Physics 116A Fall 2004 Solutions, Problem Set 1.
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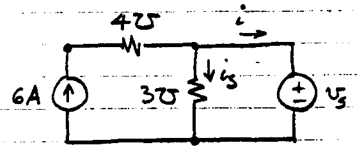
1.8 (a) $v_1 = 30V \Rightarrow i = \frac{v_1}{5} = \frac{30}{5} = \underline{\underline{6A}}$

(c) $v_3 = -9V \Rightarrow i_3 = -\frac{v_3}{3} = -\frac{-9}{3} = \underline{\underline{3A}}$

1.17

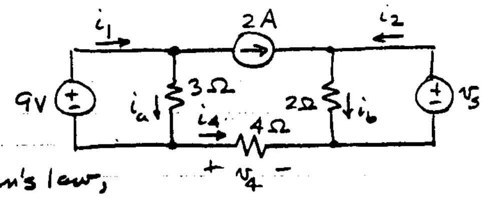


By Ohm's law, $i_3 = 3v_s$

By KCL, $i = 6 - i_3 = 6 - 3v_s$

(a) $v_s = 1V$: $\quad i = 6 - 3(1) = \underline{\underline{3A}}$

1.18



By Ohm's law,

$i_a = \frac{9}{3} = 3A \quad i_b = \frac{v_s}{2}$

By KCL, $i_1 = i_a + 2 = 3 + 2 = \underline{5A}$ $\quad i_4 = i_a - i_1$

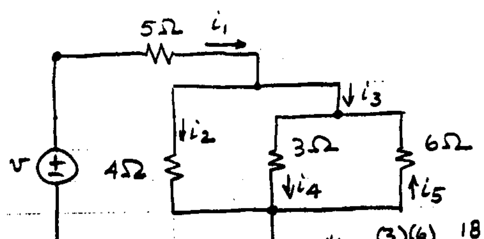
$i_4 = 3 - 5 = \underline{-2A}$

$i_2 = i_b - 2 = \underline{\frac{v_s}{2} - 2}$

By Ohm's law, $v_4 = 4i_4 = 4(-2) = \underline{-8V}$

(a) $v_s = 2V$: $i_1 = \underline{\underline{5A}}$, $i_2 = \frac{v_s}{2} - 2 = \frac{2}{2} - 2 = \underline{\underline{-1A}}$,

$v_4 = \underline{\underline{-8V}}$



$3 \| 6 = \frac{(3)(6)}{3+6} = \frac{18}{9} = 2\Omega$

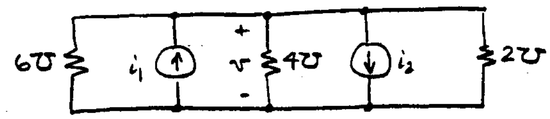
1.21 $i_2 = -2A$. Using the current-divider formula,

$i_2 = \frac{3\|6}{4 + 3\|6} i_1 = \frac{2}{4+2} i_1 = \frac{1}{3} i_1 \Rightarrow i_1 = 3i_2 = 3(-2) = \underline{\underline{-6A}} = i_1$

$i_3 = \frac{4}{4 + 3\|6} i_1 = \frac{4}{4+2} i_1 = \frac{2}{3}(-6) = \underline{\underline{-4A}} = i_3$

$i_4 = \frac{6}{3+6} i_3 = \frac{6}{3+6}(-4) = \frac{-24}{9} = \underline{\underline{-\frac{8}{3}A}} = i_4$

$-i_5 = \frac{3}{3+6} i_3 = \frac{3}{3+6}(-4) = \frac{-12}{9} = -\frac{4}{3} \Rightarrow i_5 = \underline{\underline{\frac{4}{3}A}} = i_5$



Careful: this means 6℧×v, a current.

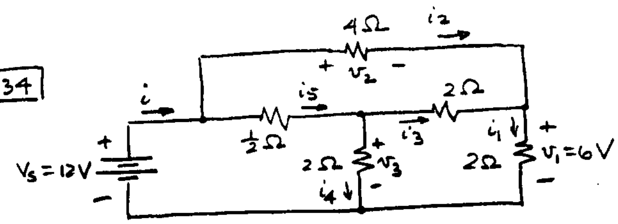
1.23 By KCL, $6v + 4v + 2v + i_2 = i_1$

$12v = i_1 - i_2$

$v = \frac{i_1 - i_2}{12}$

(c) $i_1 = 2A, i_2 = 3A \Rightarrow v = \frac{2-3}{12} = \underline{\underline{-\frac{1}{12}V}}$

1.34



By Ohm's law, $i_1 = \frac{v_1}{2} = \frac{6}{2} = 3A$

By KVL, $v_2 = V_s - v_1 = 12 - 6 = 6V$

By Ohm's law, $i_2 = \frac{v_2}{4} = \frac{6}{4} = \frac{3}{2}A$

By KCL, $i_3 = i_1 - i_2 = 3 - \frac{3}{2} = \frac{3}{2}A$

By KVL, $v_3 = 2i_3 + v_1 = 2(\frac{3}{2}) + 6 = 9V$

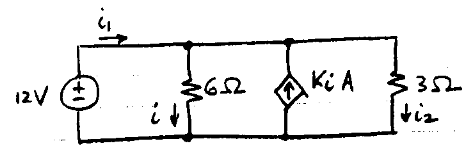
By Ohm's law, $i_4 = \frac{v_3}{2} = \frac{9}{2}A$

By KCL, $i_5 = i_3 + i_4 = \frac{3}{2} + \frac{9}{2} = 6A$

By KCL, $i = i_2 + i_5 = \frac{3}{2} + 6 = \frac{15}{2}A$

$\therefore R_{eq} = \frac{V_s}{i} = \frac{12}{15/2} = \frac{24}{15} = \frac{8}{5} = \underline{\underline{1.6\Omega}}$

1.42



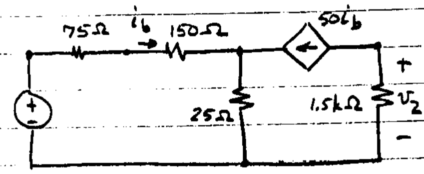
By Ohm's law, $i = \frac{12}{6} = 2A \quad i_2 = \frac{12}{3} = 4A$

By KCL, $i_1 = i - Ki + i_2 = (1-K)i + i_2$

$i_1 = (1-K)2 + 4$

(b) $K = 3 \Rightarrow i_1 = (1-3)2 + 4 = -4 + 4 = \underline{\underline{0A}}$

1.53



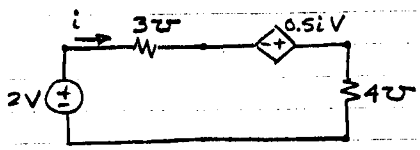
(a) $v_1 = 75 i_b + 150 i_b + 25(51 i_b) = (75 + 150 + 1275) i_b = 1500 i_b$

$i_b = \frac{v_1}{1500}$

(b) $v_2 = -1.5\times10^3 (50 i_b) = -75\times10^3 \left(\frac{v_1}{1.5\times10^3}\right) = -50 v_1$

(c) $v_2 = -50(0.1 \cos 120\pi t) = -5\cos 120\pi t$ V

1.57



$i = 24$ A

The power absorbed by the 2-V voltage source is

$p_S = 2(-i) = 2(-24) = -48$ W

The power absorbed by the 3-℧ conductance is

$p_3 = (1/3) i^2 = (1/3)(24^2) = 192$ W

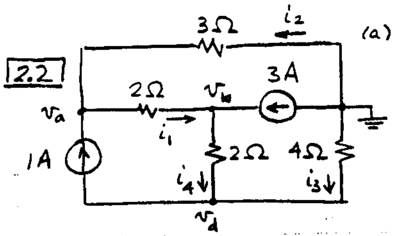
The power absorbed by the dependent voltage source is

$p_D = (0.5i)(-i) = (0.5)(24)(-24) = -288$ W

The power absorbed by the 4-℧ conductance is

$p_4 = (1/4) i^2 = (1/4)(24^2) = 144$ W

2.2



(a) By KCL at node v_a,

$i_1 = 1 + i_2$

$i_1 - i_2 = 1$

$\frac{v_a - v_b}{2} - \frac{-v_a}{3} = 1$

$3v_a - 3v_b + 2v_a = 6$

$5v_a - 3v_b = 6$

By KCL at node v_b,

$i_1 + 3 = i_4$

$i_1 - i_4 = -3$

$\frac{v_a - v_b}{2} - \frac{v_b - v_d}{2} = -3$

$v_a - v_b - v_b + v_d = -6$

$v_a - 2v_b + v_d = -6$

By KCL at node v_d,

$i_3 + i_4 = 1$

$-\frac{v_d}{4} + \frac{v_b - v_d}{2} = 1$

$-v_d + 2v_b - 2v_d = 4$

$2v_b - 3v_d = 4$

$$D = \begin{vmatrix} 5 & -3 & 0 \\ 1 & -2 & 1 \\ 0 & 2 & -3 \end{vmatrix} = 30 - 10 - 9 = 11$$

$$D_a = \begin{vmatrix} 6 & -3 & 0 \\ -6 & -2 & 1 \\ 4 & 2 & -3 \end{vmatrix} = 36 - 12 - 12 + 54 = 66 \Rightarrow v_a = \frac{D_a}{D} = \frac{66}{11} = 6\text{ V}$$

$$D_b = \begin{vmatrix} 5 & 6 & 0 \\ 1 & -6 & 1 \\ 0 & 4 & -3 \end{vmatrix} = 90 - 20 + 18 = 88 \Rightarrow v_b = \frac{D_b}{D} = \frac{88}{11} = 8\text{ V}$$

$$D_d = \begin{vmatrix} 5 & -3 & 6 \\ 1 & -2 & -6 \\ 0 & 2 & 4 \end{vmatrix} = -40 + 12 + 60 + 12 = 44 \Rightarrow v_d = \frac{D_d}{D} = \frac{44}{11} = 4\text{ V}$$

(b)

$i_1 = \frac{v_a - v_b}{2} = \frac{6-8}{2} = -1$ A $\quad i_2 = \frac{-v_a}{3} = \frac{-6}{3} = -2$ A

$i_3 = -\frac{v_d}{4} = \frac{-4}{4} = -1$ A $\quad i_4 = \frac{v_b - v_d}{2} = \frac{8-4}{2} = 2$ A