Homework 1

Due date: Sep. 27th, 2022, Tuesday

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

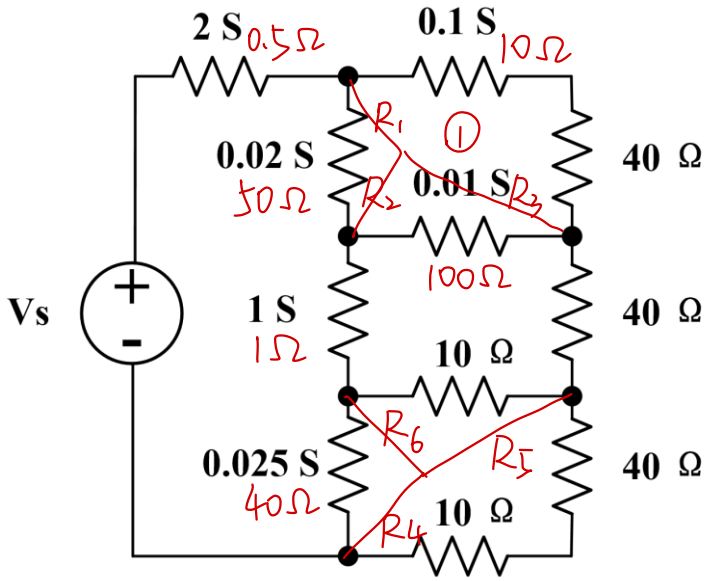
Rules:

- 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.

10'

1. (a) Find the resistance seen by the ideal voltage source **Vs** in the circuit.

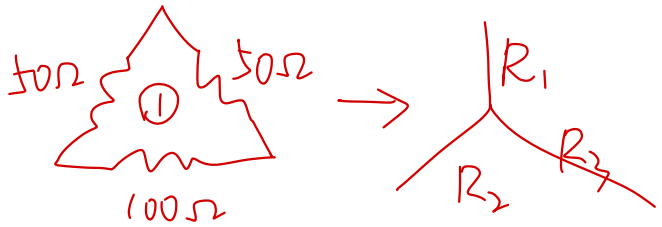
(b) If **Vs** equals 270V, how much power is dissipated in the 1S resistor?



S→Ω 1'

(a)

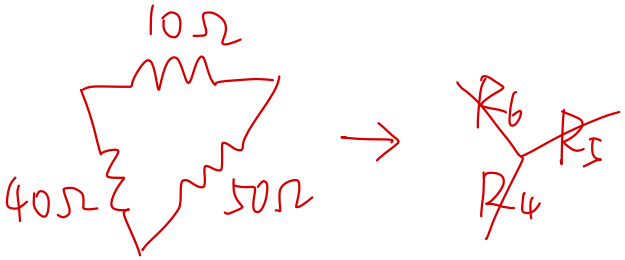
4'



$R_1 = \frac{50 \times 50}{50+50+100} = 12.5\ \Omega$

$R_2 = \frac{50 \times 100}{200} = 25\ \Omega$

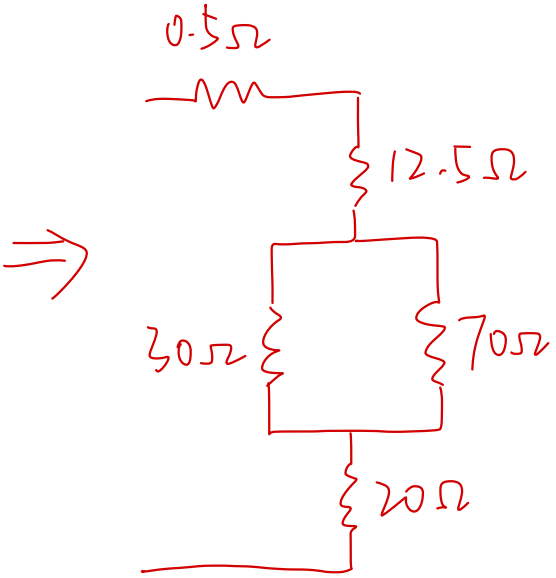
$R_3 = \frac{50 \times 100}{200} = 25\ \Omega$



$R_4 = \frac{40 \times 50}{10+40+50} = 20\ \Omega$

$R_5 = \frac{50 \times 10}{100} = 5\ \Omega$

$R_6 = \frac{40 \times 10}{100} = 4\ \Omega$



$R_{eq} = 0.5 + 12.5 + 21 + 20$

$= 54\ \Omega$

3'

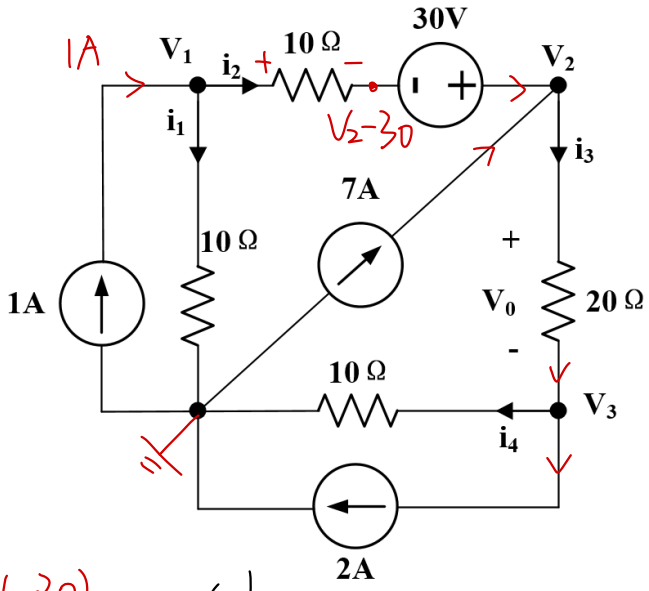
(b) $i_R = \frac{270}{54} \times \frac{70}{30+70} = 3.5\ A$

$P = i_R^2 R = 3.5^2 \times 1 = 12.25\ W$

15'

2. Apply nodal analysis method to obtain:
   (a) all the node voltages (V_1, V_2, and V_3) if assuming the bottomleft node as the reference node.
   (b) all the currents (i_1 to i_4) and the voltage on 20Ω resistor (V_0).

Unit 1'



(a)

$$\begin{cases} 1=\frac{V_1}{10}+\frac{V_1-(V_2-30)}{10} \\ \frac{V_1-(V_2-30)}{10}+7=\frac{V_2-V_3}{20} \\ \frac{V_2-V_3}{20}=\frac{V_3}{10}+2 \end{cases}$$

6'

$$\begin{cases} V_1=40\,V \\ V_2=100\,V \\ V_3=20\,V \end{cases}$$

3'

(b) $i_1=\frac{V_1}{10}$ $\quad i_1=4\,A$

$i_2=\frac{V_1-(V_2-30)}{10}$ $\quad i_2=-3\,A$

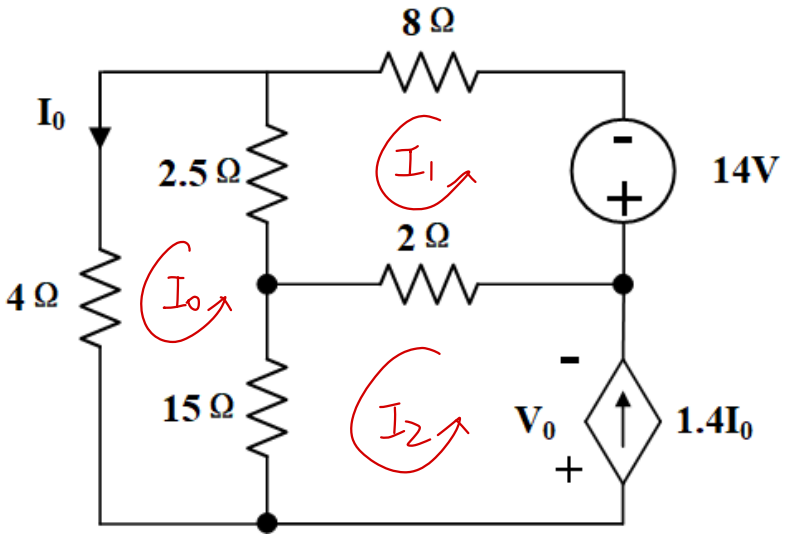
$i_3=\frac{V_2-V_3}{20}$ $\quad i_3=4\,A$

$i_4=\frac{V_3}{10}$ $\quad i_4=2\,A$

$V_0=V_2-V_3$ $\quad V_0=80\,V$

5'

10' 3. Apply mesh analysis method to obtain $\mathbf{I_0}$ and $\mathbf{V_0}$ in the following circuit.



$$\begin{cases} 4I_0 + 15(I_0 - I_2) + 2.5(I_0 - I_1) = 0 \\ 2.5(I_1 - I_0) + 2(I_1 - I_2) + 8I_1 + 14 = 0 \\ I_2 = 1.4I_0 \end{cases}$$

6'

$$\begin{cases} I_0 = 5A \\ I_1 = 1A \\ I_2 = 7A \end{cases}$$ 2'

$$2(I_2 - I_1) + 15(I_2 - I_0) + V_0 = 0$$

$$V_0 = 2(I_1 - I_2) + 15(I_0 - I_2)$$

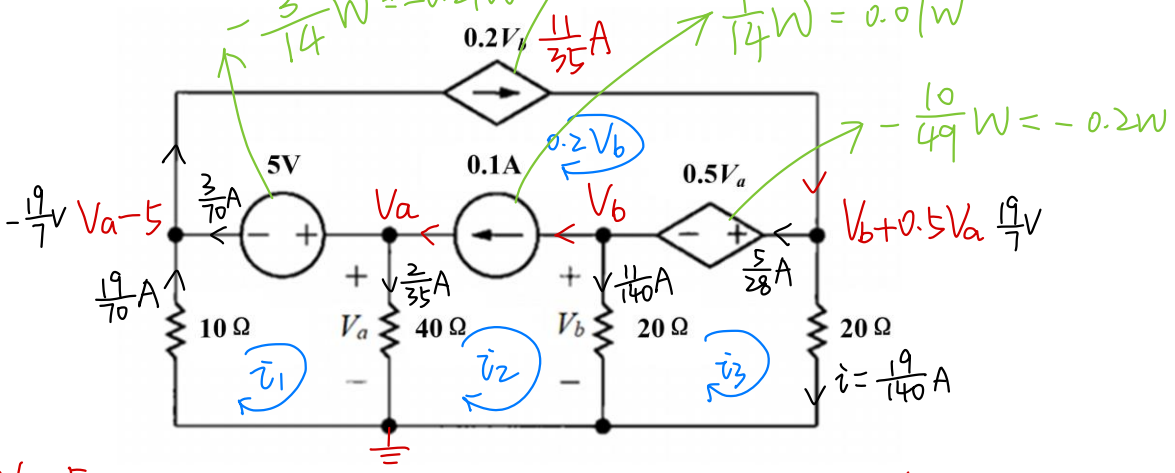
$$= 2 \times (-6) + 15 \times (-2)$$

$$= -42V$$

2'

15'

4. For the circuit below,
   (a) apply nodal analysis method to find V_a, V_b.
   (b) apply mesh analysis method to find V_a, V_b.
   (c) find the power delivered by each source (2 current sources and 2 voltage sources).



5' (a)

$$\begin{cases} \frac{V_a-5}{10} + 0.2V_b + \frac{V_a}{40} = 0.1 \\ 0.1 + \frac{V_b}{20} + \frac{V_b+0.5V_a}{20} = 0.2V_b \end{cases}$$

$$\begin{cases} V_a = \frac{16}{7}V = 2.28V \\ V_b = \frac{11}{7}V = 1.57V \end{cases}$$

5' (b)

$$\begin{cases} 10i_1 + 40(i_1 - i_2) = 5 \\ 40(i_2 - i_1) + 20(i_2 - i_3) = V_b - V_a \\ 20(i_3 - i_2) + 20i_3 + 0.5V_a = 0 \\ 0.2V_b - i_2 = 0.1 \\ V_b = 20(i_2 - i_3) \end{cases}$$

$$\begin{cases} V_a = \frac{16}{7}V \\ V_b = \frac{11}{7}V \end{cases}$$

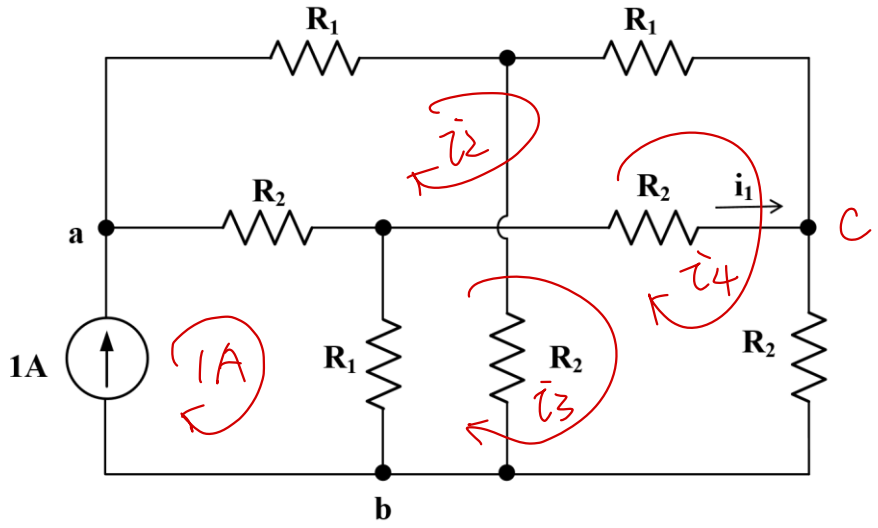
5' (c)

(10')

5. For the circuit below, $\mathbf{R_1} = 1\Omega$, $\mathbf{R_2} = 2\Omega$,

(a) Apply nodal or mesh analysis method to find $\mathbf{i_1}$

(b) If disconnect the current source from the circuit, try to find the equivalent resistance of **the pure resistor network** between node **a** and **b**.



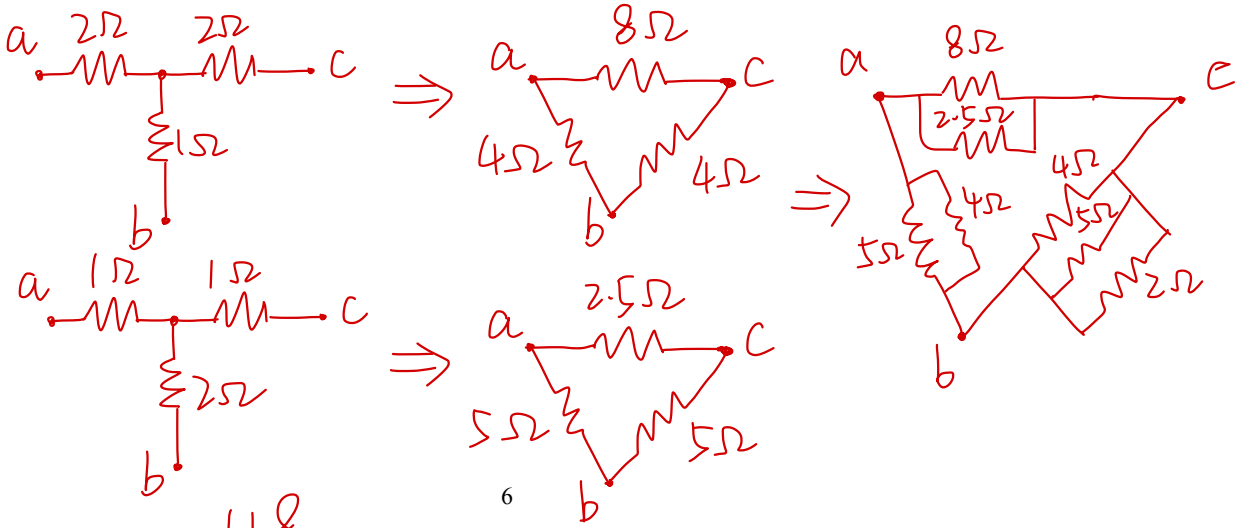
(a) (6')

$$\begin{cases} 2i_2 + i_4 + 2(i_2 - i_3) + 2(i_2 - 1) = 0 \\ i_2 + i_4 + 2(i_3 + i_4) + 2i_4 = 0 \\ i_3 - 1 + 2(i_3 - i_2) + 2(i_3 + i_4) = 0 \end{cases}$$

$$i_2 = \frac{18}{31}\,A \qquad i_3 = \frac{53}{93}\,A \qquad i_4 = -\frac{32}{93}\,A$$

(1') $i_1 = i_3 - i_2 = -\frac{1}{93}\,A \approx -0.01075\,A$

(b)



(3') $R_{eq} = \frac{118}{93} \approx 1.2688\,\Omega$