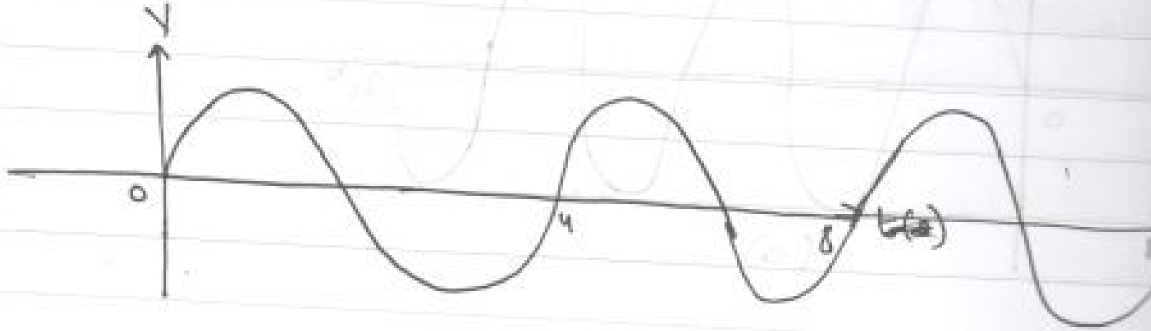
Day/Date Fri / 16-03-18

EXAMPLE #1:-



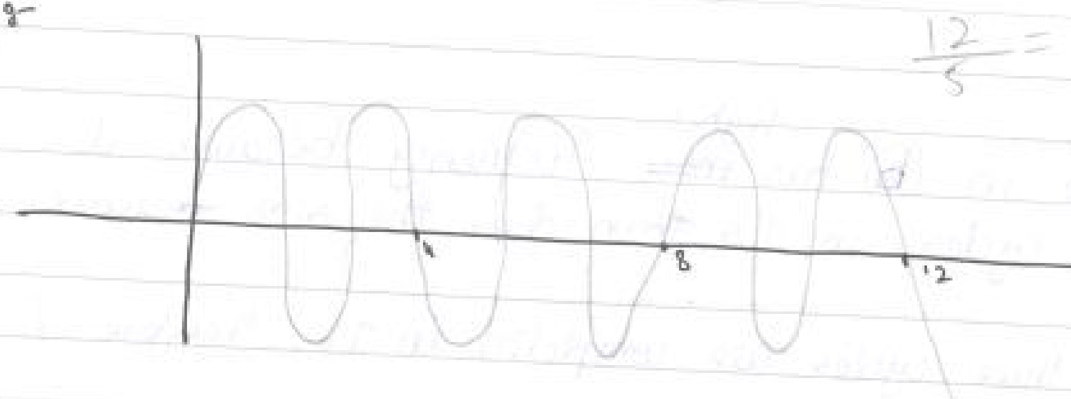
Sol:

It takes 4 seconds (4s) to complete each cycle. Therefo
the period is 4s.

$T = 4s.$

Q:- What is the period if the sine wave goes through fi
cycles in 12s?

A:-



$\frac{12}{5} =$

T = 12 s
5cycles

$T = \frac{12}{5} \Rightarrow 2.4$ secs

EXAMPLE #2:-

Which sine wave shown below has a higher frequency? Determine the frequency and the period of both waveforms.

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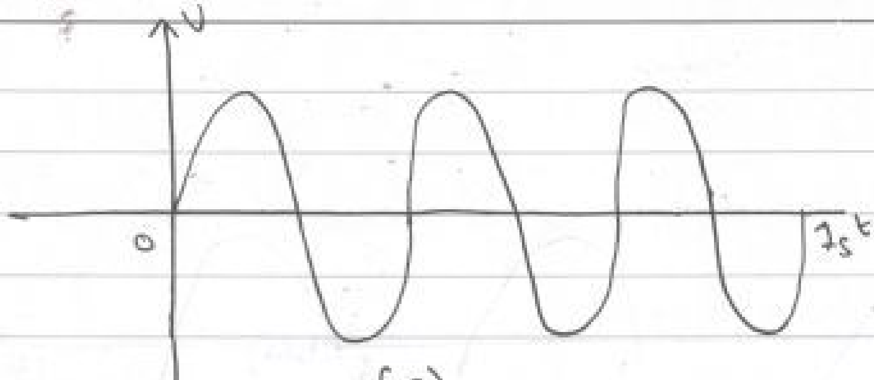
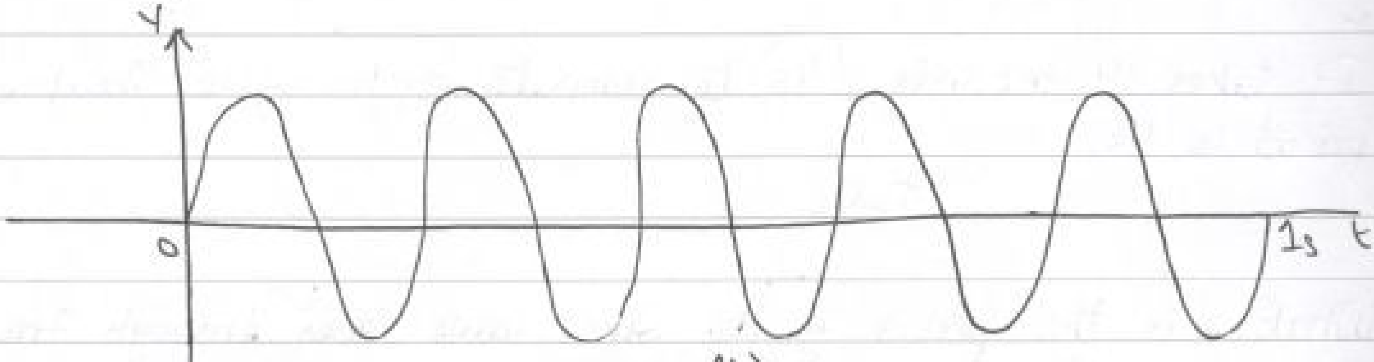


(a)



(b)

Sol:

→ The sine wave in (b) has ~~more~~ higher frequency because it completes more cycles in 1 s than does the sine wave in (a).

→ In fig (a), three cycles are completed in 1s; therefore

$$f = 3\,Hz$$

→ One cycle takes 0.333 s (one-third second), so the period is

$$T = \frac{1}{f} = \frac{1}{3} \Rightarrow 333\,ms$$

→ In fig (b), five cycles are completed in 1s; therefore

$$f = 5\,Hz$$

→ $$T = \frac{1}{f} = \frac{1}{5} \Rightarrow 200\,ms.$$

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EXAMPLE #3:-

A four-pole generator has a rotation speed of 100rps. Determine the frequency of the output voltage:-

Sol:

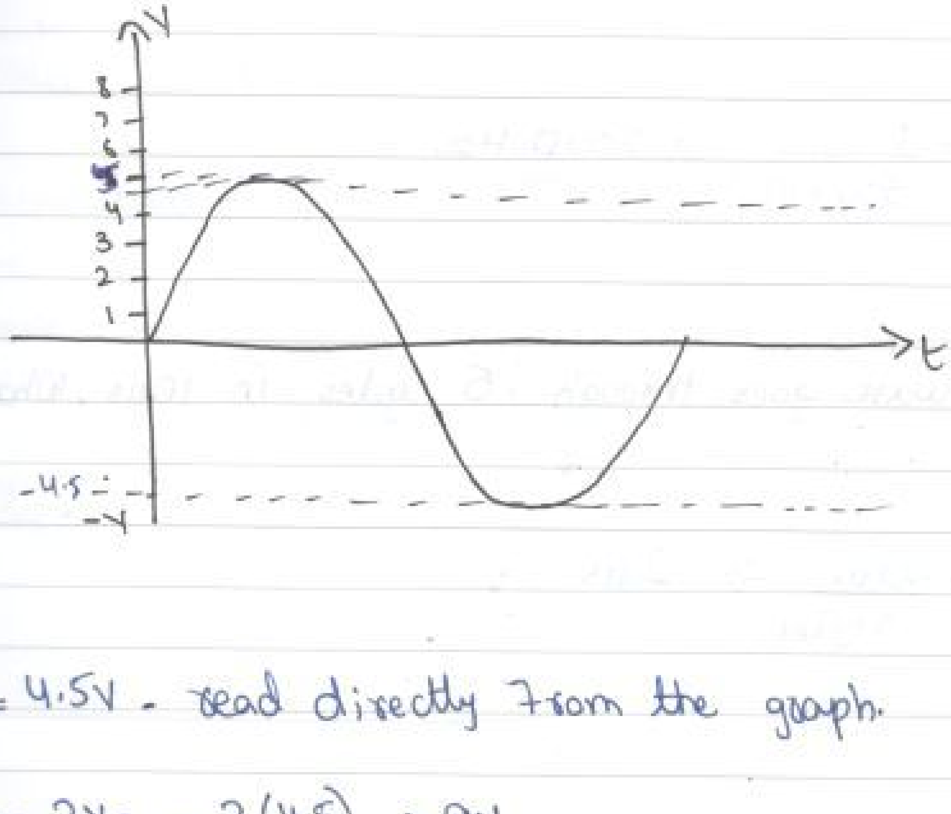
$f =$ (number of pole pairs) (rps)

~~= 2 (100) rps~~

$= 2(100\ rps) \Rightarrow 200Hz.$

EXAMPLE #4:-

Determine V_p, V_{pp}, V_{rms} and the half cycle V_{avg} for the sine wave shown below:



Sol:

$V_p = 4.5V$ - read directly from the graph.

$V_{pp} = 2V_p = 2(4.5) \Rightarrow 9V$

$V_{rms} = 0.707V_p = 0.707(4.5V) \Rightarrow 3.18V$

$V_{avg} = 0.637V_p = 0.637(4.5V) \Rightarrow 2.87V.$

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EXERCISE PROBLEMS

THE SINUSOIDAL WAVEFORMS

Q1:- Calculate the frequency for each of the following values of period:-

a) 0.2s

Sol:

$$F = \frac{1}{T}$$

$$= \frac{1}{0.2s} \Rightarrow 5Hz$$

$\longleftrightarrow$

b) 500 µs.

Sol:

$$f = \frac{1}{500 \times 10^{-6}} \Rightarrow 2000\ Hz.$$

Q2:- A sine wave goes through 5 cycles in 10µs. What is its period?

Sol:

$$T = \frac{10\,\mu s}{5\ cycles} \Rightarrow 2\,\mu s$$

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SINUSOIDAL VOLTAGE SOURCES:-

Q3:- The conductive loop on the rotor of a simple two-pole, single-phase generator rotates at a rate of 250rps. What is the frequency of the induced output voltage?

Sol:-

Two-pole single-phase

rate = 250 rps

f = ?

$f = 250 rps$ ans

As frequency is directly proportional to the rate of rotation. As it is single phase then one cycle is one revolution.

SINUSOIDAL VOLTAGE & CURRENT VALUES:-

Q4:- A sinusoidal current has an rms value of 5mA. Determine the following values:-

a) I_p, peak?

Sol:-

$I_{rms} = 5mA$

$I_p = ?$

$I_{rms} = 0.707 I_p$

$I_p = 1.414 I_{rms}$

$= 1.414 (5mA) \Rightarrow 7.07mA$

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b) $I_{avg} = ?$

Sol:-

$$I_{avg} = 0.637\, I_p$$

$$= 0.637(7.07mA) \Rightarrow 4.5\ mA$$, half cycle average value

c) $I_{pp} = ?$

Sol:-

$$I_{pp} = 2.828\, I_{rms}$$

$$= 2.828\ (5mA)$$

$$I_{pp} \Rightarrow 14.14\ mA$$

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LECTURE #2

EXAMPLE #1:

a) Convert 60° to radians.

SOL:

$$Rad = \left(\frac{\pi \, rad}{180°}\right) 60° \Rightarrow \frac{\pi}{3} rad$$

b) Convert $\pi/6$ to degrees.

SOL:

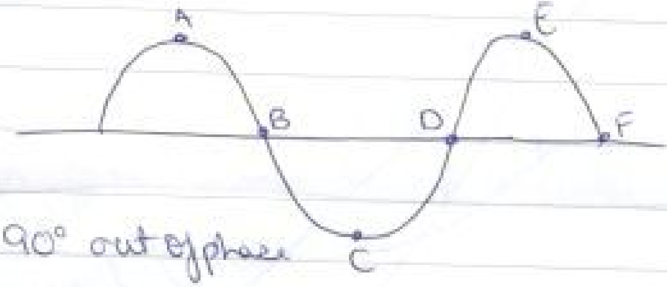
$$Degrees = \left(\frac{180°}{\pi \, rad}\right)\left(\frac{\pi}{6} rad\right) \Rightarrow 30°$$

Phase of a sine wave:

⇒ Phase: used to describe a specific location within a single wavelength.

⇒ wavelength: distance b/w two consecutive locations in phase.

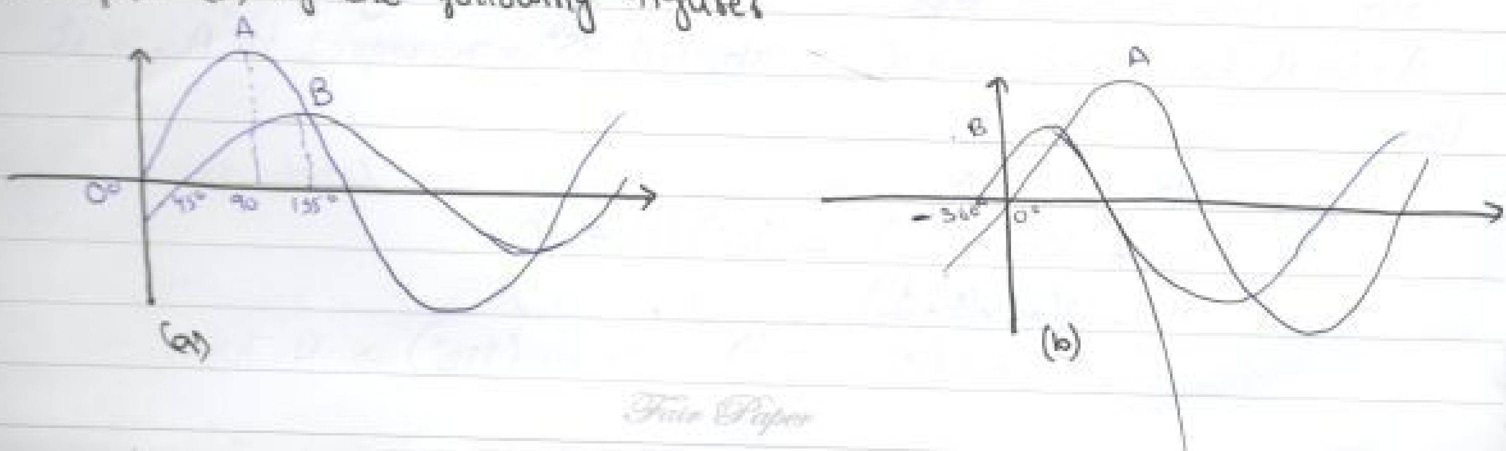
⇒ Example



A and B are 90° out of phase

EXAMPLE #2:

What are the phase angles between the two sine waves in part (a) and part (b) of the following figure?



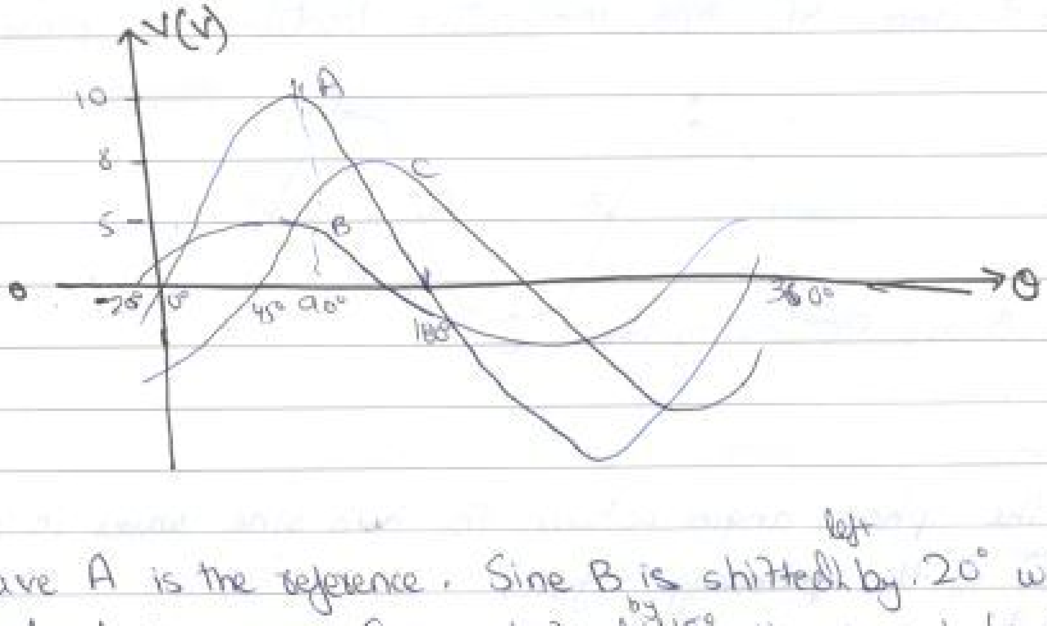
Solɾ

In figure (a) the zero crossing of sine wave A is at 0°, and the corresponding zero crossing of sine wave B is at 45°. There is a 45° phase angle between the two waveforms with sine wave B lagging sine wave A.

In figure (b), the zero crossing of sine wave B is at −30° and the corresponding zero crossing of sine wave A is at 0°. There is a 30° phase angle between the two waveforms with sine wave B leading sine wave A.

Example #3:

Determine the instantaneous value at the 90° reference point on the horizontal axis for each voltage sine wave shown below.



Sol-

Sine wave A is the reference. Sine B is shifted left by 20° with respect to A, so it leads. Sine wave C is shifted by 45° with respect to A, so it lags.

$$V_{(A)} = V_p \sin\theta$$
$$= 10\sin(90^\circ) = (10V)(1) \Rightarrow 10V$$
$$V_B = V_p \sin(\theta + \phi_B)$$
$$= 5V\sin(90^\circ + 20^\circ) = 5V\sin(110^\circ) \Rightarrow 4.70V$$

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$$V_C = V_P \sin(\theta - \phi_C)$$
$$= 8V \sin(90^\circ - 45^\circ) = 8V \sin(45^\circ) \Rightarrow 5.66V.$$

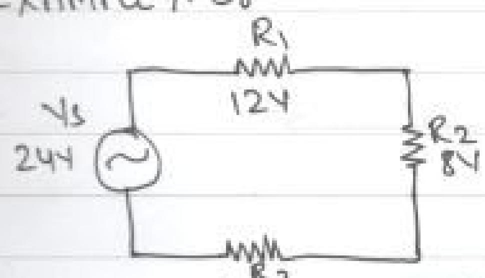
EXAMPLE #4:-

What is the value of a sinusoidal voltage at 3μs from the positive-going zero crossing when $V_p = 10V$ and $f = 50kHz$?

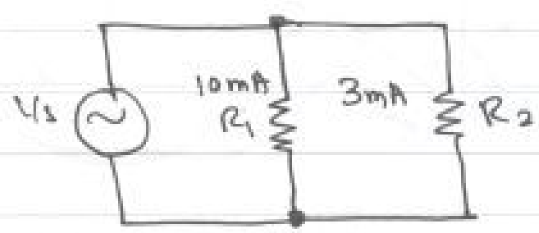
Sol:-

$$v = V_p \sin 2\pi f t$$
$$= 10V \sin(2\pi \times 50k\,Hz \times 3\times10^{-6}\,s) \Rightarrow 8.09V$$

EXAMPLE #5:-



(a)



(b)

a) Find the unknown peak voltage drop in fig(a):

Sol:-

$$V_s = V_1 + V_2 + V_3$$
$$V_{3(rms)} = V_{s(rms)} - V_{1(rms)} - V_{2(rms)}$$
$$= 24V - 12V - 8V \Rightarrow 4V$$
$$V_{3(p)} = 1.414\,V_{3(rms)}$$
$$= 1.414(4V) \Rightarrow 5.66V.$$

b) Find the total rms current in fig(b):

Sol:-

$$I_{total\,(rms)} = I_{1(rms)} + I_{2\,(rms)}$$
$$= 10mA + 3mA \Rightarrow 13\,mA$$

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c) Find the total power in fig (b) if $V_{rms} = 24V$.

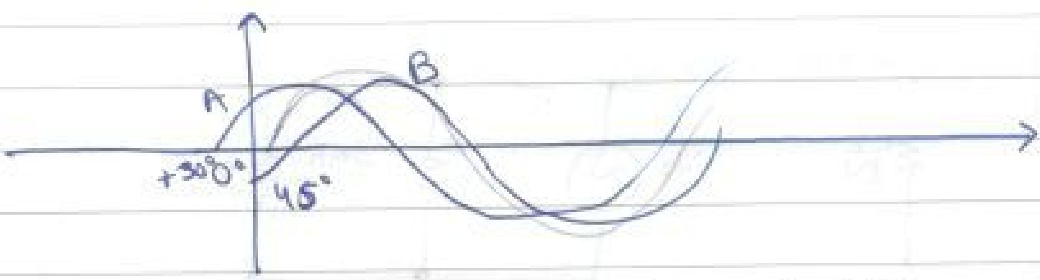
Sol:-

$$P_{total} = V_{rms} I_{rms}$$
$$= (24V)(13mA) \Rightarrow 312\ mW$$

EXERCISE PROBLEMS:-

Q1:- Sine wave A has a positive-going zero crossing at 30°. Sine wave B has a positive-going zero crossing at 45°. Determine the phase angle b/w the two signals. Which signal leads?

Sol:-



The zero crossing of sine wave A is at 30°.

" " " " " " B " " 45°

45 − 30 ⇒ 15°

The phase angle b/w the two signals is 15°. Hence sine wave A leads the sine wave B.

Q2:- For a particular 0° reference sinusoidal current, the peak value is 100 mA. Determine the instantaneous value at the following points:

a) 95°.

Sol:-

$$I = 100mA \sin(95°) \Rightarrow 99.6mA$$

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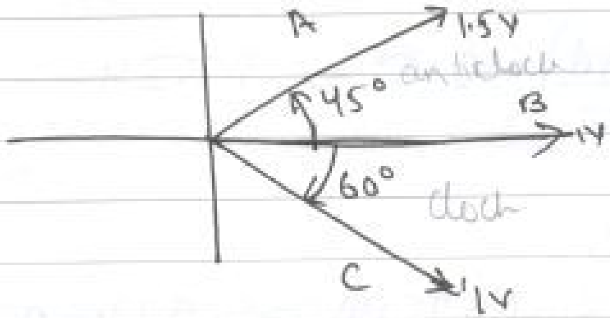
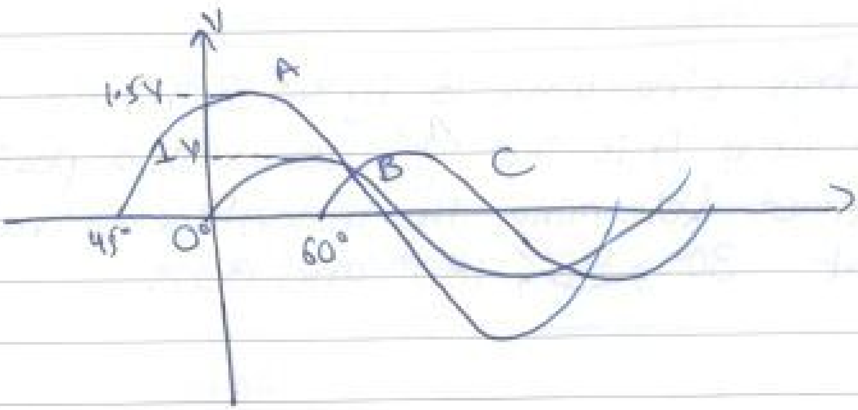
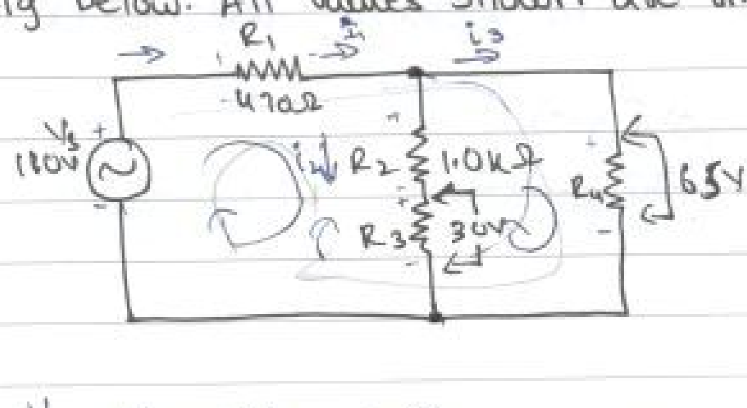
Q3:- Draw the sine wave represented by the phasor diagram in fig below. The phasor lengths represent peak values



Sol:-



Q4:- Find the half-cycle average values of the voltages across R_1 and R_2 in fig below. All values shown are rms



Sol:-

$V_S = V_{R_1} + V_{R_4} \rightarrow (1)$

$V_S = V_{R_1} + V_{R_2} + V_{R_3} \rightarrow (2)$

equ(1)

$110 = V_{R_1} + 65V$

$V_{R_1} = 110 - 65 \Rightarrow 45V$

$V_{P_1} = 1.414 V_{R_1} = 1.414 \times 45V \Rightarrow 63.63V$

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$V_{1avg} = 0.637 V_{P1} = 0.637 \times 63.63 \Rightarrow 40.5V$

equ ②

$110V = 45V + V_{R2} + 30V$

$V_{R2} = 110 - 45 - 30 \Rightarrow 35V$

$V_{P2} = 1.414 \times 35V \Rightarrow 49.49V$

$V_{2avg} = 0.637 \times 49.49 \Rightarrow 31.5V.$