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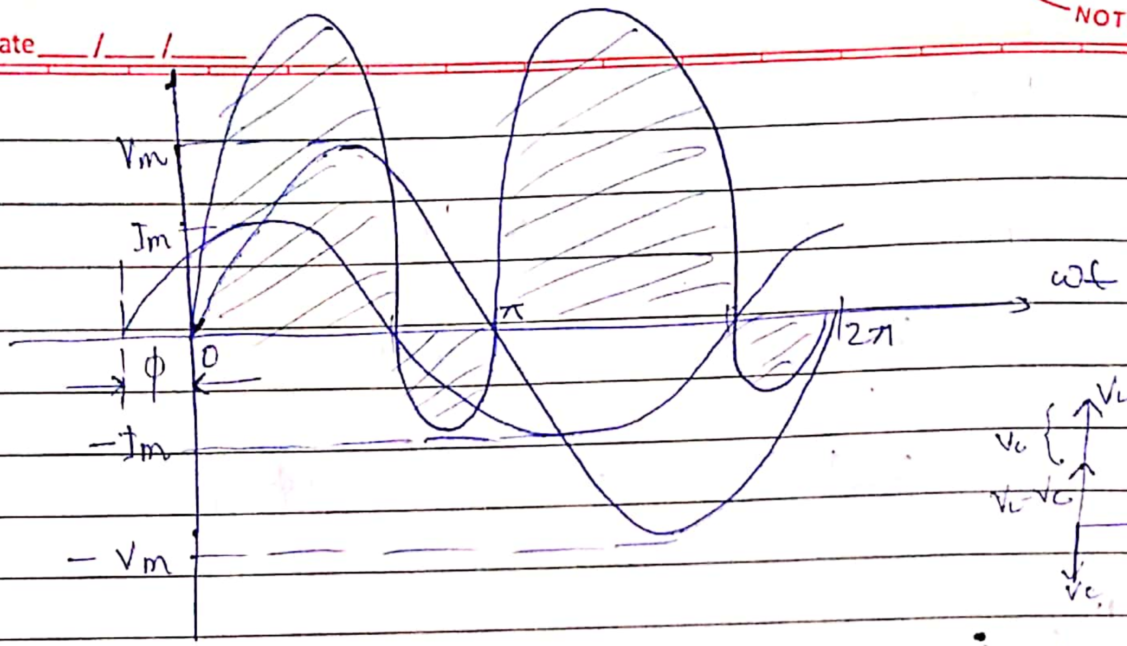
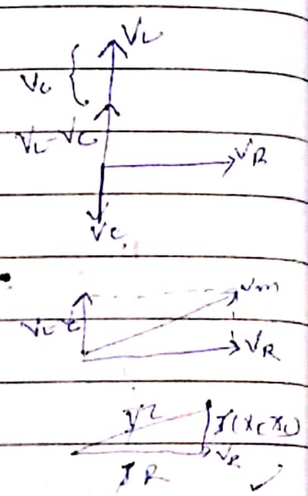




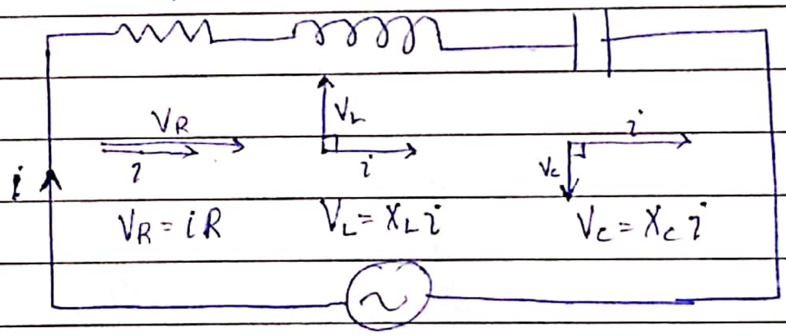
$Z^2 = R^2 + (X_L - X_C)^2$

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

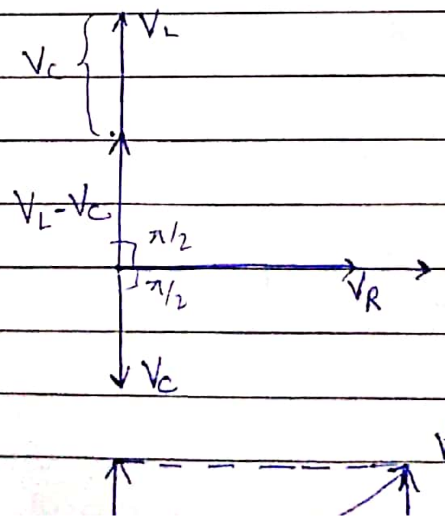
LCR Series Circuit

R $\quad X_L = \omega L \quad X_C = \frac{1}{\omega C}$

R $\quad$ L $\quad$ C



$V = V_m \sin \omega t$



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

$$\boxed{Z = \frac{V_m}{I_m}}$$

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

unit of Z = ohm Ω

if $Z \downarrow\downarrow \rightarrow I_m \uparrow\uparrow$

$Z \uparrow\uparrow \rightarrow I_m \downarrow\downarrow$

$i = i_m \sin(\omega t \pm \phi)$

$V = V_m \sin \omega t$

$$\cos\phi = \frac{R}{Z}$$

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

$$\tan\phi = \frac{X_L - X_C}{R}$$

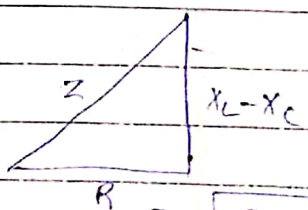
$$\phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)$$

Case. I

(i) $X_L > X_C$ RL

$\phi = +ve$

$i = i_m \sin(\omega t - \phi)$



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

(ii) $X_C > X_L$ – RC –

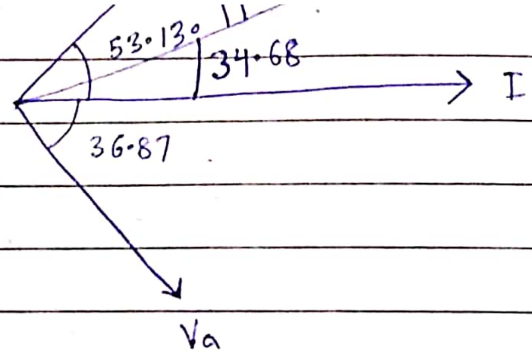
$\phi = -ve$

$i = i_m \sin(\omega t + \phi)$

(iii) $X_L = X_C$

$\phi = 0$ Purely resistive

$i = i_m \sin \omega t$



Single phase A.C ||el circuit

Admittance (Y)

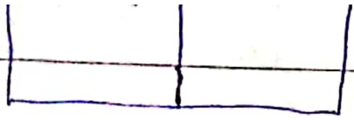
The Y of an A.C circuit is defined as the reciprocal of its Impedance i.e admittance $Y = \frac{1}{Z} = \frac{1}{V/I} = \frac{I}{V}$

unit - Simen (S)

$$Z = R + jX_L$$

$$Z = R - jX_C$$

when R & L are in ||el



Apply KCL

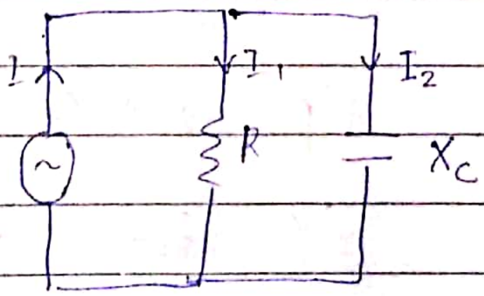
$$I = I_1 + I_2$$

$$\frac{V}{Z} = \frac{V}{R} + \frac{V}{jX_L}$$

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

$$\boxed{Y = G - jB_L}$$ Inductive substance.

R & C in ||el



Apply KCL

$$I = I_1 + I_2$$

$$\frac{V}{Z} = \frac{V}{R} + \frac{V}{-jX_C}$$

$$\boxed{Y = G + jB_c}$$

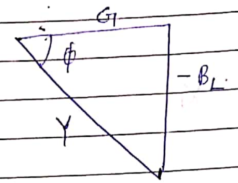
$$\boxed{\phi = \tan^{-1}\left(\frac{B}{G}\right)}$$

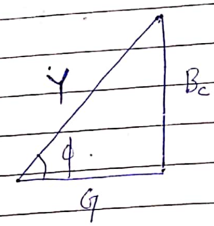
In general,

$$\boxed{Y = G \pm jB.}$$

Gojet. $T_{rot} = \frac{1}{2}\sum_{\alpha} m_\alpha \left[\omega^2 r_\alpha^2 - (\omega \cdot r_\alpha)^2\right]$

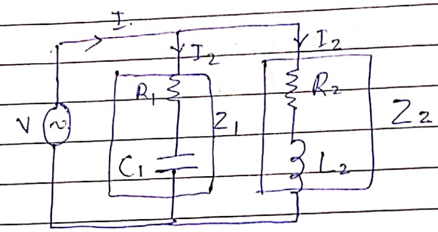
Date __/__/__





Q. Find general eqn of Y

<u>Admittance methode for ||el AC System</u>



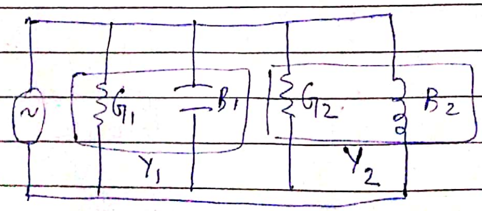
$Z_1 = R_1 - jX_{C_1}$ $\quad$ $Y_1 = G_1 + jB_1$

$Z_2 = R_2 + jX_{L_2}$ $\quad$ $Y_2 = G_2 - jB_2$

$$Y = Y_1 + Y_2$$

$$Y = (G_1 + G_2) + j(B_1 - B_2)$$

$$\boxed{Y = G + jB}$$ — General equation



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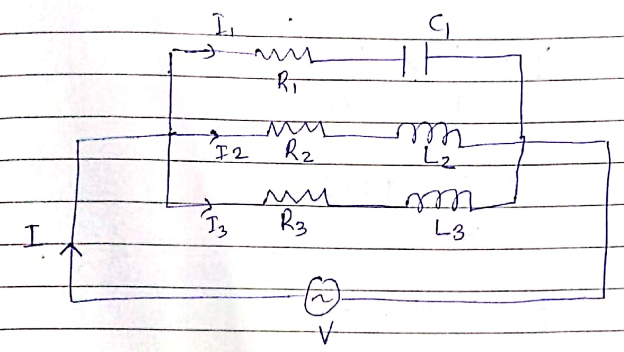
Application of admittance method



The magnitudes of various circuit values are

1. Total conductance $(G) = G_1 + G_2 + G_3$

2. Total susceptance $(B) = B_1 - B_2 - B_3$

3. Magnitude of admittance $Y = \sqrt{G^2 + B^2}$

4. Total current I in terms of Y $= VY$

5. Power factor $(\cos\phi) = G/Y$

6. Power consume $P = VI\cos\phi$
$= V^2 G$

7. Branch current $I_1 = VY_1$

8. Phase angle $\phi = \tan^{-1}\left[\frac{B}{G}\right]$

$\phi = +ve$ I leads
$\phi = -ve$ I lags

R & C in ||el

$$Y = \frac{1}{R} + \frac{1}{-jX_C}$$

$$Y = \frac{1}{R} + j\omega C$$

$$\phi = \tan^{-1}(\omega C R)$$

$$|Y| = \sqrt{\left(\tfrac{1}{R}\right)^2 + (\cancel{j}\omega C)^2}$$

R & L in ||el

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

$$Y = \frac{1}{R} + \left(\frac{-j}{\omega L}\right)$$

$$\phi = \tan^{-1}\left[\frac{-1}{\omega L} \times R\right]$$

$$= \tan^{-1}\left[\frac{R}{\omega L}\right]$$

$$|Y| = \sqrt{\left(\tfrac{1}{R}\right)^2 + \left(\frac{1}{\cancel{j}X_L}\right)^2}$$

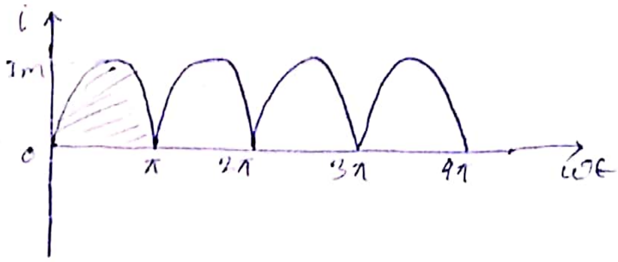
$$\text{form factor} = \frac{\text{RMS value}}{\text{Avg. value}}$$

$$= \frac{I_m}{(\sqrt{2})^2} \times \frac{\pi}{I_m}$$

$$\boxed{\text{form factor} = \frac{\pi}{2}}$$

$$\boxed{\text{peak factor} = \frac{\text{Max. value}}{\text{RMS Value}} = I_m \times \frac{2}{I_m} = 2}$$

(ii) $$I_{avg} = \frac{\text{area under wf over full cycle}}{\text{Period of the cycle.}}$$



$$= \frac{\int_0^{\pi} I_m \sin\omega t \, d(\omega t)}{\pi}$$

$$= \frac{I_m}{\pi} \int_0^{\pi} \sin\omega t \, d(\omega t)$$

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

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

$$= \frac{I_m}{\pi} \times [1+1]$$

$$\boxed{I_{avg} = \frac{2 I_m}{\pi}}$$

$$I_{rms} = \sqrt{\frac{\text{area of square wf over full cycle}}{\text{Period the full wavecycle}}}$$

$$= \sqrt{\frac{\int_0^{\pi} I_m^2 \sin^2\omega t \, dt}{\pi}}$$

$$= \sqrt{\frac{I_m^2}{2\pi} \int_0^{\pi} (2\sin^2\omega t) dt}$$

$$= \sqrt{\frac{I_m^2}{2\pi} \int_0^{\pi} (1 - \cos 2\omega t) \, d(\omega t)}$$

$$= \sqrt{\frac{I_m^2}{2\pi} \left[\omega t - \frac{\sin 2\omega t}{2}\right]_0^{\pi}}$$

$$= \left[\frac{I_m^2}{2\pi} \left(\pi - \frac{\sin 2\pi}{2} - 0 + \frac{\sin 2\times 0}{2}\right)\right]^{1/2}$$

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

$$P.f = \frac{I_m \times \sqrt{2}}{I_m}$$

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

$$\text{form factor} = \frac{I_m}{\sqrt{2}} \times \frac{\pi}{2 I_m}$$

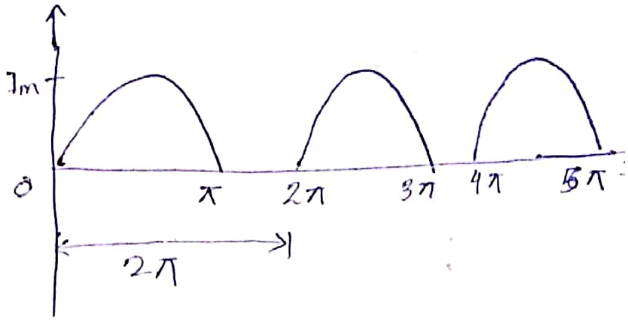
$$\boxed{f.f = \frac{\pi}{2\sqrt{2}}}$$

Find the avg. value, RMS value, form factor and peak factor for

(i) Half wave rectified AC

(ii) Full wave " AC

(i) $I_{avg} = \dfrac{\text{area under w.f over full cycle}}{\text{Period of the waveform}}$



$$= \frac{\int_0^{\pi} I_m \sin\omega t \, d(\omega t)}{2\pi}$$

$$= \frac{I_m}{2\pi}\left[-\cos\omega t\right]_0^{\pi} = \frac{I_m}{2\pi}\left[-\cos\pi - (-\cos 0^\circ)\right]$$

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

$$\boxed{\therefore I_{avg.} = \frac{I_m}{\pi}}$$

$$I_{rms} = \sqrt{\frac{\text{area of the square w.f over full cycle}}{\text{Period of the full cycle}}}$$

$$= \sqrt{\frac{\int_0^{\pi} I_m^2 \sin^2(\omega t)\, d(\omega t)}{2\pi}}$$

$$= \sqrt{\frac{I_m^2 \int_0^{\pi} (1-\cos 2\omega t)\, d(\omega t)}{4\pi}} = \sqrt{\frac{I_m^2}{4\pi}\left[\omega t - \frac{\sin 2\omega t}{2}\right]_0^{\pi}}$$

$$= \sqrt{\frac{I_m^2}{4\pi}\left[\pi - 0 - (0-0)\right]} = \sqrt{\frac{\cancel{\pi} I_m^2}{4\cancel{\pi}}} = \frac{I_m}{2}$$

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

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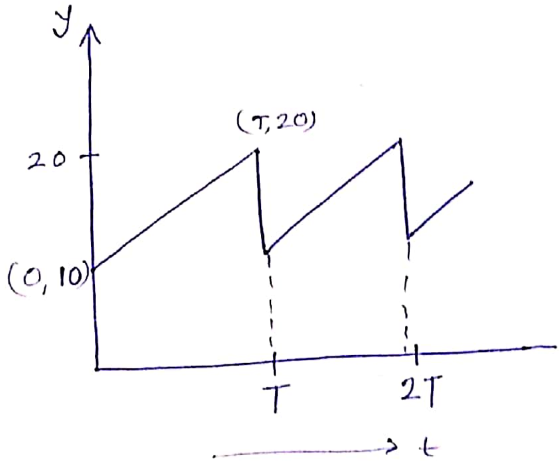
Determine rms and avg. value of waveform.



sol^n As we know that

$$y = mx + c$$

$$y = \left(\frac{20-10}{T}\right)t + 10$$

$$y = \frac{10}{T}t + 10$$

$$Y_{avg} = \frac{1}{T}\int_0^T \left(\frac{10t}{T} + 10\right) dt.$$

$$= \frac{1}{T}\left[\frac{10}{T} \times \left[\frac{t^2}{2}\right]_0^T + 10\left[t\right]_0^T\right]$$

$$= \frac{1}{T}\left[\frac{10}{\cancel{T}} \times \frac{T^{\cancel{2}}}{2} + 10T\right]$$

$$= \frac{1}{T}\left[\frac{10T + 20T}{2}\right]$$

$$Y_{avg} = 15$$

$$Y_{rms} = \sqrt{\frac{1}{T}\int_0^T y^2 dt}$$

$$= \int_0^T \left(\frac{100}{T^2}t^2 + 100\right) dt$$

$$= \frac{100}{\cancel{T^2}} \times \frac{T^{\cancel{3}}}{3} + 100T$$

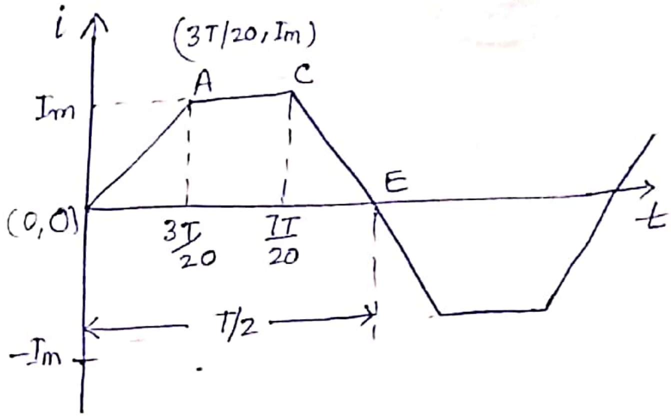
$$= \frac{100T + 300T}{3} = \frac{400T}{3}$$

$$Y_{rms} = \sqrt{\frac{1}{\cancel{T}} \times \frac{400T}{3}}$$

$$= \cancel{\frac{20}{\sqrt{3}}} = \frac{700}{3}$$

$$\therefore Y_{rms} = 15 \cdot 2$$

For the trapezoidal current wave-form. Determine the effective value



when $0 < t < \frac{3T}{20}$

$$i = \frac{I_m}{3T} \times 20 \cdot t$$

$$i = \frac{20 I_m}{3T} \cdot t$$

when $3T/20 < t < 7T/20$

$$i = I_m$$

$$i = \frac{I_m \times 20}{3T \times 1} \cdot t \quad \text{Rough}$$

$$i = \frac{I_m\, 20t}{3T}$$

$$\boxed{i = \frac{20 I_m}{3T}\, t}$$

$$I_{avg} = \frac{1}{T/2}\left\{ 2\int_0^{3T/20} i\,dt + \int_{3T/20}^{7T/20} I_m\,dt \right\}$$

$$= \frac{2}{T}\left\{ 2\int_0^{3T/20}\left(\frac{20 I_m}{3T}\right) t\,dt + I_m \int_{3T/20}^{7T/20} dt \right\}$$

$$= \frac{2}{T}\left\{ 2\left(\frac{20 I_m}{3T}\right)\left|\frac{t^2}{2}\right|_0^{3T/20} + I_m \left| t \right|_{3T/20}^{7T/20} \right\}$$

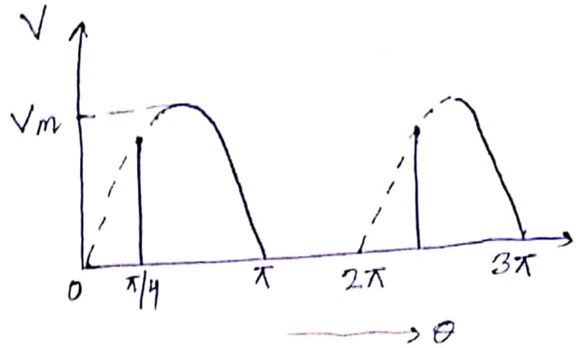
$$\boxed{I_{avg} = \frac{7}{10} I_m}$$

$$I_{rms} = \sqrt{\frac{1}{T/2}\left[2\int_0^{3T/20} i^2\,dt + \int_{3T/20}^{7T/20} I_m^2\,dt \right]}$$

$$= \sqrt{\frac{2}{T}\left[2\left[\frac{20 I_m}{3T}\right]^2 \int_0^{3T/20} t^2\,dt + I_m^2 \int_{3T/20}^{7T/20} dt \right]} = \frac{3}{5} I_m^2$$

$$\boxed{I = \sqrt{\left(\frac{3}{5}\right)} \cdot I_m = 0.775\, I_m}$$

Find the avg and effective values of voltage of sinusoidal wave form as shown



$$V_{avg} = \frac{1}{2\pi}\int_{\pi/4}^{\pi} 100\sin\theta \, d\theta$$

$$= \frac{100}{2\pi}\left| -\cos\theta \right|_{\pi/4}^{\pi}$$

$$= \frac{100}{2\pi}\left[-\cos\pi + \cos\pi/4 \right]$$

$$= \frac{100}{2\pi}\left[1 + 0.707 \right] = 27.2\,V$$

$$V_{rms} = \sqrt{\frac{1}{2\pi}\int_{\pi/4}^{\pi}\left(100^2 \sin^2\theta \, d\theta\right)}$$

$$= \sqrt{\frac{100^2}{4\pi}\int_{\pi/4}^{\pi} 2\sin^2\theta \, d\theta}$$

$$= \sqrt{\frac{100^2}{4\pi}\int_{\pi/4}^{\pi}(1-\cos 2\theta)\, d\theta}$$

$$= \sqrt{\frac{100^2}{4\pi}\left[\theta - \frac{\sin 2\theta}{2}\right]_{\pi/4}^{\pi}}$$

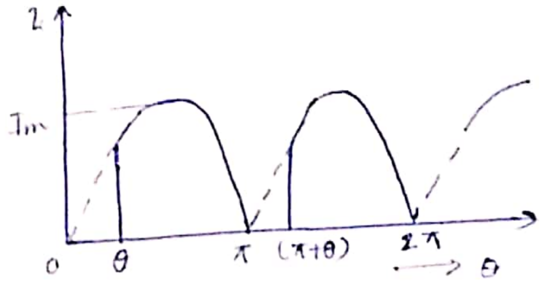
$$= \sqrt{\frac{100^2}{4\pi}\left[\frac{\pi}{1} - \frac{\sin 2\pi}{2} - \frac{\pi}{4} + \frac{\sin\frac{\pi}{2}}{2}\right]}$$

$$= \sqrt{\frac{100^2}{4\pi}\left[\pi - \frac{1}{2}\right]}$$

$$V_{rms} = \sqrt{\frac{25}{2\pi}} = 47.7\,V$$

Q. A delayed full wave rectified sinusoidal current has an avg. value equal to half its max. value. Find the delay angle θ

Sol^n: Given, $I_{avg} = \frac{I_m}{2}$



$$I_{avg} = \frac{1}{\pi}\int_{\theta}^{\pi} I_m \sin\theta \, d\theta$$

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

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

It is given that,

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

Now,

$$\frac{\cancel{I_m}}{2} = \frac{\cancel{I_m}}{\pi}\left[-\cos\pi + \cos\theta\right]$$

$$\frac{\pi}{2} - \frac{1}{1} = \cos\theta$$

$$\frac{\pi - 2}{2} = \cos\theta$$

$$\theta = \cos^{-1}\left(\frac{1.14}{2}\right)$$

$$\boxed{\therefore \theta = 55.25^\circ}$$

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