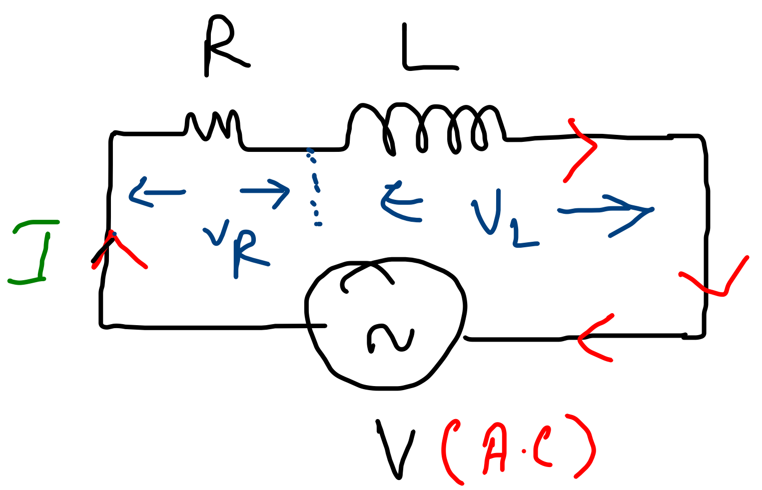
Series A.C Circuit (R-L Circuit)

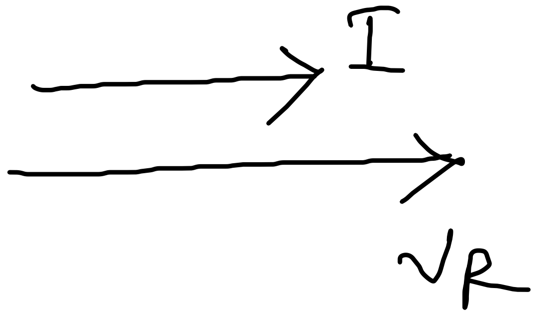


V = R.M.S value of applied voltage

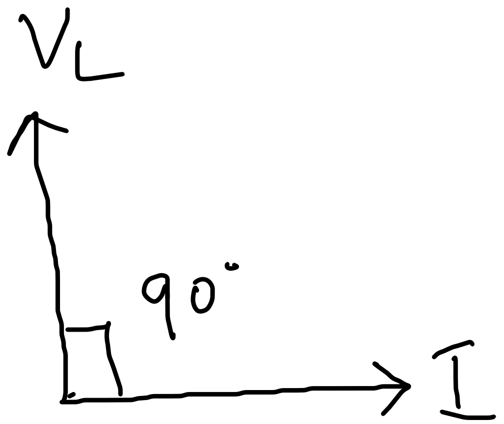
I = R.M.S current.

$v = V_m \sin\omega t$, $\quad V_{rms} = \dfrac{V_m}{\sqrt{2}}$ where V_m is the maximum value of the wave.

Same current flow throughout the circuit

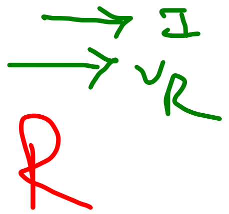


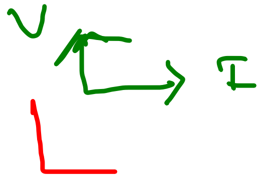
(Same phase)



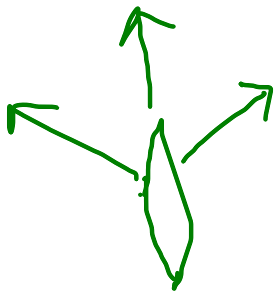
Current lagging by 90°

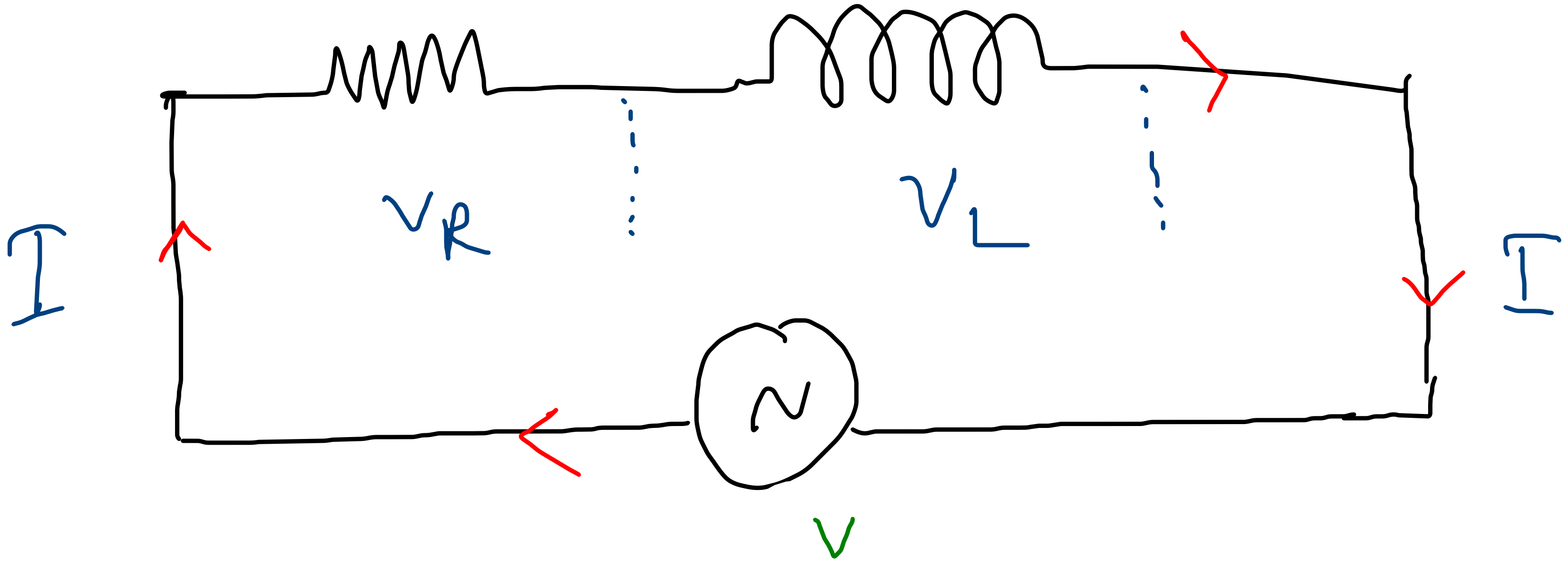
Phasor Diagram :-



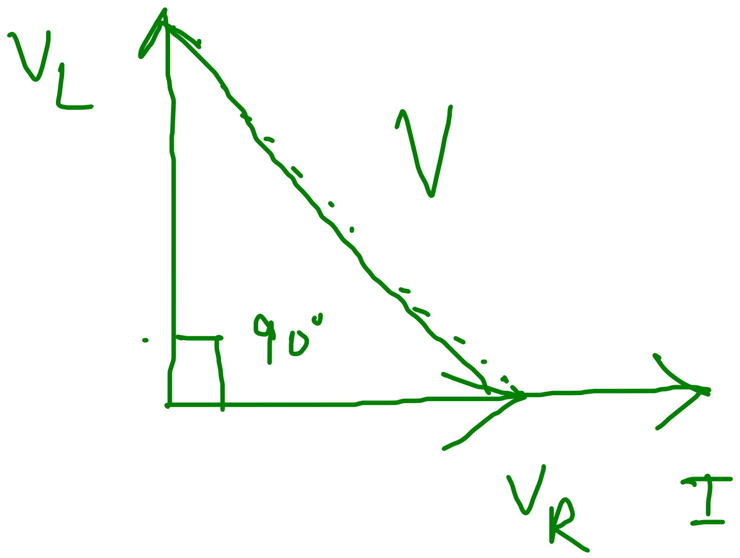


$$\vec{V} = \vec{V}_R + \vec{V}_L$$





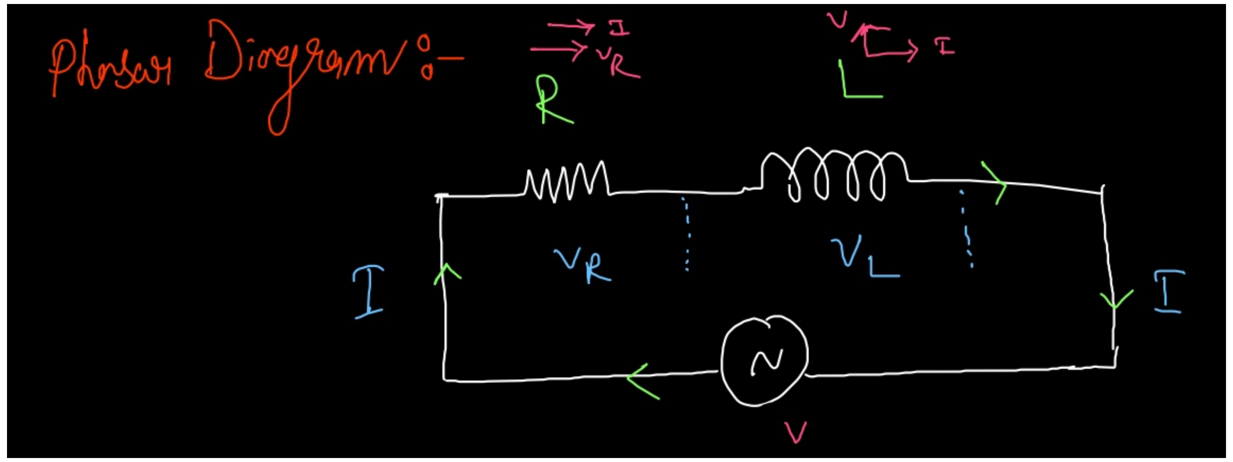
Refference value. Should be the common quantity to the all components



$$V^2 = V_L^2 + V_R^2 \quad (*)$$

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

(*) Phasor algebra



Calculations :-

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

I

ohm's law

$$V = IZ$$

R, L ⇒ Impedance (Z)

R = Resistance
X_L = Reactance

$$Z = \sqrt{R^2 + X_L^2}$$

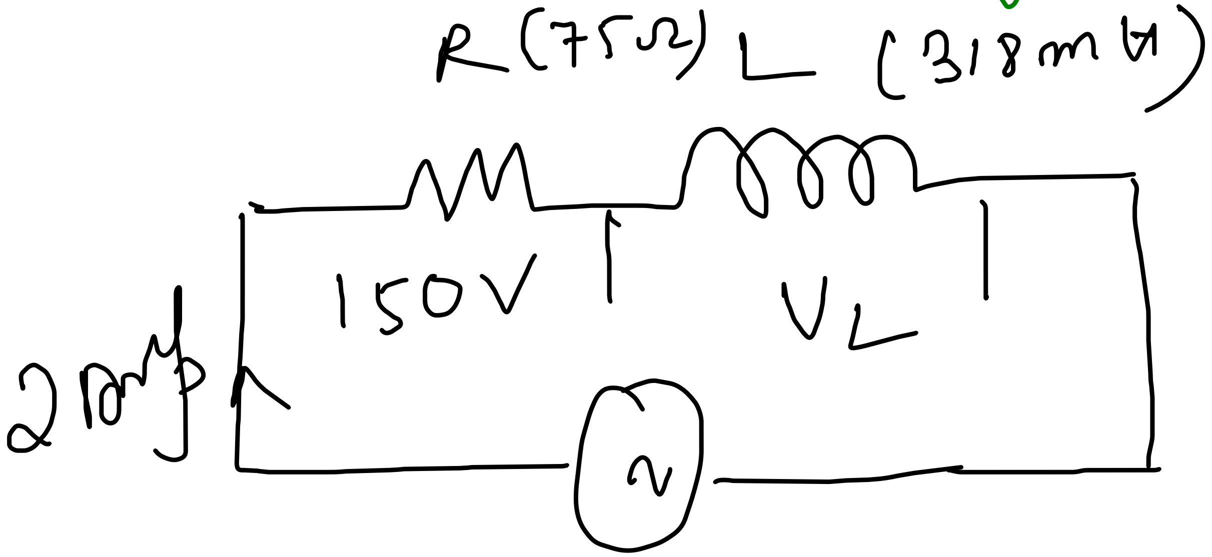
X_L unit in ohm (Ω)

$$V = IZ$$

$$\Rightarrow V = I\sqrt{R^2 + X_L^2}$$

$$\Rightarrow I = \frac{V}{\sqrt{R^2 + X_L^2}}$$

Q1) A pure Inductor of 318 mH is connected in Series with a pure resistance of 75Ω. The Circuit is Supplied from 50 Hz Source and the voltage across 75Ω resistor is found to be 150V. Calculate the Supply voltage and phase angle.



$V(50\,Hz, ?)$

$V_R = 150V, \quad R = 75\Omega$

$V_R = IR$

$\Rightarrow 150 = I \times 75$

$\Rightarrow I = 2\ Amp$

$V_L = I X_L$

$$(318\,mH = 318\times10^{-3}\,H)$$

$$X_L = \omega L$$

$$\Rightarrow X_L = 2\pi f L$$

$$\Rightarrow X_L = 2\pi \times 50 \times 318\times10^{-3}\,\Omega$$

$$\Rightarrow X_L = 99.90\,\Omega$$

$$V_L = I X_L$$

$$\Rightarrow V_L = 2 \times 99.90$$

$$\Rightarrow V_L = 199.80\,V \simeq 200\,V$$

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

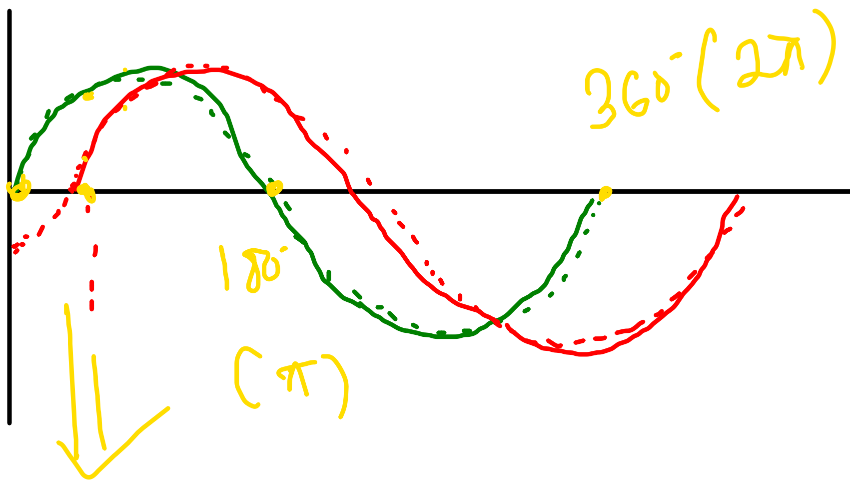
$$\Rightarrow V = \sqrt{150^2 + (199.80)^2}$$

$$\Rightarrow V = 249.84\,V \simeq 250\,V$$

(Ans)

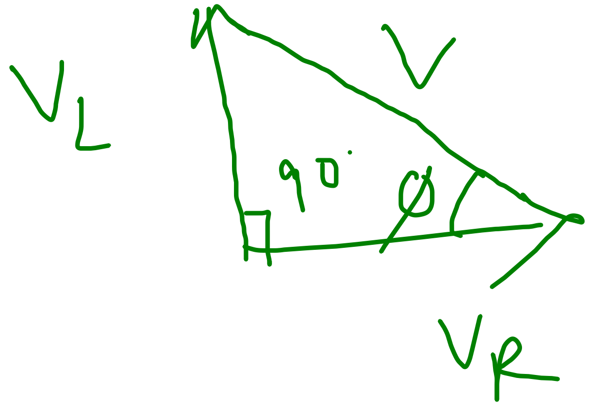
⇒ Phase Angle :-

current is lagging



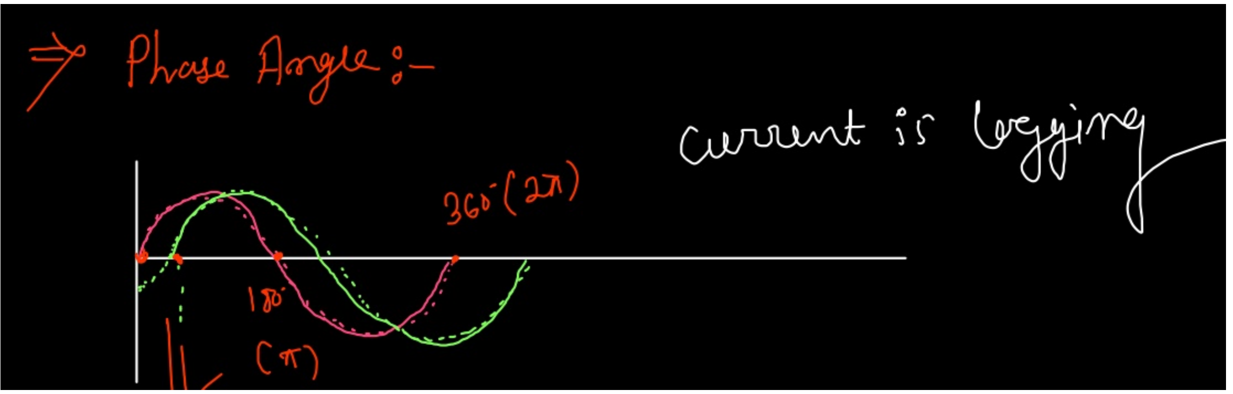
Phase angle = Angle between voltage and current.

(ϕ)

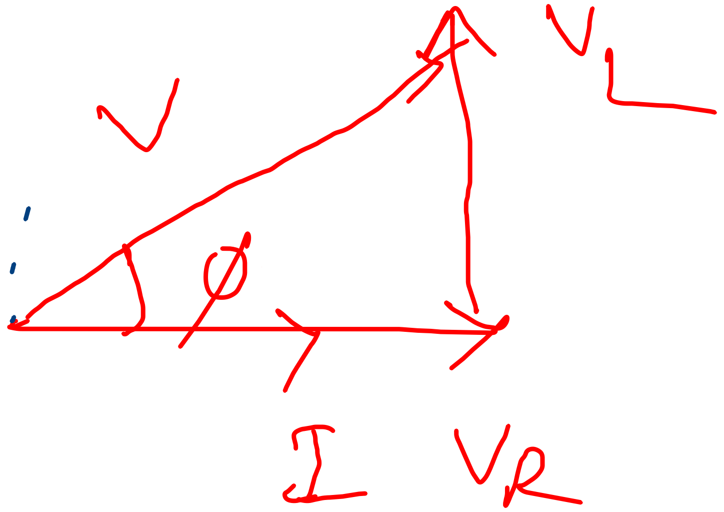


$$\tan\phi = \frac{V_L}{V_R}$$

$$= \frac{IX_L}{IR} = \frac{X_L}{R}$$



(*) Current lagging



lagging

$$v = V_m \sin \omega t$$

$$i = I_m \sin(\omega t - \phi)$$

$$\tan\phi = \frac{V_L}{V_R}$$

$$\Rightarrow \phi = \tan^{-1}\frac{V_L}{V_R}$$

$V_R = 150\,V \qquad V_L = 200\,V$

$$\phi = \tan^{-1}\frac{200}{150}$$

$$= 53.13^\circ$$

$$\tan\phi = \frac{X_L}{R}$$

$$\phi = \tan^{-1}\frac{X_L}{R}$$

$$\phi = \tan^{-1}\frac{100}{75}$$

$$= \tan^{-1} 100/75$$

$$= 53.13^\circ$$

Impedance :- The Toltal opposition offered to the flow of alternating current by a circuit called impedence.

$$Z = \sqrt{R^2 + X_2^2}$$

where $X_2 = \omega L$
$= 2\pi f L$

Admittance $\hookrightarrow Y = 1/Z$

Siemen (S) ℧

Power :-

Instantaneous power

$$P = vi$$

$$= V_m \sin \omega t \, I_m \sin(\omega t - \phi)$$

$$= \frac{1}{2} V_m I_m \cos\phi$$

$$- \frac{1}{2} V_m I_m \cos(2\omega t - \phi)$$

Zero for one complete cycle.

$\frac{1}{2} V_m I_m \cos\phi$: Average power

$\frac{1}{2} V_m I_m \cos(2\omega t - \phi)$ ✗

= pulsating power

$\therefore$ Average power $= \frac{1}{2} V_m I_m \cos\phi$

$$= \frac{V_m}{\sqrt{2}} \frac{I_m}{\sqrt{2}} \cos\phi$$

$$A.P(P) = V_{rms} I_{rms} \cos\phi$$

$$P = VI\cos\phi$$