PHASOR AND RECTANGULAR CONCEPT :-

i) $a+bi$ is in Rectangular form

ii) $r\angle\theta$ is in polar form or Phasor form.

where r is the Radius (or) Magnitude

θ is the Angle (phase angle difference)

CONVERSION FROM RECTANGLE FORM TO POLAR FORM :-

$\Rightarrow$ $a+bi \longrightarrow r=\sqrt{a^2+b^2}$ (FIRST QUADRANT)

$\theta = \tan^{-1}(b/a)$

$\Rightarrow$ $-a+bi \longrightarrow r=\sqrt{a^2+b^2}$ (SECOND QUADRANT)

$\theta = \pi - \tan^{-1}(b/a)$

$\Rightarrow$ $-a-bi \longrightarrow r=\sqrt{a^2+b^2}$ (THIRD QUADRANT)

$\theta = \pi + \tan^{-1}(b/a)$

$\Rightarrow$ $a-bi \longrightarrow r=\sqrt{a^2+b^2}$ (FOURTH QUADRANT)

$\theta = -\tan^{-1}(b/a)$

Eg:- 1. (a) $3+4i \longrightarrow r_1\angle\theta_1$ Calculate $r_1, r_2, r_3, r_4, \theta_1, \theta_2, \theta_3$ & θ_4.

(b) $-3+4i \longrightarrow r_2\angle\theta_2$

(c) $-3-4i \longrightarrow r_3\angle\theta_3$

(d) $3-4i \longrightarrow r_4\angle\theta_3$.

Sol:- (a) $3+4i \longrightarrow \sqrt{3^2+4^2}\angle\tan^{-1}(4/3) = 5\angle 53.13^\circ$

(b) $-3+4i \longrightarrow \sqrt{3^2+4^2}\angle\pi-\tan^{-1}(4/3) = 5\angle 180-53.13^\circ$

$= 5\angle 126.86^\circ$

(c) $-3-4i \longrightarrow 5\angle\pi+\tan^{-1}(4/3) = 5\angle 233.13 = 5\angle -126.86^\circ$

(d) $3-4i \longrightarrow 5\angle -\tan^{-1}(4/3) = 5\angle -53.13^\circ$

$r_1 = 5 \quad \theta_1 = 53.13^\circ$

$r_2 = 5 \quad \theta_2 = 126.86$

$r_3 = 5 \quad \theta_3 = -126.86^\circ$

$r_4 = 5 \quad \theta_4 = -53.13^\circ$

CONVERSION FROM POLAR TO RECTANGULAR FORM :-

$\rightarrow \; r\angle\theta = r\cos\theta + i(r\sin\theta)$

Q. Convert $5\angle 30°$ and $5\angle -120°$ into Rectangular form.

Sol:- $5\angle 30° = 5\cos 30° + i(5\sin 30°) = 4.33 + i(2.5)$

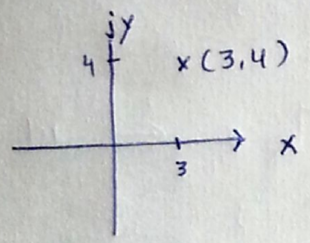
$5\angle -120° = 5\cos(-120°) + i(5\sin(-120°)) = -2.5 + i(-4.33)$

$= -2.5 - i(4.33)$

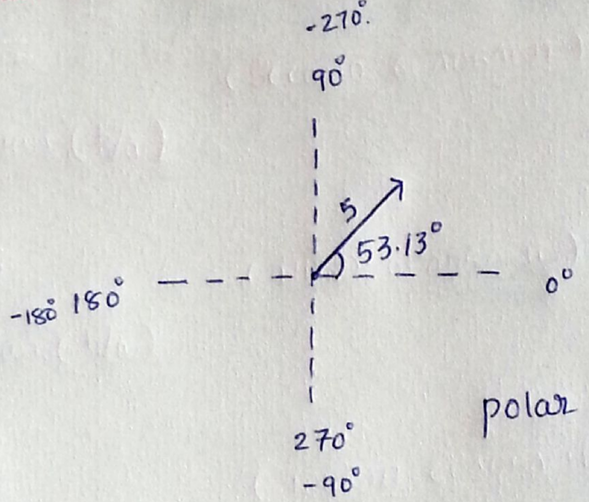
$\Rightarrow$ **Graphical Representation of polar form and Rectangular form.**

Q Represent $3+4i$ in polar and Rectangular form.

Sol:- $3+4i = 5\angle 53.13°$



Rectangular form.



polar (or) phasor Representation

Q Represent the following in polar form.

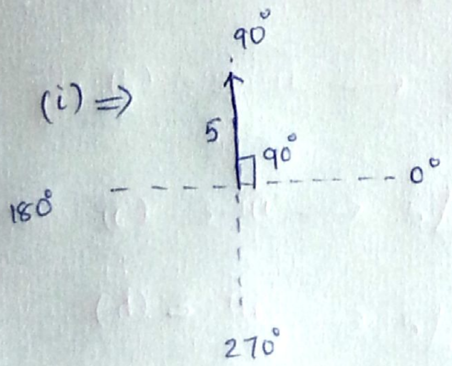
i) $5j$ ii) $-3j$ iii) $1+3j$

Sol:- i) $5j = 0+5j = 5\angle \tan^{-1}\left(\frac{5}{0}\right) = 5\angle 90°$

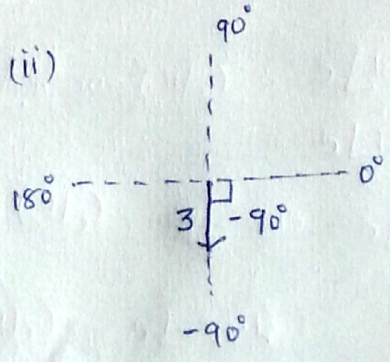
ii) $-3j = 0-3j = 3\angle -90° = 3\angle -90°$

iii) $1+3j = \sqrt{1+9}\,\angle \tan^{-1}(3) = 3.16\angle 71.56$

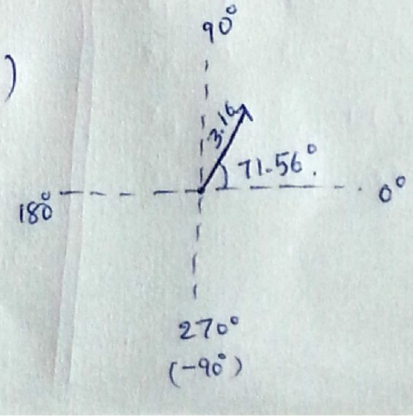
(i) $\Rightarrow$



(ii)

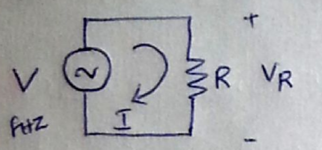


iii)

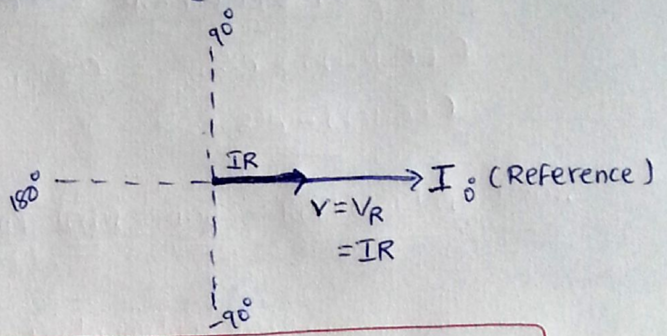


LEADING, LAGGING AND IN, OUT PHASE CONCEPT IN R, L, C CIRCUITS :-

i) purely Resistive Circuit :-



Phasor Representation



$-V + IR = 0.$

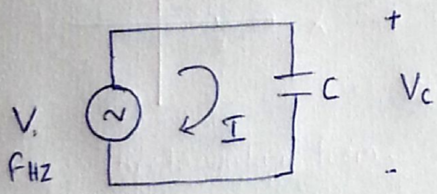
$\Rightarrow V = IR$

$= IR\angle 0°.$

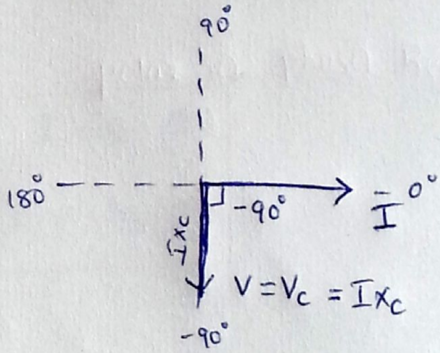
$V_R = IR = IR\angle 0°.$

$\boxed{\text{V and I are in Same phase}}$

ii) purely Capacitive Circuit :-



Phasor Representation



$-V - jIX_c = 0.$; $X_c = \frac{1}{2\pi f c}\ \Omega$

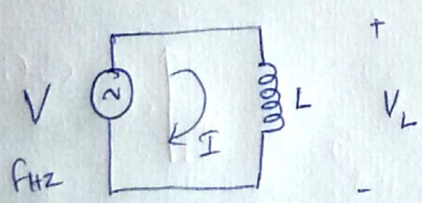
$\Rightarrow V = -IX_c j$

$= IX_c \angle -90°.$

$V_c = IX_c \angle -90° = V$

I leads V by 90°
(or)
V lags I by 90°

iii) purely Inductive Circuit.



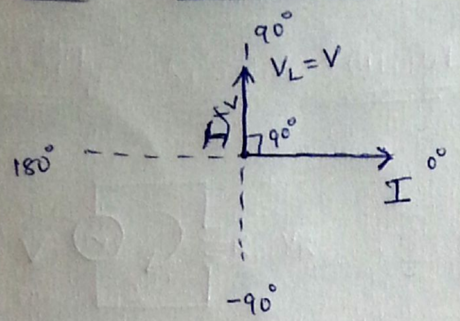
$X_L = 2\pi f L\ \Omega.$

$-V + IjX_L = 0.$

$\Rightarrow V = IX_L j$

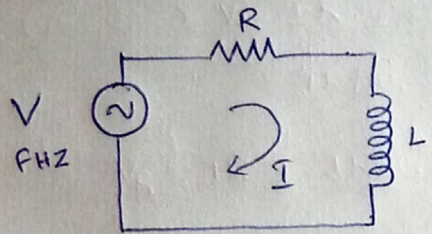
$= IX_L \angle 90°. = V_L$

Phasor representation



$\boxed{\text{V lead I by } 90^\circ \text{ or I lags V by } 90^\circ}$

SERIES RL Circuit :-



$$-V + IR + j(IX_L) = 0.$$

$$\Rightarrow V = IR + j(IX_L)$$

$$= V_R + jV_L$$

$$|V| = \sqrt{V_R^2 + V_L^2}$$

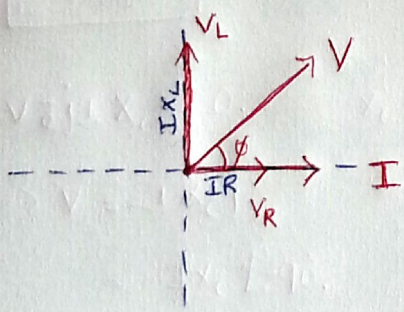
$X_L = \omega L \, \Omega$

$= 2\pi f L \, \Omega.$

$$V_R = IR = IR\angle 0^\circ$$

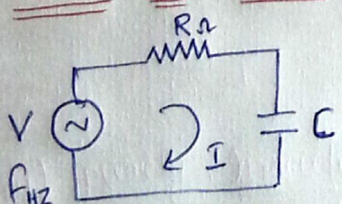
$$V_L = IX_L j = IX_L \angle 90^\circ.$$

~~Vhz~~ phasor Representation :-



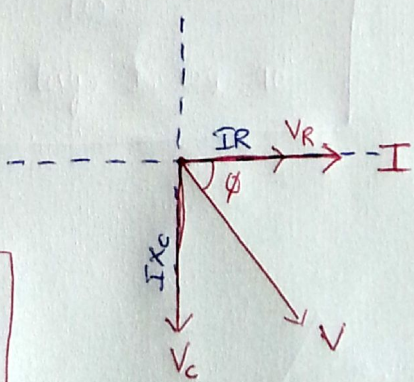
$\boxed{\text{V lead I by } \phi \text{ , I lags V by } \phi.}$

SERIES RC CIRCUIT :-



$$V_R = IR = IR\angle 0^\circ$$

$$V_c = -IX_c j = IX_c \angle -90^\circ$$



$$X_c = \frac{1}{2\pi f c} \, \Omega.$$

$\boxed{\text{I leads V by } \phi \text{ , V lags I by } \phi}$

$$-V + IR - jIX_c = 0.$$

$$\Rightarrow V = IR - jIX_c$$

$$= V_R - jV_c$$

$$|V| = \sqrt{V_R^2 + V_c^2}$$

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Resonance Concept (Not in syllabus)

→ The Frequency at which Inductive Reactance is equal to Capacitive Reactance is known as Resonance Frequency

$$X_L = X_C.$$

$$\Rightarrow \omega L = \frac{1}{\omega C} \qquad \Rightarrow 2\pi f_e L = \frac{1}{2\pi f C}.$$

$$\Rightarrow (2\pi f)^2 = \frac{1}{LC}.$$

$$\Rightarrow \boxed{f = \frac{1}{2\pi\sqrt{LC}}}$$

NUMERICAL (Eg:)

Q. How Much voltage is necessary to flow a current of 20 milli Ampere through the Series RC Circuit having Resistance of 100Ω and Capacitance of 50μFarad at 100Hz.

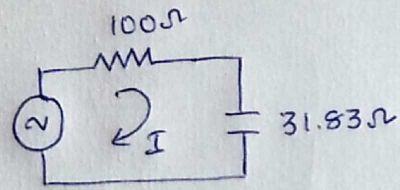
Sol:- Given data. $I = 20$ milli Ampere

$R = 100\Omega$ $\qquad V = ?$

$C = 50\mu F.$

$F = 100\,HZ.$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C} = \frac{1}{2\pi(100)(50)\times10^{-6}} = 31.83\Omega$$



By Applying KVL,

$$-V + 100I - j(31.83)I = 0.$$

$$\Rightarrow V = I(100 - j31.83)$$

$$= 20\times10^{-3}(100 - j31.83)$$

$$|V| = 20\times10^{-3}\sqrt{100^2 + 31.83^2}$$

$$= \underline{2.09 \text{ Volt}}.$$

∴ 2.09 Volts is necessary.