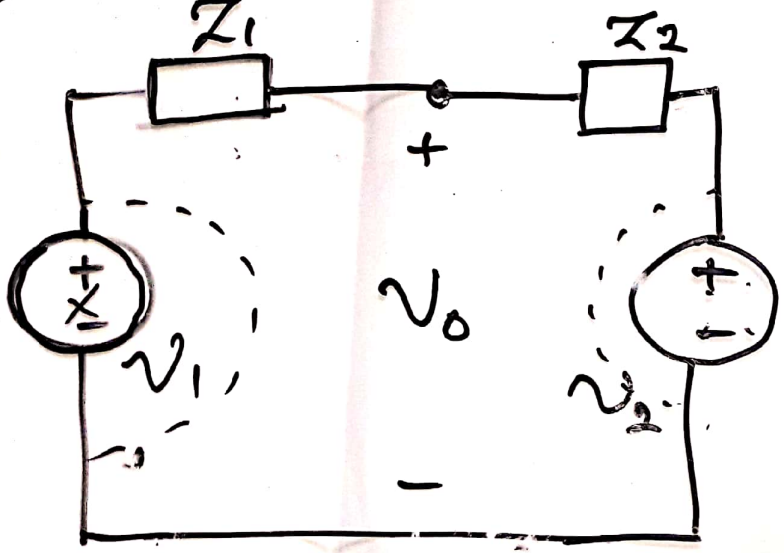
① Superposition

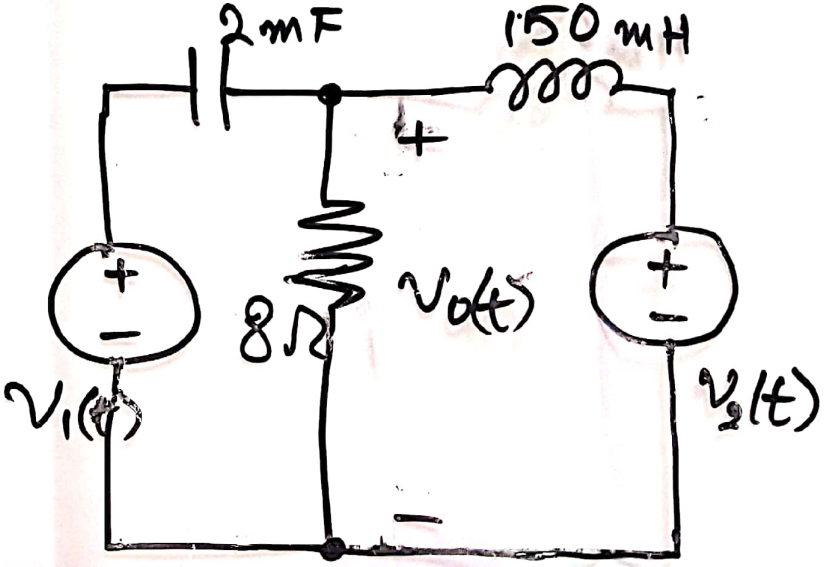


$v_1 = V_{m_1} \cos \omega_1 t$.

$v_2 = V_{m_2} \cos \omega_2 t$.

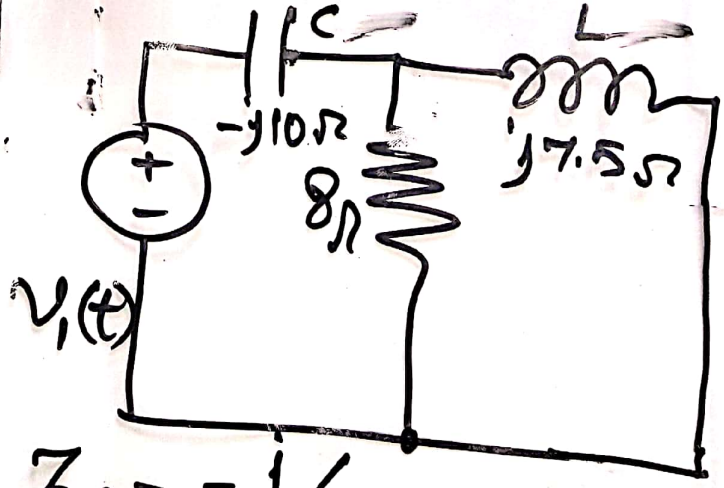
$v_0 = v_{01} + v_{02}$

Ex : 10.8-1



$v_1(t) = 20 \cos(50t)$

$v_2(t) = 20 \cos(10t)$

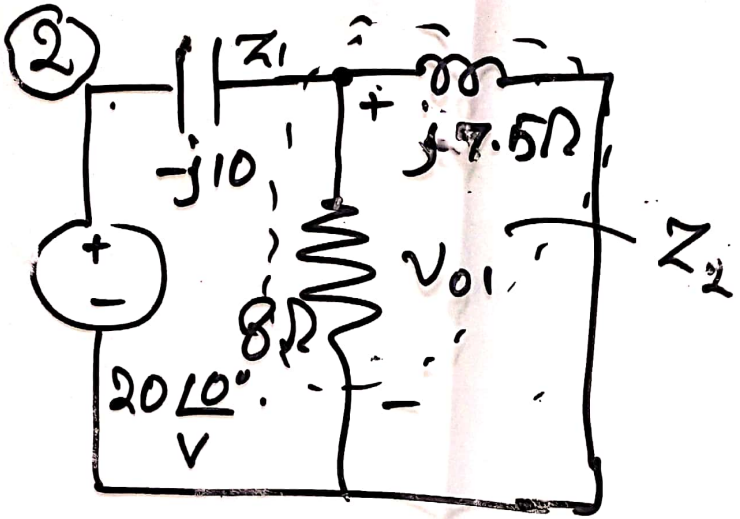


$Z_L = j\,50 \times 150 \times 10^{-3}$

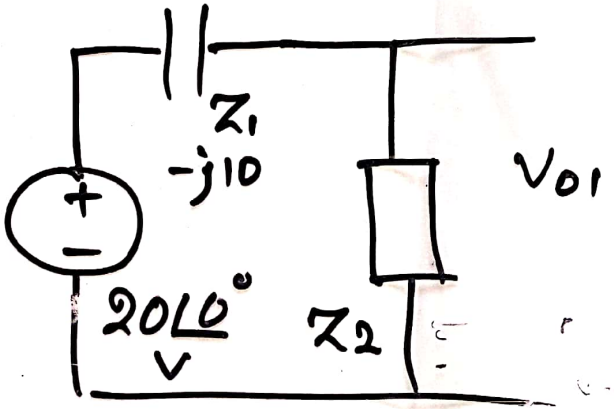
$= j\,7.5\,\Omega$.

$Z_c = -j/50 \times 2 \times 10^{-3} = -j\,\frac{10}{100} = -j10\,\Omega$.

(2)



$\omega_1 = 50$ rad/s.



$$Z_2 = \frac{8 \times j7.5}{8 + j7.5} = \frac{60\angle 90^\circ}{10.96\angle 43.1^\circ}$$

$$= 5.47\angle 46.9^\circ\ \Omega.$$

$$= 3.73 + j3.99\ \Omega$$

Applying Voltage divider formula.

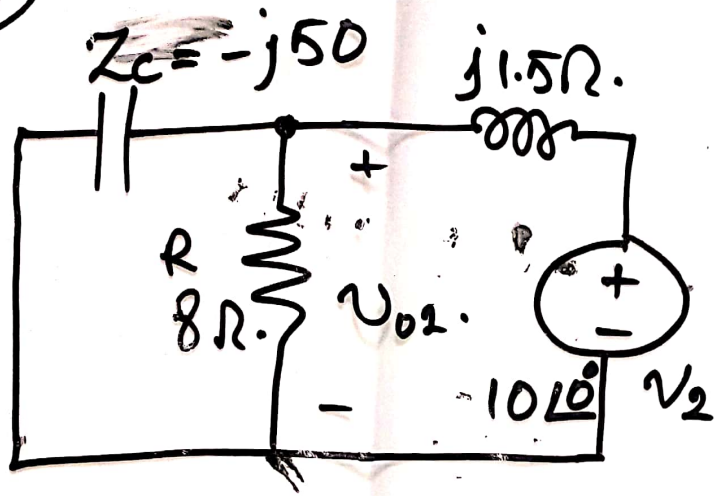
$$V_{01} = \frac{Z_2}{Z_1 + Z_2} \times 20^\circ\angle 0^\circ$$

$$= \frac{5.47\angle 46.9}{-j10 + 3.73 + j3.99} \times 20\angle 0^\circ$$

$$= \frac{5.47\angle 46.9 \times 20\angle 0^\circ}{3.73 - j6.01} = \frac{5.47\angle 46.9}{7.07\angle -58.1} \times 20\angle 0^\circ$$

$$= 15.46\angle 104.9^\circ\ V.$$

(3)



$\omega_2 = 10$ rad/s.

$$Z_c = \frac{-j}{10 \times 2 \times 10^{-3}} = \frac{-j50}{2}$$

$$-j50$$

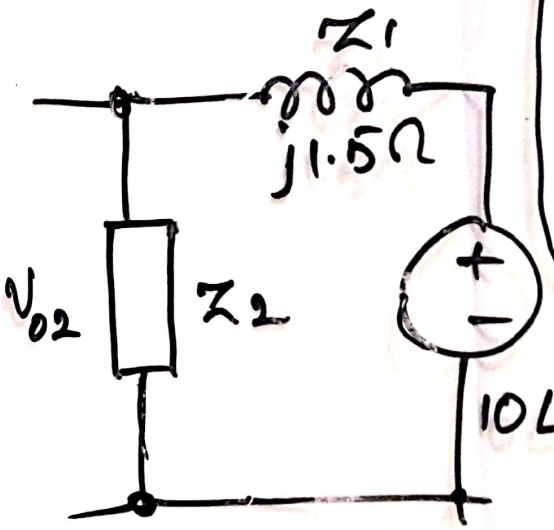
$$Z_L = j \times 10 \times 150 \times 10^{-3}$$

$$= j1.5\ \Omega.$$

$$Z_2 = Z_c \,||\, R = \frac{8 \times (-j50)}{8 - j50} = \frac{400\angle -90}{50.63\angle 9.09}$$

$$= 7.9\angle -99.1^\circ\ \Omega.$$

$$= 1.17 - j7.40\ \Omega.$$



$$v_{02} = \frac{Z_2}{Z_1 + Z_2} \times 10\angle 0°$$

$$= \frac{7.9\angle -99.1}{1.17 - j7.40 + j1.5} \times 10\angle 0°$$

$$= \frac{7.9\angle -99.1}{6.02\angle -78.76} \times 10\angle 0°$$

$$13.1\angle -177.76.$$

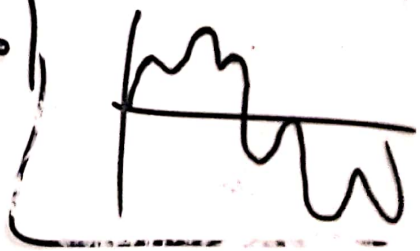
$$v_0 = v_{01} + v_{02}$$

$$= 15.46\angle 104.9° + 13.1\angle -177$$

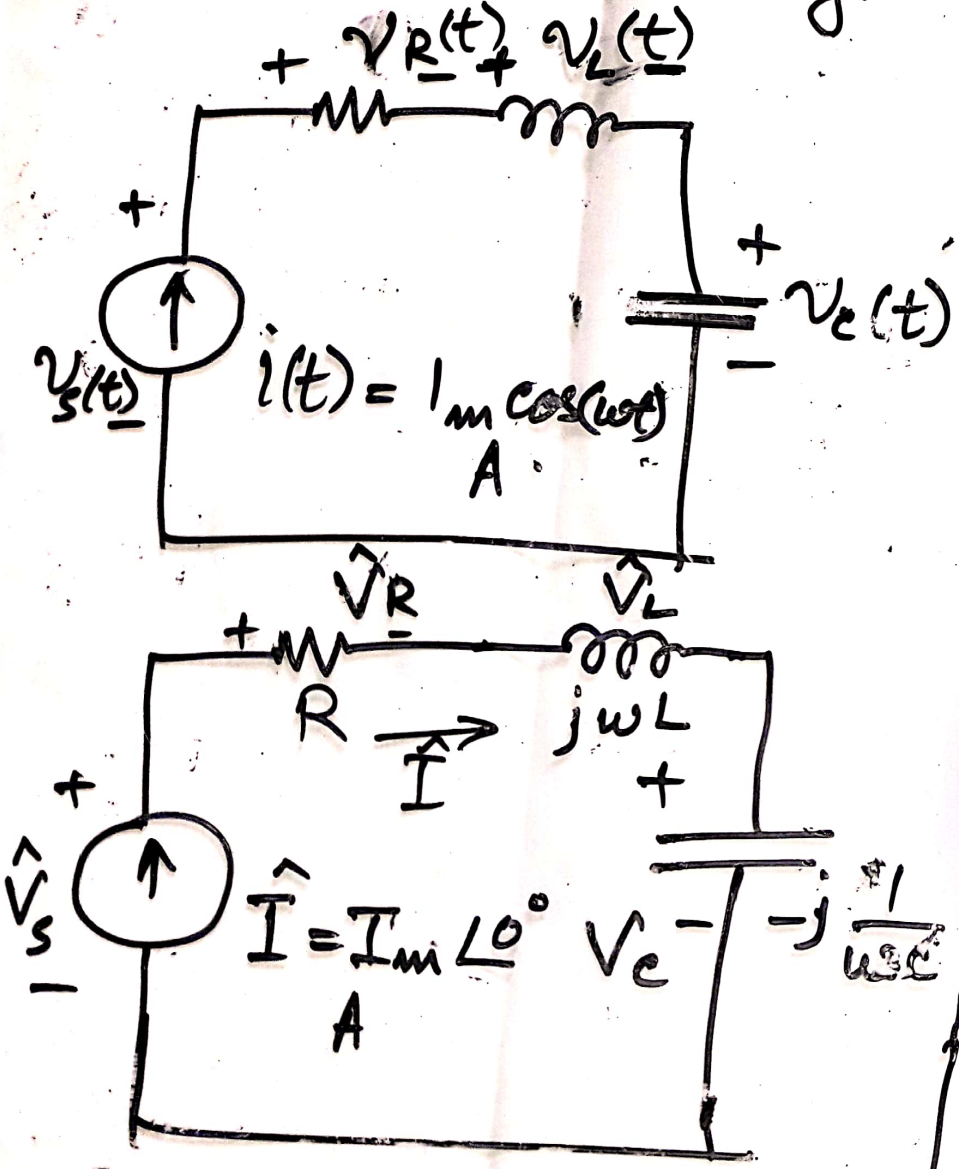
* $v_0(t)$

$15.46\cos(50t + 104.9$

$+13.1\cos(10t - 177.7$



Phasor Diagram



$$\hat{I} = I_m \angle 0^\circ$$

$$V_R = R(I_m \angle 0^\circ)$$

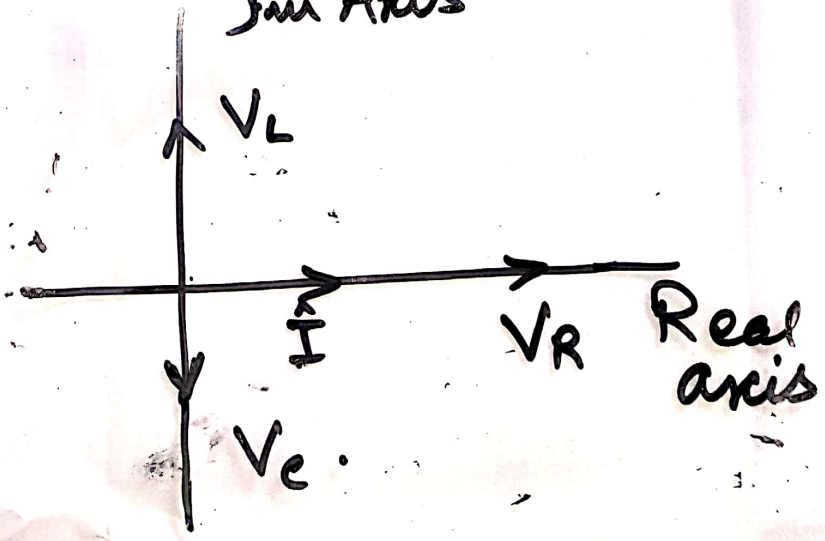
$$= R I_m \angle 0^\circ \cdot V$$

$$V_L = j\omega L (I_m \angle 0^\circ)$$

$$\omega L I_m \angle 90^\circ \cdot V$$

$$V_c = \left(-j\frac{1}{\omega C}\right)(I_m \angle 0^\circ)$$

$$\frac{I_m}{\omega C} \angle -90^\circ \; V$$



(4) $\hat{V}_S = \hat{V}_R + \hat{V}_L + \hat{V}_C$

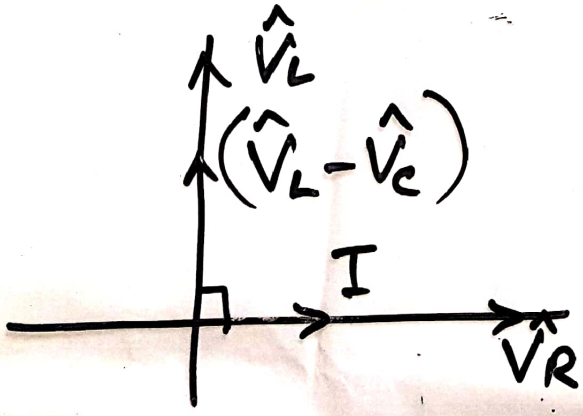
$= \hat{V}_R + (\hat{V}_L + \hat{V}_C)$

$\hat{V}_L + \hat{V}_C = j\omega L I_m \angle 0^\circ - j \frac{I_m \angle 0^\circ}{\omega C}$

$= j\left(\omega L - \frac{1}{\omega C}\right)(I_m \angle 0^\circ)$

$= \left(\omega L - \frac{1}{\omega C}\right) I_m \angle 90^\circ$

Let $V_L > V_C$.



$V_S = V_R + (V_L + V_C)$

$= R I_m + j\left(\omega L - \frac{1}{\omega C}\right) I_m$.