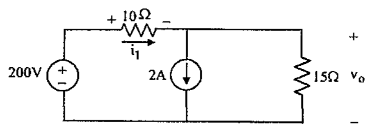
PS3

Problem Set #3

UNIVERSITY OF UTAH
ELECTRICAL AND COMPUTER ENGINEERING DEPARTMENT

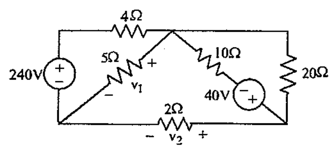
ECE 1270 HOMEWORK #3 Summer 2006

1.



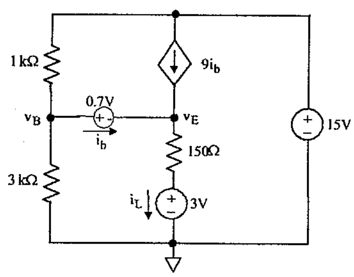
Use the node-voltage method to find i_1 and v_o.

2.



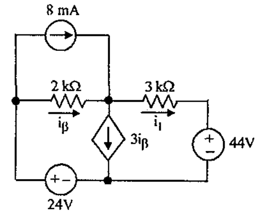
a. Use the node-voltage method to find v_1 and v_2.
b. Calculate the power dissipated by the 10Ω resister.

3.



Use the node-voltage method to find v_B and v_E. Then find i_L.

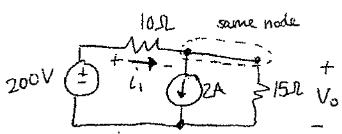
4.



a. Use the mesh-current method to find i_1.
b. Find the power dissipated by the dependent current source.

HW #3 Solution

1.



$i_1 = \frac{200-V_o}{10}$ (Loop eq: $+200 - i_1(10) - V_o = 0$)

Node-Voltage eq: (+ going out)

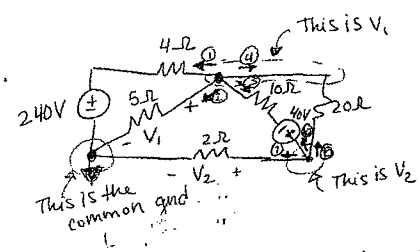
$\underbrace{\frac{V_o-200}{10}}_{-i_1} + 2 + \frac{V_o}{15} = 0$

$V_o\left(\frac{1}{10}+\frac{1}{15}\right) = \frac{200}{10} - 2 = 18$

$V_o = \frac{18}{\frac{3}{30}+\frac{2}{30}} = \frac{18(30)}{5} = 18(6)\ V = \boxed{108V}$

$i_1 = \frac{200-108}{10} = \boxed{9.2A}$

2.



node-voltage: · put all currents going out from the node and use + going out for summation

⇒ node-voltage for V_1: (top node)

$i_1 + i_2 + i_3 + i_4 = 0$

i_1: $+240 + i_1(4) - V_1 = 0 \Rightarrow i_1 = \frac{-240+V_1}{4}$

i_2: $\frac{V_1}{5} = i_2$

i_3: $+V_1 - 10 i_3 + 40 - V_2 = 0$ $\quad i_3 = \frac{V_1+40-V_2}{10}$

i_4: $\frac{V_1-V_2}{20} = i_4$

∴ $\frac{V_1-240}{4} + \frac{V_1}{5} + \frac{V_1+40-V_2}{10} + \frac{V_1-V_2}{20} = 0$

$V_1\left(\frac14+\frac15+\frac1{10}+\frac1{20}\right) - V_2\left(\frac1{10}+\frac1{20}\right) = \frac{240}{4} - \frac{40}{10}$

(Eq. 1) $V_1\left(\frac{12}{20}\right) - V_2\left(\frac{3}{20}\right) = 56$

⇒ Node-voltage for V_2: $i_5 + i_6 + i_7 = 0$

$\frac{V_2-V_1}{20} + \frac{V_2-40-V_1}{10} + \frac{V_2}{2} = 0$

$V_2\left(\frac1{20}+\frac1{10}+\frac12\right) - V_1\left(\frac1{20}+\frac1{10}\right) = \frac{40}{10}$

(Eq. 2) $V_2\left(\frac{13}{20}\right) - V_1\left(\frac{3}{20}\right) = 4$

2. (cont.)

$$3\left[V_1\left(\tfrac{12}{20}\right) - V_2\left(\tfrac{3}{20}\right) = 56\right]$$
$$12\left[-V_1\left(\tfrac{3}{20}\right) + V_2\left(\tfrac{13}{20}\right) = 4\right]$$

$$V_1\left(\tfrac{36}{20}\right) - V_2\left(\tfrac{9}{20}\right) = 168$$
$$+\quad -V_1\left(\tfrac{36}{20}\right) + V_2\left(\tfrac{156}{20}\right) = 48$$
$$0 \quad + V_2\left(\tfrac{147}{20}\right) = 216$$

$$\therefore\ V_2 = \frac{4320}{147} = \boxed{\frac{1440}{49}V}$$

$$\frac{1440}{49}\left(\tfrac{13}{20}\right) - V_1\left(\tfrac{3}{20}\right) = 4 \Rightarrow V_1 = \frac{-3920+18720}{980}\left(\frac{20}{3}\right)$$

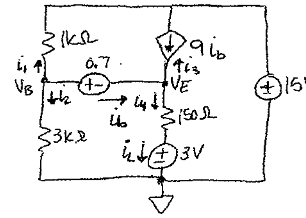
$$V_1 = \boxed{\frac{14800}{49(3)}}$$

$$i_{through(10)} \Rightarrow\ +V_1 - i_{③}(10) + 40 - V_2 = 0$$

$$i_{③} = \frac{V_1 - V_2 + 40}{10} = \frac{\frac{14800}{49(3)} - \overbrace{\frac{3(1440)}{49(3)}}^{4320} + \overbrace{\frac{40(49)(3)}{49(3)}}^{5880}}{10} = \frac{1636}{49(3)}$$

$$\text{power} = i_{③}^2\cdot(10) = \left[\frac{1636}{49(3)}\right]^2(10) \approx \boxed{1238.6W}$$

3.



$$V_B - V_E = 0.7V \Rightarrow V_E = V_B - 0.7$$

$$\underbrace{\frac{V_B-15}{1k}}_{i_1} + \underbrace{\frac{V_B}{3k}}_{i_2} + i_b = 0$$

$$-9i_b - i_b + \underbrace{\frac{V_B-3}{150}}_{i_4} = 0 \Rightarrow \quad i_b = \frac{V_B-3}{150(10)}$$

$$\frac{V_B-15}{1k} + \frac{V_B}{3k} + \frac{\overbrace{(V_B-0.7)}^{V_E}-3}{150(10)} = 0$$

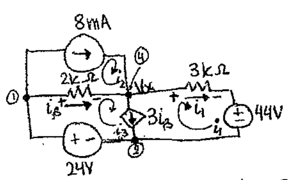
$$V_B\left(\frac{1}{1k} + \frac{1}{3k} + \frac{1}{150(10)}\right) = \frac{15}{1k} + \frac{3.7}{150(10)} = \frac{45}{3k} + \frac{7.4}{3k}$$

$$V_B\left(\frac{6}{3k}\right) = \frac{52.4}{3k} \Rightarrow \boxed{V_B = \frac{52.4}{6}V}$$

$$\therefore V_E = V_B - 0.7 = \boxed{\frac{48.2}{6}V}$$

$$i_L = \frac{V_E-3}{150} = \frac{\frac{48.2}{6} - \frac{18}{6}}{150} = \boxed{\frac{30.2}{6(150)}A}$$

4.



① $i_\beta = i_3 - i_2$ where $i_2 = 8mA$

② $3i_\beta = i_3 - i_1$

③ $+24 - i_\beta(2k) - i_1(3k) - 44 = 0$

subtracting ② from ① ⇒ or summation at node ④

$$2i_\beta = -i_1 + 8m$$

plugging into ③

$$24 - (2k)\left(\frac{-i_1+8m}{2}\right) - i_1(3k) - 44 = 0$$
$$-20 + i_1(1k) - 1k(8m) - i_1(3k) = 0$$
$$i_1(-2k) = 20+8$$
$$\therefore \boxed{i_1 = -14mA}$$

Voltage, V_x, across $3i_\beta$:

$$+V_x - i_1(3k) - 44 = 0$$
$$V_x = -14m(3k) + 44 = +2V$$

∴ power absorbed ⇒

$$V_x\cdot 3i_\beta = +2(3)\cdot i_\beta$$

$$i_\beta = \frac{14m+8m}{2} = 11mA$$

$$\therefore \text{power} = \boxed{+66mW}$$