Homework 2

Due date: Oct. 31st, 2023

Turn in your hard-copy hand-writing homework in class

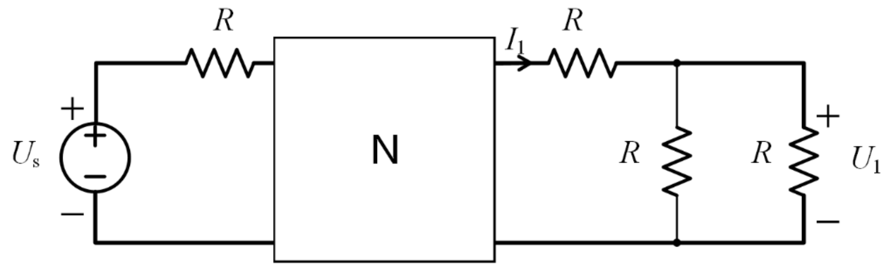
Rules:

- Work on your own. Discussion is permissible, but extremely similar submissions will be judged as plagiarism.
- Please show all intermediate steps: a correct solution without an explanation will get zero credit.
- Please submit on time. No late submission will be accepted.
- Please prepare your submission in English only. No Chinese submission will be accepted.

1. N is a linear resistive network with sources inside.

When $U_s = 6V$, $I_1 = 1A$, $U_1 = 2V$; When $U_s = 10V$, $I_1 = 2A$.

Use linear property to find I_1 and U_1 if $U_s = 12V$. 10'



1, $U_1 = 0.5RI_1$, from $I_1 = 1A$. $U_1 = 2V \Rightarrow R = 4\Omega$

$\because$ $I_1 = k + k_1 U_s$, $\begin{cases} 1 = k + 6k_1 \\ 2 = k + 10k_1 \end{cases} \Rightarrow \begin{cases} k = 0.5 \\ k_1 = 0.25 \end{cases}$ 5'

when $U_s = 12V$, $I_1 = -0.5 + 0.25 \times 12 = 2.5A$ $U_1 = 0.5RI_1 = 5V$

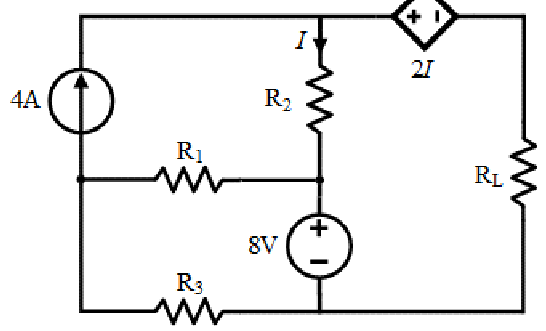
5'

2. $R_1=R_2=2\Omega$, $R_3=1\Omega$, $R_L=2\Omega$

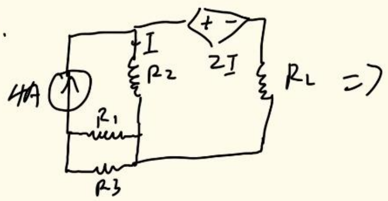
a. Calculate the current of R_L when an independent current source acts alone.5'

b. Calculate the current of R_L when an independent voltage source acts alone.5'

c. Calculate the current on R_L using the superposition theorem.5'



a.



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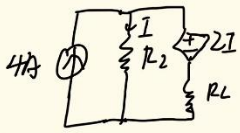
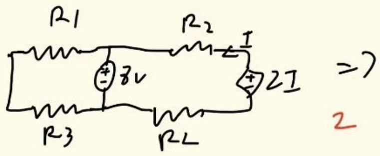


$\frac{IR_2 - 2I}{R_L} + I = 4$ 2

$I = 4A$

$i_{R_L} = 0A$ 2

b.



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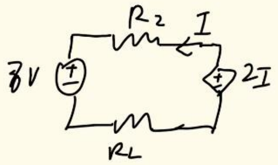


$-I \cdot (R_2 + R_L) + 2I = 8$ 2

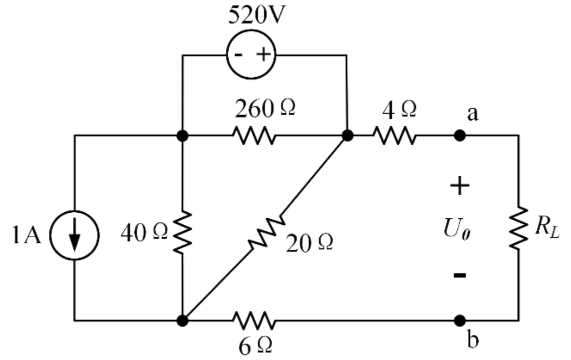
$I = -4A$

$i_{R_L} = -I = 4A$ 2

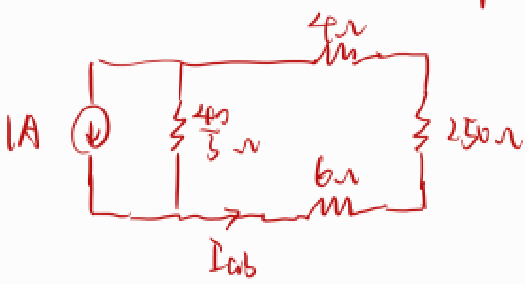
c. $I_{R_L} = 0 + 4 = 4A$ 3

3. (a) Apply superposition to find U_0 in the circuit below when R_L=250Ω.5’

(b) Find the Thevenin equivalent circuit for the left hand side circuit of node a and node b.10’



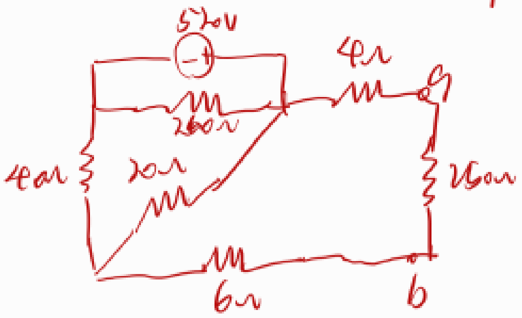
3. a. when the independent current source acts:



$I_{ab} = \frac{\frac{40}{3}}{\frac{40}{3}+4+6+250} \times 1 = \frac{2}{41}$ A

$U_{ab} = -I_{ab} \cdot 250\Omega = -\frac{500}{41}$ V $= -12.19$V 5'

when the independent voltage source acts:



$I = \frac{520}{40+\frac{20\times260}{20+260}} \times \frac{20}{20+260} = \frac{26}{41}$ A

$U'_{ab} = \frac{26}{41} \times 250 = \frac{6500}{41}$ V $= 158.53$V

$\therefore U_0 = U_{ab} + U'_{ab} = \frac{6000}{41}$ V $= 146.34$V 5'

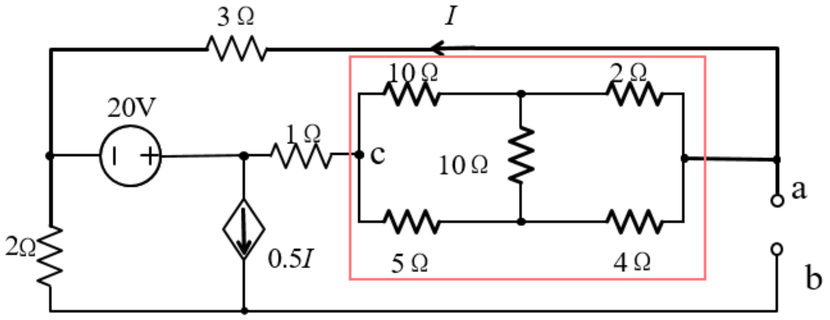
b. $R_{eq} = 4+6+\frac{40\times20}{40+20} = \frac{70}{3}\Omega = 23.3\Omega$

$-260\times2+40(I+1)+20I=0$ 5'

$I = 8$A $\quad U_{oc} = 20\times8 = 160$V

4. a. Find the equivalent resistance R_{ac} 5'

   b. Find the Thevenin equivalent circuit between node a and b 15'

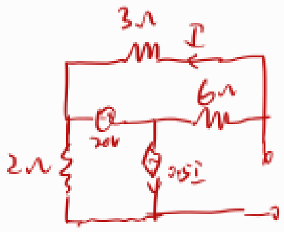


4.

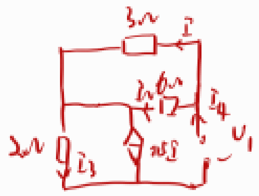
a. $\Delta \to Y$ $\quad R_{eq} = 2 + [(4+2) \parallel (4+2)] = 2+3 = 5\Omega$ 5'

b. $I = \frac{20V}{6+3\Omega} = \frac{20}{9} A \quad U_{oc} = I \times 3\Omega - 0.5I \times 2\Omega = 3 \times \frac{20}{9} - 0.5 \times \frac{20}{9} \times 2$ 5'

$= \frac{60}{9} - \frac{20}{9} = \frac{40}{9} V$



$3\Omega \times I = 6\Omega \times I_2 \qquad I_2 = 0.5I$

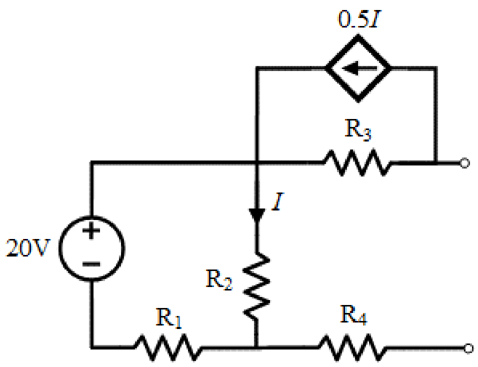


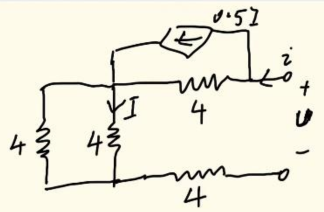
$I_3 = I + I_2 - 0.5I = I$ 5'

$R_{eq} = \frac{U_1}{I_1} = \frac{6\Omega \times I_2 + 2\Omega \times I_3}{I + I_2} = \frac{3I + 2I}{1.5I} = \frac{5I}{1.5I} = \frac{10}{3}\Omega$ 5'

5. $R_1 = R_2 = R_3 = R_4 = 4\Omega$.

Find the Norton equivalent circuit of the two port network. 15’

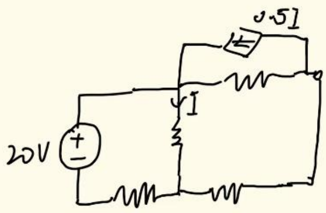


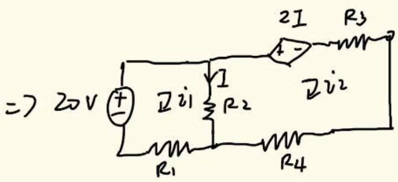


$$\begin{cases} (i - 0.5I)R_3 + IR_2 + iR_4 = U \\ \dfrac{IR_2}{R_1} + I = i \end{cases} \quad 4$$

$\therefore\ i = 2I$

$R_{eq} = \dfrac{U}{i} = 9\Omega$ 2

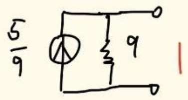




$$\begin{cases} (R_1+R_2)i_1 - i_2R_2 = 20 \\ (R_2+R_3+R_4)i_2 + 2I - i_1R_2 = 0 \end{cases} \quad 4$$

$I = i_1 - i_2$

$\therefore\ i_1 = \dfrac{25}{9}$ 2 $\quad i_2 = \dfrac{5}{9}$ 2



1

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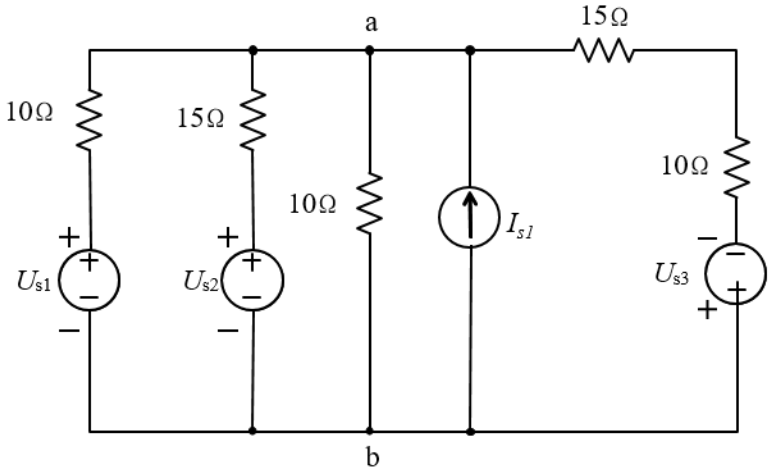
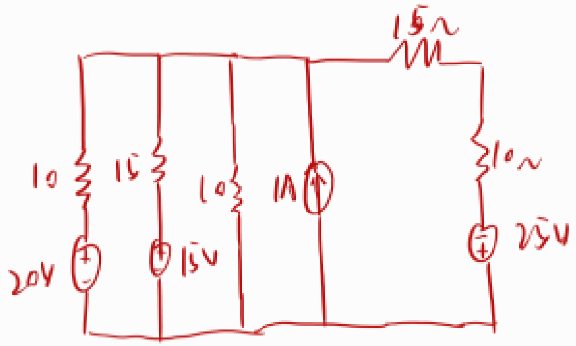
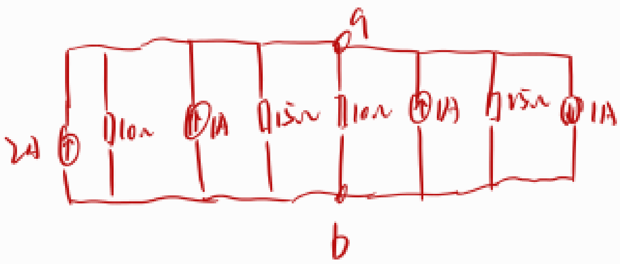
6. U_{s1} = 20V, U_{s2} = 15V, U_{s3} = 25V, I_{s1} = 1A, using source transfer to calculate U_{ab} 10’

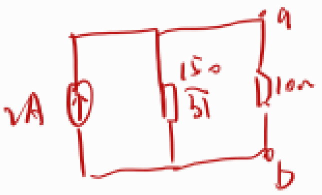


6.





$I_{total} = 2+1+1-1 = 3A$ 5’



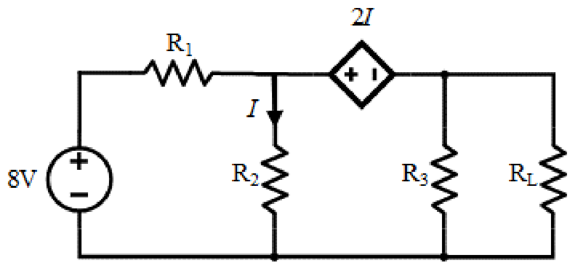
$$I_{ab} = 3 \times \frac{\frac{150}{31}}{10+\frac{150}{31}} = \frac{45}{46} = 0.98A$$

$$U_{ab} = 10 \times \frac{45}{46} = 9.78V$$ 5’

7. $R_1 = 2\Omega$, $R_2 = 6\Omega$, $R_3 = 1\Omega$

a. Determine the value of R_L when maximum power could be transferred to it, and calculate the maximum power P_{RL}. 10’

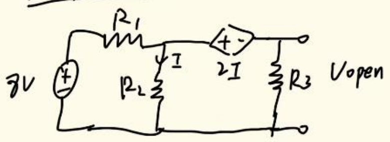
b. Calculate the ratio of P_{RL} to the output power of the independent voltage source. 5’



equivalent circuit

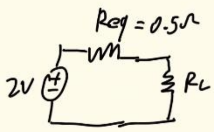
$$R_{eq} = R_3 // \left(\frac{R_2 - 2}{R_2/R_1 + 1} \right) = 0.5\Omega \quad 2$$

3



$$\begin{cases} U_{open} + 2I = IR_2 \\ 8 = IR_2 + R_1\left(\frac{U_{open}}{R_3} + I\right) \end{cases} \quad 3$$

$\therefore U_{open} = 2V$



when $R_L = 0.5\Omega$, $P_{av} = \frac{2^2}{4 \cdot 0.5} = 2W$

2

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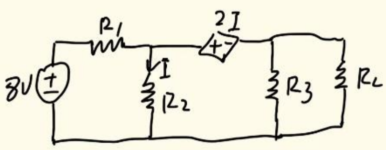

$$\left[\frac{(IR_2 - 2I)}{R_3 // R_L} + I \right] R_1 + IR_2 = 8V$$

3

$\therefore I = \frac{13}{4} A$

$P_{out} = 8 \cdot \frac{13}{4} = 26W$

$\eta = \frac{P_{RL}}{P_{out}} = \frac{1}{13}$ 2