EE 202 (Semester 131)

Homework # 2 Solution

Problems from the text book (***Electric Circuits,*** James Nilsson and Susan Riedel, 9th edition, Prentice Hall, 2011)

3.6, 3.26, 3.28, &

4.6, 4.13, 4.17, 4.24, 4.28

P 3.6 **[a]** $60\|30 = 1800/90 = 20\,\Omega$ $\quad 12\|24 = 288/36 = 8\,\Omega$

$20 + 8 + 12 = 40\,\Omega$ $\quad 40\|120 = 3600/150 = 30\,\Omega$

$R_{\rm ab} = 15 + 30 + 25 = 70\,\Omega$

[b] $35 + 40 = 75\,\Omega$ $\quad 75\|50 = 3750/125 = 30\,\Omega$

$30 + 20 = 50\,\Omega$ $\quad 50\|75 = 3750/125 = 30\,\Omega$

$30 + 10 = 40\,\Omega$ $\quad 40\|60 + 9\|18 = 24 + 6 = 30\,\Omega$

$30\|30 = 15\,\Omega$ $\quad R_{\rm ab} = 10 + 15 + 5 = 30\,\Omega$

[c] $50 + 30 = 80\,\Omega$ $\quad 80\|20 = 16\,\Omega$

$16 + 14 = 30\,\Omega$ $\quad 30 + 24 = 54\,\Omega$

$54\|27 = 18\,\Omega$ $\quad 18 + 12 = 30\,\Omega$

$30\|30 = 15\,\Omega$ $\quad R_{\rm ab} = 3 + 15 + 2 = 20\,\Omega$

P 3.26 $$i_{\rm 10k} = \frac{(18)(15\text{ k})}{40\text{ k}} = 6.75\text{ mA}$$

$$v_{\rm 15k} = -(6.75\text{ m})(15\text{ k}) = -101.25\text{ V}$$

$$i_{\rm 3k} = 18\text{ m} - 6.75\text{ m} = 11.25\text{ mA}$$

$$v_{\rm 12k} = -(12\text{ k})(11.25\text{ m}) = -135\text{ V}$$

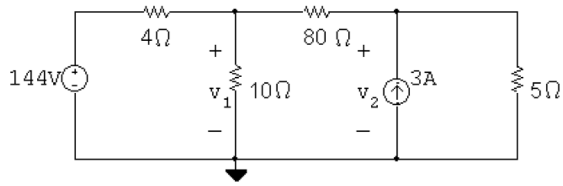
$$v_o = -101.25 - (-135) = 33.75\text{ V}$$

P 3.28 $5\,\Omega \| 20\,\Omega = 4\,\Omega$; $\quad 4\,\Omega + 6\,\Omega = 10\,\Omega$; $\quad 10\|(15+12+13) = 8\,\Omega$;

$$\text{Therefore, } i_g = \frac{125}{12+8} = 6.25 \text{ A}$$

$$i_{6\Omega} = \frac{8}{6+4}(6.25) = 5 \text{ A}; \quad i_o = \frac{5\|20}{20}(5) = 1 \text{ A}$$

P 4.6

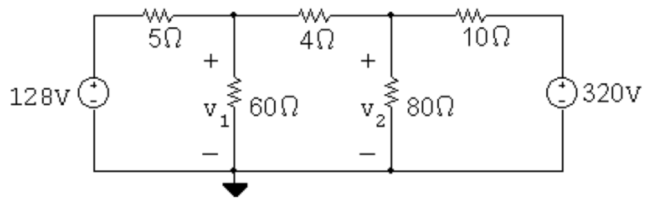


$$\frac{v_1 - 144}{4} + \frac{v_1}{10} + \frac{v_1 - v_2}{80} = 0 \qquad \text{so} \qquad 29v_1 - v_2 = 2880$$

$$-3 + \frac{v_2 - v_1}{80} + \frac{v_2}{5} = 0 \qquad \text{so} \qquad -v_1 + 17v_2 = 240$$

Solving, $v_1 = 100$ V; $\quad v_2 = 20$ V

P 4.13 **[a]**



$$\frac{v_1 - 128}{5} + \frac{v_1}{60} + \frac{v_1 - v_2}{4} = 0$$

$$\frac{v_2 - v_1}{4} + \frac{v_2}{80} + \frac{v_2 - 320}{10} = 0$$

In standard form,

$$v_1\left(\frac{1}{5} + \frac{1}{60} + \frac{1}{4}\right) + v_2\left(-\frac{1}{4}\right) = \frac{128}{5}$$

$$v_1\left(-\frac{1}{4}\right) + v_2\left(\frac{1}{4} + \frac{1}{80} + \frac{1}{10}\right) = \frac{320}{10}$$

Solving, $v_1 = 162$ V; $\quad v_2 = 200$ V

$$i_a = \frac{128 - 162}{5} = -6.8 \text{ A}$$

$$i_b = \frac{162}{60} = 2.7 \text{ A}$$

$$i_c = \frac{162 - 200}{4} = -9.5 \text{ A}$$

$$i_d = \frac{200}{80} = 2.5 \text{ A}$$

$$i_e = \frac{200 - 320}{10} = -12 \text{ A}$$

[b] $p_{128V} = -(128)(-6.8) = 870.4$ W (abs)
$p_{320V} = (320)(-12) = -3840$ W (dev)
Therefore, the total power developed is 3840 W.

P 4.17 [a] $$-25 + \frac{v_1}{40} + \frac{v_1}{160} + \frac{v_1 - v_2}{10} = 0 \quad \text{so} \quad 21v_1 - 16v_2 + 0i_\Delta = 4000$$

$$\frac{v_2 - v_1}{10} + \frac{v_2}{20} + \frac{v_2 - 84i_\Delta}{8} = 0 \quad \text{so} \quad -16v_1 + 44v_2 - 1680i_\Delta = 0$$

$$i_\Delta = \frac{v_1}{160} \quad \text{so} \quad v_1 + (0)v_2 - 160i_\Delta = 0$$

Solving, $v_1 = 352$ V; $v_2 = 212$ V; $i_\Delta = 2.2$ A;

$$i_{\text{depsource}} = \frac{212 - 84(2.2)}{8} = 3.4 \text{ A}$$

$$p_{84i_\Delta} = 84(2.2)(3.4) = 628.32 \text{ W(abs)}$$

$$p_{25\text{A}} = -25(352) = -8800 \text{ W(del)}$$

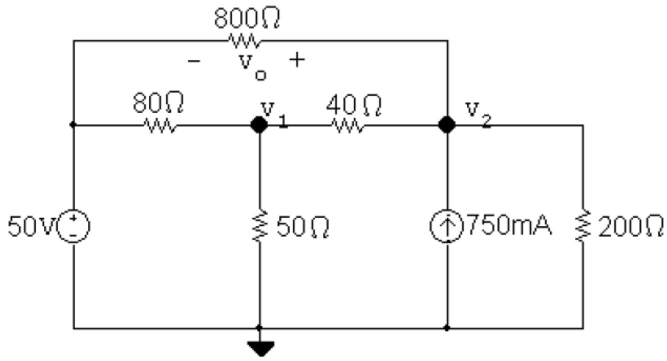
$$\therefore \quad p_{\text{dev}} = 8800 \text{ W}$$

[b] $$\sum p_{\text{abs}} = \frac{(352)^2}{40} + \frac{(352)^2}{160} + \frac{(352 - 212)^2}{10} + \frac{(212)^2}{20}$$

$$+(3.4)^2(8) + 628.32 = 8800 \text{ W}$$

$$\therefore \quad \sum p_{\text{dev}} = \sum p_{\text{abs}} = 8800 \text{ W}$$

P 4.24



The two node voltage equations are:

$$\frac{v_1 - 50}{80} + \frac{v_1}{50} + \frac{v_1 - v_2}{40} = 0$$

$$\frac{v_2 - v_1}{40} - 0.75 + \frac{v_2}{200} + \frac{v_2 - 50}{800} = 0$$

Place these equations in standard form:

$$v_1\left(\frac{1}{80} + \frac{1}{50} + \frac{1}{40}\right) + v_2\left(-\frac{1}{40}\right) = \frac{50}{80}$$

$$v_1\left(-\frac{1}{40}\right) + v_2\left(\frac{1}{40} + \frac{1}{200} + \frac{1}{800}\right) = 0.75 + \frac{50}{800}$$

Solving, $v_1 = 34$ V; $v_2 = 53.2$ V.

Thus, $v_o = v_2 - 50 = 53.2 - 50 = 3.2$ V.

POWER CHECK:

$$i_g = (50 - 34)/80 + (50 - 53.2)/800 = 196 \text{ m A}$$

$$p_{50\text{V}} = -(50)(0.196) = -9.8 \text{ W}$$

$$p_{80\Omega} = (50 - 34)^2/80 = 3.2 \text{ W}$$

$$p_{800\Omega} = (50 - 53.2)^2/800 = 12.8 \text{ m W}$$

$$p_{40\Omega} = (53.2 - 34)^2/40 = 9.216 \text{ W}$$

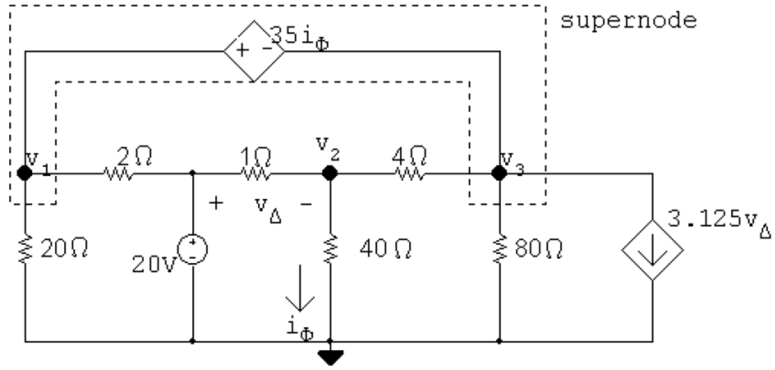
$$p_{50\Omega} = 34^2/50 = 23.12 \text{ W}$$

$$p_{200\Omega} = 53.2^2/200 = 14.1512 \text{ W}$$

$$p_{0.75\text{A}} = -(53.2)(0.75) = -39.9 \text{ W}$$

$\sum p_{\text{abs}} = 3.2 + .0128 + 9.216 + 23.12 + 14.1512 = 49.7 \text{ W} = \sum p_{\text{del}} = 9.8 + 39.9 = 49.7$

P 4.28



Node equations:

$$\frac{v_1}{20} + \frac{v_1 - 20}{2} + \frac{v_3 - v_2}{4} + \frac{v_3}{80} + 3.125 v_\Delta = 0$$

$$\frac{v_2}{40} + \frac{v_2 - v_3}{4} + \frac{v_2 - 20}{1} = 0$$

Constraint equations:

$v_\Delta = 20 - v_2$

$v_1 - 35 i_\phi = v_3$

$i_\phi = v_2/40$

Solving, $v_1 = -20.25$ V; $v_2 = 10$ V; $v_3 = -29$ V

Let i_g be the current delivered by the 20 V source, then

$$i_g = \frac{20 - (20.25)}{2} + \frac{20 - 10}{1} = 30.125 \text{ A}$$

p_g (delivered) $= 20(30.125) = 602.5$ W