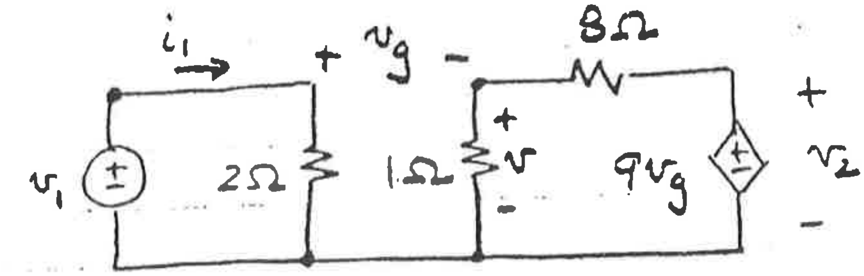
1.47



(a) By KVL, $v_1 = 2i_1$

$$\therefore R_{eq} = \frac{v_1}{i_1} = \underline{\underline{2\,\Omega}}$$

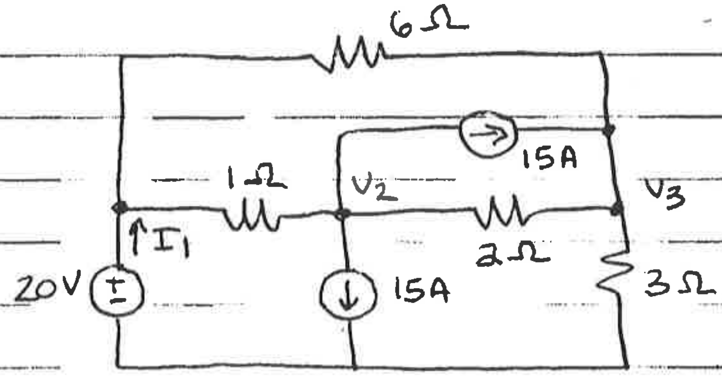
(b) By voltage division, $v = \frac{1}{1+8}(9v_g) = \underline{\underline{v_g}}$

(c) By KVL, $v_1 = v_g + v = v_g + v_g = 2v_g$

$$\therefore v_g = \frac{1}{2} v_1$$

Thus, $v_2 = 9v_g = 9\left(\frac{1}{2} v_1\right) = \frac{9}{2} v_1 = \underline{\underline{4.5\,v_1}}$

(2.6)



$V_1 = 20$ volts

Node V_1: $I_1 = \frac{20 - V_2}{1} + \frac{20 - V_3}{6}$

Node V_2: $\frac{V_2 - 20}{1} + 30 + \frac{V_2 - V_3}{2} = 0$

Node V_3: $\frac{V_3 - V_2}{2} + \frac{V_3}{3} - 15 + \frac{V_3 - 20}{6} = 0$

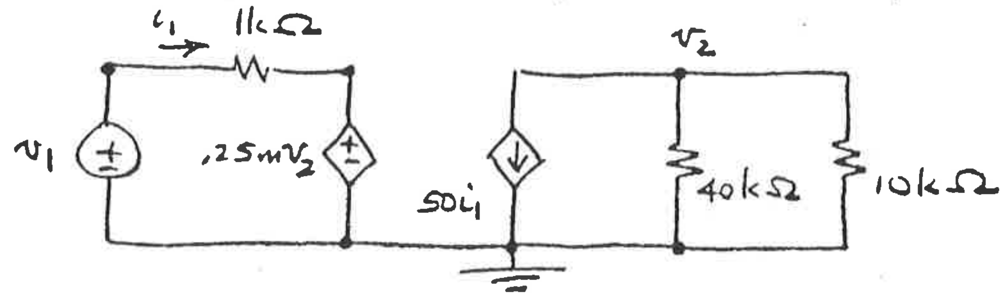
Rewrite

$$\begin{bmatrix} 1 & 1 & \frac{1}{6} \\ 0 & 1.5 & -\frac{1}{2} \\ 0 & -\frac{1}{2} & 1 \end{bmatrix} \begin{bmatrix} I_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} \frac{70}{3} \\ -10 \\ \frac{55}{3} \end{bmatrix}$$

$$V_2 = \frac{\begin{vmatrix} 1 & \frac{70}{3} & \frac{1}{6} \\ 0 & -10 & -\frac{1}{2} \\ 0 & \frac{55}{3} & 1 \end{vmatrix}}{\begin{vmatrix} 1 & 1 & \frac{1}{6} \\ 0 & 1.5 & -\frac{1}{2} \\ 0 & -\frac{1}{2} & 1 \end{vmatrix}} = \frac{-10 - \left(\frac{55}{3}\right)\left(-\frac{1}{2}\right)}{1.5 - \left(-\frac{1}{2}\right)\left(-\frac{1}{2}\right)} = -\frac{2}{3} \text{ volts}$$

$$V_3 = \frac{\begin{vmatrix} 1 & 1 & \frac{70}{3} \\ 0 & 1.5 & -10 \\ 0 & -\frac{1}{2} & \frac{55}{3} \end{vmatrix}}{1.5 - \frac{1}{4}} = \frac{\frac{3}{2}\,\frac{55}{3} - \left(-\frac{1}{2}\right)(-10)}{\frac{5}{4}} = 18 \text{ volts}$$

$\boxed{2.11}$



(a)

By Ohm's law, $i_1 = \dfrac{v_1 - .25m\, v_2}{1k}$

By KCL at node v_2,

$$50 i_1 + \frac{v_2}{40k} + \frac{v_2}{10k} = 0$$

$$50\, \frac{v_1 - .25m\, v_2}{1k} + \frac{v_2}{40k} + \frac{v_2}{10k} = 0$$

$$2k\,(v_1 - .25m\, v_2) + v_2 + 4 v_2 = 0$$

$$2k v_1 - .5 v_2 + v_2 + 4 v_2 = 0$$

$$2k v_1 + 4.5 v_2 = 0$$

$$4.5 v_2 = -2k v_1$$

$$\frac{v_2}{v_1} = \frac{-2k}{4.5} = \underline{\underline{-444}}$$

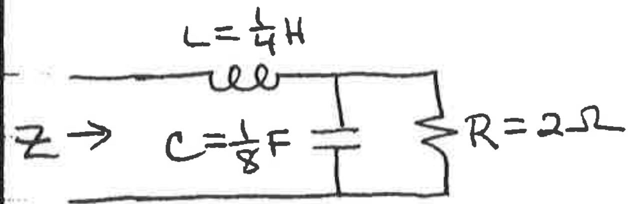
(b) From above,

$$i_1 = \frac{v_1 - 0.25m\left(\frac{-2k}{4.5} v_1\right)}{1k}$$

$$i_1 = \frac{v_1 + \frac{0.5}{4.5} v_1}{1k} = \frac{5}{4.5k} v_1$$

$$\therefore R_{in} = \frac{v_1}{i_1} = \frac{4.5k}{5} = \underline{\underline{900\,\Omega}}$$

4.15



$$Z = j\omega L + \frac{R\left(\frac{1}{j\omega C}\right)}{R + \frac{1}{j\omega C}} = j\omega L + \frac{R}{(1 + j\omega CR)} \cdot \frac{(1 - j\omega CR)}{(1 - j\omega CR)}$$

$$= j\omega L + \frac{R - j\omega CR^2}{1 + \omega^2 C^2 R^2} = \frac{j\omega L + j\omega^3 LC^2R^2 + R - j\omega CR^2}{1 + \omega^2 C^2 R^2}$$

$$= \frac{R + j\omega\left(L + \omega^2 LC^2R^2 - CR^2\right)}{1 + \omega^2 C^2 R^2}$$

$$= \frac{2 + j\omega\left(\frac{1}{4} + \omega^2 \frac{1}{4}\left(\frac{1}{8}\right)^2 2^2 - \frac{1}{8}2^2\right)}{1 + \omega^2\left(\frac{1}{8}\right)^2 2^2}$$

$$= \frac{2 + j\omega\left(-\frac{1}{4} + \frac{\omega^2}{64}\right)}{1 + \frac{\omega^2}{16}}$$

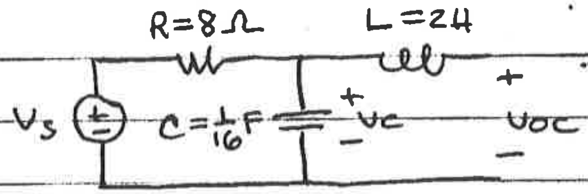
$$= \frac{2 + \frac{j\omega}{4}\left(-1 + \frac{\omega^2}{16}\right)}{1 + \frac{\omega^2}{16}}$$

$$= \frac{2 + \frac{j\omega}{4}\left(\frac{\omega^2 - 16}{16}\right)}{\frac{\omega^2 + 16}{16}}$$

$$= \frac{32 + \frac{j\omega}{4}(\omega^2 - 16)}{\omega^2 + 16}$$

$$= \frac{32}{\omega^2 + 16} + \frac{j\omega(\omega^2 - 16)}{4(\omega^2 + 16)}$$

4.18 <u>Find Voc</u>



$V_{oc} = V_c$ because the current in L is zero

$$\frac{V_{oc}}{V_s} = \frac{V_c}{V_s} = \frac{\frac{1}{j\omega C}}{R + \frac{1}{j\omega C}} = \frac{1}{1 + j\omega CR}$$

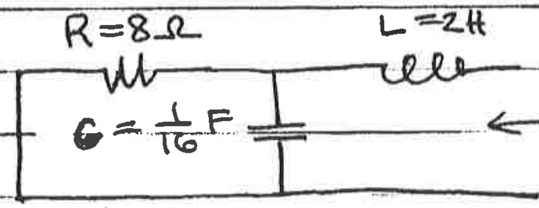
Since $v_s(t) = 4\cos(2t - 60^\circ)$ V, $\omega = 2\,\frac{r}{s}$

$$\frac{V_{oc}}{V_s} = \frac{1}{1 + j(2)\frac{1}{16}(8)} = \frac{1}{1 + j1} = \frac{1}{\sqrt{2}}\angle -45^\circ$$

$$V_{oc} = \frac{1}{\sqrt{2}}\angle -45^\circ\, V_s$$

$$V_{oc} = \frac{1}{\sqrt{2}}\angle -45^\circ (4\angle -60^\circ) = \boxed{2\sqrt{2}\angle -105^\circ}$$

<u>Find Zo</u>

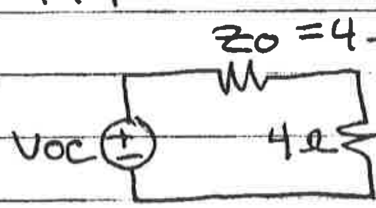


$$Z_o = j\omega L + \frac{R\,\frac{1}{j\omega C}}{R + \frac{1}{j\omega C}} = \frac{R + j\omega(L + \omega^2 LC^2R^2 - CR^2)}{1 + \omega^2 C^2 R^2}$$ From Prob. 4.15

$$= \frac{8 + j(2)\left(2 + 4\cdot 2\cdot \frac{1}{256}\cdot 64 - \frac{1}{16}\cdot 64\right)}{1 + 4\,\frac{1}{256}\cdot 64}$$

$$= \frac{8 + j(2)(2 + 2 - 4)}{1 + 1} = \boxed{4\,\Omega}$$

<u>Find vo(t)</u>



$V_o = \frac{1}{2}V_{oc} = \sqrt{2}\angle -105^\circ$

so $\boxed{v_o(t) = \sqrt{2}\cos(2t - 105^\circ) \text{ volts}}$