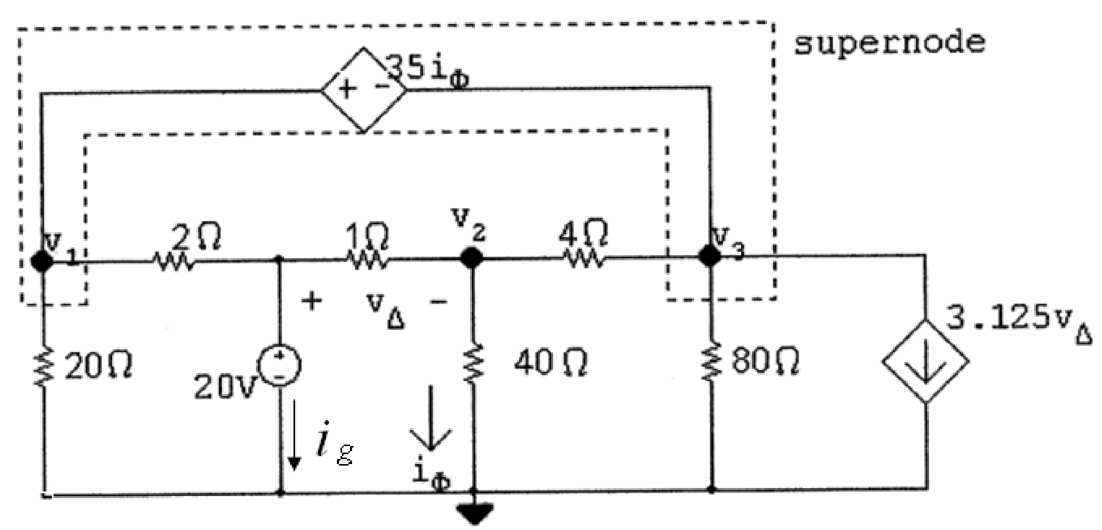
HW2-EE 201-Winter 2011

Problem 4.29



Node equations:

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

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

Constraint equations:

$$v_\Delta = 20 - v_2$$

$$v_1 - 35i_\phi = v_3$$

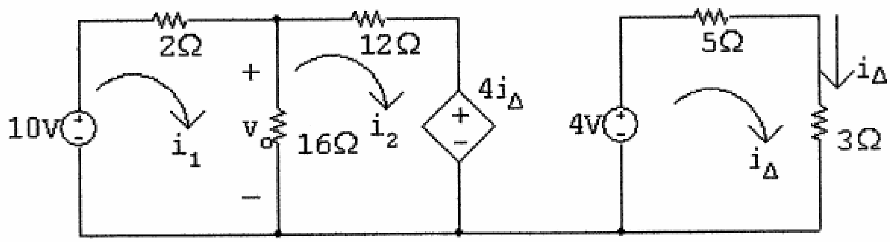
$$i_\phi = v_2/40$$

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

Problem 4.29

[a]



$$10 = 18i_1 - 16i_2$$

$$0 = -16i_1 + 28i_2 + 4i_\Delta$$

$$4 = 8i_\Delta$$

Solving, $i_1 = 1$ A; $\quad i_2 = 0.5$ A; $\quad i_\Delta = 0.5$ A

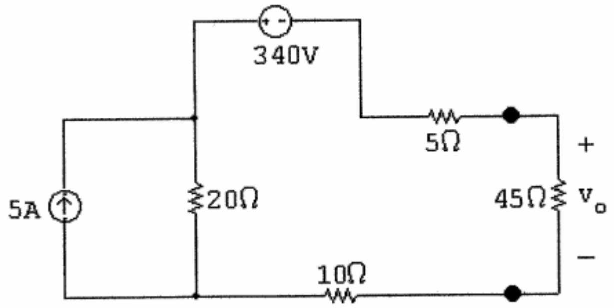
$$v_0 = 16(i_1 - i_2) = 16(0.5) = 8 \text{ V}$$

[b] $p_{4i_\Delta} = 4i_\Delta i_2 = (4)(0.5)(0.5) = 1$ W (abs)

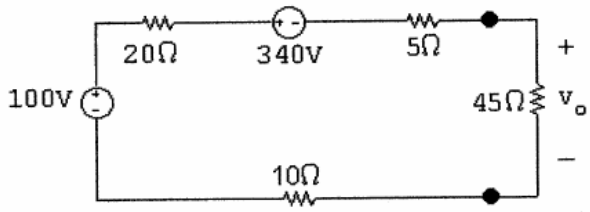
$\therefore \; p_{4i_\Delta}$ (deliver) $= -1$ W

Problem 4.61

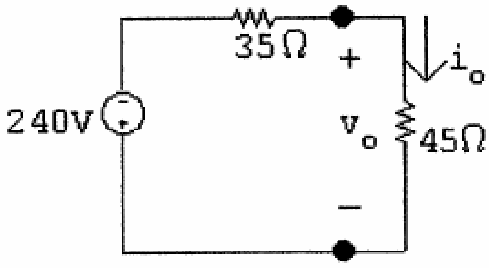
[a] First remove the 8 Ω and 80 Ω resistors:



Next use a source transformation to convert the 5 A current source and 20 Ω resistor:

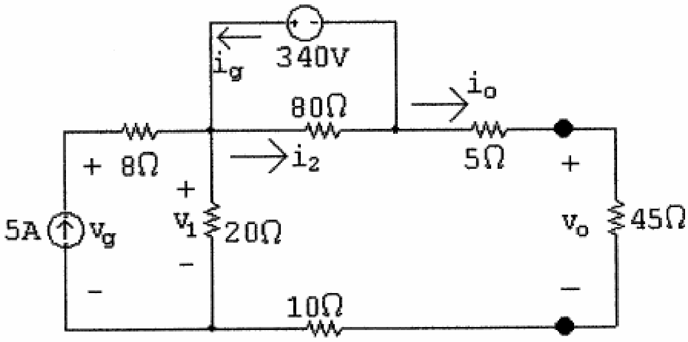


which simplifies to



$$\therefore \quad v_o = \frac{45}{80}(-240) = -135 \text{ V}; \qquad i_o = \frac{-135}{45} = -3 \text{ A}$$

[b] Return to the original circuit with $v_o = -135$ V and $i_o = -3$ A:



$$i_g = \frac{340}{80} - (-3) = 7.25 \text{ A}$$

$$p_{340\text{V}} = -(340)(7.25) = -2465 \text{ W}$$

Therefore, the 340 V source is developing 2465 W.

[c] $v_1 = 340 + 60i_o = 340 - 180 = 160$ V

$$v_g = v_1 + 5(8) = 160 + 40 = 200 \text{ V}$$

$$p_{5\text{A}} = -(5)(200) = -1000 \text{ W}$$

Therefore the 5 A source is developing 1000 W.

[d] $\sum p_{\text{dev}} = 2465 + 1000 = 3465$ W

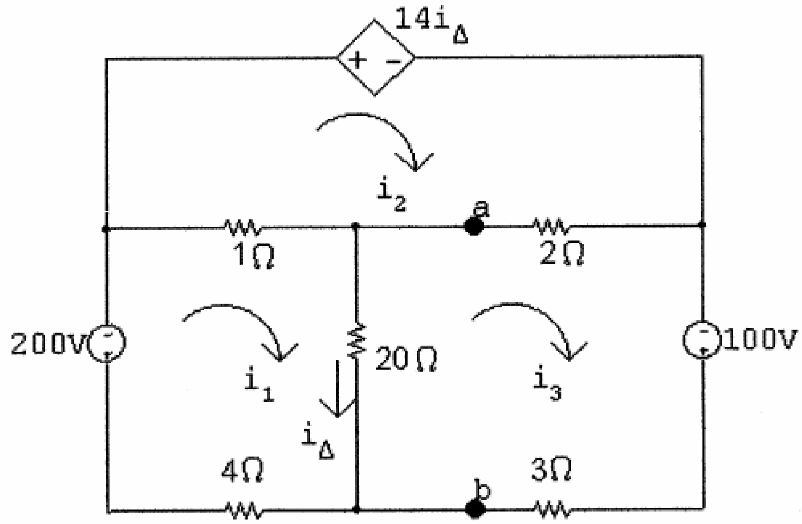
$$\sum p_{\text{diss}} = (5)^2(8) + (8)^2(20) + (4.25)^2(80) + (3)^2(60) = 3465 \text{ W}$$

$$\therefore \quad \sum p_{\text{diss}} = \sum p_{\text{dev}}$$

Problem 4.86

[a] We begin by finding the Thévenin equivalent with respect to the terminals of R_o.

Open circuit voltage



$$-200 = 25i_1 - 1i_2 - 20i_3$$

$$0 = -i_1 + 3i_2 - 2i_3 + 14i_\Delta$$

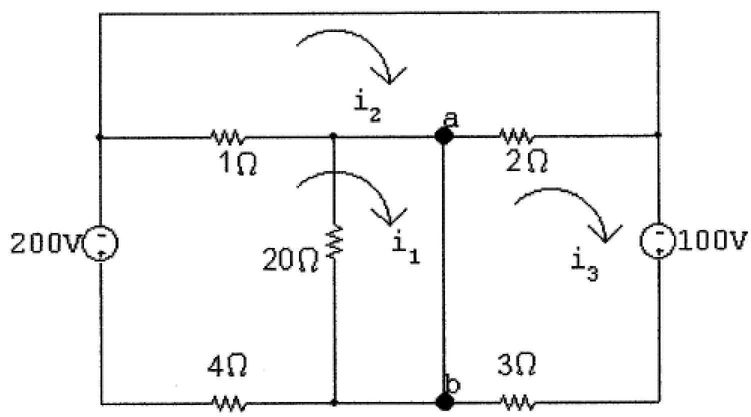
$$100 = -20i_1 - 2i_2 + 25i_3$$

$$i_\Delta = i_1 - i_3$$

Solving, $i_1 = -2.5$ A; $i_2 = 37.5$ A; $i_3 = 5$ A; $i_\Delta = -7.5$ A

$$v_{\text{Th}} = 20(i_1 - i_3) = 20(-7.5) = -150 \text{ V}$$

Now find the short-circuit current.



Note with the short circuit from a to b that i_Δ is zero, hence $14i_\Delta$ is also zero.

$-200 = 5i_1 - 1i_2 + 0i_3$

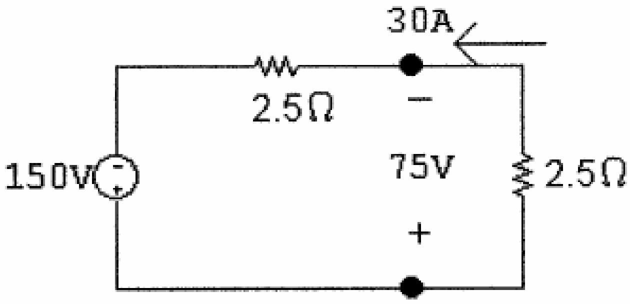
$0 = -1i_1 + 3i_2 - 2i_3$

$100 = 0i_1 - 2i_2 + 5i_3$

Solving, $i_1 = -40$ A; $\quad i_2 = 0$ A; $\quad i_3 = 20$ A

$i_{sc} = i_1 - i_3 = -60$ A

$R_{Th} = (-150)/(-60) = 2.5\,\Omega$

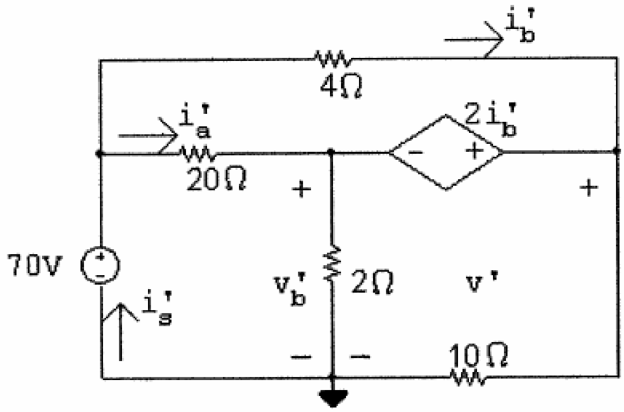


For maximum power transfer $\quad R_o = R_{Th} = 2.5\,\Omega$

[b] $p_{max} = \frac{75^2}{2.5} = 2250$ W

Problem 4.92

70-V source acting alone:



$$v' = 70 - 4i_b'$$

$$i_s' = \frac{v_b'}{2} + \frac{v'}{10} = i_a' + i_b'$$

$$70 = 20i_a' + v_b'$$

$$i_a' = \frac{70 - v_b'}{20}$$

$$\therefore \quad i_b' = \frac{v_b'}{2} + \frac{v'}{10} - \frac{70 - v_b'}{20} = \frac{11}{20}v_b' + \frac{v'}{10} - 3.5$$

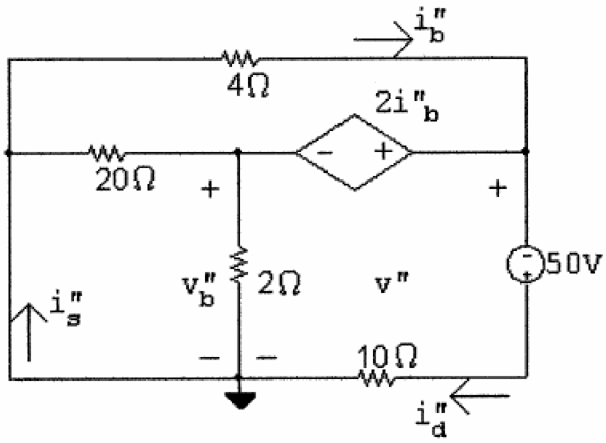
$$v' = v_b' + 2i_b'$$

$$\therefore \quad v_b' = v' - 2i_b'$$

$$\therefore \quad i_b' = \frac{11}{20}(v' - 2i_b') + \frac{v'}{10} - 3.5 \quad \text{or} \quad i_b' = \frac{13}{42}v' - \frac{70}{42}$$

$$\therefore \quad v' = 70 - 4\left(\frac{13}{42}v' - \frac{70}{42}\right) \quad \text{or} \quad v' = \frac{3220}{94} = \frac{1610}{47}\text{ V} = 34.255\text{ V}$$

50-V source acting alone:



$$v'' = -4i''_b$$

$$v'' = v''_b + 2i''_b$$

$$v'' = -50 + 10i''_d$$

$$\therefore \quad i''_d = \frac{v'' + 50}{10}$$

$$i''_s = \frac{v''_b}{2} + \frac{v'' + 50}{10}$$

$$i''_b = \frac{v''_b}{20} + i''_s = \frac{v''_b}{20} + \frac{v''_b}{2} + \frac{v'' + 50}{10} = \frac{11}{20}v''_b + \frac{v'' + 50}{10}$$

$$v''_b = v'' - 2i''_b$$

$$\therefore \quad i''_b = \frac{11}{20}(v'' - 2i''_b) + \frac{v'' + 50}{10} \quad \text{or} \quad i''_b = \frac{13}{42}v'' + \frac{100}{42}$$

Thus, $$v'' = -4\left(\frac{13}{42}v'' + \frac{100}{42}\right) \quad \text{or} \quad v'' = -\frac{200}{47}\text{ V} = -4.255\text{ V}$$

Hence, $$v = v' + v'' = \frac{1610}{47} - \frac{200}{47} = \frac{1410}{47} = 30\text{ V}$$