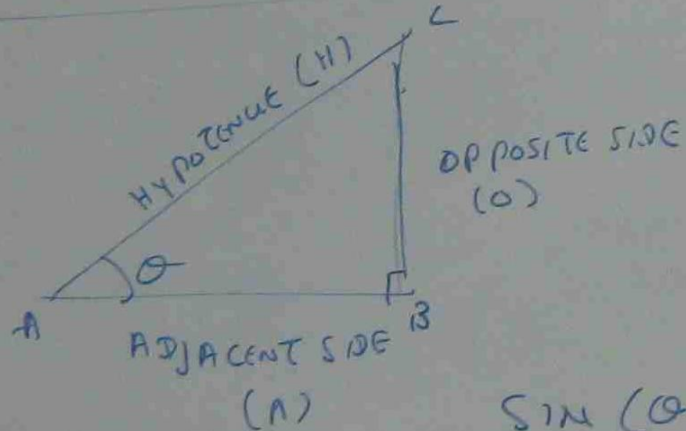
UEENEEG 002 B SOLVE PROBLEMS IN LOW VOLTAGE SINGLE PHASE AND THREE PHASE CIRCUIT

BASIC TRIGONOMETRY



SIN	COS	TAN	COT	SEC	COSEC
O	A	O	A	H	H
H	H	A	O	A	O

$$\sin(\theta) = \frac{BC}{AC}$$

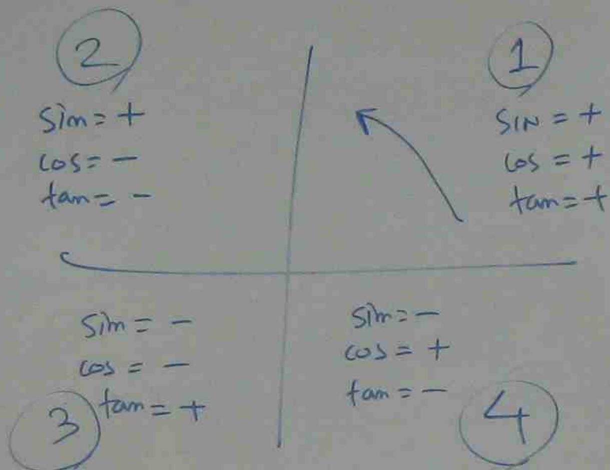
$$\cos\theta = \frac{AB}{AC}$$

$$\tan\theta = \frac{BC}{AB}$$

$$\cot\theta = \frac{AB}{BC}$$

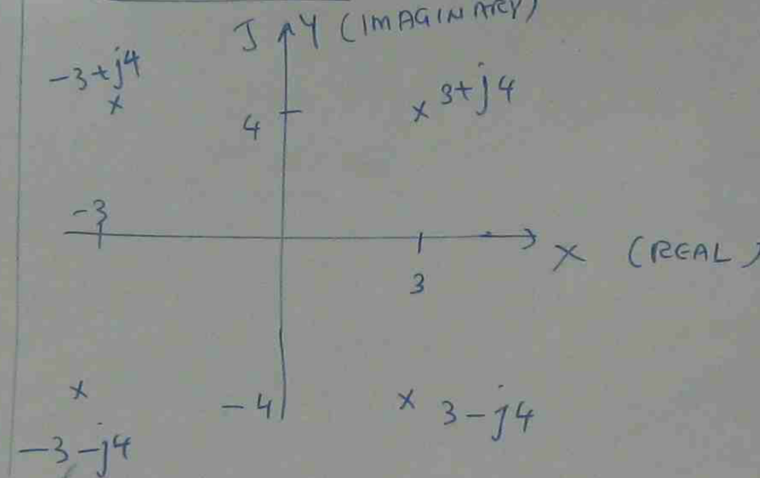
$$\sec\theta = \frac{AC}{AB}$$

$$\cos\theta = \frac{AC}{BC}$$



180° = π RADIAN

PHASOR



$j = \sqrt{-1}$

3+j4 = RECTANGULAR FORM

$\sqrt{3^2+4^2}\ \angle \tan^{-1}\frac{4}{3} = 5\ \angle 53.2°$

POLAR FORM

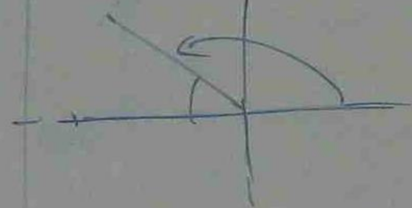
PHASO

$$3-j4 = \sqrt{3^2+4^2}\,\angle{-\tan^{-1} 4/3} = 5\,\angle{-53.2^\circ}$$

$$-3+j4 = \sqrt{3^2+4^2}\,\angle{180-\tan^{-1}\tfrac{4}{3}} = 5\,\angle{180-53.2^\circ}$$

$$= 5\,\angle{126.8^\circ}$$

V=5o



$$-3-j4 = \sqrt{3^2+4^2}\,\angle{-(180-\tan^{-1} 4/3)}$$

$$= 5\,\angle{-126.8^\circ}$$

POLAR → RECTANGULAR

z.

$$Z\angle\theta = Z\cos\theta + jZ\sin\theta$$

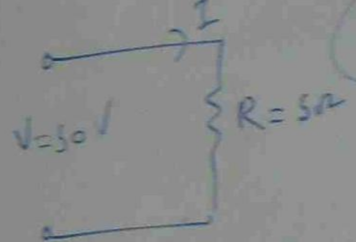
$$5\angle 53.2 = 5(\cos 53.2) + j5(\sin 53.2)$$

LAR FORM

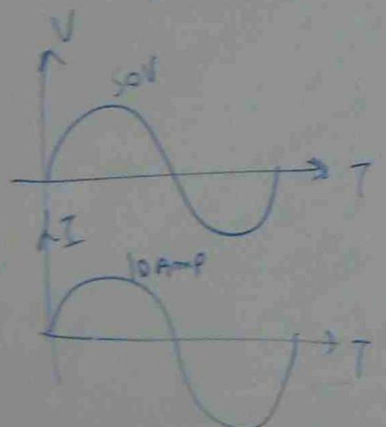
$$5\angle{-126.8} = 5(\cos(-126.8)) + j5(\sin(-126.8))$$

PHASOR DIAGRAM

RESISTIVE CIRCUIT



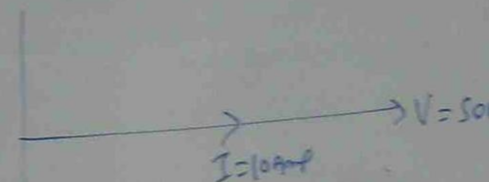
$$I = \frac{50V}{5\Omega} = 10\ \text{Amp}$$



WAVE FORM

IN PHASE

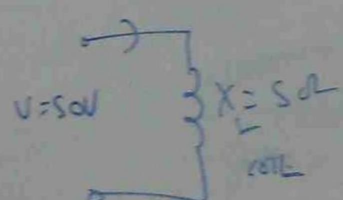
VECTOR | PHASOR DIAGRAM

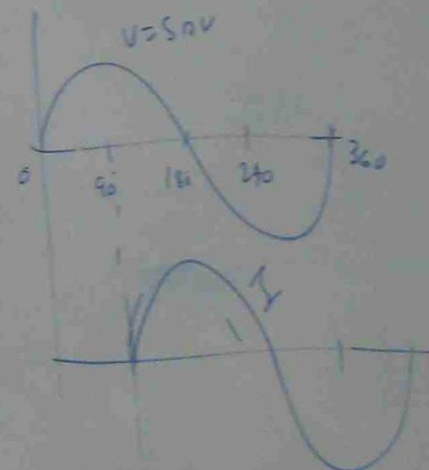


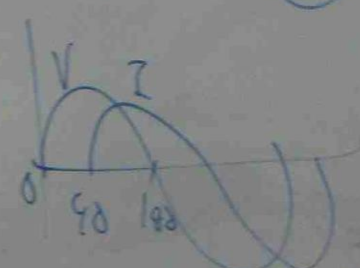
$$Z = \frac{V}{I} = \frac{50\angle 0}{10\angle 0} = 5\angle 0$$

POLAR FORM

INDUCTIVE CIRCUIT







CURRENT IS 90 LAGG

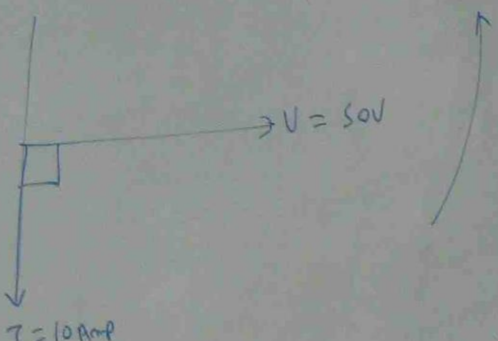
$V = 50\angle 0$ V,

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

$$\frac{Z_1\angle\theta_1}{Z_2\angle\theta_2}$$

$Z_1\angle\theta_1 \times Z_2$

CURRENT IS 90° LAGGING VOLTAGE



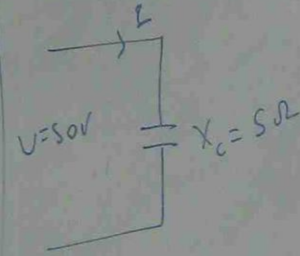
$V = 50\angle 0°\ V, \quad I = 10\angle -90°\ \text{Amp.}$

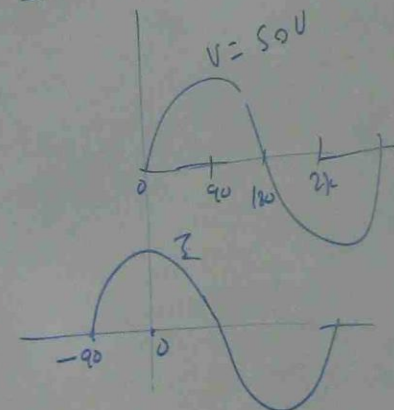
$$X_L = \frac{V}{I} = \frac{50\angle 0}{10\angle -90} = 5\angle 0-(-90)$$
$$= 5\angle 90$$

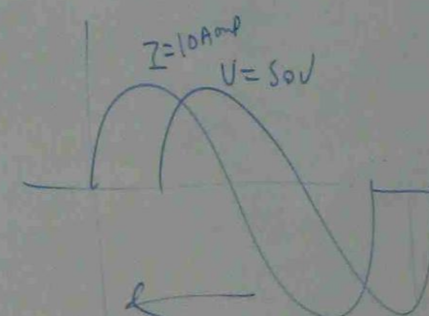
$$\frac{Z_1\angle \theta_1}{Z_2\angle \theta_2} = \left(\frac{Z_1}{Z_2}\right)\angle \theta_1-\theta_2$$

$$Z_1\angle \theta_1 \times Z_2\angle \theta_2 = (Z_1 Z_2)\angle \theta_1+\theta_2$$

CAPACITIVE CIRCUIT





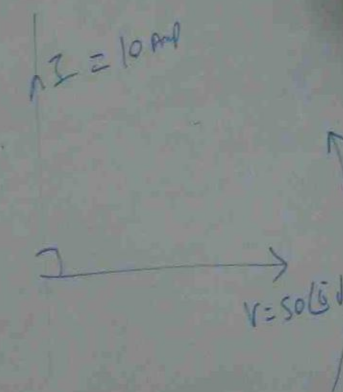


CURRENT LEADS VOLTAGE BY 90°

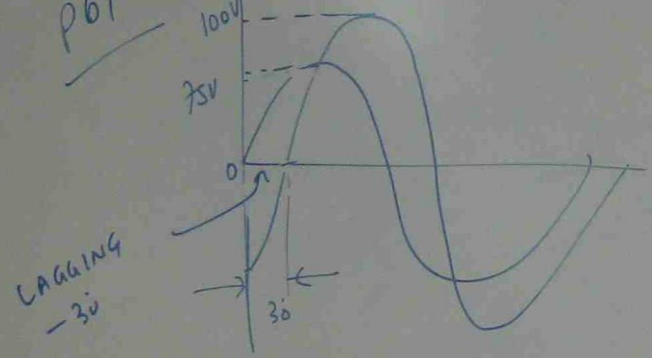
$V = 50\angle 0$

$X_C = 5\angle -90°$

$$I = \frac{V}{X_C} = \frac{50\angle 0}{5\angle -90} = 10\angle +90°\ \text{Amp}$$

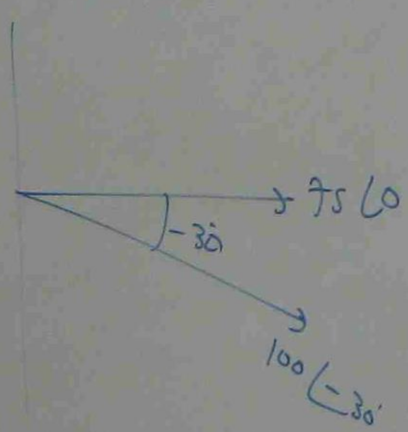


pb1

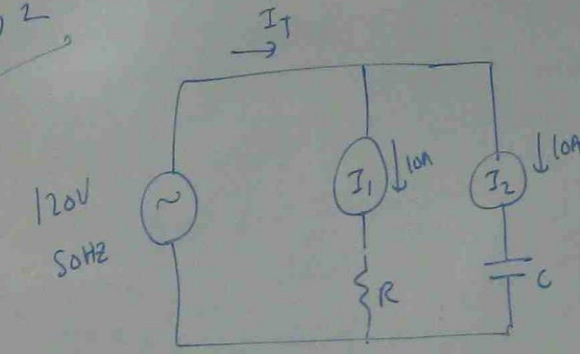


DRAW THE VECTOR DIAGRAM FOR ABOVE WAVE FORM

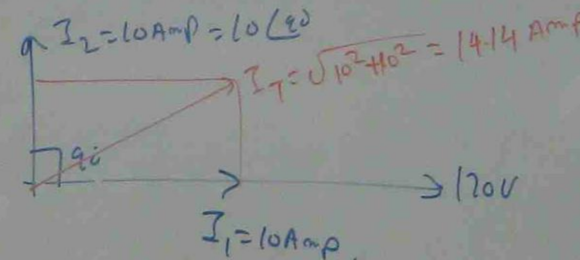
$75\angle 0 \qquad 100\angle -30$



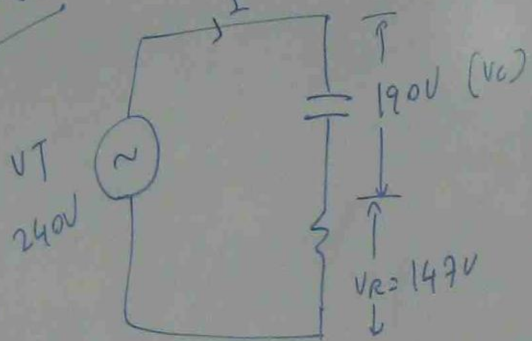
pb 2



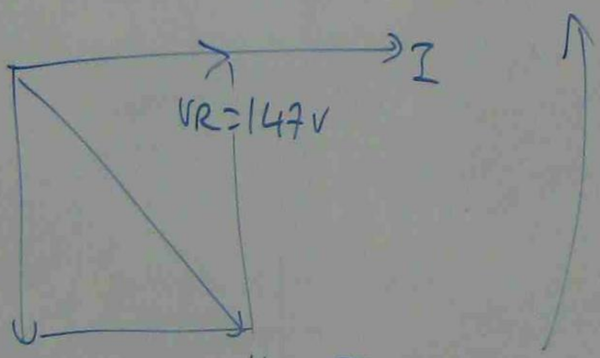
DRAW THE VECTOR DIAGRAM FOR GIVEN CIRCUIT



pb (3)



DRAW THE VECTOR DIAGRAM FOR GIVEN CIRCUIT.

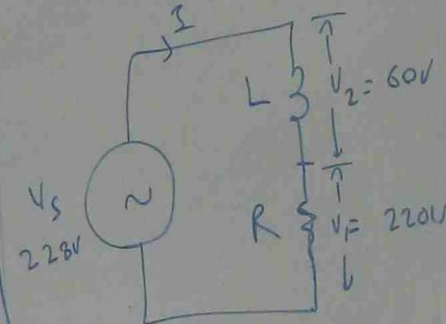


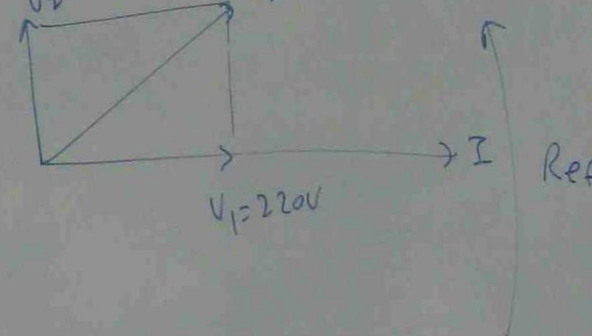
$V_T = \sqrt{147^2 + 190^2} = 240V$

pb (4)

THE CIRCUIT SHOWS A CHOKE (INDUCTOR) IN SERIES WITH A RESISTIVE INDUSTRIAL OVEN. THE VOLTAGE ACROSS THE RESISTOR IS IN PHASE WITH THE CURRENT AND THE VOLTAGE ACROSS THE INDUCTOR LEADS THE CURRENT BY 90°

DRAW A PHASOR DIAGRAM FOR THE CIRCUIT SHOWING V_1, V_2 AND V_S

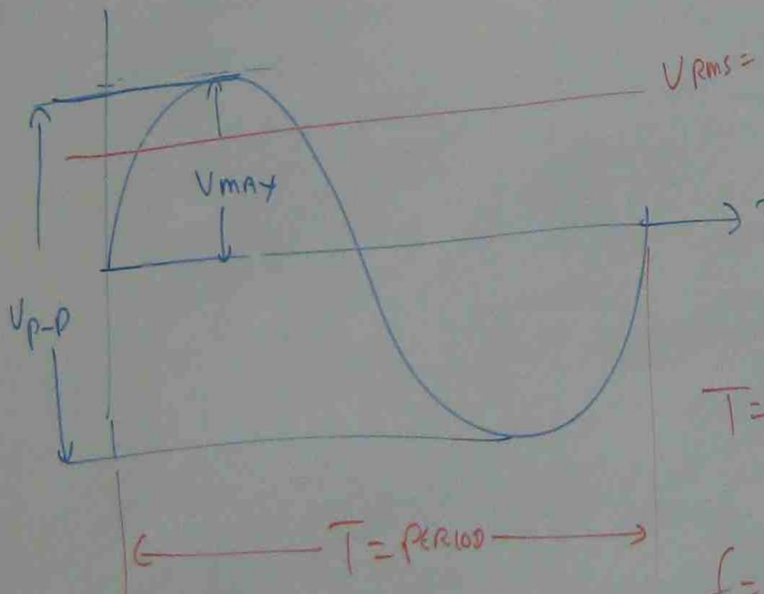




$V_S = \sqrt{220^2 + 60^2} = 228V$

AC THEORY

ALTERNATING QUANTITIES



$$V_{RMS} = \frac{V_{MAX}}{\sqrt{2}} = \frac{V_{MAX}}{1.4142}$$

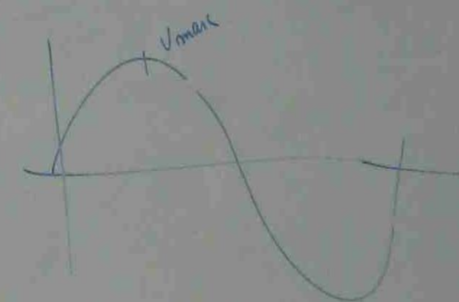
$$T = \frac{1}{f}$$

f = FREQUENCY

T = second

TIME DOMAIN

$$\omega = 2\pi f$$



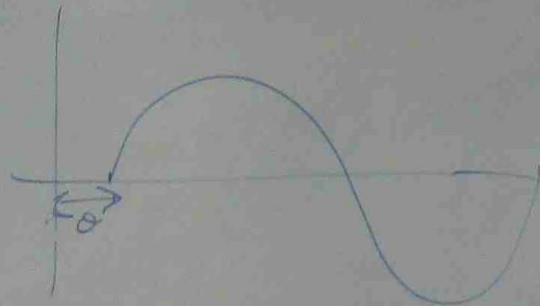
$$V(t) = V_{max}\left(\sin \omega t\right)$$

$$V(t) = V_{max} \cdot \sin(\omega t + \theta)$$

$\omega = 2\pi f$

$\omega t \,)$

$n(\omega t + \theta\,)$



$V(t) = V_{max} \sin(\omega t - \theta)$

FREQUENCY DOMAIN

$V(t) = V_{max} \sin \omega t \longrightarrow \frac{V_{max}}{\sqrt{2}} \angle 0$

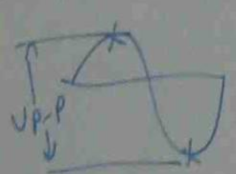
$V(t) = V_{max} \sin(\omega t + \theta) \longrightarrow \frac{V_{max}}{\sqrt{2}} \angle +\theta$

$V(t) = V_{max} \sin(\omega t - \theta) \longrightarrow \frac{V_{max}}{\sqrt{2}} \angle -\theta$

AVERAGE VALUE $= \frac{V_{MAX}}{\pi}$

Q1 THE VALUE OF LINE VOLTAGE WHICH IS USED ON APPLIANCE RATING PLATE FOR AC SUPPLY IS ___Rms VALUE___.

Q2 THE VOLTAGE MEASURED BETWEEN THE MAXIMUM POSITIVE AND NEGATIVE VALUE OF SINE WAVE IS ___PEAK TO PEAK VOLTAGE___.



Q3 THE FREQUENCY OF A SINE WAVE THAT HAS A PERIOD OF 10 MILISECOND IS

$$f = \frac{1}{T} = \frac{1}{10 \times 10^{-3}}$$

$$= \frac{10^3}{10} = 100\,Hz$$

Q4 IF THE INSTANTANEOUS VALUE OF CURRENT IS 10 AMP AT ANGLE OF 30° THE RMS VALUE OF CURRENT IS ___.

$I_{MAX} \sin\theta$ = INSTANTANEOUS VALUE

$$I_{MAX} \sin 30° = 10$$

$$I_{MAX} = \frac{10}{\sin 30} = \frac{10}{0.5} = 20\,Amp$$

$$I_{Rms} = \frac{I_{MAX}}{\sqrt{2}} = \frac{20}{1.4142} = 14.14\,Amp.$$

Q5 A SINE WAVE HAS PEAK VALUE 390V. DETERMINE

(a) Rms VOLTAGE

(b) AVERAGE VOLTAGE

$$(a)\ V_{Rms} = \frac{V_{MAX}}{\sqrt{2}} = \frac{390}{1.4142} = 275V$$

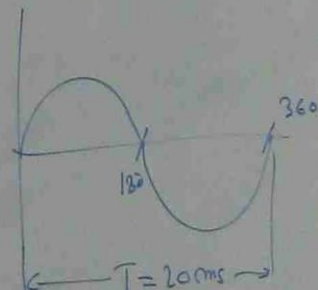
$$(b)\ V_{Avg} = \frac{V_{MAX}}{\pi} = \frac{390}{3.1416} = 124.14V$$

Q6 A SINE WAVE HAS A MAXIMUM VALUE OF 100V AND FREQUENCY OF 50HZ

DETERMINE THE VALUE OF WAVE FORM AT

(a) 30 ELECTRICAL DEGREE (b) 90 ELECTRICAL DEGREE (c) 270 ELECTRICAL DEGREE

(c) AFTER TIME LAPSE OF 4 MILL SECONDS.



(a) $V_{MAX} \sin 30 = 100 \times 0.5 = 50V$

(b) $V_{MAX} \sin 90 = 100 \times 1 = 100V$

(c) $V_{MAX} \sin 270 = 100 \times (-1) = -100V$

(d) $T = \frac{1}{f} = \frac{1}{50} = \frac{1000\ ms}{50} = 20\ ms$

$20\ ms \longrightarrow 360°$

$4 \longrightarrow ? = \frac{360 \times 4}{20} = 72°$

$V_{MAX} \sin 72$

$= 100 \sin 72 = 95V$

Q7 DETERMINE THE PERIODIC TIME FOR THE FOLLOWING WAVE FORMS

(a) 50HZ SINE WAVE (b) 125 HZ SQUARE WAVE

(c) 1000 HZ TRIANGULAR WAVE

(a) $T = \frac{1}{f} = \frac{1}{50} = 0.02S$ | (b) $T = \frac{1}{125} = 8\ ms$ | (c) $T = \frac{1}{1000} = 1ms$

Q8 CALCULATE THE FREQUENCIES FOR THE FOLLOWING PERIODIC TIMES.

(a) 0.02 sec

(b) 0.0167 sec

(c) 0.2 mili second

(a) $f = \frac{1}{T} = \frac{1}{0.02} = 50Hz$

(b) $f = \frac{1}{T} = \frac{1}{0.0167} = 60Hz$

(c) $f = \frac{1}{T} = \frac{1}{0.2 \times 10^{-3}} = \frac{10^3}{0.2} = \frac{10^4}{2} = 5000HZ$

Q9 FOR THE WAVE FORM SHOWN IN FIGURE DETERMINE THE

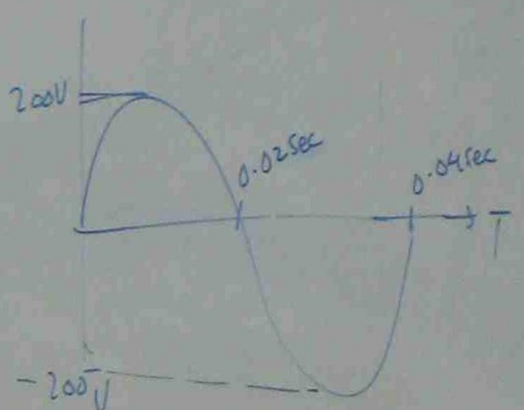
(a) MAXIMUM VOLTAGE

(b) FREQUENCY

(c) PERIOD

(d) PEAK TO PEAK VALUE

(e) RMS VALUE



(a) 200V

(b) $f = \frac{1}{T} = \frac{1}{0.04}$

$= \frac{100}{4}$

$= 25Hz$

(c) $T = 0.04$ sec

(d) $V_{p-p} = 400V$

(e) $V_{Rms} = \frac{V_{MAX}}{\sqrt{2}}$

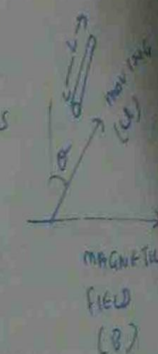
$= \frac{200}{1.4142}$

$= 141.42V$

Q10

A SINGLE CONDUCTOR OF LENGTH 1.5m IS MOVING THROUGH A MAGNETIC FIELD OF 0.5 TESLA AT VELOCITY OF 2 m/s. DETERMINE THE INDUCED VOLTAGE OF THE CONDUCTOR IN THE MAGNETIC FIELD AT

(a) 90 (b) 45 (c) 60



$B = 0.5T$ $L = 1.5m$ $V = 2m/s$ VELOCITY

INDUCED VOLTAGE IN MOVING CONDUCTOR $= BLV \sin\theta$

$V = BLV \sin\theta$

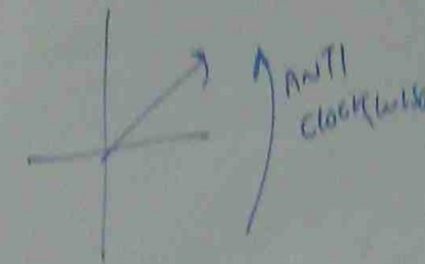
(a) $V = 0.5 \times 1.5 \times 2 \sin 90 = 1.5V$

(b) $V = 0.5 \times 1.5 \times 2 \sin 45 = 1.5 \times 0.707 = 1.06V$

(c) $V = 0.5 \times 1.5 \times 2 \sin 60 = 1.5 \times 0.866 = 1.3V$

REVIEW QUESTIONS

(1) PHASOR NORMALLY ROTATE IN ANTI CLOCKWISE



(2) IN PRACTICE, AC QUANTITIES BY PHASOR DIAGRAM.

THE PHASORS ARE NORMALLY DRAWN TO SCALE TO

REPRESENT RMS VALUE.

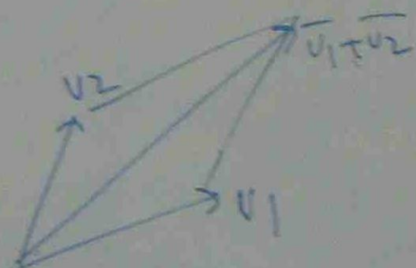
(3) PHASORS ARE QUANTITIES WHICH VARY IN MAGNITUDE AND DIRECTION

(4) THE RESULTANT OF TWO VOLTAGES HAVING THE SAME ANGLE OF LAG BUT DIFFERENT NUMERICAL VALUES CAN BE DETERMINED BY ____

<u>NUMERICAL SUBSTRACTION</u> $\overset{3}{\leftarrow}\overset{4}{\longrightarrow} = 4-3$

<u>NUMERICAL ADDITION</u> $\overset{4}{\longrightarrow}\overset{3}{\longrightarrow} = 4+3$

(5) THE RESULTANT OF TWO OR MORE VOLTAGES DIFFERING IN PHASE MAY BE DETERMINED BY ALGEBRIC ADDITION (OR) SUBSTRACTION



$V_1 - V_2 = V_1 + (-V_2)$