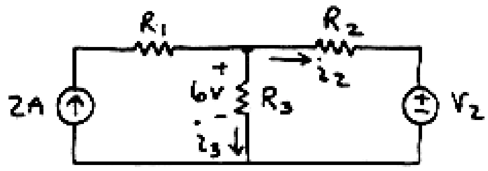
Exercises

Ex 3.3-1



$$i_3 = \frac{6V}{R_3} = \frac{6V}{2\Omega} = 3A$$

from KCL at top node

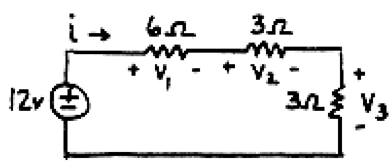
$i_2 = 2 - i_3 = 2 - 3 = -1A$

KVL around 2nd loop : $-6 + R_2 i_2 + v_2 = 0 \quad \Rightarrow v_2 = 6 - (1)(-1) = 7V$

Ex 3.3-2 $\quad -18 + 0 - 12 - v_a = 0 \quad \Rightarrow \quad v_a = -30\text{ V}$

Ex 3.3-3 $\quad -v_a - 10 + 4v_a - 8 = 0 \quad \Rightarrow \quad v_a = \dfrac{18}{3} = 6\text{ V}$

Ex 3.4-1



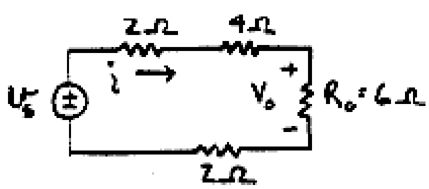
from voltage divider

$$v_3 = 12\left(\frac{3}{3+9}\right) = 3V \ \therefore\ i = \frac{v_3}{3} = 1A$$

$$\left.\begin{aligned} \text{now}\quad P_{6\Omega} &= i^2(6) = (1)^2(6) = 6W \\ P_{3\Omega_1} &= i^2(3) = (1)^2(3) = 3W \\ P_{3\Omega_2} &= i^2(3) = (1)^2(3) = 3W \end{aligned}\right\} P_{6\Omega} + P_{3\Omega_1} + P_{3\Omega_2} = 12W \text{ absorbed}$$

$$P_{source} = vi = (12V)(1A) = 12W \text{ supplied}$$

Ex 3.4-2



if $P_0 = 6W$ and $R_0 = 6\Omega \ \Rightarrow\ i^2 = \dfrac{P_0}{R_0} = \dfrac{6}{6} = 1$ or $i = 1A$

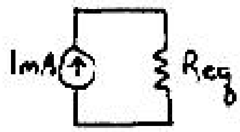
$\therefore\ v_0 = iR_0 = (1)(6) = 6V$

from KVL: $-v_s + i(2+4+6+2) = 0 \ \Rightarrow\ v_s = 14i = 14V$

Ex 3.4-3 from voltage divider $\Rightarrow v_m = \dfrac{25}{25+75} 8 = 2 \text{ V}$

Ex 3.4-4 from voltage divider $\Rightarrow v_m = \dfrac{25}{25+75}(-8) = -2 \text{ V}$

Ex. 3.5-1 Equiv. Ckt.



$$\frac{1}{Reg} = \frac{1}{1}+\frac{1}{1}+\frac{1}{1}+\frac{1}{1}$$

$Reg = \underline{1/4\ k\Omega}$

i in each R= $\frac{1}{4}$(1mA) = $\underline{\frac{1}{4}\text{mA}}$

Ex 3.5-2 from current divider $\Rightarrow i_m = \frac{10}{10+40}(-5) = -2 \quad A$

Ex 3.6-1 $R_p = \frac{(4)(2)}{4+2} = \frac{8}{6} = \underline{\frac{4}{3}}\Omega$

$\therefore V = R_p\ (3A) = \frac{4}{3}(3) = \underline{4V}$

Problems

Section 3-3 Kirchoff's Laws

P3.3-1 KVL : $v_1 + 2 - 3 - 6 - 8 + 4 = 0$ (outside loop)

$\underline{v_1 = +11\ V}$

KVL : $v_2 + 2 - 3 - 6 = 0$ (right mesh)

$\underline{v_2 = 7\ V}$

KVL : $3 + 2 - i_3 = 0$ (top node)

$\underline{i_3 = 5\ A}$

P3.3-2 KVL : $-v_1 + 2 + 4 + 5 = 0$ (outside loop)

$\underline{v_1 = 11\ V}$

KCL : $-1 + 3 + i_4 = 0$ (top,left node)

$\underline{i_4 = -2A}$

KCL : $1 + i_3 - 3 = 0$ (bottom, left node)

$\underline{i_3 = 2\ A}$

KCL : $-i_4 + 2 + i_2 = 0$ (top,right node)

$-(-2) + 2 + i_2 = 0 \quad \Rightarrow \quad \underline{i_2 = -4A}$

P3.3-3

KVL : $-12 - R_2(3) + v = 0$ (outside loop)

$$v = 12 + 3R_2 \quad \text{or} \quad R_2 = \frac{v-12}{3}$$

KCL $$i + \frac{12}{R_1} - 3 = 0 \quad \text{(top node)}$$

$$i = 3 - \frac{12}{R_1} \quad \text{or} \quad R_1 = \frac{12}{3-i}$$

(a)

$$v = 12 + 3(3) = \underline{21\ \text{V}}$$

$$i = 3 - \frac{12}{6} = \underline{1\ \text{A}}$$

(b) $$R_2 = \frac{2-12}{3} = \underline{-\frac{10}{3}\Omega}\ ;\quad R_1 = \frac{12}{3-1.5} = \underline{8\Omega}$$

(c) $24 = -12\ i$, because 12 and i adhere to the passive convention.

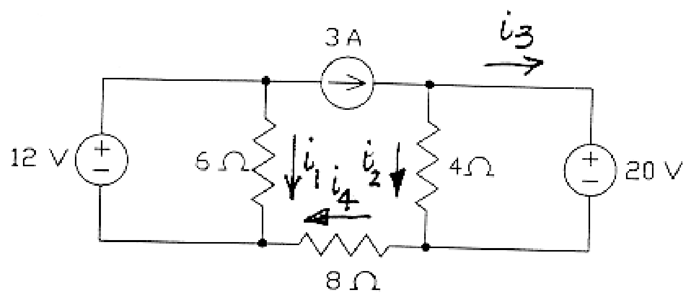
$$\therefore\ \underline{i = -2\text{A}} \quad \text{and} \quad R_1 = \frac{12}{3+2} = \underline{2.4\Omega}$$

$9 = 3v$, because 3 and v do not adhere to the passive convention

$$\therefore\ \underline{v = 3} \quad \text{and} \quad R_2 = \frac{3-12}{3} = \underline{-3\Omega}$$

The situations described in (b) and (c) cannot occur if R_1 and R_2 are required to be nonnegative.

P3.3-4



$$i_1 = \frac{12}{6} = 2\text{A}$$

$$i_2 = \frac{20}{4} = 5\text{A}$$

$$i_3 = 3 - i_2 = -2\text{A}$$

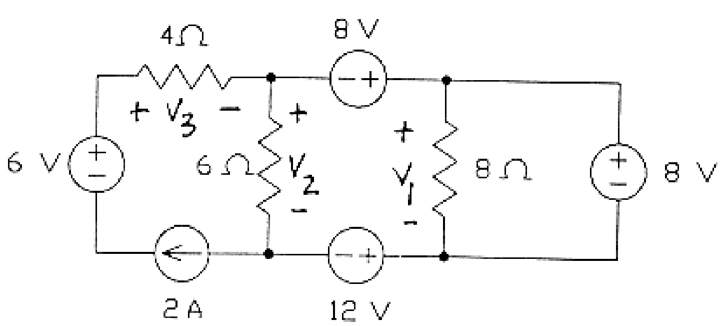
$$i_4 = i_2 + i_3 = 3\text{A}$$

Power absorbed by the 4Ω resistor $= 4 \cdot i_2^2 = \underline{100\ \text{W}}$

Power absorbed by the 6Ω resistor $= 6 \cdot i_1^2 = \underline{24\ \text{W}}$

Power absorbed by the 8Ω resistor $= 8 \cdot i_4^2 = \underline{72\ \text{W}}$

P3.3-5



$$v_1 = 8\text{V}$$

$$v_2 = -8+8+12 = 12\ \text{V}$$

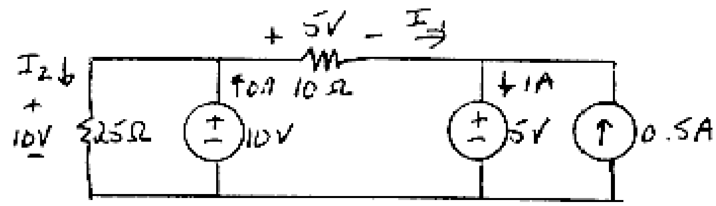
$$v_3 = 2 \cdot 4 = 8\text{V}$$

$$4\Omega : P = \frac{v_3^2}{4} = \underline{16\ \text{W}}$$

$$6\Omega : P = \frac{v_2^2}{6} = \underline{24\ \text{W}}$$

$$8\Omega : P = \frac{v_1^2}{8} = \underline{8\ \text{W}}$$

P3.3-9



$$I_1 = \frac{5\text{V}}{10\Omega} = 0.5 \text{ A}$$

$$I_2 = \frac{10\text{V}}{25\Omega} = 0.4 \text{ A}$$

$$P_{10\text{V}} = (-10)\ (0.9) = -9\text{W}_{\text{absorbed}} = \underline{9\text{W}_{\text{delivered}}}$$

$$P_{5\text{V}} = (5)\ (1) = \underline{5\text{W}_{\text{absorbed}}}$$

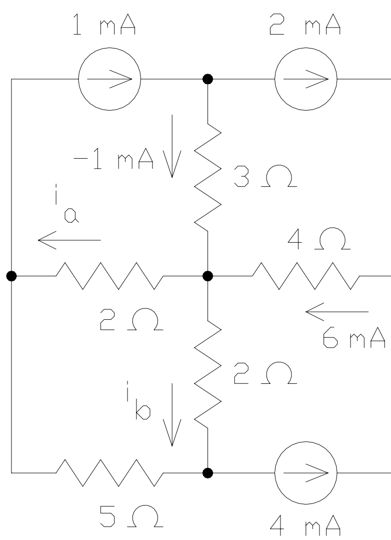
$$P_{0.5\text{A}} = (-5)\ (0.5) = -2.5\text{W}_{\text{absorbed}} = \underline{2.5\text{W}_{\text{delivered}}}$$

$$P_{10\Omega} = (5)\ (0.5) = \underline{2.5\text{W}_{\text{absorbed}}}$$

$$P_{25\Omega} = (10)\ (0.4) = \underline{4\text{W}_{\text{absorbed}}}$$

$$\Sigma\, P_{\text{absorbed}} = \underline{0\text{W}}$$ energy balance

P3.3-10



$$i_a + i_b = 6 - 1 = 5 \text{ mA} = 0.005 \text{ A}$$

$$-2\,i_a + 2i_b - 5\left(i_a - 0.001\right) = 0$$

Solving yields:

$$i_a = 0.00167 = 1.67 \text{ mA}$$

$$i_b = 0.005 - i_a = 0.00333 = 3.33 \text{ mA}$$

Section 3-4 A Single-Loop Circuit – The Voltage Divider

P3.4-1

$$V_1 = \frac{6}{6+3+5+4}\ 12 = \frac{6}{18}\ 12 = \underline{4\text{ V}}$$

$$V_2 = \frac{3}{18}\ 12 = \underline{2\text{V}}\ ;\ V_3 = \frac{5}{18}\ 12 = \underline{\frac{10}{3}\text{ V}}$$

$$V_4 = \frac{4}{18} 12 = \underline{\frac{8}{3}\text{ V}}$$

P3.4-2

(a) $R = 6 + 3 + 2 + 4 = \underline{15\Omega}$

(b) $$i = \frac{28}{R} = \frac{28}{15} = \underline{1.867 \text{ A}}$$

(c) $P = 28 \cdot i$ (28 and i do not adhere to the passive convention.)

$= 28(1.867) = \underline{52.27 \text{ W}}$