

1) A Voltage of $v = 340 \sin 314t$ is applied to a circuit and the resulting current is $i = 42.5 \sin 314t$. Identify and hence find the Value of the component and the average Power.

Soln. gn, $V = 340 \sin 314t$

$$i = 42.5 \sin 314t$$

$$P_{avg} = ? \quad R, L, C = ?$$

' i ' and ' v ' are in phase,
So, it's a pure Resistive Circuit.

$$R = ?$$

$$R = \frac{V_m}{I_m}$$

$$R = \frac{V}{i} = \frac{340 \cancel{\sin 314t}}{42.5 \cancel{\sin 314t}}$$

$$R = \frac{340}{42.5} = 8 \Omega$$

$$P_{avg} = V_{RMS} I_{RMS}$$

$$= \frac{V_m}{\sqrt{2}} \cdot \frac{I_m}{\sqrt{2}}$$

$$P_{avg} = \frac{340}{\sqrt{2}} \cdot \frac{42.5}{\sqrt{2}}$$

$$P_{avg} = 7225 \text{ W}$$

2) A pure inductor of 1.273 mH is connected to a resistor of 30Ω in series. If the frequency of the supply is 5 kHz and the potential difference across the 30Ω resistor is 6 V . Determine the supply voltage, voltage across the inductor, phasor diagram and the impedance plot.

Soln : $V = ?$ $V_L = ?$

$$V_R = 6 \text{ V}, R = 30 \Omega$$

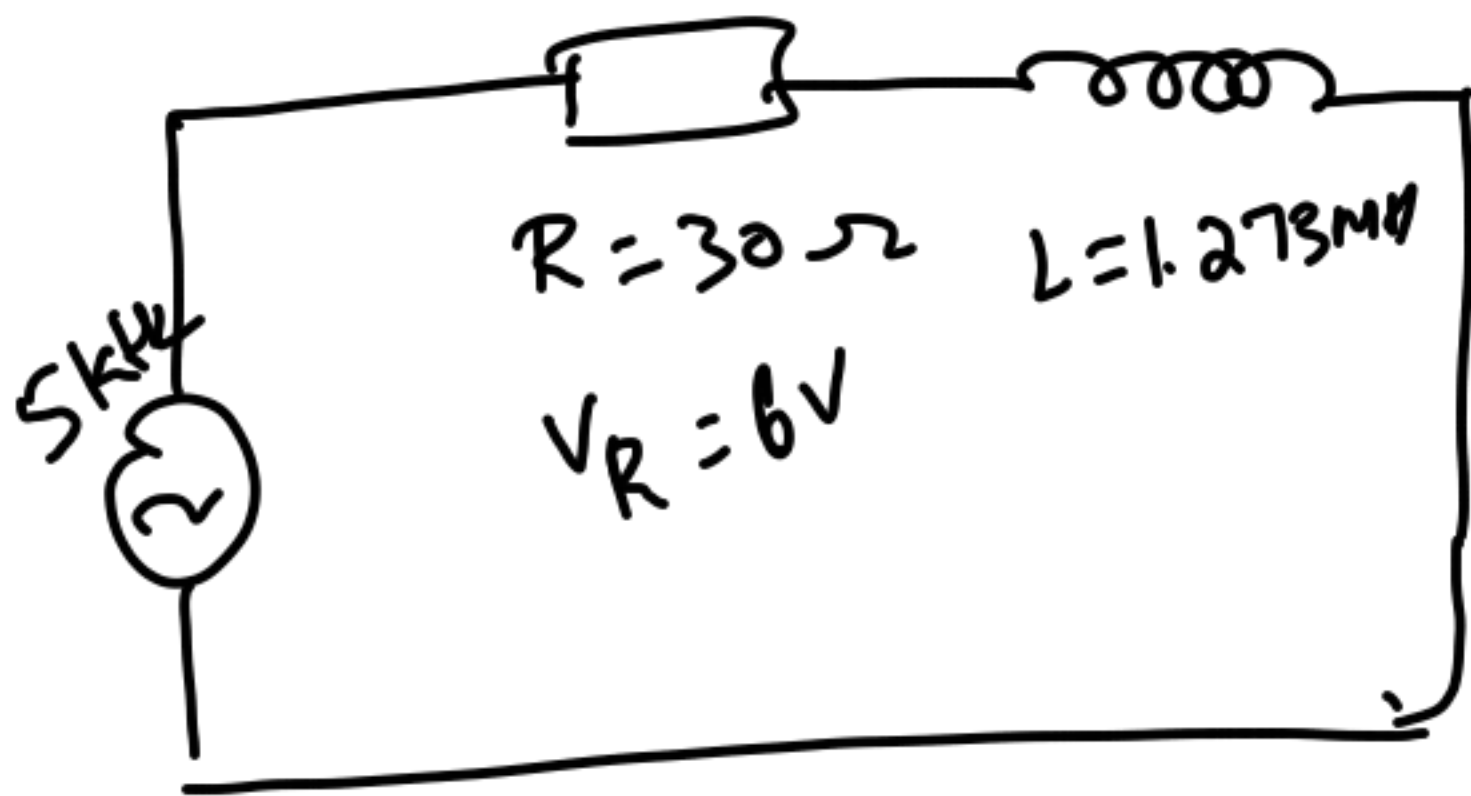
$$L = 1.273 \text{ mH}$$

Phasor diagram

ϕ, V, V_L, V_R, I

Impedance plot

Z, X_L



$$V = IZ$$

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

$$X_L = 2\pi fL$$

$$= 2\pi \times 5 \times 10^3 \times 1.273 \times 10^{-3}$$

$$X_L = 39.99 \Omega$$

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

$$= \sqrt{30^2 + (39.99)^2}$$

$$Z = 49.99 \Omega$$

$$I = \frac{V_R}{R} = \frac{6}{30}$$

$$I = 0.2 A$$

$$V_L = I X_L$$

$$= 0.2 \times 39.99$$

$$V_L = 8 V$$

$$V = I Z$$

$$V = 0.2 \times 49.99$$

$$V = 10 V$$

(or)

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

$$V = \sqrt{6^2 + 8^2}$$

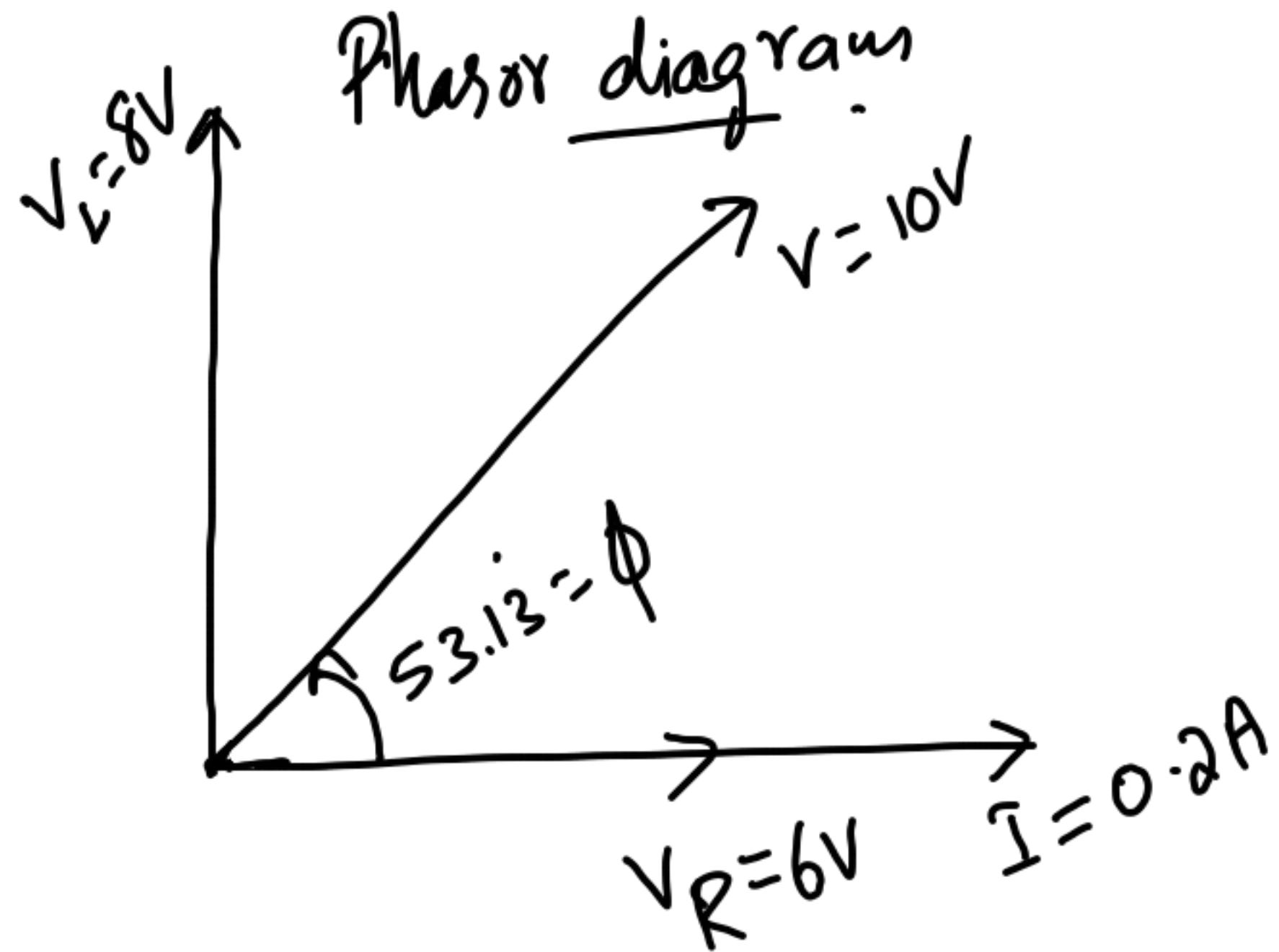
$$V = 10 V$$

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

$$= \tan^{-1} \left(\frac{39.99}{30} \right)$$

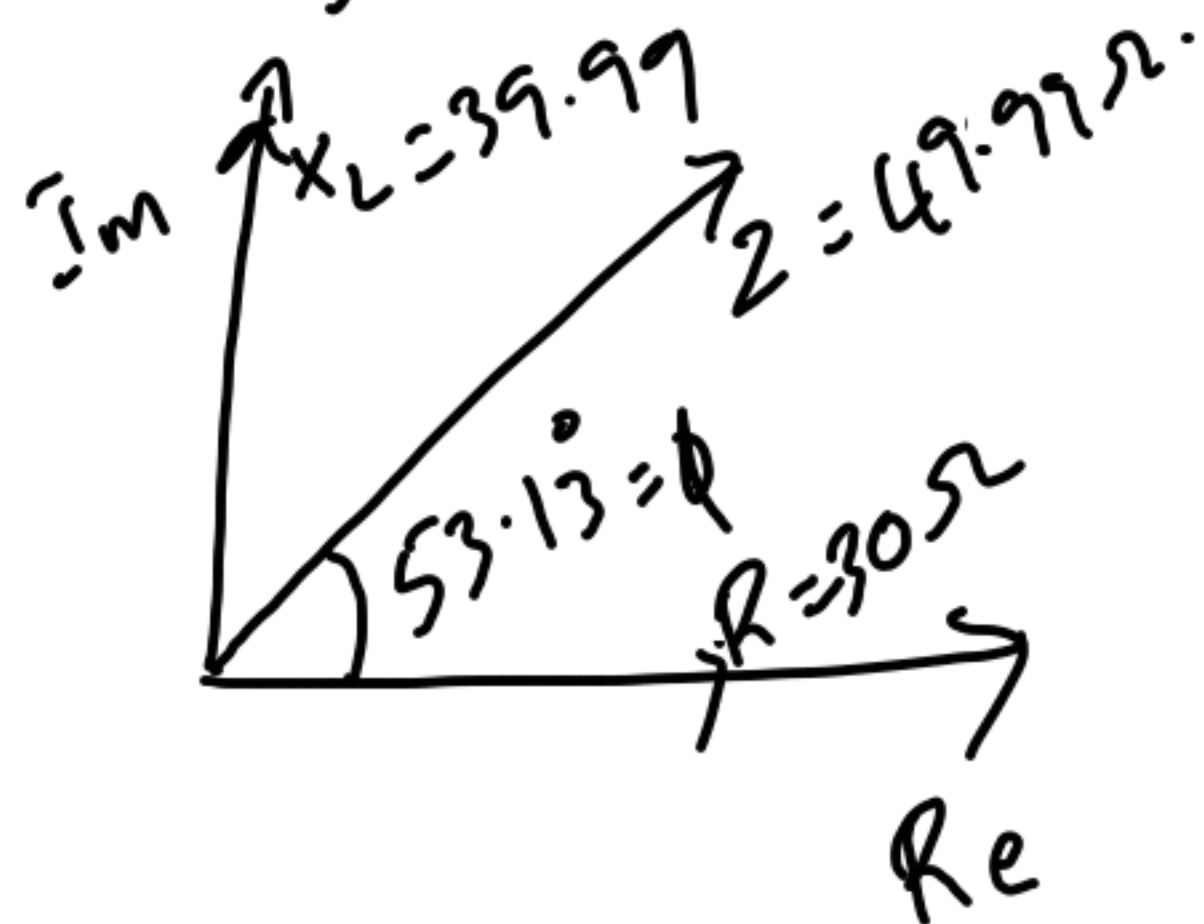
$$\phi = 53.13^\circ \text{ (lagging)}$$

V_R , V_L , $\hat{I}$, ϕ , V



Impedance plot

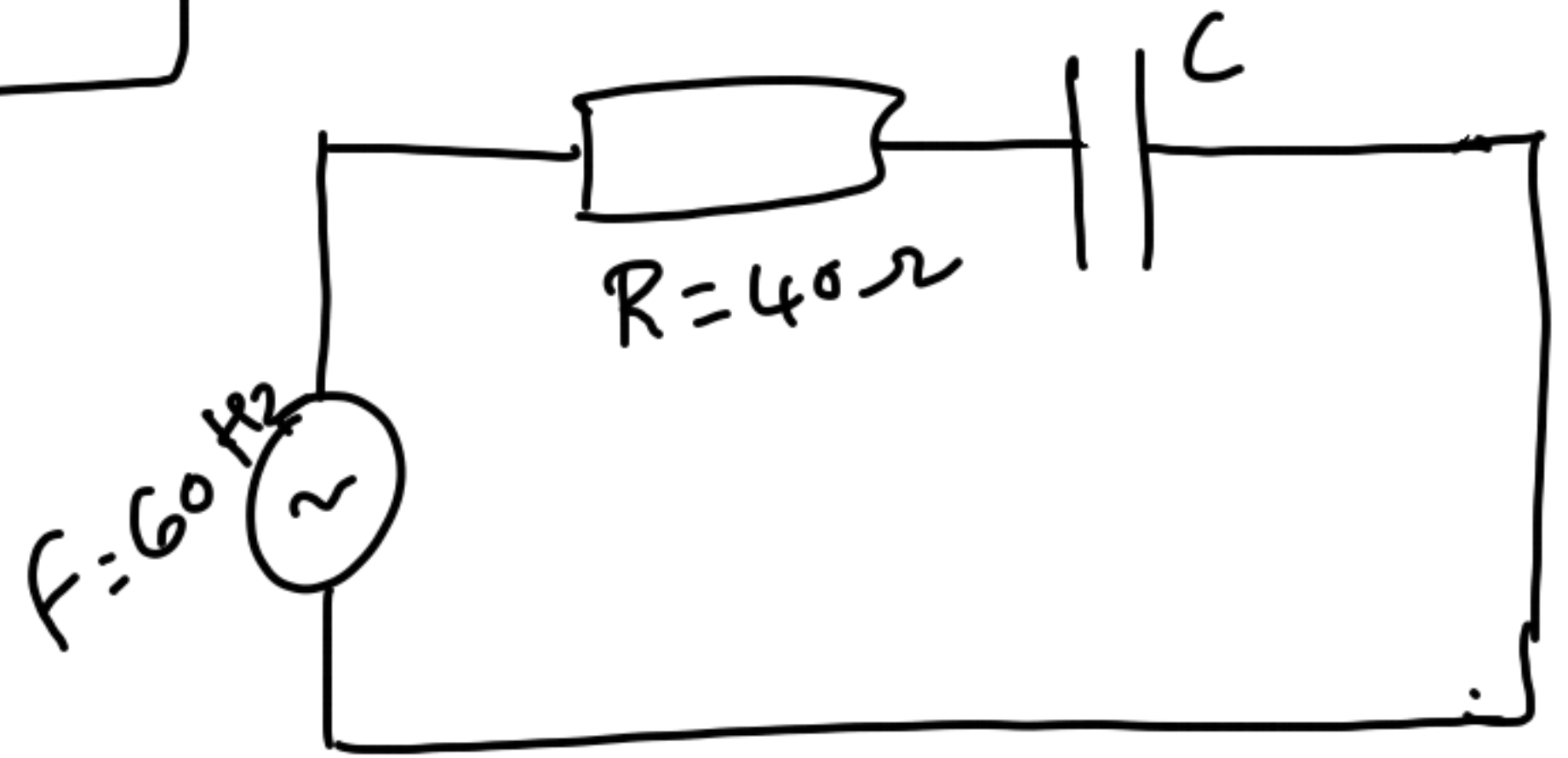
$$Z = R + jX_L = 30 + j39.99$$



3) A series R-C Circuit draws an RMS current of 3A. The total impedance is 50Ω , the resistance is 40Ω and the supply frequency is 60Hz. Determine

- i) the Capacitive Reactance
- ii) Supply voltage
- iii) Circuit phase angle.
- iv) Voltage across each component.
- v) Sketch the phasor diagram & impedance plot.

Soln : $I = 3A$. $Z = 50\Omega$.
 $f = 60Hz$.



a) Capacitive Reactance
We know that

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

$$Z^2 = R^2 + X_c^2$$

$$X_C = \sqrt{Z^2 - R^2}$$

$$X_C = \sqrt{(50)^2 - 40^2}$$

$$X_C = 30 \Omega$$

b) Supply voltage.

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

$$V = 3 \times 50 = 150 \text{ V}$$

c) Phase angle

$$\begin{aligned} \phi &= \tan^{-1} \left(\frac{-X_C}{R} \right) = \tan^{-1} \left(\frac{-30}{40} \right) \\ &= -36.87^\circ \\ &= 36.87^\circ (\text{leading}) \end{aligned}$$

d) Voltage across Capacitor

$$V_C = \hat{I} \cdot X_C$$

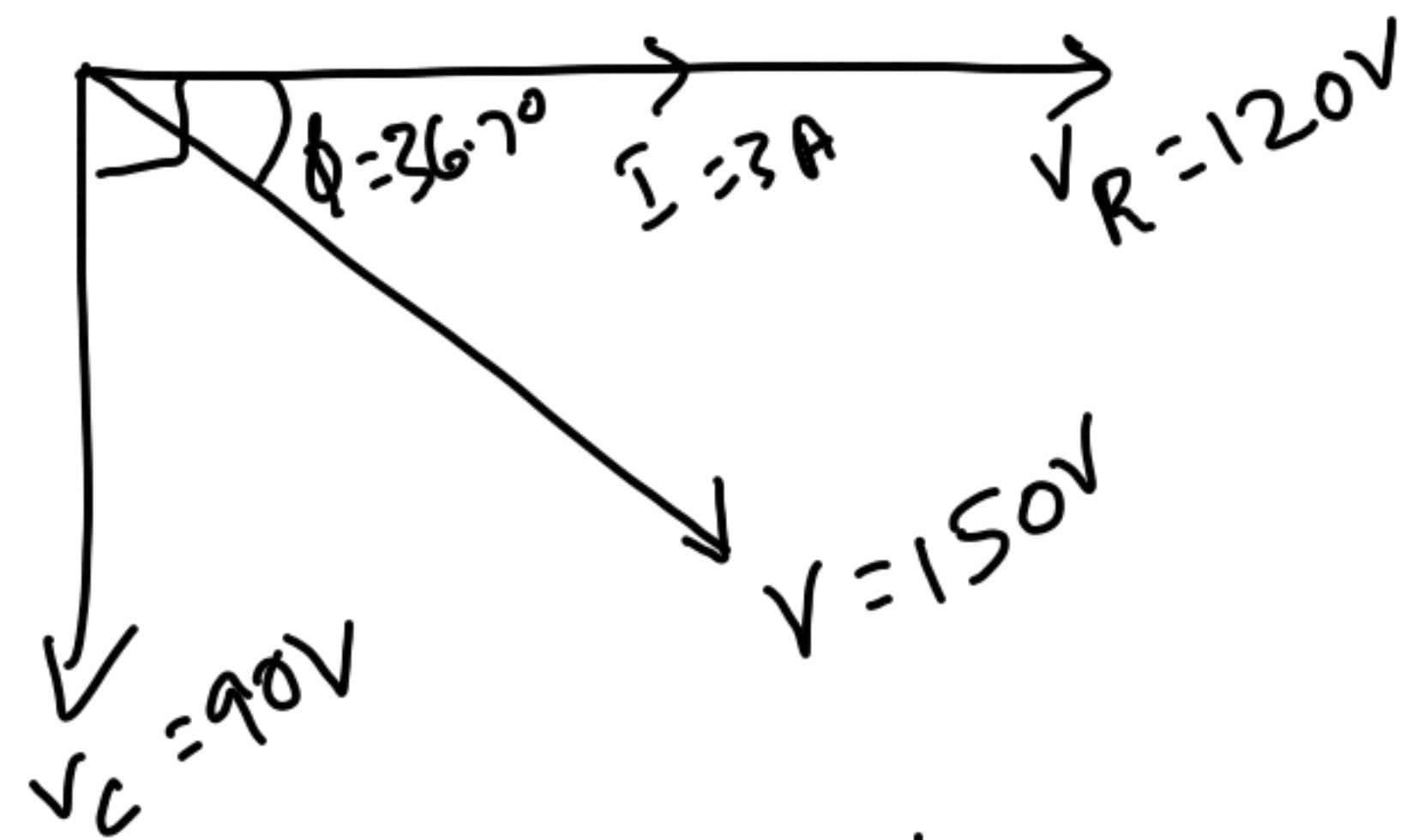
$$V_C = 3 \times 30 = 90 \text{ V}$$

Voltage across Resistor

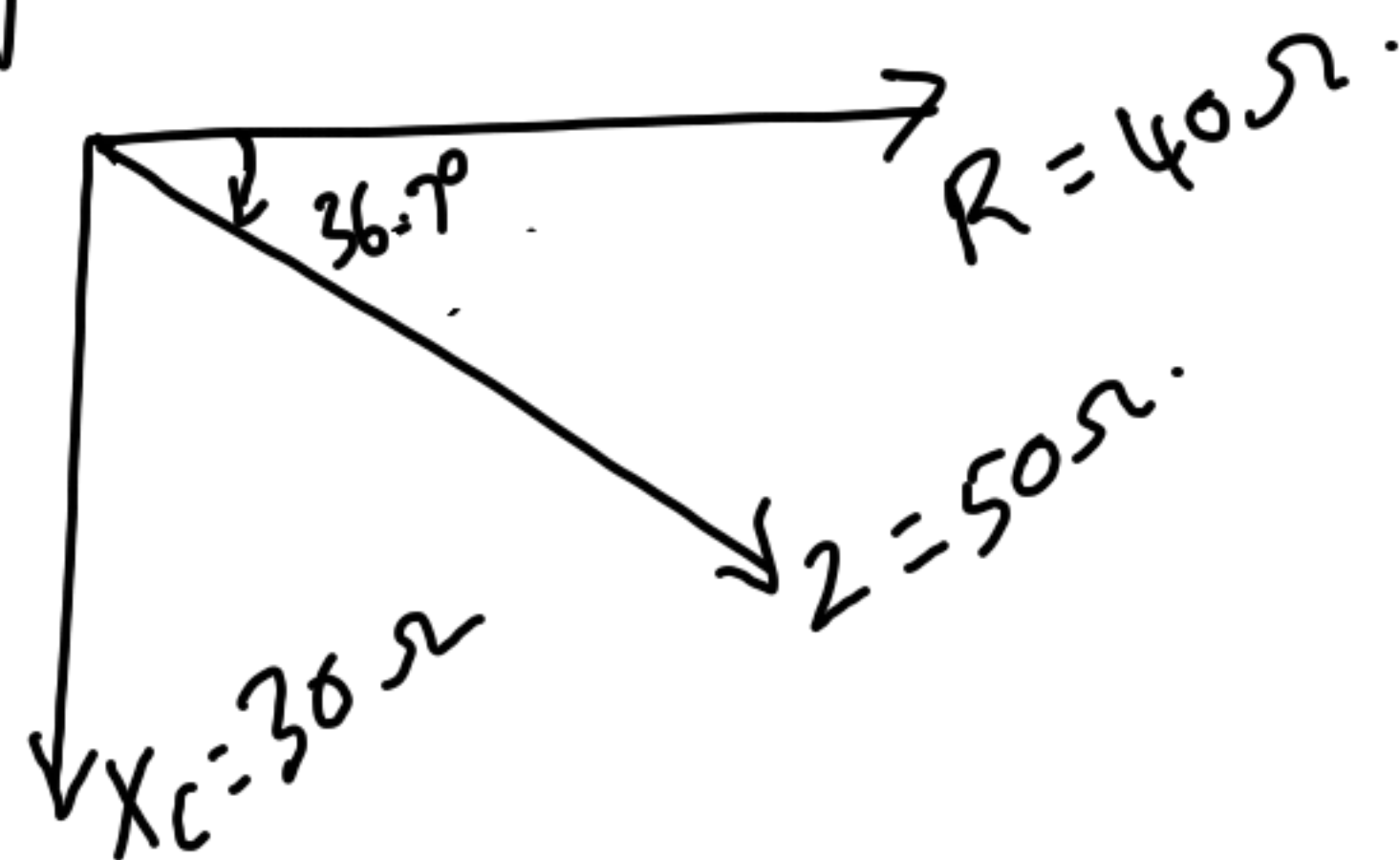
$$V_R = \hat{I} \cdot R$$

$$V_R = 3 \times 40 = 120 \text{ V}$$

Phasor diagram

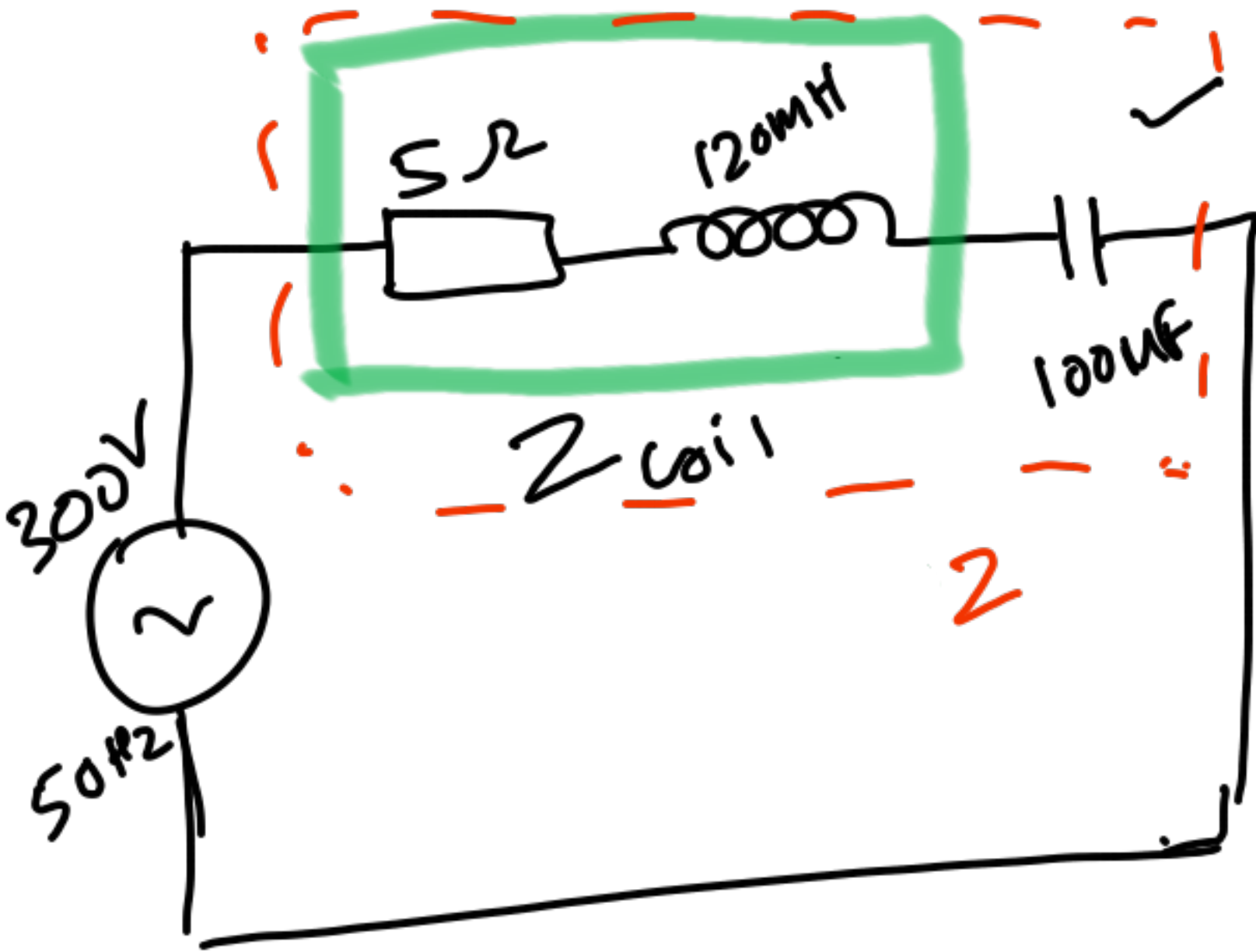


Impedance plot.



4) A Coil of Resistance 5Ω and inductance of 120mH in Series with $100\mu\text{F}$ Capacitor is Connected to a 300V , 50Hz Supply Calculate the

- current ✓
- phase difference between V and I
- Voltage across the coil ✓
- voltage across the Capacitor
- phase angle of the coil ✓
- phasor diagram.



$$R = 5\Omega, L = 120\text{mH}$$

$$C = 100\mu\text{F}, V = 300\text{V}$$

$$f = 50\text{Hz}$$

$$X_L = 2\pi fL$$

$$= 2\pi \times 50 \times 120 \times 10^{-3}$$

$$X_L = 37.7\Omega$$

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times 100 \times 10^{-6}}$$

$$X_C = 31.83\Omega$$

$$X_L > X_C$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

$$= \sqrt{5^2 + (37.7 - 31.83)^2}$$

$$Z = 7.71\Omega$$

a) Current, $I = \frac{V}{Z} = \frac{300}{7.71} = 38.91\text{A}$

b) Phase angle.

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

$$= \tan^{-1} \left(\frac{37.7 - 31.83}{5} \right)$$

$$\phi = 49.58^\circ$$

c) Voltage across the coil.

$$V_{\text{coil}} = I \cdot Z_{\text{coil}}$$

$$Z_{\text{coil}} = \sqrt{R^2 + X_L^2}$$

$$Z_{\text{coil}} = \sqrt{5^2 + 37.7^2} = 38.03 \Omega.$$

$$V_{\text{coil}} = 38.91 \times 38.03$$

$$V_{\text{coil}} = 1479.75 \text{ V}$$

d) Voltage across the Capacitor.

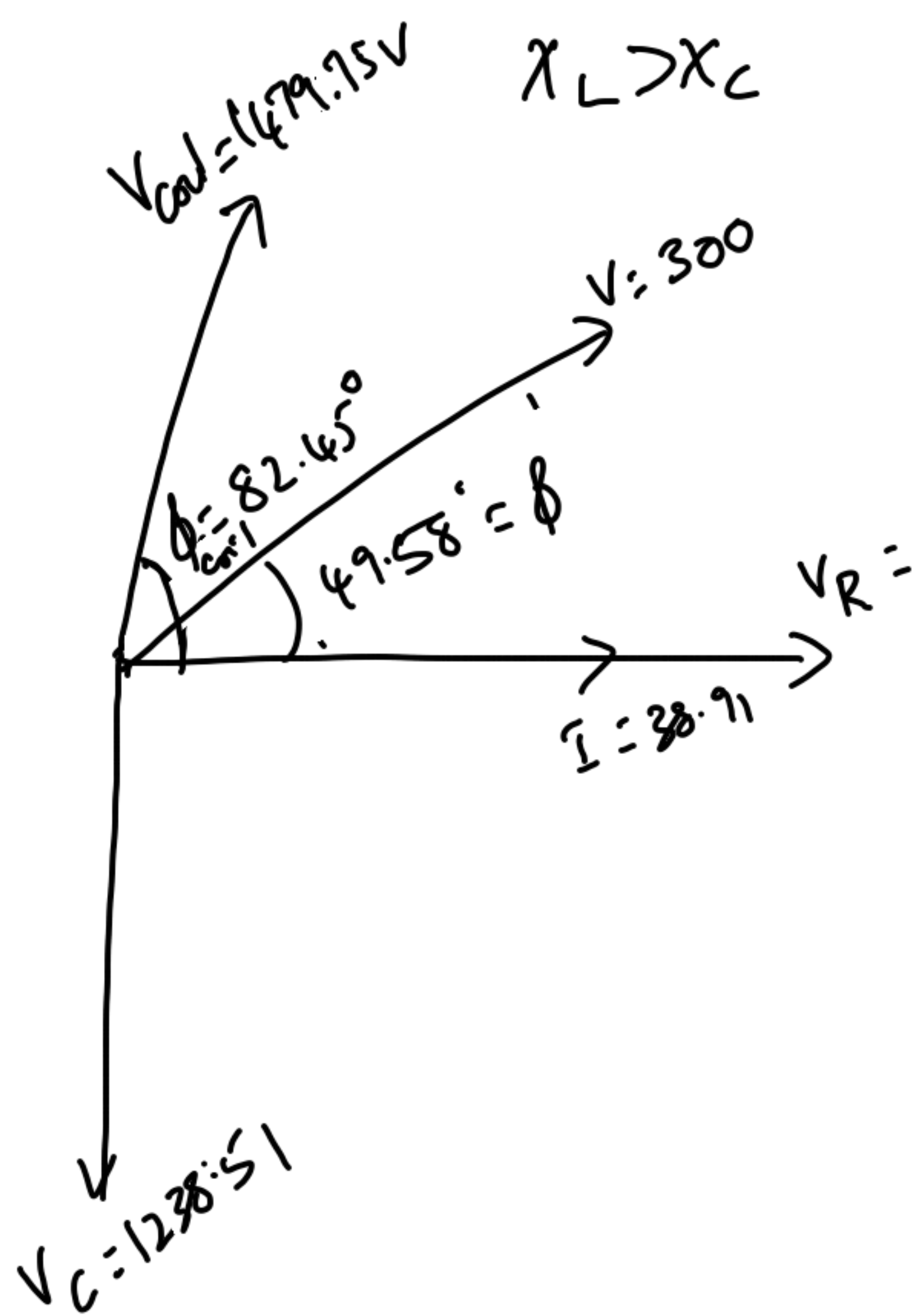
$$V_C = I \cdot X_C = 38.91 \times 31.83$$

$$V_C = 1238.51 \text{ V.}$$

e) phase difference in the coil

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

$$= \tan^{-1} \left(\frac{37.7}{5} \right) = 82.45^\circ (\text{lagging})$$



300V

$$V = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$$V_R = I \cdot R = 38.91 \times 5 = 194.6 \text{ V}$$

$$V_L = I \cdot X_L = 38.91 \times 37.7 = 1466.91 \text{ V}$$

$$V = \sqrt{(194.6)^2 + (1466.91 - 1238.51)^2}$$

$$V = 300.1 \text{ V}$$

$$V = V_1 + V_2 + V_3$$

5) The following three impedances are connected in series across a 40V, 20kHz supply.

i) a Resistor of 8Ω .

ii) a coil of inductor $130\mu\text{H}$ and Resistor 5Ω .

iii) a 10Ω Resistor in series with a $0.25\mu\text{F}$ capacitor.

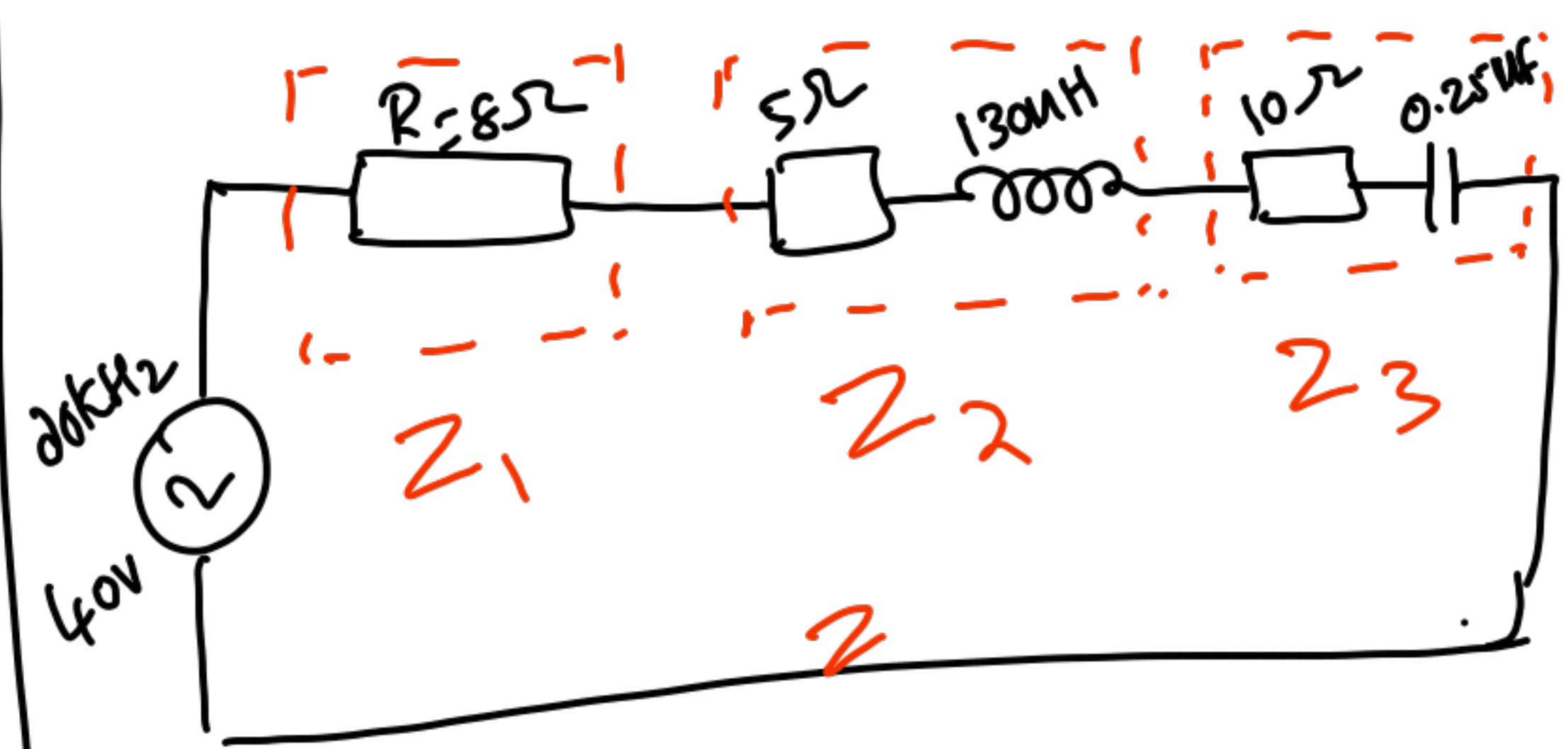
Calculate,

a) Circuit current

b) Circuit phase angle

c) Voltage drop across each impedance

d) phasor diagram.



$$X_L = 2\pi fL$$

$$X_L = 2\pi \times 20 \times 1000 \times 130 \times 10^{-6}$$

$$X_L = 16.34\Omega$$

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 20 \times 1000 \times 0.25 \times 10^{-6}} = 31.83\Omega$$

$$X_C > X_L$$

$$Z = \sqrt{R^2 + (X_C - X_L)^2}$$

$$= \sqrt{23^2 + (31.83 - 16.34)^2}$$

$$Z = 27.73 \Omega$$

a) Circuit current

$$\hat{I} = \frac{V}{Z} = \frac{40}{27.73} = 1.44 \text{ A}$$

b) Phase angle

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

$$\phi = \tan^{-1} \left(\frac{31.83 - 16.34}{23} \right)$$

$$\phi = 33.96^\circ \text{ (leading)}$$

c) Voltage drop across each impedance.

Z_1

$$V_1 = \hat{I} R = 1.44 \times 8 = 11.52 \text{ V}$$

$$\underline{\underline{Z_2}}$$

$$V_2 = I Z_2$$

To find.

$$Z_2 = \sqrt{R_2^2 + X_L^2}$$

$$= \sqrt{5^2 + 16.3^2}$$

$$Z_2 = 17.12 \Omega$$

$$V_2 = 1.44 \times 17.12$$

$$V_2 = 24.65 \text{ V}$$

$$\underline{\underline{Z_3}}$$

$$V_3 = I Z_3$$

$$= 1.44 \times \sqrt{10^2 + 31.83^2}$$

$$V_3 = 48.04 \text{ V}$$

$$Z_1(R)$$

$$\downarrow$$

$$V_1$$

$$Z_2(L)$$

$$\downarrow$$

$$V_2$$

$$Z_3(C), I, V, \phi$$

$$\downarrow$$

$$V_3$$

$$\phi_2 = \tan^{-1} \left(\frac{X_L}{R_2} \right)$$

$$= \tan^{-1} \left(\frac{16.32}{5} \right)$$

$$\phi_2 = 72.97^\circ (\text{lag})$$

$$\phi_3 = \tan^{-1} \left(\frac{-X_C}{R_3} \right)$$

$$= \tan^{-1} \left(\frac{-31.83}{10} \right)$$

$$\phi_3 = -72.6^\circ$$

$$\phi_3 = 72.6^\circ (\text{leading})$$

Phasor diagram

$$X_C > X_L$$

