P2.08 $V_T = -1 \times 2 \| (6+4) \times \frac{4}{4+6} = -0.667\text{ V}$

$R_{eq} = 4 \| (6+2) = 2.67\,\Omega$

$i = -\frac{0.667}{8+2.67} = -0.0625\text{ A}$

P2.09. (a) $V_T = +5\text{mA} \times \left(\frac{\frac{1}{18+6}}{\frac{1}{18+6} + \frac{1}{12}} \right) \times 6\text{k}\Omega - \frac{40 \times 6}{6+18+12}$

$= 10 - 6.67 = 3.33\text{ V}$

$R_{eq} = 6 \| (18+12) = 5\text{ k}\Omega$

(b) $v_{ab} = 3.33 \times \frac{3}{3+5} = 1.25\text{V}$ (c) $R_L = R_{eq} = 5\text{ k}\Omega$

(d) $v_{ab} = 0.1\text{mA} \times 6\text{k}\Omega = 0.6\text{V} = 3.33 \times \frac{R_L}{5+R_L}$

$\frac{5}{R_L} + 1 = \frac{3.33}{0.6} \Rightarrow R_L = 1.10\text{ k}\Omega$

P2.10. $10 = \frac{V_T^2}{4(20)} \Rightarrow V_T = \sqrt{800} = 28.3\text{ V}$

P2.13. (a) $R = 6 \| 2 = 1.50\,\Omega$ for max power

(b) Find current

$i_{12} = \underbrace{\frac{12}{2 + 6\|1.5}}_{\text{out of +}} - \frac{8}{6 + 2\|1.5} \times \frac{\frac{1}{2}}{\frac{1}{2} + \frac{1}{1.5}} = 3.75 - 0.5 = 3.25\text{ A}$

$P_{12} = 12 \times 3.25 = 39.0\text{W}$

P2.25.

V	I	R_L
0	0.15	0
10	0.0333	300Ω
12.9	0	∞

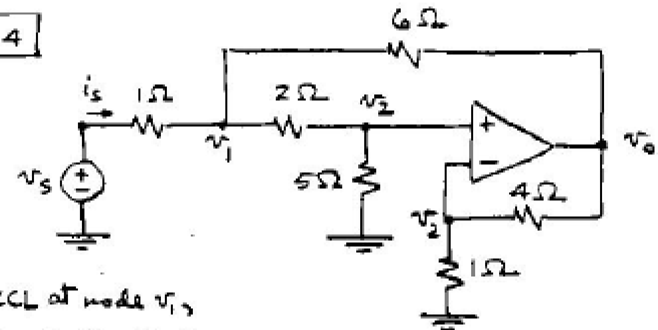
$\rightarrow 10 = \frac{V_T}{R_{eq}+300} \times 300$

but $V_T = \underbrace{0.15}_{IN} R_{eq}$

so $\frac{R_{eq}+300}{0.15 R_{eq}} = \frac{300}{10} = 30 \Rightarrow R_{eq} = 85.7\Omega$, $V_T = 12.9$ so

$I = \frac{12.9}{385.7} = 0.0333A$

2.34



(a)

By KCL at node v_1,

$\frac{v_1 - v_s}{1} + \frac{v_1 - v_2}{2} + \frac{v_1 - v_0}{6} = 0$

$6v_1 - 6v_s + 3v_1 - 3v_2 + v_1 - v_0 = 0$

$10v_1 - 3v_2 - v_0 = 6v_s$

By KCL at the noninverting input of the op amp,

$\frac{v_2 - v_1}{2} + \frac{v_2}{5} = 0$

$5v_2 - 5v_1 + 2v_2 = 0$

$7v_2 = 5v_1 \Rightarrow v_1 = \frac{7}{5} v_2$

$10(\frac{7}{5} v_2) - 3v_2 - v_0 = 6v_s$

$11 v_2 - v_0 = 6v_s$

By KCL at the inverting input of the op amp,

$\frac{v_2}{1} + \frac{v_2 - v_0}{4} = 0$

$4v_2 + v_2 - v_0 = 0$

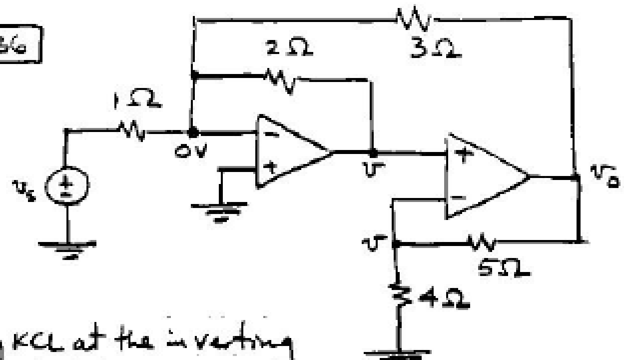
$5v_2 = v_0 \Rightarrow v_2 = \frac{1}{5} v_0$

$11(\frac{1}{5} v_0) - v_0 = 6v_s$

$\frac{6}{5} v_0 = 6v_s$

$v_0 = 5v_s$

2.36



By KCL at the inverting input of the op amp on the left,

$$\frac{v_s}{1} + \frac{v}{2} + \frac{v_o}{3} = 0$$

$$6v_s + 3v + 2v_o = 0$$

By KCL at the inverting input of the op amp on the right,

$$\frac{v}{4} + \frac{v - v_o}{5} = 0$$

$$5v + 4v - 4v_o = 0$$

$$9v = 4v_o$$

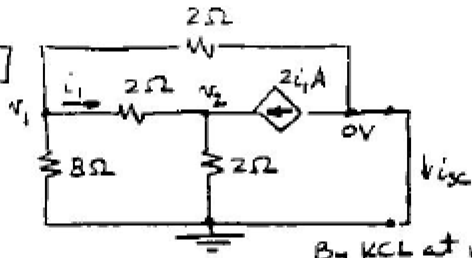
$$v = \frac{4}{9}v_o$$

$$6v_s + 3\left(\frac{4}{9}v_o\right) + 2v_o = 0$$

$$6v_s = -\frac{4}{3}v_o - 2v_o = -\frac{10}{3}v_o$$

$$\therefore\ v_o = -\frac{3}{10}(6v_s) = -\frac{9}{5}v_s = \underline{\underline{-1.8v_s}}$$

2.43



By KCL at node v_1,

$$\frac{v_1}{8} + \frac{v_1}{2} + \frac{v_1 - v_2}{2} = 0$$

$$v_1 + 4v_1 + 4v_1 - 4v_2 = 0$$

$$9v_1 - 4v_2 = 0$$

$$3v_1 - 4v_2 = 0$$

$$6v_1 = 0$$

$$v_1 = 0\text{ V}$$

By KCL at node v_2,

$$i_1 + 2i_1 = \frac{v_2}{2}$$

$$3i_1 = \frac{v_2}{2}$$

$$3\left(\frac{v_1 - v_2}{2}\right) = \frac{v_2}{2}$$

$$3v_1 - 3v_2 = v_2$$

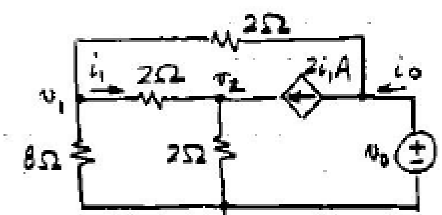
$$3v_1 - 4v_2 = 0$$

$$3(0) - 4v_2 = 0$$

$$-4v_2 = 0 \Rightarrow v_2 = 0\text{ V}$$

By KCL,

$$i_{sc} = \frac{v_1}{2} - 2i_1 = \frac{v_1}{2} - 2\left(\frac{v_1 - v_2}{2}\right) = \underline{\underline{0\text{ A}}}$$



By KCL at node v_1,

$$\frac{v_1}{8} + \frac{v_1 - v_2}{2} + \frac{v_1 - v_0}{2} = 0$$

$$v_1 + 4v_1 - 4v_2 + 4v_1 - 4v_0 = 0$$

$$9v_1 - 4v_2 = 4v_0$$

By KCL at node v_2, as above $\longrightarrow$

$$3v_1 - 4v_2 = 0$$

$$6v_1 = 4v_0 \Rightarrow v_1 = \frac{2}{3}v_0$$

$$3v_1 = 4v_2 \Rightarrow v_2 = \frac{3}{4}v_1$$

$$v_2 = \frac{3}{4}\left(\frac{2}{3}v_0\right) = \frac{1}{2}v_0$$

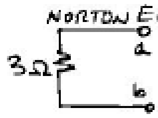
By KCL,

$$i_0 = 2i_1 + \frac{v_0 - v_1}{2} = 2\left(\frac{v_1 - v_2}{2}\right) + \frac{v_0 - v_1}{2} = \frac{2}{3}v_0 - \frac{1}{2}v_0 + \frac{v_0 - \frac{2}{3}v_0}{2}$$

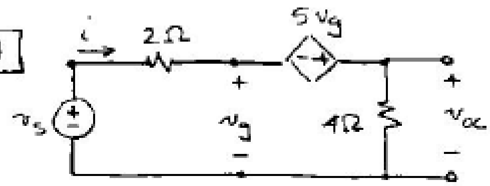
$$i_0 = \frac{2}{3}v_0 - \frac{1}{3}v_0 = \frac{1}{3}v_0$$

$$\therefore R_0 = \frac{v_0}{i_0} = \underline{\underline{3\,\Omega}}$$

NORTON EQUIVALENT CIRCUIT



2.44



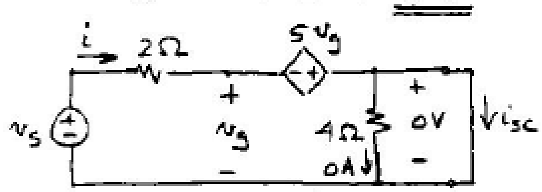
By KVL, $v_s = 2i - 5v_g + 4i$ Also, $-v_g - 5v_g + 4i = 0$

$v_s = 6i - 5v_g$ $4i = 6v_g \Rightarrow v_g = \frac{4}{6}i$

$v_s = 6i - 5\left(\frac{4}{6}i\right) = 6i - \frac{10}{3}i = \frac{8}{3}i \Rightarrow i = \frac{3}{8}v_s$

By Ohm's law,

$v_{oc} = 4i = 4\left(\frac{3}{8}v_s\right) = \underline{\underline{\frac{3}{2}v_s}}$



By KVL, $v_s = 2i - 5v_g$ Also, $-v_g - 5v_g = 0$

$-6v_g = 0 \Rightarrow v_g = 0V$

$\therefore v_s = 2i \Rightarrow i = \frac{1}{2}v_s$

By KCL,

$i_{sc} = i = \frac{1}{2}v_s$

$\therefore R_0 = \frac{v_{oc}}{i_{sc}} = \frac{\frac{3}{2}v_s}{\frac{1}{2}v_s} = \underline{\underline{3\,\Omega}}$

Thus, the Thévenin-equivalent circuit is