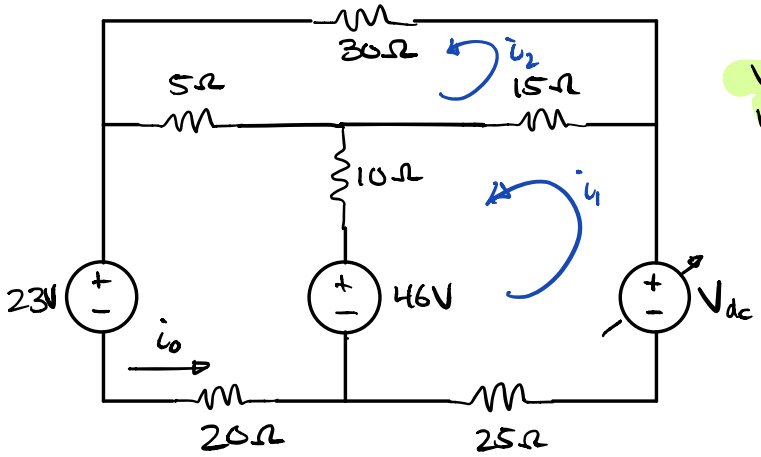
ENGR 221, HW#5, Due 5/31/20, Sean Lai

Ch 4: #'s 58, 62, 72ab*, 74, 78, 82, 93
* LTSpice. see assignment desc.

4.58:

Given:



V_{dc} adjusted to make $i_o = 0$

Find: a) Would you use NVA or MCA? Explain.
b) Find V_{dc} using method from a)
c) Show $P_{dev} = P_{diss}$

Solution:

a) Use **MCA** since we know $i_o = 0$, leaving 2 meshes to analyze.

b) 0: $+23V + 0(20) - 46V + 10(i_o - i_1) + 5(i_o - i_2) = 0$

1: $-V_{dc} + 15(i_1 - i_2) + 10(i_1 - i_o) + 46V + 25(i_1) = 0$

2: $30i_2 + 5(i_2 - i_o) + 15(i_2 - i_1) = 0$

i_1	i_2	V_{dc}	
−10	−5	0	23
(15+10+25)	(−15)	−1	−46
(−15)	(30+5+15)	0	0

$i_1 = -2A$
$i_2 = -0.6A$
$V_{dc} = -45V$

→ **$V_{dc} = -45V$**

→ continued

4.58 continued ⟶

c) $P_{dev} = 23(i_0)^0 + -46(i_1) + V_{dc}(i_1)$, $V_{dc} = -45V$, $i_1 = -2A$

$P_{dev} = 182W$

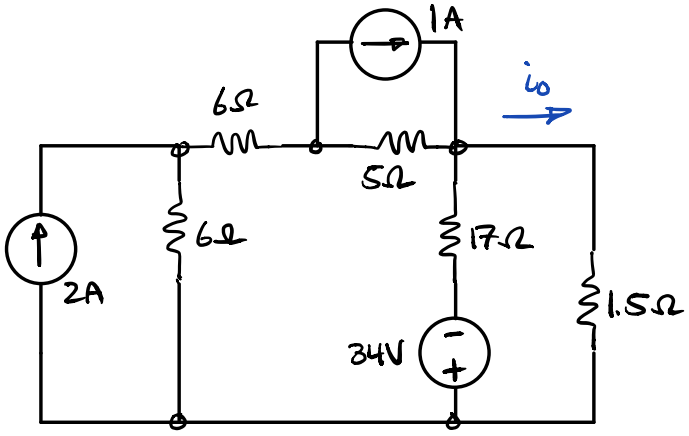
$P_{diss} = i_0(20)^0 + i_1^2(10+25) + 15(|i_2 - i_1|)^2 + i_2^2(30+5)$

$P_{diss} = 182W$

⟶ $P_{dev} = P_{diss} = 182W$

4.62:

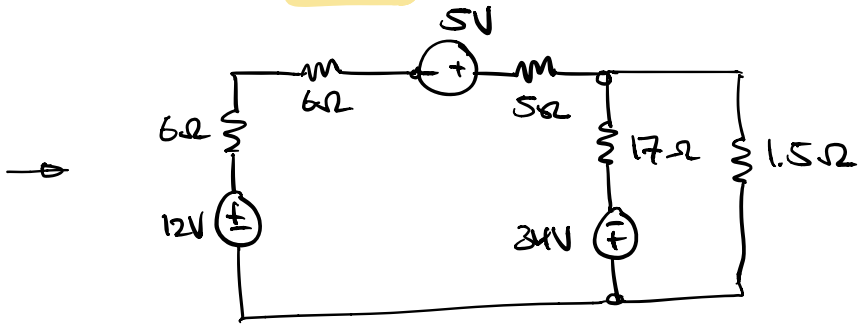
Given:

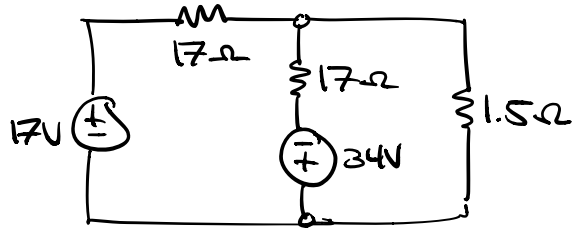


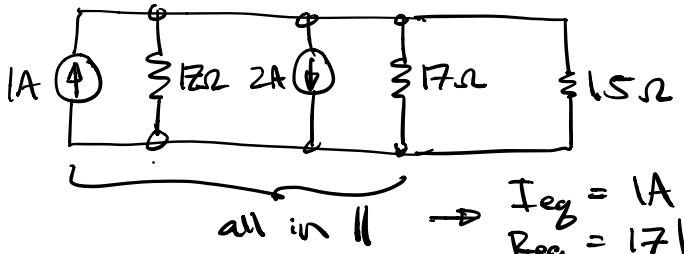
Find: a) Use source transforms to find i_o.
b) Verify by using NKA to find i_o.

Solution:

a) using $i_s = \frac{V_s}{R}$



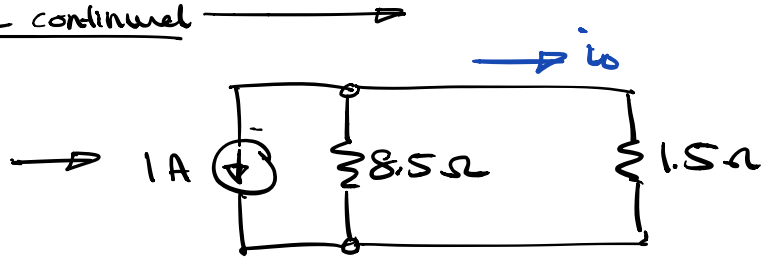




all in ∥ → $I_{eq} = 1A \downarrow$
$R_{eq} = 17 \| 17 = 8.5\Omega$

Continued →

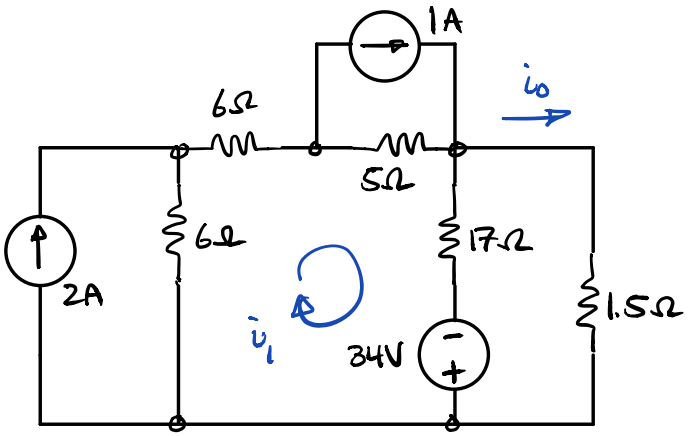
4.62 continued →



$$i_o = \frac{8.5}{10} = 1A$$

$$\boxed{i_o = -0.85A}$$

b)



0: $1.5(i_0) + 34 + 17(i_0 - i_1) = 0$

1: $6(i_1 - 2) + 6(i_1) + 5(i_1 - 1) + 17(i_1 - i_0) - 34 = 0$

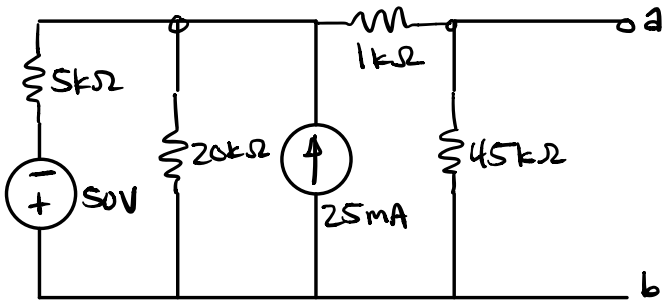
	i_0	i_1	
→	(1.5+17)	−17	−34
	−17	(6+6+5+17)	34+12+5

$i_0 = -0.85$
$i_1 = 1.075$

→ $\boxed{i_0 = -0.85A}$ ✓

4.72:

Given:



Find: a) using LTspice, sim using ideal V meter, and one with 85.5kΩ resistance. Record findings

b) compare results using % error

Solution:

a) From LTSpice: 0Ω V_{meter} : V = 54V

85.5Ω V_{meter}: V = 51.2849V

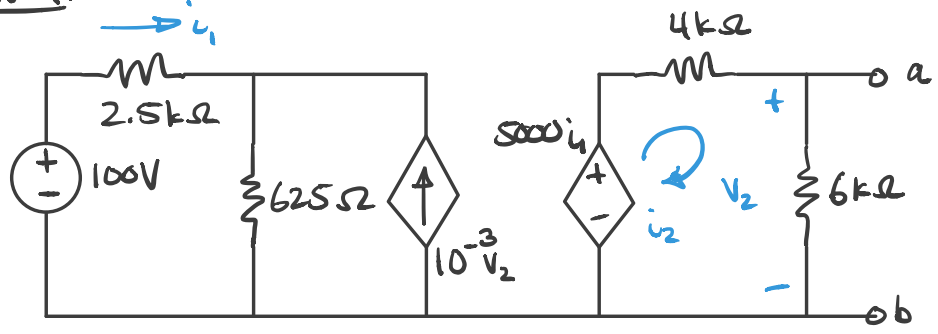
b) $\%\text{Error} = \frac{-51.2849 - 54}{54} \cdot 100$

$= -0.05 \cdot 100$

% Error = −5%

4.74:

Given:



Find: Thévenin equivalent with respect to a, b

Solution:

OC: $-100 + 2.5k(i_1) + 625(i_1 + 10^{-3}V_2) = 0$

$$V_2 = \frac{6k}{4k+6k} \cdot 5000\, i_1$$

i_1	V_2	
$2500 + 625$	-10^{-3}	0
$\frac{6}{10}(5000)$	-1	0

$i_1 = 0.2A$

$V_2 = 60V$

SC: $V_2 = 0$

$$i_{sc} = \frac{5000\, i_1}{4k} \quad , \quad i_1 = \frac{100V}{2500+625}$$

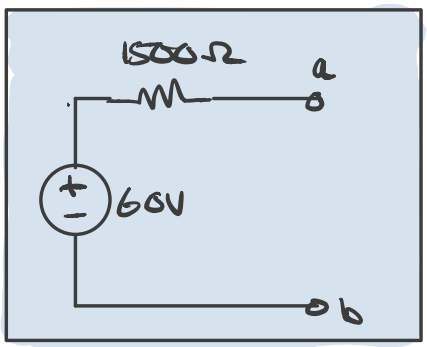
$$i_1 = 0.032A$$

$\rightarrow$ $i_{sc} = 0.04A$

$$R_{TH} = \frac{V_{oc}}{i_{sc}} = \frac{60V}{0.04A}$$

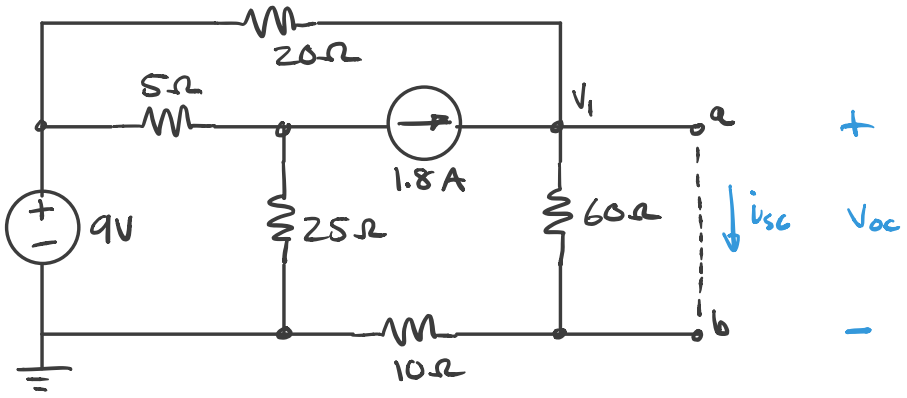
$$R_{TH} = 1500\Omega$$

$\rightarrow$



4.78:

Given:



Find: a) Thévenin equivalent w/ respect to a, b
b) Thévenin resistance with sources removed. compare w/ a)

Solution:

OC: $\frac{V_1 - 9}{20} + \frac{V_1}{70} - 1.8 = 0$

$\left(\frac{1}{20} + \frac{1}{70}\right)V_1 = 1.8 + \frac{9}{20}$

$V_1 = 35\,V$

$V_{oc} = V_1 \cdot \frac{60}{70}$

$\rightarrow V_{oc} = 30\,V$

SC: $\frac{V_1 - 9}{20} + \frac{V_1}{10} - 1.8 = 0$

$\left(\frac{1}{20} + \frac{1}{10}\right)V_1 = 1.8 + \frac{9}{20}$

$V_1 = 15\,V$

$i_{sc} = \frac{V_1}{10\Omega}$

$i_{sc} = 1.5\,A$

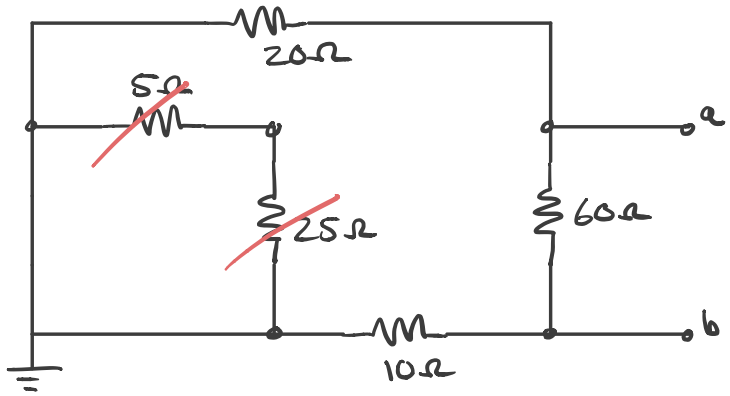
$\rightarrow R_{TH} = \frac{V_{oc}}{i_{sc}}$

$R_{TH} = 20\Omega$

$V_{TH} = 30\,V$

CONTINUED →

b)

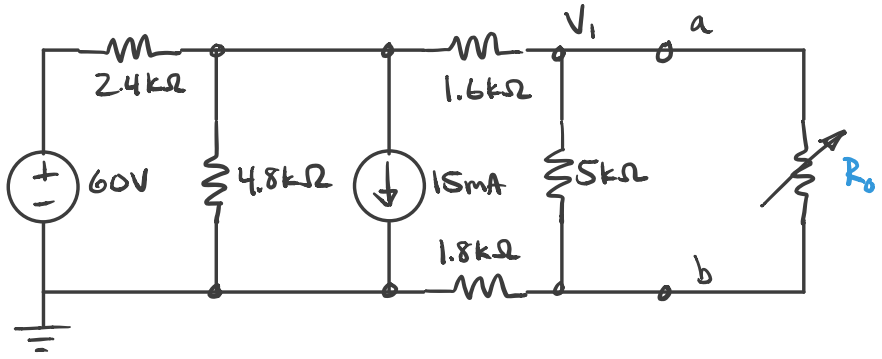


$$R_{ab} = 60 \parallel (20+10)$$
$$= 60 \parallel 30$$

$$\boxed{R_{ab} = 20\,\Omega} \quad \surd$$

4.82:

Given:



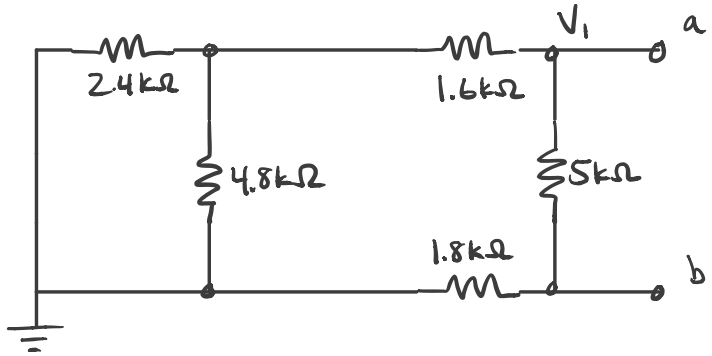
R_o adjusted for maximum power transfer

Find:

a) R_o
b) P_{max} delivered to R_o
c) Resistor in Appendix H closest to R_o. How much power is delivered to that resistor?

Solution:

Find R_{TH} for a,b.



$$R_{TH} = 5000 \,||\, \left(1600 + (2400 \,||\, 4800) + 1800\right)$$

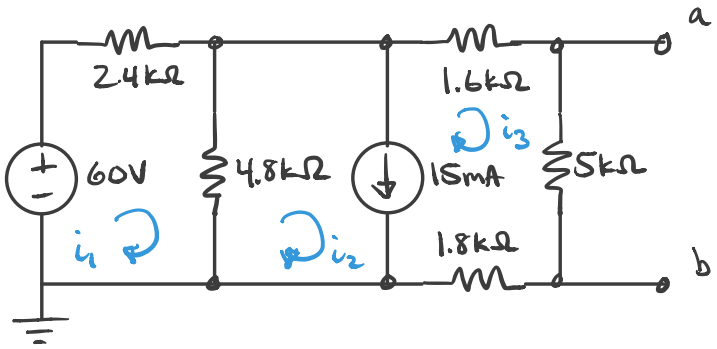
$$R_{TH} = 2500\,\Omega$$

a) Max power when $R_o = R_{TH}$

$$\rightarrow \boxed{R_o = 2500\,\Omega}$$

CONTINUED →

b)



i_2, i_3 supermesh

$$-60 + 2400(i_1) + 4800(i_1 - i_2) = 0$$

$$4800(i_2 - i_1) + 8400 i_3 = 0$$

$$i_2 - i_3 = 0.015$$

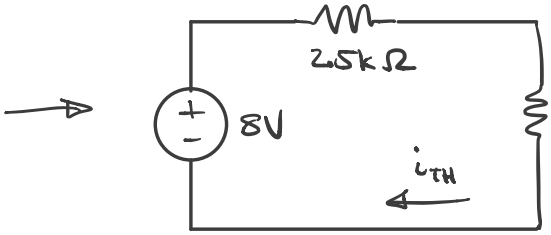
i_1	i_2	i_3	
2400 + 4800	−4800		60
−4800	4800	8400	0
0	1	−1	0.015

$i_1 = 0.0194$

$i_2 = 0.0166$

$i_3 = 0.0016$

$$V_{oc} = i_3 \cdot 5k$$
$$= 8V$$



$$i_{TH} = \frac{8V}{5000} = 1.6mA$$

$$P_{max} = i_{TH}^2 (2500)$$

$$\boxed{P_{max} = 6.4\,mW}$$

c) 2.7kΩ is closest.

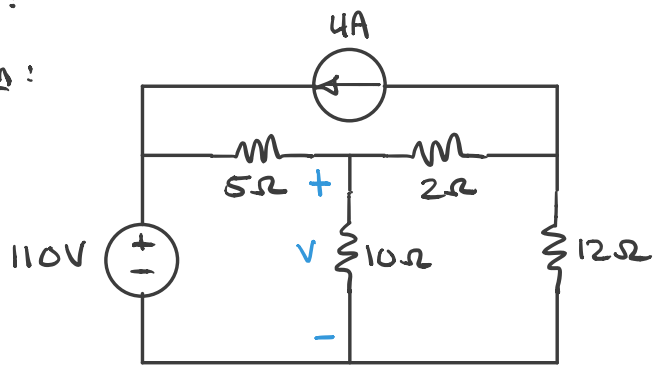
$$i = \frac{8V}{5200} = 0.00154\,A$$

$$P_{max} = i^2 (2700)$$

$$\boxed{P_{max} = 6.39\,mW}$$

4.93:

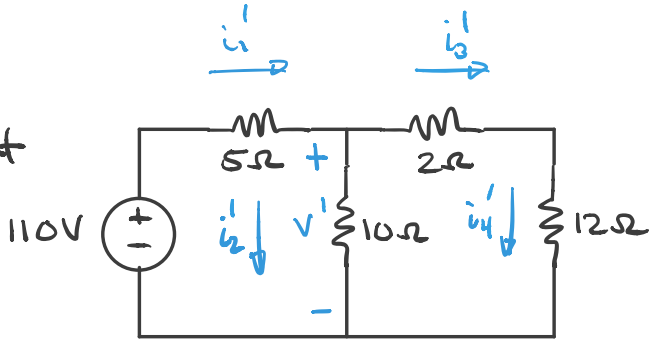
Given:



Find: a) Use superposition to find v
b) $P_{10\Omega}$

Solution:

a) Deactivate current source



$$\rightarrow \frac{v'-110}{5} + \frac{v'}{10} + \frac{v'}{14} = 0$$

$$v'\left(\frac{1}{5}+\frac{1}{10}+\frac{1}{14}\right) = \frac{110}{5}$$

$$v' = 59.23\,V$$

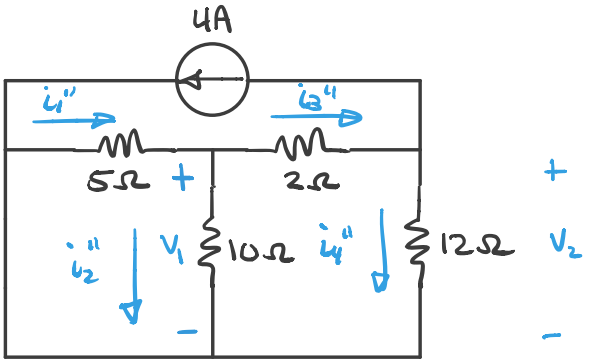
$$i_4' = \frac{110-59.23}{5} = 10.154\,A$$

$$i_2' = \frac{59.23}{10} = 5.923\,A$$

$$i_3' = i_4' = \frac{59.23}{14} = 4.231\,A$$

CONTINUED →

Deactivate Voltage Source:



$$\frac{V_1}{5} + \frac{V_1}{10} + \frac{V_1 - V_2}{2} = 0$$

$$\frac{V_2}{12} + \frac{V_2 - V_1}{2} + 4 = 0$$

$$V_1\left(\frac{1}{5} + \frac{1}{10} + \frac{1}{2}\right) + V_2\left(-\frac{1}{2}\right) = 0$$

$$V_1\left(-\frac{1}{2}\right) + V_2\left(\frac{1}{12} + \frac{1}{2}\right) = -4$$

$$V_2 = 1.6\,V_1$$

$$V_1\left(-\frac{1}{2} + 1.6\left(\frac{1}{12} + \frac{1}{2}\right)\right) = -4$$

$$V_1 = -9.23\,V$$

$$V = V' + V_1$$
$$= 59.23 + -9.23$$

V = 50V

b) $P_{10\Omega} = \frac{V^2}{R}$

$P_{10\Omega}$ = 250W