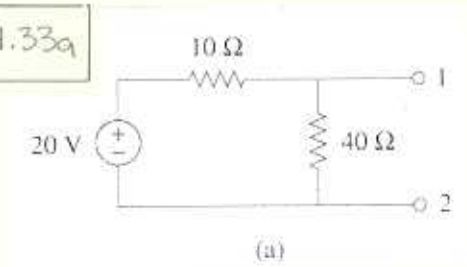
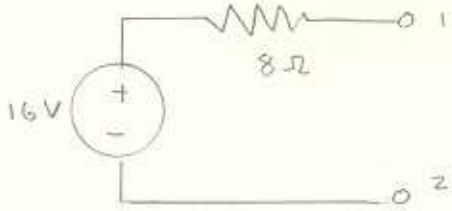
EE331 PS6 | P.4.33a, 39, 51a, 85

P4.33a

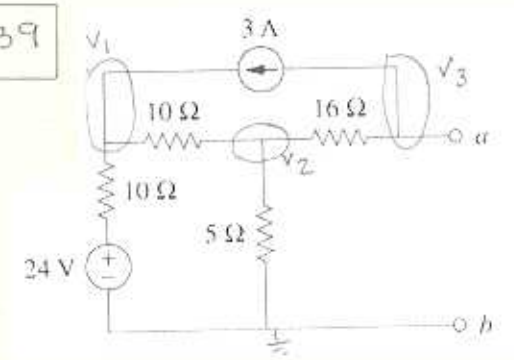


$R_{th} = 10 \| 40 = \boxed{8\,\Omega}$

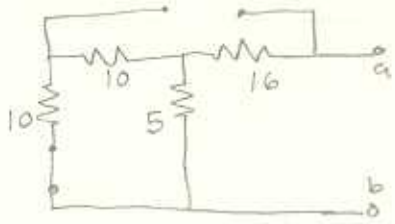
$V_{th} = \frac{40}{10+40} \cdot 20 = 0.8 \cdot 20 = \boxed{16\text{ V}}$



P4.39



Find R_{th}



$R_{th} = 16 + (10+10) \| 5$

$= 16 + 20 \| 5$

$= 16 + 4$

$R_{th} = \boxed{20\,\Omega}$

Find V_{th}

① $\frac{v_1 - 24}{10} + \frac{v_1 - v_2}{10} = 3 \qquad 2v_1 - v_2 = 54$

② $\frac{v_2 - v_1}{10} + \frac{v_2}{5} + \frac{v_2 - v_3}{16} = 0 \qquad 8v_2 - 8v_1 + 16v_2 + 5v_2 - 5v_3 = 0$

$-8v_1 + 29v_2 - 5v_3 = 0$

③ $\frac{v_3 - v_2}{16} = -3 \qquad -v_2 + v_3 = -48$

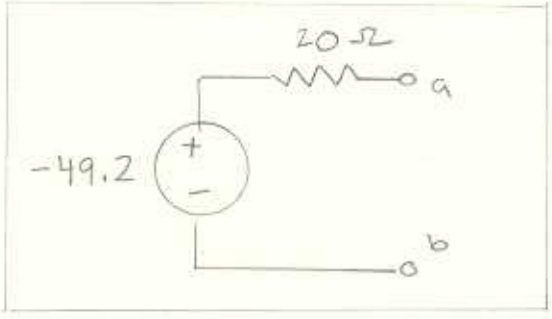
$$\begin{bmatrix} 2 & -1 & 0 \\ -8 & 29 & -5 \\ 0 & -1 & 1 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} = \begin{bmatrix} 54 \\ 0 \\ -48 \end{bmatrix}$$

$v_1 = 26.4$ V

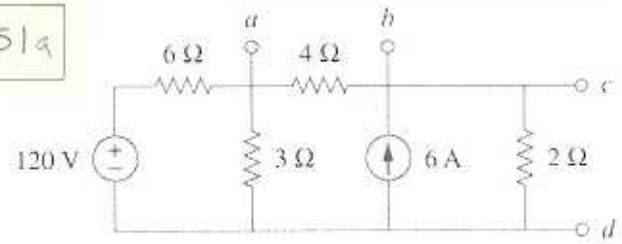
$v_2 = -1.2$ V

$v_3 = -49.2$ V

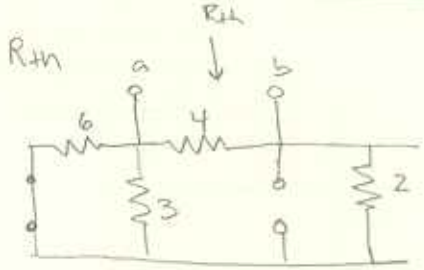
$\boxed{V_{th} = V_3 = -49.2}$



P4.51a



R_{th}



$R_{th} = 4 \,||\, (3||6+2)$

$= 4 \,||\, (2+2)$

$= 4 \,||\, 4 = \boxed{2\,\Omega}$

Find V_{th} ①

$$\frac{V_a-120}{6} + \frac{V_a}{3} + \frac{V_a-V_b}{4} = 0$$

$$2V_a - 240 + 4V_a + 3V_a - 3V_b = 0$$

$$9V_a - 3V_b = 240$$

② $$\frac{V_b-V_a}{4} + \frac{V_b}{2} = 6$$

$$V_b - V_a + 2V_b = 24 \qquad -V_a + 3V_b = 24$$

$$\begin{bmatrix} 9 & -3 \\ -1 & 3 \end{bmatrix} \begin{bmatrix} V_a \\ V_b \end{bmatrix} = \begin{bmatrix} 240 \\ 24 \end{bmatrix}$$

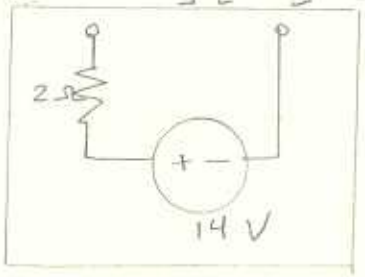
$V_a = 33$

$V_b = 19$

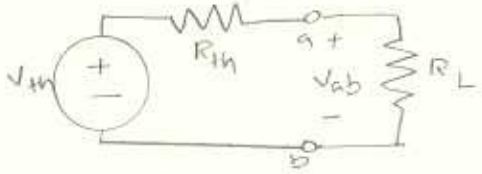
$V_{th} = V_a - V_b$

$= 33 - 19$

$= \boxed{14\ V}$



P4.85



$$V_{ab} = \frac{R_L}{R_L + R_{th}} \cdot V_{th}$$

(a)

Case 1 ($R_L = 10\,k\Omega$) → $V_{ab} = 6V$

$$6 = \frac{10}{10 + R_{th}} \cdot V_{th} \qquad 60 + 6R_{th} = 10V_{th}$$

$$10V_{th} - 6R_{th} = 60$$

Case 2 ($R_L = 30k$, $V_{ab} = 12V$)

$$12 = \frac{30}{30 + R_{th}} V_{th} \qquad 360 + 12R_{th} = 30V_{th}$$

$$30V_{th} - 12R_{th} = 360$$

$$\begin{bmatrix} 10 & -6 \\ 30 & -12 \end{bmatrix} \begin{bmatrix} V_{th} \\ R_{th} \end{bmatrix} = \begin{bmatrix} 60 \\ 360 \end{bmatrix}$$

$V_{th} = 24\ V$

$R_{th} = 30\,k\Omega$

(b) if $R_L = 20\,k\Omega$

$$V_{ab} = \frac{20}{20+30} \cdot 24 = \frac{20}{50} \cdot 24 = \boxed{9.6\ V}$$