# Assignment - 2

Ashwani kr. Chaudhary
[BCT-A] 019

Q(1) An alternating current of sinusoidal wave form has an rms value of 10 A. What is the maximum value of the current?

=> Solⁿ,

Here, $V_{rms} = 10\,A$

$$V_{rms} = \frac{V_0}{\sqrt{2}}$$

$$\therefore V_0 = V_{rms} \times \sqrt{2}$$
$$= 10\sqrt{2}$$
$$= 14.142\,A$$

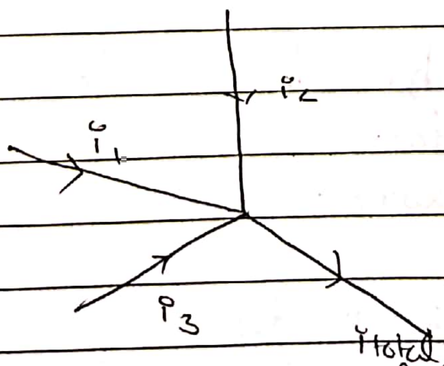
(2) The following three sinusoidal current flow into junction

=> Here,

Solⁿ.

$$i_1 = 3\sqrt{2}\sin(\omega t)$$
$$i_2 = 5\sqrt{2}\sin(\omega t + 30°)$$
$$i_3 = 6\sqrt{2}\sin(\omega t - 120°)$$

Here,




writing eqⁿ in polar form

$$i_1 = 3\sqrt{2}\angle 0$$
$$i_2 = 5\sqrt{2}\angle 30°$$
$$i_3 = 6\sqrt{2}\angle -120°$$

$i_{total} = i_1 + i_2 + i_3$

$= 3\sqrt{2}\,(\cos 0 + i\sin 0) + 5\sqrt{2}\,(\cos 30^\circ + i\sin 30) +$

$6\sqrt{2}\,(\cos 120^\circ - i\sin 120^\circ)$

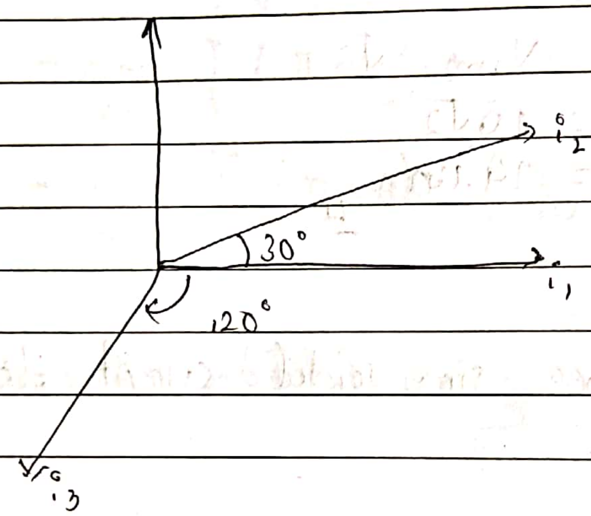
$= 6.123 - 3.8\,i$

Now $\phi = -31.824$

again

$i_{total} = \sqrt{6.123^2 + 3.8^2} = 7.206$

Now, $i_{total} = 7.21\sin(\omega t - 31.824)$




(Q.4) If $v = 14.14\sin(\omega t + 30)\,V$ & $i = 11.31\sin(\omega t - 30)A$. Find.

a) Maximum value of each

=> ans

$V_{max} = 14.14V$

$I_{max} = 11.31A$

b) The rms value of each

=> ans $V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{14.14}{\sqrt{2}}$

$= 9.994$

(c) $I_{rms} = \frac{I_0}{\sqrt{2}} = \frac{11.31}{\sqrt{2}} = 7.99 V$

(d) The phasor expression in polar & rectangle form

=> ans,

In polar form

$V_1 = 14.14 (\cos 30 + i\sin 30^\circ)$

$\Rightarrow 14.14 \angle 30^\circ$

$I = 11.31 (\cos 30 \cancel{+} i\sin 30)$

$\Rightarrow 11.31 \angle -30^\circ$

Now, in Rectangular form

$V = 14.14 \cos 30^\circ + 14.14 \times i\sin 30^\circ = 12.24 + i\,7.07$

$I = 11.31 \cos 30 - i\,11.31 \times \sin 30 = 9.7 - 5.55i$

Q.5) Find the time taken for a sinusoidal alternating current of maximum value of 20A to reach 15A the first time of the current state from zero. The supply frequency is 40 Hz.

=> Soln,

eqn of current is (from zero)

$I = I_0 \sin wt$

so, $I = 20 \sin wt$

Now,

let at $t = t_1 \Rightarrow I = 15A$

so,

$15 = 20 \sin wt_1$

$\sin wt_1 = 15/20$

Date
Page

$\Rightarrow \omega t_1 = 15/20$

$\Rightarrow \omega t_1 = \sin^{-1}(15/20)$

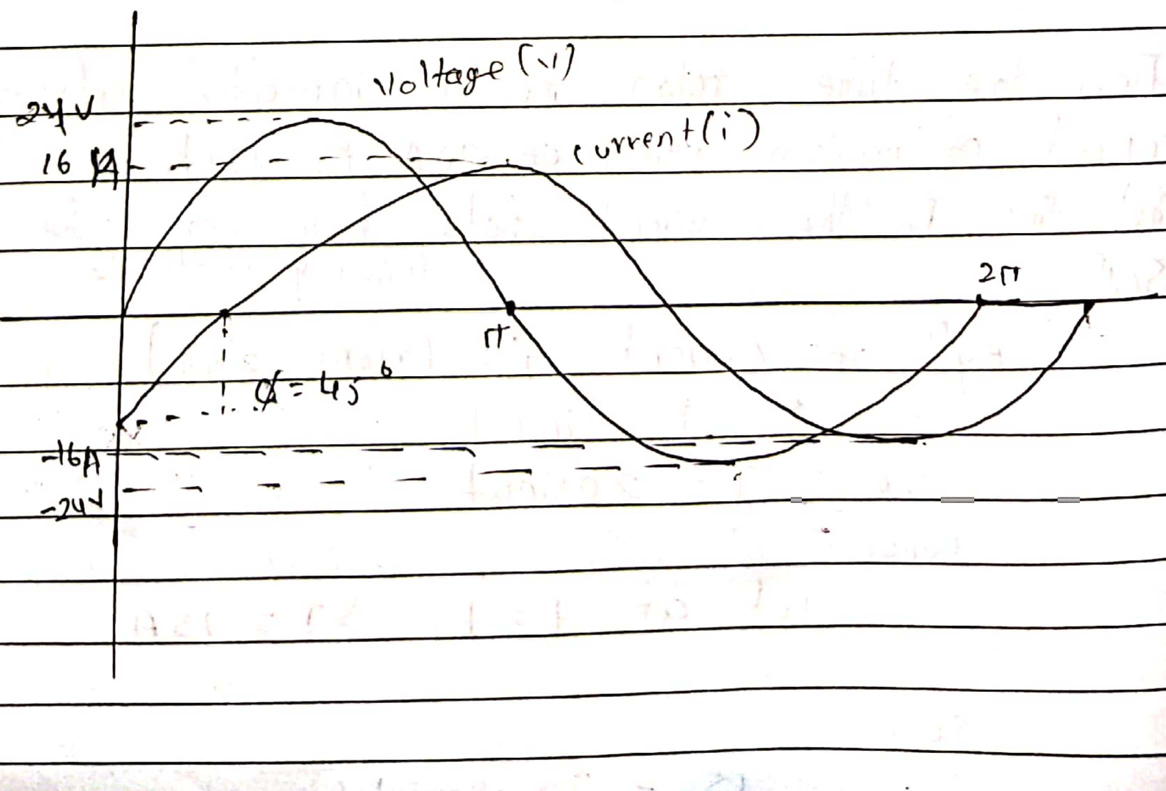
$\Rightarrow 2\pi f t_1 = 48.59°$

$\Rightarrow t_1 = \frac{48.59°}{2\pi f} = \frac{48.59°}{2\times\pi\times 40}$

$= \frac{48.59 \times \pi/180}{2\pi \times 40}$

$= 3.37$ milisecond #

Q6) A sinusoidal alternating voltage of peak value 24 V is applied to a circuit resulting a current of maximum 16 A. The current is also sinusoidal and lags the voltage by 45°. Draw the voltage & current waveform in proper phase relationship over 1 complete cycle



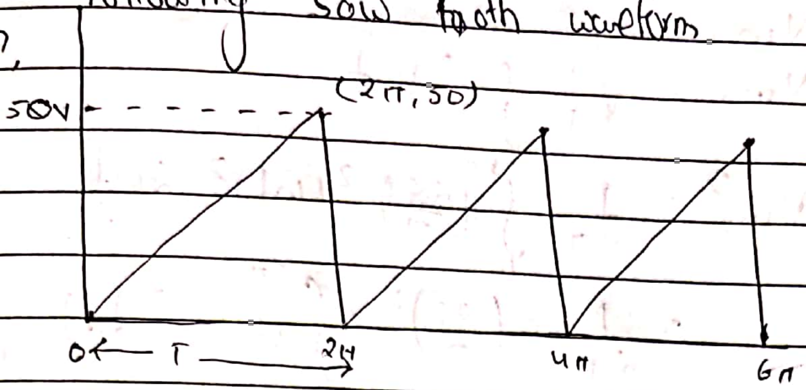
classmate

Date

Page

Q7) Calculate the average, rms value, form factor & peak factor for the following saw tooth waveform

$\Rightarrow$ Sol$^n$,




for average value

$$y - 0 = \frac{50 - 0}{2\pi - 0}(x - 0)$$

$$y = \frac{50}{2\pi} x$$

$$y = \frac{25}{\pi} x$$

$$y = \frac{25}{\pi} \omega t$$

now

$$V_{avg} = \frac{1}{T}\int_0^{2\pi} v \, d\omega t$$

$$= \frac{1}{2\pi}\int_0^{2\pi}\left(\frac{25}{\pi}\omega t\right) d\omega t$$

$$= \frac{1}{2\pi} \times \frac{25}{\pi}\int_0^{2\pi} \omega t \, d\omega t$$

$$= \frac{1}{2\pi} \times \frac{25}{\pi}\left[\frac{\omega t^2}{2}\right]_0^{2\pi}$$

$$= \frac{1}{2\pi} \times \frac{25}{\pi}\left[\frac{(2\pi)^2}{2} - 0\right]$$

$$= \frac{25}{\cancel{2\pi^2}} \times \frac{\cancel{4}\pi^2}{2}$$

$$V_{avg} = 25\,V$$

Scanned with CamScanner

Now,

for $V_{rms}$

$$V_{rms} = \sqrt{\frac{1}{T}\int v^2 \, d\omega t}$$

$$V_{rms}^2 = \frac{1}{2\pi}\int_0^{2\pi}\left(\frac{25}{\pi}\right)^2(\omega t)^2 \, d\omega t$$

$$= \frac{1}{2\pi} \times \left(\frac{25}{\pi}\right)^2 \times \int_0^{2\pi}(\omega t)^2 \, d\omega t$$

$$= \frac{1}{2\pi}\left(\frac{25}{\pi}\right)^2 \times \left[\frac{(\omega t)^3}{3}\right]_0^{2\pi}$$

$$= \frac{1}{2\pi} \times \left(\frac{25}{\pi}\right)^2 \times \frac{(2\pi)^3}{3}$$

$$= \cancel{\frac{(25)^2 \times 2\pi^3}{2\pi^3 \times 3}} = \frac{(25)^2 \times 8 \times \pi^3}{2\pi^3 \times 3}$$

$$= \cancel{25^2} = \frac{(50)^2}{3}$$

$$V_{rms}^2 = \frac{(50)^2}{3}$$

$$V_{rms} = \frac{50}{\sqrt{3}} = 28.86 \text{ V.}$$

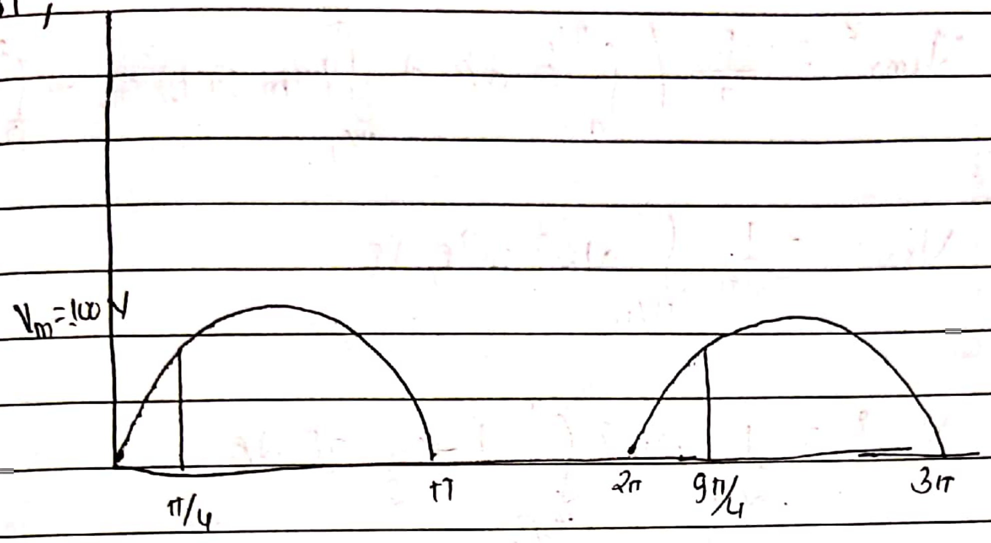
Now,

$$\text{form factor} = \frac{V_{rms}}{V_{avg}} = \frac{28.86}{25} = 1.15 \text{ Ans}$$

$$\text{peak factor} = \frac{V_{max}}{V_{rms}} = \frac{50}{28.86} = 1.76 \text{ Ans}$$

Q (2) Determine the average & rms value of the voltage for sinusoidal voltage waveform as shown below.

⇒ Soln;




Here

The figure / wave form is periodic at a interval on $2\pi$ ie symmetric so, we have,

Here

$V = 0 \quad (0 < \theta < \pi/4)$

$V = V_m \sin\theta \quad (\pi/4 < \theta < \pi)$

$V = 0 \quad (\pi < \theta < 2\pi)$

Now,

$$V_{avg} = \frac{1}{T}\left[\int_0^{\pi/4} 0\,d\theta + \int_{\pi/4}^{\pi} V_m \sin\theta\,d\theta + \int_{\pi}^{2\pi} 0\,d\theta\right]$$

$$= \frac{1}{2\pi} V_m \left[-\cos\theta\right]_{\pi/4}^{\pi}$$

$$= \frac{-1}{2\pi} V_m \left(\cos\pi - \cos\pi/4\right)$$

$$= \cancel{\frac{-1}{2\pi}\, 100 (\cos\pi} = \frac{1}{2\pi} \times 100 \times 1.7$$

$$= 27.12\,V.$$

Scanned with CamScanner

Now,

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^T v^2\, d\theta}$$

$$V_{rms}^2 = \frac{1}{T}\left(\int_0^{\pi/4} 0^2 d\theta + \int_{\pi/4}^{\pi}(V_m \sin\theta)^2 d\theta + \int_{\pi}^{2\pi} 0\, d\theta\right)$$

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

$$V_{rms}^2 = \frac{1}{2\pi} \times V_m^2 \int_{\pi/4}^{\pi} \frac{1-\cos 2\theta}{2}\, d\theta$$

$$V_{rms}^2 = \frac{1}{2\pi} \times V_m^2 \left[\int_{\pi/4}^{\pi} \frac{1}{2}\, d\theta - \int_{\pi/4}^{\pi} \frac{\cos 2\theta}{2}\, d\theta\right]$$

$$V_{rms}^2 = \frac{1}{2\pi} \times V_m^2 \left\{\frac{1}{2}\left[\theta\right]_{\pi/4}^{\pi} - \frac{1}{4}\left[\sin 2\theta\right]_{\pi/4}^{\pi}\right\}$$

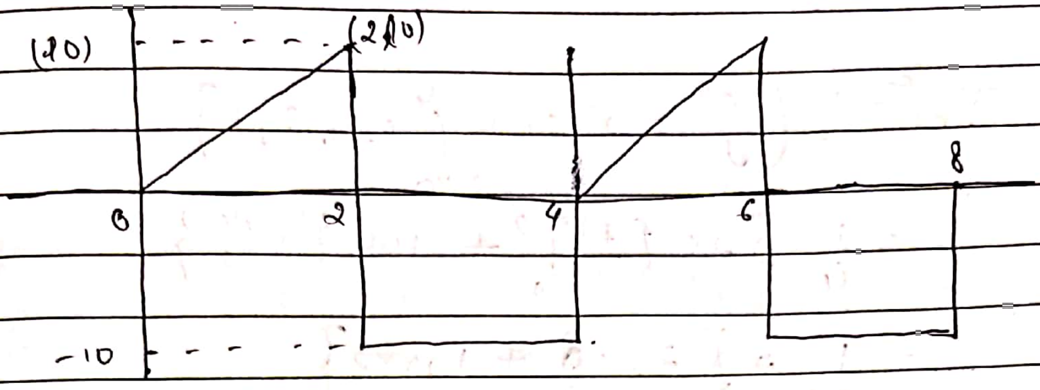
$$V_{rms}^2 = \frac{1}{2\pi} \times V_m^2 \left\{\frac{1}{2}\left(\pi - \pi/4\right) - \frac{1}{4}\left(\sin 2\pi - \sin\frac{\pi}{4}\right)\right\}$$

$$V_{rms}^2 = \frac{1}{2\pi} V_m^2 \left(\frac{1}{2} \times \frac{3\pi}{4} + \frac{1}{4} \times\right]$$

$$V_{rms}^2 = \frac{1}{2\pi} \times 100^2 \times 1.42$$

$$V_{rms} = \sqrt{2260} = 47.53\ V \text{ ans}$$

Q.N.9) Determine the average & rms value of current for current waveform as show below.




Here,

$$y-0 = \frac{10-0}{2-0}(x-0)$$

$$y = 5x$$

$$y_1 = 5t \quad (0<t<2)$$

also,

$$y_2 = -10 \quad (2<t<4)$$

Now,

$$I_{avg} = \frac{1}{T}\int_0^T I\,dt$$

$$= \frac{1}{4}\left[\int_0^2 5t\,dt + \int_2^4 -10\,dt\right]$$

$$= \frac{1}{4}\left\{5\left[\frac{t^2}{2}\right]_0^2 + (-10)\left[t\right]_2^4\right\}$$

$$= \frac{1}{4}\left\{5\left[\frac{4}{2}\right] + (-10)\left[4-2\right]\right\}$$

$$= \frac{1}{4}\left[10-20\right]$$

$$= -10/4$$

$$= -2.5\text{ A.}$$

Now,

$$I_{rms} = \sqrt{\frac{1}{T}\int_0^T i^2\,dt}$$

$$I_{rms}^2 = \frac{1}{4}\left\{\int_0^2 25t^2\,dt + \int_0^4 (-10)^2\,dt\right\}$$

$$= \frac{1}{4}\left\{25\left[\frac{t^3}{3}\right]_0^2 + 100\left[t\right]_2^4\right\}$$

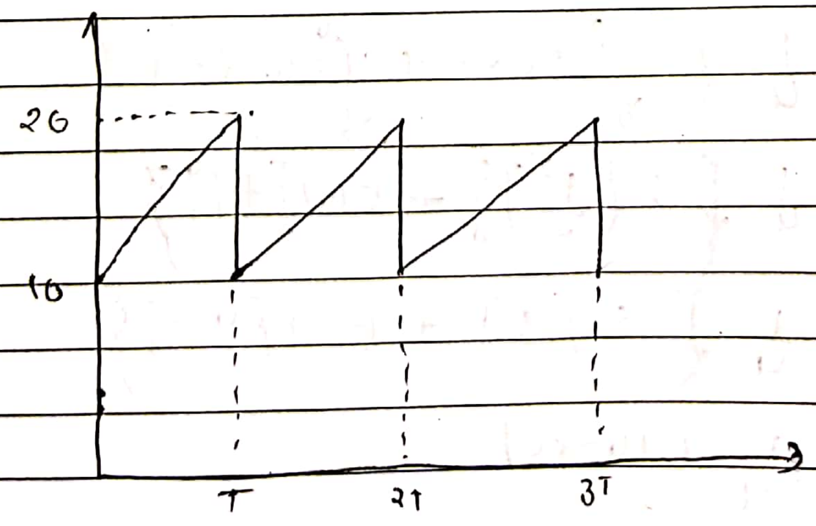
$$= \frac{1}{4} \times \left\{25 \times \frac{8}{3} + 100 \times 2\right\}$$

$$= 66.66$$

$$I_{rms} = \sqrt{66.66}$$

$$I_{rms} = 8.16\,A$$

Q.10) Calculate the average, rms value, form factor & peak factor of the following wave form.




Here,

the waveform is periodic at an interval of T, so, avg is defined for time T. So.

$(0,10) = (x_1, y_1)$
$(T, 20) = (x_2, y_2)$

$$y - 10 = \frac{20-10}{T-0}(x-0)$$

$$y - 10 = \frac{10x}{T}$$

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

Now,

$$V_{avg} = \frac{1}{T}\left[\int_0^T \left(\frac{10t}{T} + 10\right) dt\right]$$

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

$$= \frac{1}{T}\left[\frac{5T^2}{T} + 10T\right]$$

$$= \cancel{\frac{1}{T}\left[\frac{5T^2}{T}\right.} \quad \frac{15T}{T}$$

$$= 15\text{V}.$$

$$V_{rms} = \sqrt{\frac{1}{T}\int_0^t v^2 dt}$$

$$(V_{rms})^2 = \frac{1}{T}\int_0^T \left(\frac{10t}{T} + 10\right)^2 dt$$

$$= \frac{1}{T}\left[\int_0^T \frac{100t^2}{T^2} + \frac{200t}{T} + 100\right) dt$$

$$= \frac{1}{T}\left[\int_0^T \frac{100t^2}{T^2} dt + \int_0^T \frac{200t}{T} dt + \int_0^T 100 dt\right]$$

$$= \frac{1}{T}\left\{\frac{100}{T^2} \times \left[\frac{t^3}{3}\right]_0^T + \frac{200}{T}\left[\frac{t^2}{2}\right]_0^T + 100\left[t - 0\right]\right\}$$

$$= \frac{1}{T}\left[\frac{100}{\cancel{T^2}} \times \frac{T^{\cancel{3}}}{3} + \frac{\cancel{200}}{\cancel{T}} \times \frac{T^{\cancel{2}}}{\cancel{2}} + 100T\right]$$

$$= \frac{1}{T}\left[\frac{100T}{3} + 100T + 100T\right]$$

$$= \frac{100}{3} + 100 + 100$$

$$V_{rms}^2 = 233.33$$

$$V_{rms} = \sqrt{233.33} = 15.27V.$$

Now,

$$\text{form factor} = \frac{V_{rms}}{V_{avg}} = \frac{15.27}{15}$$

$$= 1.01$$

$$\text{Peak factor} = \frac{V_{max}}{V_{rms}} = \frac{20}{15.27}$$

$$= 1.309$$

Q.11) The $eq^n$ relating the current in a circuit with time is
$i = 141.\sin 377t$.

a) find the value of $I_{rms}$.

=> Here

$$i_o = 141.4$$

$$I_{rms} = \frac{I_0}{\sqrt{2}} = \frac{141.4}{\sqrt{2}} = 99.99A$$

b) frequency

=> Here

$$\omega t = 377t$$

$$\omega = 377$$

$$2\pi f = 377$$

$$f = \frac{377}{2\pi} = 592.19\ Hz$$ (In ans sheet it's wrong)

(c) Instantaneou value of the current I in 3 milisecond

=> Sol$^n$

$t = 3\times10^{-3}$ second

$i = 141.4 \sin 377 \times 3\times10^{-3}$

$= 2.79A$ (not equal to given ans)

Q(2) A sinusoidal voltage is applied to three parallel branches yielding branch current $i_1 = 14.14 \sin(\omega t - 45)$ $i_2 = 28.3 \cos(\omega t - 60°)$ & $i_3 = 7.07 \sin(\omega t + 60°)$. Find the complete time expression for the source current. Draw the phasor diagram in term of effective value

=> sol$^n$,

$i_1 = 14.14 \sin(\omega t - 45°)$

$i_2 = 28.3 \sin(\omega t - 60) = 28.3 \sin(\omega t + 30)$

$i_3 = 7.07 \sin(\omega t + 60)$

writing above eq$^n$ in rectangle form

$i_1 = 9.99 + i(-9.99)$

$= 9.99 - 9.99i$

$i_2 = 24.50 + i14.15$

$i_3 = 3.535 + i6.122$

now, adding above eq$^n$

$i = 9.99 - i9.99 + 24.5 + i14.15 + 3.535 + i6.122$

$= 28.025 + i10.282$

Scanned with CamScanner

also,

$$|i| = \sqrt{x^2+y^2} = \sqrt{(38.025)^2+(10.282)^2}$$

$$= 39.39$$

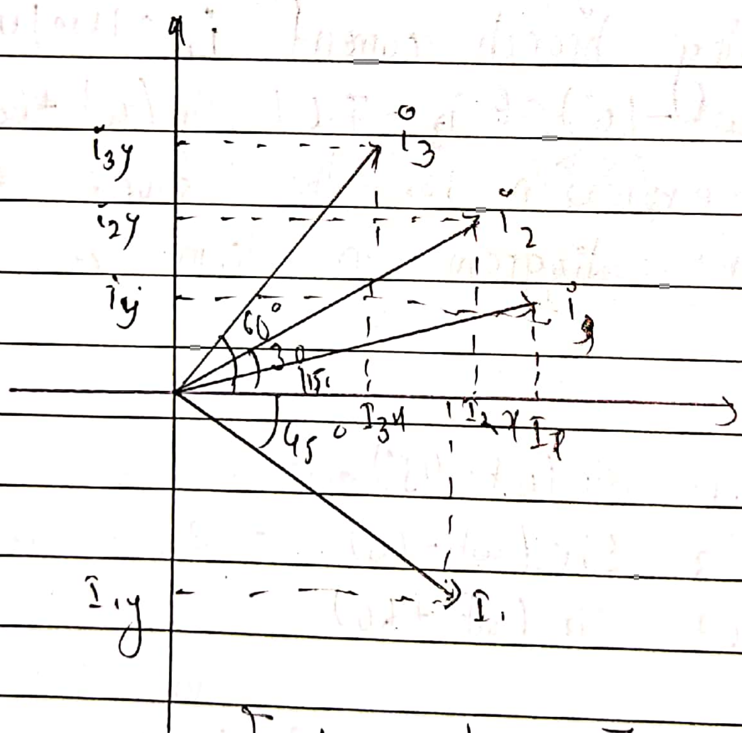
$$\phi = \tan^{-1}(y/x) = \tan^{-1}\left(\frac{10.282}{38.025}\right)$$

$$\phi = 15.13$$

so,

required $eq^n$ is

$$i = 39.4\sin(\omega t + 15.13)$$ #




[phasor diagram]

QN 3) If $V = 45\sqrt{2} - j45$, $Z_1 = 2.5\sqrt{2} - j2.5\sqrt{2}$, $Z_2 = 7.5 + j7.5$.

$\Rightarrow$ Sol$^n$,

$$V.Z_1 = (45\sqrt{2} - j45)(2.5\sqrt{2} - j2.5\sqrt{2})$$
$$= 65.9 - 384.09i$$

Now,

$$\frac{V.Z_1}{Z_2} = \frac{65.9 - 384.09i}{(7.5 + j7.5\sqrt{3})}$$
$$= -19.9 - 16.6i$$

$$\left|\frac{V.Z_1}{Z_2}\right| = 25.9$$

or

$$\left|\frac{V.Z_1}{Z_2}\right| = \frac{|V||Z_1|}{|Z_2|} = \frac{77.9 \times 5}{15}$$

$= 25.9$ (which is not equal to given ans)

Now,

$$\tan\phi = y/x$$
$$\phi = \tan^{-1}\left(\frac{-16.6}{-19.9}\right)$$
$$= 39.83$$

$25.9 < 39.83$ is the ans#