minimum

$$I_{pa} = \left(\frac{V}{\frac{L}{CR}}\right) A$$

The net impedance of parallel circuit is max and given by

$$Z_{ph} = \left(\frac{L}{CR}\right) \Omega$$

At parallel resonance, power factor is unity

The resonant frequency is given by

$$f_r = \frac{1}{2\pi} \sqrt{\frac{1}{LC} - \frac{R^2}{L^2}} \text{ Hz}$$

The two branch currents are equal in magnitude & 180° out of phase with each other