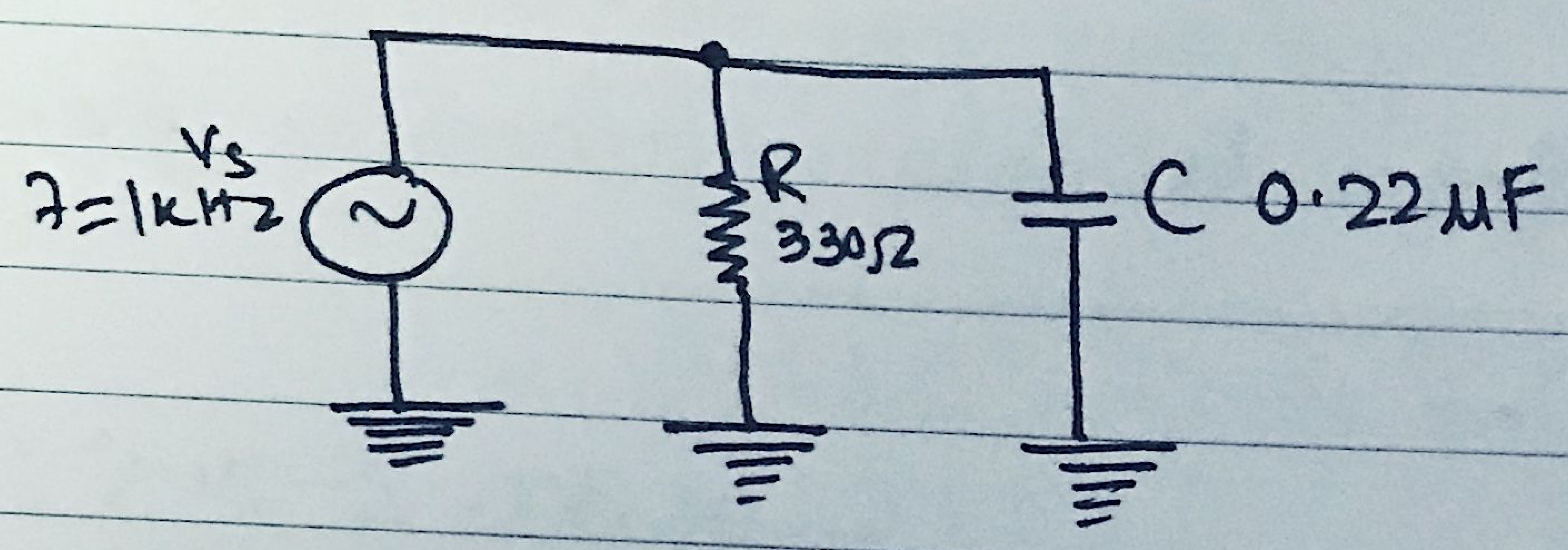
29/05/18 – MONDAY

:- LECTURE#8 :-

EXAMPLE #1:-

Total admittance = ?
Convert it to total impedance = ?
Phasor diagram = ?



Sol:-

The capacitive reactance : $X_C = \frac{1}{2\pi f C}$

$$= \frac{1}{2 \times \pi \times 1 \times 10^3 \times 0.22 \times 10^{-6}}$$

$$X_C \Rightarrow 723\Omega$$

The capacitive susceptance magnitude $= B_C = \frac{1}{X_C}$

$$= \frac{1}{723} \Rightarrow 1.38mS$$

$$G = \frac{1}{R} \Rightarrow \frac{1}{330\Omega} \Rightarrow 3.03mS$$

The total admittance is

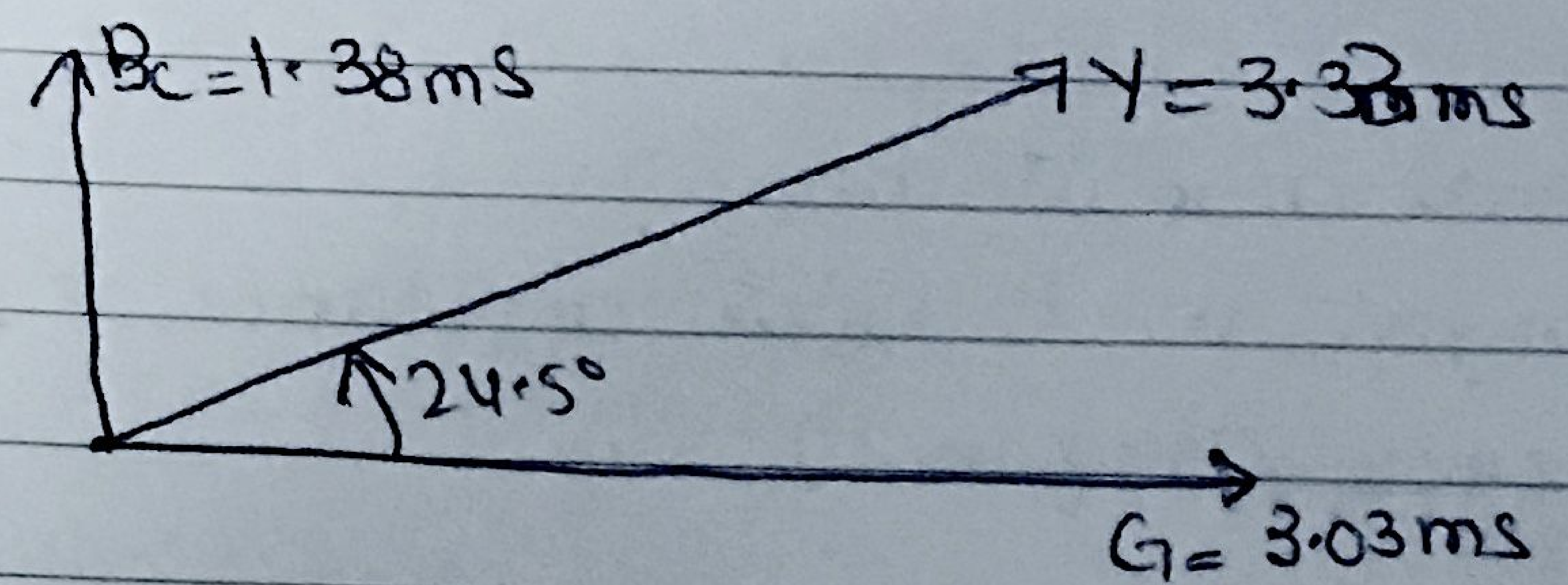
$$Y_{tot} = G + jB_C \Rightarrow (3.03 + j1.38)\,mS$$

In polar form $\Rightarrow$ $Y_{tot} = \sqrt{G^2 + B_C^2} \angle \tan^{-1}\left(\frac{B_C}{G}\right)$

$$= \sqrt{(3.03)^2 + (1.38)^2} \angle \tan^{-1}\left(\frac{1.38}{3.03}\right)$$

$$Y_{tot} \Rightarrow 3.33 \angle 24.5^\circ\,mS$$

The admittance phasor diagram is:-



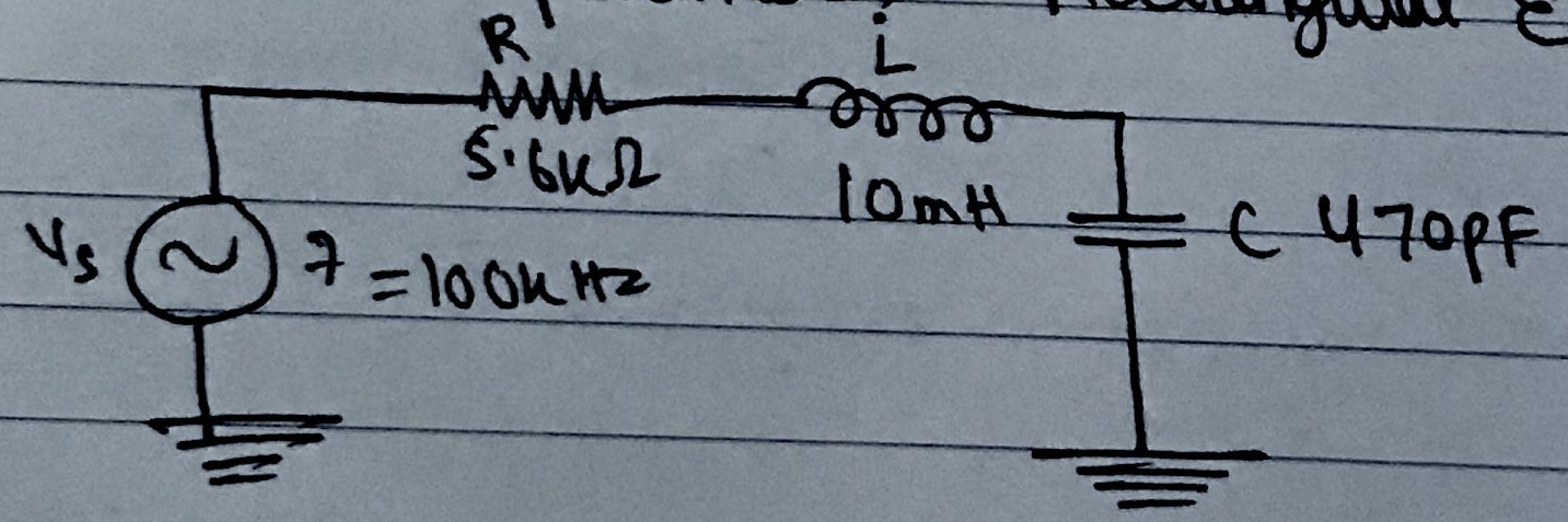
Convert total admittance to total impedance as follows:

$$Z_{tot} = \frac{1}{Y_{tot}}$$

$$= \frac{1}{3.33\,mS \angle 24.5°} \Rightarrow 300 \angle -24.5°\ \Omega$$

EXAMPLE #2:-

Total impedance = ? Rectangular & Polar = ?



Sol:-

X_C & X_L = ?

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2 \times \pi \times 100\times10^3 \times 470\times10^{-12}}$$

$$X_C \Rightarrow 3.39\,k\Omega$$

$$X_L = 2\pi f L = 2\pi \times 100\times10^3 \times 10\times10^{-3}$$

$$X_L \Rightarrow 6.28\,k\Omega$$

In this case X_L is greater than X_C and thus the circuit is more inductive than capacitive.

The magnitude of total reactance is, $X_{tot} = |X_L - X_C|$

$$= |6.28\,k\Omega - 3.39\,k\Omega| \Rightarrow 2.89\,k\Omega \text{ inductive}$$

The impedance in rectangular form is:

$\bar{Z} = R + (jX_L - jX_C)$

$= 5.6k\Omega + (j6.28k\Omega - j3.39k\Omega)$

$\bar{Z} \Rightarrow 5.6k\Omega + j2.89k\Omega$

The impedance in polar form is:

$\bar{Z} = \sqrt{R^2 + X_{tot}^2} \angle \tan^{-1}\left(\frac{X_{tot}}{R}\right)$

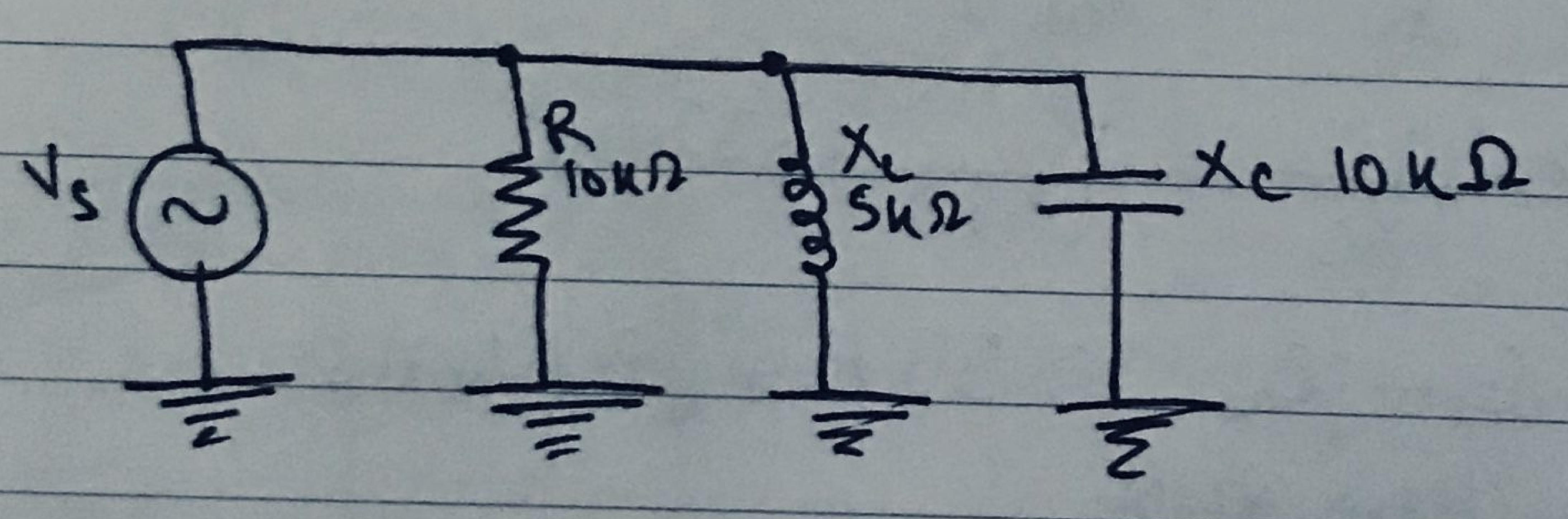
$= \sqrt{(5.6k\Omega)^2 + (2.89k\Omega)^2} \angle \tan^{-1}\left(\frac{2.89k}{5.6k}\right)$

$\bar{Z} = 6.30 \angle 27.3^\circ \, k\Omega$

The positive angle shows that circuit is inductive.

EXAMPLE # 3:-

Conductance, capacitive susceptance, inductive susceptance =? total admittance =?



Sol:-

$\bar{G} = \frac{1}{R\angle 0^\circ} = \frac{1}{10\angle 0^\circ k\Omega} \Rightarrow 100 \angle 0^\circ \, \mu S$

$\bar{B}_C = \frac{1}{X_C \angle -90^\circ} = \frac{1}{10\angle -90^\circ k\Omega} \Rightarrow 100 \angle 90^\circ \, \mu S$

$\bar{B}_L = \frac{1}{X_L \angle 90^\circ} = \frac{1}{5\angle 90^\circ k\Omega} \Rightarrow 200 \angle -90^\circ \, \mu S$

$\bar{Y}_{tot} = G + jB_C - jB_L = 100\mu S + j100\mu S - j(200\mu S)$

$= 100\mu S - j100\mu S \Rightarrow 141.4 \angle -45^\circ \, \mu S$

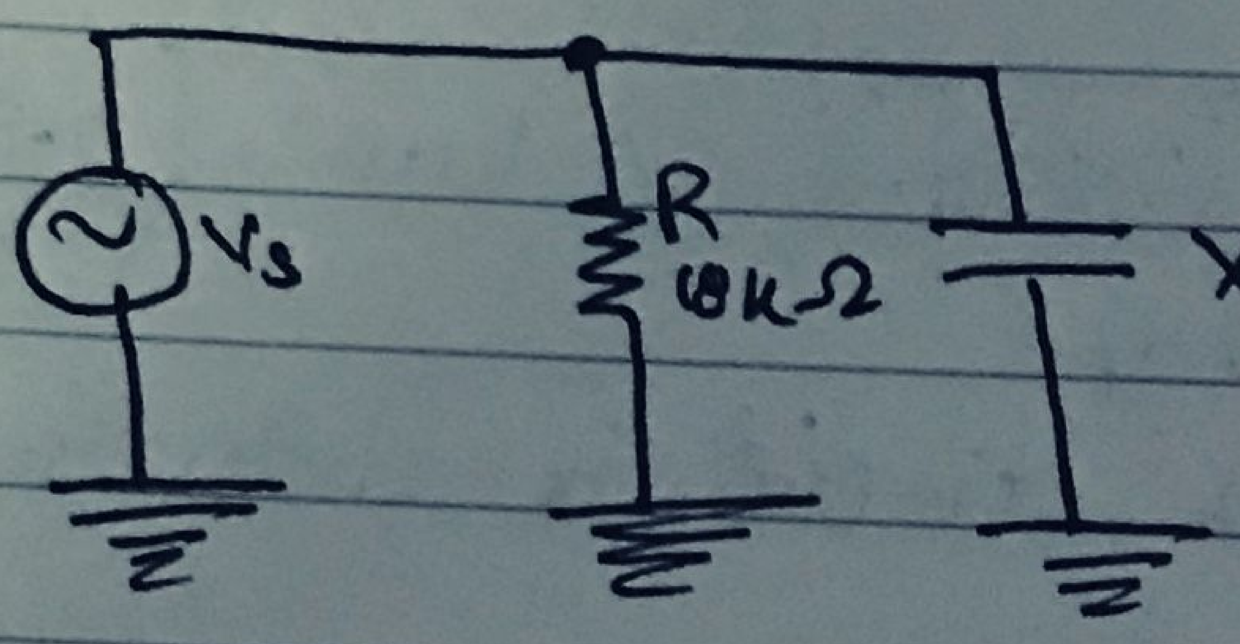
From Y_{tot} you can determine Z_{tot}.

$$Z_{tot} = \frac{1}{Y_{tot}} = \frac{1}{141.4\angle -45^\circ \mu S}$$

$$\Rightarrow 7.07\angle 45^\circ k\Omega$$

EXAMPLE #4:

parallel → Series Circuit



Sol:

First, Find the admittance of the parallel circuit as follows:

$$G = \frac{1}{R} = \frac{1}{18k\Omega} \Rightarrow 55.6\mu S$$

$$B_C = \frac{1}{X_C} = \frac{1}{27k\Omega} \Rightarrow 37.0\mu S$$

$$\bar{Y} = G + jB_C \Rightarrow 55.6 + j37.0\ \mu S$$

Converting to polar form yields

$$\bar{Y} = \sqrt{G^2 + B_C^2} \angle \tan^{-1}\left(\frac{B_C}{G}\right)$$

$$= \sqrt{(55.6\mu)^2 + (37.0\mu)^2} \angle \tan^{-1}\left(\frac{37.0\mu}{55.6\mu}\right)$$

$$\bar{Y} = 66.8\angle 33.6^\circ \mu S$$

Than, total impedance is

$$\bar{Z}_{tot} = \frac{1}{\bar{Y}} = \frac{1}{66.8\angle 33.6} \Rightarrow 15.0\angle -33.6^\circ k\Omega$$

Converting to rectangular yields.

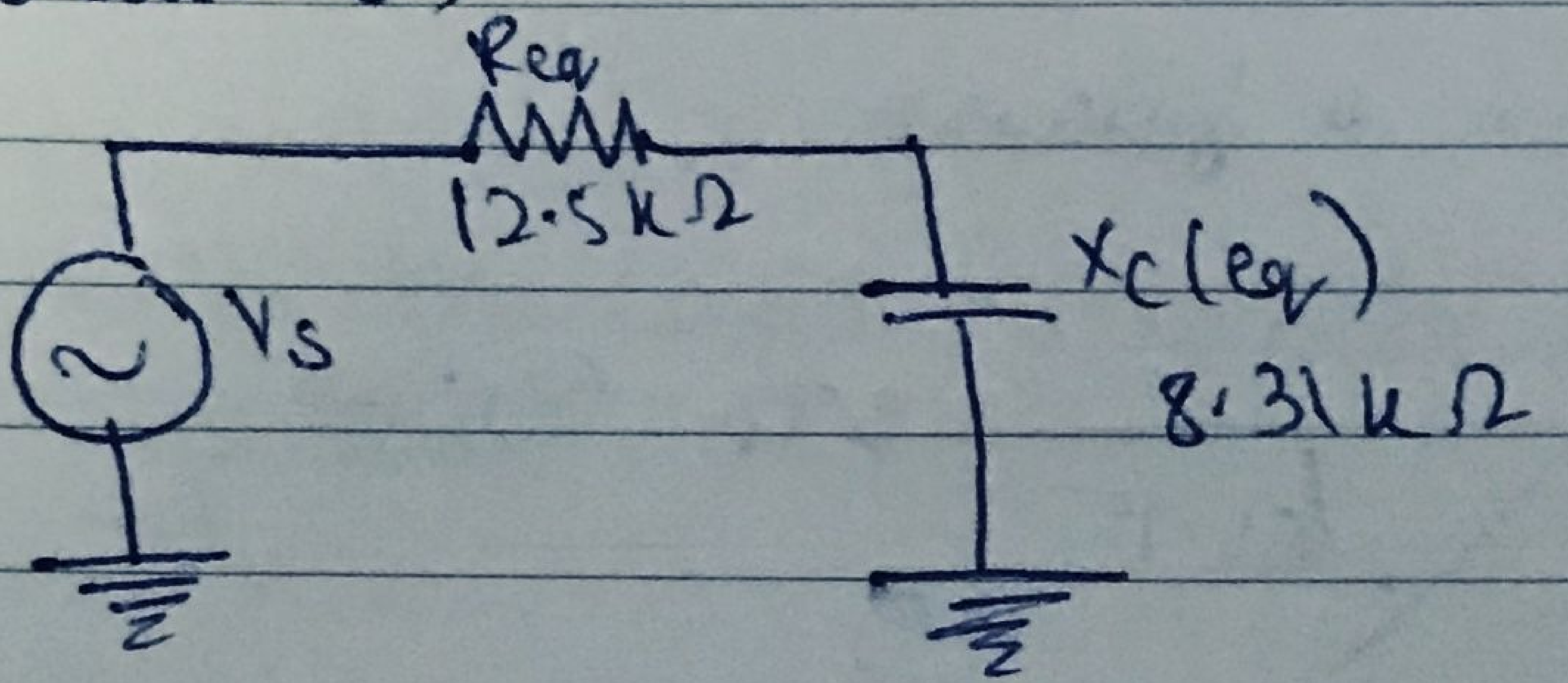
$$\bar{Z}_{tot} = Z\cos\theta - jZ\sin\theta$$

$$= R_{eq} - jX_{C(eq)}$$

$$= 15.0k\Omega\cos(-33.6°) - j15.0k\Omega\sin(-33.6°)$$

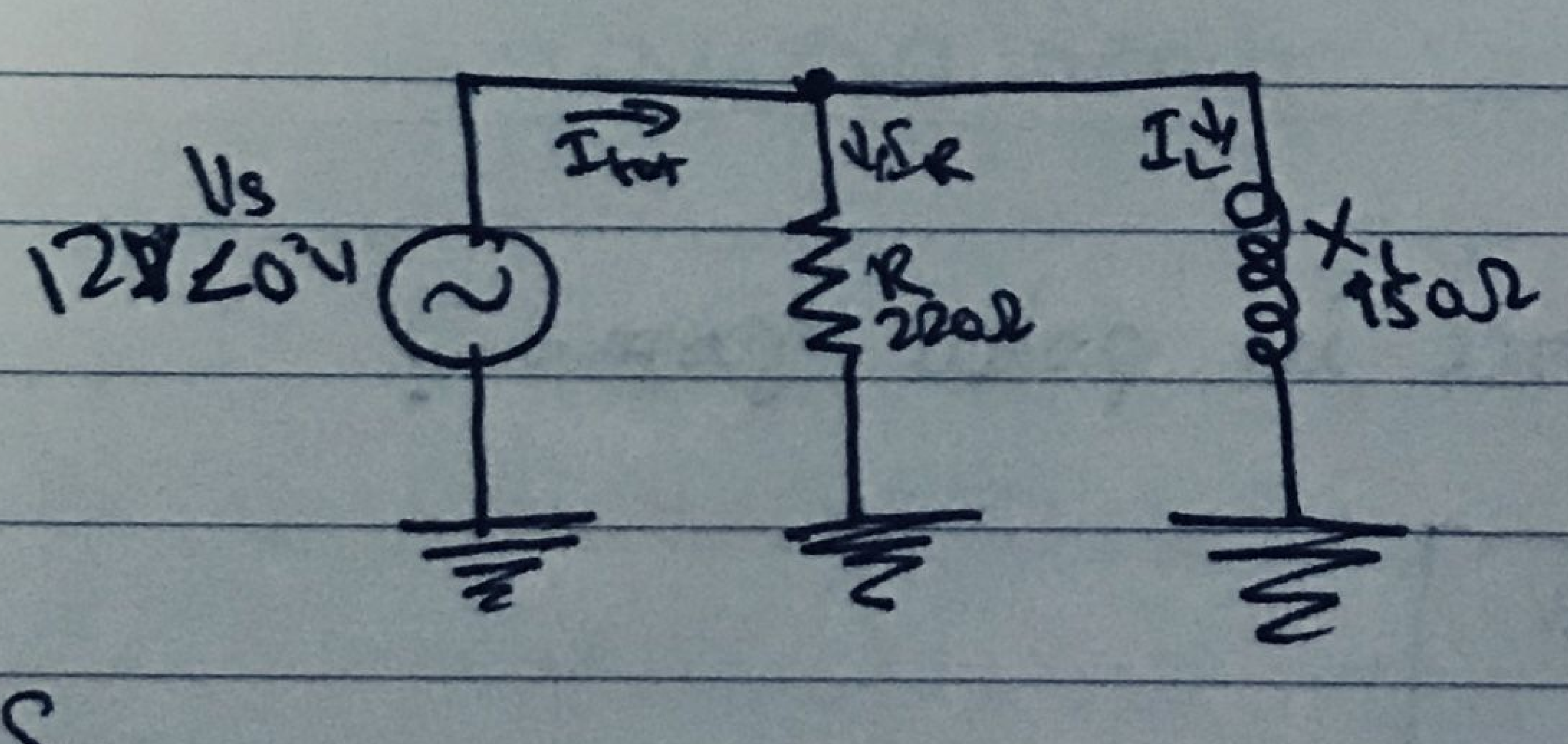
$$\bar{Z}_{tot} \Rightarrow 12.5k\Omega - j8.31k\Omega$$

The equivalent circuit is,



EXAMPLE#5:-

Each current & voltage=?



Sol:-

$$I_R = \frac{V_s}{R} = \frac{12\angle 0°V}{220\angle 0°\Omega} \Rightarrow 54.5\angle 0°mA$$

$$I_L = \frac{V_s}{X_L} = \frac{12\angle 0°V}{150\angle 90°\Omega} \Rightarrow 80\angle -90°mA$$

$$I_{tot} = I_R - jI_L$$

$$= 54.5mA - j\,80mA$$

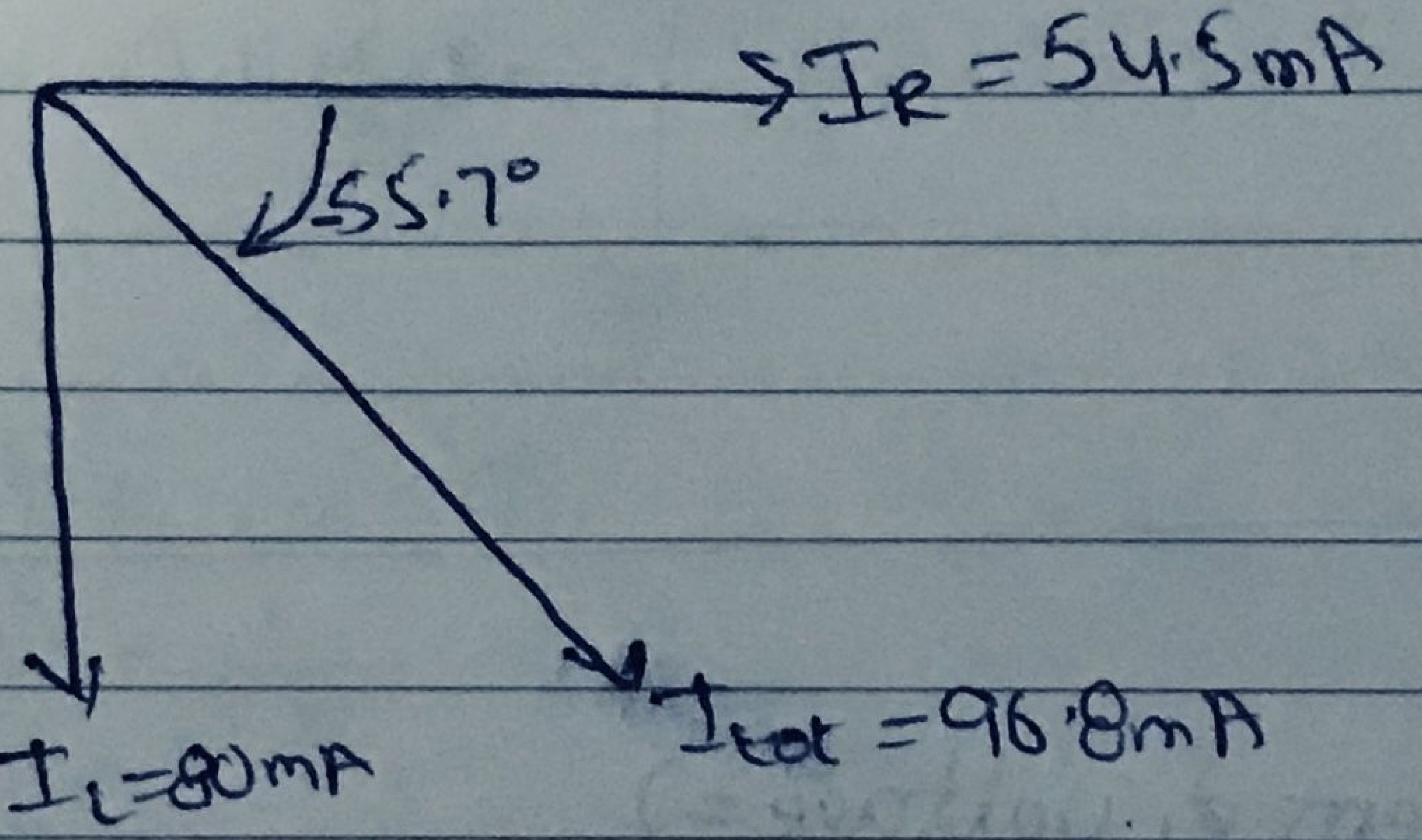
I_{tot} to polar form yields

$$I_{tot} = \sqrt{I_R^2 + I_L^2} \angle -\tan^{-1}\left(\frac{I_L}{I_R}\right)$$

$$= \sqrt{(54.5m)^2 + (80mA)^2} \angle -\tan^{-1}\left(\frac{80mA}{54.5mA}\right)$$

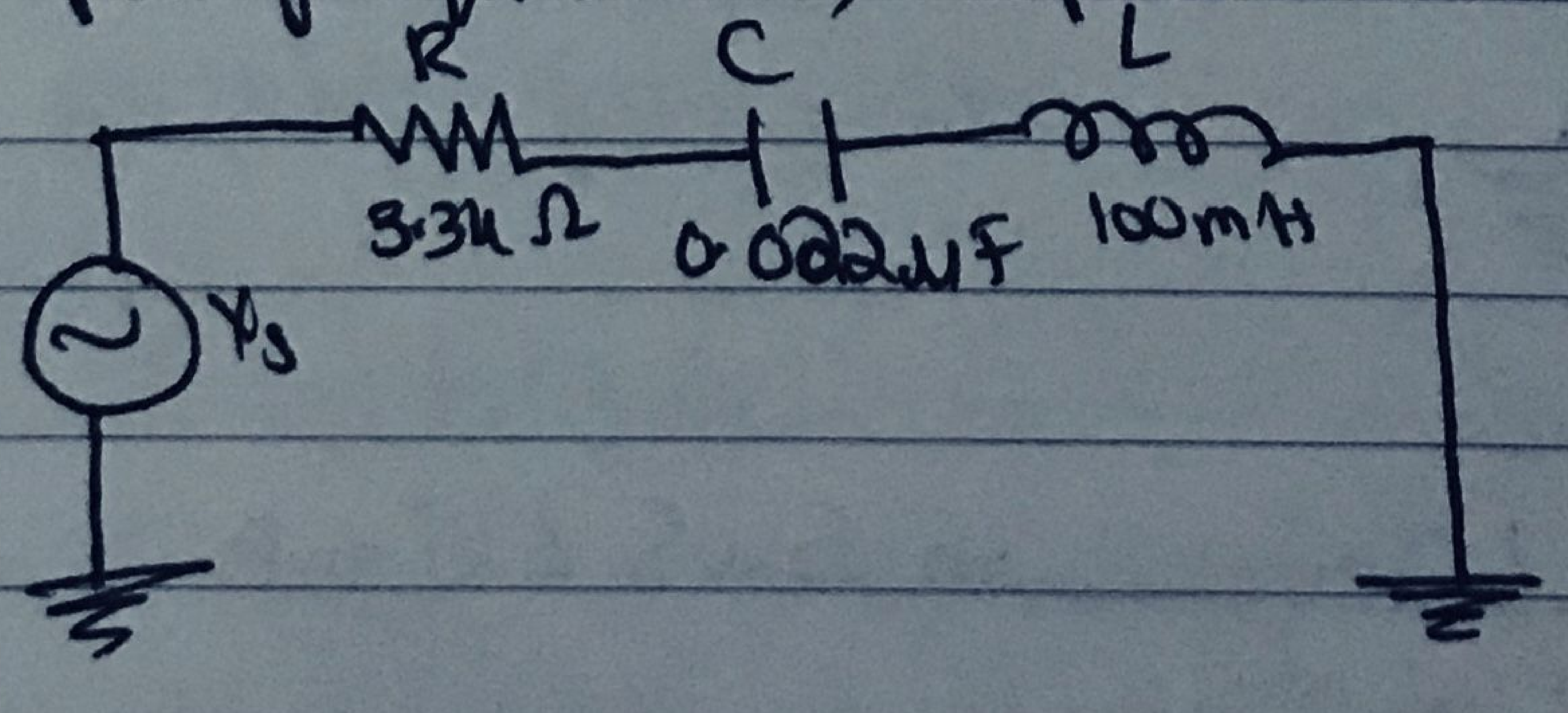
$$I_{tot} \Rightarrow 96.8 \angle -55.7^\circ \text{ mA}$$

The phasor diagram is follows:-



EXAMPLE#6:-

input frequencies, impedance in polar form = ?



a) $f = 1kHz$

Sol:-

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 1\times 10^3 \times 0.022\mu}$$

$$X_C \Rightarrow 7.23k\Omega$$

$X_L = 2\pi f L \Rightarrow 2\pi (1kHz)(100mH)$

$X_L \Rightarrow 628\Omega$

The circuit is clearly capacitive, and the impedance is

$$Z = \sqrt{R^2 + (X_L - X_C)^2} \quad \angle -\tan^{-1}\left(\frac{X_{tot}}{R}\right)$$

$$= \sqrt{(3.3k\Omega)^2 + (628\Omega - 7.23k\Omega)^2} \quad \angle -\tan^{-1}\left(\frac{6.60k\Omega}{3.3k\Omega}\right)$$

$$Z \Rightarrow 7.38 \angle -63.4^\circ \ k\Omega$$

The negative sign for the angle is used to indicate that the circuit is capacitive.

b) $f = 3.5kHz$

Sol:

$$X_C = \frac{1}{2\pi f C} = \frac{1}{2\pi (3.5kHz)(0.022\mu F)}$$

$$X_C \Rightarrow 2.07k\Omega$$

$$X_L = 2\pi f L = 2\pi \times 3.5kHz \times 100mH \Rightarrow 2.20k\Omega$$

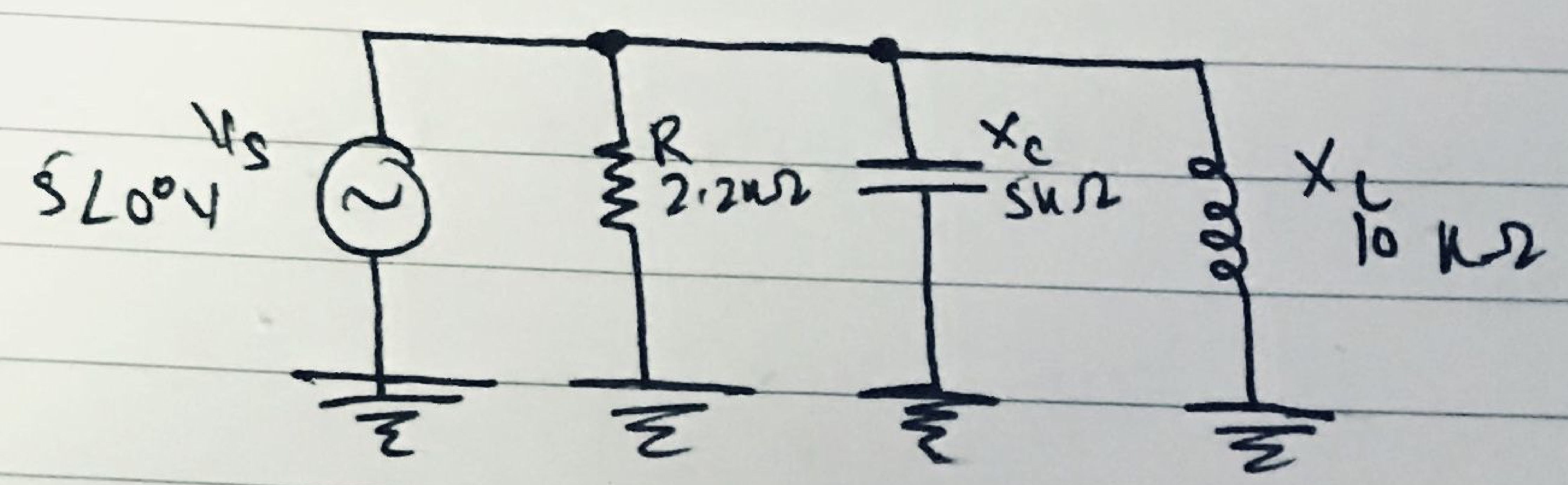
The circuit is very close to being purely resistive because X_C and X_L are nearly equal, but it is slightly inductive.

The impedance is,

$$Z = \sqrt{(3.3k\Omega)^2 + (2.20k\Omega - 2.07k\Omega)^2} \quad \angle \tan^{-1}\left(\frac{0.13k\Omega}{3.3k\Omega}\right)$$

$$Z = 3.3 \angle 2.26^\circ \ k\Omega$$

EXAMPLE #7:



Sol:

$$I_R = \frac{V_s}{R} = \frac{5\angle 0° V}{2.2\angle 0° k\Omega} \Rightarrow 2.27\angle 0° mA$$

$$I_C = \frac{V_s}{X_C} = \frac{5\angle 0° V}{5\angle -90° k\Omega} \Rightarrow 1\angle 90° mA$$

$$I_L = \frac{V_s}{X_L} = \frac{5\angle 0° V}{10\angle 90° k\Omega} \Rightarrow 0.5\angle -90° mA$$

The total current is the phasor sum of the branch currents.

$$I_{tot} = I_R + I_C + I_L$$
$$= 2.27\angle 0° mA + 1\angle 90° mA + 0.5\angle -90° mA$$

$$I_{tot} = 2.27 mA + j1 mA - j0.5 mA$$
$$\Rightarrow 2.27 + j0.5 mA$$

Converting to polar form yields,

$$I_{tot} = \sqrt{I_R^2 + (I_C - I_L)^2} \angle \tan^{-1}\left(\frac{I_{CL}}{I_R}\right).$$

$$= \sqrt{(2.27 mA)^2 + (0.5 mA)^2} \angle \tan^{-1}\left(\frac{0.5 mA}{2.27 mA}\right)$$

$$I_{tot} = 2.32\angle 12.4° mA$$

The total current is 2.32 mA leading V_s by 12.4°
The current phasor diagram is: