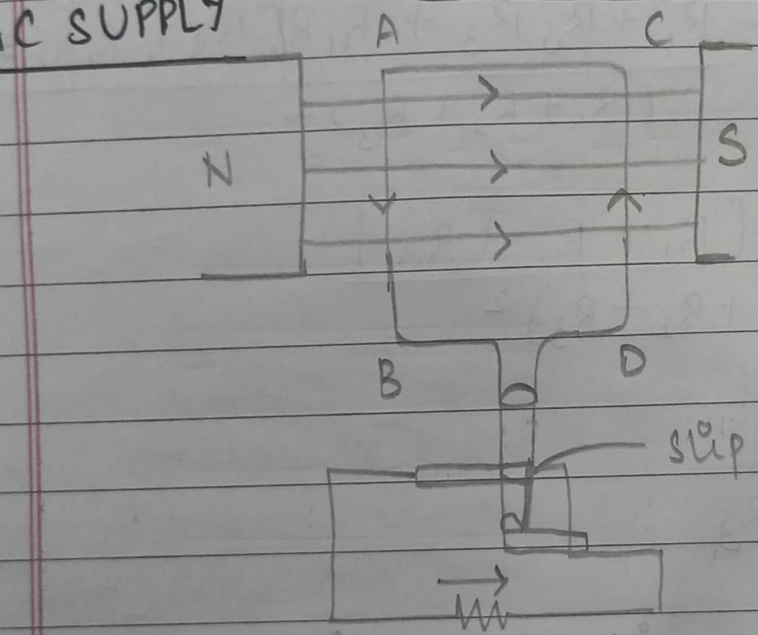
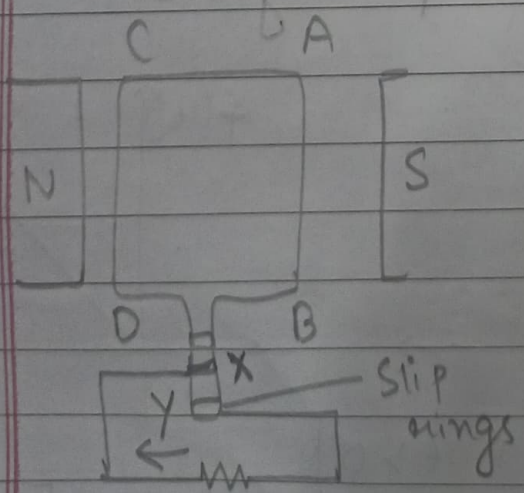
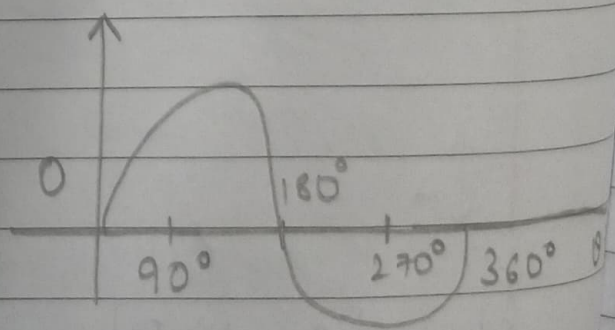
A.C. Fundamentals

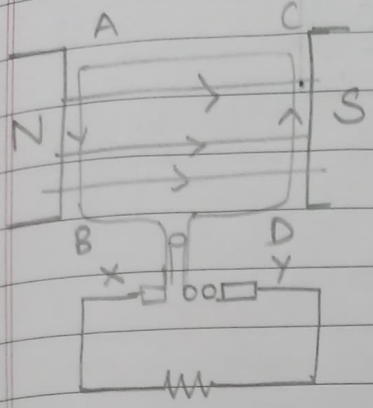
(1) AC SUPPLY

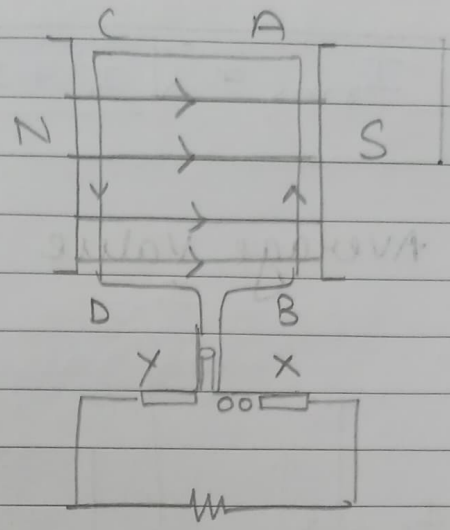


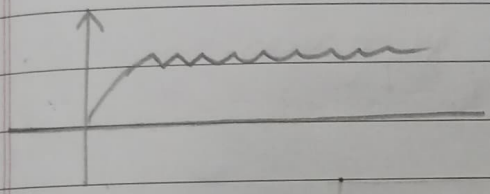




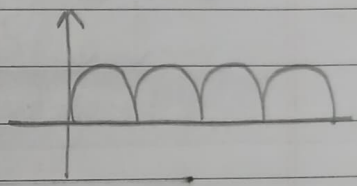
② DC SUPPLY

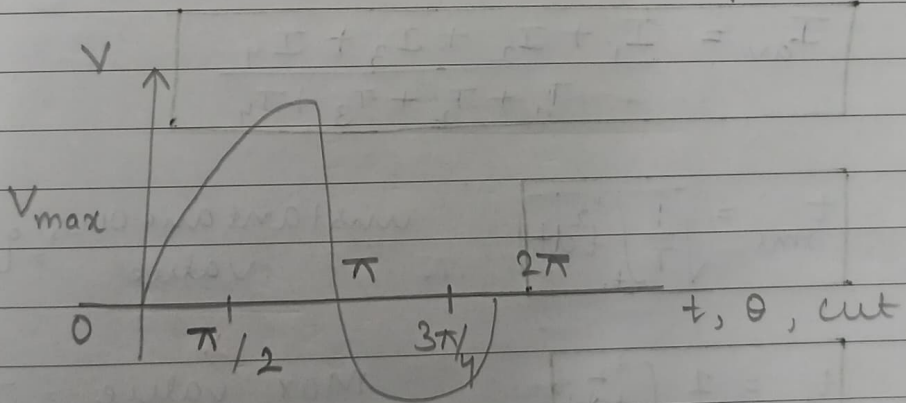






Curve

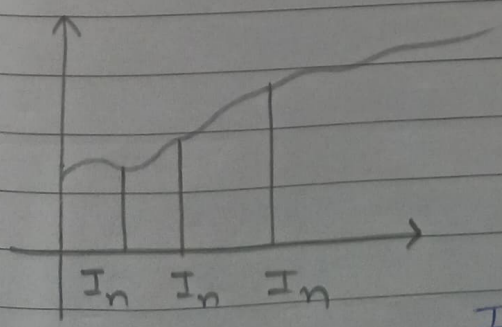




instantaneous value = v

max voltage = V_{max}

R.M.S → Root mean square value



$$I^2RT = I_1^2R\,T/n + I^2R\,T/n + \dots$$

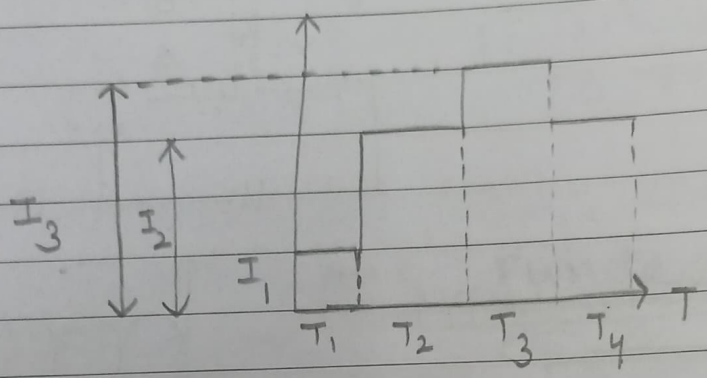
$$\dots + I_n^2\,R/T_n$$

$$I^2RT = \frac{RT}{n}\left[I_1^2 + I_2^2 + \dots + I_n^2\right]$$

R.H.S. Value

$$I_{rms} = \sqrt{\frac{I_1^2 + I_2^2 + \dots + I_n^2}{n}}$$

Average Value



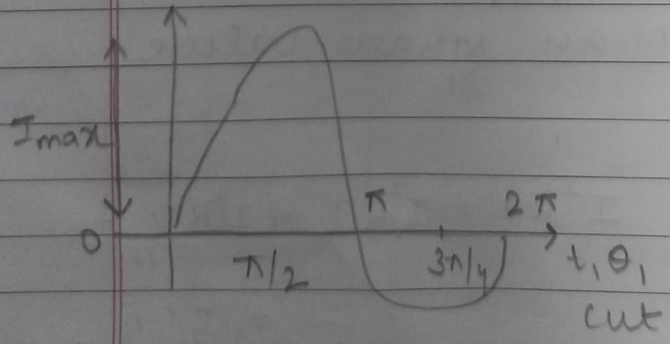
$$I_{av} = \frac{I_1 + I_2 + I_3 + I_4}{T_1 + T_2 + T_3 + T_4}$$

$$t_{rms} = \sqrt{\frac{1}{T}\int_{t_1}^{t_2} t\,dt}$$

instantaneous value = t

$$t_{avg} = \frac{1}{T}\int_{t_1}^{t_2} t\,dt$$

Max. value = I_{max}



$$I_{rms} = \sqrt{\frac{1}{\pi}\int_0^{\pi} [i]^2\, d_{cut}}$$

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

$$= I_{max} \sqrt{\frac{1}{\pi}}$$

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

$$I_{rms} \Rightarrow I_{max} \sqrt{\frac{1}{2\pi} \int_0^{\pi} (1 - \cos 2\omega t) \, d\omega t}$$

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

$$I_{max} = \sqrt{\frac{1}{2\pi} \int_0^{\pi} d\omega t - \frac{\sin 2\omega t}{2} \times d\omega t}$$

$$\cos 2\omega t = 1 - \sin^2 \omega t$$

$$\sin^2 \omega t = \frac{1 - \cos 2\omega t}{2}$$

$$I_{avg} = \frac{1}{\pi} \int_0^{\pi} [i] \, d\omega t$$

$$= \frac{1}{\pi} \int_0^{\pi} I_{max} \sin \omega t \, d\omega t$$

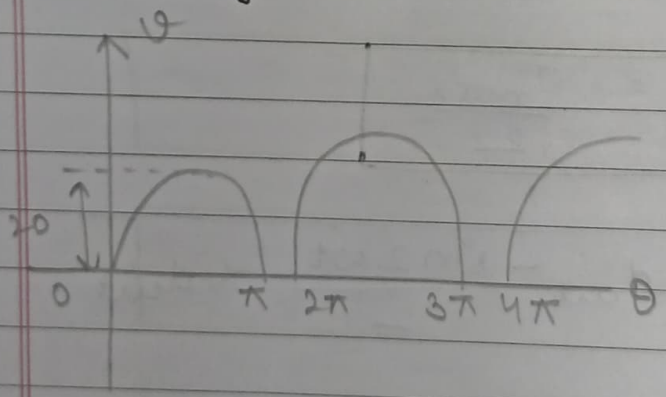
$$\cos \omega t = 1 - \sin^2 \omega t$$

$$\sin^2 \omega t = \frac{1 - \cos 2\omega t}{2}$$

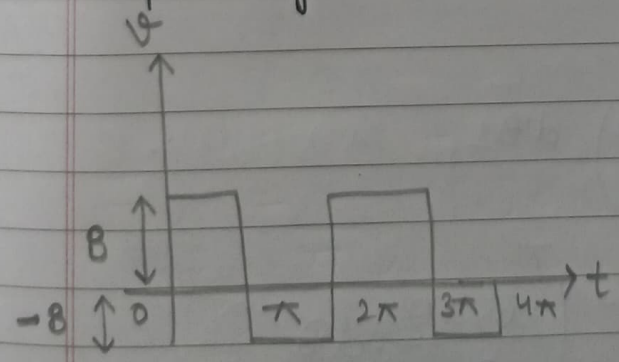
Form factor : $K_f = \frac{\text{R.M.S value}}{\text{Avg. value}} \Rightarrow \frac{\frac{I_{rms}}{\sqrt{2}}}{\frac{2I_{max}}{\pi}} = 1.11$

Peak factor : $K_p = \frac{\text{Max. value}}{\text{R.M.S value}} = \frac{I_{max}}{\frac{I_{max}}{\sqrt{2}}} = 1.41$

Q Find the rms value, average value, form factor, peak factor of given waveform.



(2) Find rms value, avg. value, form factor peak factor.



$f(t) = 8$

$$V_{rms} = \sqrt{\frac{1}{\pi} 64 \int_0^{\pi} dt}$$

$$= \sqrt{\frac{64}{\pi} (\pi - 0)}$$

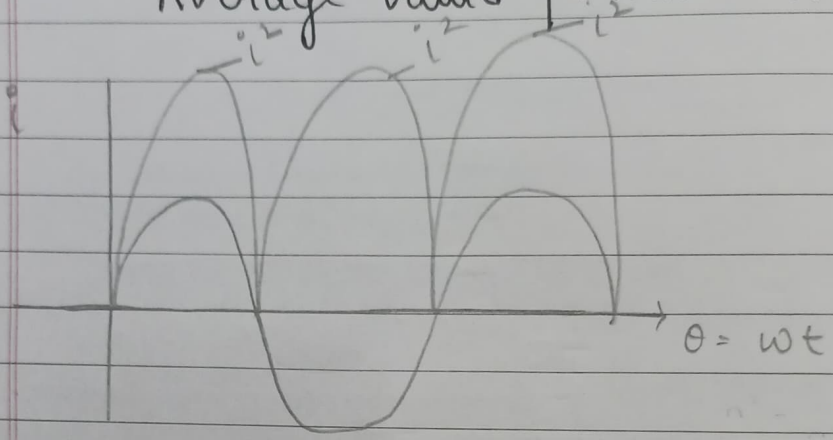
$$\boxed{V_{rms} = 8 \text{ volt}}$$

$$V_{avg} = \frac{8(\pi - 0)}{\pi} \Rightarrow 8 \text{ volt}$$

$$K_f = \frac{8}{8} = 1$$

$$K_p = 8/8 = 1$$

Average value / Mean Value :-



$$i = I_m \sin \omega t$$

$$i = I_m \sin \theta$$

$$i_{ms} = \int_0^{\pi} \frac{i^2 \cdot d\theta}{\pi} = \int_0^{\pi} \frac{(I_m \sin\theta)^2 \cdot d\theta}{2}$$

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

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

$$\frac{I_m^2}{\pi} \left[\int_0^{\pi} \frac{1}{2} \cdot d\theta - \int_0^{\pi} \frac{\cos 2\theta}{2} \cdot d\theta \right.$$

$$\frac{I_m^2}{\pi} \left| \frac{\theta}{2} \right|_0^{\pi} = \frac{I_m^2}{\pi} \frac{(\pi - 0)}{2}$$

$$\cos 2\theta = 1 - 2\sin^2\theta$$

$$2\sin^2\theta = 1 - \cos 2\theta$$

$$\sin^2\theta = \frac{1 - \cos 2\theta}{2}$$

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

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

$$= 0.707\, I_m \quad = 70.7\%\ \text{of}\ I_m$$

$$i = I_m \sin \omega t$$

Q $i = 5 \sin 314t$

Find $i_{av} = ?$

$i_{rms} = ?$

$I_{max} = ?$

$T = ?$

$f = ?$

angular frequency $= ?$

Ans

(i) $$i_{avg} = \frac{2I_m}{\pi} = \frac{2 \times 5}{\pi} = \frac{10}{\pi} = 3.18\ A$$

(ii) $$i_{rms} = \frac{I_m}{\sqrt{2}} = \frac{5}{\sqrt{2}} = 3.54\ A$$

(iii) $I_m = 5A$

$\omega = 314$ rad/s

(iv) $2\pi f = 314$

$2 \times 3.14 f = 314$

$f = \frac{100}{2} = 50 Hz$

(v) $T = \frac{1}{f} = \frac{1}{50} = 0.028 sec$

(vi) angular freq $= \frac{2\pi}{T}$

$= \frac{2 \times \frac{22}{7}}{0.02} = \frac{6.28}{0.02}$

$= 314$ rad/sec

$i = I_{max} \sin \omega t$

$i = I_{max} \sin t$

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

$\Rightarrow$ $I_m \sin(\omega t + \theta)$ (lack) $I_m \sin(\omega t - \theta)$ (lead)

Q $i = 10 \sin 314t$

Calculate the instantaneous value at $t = 10$ secs max value, R.M.S value, Average value, K_f, K_p

Ans

$I_m = 10$

$\sin(\omega t + \theta) = \sin 314 \times 10$

$= \sin 3140$

$= -0.9976$

$i = I_{max} \sin \omega t$

$= 10 \times \sin 314 \times 10$

$= 10 \times (-0.99)$

$\boxed{i = -9.9\ A}$

Q

$i_1 = 10 \sin 314t$

$i_2 = 20 \sin\left(314t + \frac{\pi}{2}\right)$

$i_3 = -50 \sin\left(314t - \frac{3\pi}{4}\right)$

$i_x = 10(\cos 0) + 20\cos(\pi/2) - 50\cos(-3\pi/4)$

$=$

$i_y = 10 \sin 0^\circ + 20 \sin\left(\frac{\pi}{2}\right) - 50 \sin\left(\frac{-3\pi}{4}\right)$

$i_x = 10 \times 1 + 20 \times 0 - 50(-0.707)$

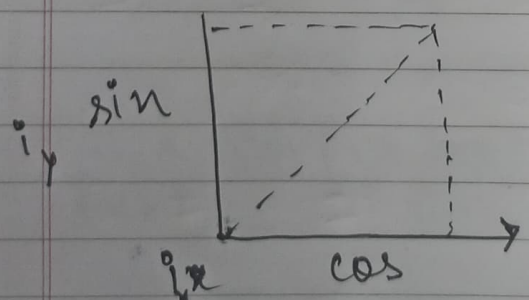
$= 10 + 0 + 35.35$

$= 45.35$

$i_y = 10 \times 0 + 20 \times 1 - 50 \times (-0.707)$

$= 20 + 35.35$

$= 55.35$



$$i_R = \sqrt{i_x^2 + i_y^2}$$

$$i_R = \sqrt{2056.62 + 3063.62}$$

$$= \sqrt{5120.24} = 71.55$$

$$\tan\theta = \left(\frac{i_y}{i_x}\right) = 1.220$$

$$\theta = \tan^{-1}\left(\frac{i_y}{i_x}\right)$$

$$= \tan^{-1}(1.22)$$

$$= 50.65^\circ$$

$$\boxed{i_y = I_r \sin(\omega t \pm \theta)}$$

$$i_y = 71.5 \sin(314t + 50.65)$$

Q Find the instantaneous value, rms value, avg value, form factor, peak factor of K_f, K_p of the net current in a circuit which having the currents

$$i_1 = 20 \sin(314t + \pi/2)$$

$$i_2 = 25 \cos(314t)$$

$$i_3 = -5 \sin(314t)$$

Ans

$$i_x = 20 \cos\left(\frac{\pi}{2}\right) + 25 \cos 0 - 5 \cos(0)$$

$$= 20 \times 0 + 25 \times 1 - 5 \times 1$$

$$= 25 - 5 = 20$$

$$i_y = 20 \sin(\pi/2) + 25 \sin 0 - 5 \sin(0)$$

$\Rightarrow 20 \times 1 + 25 \times 0 - 5 \times 0$

$\therefore \Rightarrow 20$

$$\dot{i}_R = \sqrt{400 + 400}$$

$$= \sqrt{800}$$

$$= 28.28$$

$$\tan\theta = \left(\frac{20}{20}\right) = 1$$

$$\boxed{\theta = 45^\circ}$$

$$\tan^{-1}\left(\frac{20}{20}\right) \Rightarrow \tan^{-1} 1$$

$$\Rightarrow 45^\circ$$

$\Rightarrow I_R = I_R \sin(\omega t \pm \theta)$

$= 28.28 \sin(314t + 45)$

$= 28.28 \sin(314 \times 20 + 45)$

$= 28.28 \sin(6280 + 45)$

$= 28.28 \sin(6325)$

$= 28.28 \times -0.422$

$= -11.93$

$$I_{rms} = 0.707 \times I_{max}$$
$$= 0.707 \times 28.28$$
$$= 19.99$$

$$I_{avg} = 0.637 \times I_{max}$$
$$= 0.637 \times 28.28$$
$$= 18.01$$

$$K_f = \frac{19.99}{18.01} = 1.1099$$

$$K_p = \frac{28.28}{19.99} = 1.41$$