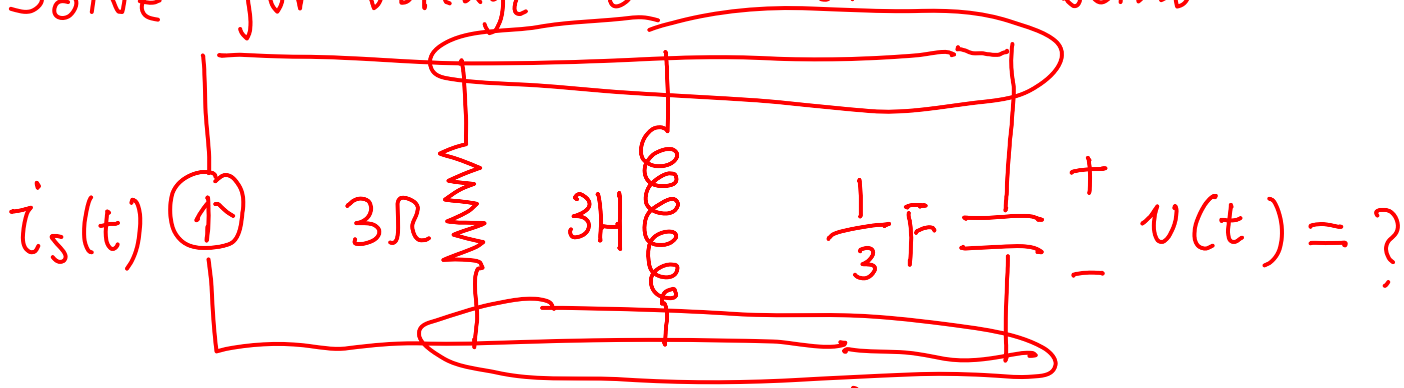
Solve for voltage v in circuit below



$i_s(t) = 10 \cos 2t \quad (A)$

$I_s(jw) = 10 \angle 0°$

$Z_R = 3\Omega \qquad Z_L = jwL = j \cdot 2 \cdot 3 = 6j\ \Omega$

$Z_C = \frac{1}{jwC} = -\frac{j}{wC} = -\frac{j}{2 \cdot \frac{1}{3}} = -1.5j\,\Omega$

$Z_{eq} = ?$

$$\frac{1}{Z_{eq}} = \frac{1}{Z_R} + \frac{1}{Z_C} + \frac{1}{Z_L}$$

$$Z_{eq} = \frac{1}{\frac{1}{Z_R} + \frac{1}{Z_C} + \frac{1}{Z_L}}$$

do it yourself !

slight different approach

$$Z_{eq} = Z_R \,//\, Z_L \,//\, Z_C$$

$$= \frac{Z_R \cdot Z_L}{Z_R + Z_L} \,//\, Z_C$$

$$= \frac{3 \times 6j}{3 + 6j} \,//\, Z_C$$

$$= \frac{6j\,(1-2j)}{(1+2j)(1-2j)} \,//\, Z_C$$

$$= \frac{12+6j}{5} \,//\, Z_C$$

$$= (2.4 + 1.2j) \,//\, (-1.5j)$$

$$= \frac{(2.4+1.2j)(-1.5j)}{2.4 + 1.2j - 1.5j}$$

$$= \frac{(1.8 - 3.6j)(2.4 + 0.3j)}{(2.4 - 0.3j)(2.4 + 0.3j)}$$

$$(1+2j)(1-2j)$$

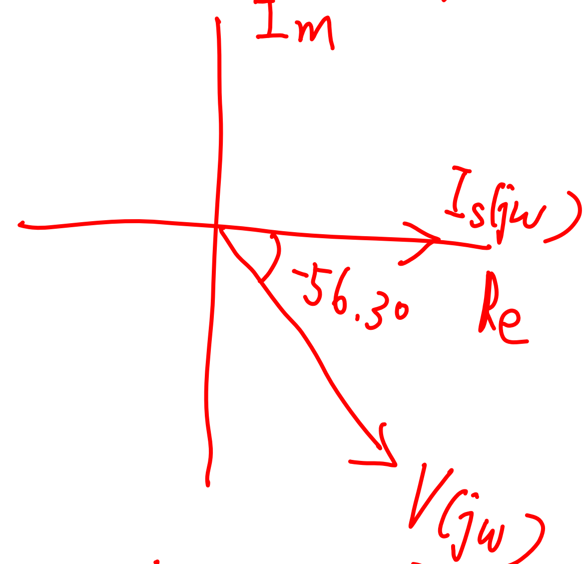
$$= 1 - (2j)^2$$

$$= 1 - (-4) = 5$$

$$Z_{eq} = \frac{5.4 - 8.1j}{(2.419)^2}$$

$$= (0.923 - 1.385j)\,\Omega$$

$$V(j\omega) = I_s(j\omega)\,Z_{eq}$$



$$\text{modulus} = \sqrt{(0.923)^2 + (1.385)^2} = 1.66$$

$$\text{angle} = \tan^{-1}\left(\frac{-1.385}{0.923}\right) = -56.3°$$

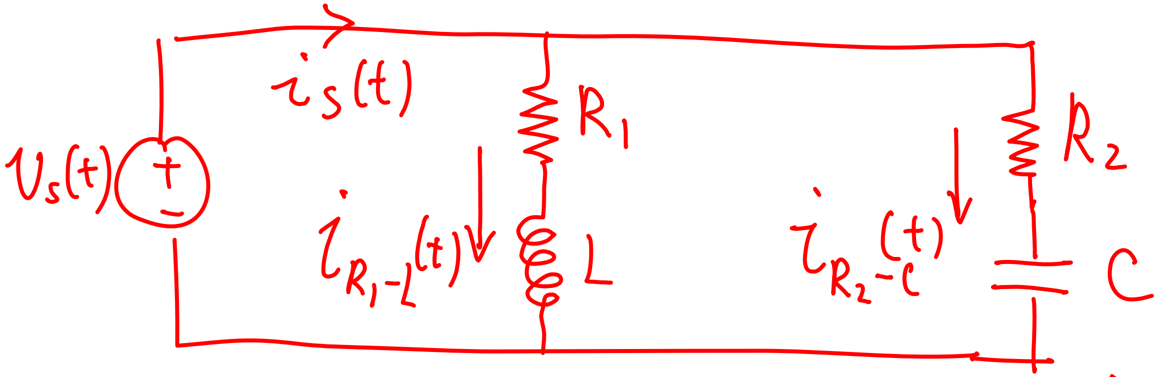
$$Z_{eq} = 1.66 \angle -56.3°$$

$$V(j\omega) = I_s(j\omega)\,Z_{eq} = (10\angle 0)\cdot(1.66\angle -56.3°)$$

$$V(j\omega) = 16.6 \angle -56.3°$$

$$v(t) = 16.6 \cos(2t - 56.3°)$$

Determine the current in each branch



$$\frac{\pi}{12} = 15^\circ$$

$$v_s(t) = 636\cos\left(3000t + \frac{\pi}{12}\right) \quad (V)$$

$R_1 = 3.3\,k\Omega \quad R_2 = 22\,k\Omega \quad L = 1.90\,H \quad C = 6.8\,nF$

$i_s(t) = ?$

$$V_s(j\omega) = 636\angle 15^\circ$$

$Z_{R_1} = 3300\,\Omega \quad Z_{R_2} = 22000\,\Omega$

$$Z_L = j\omega L = j(3000 \times 1.9) = 5700j\ \Omega$$

$$Z_C = \frac{1}{j\omega C} = -\frac{j}{\omega C} = -\frac{j}{3000 \times (6.8 \times 10^{-9})} = -4.9 \times 10^4 j\,\Omega$$

$$Z_{eq} = (Z_C + Z_{R_2}) \,//\, (Z_L + Z_{R_1})$$

$$= \frac{(Z_C + Z_{R_2})(Z_L + Z_{R_1})}{Z_C + Z_{R_2} + Z_L + Z_{R_1}}$$

$$= \frac{(22000 - 4.9\times10^4 j)(5700j + 3300)}{22000 + 3300 - 4.9\times10^4 j + 5700j}$$

$$= \frac{(22000 - 49000j)(3300 + 5700j)}{25300 - 43300j}$$

$$= \frac{(53712\angle -65.8^\circ)\cdot(6586\angle 59.9^\circ)}{50149\angle -59.7^\circ}$$

$$= 7054\angle 53.8^\circ \ \Omega$$

$$I_s(j\omega) = \frac{V_s(j\omega)}{Z_{eq}} = \frac{636\angle 15^\circ}{7054\angle 53.8} = 0.090\angle -38.8^\circ$$

$$i_s(t) = 0.090\cos(3000t - 38.8^\circ)\ (A)$$

$$i_{R_1-L} = ? \qquad I_{R_1-L}(j\omega)$$

$$I_{R_1-L}(j\omega) = \frac{V_s(j\omega)}{Z_L + Z_{R_1}} = \frac{636\angle 15^\circ}{6586\angle 59.9^\circ}$$

$$= 0.096\angle -44.9^\circ$$

$$i_{R_1-L}(t) = 0.096\cos(3000t - 45^\circ)$$

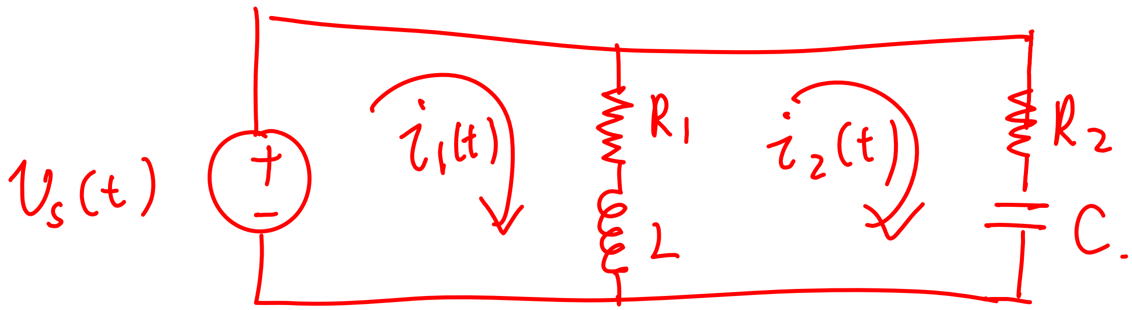
$$i_{R_2-C}(t) = ?$$

$$I_{R_2-C}(j\omega) = \frac{V_s(j\omega)}{Z_C + Z_{R_2}} = \frac{636\angle 15^\circ}{53712\angle -65.8^\circ}$$

$$= 0.012\angle 80.8^\circ$$

$$i_{R_2-C}(t) = 0.012\cos(3000t + 80.8^\circ)$$

Mesh analysis



$$V_s(j\omega) = 636\angle 15^\circ$$

$$I_1(j\omega) = ? \qquad I_2(j\omega) = ?$$

$$(Z_{R_1} + Z_L) I_1(j\omega) - (Z_{R_1} + Z_L) I_2(j\omega) = V_s(j\omega)$$

$$-(Z_{R_1} + Z_L) I_1(j\omega) + (Z_{R_1} + Z_L + Z_{R_2} + Z_C) I_2(j\omega) = 0$$

$$I_1(j\omega) = \frac{\begin{vmatrix} V_s(j\omega) & -(Z_{R_1} + Z_L) \\ 0 & (Z_{R_1} + Z_L + Z_{R_2} + Z_C) \end{vmatrix}}{\begin{vmatrix} Z_{R_1} + Z_L & -(Z_{R_1} + Z_L) \\ -(Z_{R_1} + Z_L) & (Z_{R_1} + Z_L + Z_{R_2} + Z_C) \end{vmatrix}}$$

$$I_1(j\omega) = \frac{V_s(j\omega)(Z_{R_1} + Z_L + Z_{R_2} + Z_C)}{(Z_{R_1} + Z_L + Z_{R_2} + Z_C)(Z_{R_1} + Z_L) - (Z_{R_1} + Z_L)^2}$$

$$= \frac{V_s(j\omega)(Z_{R_1} + Z_L + Z_{R_2} + Z_C)}{(Z_{R_2} + Z_C)(Z_{R_1} + Z_L)}$$

$$= \frac{(636\angle 15^\circ)(50149\angle -59.7^\circ)}{(53712\angle -65.8^\circ)(6586\angle 59.9^\circ)}$$

$$= 0.090\angle -38.8^\circ$$

$$i_1(t) = 0.090\cos(300t - 38.8^\circ)$$