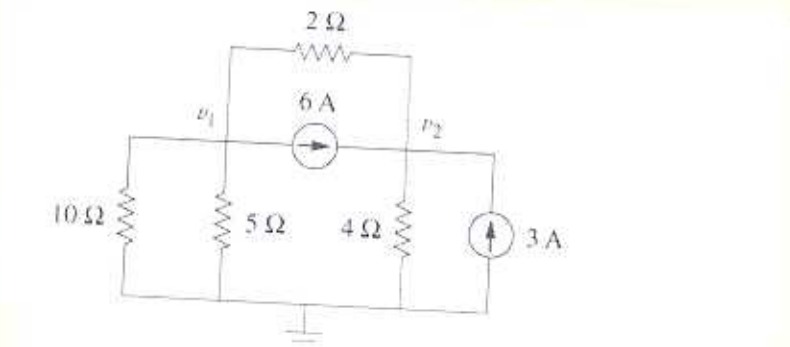
EE 331 PS 5 | P3.2, 3.14, 3.19, 3.48

P3.2 Find v_1 and v_2.



① $\frac{v_1}{10} + \frac{v_1}{5} + \frac{v_1 - v_2}{2} = -6$

$v_1 + 2v_1 + 5v_1 - 5v_2 = -60$

$8v_1 - 5v_2 = -60$

② $\frac{v_2 - v_1}{2} + \frac{v_2}{4} = 3 + 6$

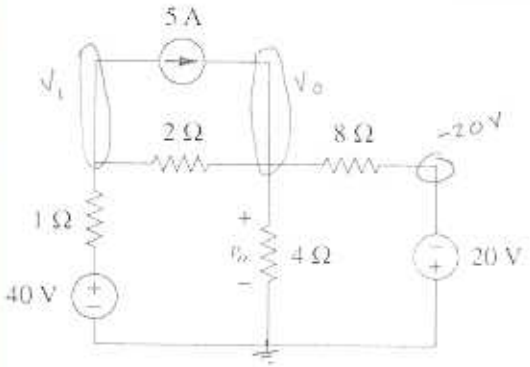
$2v_2 - 2v_1 + v_2 = 36$

$-2v_1 + 3v_2 = 36$

$$\begin{bmatrix} 8 & -5 \\ -2 & 3 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \end{bmatrix} = \begin{bmatrix} -60 \\ 36 \end{bmatrix}$$

$\boxed{v_1 = 0\ V \quad v_2 = 12\ V}$

P3.15 Find v_o.



① $\frac{v_1 - 40}{1} + \frac{v_1 - v_o}{2} = -5$

$2v_1 - 80 + v_1 - v_o = -10$

$3v_1 - v_o = 70$

② $\frac{v_o - v_1}{2} + \frac{v_o}{4} + \frac{v_o - (-20)}{8} = 5$

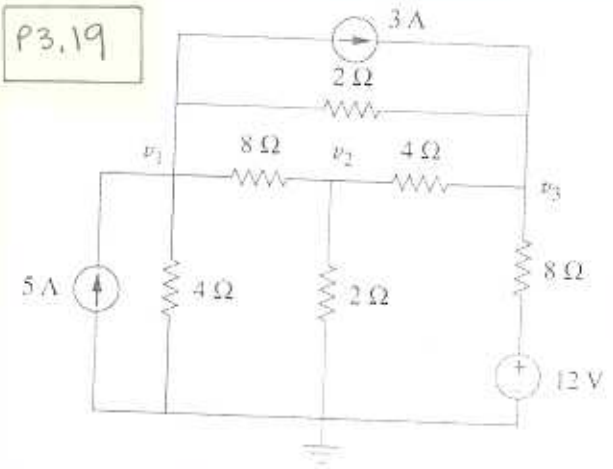
$4v_o - 4v_1 + 2v_o + v_o + 20 = 40$

$-4v_1 + 7v_o = 20$

$$\begin{bmatrix} 3 & -1 \\ -4 & 7 \end{bmatrix} \begin{bmatrix} v_1 \\ v_o \end{bmatrix} = \begin{bmatrix} 70 \\ 20 \end{bmatrix}$$

$\boxed{v_o = 20\ V}$ $\quad v_1 = 30\ V$

P3.19



① $\frac{V_1}{4} + \frac{V_1 - V_2}{8} + \frac{V_1 - V_3}{2} = 5 - 3$

$2V_1 + V_1 - V_2 + 4V_1 - 4V_3 = 16$

$7V_1 - V_2 - 4V_3 = 16$

② $\frac{V_2 - V_1}{8} + \frac{V_2}{2} + \frac{V_2 - V_3}{4} = 0$

$V_2 - V_1 + 4V_2 + 2V_2 - 2V_3 = 0$

$-V_1 + 7V_2 - 2V_3 = 0$

③ $\frac{V_3 - V_2}{4} + \frac{V_3 - 12}{8} + \frac{V_3 - V_1}{2} = 3$

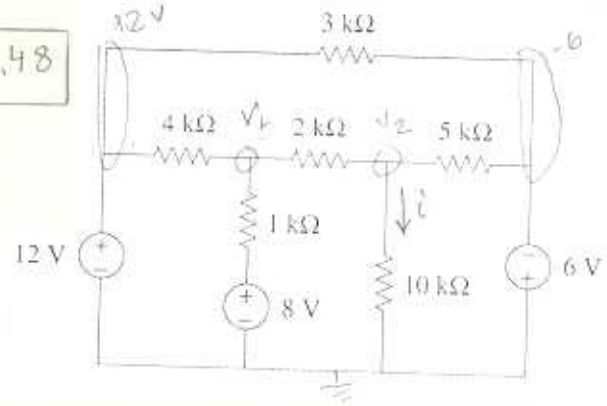
$2V_3 - 2V_2 + V_3 - 12 + 4V_3 - 4V_1 = 24$

$-4V_1 - 2V_2 + 7V_3 = 36$

$$\begin{bmatrix} 7 & -1 & -4 \\ -1 & 7 & -2 \\ -4 & -2 & 7 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 16 \\ 0 \\ 36 \end{bmatrix}$$

$V_1 = 10$ V
$V_2 = 4.93$ V
$V_3 = 12.27$ V

P 3.48



① $\frac{V_1 - 12}{4} + \frac{V_1 - 8}{1} + \frac{V_1 - V_2}{2} = 0$

$V_1 - 12 + 4V_1 - 32 + 2V_1 - 2V_2 = 0$

$7V_1 - 2V_2 = 44$

② $\frac{V_2 - V_1}{2} + \frac{V_2}{10} + \frac{V_2 - (-6)}{5} = 0$

$5V_2 - 5V_1 + V_2 + 2V_2 + 12 = 0$

$-5V_1 + 8V_2 = -12$

$$\begin{bmatrix} 7 & -2 \\ -5 & 8 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 44 \\ -12 \end{bmatrix}$$

$V_1 = 7.13$ V
$V_2 = 2.96$ V

$i = \frac{V_2}{10k} = \frac{2.96\text{ V}}{10\text{ k}}$

$= 0.296$ mA