

1) A coil of inductance 0.20H and Resistance of 60Ω is connected in parallel with a $20\mu\text{F}$ Capacitor across 20V variable frequency supply.

Calculate

- Resonance frequency
- The dynamic Resistance.
- the current at resonance
- the circuit Q-factor at resonance.

Soln

$$\begin{aligned} \text{a) } f_r &= \frac{1}{2\pi} \sqrt{\frac{1}{LC} - \frac{R^2}{L^2}} \\ &= \frac{1}{2\pi} \sqrt{\frac{1}{0.20 \times 20 \times 10^{-6}} - \frac{60^2}{(0.20)^2}} \end{aligned}$$

$$f_r = 63.66 \text{ Hz}$$

b) dynamic Resistance.

$$\begin{aligned} R_D &= \frac{L}{RC} = \frac{0.2}{60 \times 20 \times 10^{-6}} \\ &= 166.7 \Omega. \end{aligned}$$

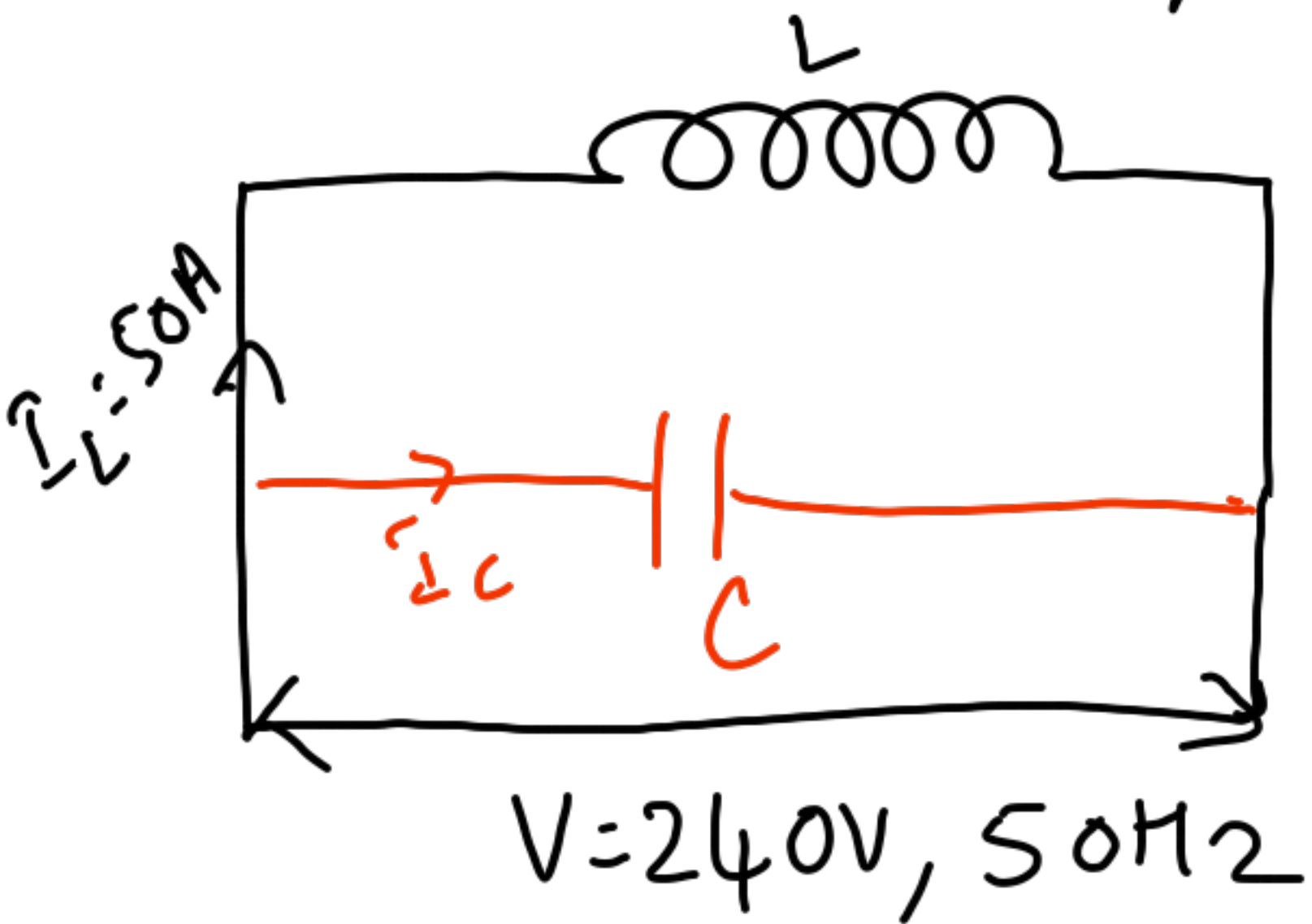
c) Current at resonance

$$\begin{aligned} I_r &= \frac{V}{R_D} = \frac{20}{166.7} \\ &= 0.12 \text{ A} = 120 \text{ mA} \end{aligned}$$

d) Q.- factor at Resonance

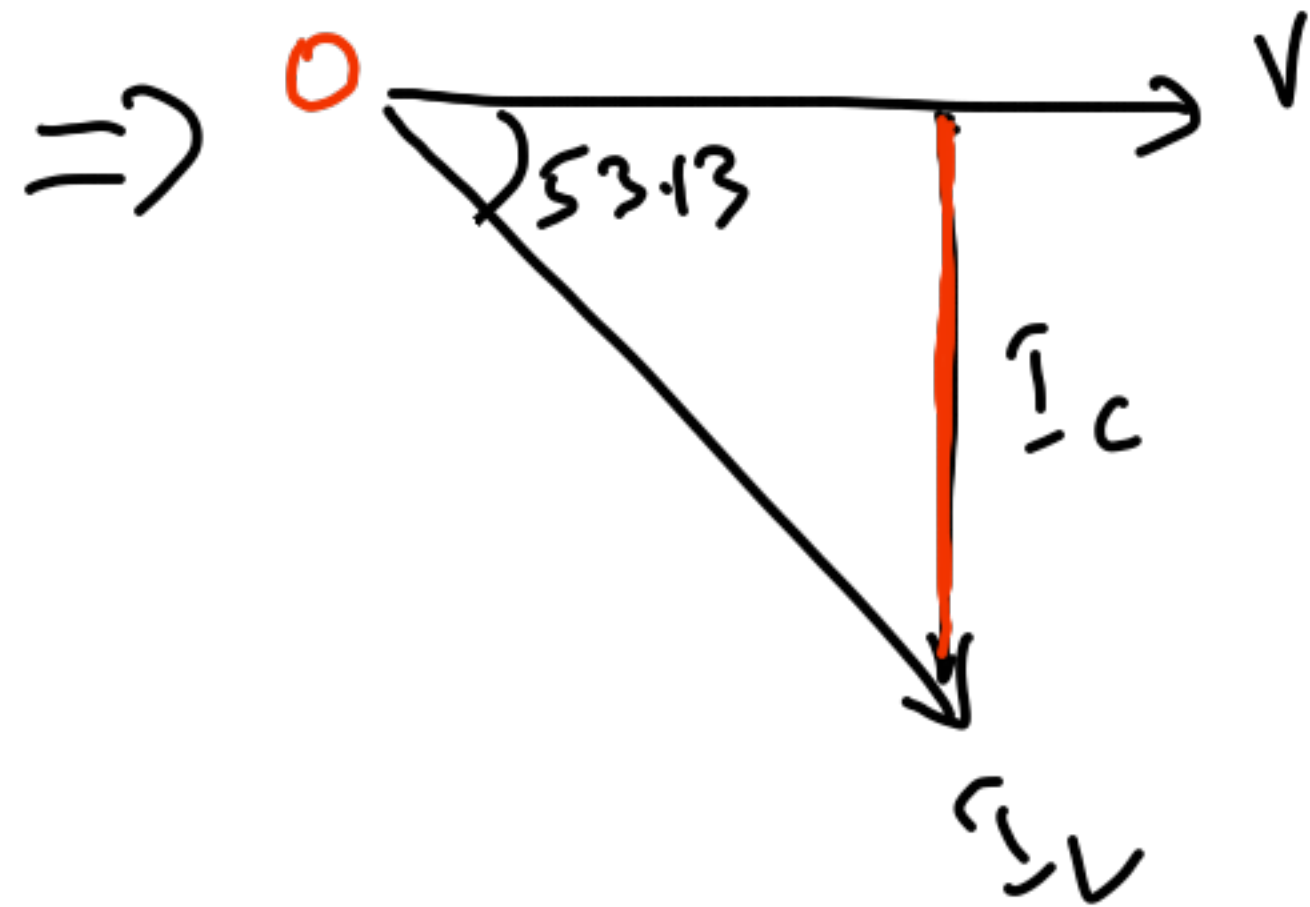
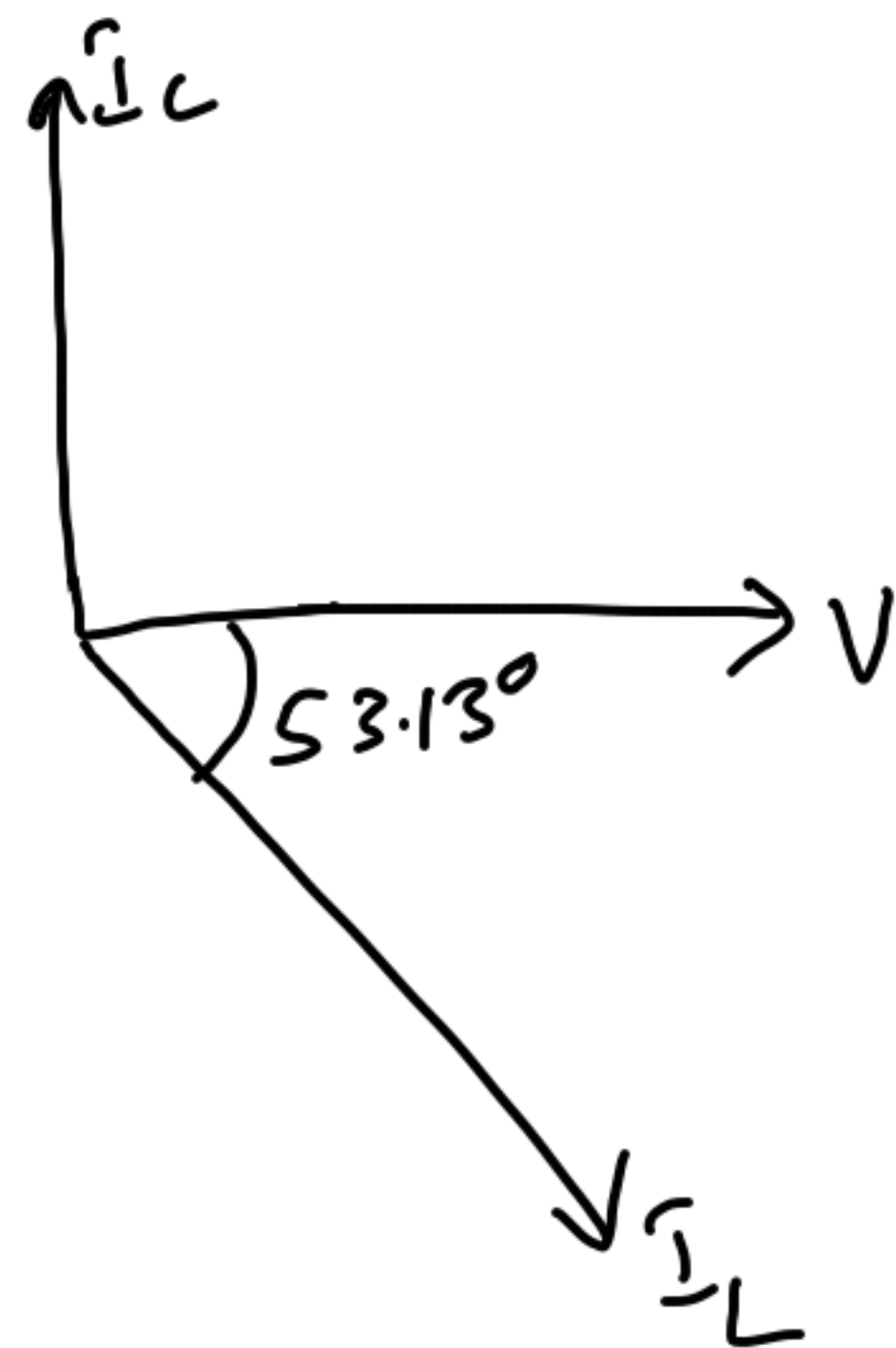
$$\begin{aligned} &= \frac{2\pi f_r L}{R} = \frac{2\pi \times 63.66 \times 0.20}{60} \\ &= 1.33 \end{aligned}$$

2) What value of the capacitor is needed to improve the power factor from 0.6 lagging to unity.



$$\cos \phi = 0.6$$

$$\phi = \cos^{-1}(0.6) = 53.13^\circ$$



$$\sin \phi = \frac{\text{opp}}{\text{hyp}}$$

$$\sin \phi = \frac{I_C}{I_L}$$

$$\sin(53.13^\circ) = \frac{I_c}{50}$$

$$I_c = 50 \times \sin(53.13^\circ)$$

$$I_c = 40 \text{ A}$$

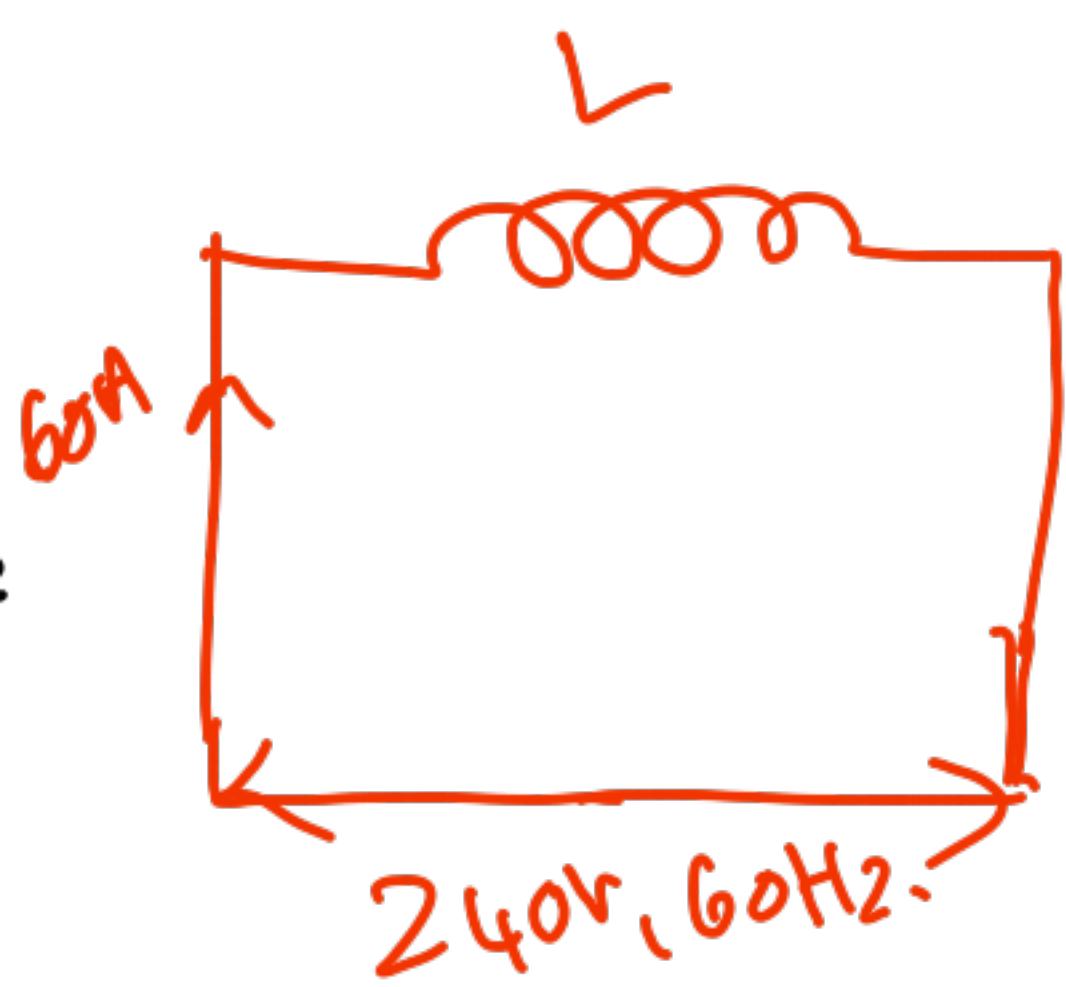
W.K.T.

$$I_c = \frac{V}{X_c} = \frac{V}{\frac{1}{2\pi fC}} = V 2\pi fC$$

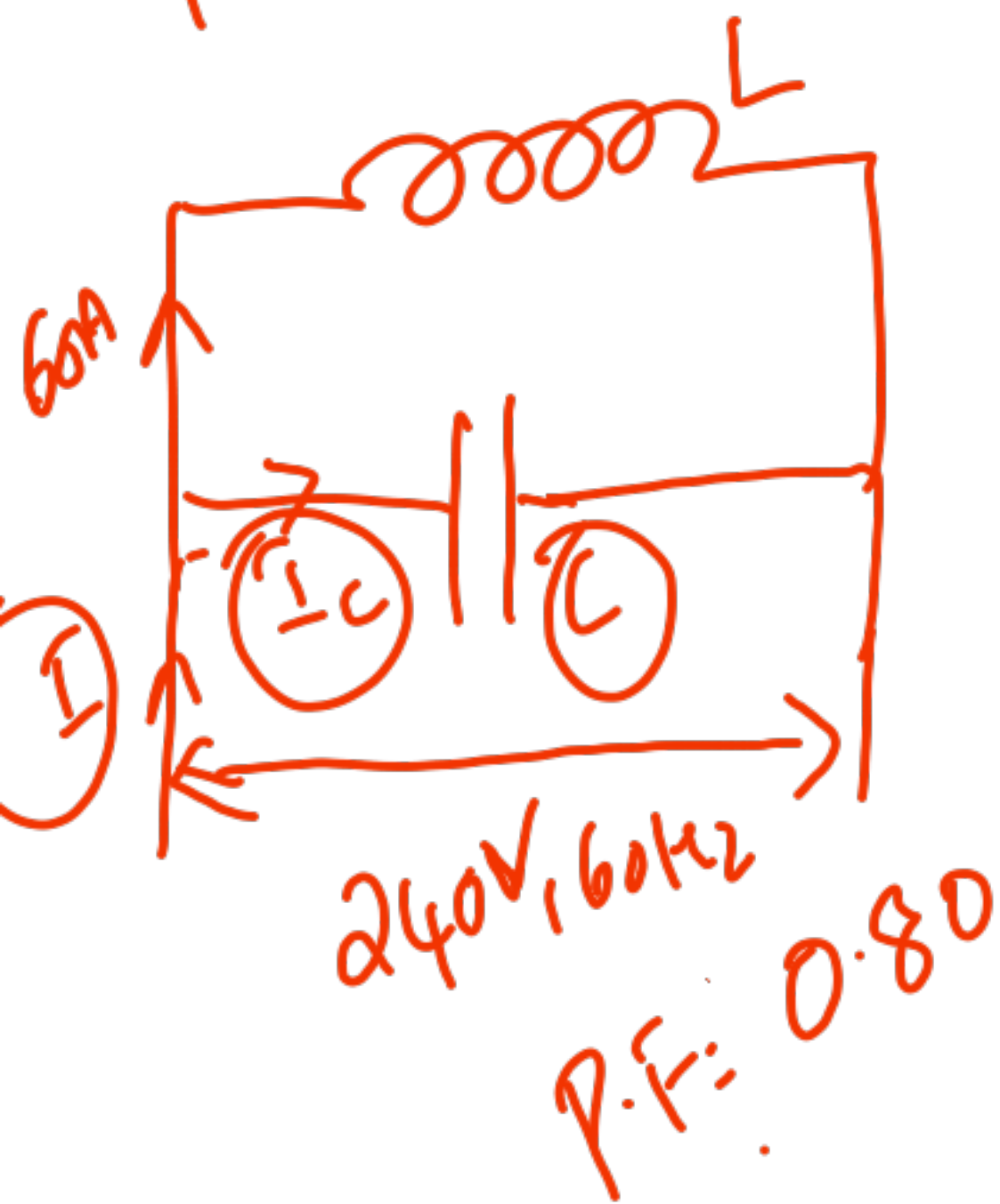
$$I_c = 2\pi V f C$$

$$C = \frac{I_c}{2\pi V f} = 530.5 \mu\text{F}$$

3) An inductive load takes a current of 60A at a power factor of 0.643 lagging when connected to a 240V, 60Hz supply. It is required to improve the power factor to 0.80 lagging by connecting a capacitor in parallel with the load. Calculate (a) a new supply current (b) the capacitor current (c) value of the power factor correction capacitor.



P.F. = 0.643



$$\cos \phi = 0.643$$

$$\phi = \cos^{-1}(0.643)$$

$$\phi = 50^\circ$$

improved power factor.

$$\cos \phi = 0.80$$

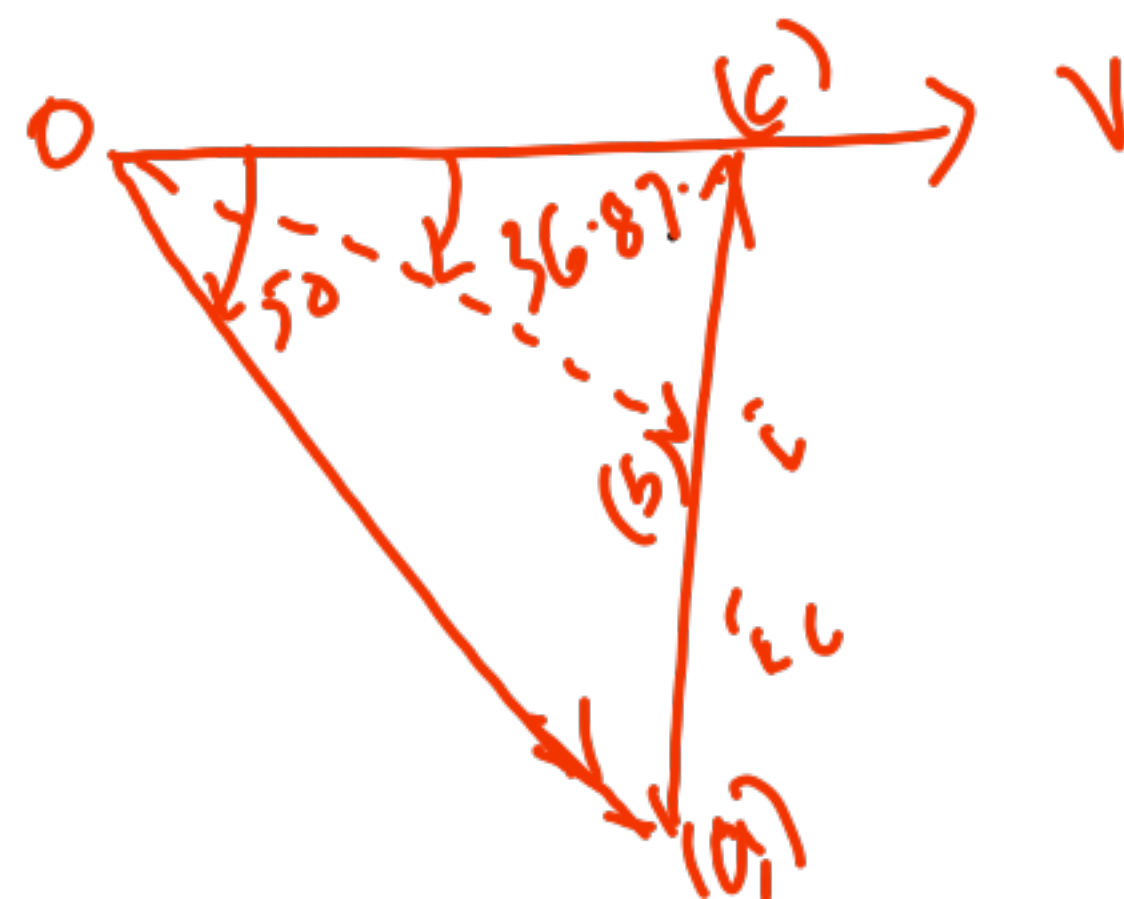
$$\phi = \cos^{-1}(0.80)$$

$$\phi = 36.87^\circ$$



$I_L = 48.21A$

$I_L = 60A$



Δobc

$$\cos 36.87 = \frac{oc}{\hat{I}}$$

$\frac{adj}{hyp}$

Δoac

$$\cos 50^\circ = \frac{adj}{hyp} = \frac{oc}{oa}$$

$$= \frac{oc}{\hat{I}_L} = \frac{oc}{60}$$

$$\cos 50 = \frac{oc}{60}$$

$$oc = 60 \times \cos 50^\circ = 38.57$$

Sub oc in $\cos 36.87 = \frac{oc}{\hat{I}}$

$$\cos 36.87 = \frac{38.57}{\hat{I}}$$

$$\hat{I} = \frac{38.57}{\cos 36.87} = 48.21A$$

b) To find $\hat{I}_C$

Total current

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

$$\begin{aligned}\hat{I}_C &= \hat{I} - \hat{I}_L = 48.21 \angle -36.87^\circ \\ &\quad - 60 \angle -50^\circ \\ &= 17.03 \angle 90^\circ\end{aligned}$$

$$= 48 \cdot 21 \angle -36.87^\circ - 60 \angle -50^\circ$$
$$= \left[48 \cdot 21 \cos(-36.87^\circ) + j 48 \cdot 21 \sin(-36.87^\circ) \right] - \left[60 \cos(-50^\circ) + j 60 \sin(-50^\circ) \right]$$
$$= (38.568 - j 28.246) - (38.568 + j 45.96)$$
$$= 0 + j 17.03$$

$$I_C = 17.03 \angle 90^\circ$$

To find Capacitor value

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

$\gamma L\phi$ - Polar

Rektzyklar $\Rightarrow r \cos \phi + j r \sin \phi$

$$(x + jy) + (A + jB)$$

$$(X + A) + j(Y + B)$$

$$X + jY \Rightarrow$$

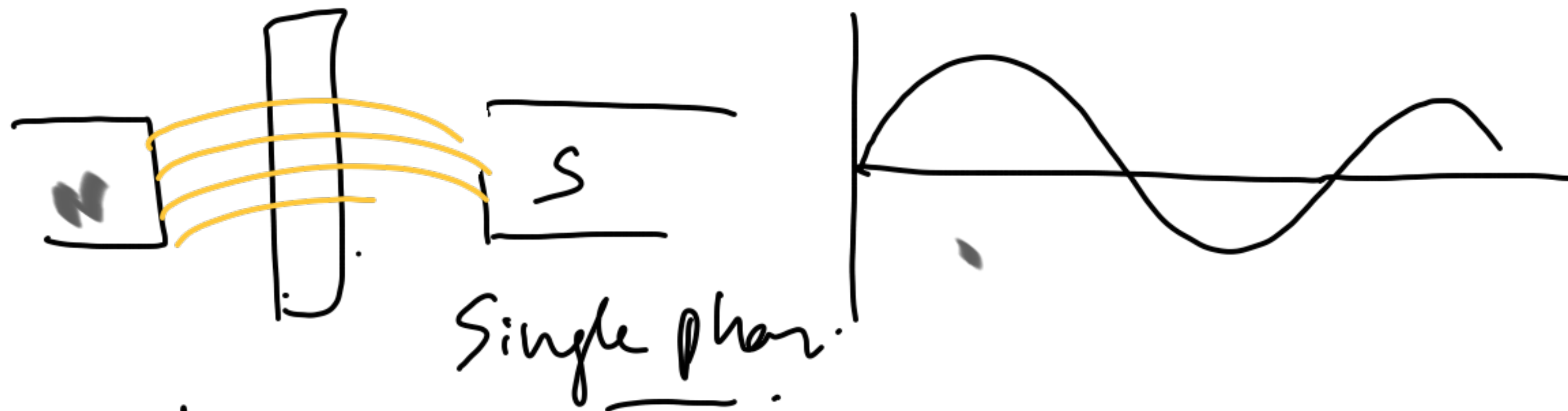
$$r = \sqrt{x^2 + y^2}$$

$$\theta = \tan^{-1}\left(\frac{y}{x}\right)$$

$$\tan^{-1}\left(\frac{17.0}{0}\right)$$

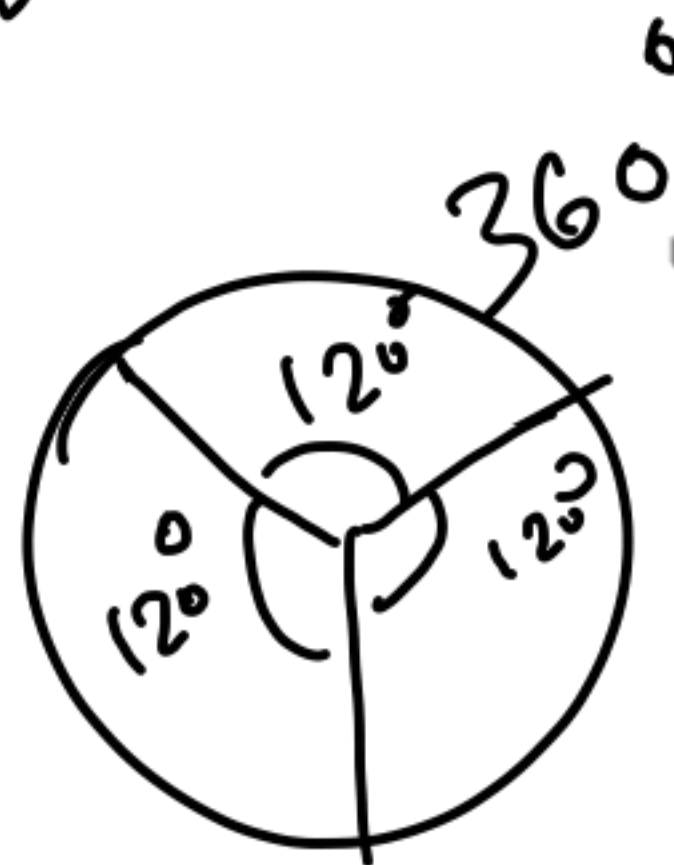
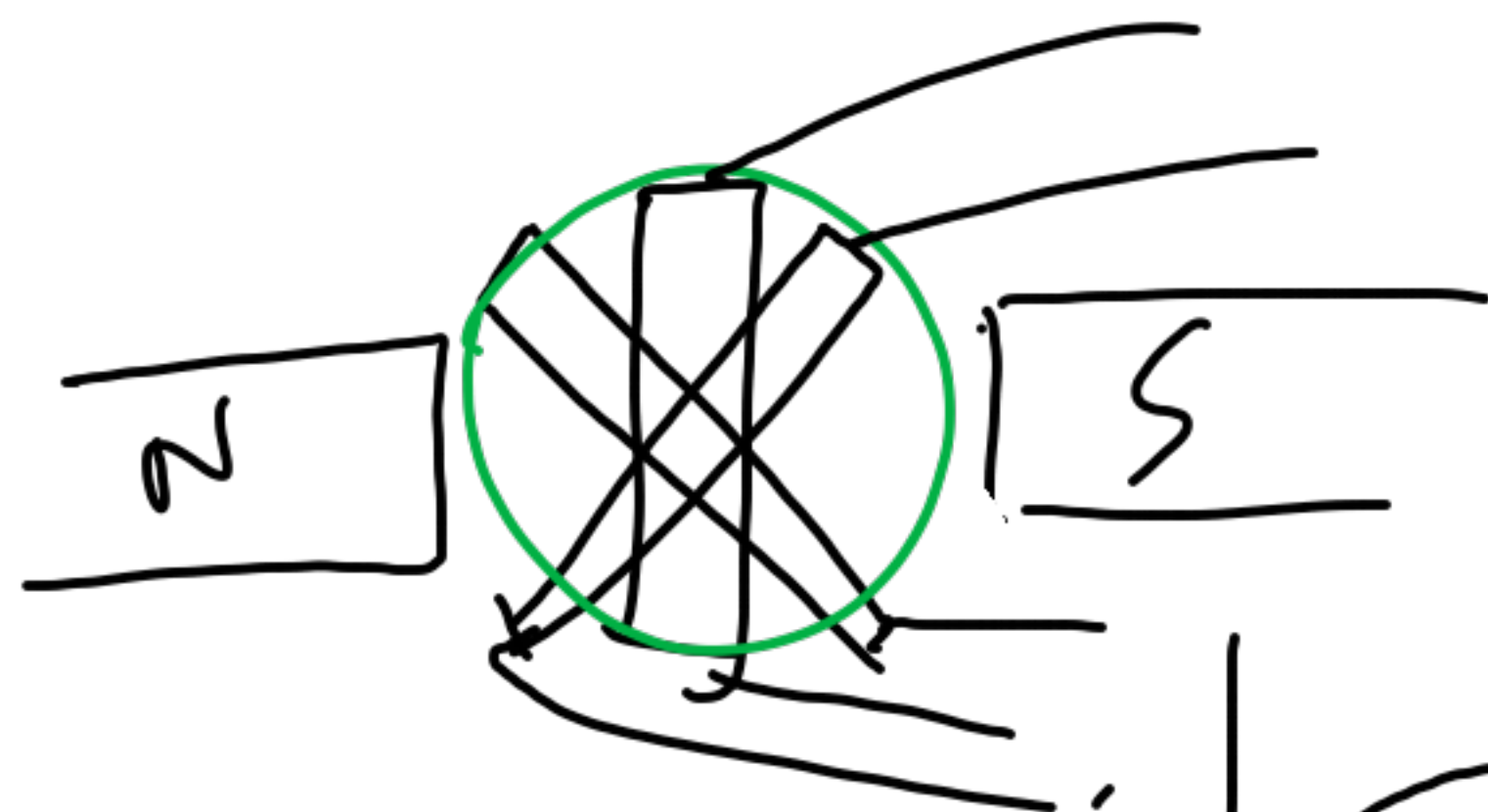
$$\tan^{-1}(\alpha) = 90^\circ$$

$$\tan(\alpha) = \underline{\underline{96^\circ}}$$



Star
Delta / mesh

Red
Blank

$$\left. \begin{array}{l} + \\ - \end{array} \right\} \frac{240V}{220-240V}$$


Red / Yellow / Blue

R
Y
B

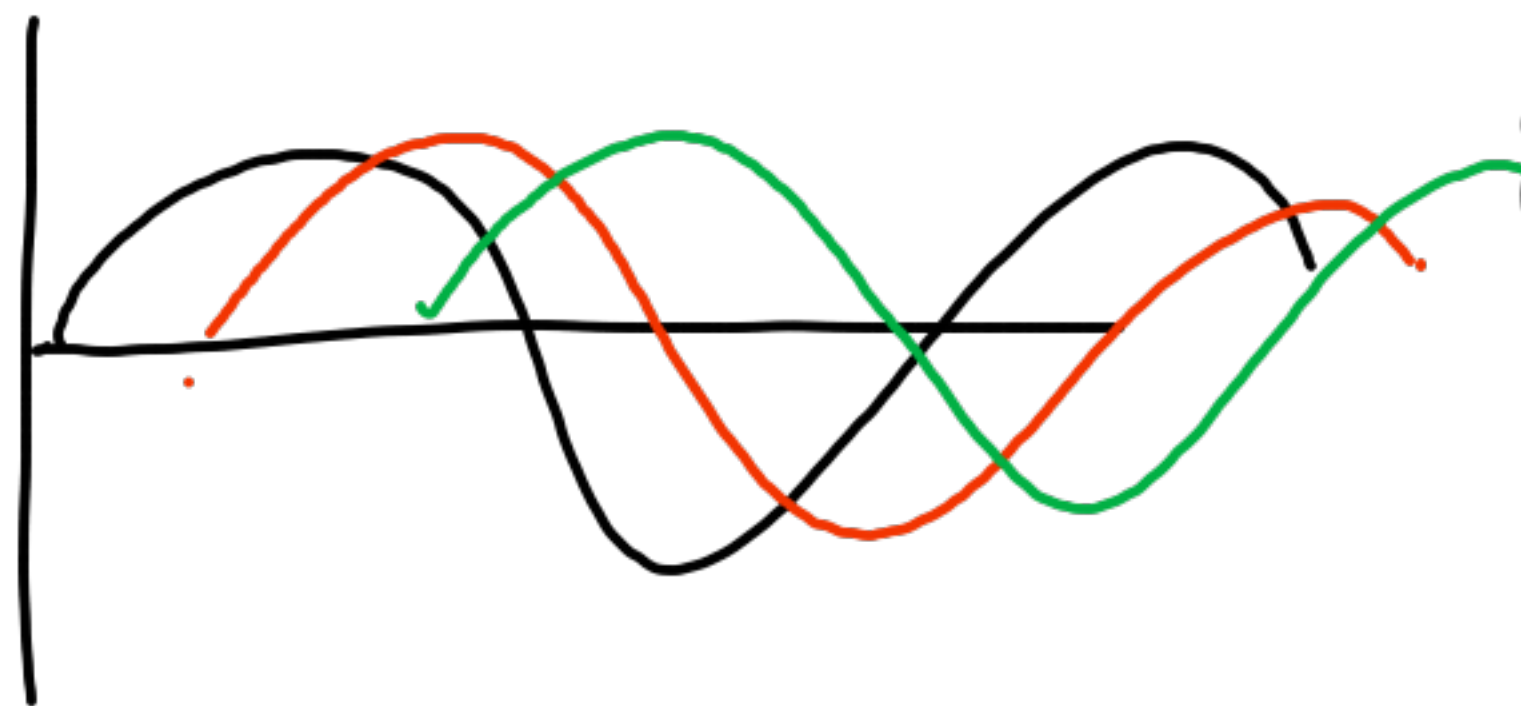
P

N

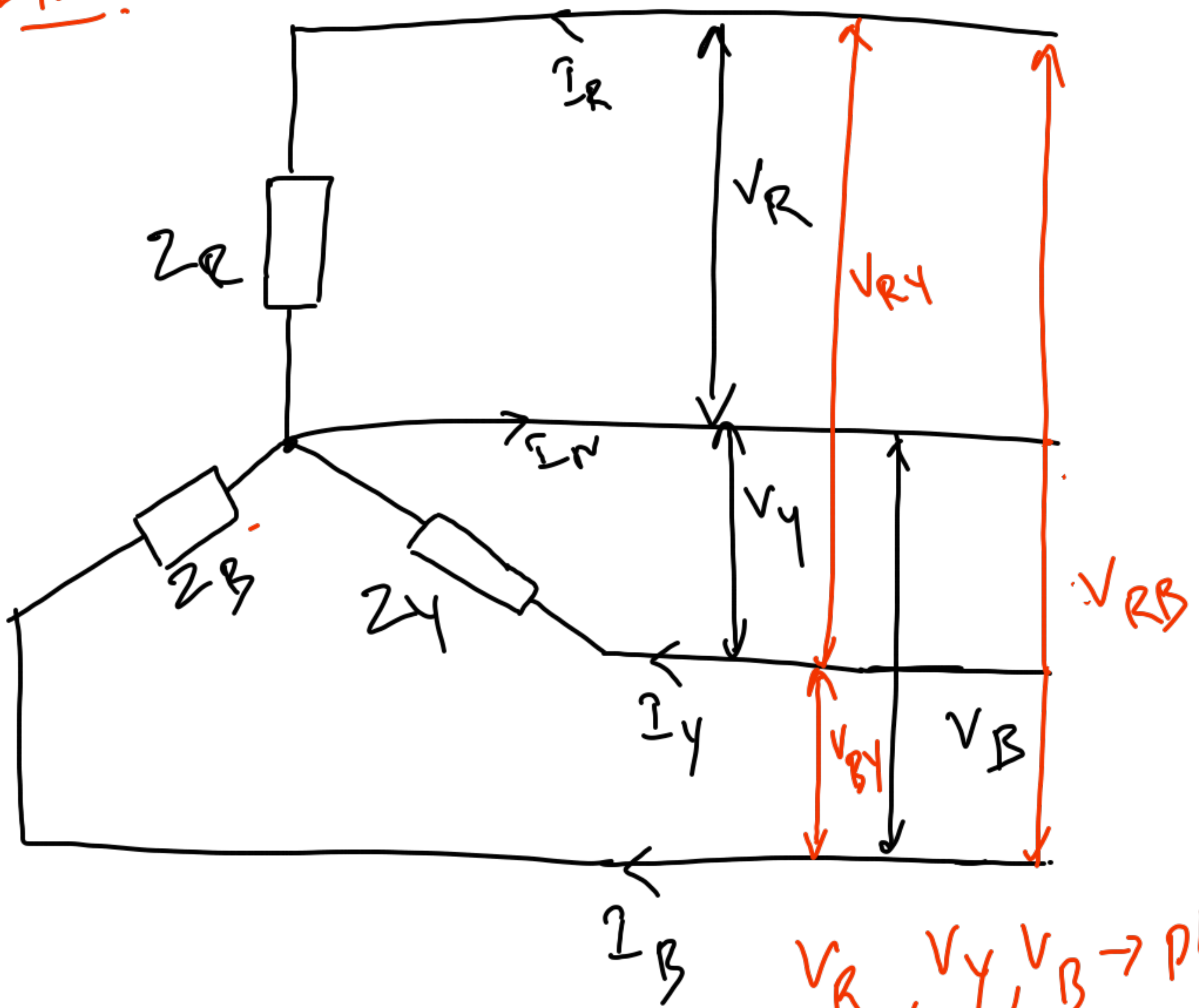
Blank.

$$415V$$

420-440
415V



Star.



$$I_L = I_P$$

$$V_L = \sqrt{3} V_P$$

Balance network.

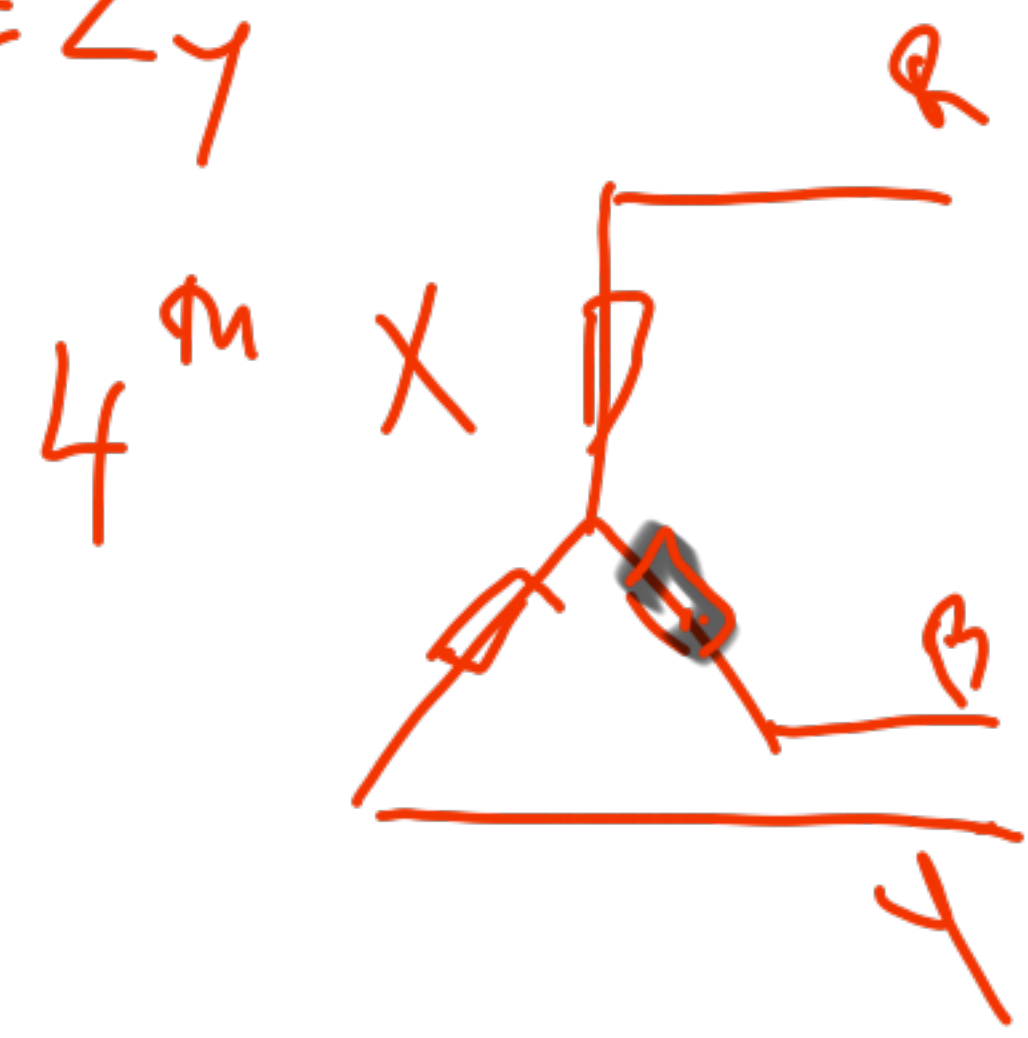
$$V_R = V_Y = V_B$$

$$V_{RY} = V_{YB} = V_{RB}$$

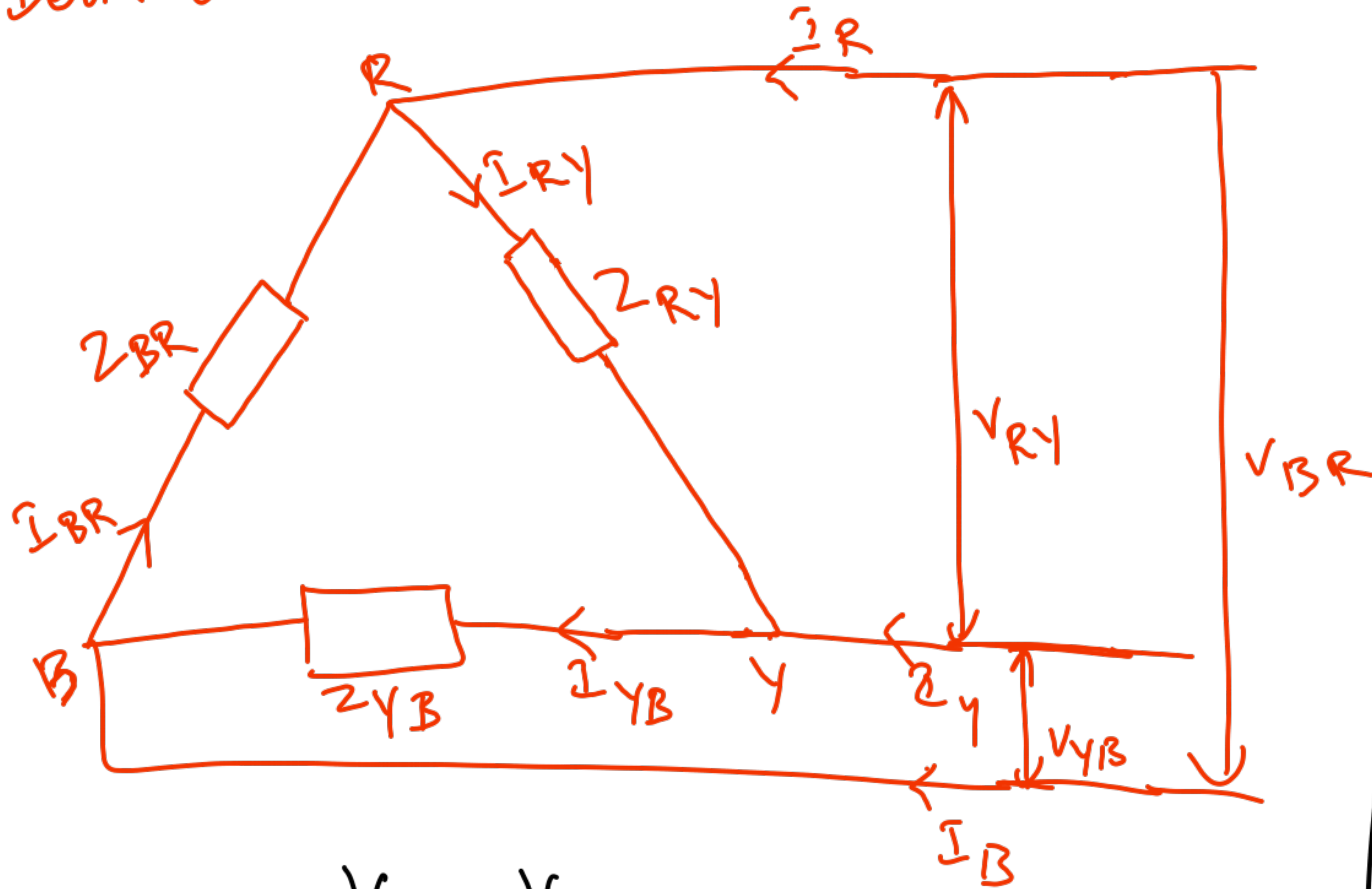
$$Z_R = Z_Y = Z_B$$

$V_R, V_Y, V_B \rightarrow$ phase voltages

$V_{RY}, V_{YB}, V_{RB} \rightarrow$ line voltages



Delta Connection.



$$V_L = V_P$$

$$I_L = \sqrt{3} I_P$$

Power in 3 phase

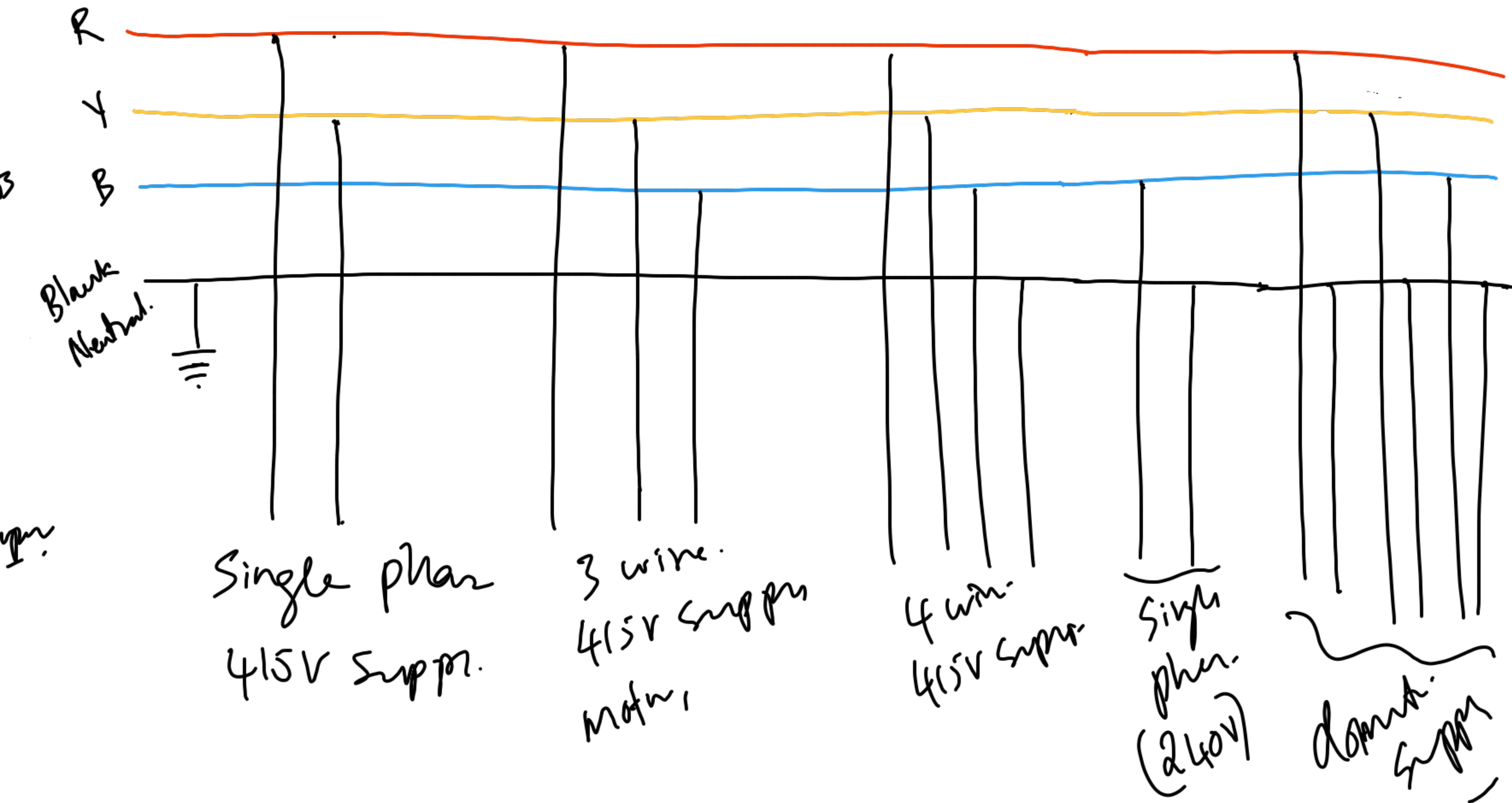
$$P = \sqrt{3} V_L I_L \cos \phi \text{ Watts}$$

(or)

$$P = 3 I_P^2 R_P \text{ Watts}$$

Volt-Ampere

$$S = \sqrt{3} V_L I_L \text{ volt-M}$$

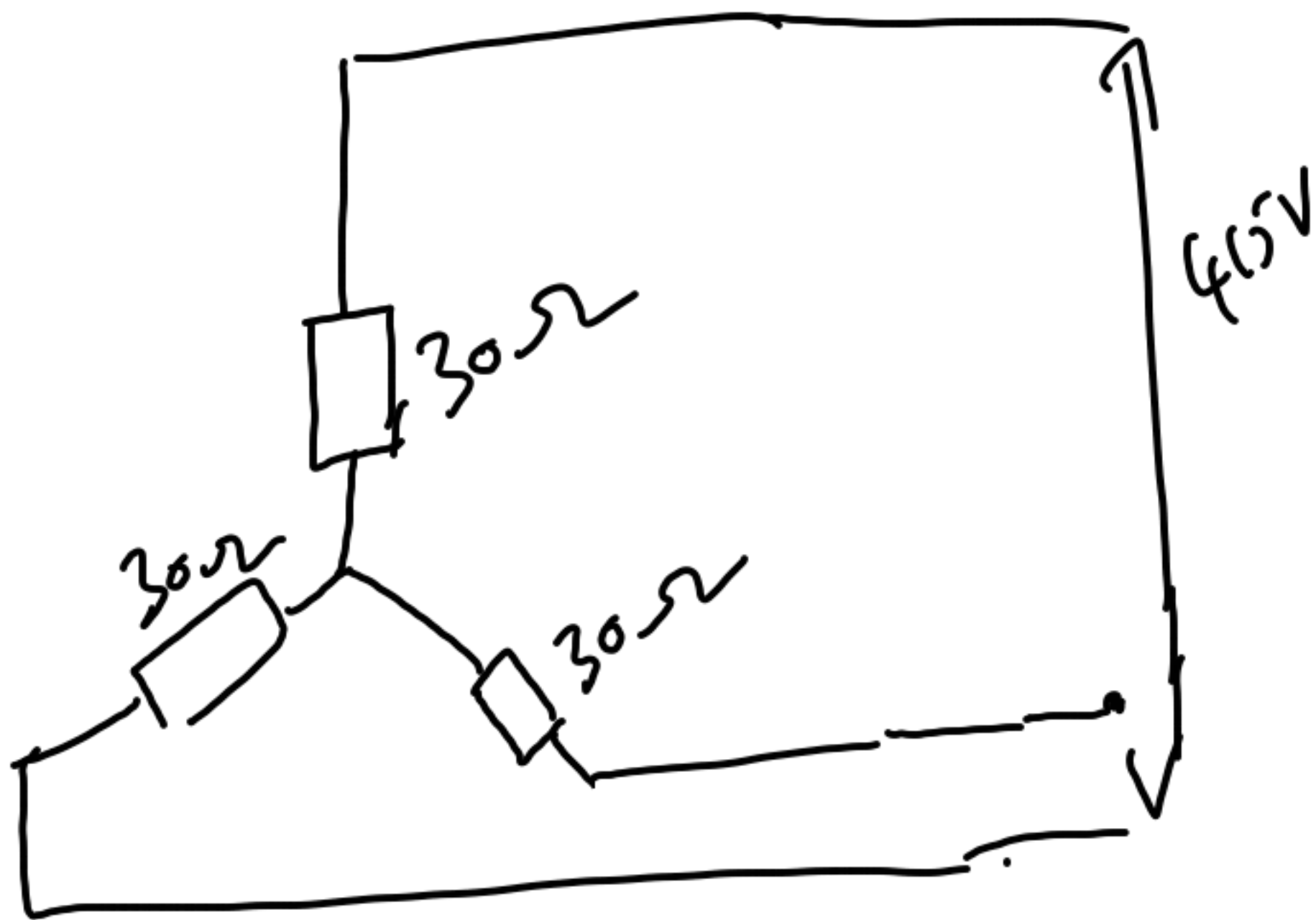


1) Three load each of resistor 30Ω are connected in star to a $415V$, three phase supply.

Determine (a) the system phase

Voltage (b) the phase current.

(c) the line current



$$V_p = ? \quad I_p = ?$$

$$I_L = ?$$

$$\text{Gn. } R = 30\Omega$$

$$R_Y = R_B = R_R = 30\Omega$$

$$V_L = 415V$$

$$V_L = \sqrt{3} V_p$$

$$V_p = \frac{V_L}{\sqrt{3}} = \frac{415}{\sqrt{3}} = 240V$$

$$V_p = 240V$$

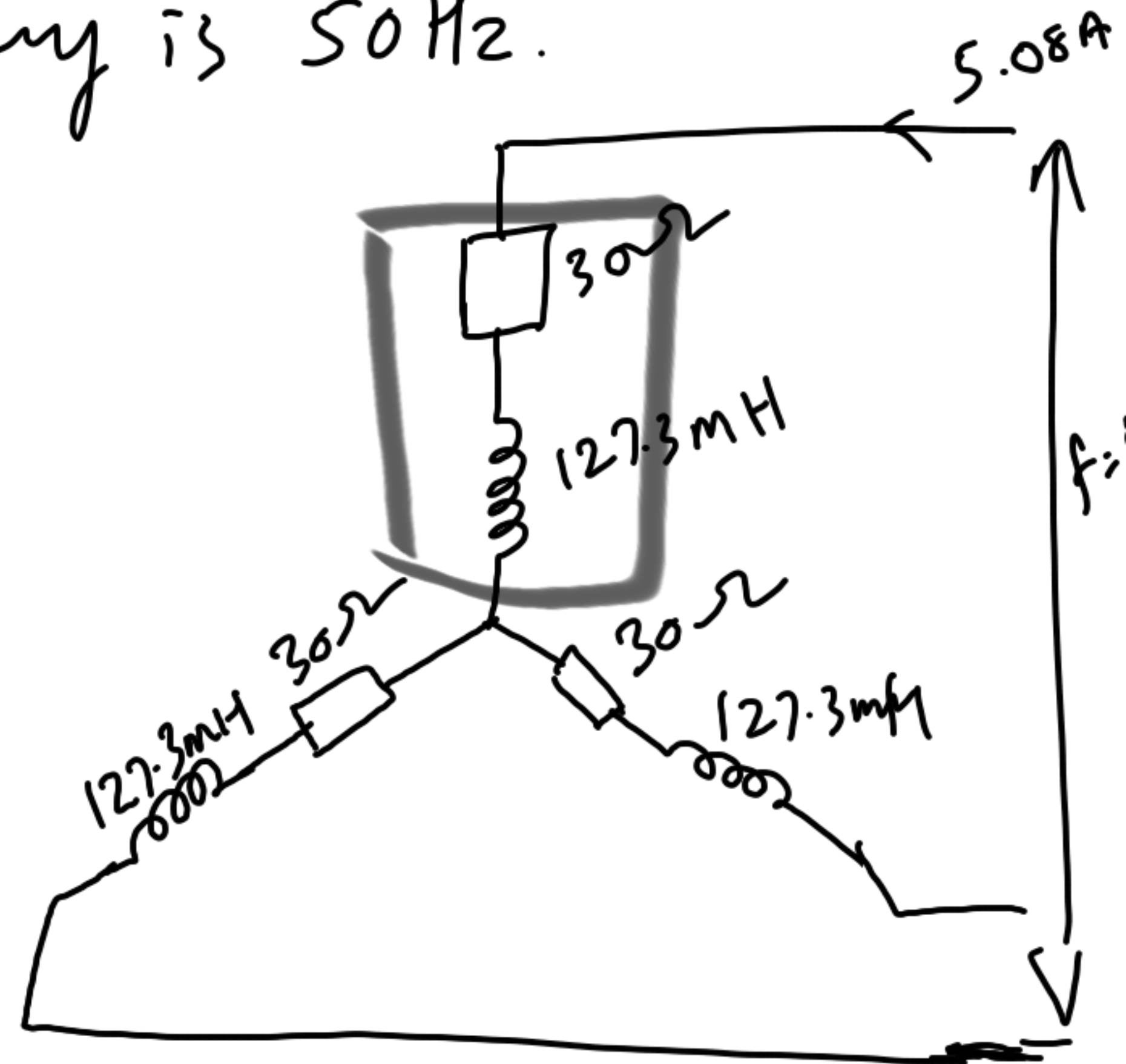
$$I_P = \frac{V_P}{R_P} = \frac{240}{30} = 8 \text{ A}$$

I_L , in star - 3 phase N/w.

$$I_L = I_P$$

$$I_L = 8 \text{ A}$$

2) A star connected load consists of three identical coils each of resistance 30Ω and inductance 127.3 mH . If the line current is 5.08 A . Calculate the line voltage if the supply frequency is 50 Hz .



$$X_L = 2\pi fL$$

$$= 2\pi \times 50 \times 127.3 \times 10^{-3}$$

$$X_L = 40\Omega$$

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

$$Z_p = \sqrt{(40)^2 + (30)^2}$$

$$Z_p = 50\Omega$$

$$\hat{I}_L = 5.08 \text{ A}$$

$$\hat{I}_L = \hat{I}_p = 5.08$$

$$V_p = \hat{I}_p \cdot Z_p = 5.08 \times 50$$

$$= 254 \text{ V}$$

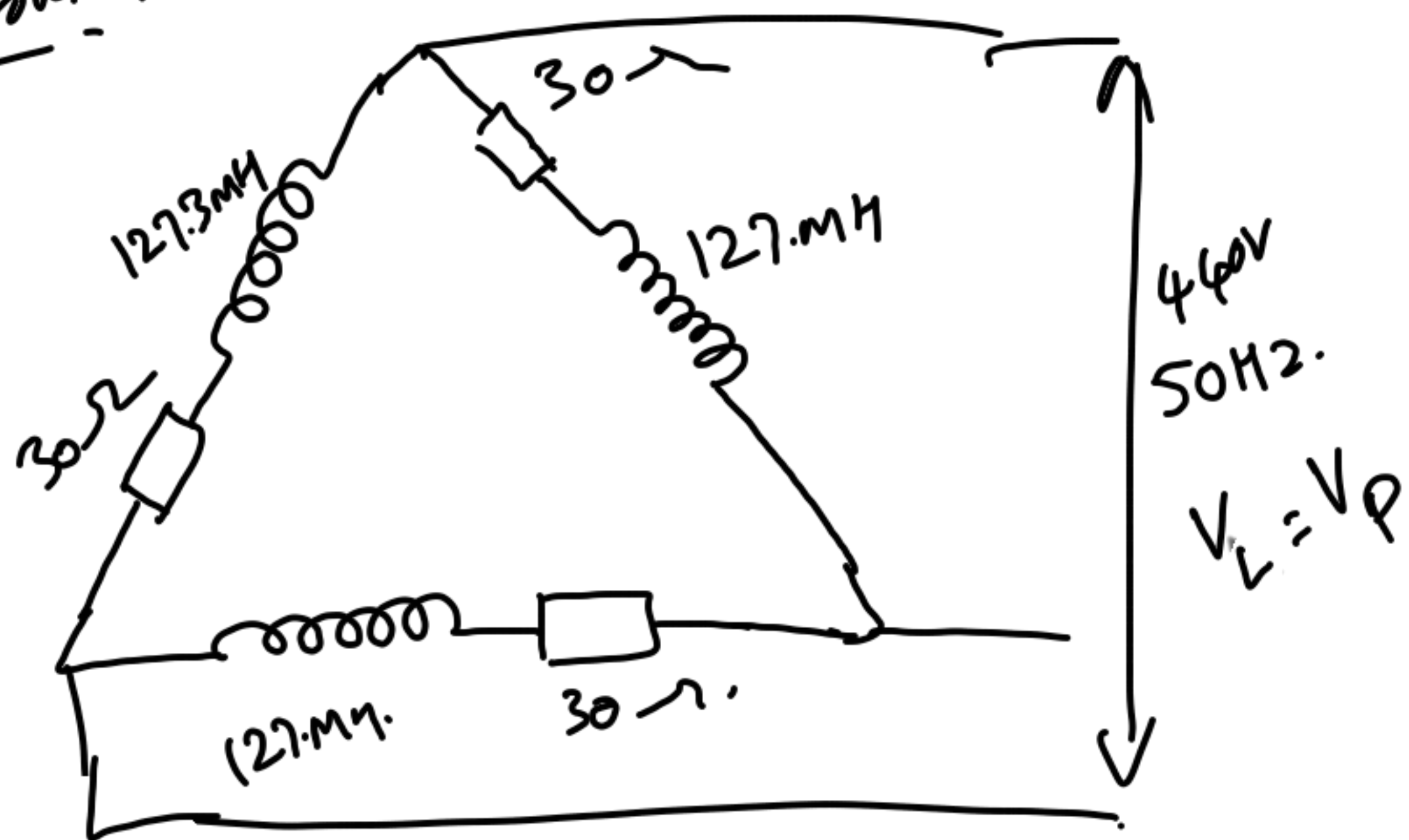
$$V_L = \sqrt{3} V_p$$

$$= \sqrt{3} \times 254$$

$$V_L = 440 \text{ V}$$

3) Three identical coils each of resistance 30Ω and inductance 127.3 mH are connected in delta to a 440 V , 50 Hz three phase supply. Determine.
(a) Phase current (b) line current.

Soln.



$$\hat{I}_p \text{ \& } \hat{I}_L = ?$$

$$X_L = 2\pi fL = 40\Omega$$

$$Z_p = \sqrt{30^2 + 40^2} = 50\Omega$$

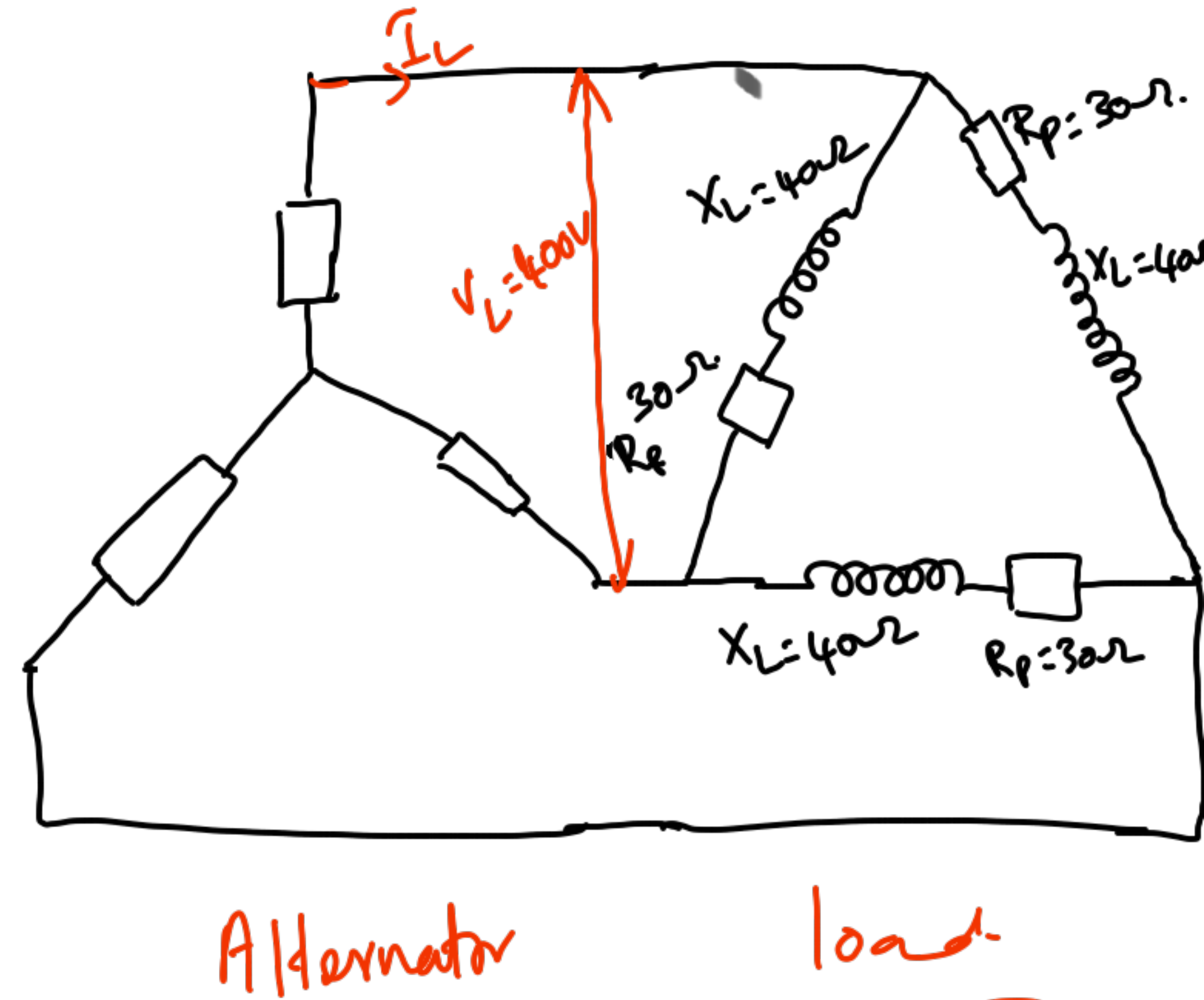
$$\hat{I}_p = \frac{V_p}{Z_p} = \frac{440}{50} = 8.8A$$

$$\hat{I}_L = \sqrt{3} \hat{I}_p$$

$$= \sqrt{3} \times 8.8$$

$$\hat{I}_L = 15.24A$$

4) A 400 V three phase star connected alternator supplies a delta connected load, each phase of which has a resistance of $30\ \Omega$ and inductive reactance $40\ \Omega$. Calculate (a) current supplied by the alternator (b) the output power and the KVA of the alternator, neglecting losses in the line between alternator and load.



$V_p = V_L$

$$\text{Impedance } Z_p = \sqrt{X_L^2 + R_p^2}$$

$$= \sqrt{40^2 + 30^2}$$

$$Z_p = 50 \Omega$$

$$V_L = V_p = 400 \text{ V}$$

$$\hat{I}_p = \frac{V_p}{Z_p} = \frac{400}{50} = 8 \text{ A}$$

$$\hat{I}_L = \sqrt{3} \hat{I}_p = \sqrt{3} \times 8 = 13.85 \text{ A}$$

$$\hat{I}_L = 13.85 \text{ A}$$

$$b) P = \sqrt{3} \hat{I}_L V_L \cos \phi$$

$$\cos \phi = \frac{30}{50}$$

$$P = \sqrt{3} \times 13.85 \times 400 \times \frac{30}{50}$$

$$P = 5.75 \text{ kW}$$

Volt-Ampere.

$$S = \sqrt{3} V_L \hat{I}_L$$

$$S = 9.6 \text{ KVA}$$

$$\cos \phi = \frac{R_p}{Z_p}$$

Q - 6 ~ 100

Each - Q - 20 mark.

Any 5 120

Q. (a) — 5
(b) — (5)
(c) (i) — (2)
 (ii)

} 20