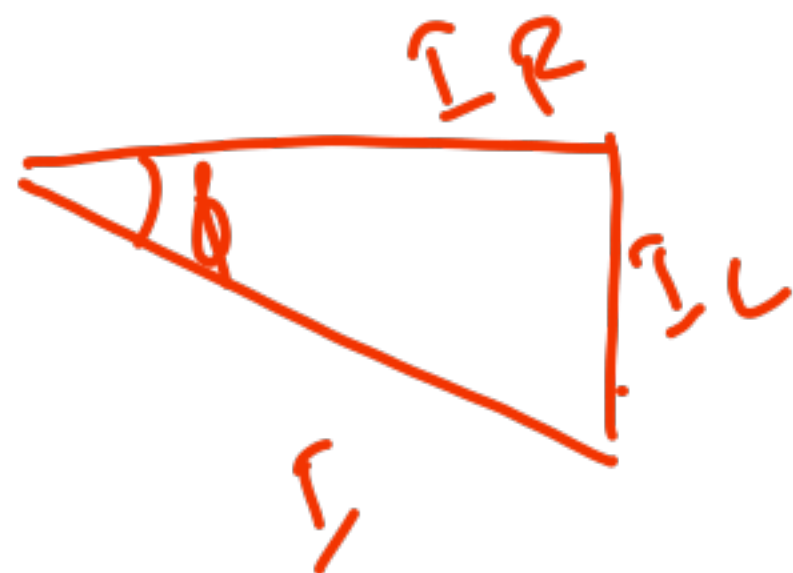


RL

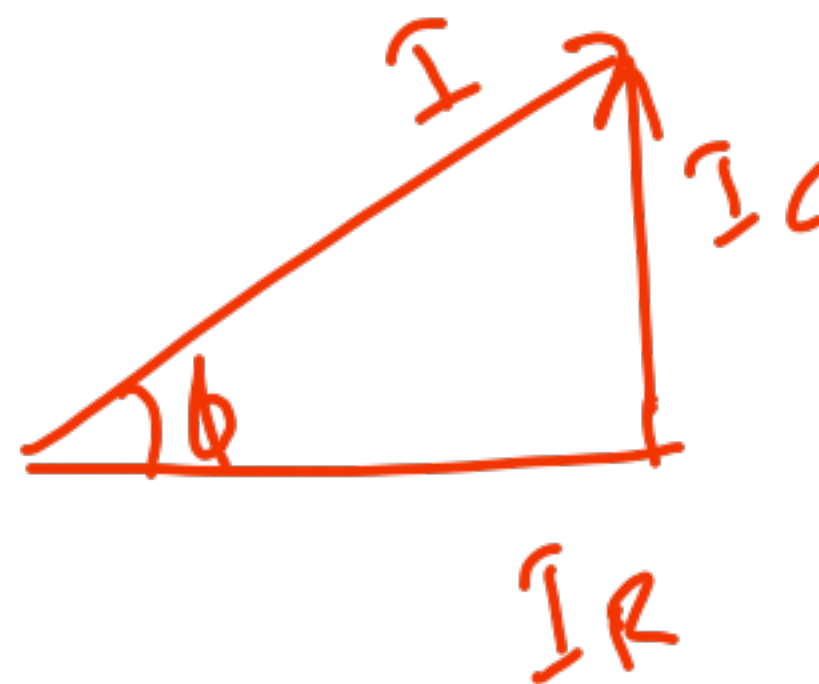
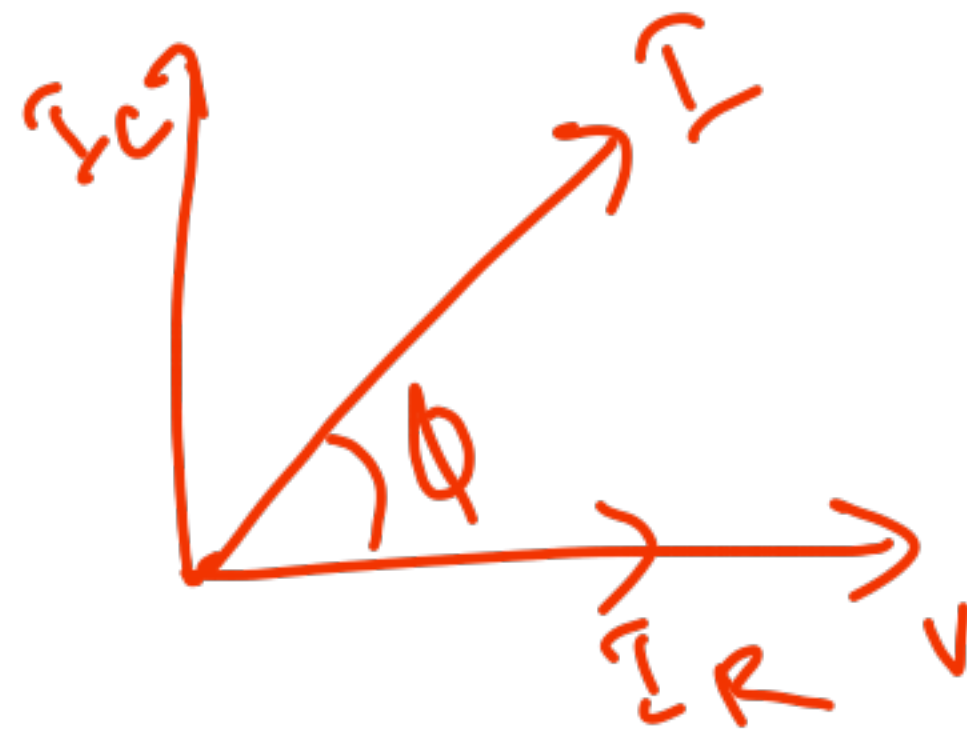
$$I = \sqrt{I_R^2 + I_L^2}$$



$\tan \phi$   
and  
'find'

RC

$$I = \sqrt{I_R^2 + I_C^2}$$



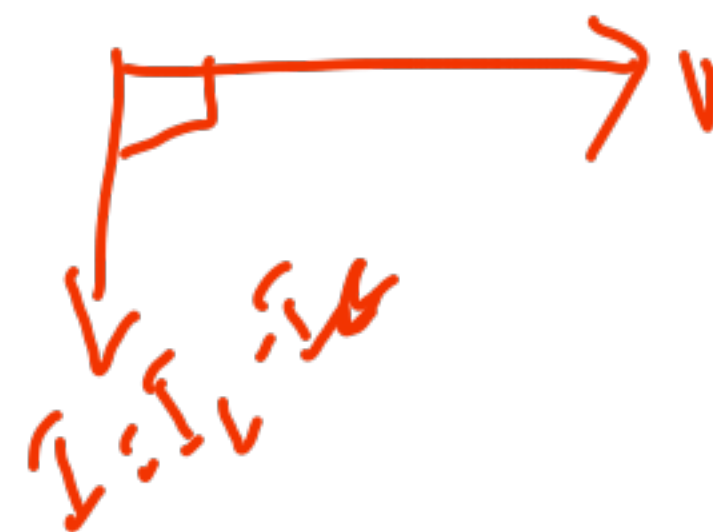
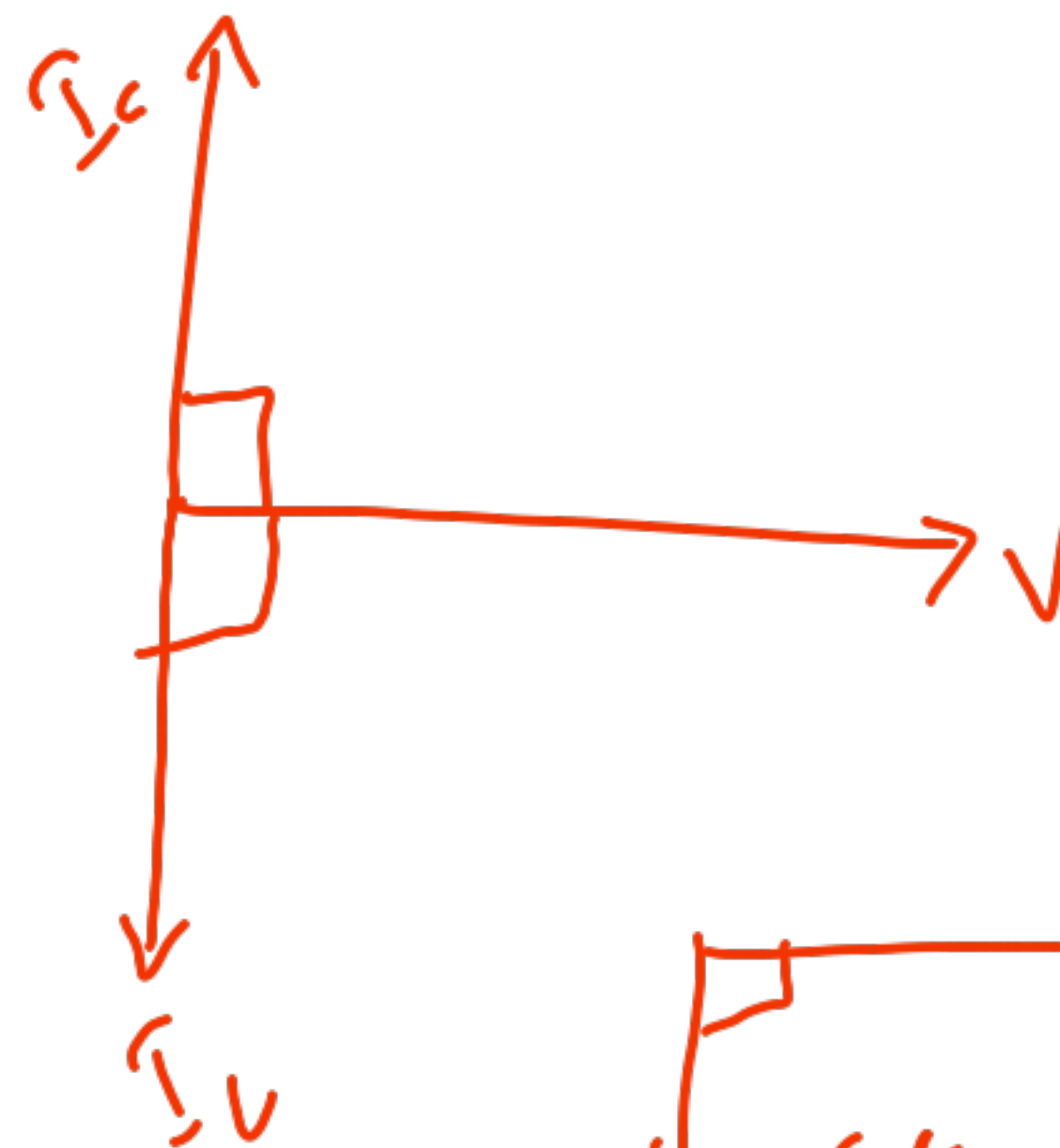
$$Z = R - jX_C$$

LC

$$I_L > I_C, \quad L \uparrow \quad X_L \checkmark$$

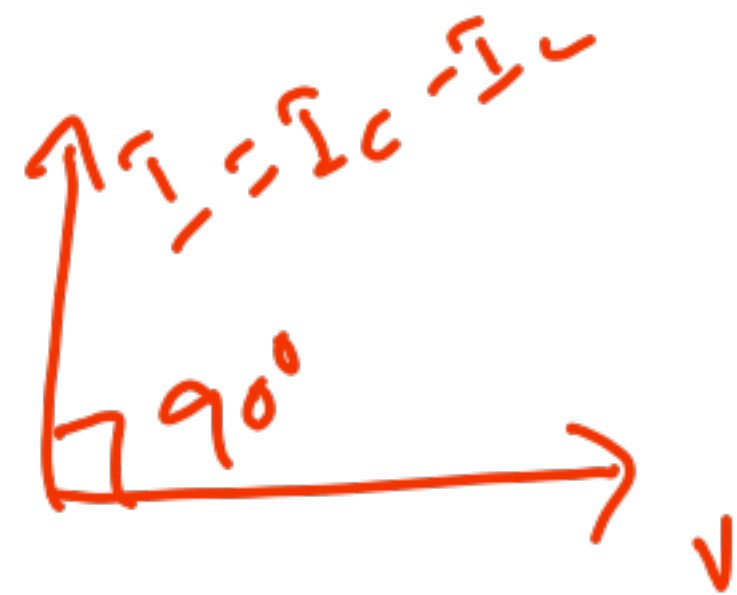
$$I_C > I_L, \quad C \uparrow$$

$$I_L = I_C, \quad I = 0$$



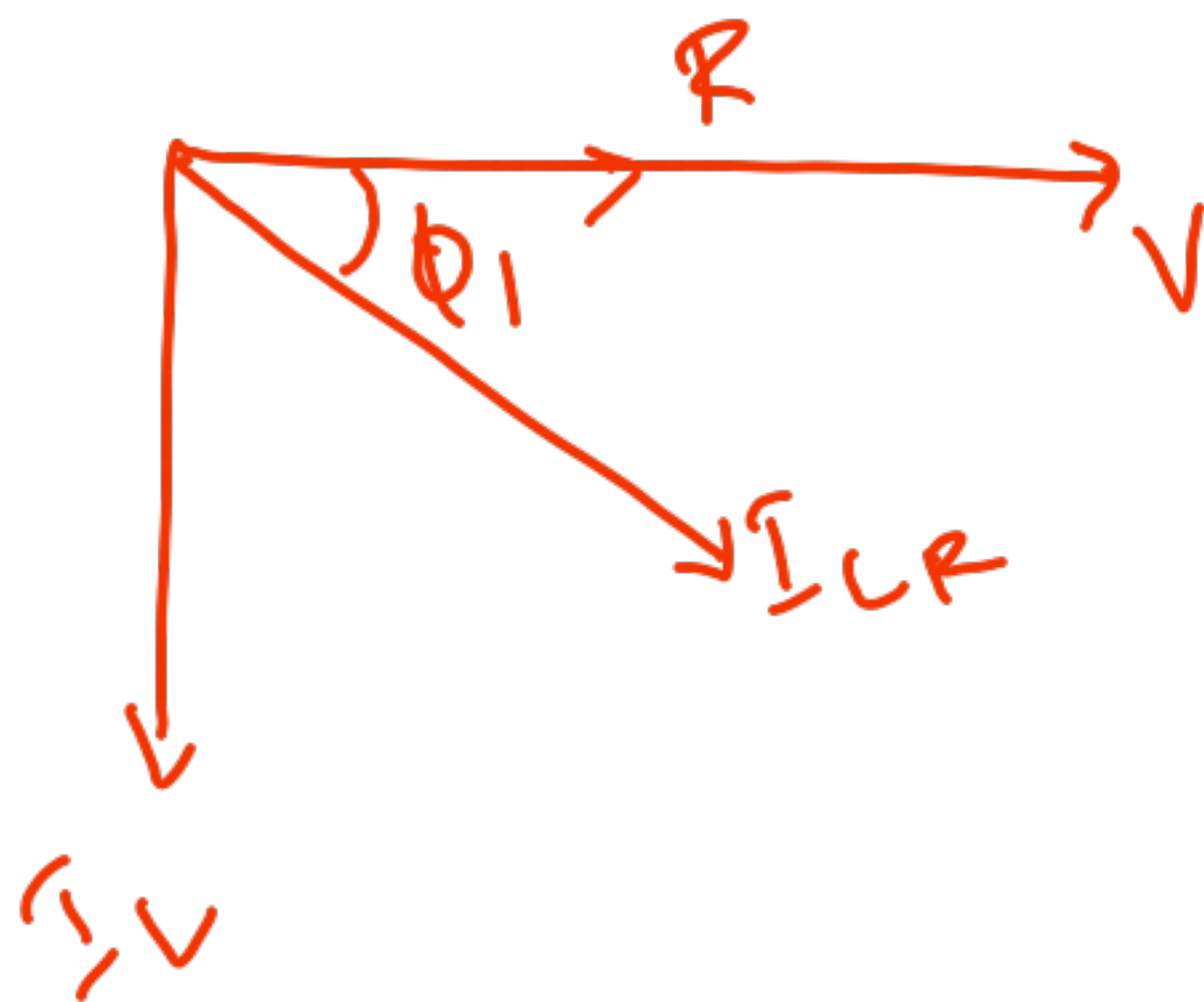
$$\vec{I} = \vec{I}_C - \vec{I}_L$$

$$I_C > I_L$$

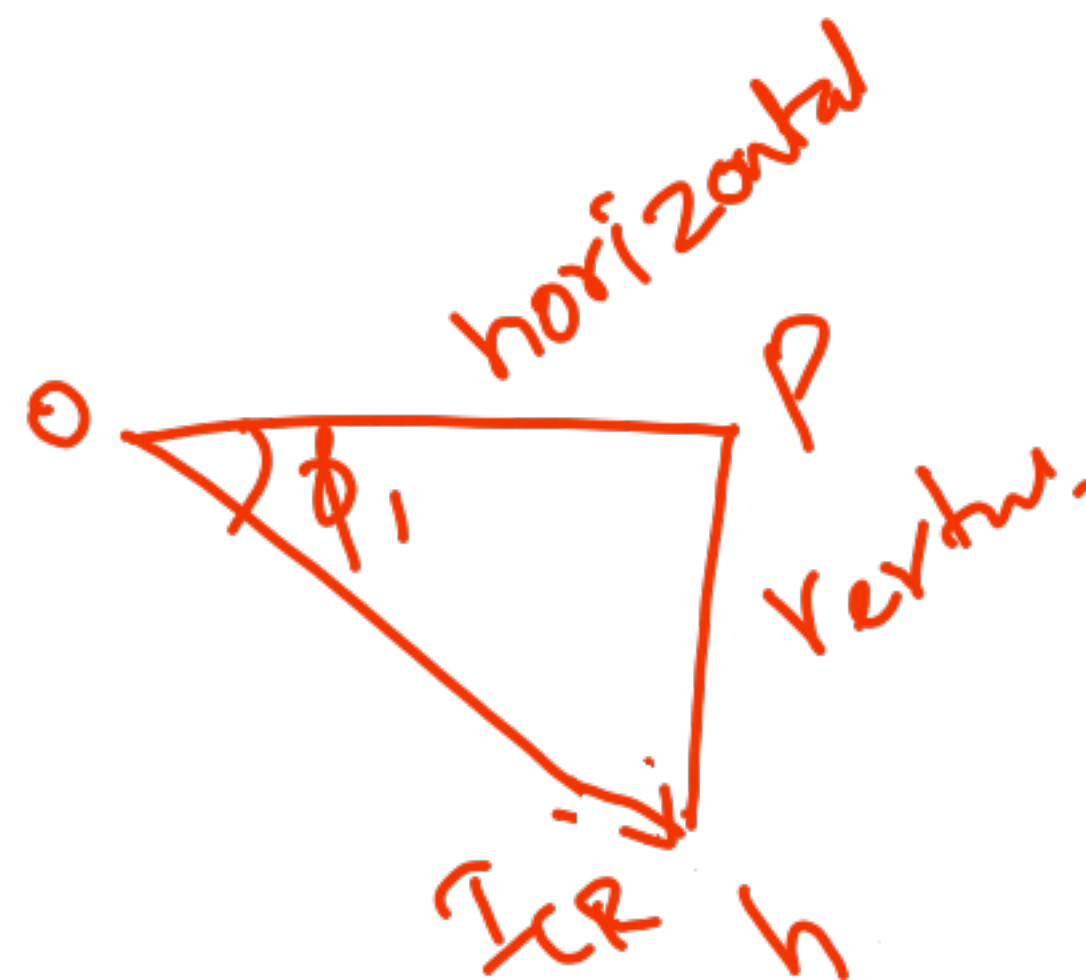
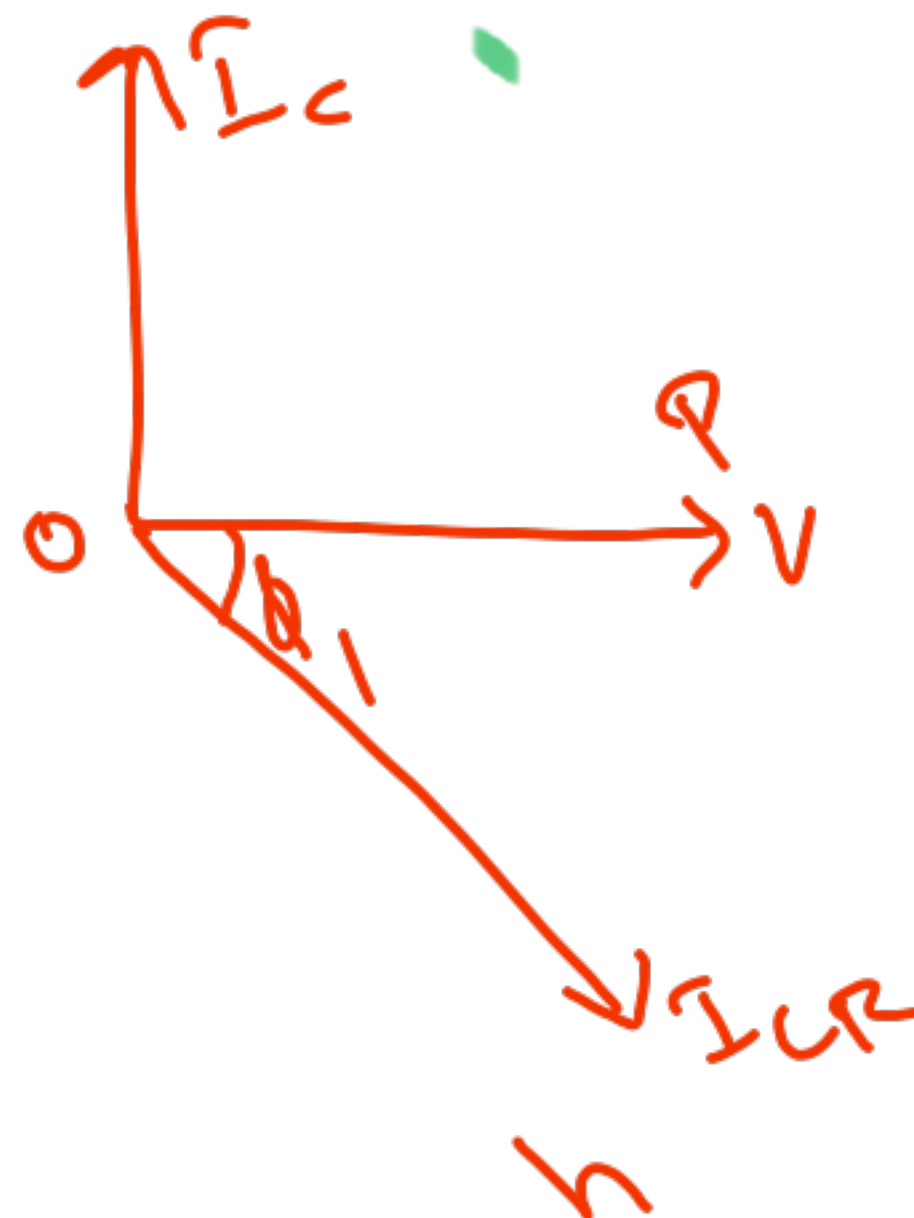


$$\underline{C-LR}$$

$$\underline{LR} \Rightarrow \phi_1$$



$$\underline{C-LR}$$



$$\sin \phi_1 = \frac{P_h}{I_{LR}}$$

$$P_h = I_{LR} \sin \phi_1 \quad (\text{vert})$$

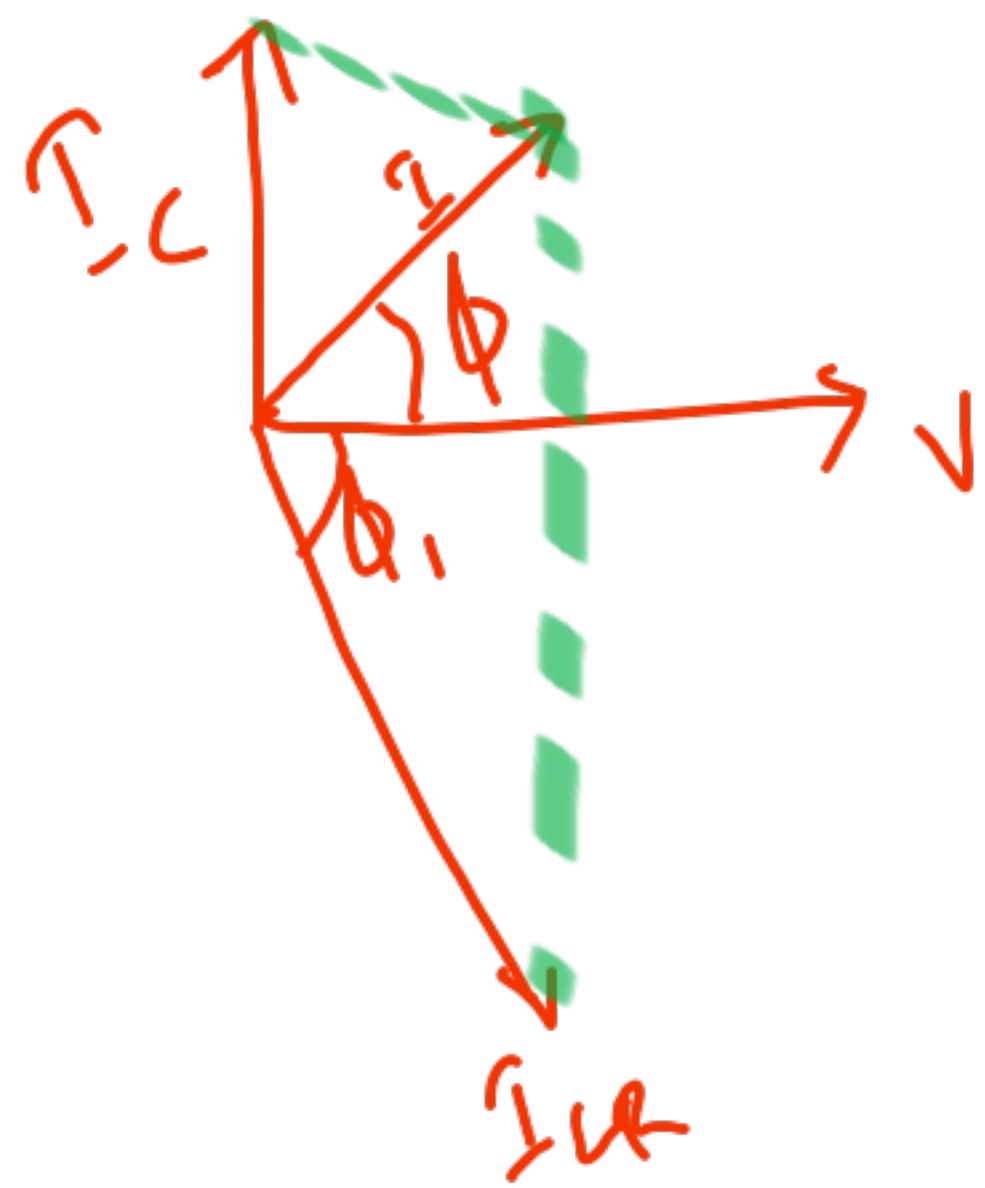
$$\cos \phi_1 = \frac{OP}{I_{LR}} \Rightarrow OP = I_{LR} \cos \phi_1 \quad (\text{horiz})$$

$$I_c > I_{LR} \sin \phi_1, \quad C \uparrow$$

$$I_c < I_{LR} \sin \phi_1 \rightarrow L \uparrow$$

$$I_c = I_{LR} \sin \phi_1$$

$$\underline{I_c > I_{LR} \sin \phi_1}$$



$$I = \sqrt{(I_{LR} \cos \phi_1)^2 + (I_{LR} \sin \phi_1 - I_c)^2}$$

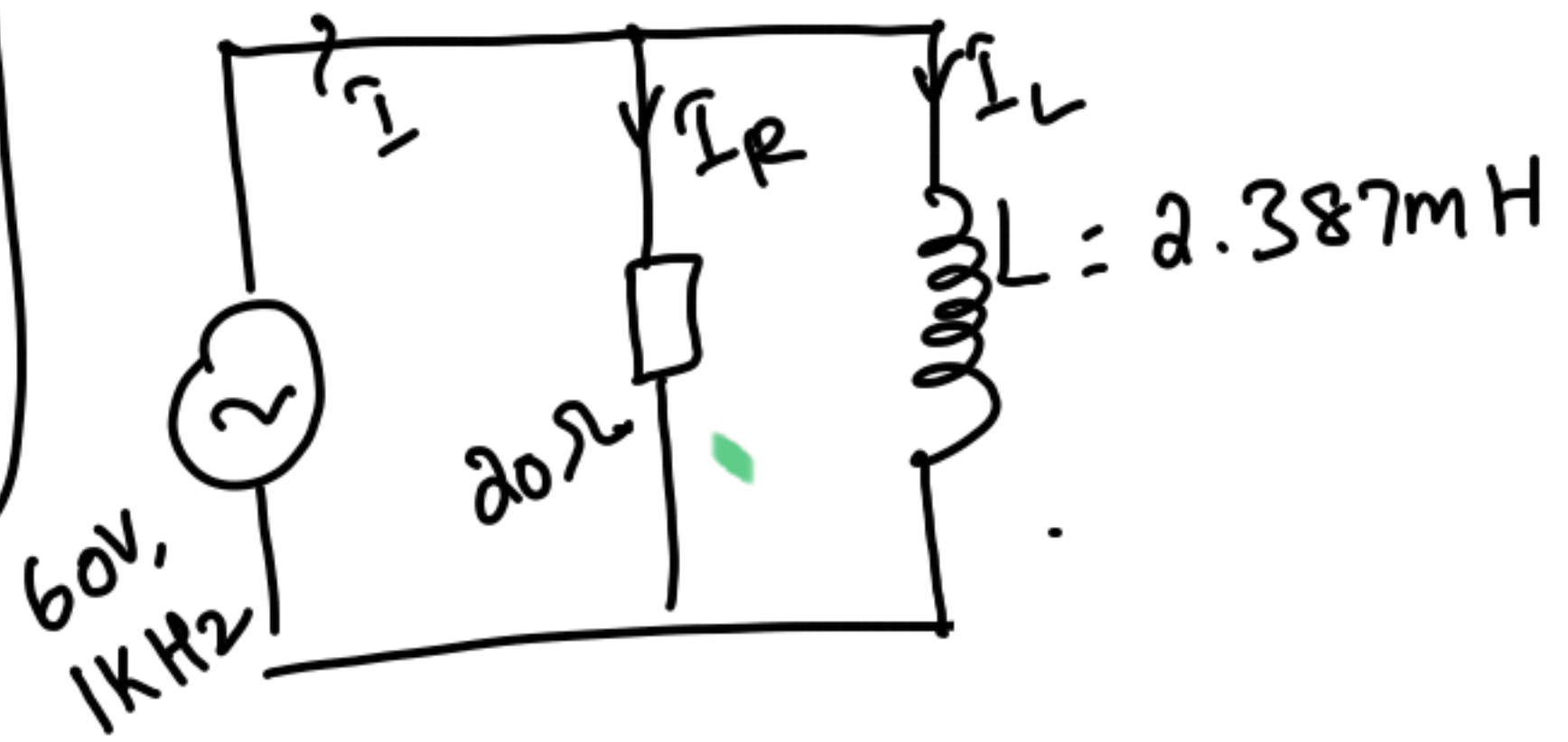
$$I_c < I_{LR} \sin \phi_1$$



$$\tan \phi = \frac{P.B.}{O.P.}$$

$$\tan \phi = \frac{I_{LR} \sin \phi_1 - I_c}{I_{LR} \cos \phi_1}$$

1) A  $20\Omega$  Resistor is connected in parallel with an inductor of  $2.387\text{mH}$  across a  $60\text{V}$ ,  $1\text{kHz}$  Supply. Calculate (a) the current in each branch



- b) Supply current  
c) Circuit phase angle  
d) Circuit Impedance  
e) Power consumed.

$$X_L = 2\pi fL$$
$$= 2\pi \times 1000 \times 2.387 \times 10^{-3}$$

$$X_L = 15$$

$$I_R = \frac{V}{R} = \frac{60}{20} = 3\text{A}$$

$$I_L = \frac{V}{X_L} = \frac{60}{15} = 4\text{A}$$

$$b) \quad \underline{I} = \sqrt{\underline{I}_L^2 + \underline{I}_R^2}$$

$$= \sqrt{4^2 + 3^2}$$

$$\underline{I} = 5A$$

c) phase angle

$$\phi = \tan^{-1}\left(\frac{\underline{I}_L}{\underline{I}_R}\right)$$

$$= \tan^{-1}\left(\frac{4}{3}\right)$$

$$\phi = 53.13^\circ$$

d) Impedance.

$$Z = \frac{V}{\underline{I}} = \frac{60}{5} = 12 \Omega.$$

e) Power

$$P = VI \cos \phi$$

$$= 60 \times 5 \times \cos(53.13^\circ)$$

$$P = 180W$$

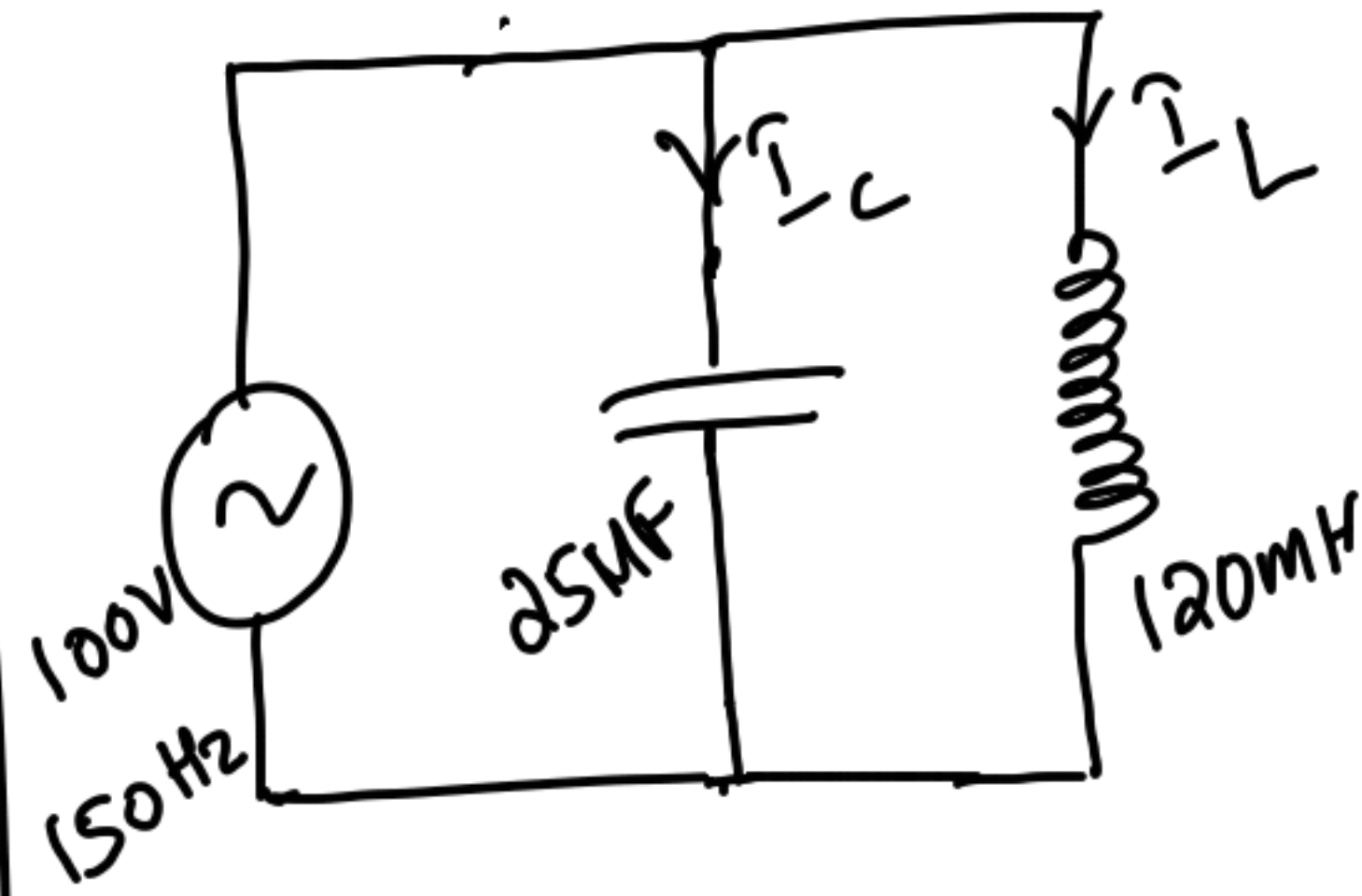
$$P = \underline{I}_R^2 R$$

$$= 3^2 \times 20$$

$$P = 9 \times 20 = 180W$$

2) A pure inductance of  $120\text{mH}$  is connected in parallel with  $25\mu\text{F}$  Capacitor and the circuit is connected to  $100\text{V}$ ,  $150\text{Hz}$  Supply. Determine.

- Branch Current
- Supply current and its phase angle
- Circuit impedance
- Power consumed.



$$I_C = \frac{V}{X_C}$$

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

$$X_L = 2\pi fL = 2\pi \times 150 \times 120 \times 10^{-3}$$

$$X_L = 113.1\Omega$$

$$X_C = \frac{1}{2\pi fC}$$

$$= \frac{1}{2\pi \times 150 \times 25 \times 10^{-6}}$$

$$X_C = 42.44 \Omega.$$

$$\hat{I}_C = \frac{100}{42.44} = 2.36 A$$

$$\hat{I}_L = \frac{100}{113.1}$$

$$\hat{I}_L = 0.88 A$$

$$\hat{I} = \hat{I}_C - \hat{I}_L$$

$$= 2.36 - 0.88$$

$$\hat{I} = 1.48 A$$

In L-C parallel Circ., the.

Resulting current  $\hat{I}$  will be  
at  $90^\circ$

$$\hat{I}_C > \hat{I}_L$$

$$\phi = 90^\circ (\text{leading})$$

Circuit Impedance.

$$Z = \frac{V}{\hat{I}}$$

$$= \frac{100}{1.48}$$

$$Z = 67.57 \Omega.$$

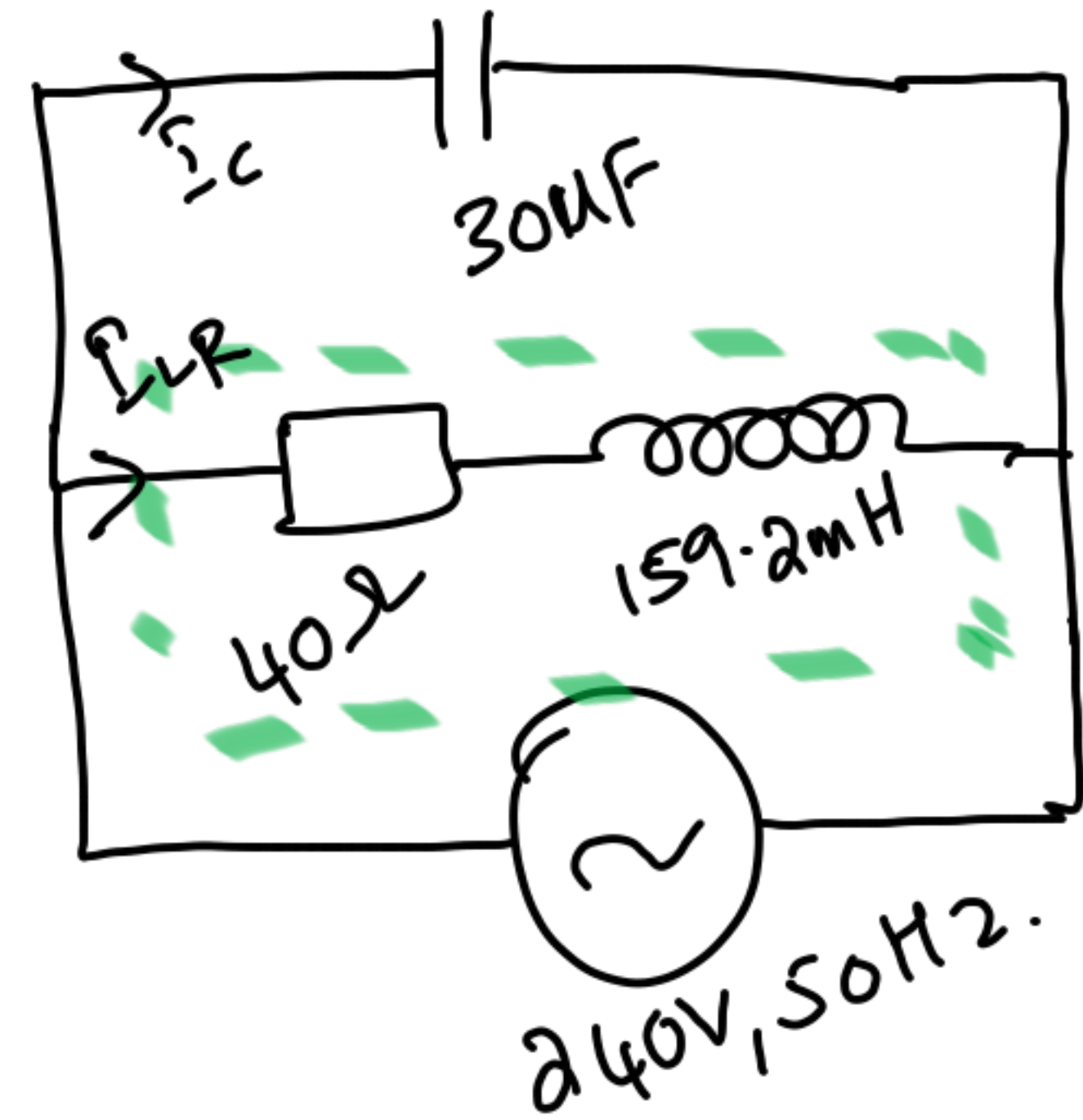
$$P = V\hat{I} \cos \phi$$

$$P = 100 \times 1.48 \cos 90$$

$$P = 0 W$$

- 3) A coil of inductance  $159.2\text{mH}$  and Resistance of  $40\Omega$  is connected in parallel with a  $30\mu\text{F}$  Capacitor across  $240\text{V}$ ,  $50\text{Hz}$  Supply. Calculate
- The Current in the Coil and phase angle
  - Current in the Capacitor and phase angle
  - Supply current and phase angle
  - Circuit Impedance
  - Power Consumed, Reactive power and Apparent power.

Soln.



C - LR — Parallel Circ.

a) Current in the coil

$$I_{LR} = \frac{V}{Z_{LR}}$$

$$X_L = 2\pi fL$$
$$= 2\pi \times 50 \times 159.2 \times 10^{-3}$$

$$X_L = 50 \Omega$$

$$Z_{LR} = \sqrt{X_L^2 + R^2}$$
$$= \sqrt{50^2 + 40^2}$$

$$Z_{LR} = 64.03 \Omega$$

$$I_{LR} = \frac{240}{64.03} = 3.75 \text{ A}$$

phase angle.

$$\phi_{LR} = \tan^{-1} \left( \frac{X_L}{R} \right)$$

$$= \tan^{-1} \left( \frac{50}{40} \right)$$

$$\phi_{LR} = 51.34^\circ$$

b) Current across Capacitor

$$I_C = \frac{V}{X_C}$$

$$X_C = \frac{1}{2\pi fC}$$

$$= \frac{1}{2\pi \times 50 \times 30 \times 10^{-6}}$$

$$X_C = 106.1 \Omega$$

$$I_C = \frac{240}{106.1}$$

$$I_C = 2.26 \text{ A}$$

$$\phi_c = 90^\circ \text{ [leading]}$$

c) Supply current

$$I = \sqrt{(I_{LR} \cos \phi_{LR})^2 + (I_{LR} \sin \phi_{LR} - I_c)^2}$$

$$I_{LR} \cos \phi_{LR} = 3.75 \cos(51.34^\circ) = 2.34 \text{ A}$$

$$I_{LR} \sin \phi_{LR} = 3.75 \sin(51.34^\circ) = 2.93 \text{ A}$$

$$I = \sqrt{(2.34)^2 + (2.93 - 2.26)^2} = 2.43 \text{ A}$$

$$\phi = \tan^{-1} \left( \frac{I_{LR} \sin \phi_{LR} - I_c}{I_{LR} \cos \phi_{LR}} \right)$$

$$= \tan^{-1} \left( \frac{2.93 - 2.26}{2.34} \right)$$

$$\phi = 15.98^\circ \text{ [lagging]}$$

As,  $I_c < I_{LR} \sin \phi_{LR}$

d) Impedance

$$Z = \frac{V}{I} = \frac{240}{2.43} = 98.77 \Omega$$

e) Power Consumed

$$P = VI \cos \phi$$

$$P = 240 \times 2.43 \cos(15.98^\circ)$$

$$P = 560.66 \text{ W}$$

Apparent power

$$S = VI$$

$$= 240 \times 2.43$$

$$S = 583.2 \text{ VA}$$

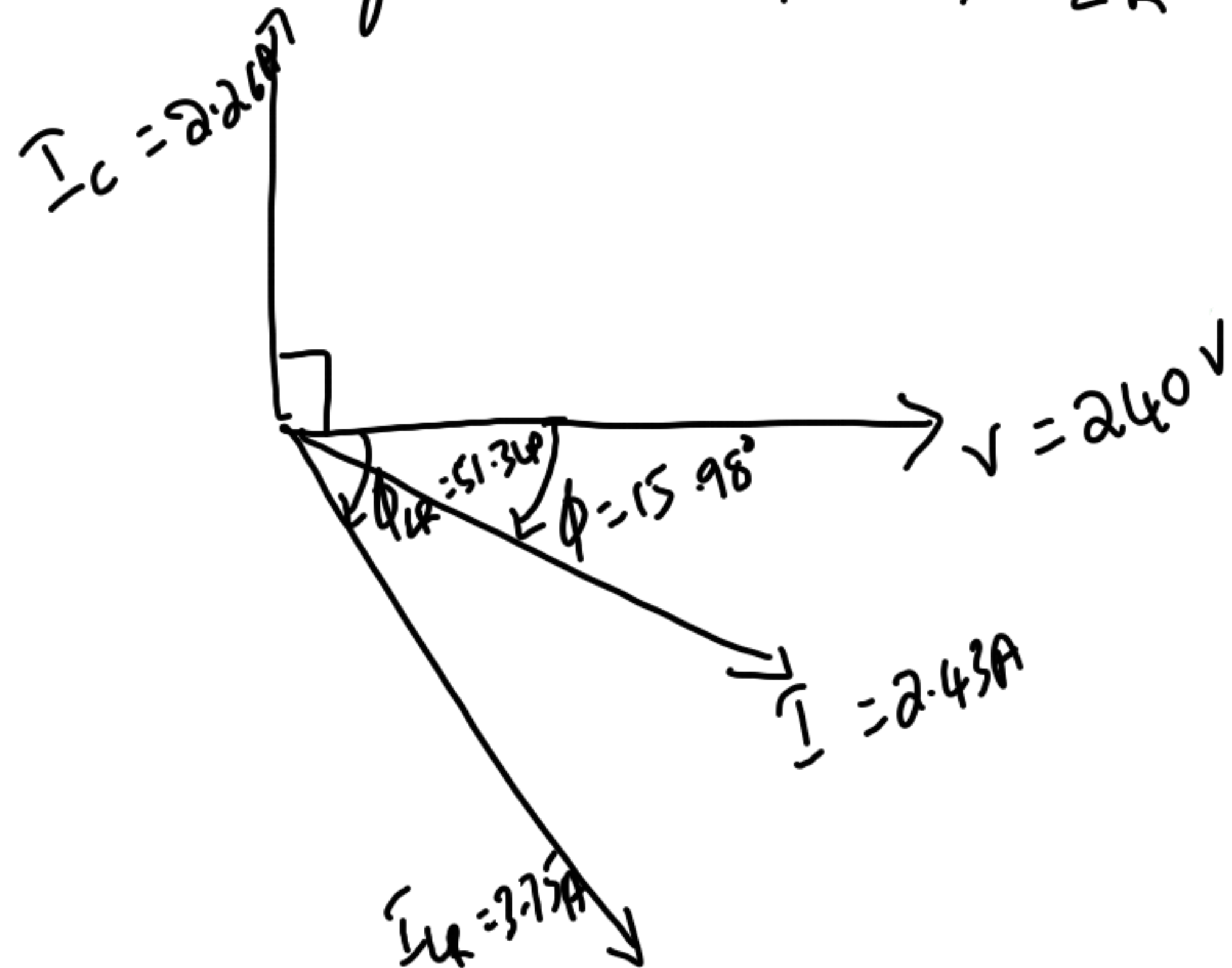
Reactive power

$$Q = VI \sin \phi$$

$$= 240 \times 2.43 \sin(15.98^\circ)$$

$$Q = 160.56 \text{ VAR}$$

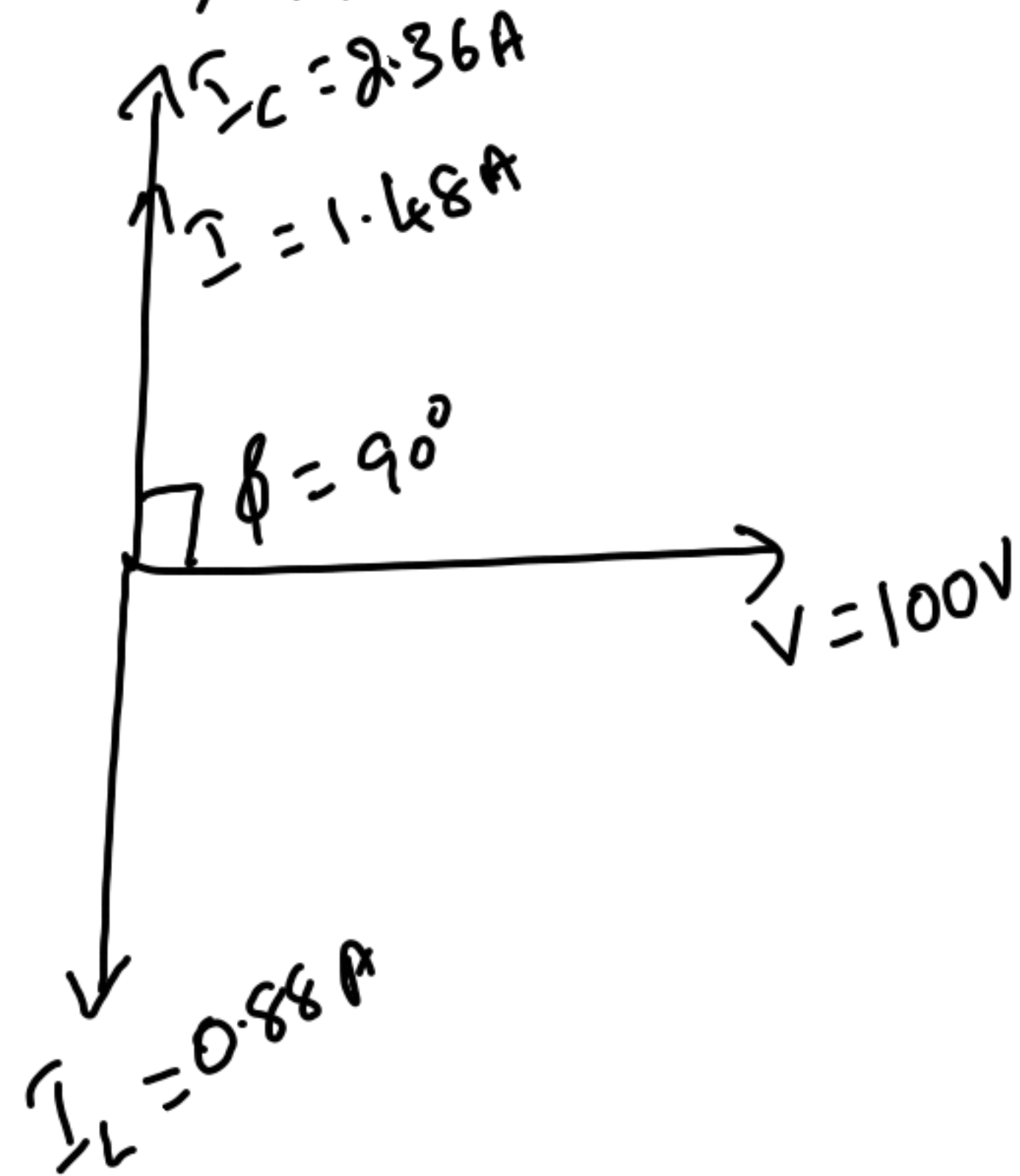
Phasor diagram,  $\vec{I}_{LR}$ ,  $\vec{I}_C$ ,  $\phi_{LR}$ ,  $\phi$ ,  $\vec{I}$ ,  $\vec{V}$   
 $\phi_C$



Q2. Phasor Diagram

L-C Parallel.

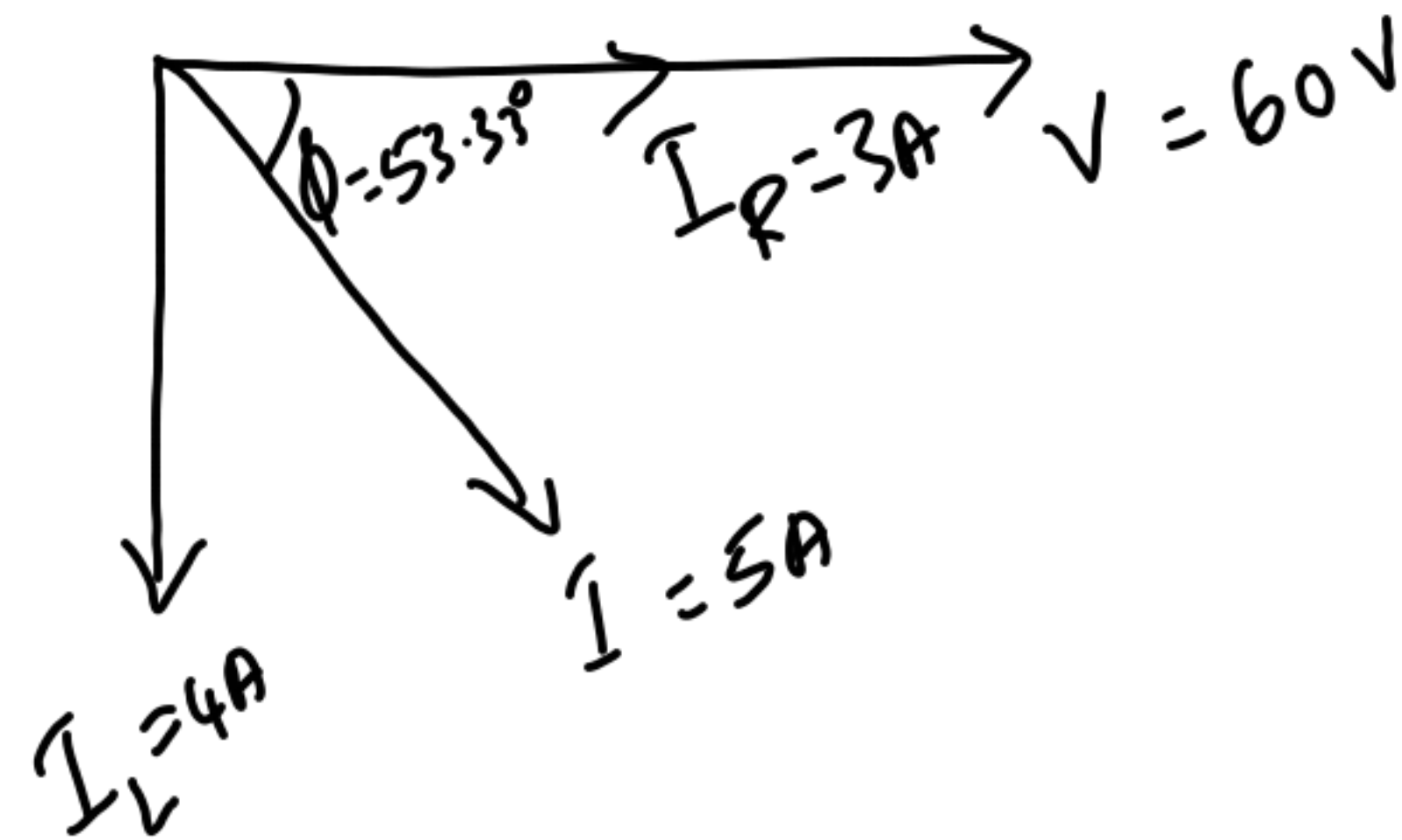
$\underline{I}_C$ ,  $\underline{I}_L$ ,  $\phi$ ,  $\underline{I}$ ,  $V$



Q1. Phasor diagram

RL Parallel Circuit.

$\underline{I}_L$ ,  $\underline{I}_R$ ,  $\phi$ ,  $V$ ,  $\underline{I}$



4) A pure inductance of  $150\text{mH}$  is and Resistor of  $50\Omega$  is connected in parallel with a capacitor of  $20\mu\text{F}$  across  $20\text{V}$ . Calculate the Resonant frequency.

Soln.

$$R = 50\Omega$$

$$L = 150\text{mH}$$

$$C = 20\mu\text{F}$$

$$f_r = \frac{1}{2\pi} \sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$$

$$f_r = \frac{1}{2\pi} \sqrt{\frac{1}{150 \times 10^{-3} \times 20 \times 10^{-6}} - \frac{50^2}{(150 \times 10^{-3})^2}}$$

$$f_r = 75.02 \text{ Hz}$$