a) $3\cos(20t+10^\circ) \rightarrow 3\angle 10^\circ$ $\qquad 5\cos(20t-30) \rightarrow 5\angle -30^\circ$

$3\angle 10^\circ - 5\angle -30^\circ = 2.954 + j0.520 - 4.33 + j2.5$

$= -1.376 + j3.021 = 3.32\angle 114.5^\circ$

$\rightarrow 3.32\cos(20t + 114.5^\circ)$

b) $40\sin 50t \rightarrow 40\angle -90^\circ$ $\qquad 30\cos(50t-45^\circ) \rightarrow 30\angle -45^\circ$

$40\angle -90^\circ + 30\angle -45^\circ = -j40 + 21.21 - j21.21 =$

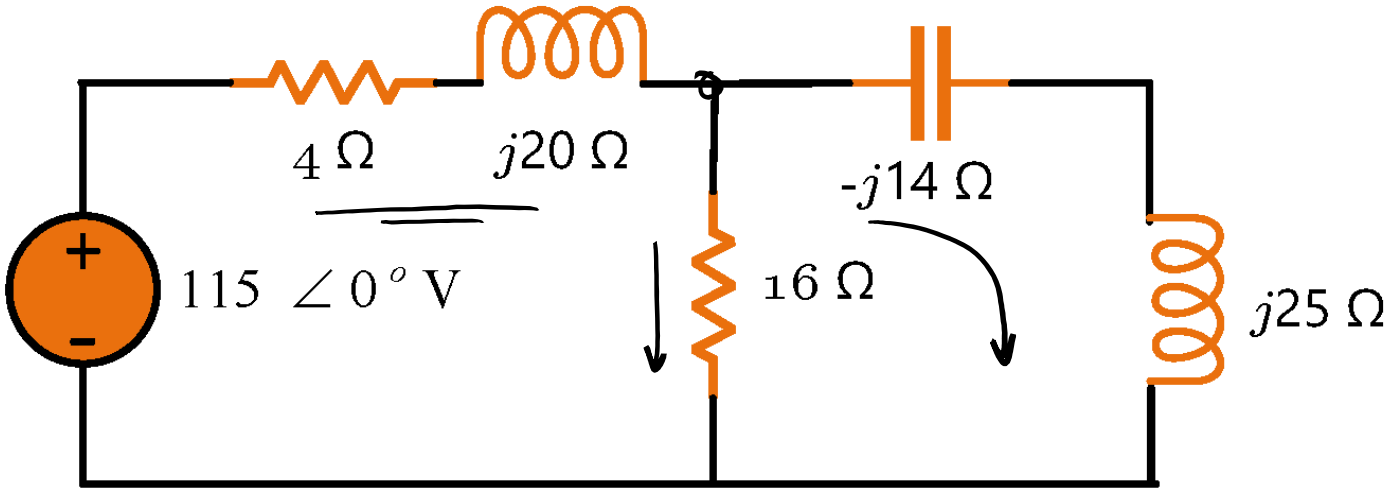
$= 21.21 - j61.21 = 64.78\angle -70.89^\circ$

$\rightarrow 64.78\cos(50t - 70.89^\circ)$

c) $20\angle 30^\circ + 10\angle 60^\circ - 5\angle 110^\circ = -j20 + 5 + j8.66 - 1.71 + j4.699$

$= 6.71 - j6.64 = 9.44\angle -44.7^\circ$

$\rightarrow 9.44\cos(400t - 44.7^\circ)$

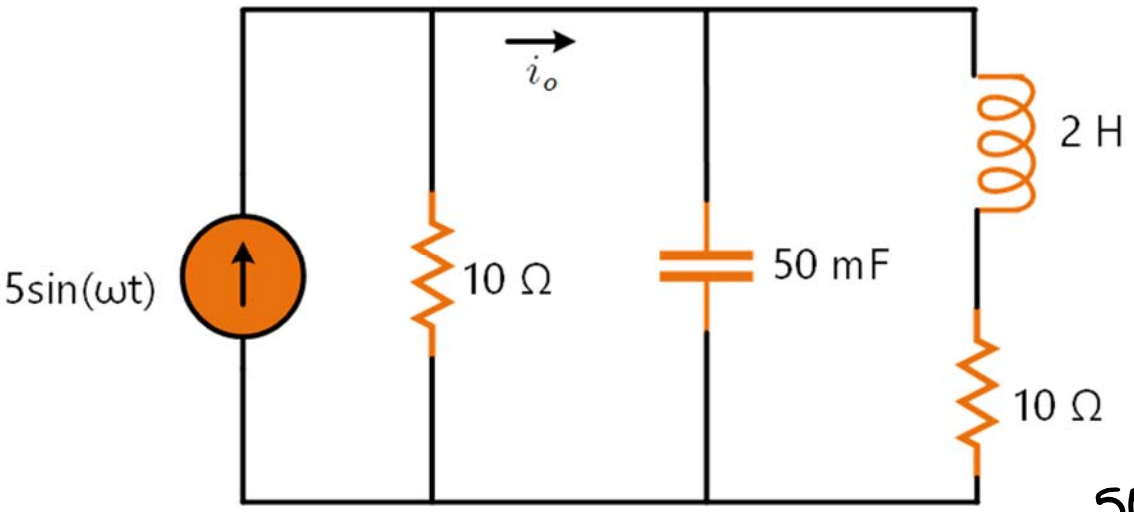


$$Z_{eq} = 4 + j20 + \left(16 \,\|\, (j25 - j14)\right) = 4 + j20 + \left(\frac{16\,(j11)}{16 + j11}\right) =$$

$$= 9.135 + j27.47\ \Omega$$

in polar form $\rightarrow 28.95 \angle 71.61^\circ\ \Omega$

$$I = \frac{V}{Z_{eq}} = \frac{115 \angle 0}{28.95 \angle 71.61} = 3.972 \angle -71.6^\circ\ A$$



We can find i_o using current division

$$I_o = I \frac{Z_1}{Z_1 + Z_2} \qquad Z_1 = 10\Omega$$

$$Z_2 = 50mF \parallel (10\Omega + 2H)$$

a) at $\omega = 1$ rad/sec

$$50mF \rightarrow \frac{1}{j\,1.005} = -j20\Omega$$

$$2H \rightarrow j\,2.1 = j2\Omega$$

$$Z_2 = -j20 \parallel (10 + j9) = 9.434 - j3.018$$

$$= 9.9 \angle -17.75^\circ \ \Omega$$

$$I_o = 2.542 \angle 8.83 \ A$$

$$i_o(t) = 2.542 \sin(t + 8.83^\circ) \ A$$

b) at $\omega = 5$ rad/sec

$$50mF \rightarrow -j4\Omega \qquad 2H \rightarrow j10\Omega$$

$$Z_2 = (-j4) \parallel (10 + j10) = 1.17 - j4.706\Omega$$

$$= 4.85 \angle -75.964^\circ \ \Omega$$

$$I_o = 4.123 \angle 22.83^\circ \ A$$

$$i_o(t) = 4.123 \sin(5t + 22.83^\circ) \ A$$

c) at $\omega = 10$ rad/sec

$$50mF \rightarrow -j2 \qquad 2H \rightarrow j20$$

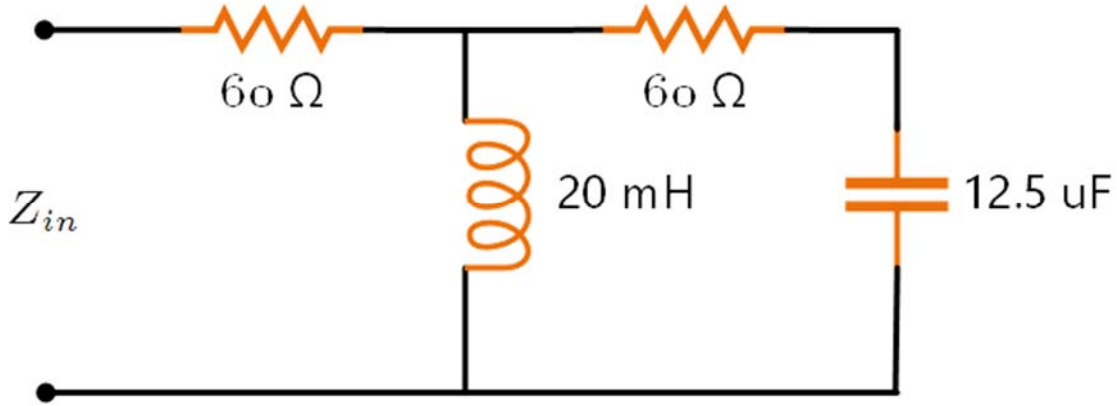
$$Z_2 = (-j2) \parallel (10 + j20) = 0.094 - j2.1698\Omega$$

$$= 2.17 \angle -87.51^\circ \ \Omega$$

$$I_o = 4.843 \angle 12.13 \ A$$

$$i_o(t) = 4.843 \sin(10t + 12.13^\circ) \ A$$

$\omega = 10$ rad/sec



$20\text{mH} \rightarrow j \cdot 10^3 \cdot 20 \cdot 10^{-3}$

$= j20\,\Omega$

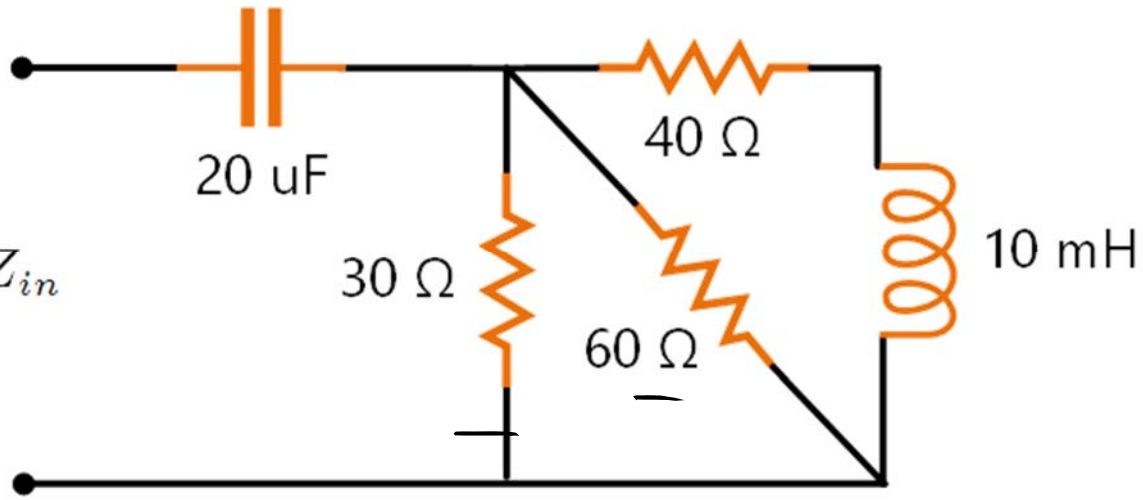
$12.5\mu\text{F} \rightarrow \dfrac{1}{j \cdot 10^3 \cdot 12.5 \cdot 10^{-6}} = -j80\,\Omega$

$$Z_{in} = 60 + \left(j20 \,\|\, (60 - j80)\right) = 60 + \frac{(j20)(60 - j80)}{60 - j60} = 63.33 + j23.33\,\Omega$$

$$= 67.49 \angle 20.22^\circ\,\Omega$$

$$Y_{in} = \frac{1}{Z_{in}} = 14.8 \angle -20.22^\circ\ \text{mS}$$

$\omega = 10^3$ rad/sec



$10\text{mH} \rightarrow j\,10^3 \cdot 10 \cdot 10^{-3} = j10\,\Omega$ Z_{in}

$20\,\mu\text{F} \rightarrow \frac{1}{j\omega C} = \frac{1}{j(10^3)\cdot 20\cdot 10^{-6}}$

$= -j50\,\Omega$

$30 \| 60 = 20\,\Omega$

$$Z_{in} = -j50 + (20 \| 40 + j10) = -j50 + \frac{20(40+j10)}{60+j10} =$$

$$= 13.5 - j48.99 = 50.75 \angle -74.56^\circ\ \Omega$$

$$Y_{in} = \frac{1}{Z_{in}} = 19.7 \angle 74.56^\circ\ \text{mS}$$