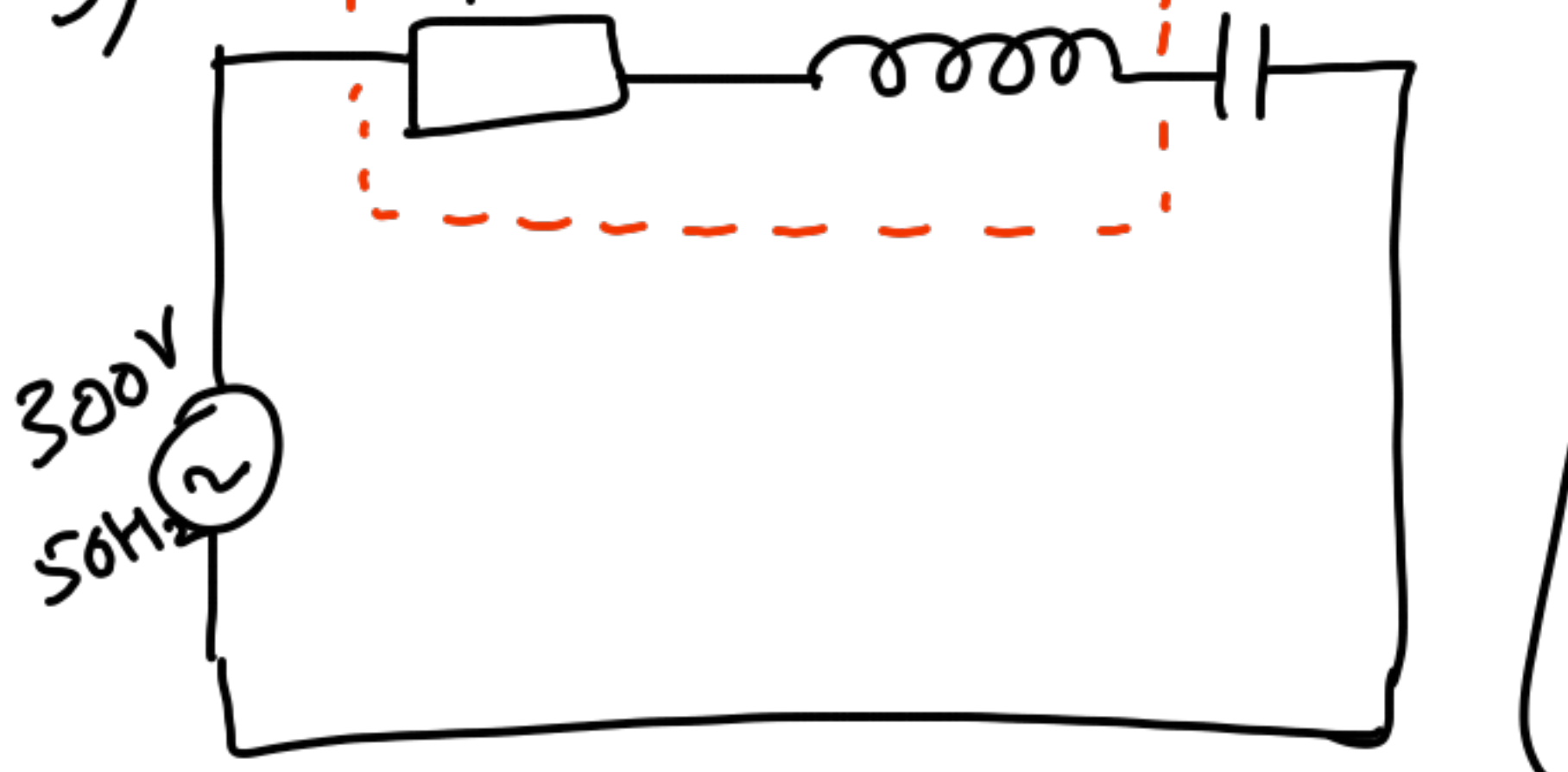


RLL

5)



a) Current

$$I = \frac{V}{Z} = \frac{300}{7.71} = 38.8 \text{ A}$$

b) Phase Angle

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

$$Z_{\text{coil}} = \sqrt{R^2 + X_L^2} = \sqrt{5^2 + (37.7)^2}$$

$$Z_{\text{coil}} = 38 \Omega$$

$$V_{\text{coil}} = 38.8 \times 38$$

$$V_{\text{coil}} = 1474.4 \text{ V}$$

$$V_C = I X_C$$

$$= 38.8 \times 31.83$$

$$V_C = 1230 \text{ V}$$

$$X_L = 2\pi fL = 2\pi \times 50 \times 120 \times 10^{-3} = 37.7 \Omega$$

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 50 \times 100 \times 10^{-6}} = 31.83 \Omega$$

$$X_L > X_C$$

Impedance

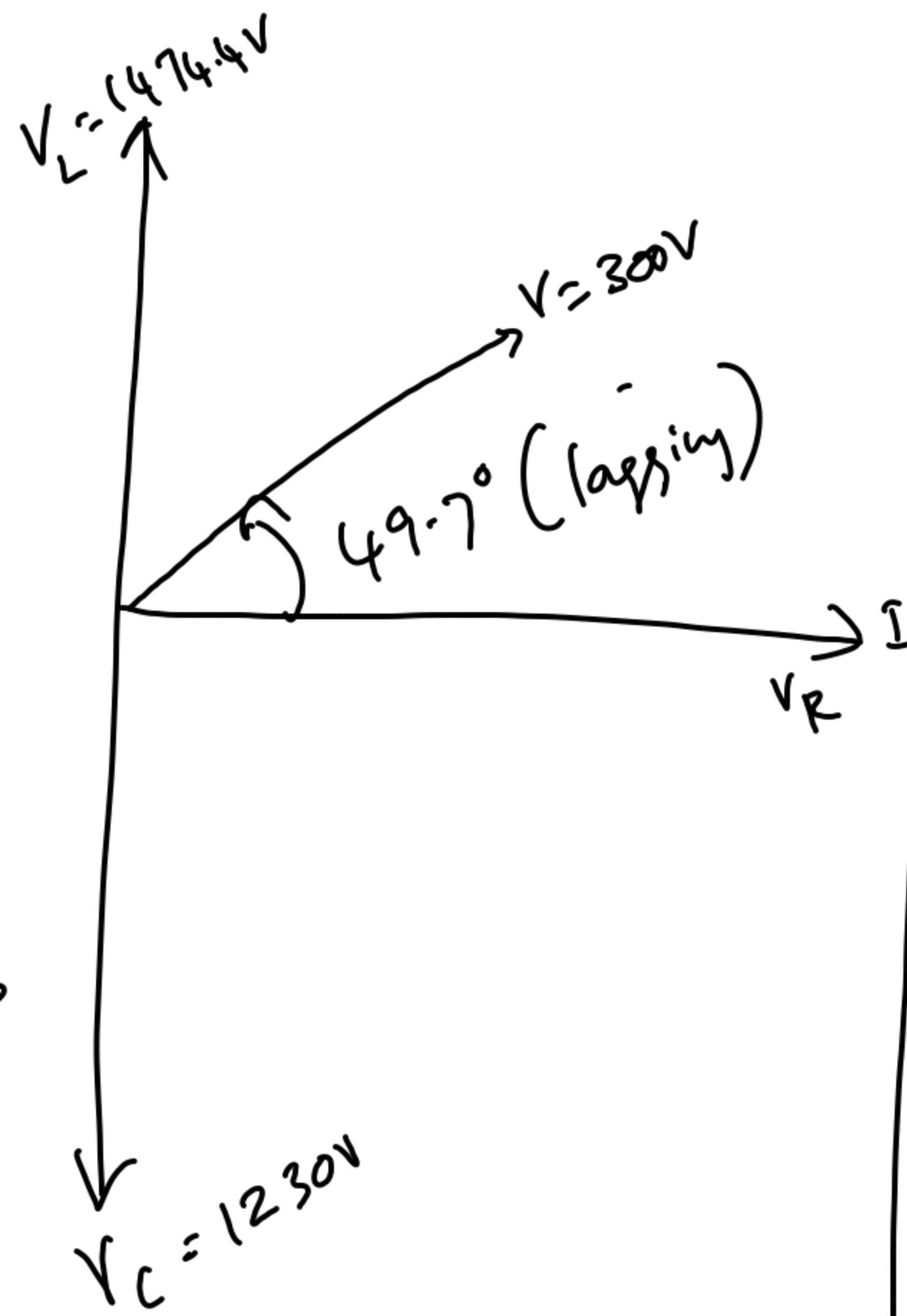
$$Z = \sqrt{R^2 + (X_L - X_C)^2} = 7.71 \Omega$$

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

$$\phi = 49.7^\circ$$

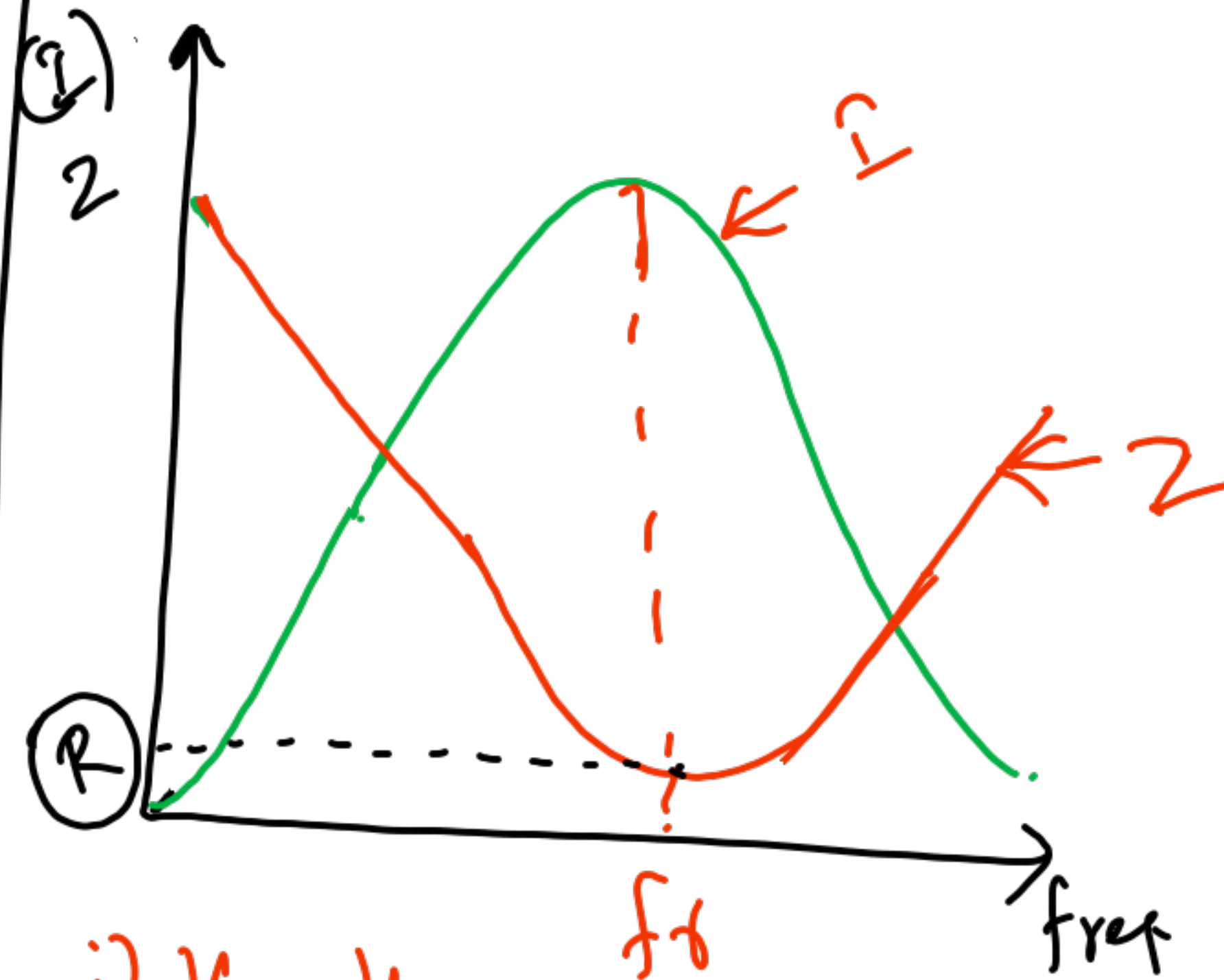
c) Voltage across the coil

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



Series Resonance

$$X_L = X_C$$



i) $V_L = V_C$

ii) In this condition most of the supply voltage will be across the Resistor

iii) $Z = R$

iv) $I = \frac{V}{R}$ $I = \frac{V}{Z}$

$$X_L = X_C$$

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

$$2\pi fL \times 2\pi fC = 1$$

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

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

f_r is the resonant freq.

② Series Resonant circuit is also called as Acceptor Circuit, Since it has minimum impedance and Maximum Current.

Quality factor (Q-factor)

$$X_L = X_C, \quad R < X_L \text{ (or) } X_C$$

$$\underline{V_L} \text{ and } \underline{V_C} \rightarrow \uparrow \text{ then } \underline{V}$$

Voltage magnification.

$$\text{Voltage magnification at Resonance} = \frac{\text{Voltage across } (L \text{ or } C)}{\text{Supply voltage}}$$

Quality factor is the ratio of the voltage across L (or) C to the supply vol

$$Q \text{ factor} = \frac{V_L}{V} = \frac{\hat{I} X_L}{\hat{I} R} = \frac{X_L}{R} = \frac{2\pi f_r L}{R} \quad \text{--- ①}$$

$$Q \text{ factor} = \frac{V_C}{V} = \frac{\hat{I} X_C}{\hat{I} R} = \frac{X_C}{R} = \frac{1}{2\pi f_r R C} \quad \text{--- ②}$$

We know that

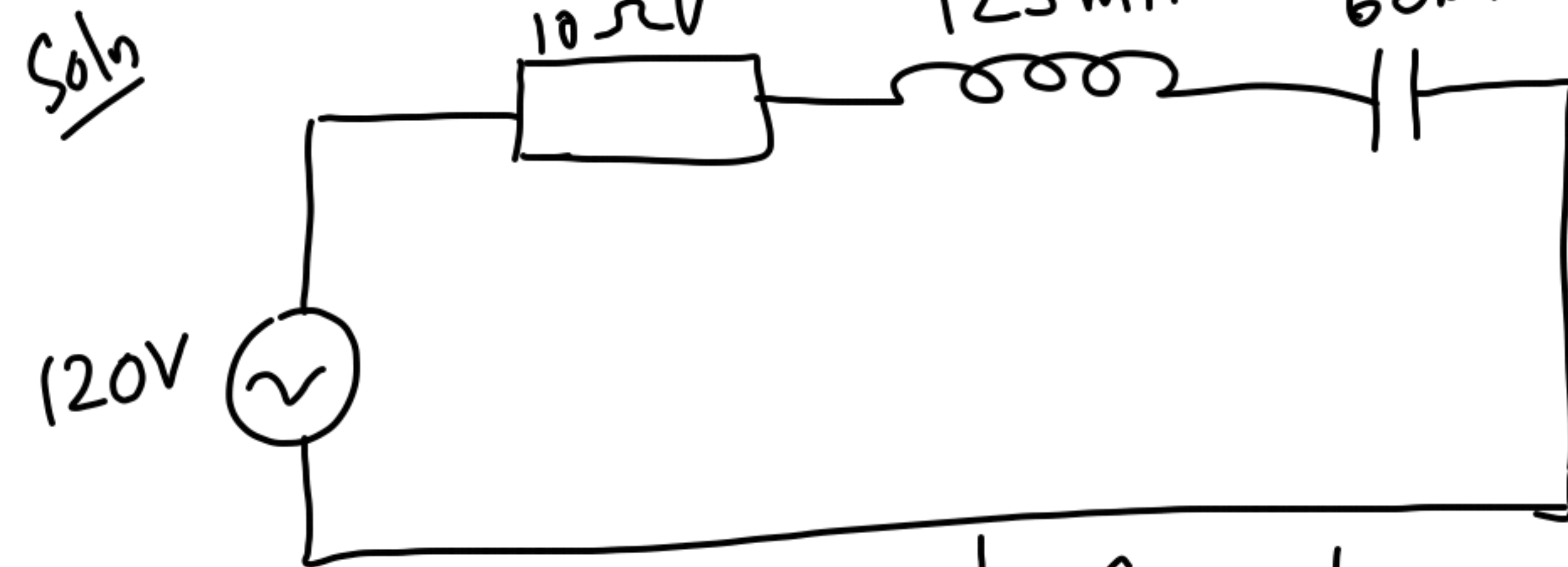
$$f_r = \frac{1}{2\pi\sqrt{LC}} \Rightarrow 2\pi f_r = \frac{1}{\sqrt{LC}}$$

1) ① $\Rightarrow$ $Q \text{ factor} = \frac{L}{R} \times \frac{1}{\sqrt{LC}} = \frac{\cancel{\sqrt{L}} \cancel{\sqrt{L}}}{R} \times \frac{1}{\cancel{\sqrt{L}} \sqrt{C}}$

$$= \frac{\sqrt{L}}{R\sqrt{C}} = \frac{1}{R} \sqrt{\frac{L}{C}}$$

$$Q \text{ factor} = \frac{1}{R} \sqrt{\frac{L}{C}}$$

A Coil having a resistance of 10Ω and an inductance of 125mH is connected in Series with a $60\mu\text{F}$ Capacitor across a 120V Supply. At what frequency does resonance occurs? Find the Current flowing at the resonant frequency.



At resonance, $X_L = X_C$

$$Z = R$$

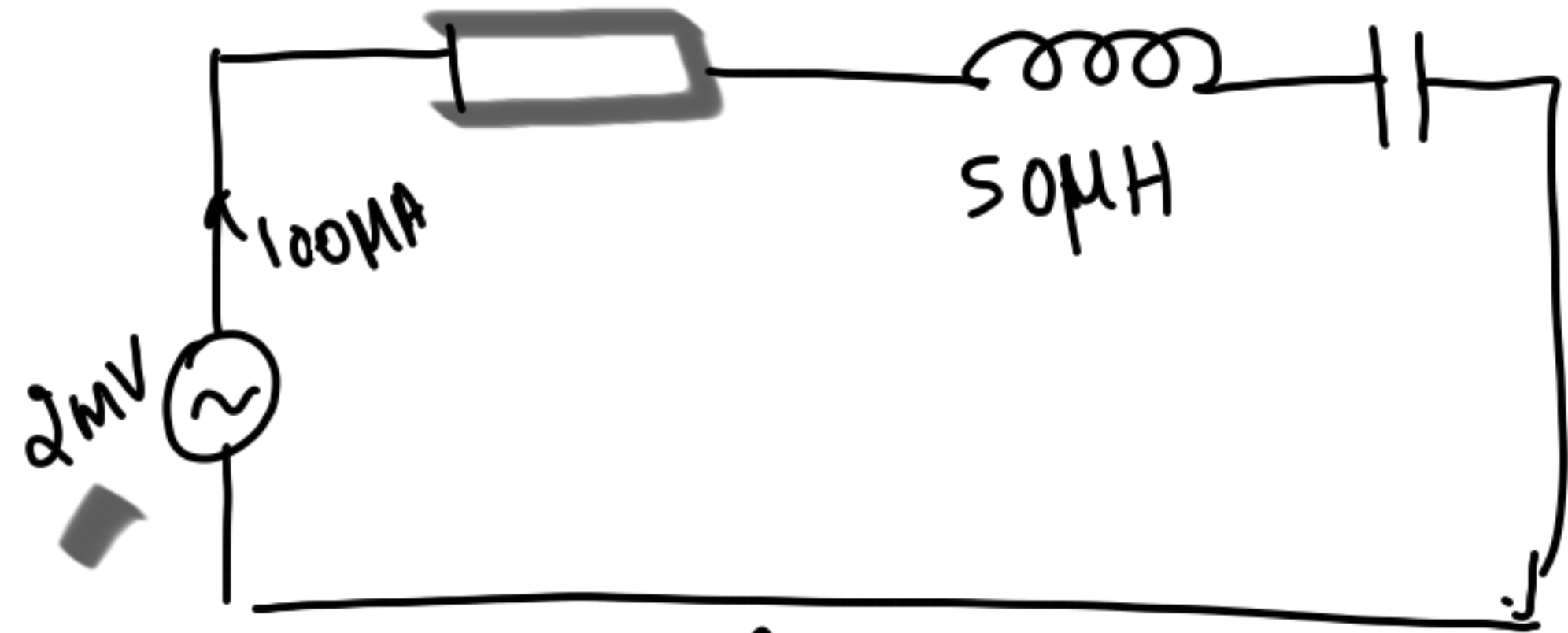
$$I = \frac{V}{R} = \frac{120}{10} = 10\text{A}$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$f_r = \frac{1}{2\pi\sqrt{125 \times 10^{-3} \times 60 \times 10^{-6}}}$$

$$f_r = 58\text{Hz}$$

2) The current at resonance in a Series L-C-R Circuit is 100mA. If the applied voltage is 2mV at a frequency of 200kHz and the circuit inductance is 50μH. Calculate the Circuit Resistance and the Capacitance



$$f = 200 \text{ kHz}$$

Soln

At Resonance $X_L = X_C$

$$Z = R$$

$$R = \frac{V}{I} = \frac{2 \times 10^{-3}}{100 \times 10^{-6}} = 20 \Omega$$

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

$$200 \times 10^3 = \frac{1}{2\pi\sqrt{50 \times 10^{-6} C}}$$

Squaring both the sides

$$(200 \times 10^3)^2 = \frac{1}{4\pi^2 \times (50 \times 10^{-6}) \times C}$$

$$C = \frac{1}{(200 \times 10^3)^2 \cdot 4\pi^2 (50 \times 10^{-6})}$$

$$C = 12.7 \times 10^{-9} \text{ F} = 12.7 \text{ nF}$$

3) A coil of inductance 80 mH and negligible resistance in the coil is connected in series with a capacitance of $0.25 \mu\text{F}$ and a resistance of 12.5Ω . across a 100 V supply. Calculate

a) Resonant frequency (b) the current at resonance. (c) How many times greater than the supply voltage is the voltage across the reactance at resonance?

Soln

$$\text{Resonance frequency } f_r = \frac{1}{2\pi \sqrt{LC}}$$

$$L = 80 \text{ mH}, R = 12.5 \Omega,$$

$$V = 100 \text{ V}, C = 0.25 \mu\text{F}$$

$$= \frac{1}{2\pi \sqrt{80 \times 10^{-3} \times 0.25 \times 10^{-6}}} \\ = 1.1254 \text{ kHz}$$

$$b) \ I = \frac{V}{R} = \frac{100}{12.5} = 8A$$

c) Voltage magnification

$$(Q\text{-factor}) = \frac{V_L}{V} = \frac{V_C}{V}$$

$$= \frac{1}{R} \sqrt{\frac{L}{C}}$$

$$V_L = I X_L$$

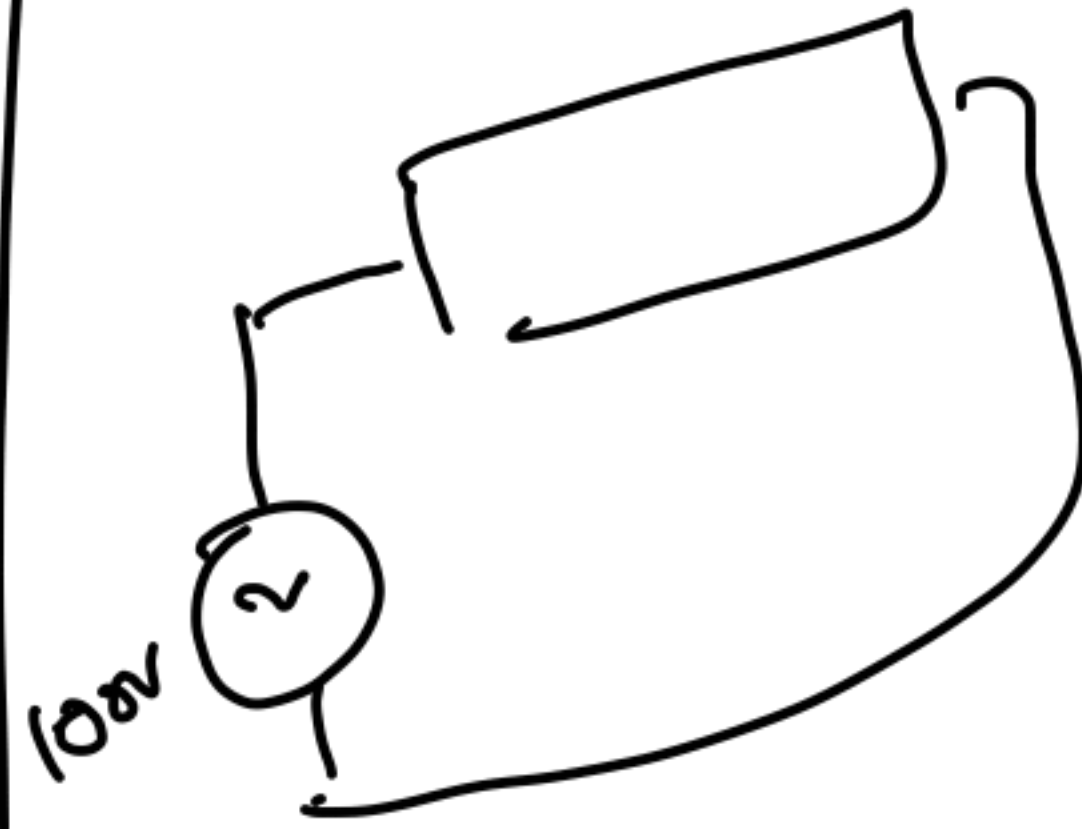
$$V_C = I X_C$$

$$\text{Voltage magnification} = \frac{1}{R} \sqrt{\frac{L}{C}}$$

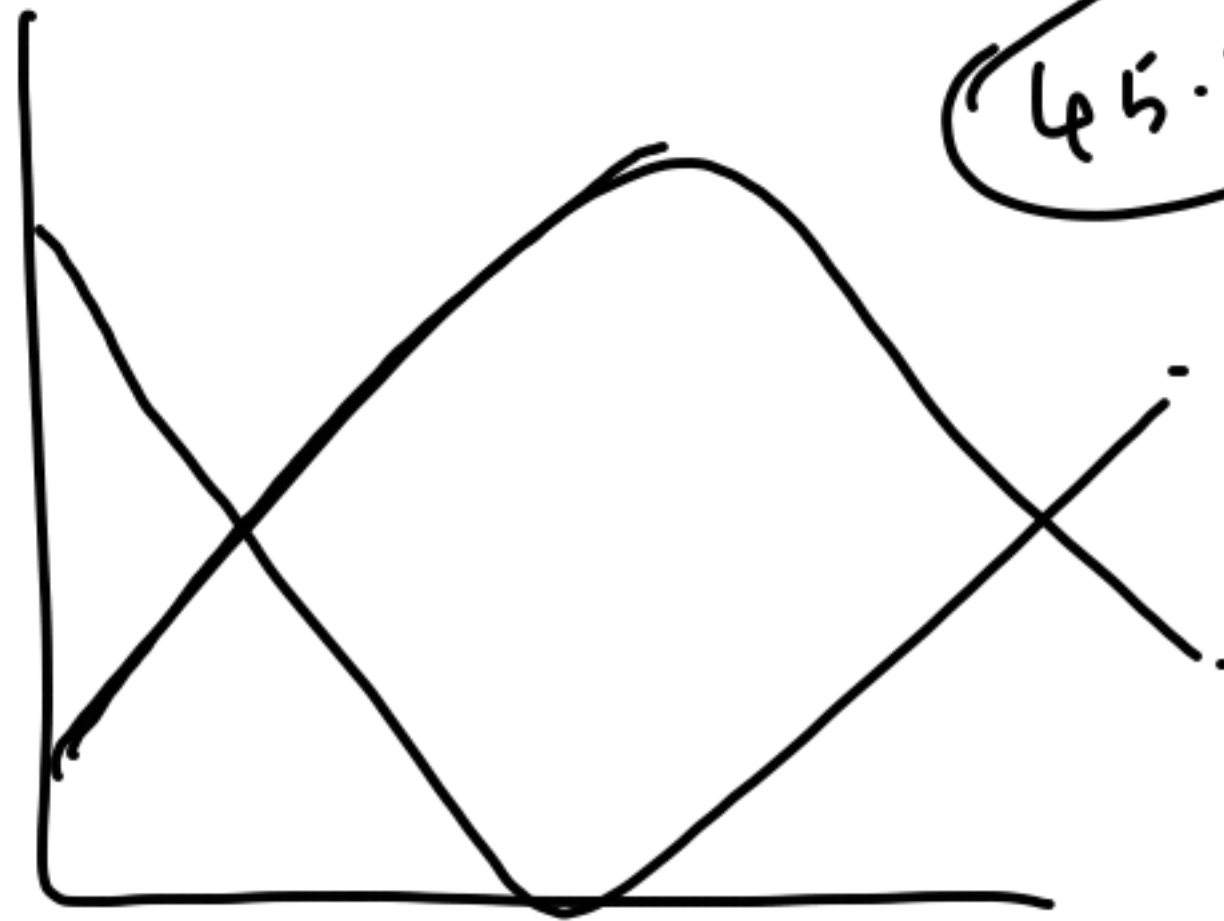
$$= \frac{1}{12.5} \sqrt{\frac{8 \times 10^{-3}}{0.25 \times 10^{-6}}}$$

$$= 45.25$$

$$45.25 \times V$$



$$45.25 \times 100$$



4) A series circuit comprises a coil of resistance 2Ω and inductance 60 mH and capacitance of $30\mu\text{F}$. Calculate the Q-Factor at Resonance.

Soln

$$Q \text{ factor} = \frac{1}{R} \sqrt{\frac{L}{C}}$$
$$= \frac{1}{2} \sqrt{\frac{60 \times 10^{-3}}{30 \times 10^{-6}}}$$

$$Q\text{-fact.} = 22.4$$