NAME:

Homework 1
-
DC Circuits

Deadline: Tuesday, 8 Mar. 2022, 11:00 AM

You can send your solutions through NYU Brightspace. **No extended deadline!**

Exercise 1 - Simple questions

Tick the **valid statements**:

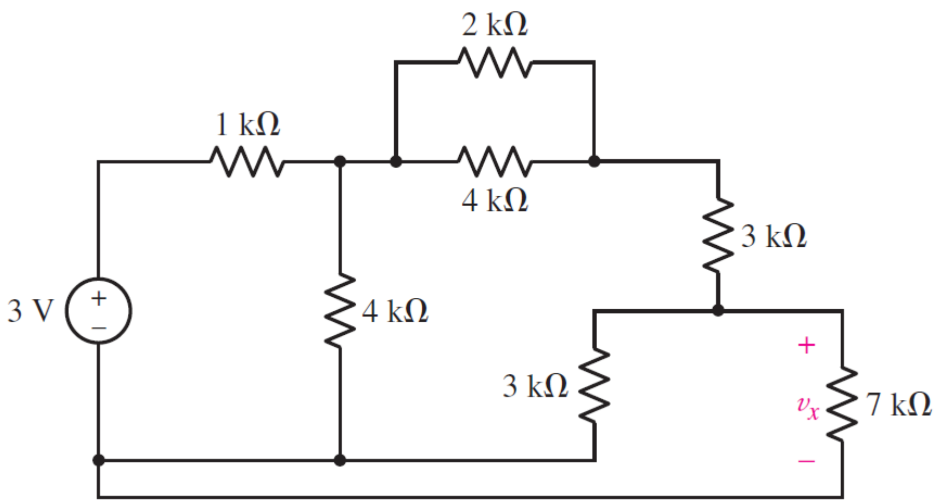
- ☐ Current sources can be connected in series
- ☐ A circuit with a single mesh should be analyzed with KCL
- ☑ If passive sign convention is not satisfied, Ohm's law is $v = -R \cdot i$
- ☑ The power absorbed by a element is expressed by $p = \pm v \cdot i$
- ☐ The power absorbed by a resistor is expressed by $p = \pm R \cdot i^2$
- ☑ Nodal analysis can be applied to non planar circuits
- ☐ For nodal analysis, supernode should be used when a branch has a single current source
- ☑ An ideal voltage source can provide any amount of current
- ☐ A current source and a voltage source can be connected in parallel
- ☐ A current source and a voltage source can be connected in series

$P = V \cdot i = iR \cdot i = i^2R$

$P = -Vi = -(-iR) \cdot R$

$= i^2R$

Exercise 2 - Voltage division



Simplify the circuit using appropriate resistor combinations and iteratively employ voltage division to determine v_x.

$V_x = V_{R_2} \cdot \frac{3k\Omega // 7k\Omega}{R_1} = 0.7V$

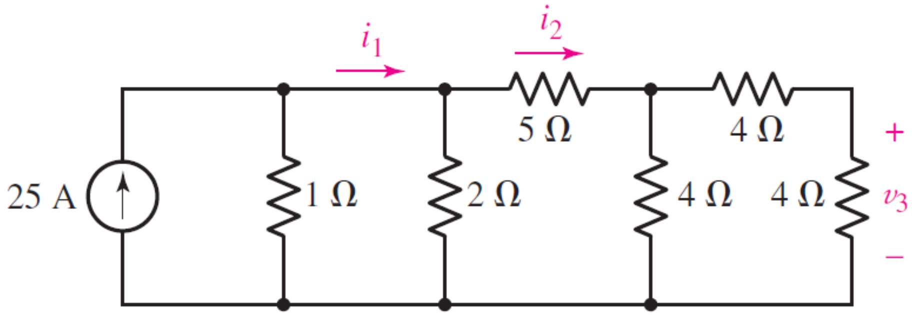
$\frac{2 \times 4}{2+4} = \frac{8}{6} = \frac{4}{3}\ \Omega$

$R_1 \quad 2k // 4k + 3k + 3k\Omega // 7k\Omega$

$R_2 = R_1 // 4\ k\Omega$

$V_{R_2} = 3V \times \frac{R_2}{R_2 + 1k\Omega} = V_{R_1}$

Exercise 3 - Current division



Employing resistance combination and current division as appropriate, dtermine values for i_1, i_2, and v_3 in the circuit.

$R_1 = 4\Omega \parallel (4\Omega + 4\Omega)$

$R_2 = 2\Omega \parallel (R_1 + 5\Omega)$

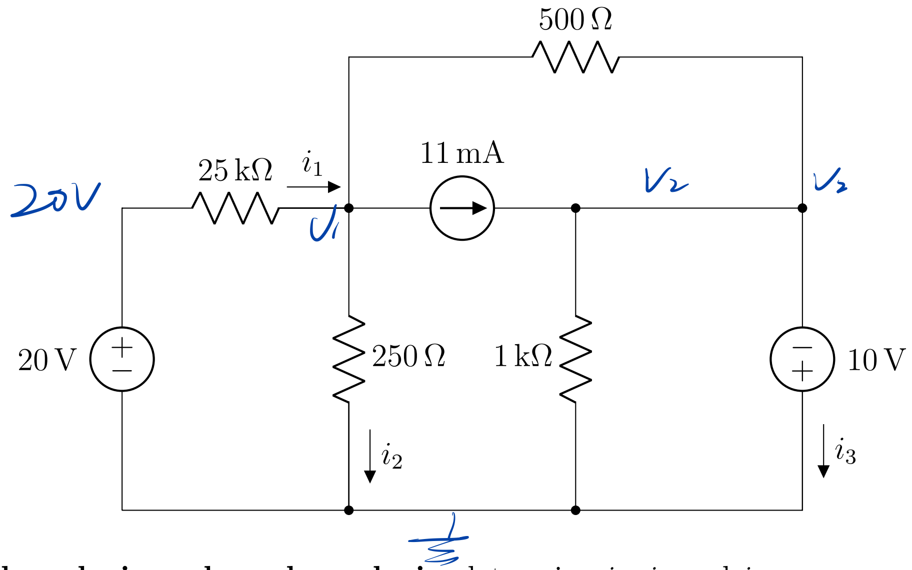
$i_1 = 25A \cdot \frac{1\Omega}{R_2} = 9.05\,A$

$i_2 = i_1 \times \frac{2\Omega}{2\Omega + R_1 + 5\Omega} = 2A$

$V_3 = i_2 \times \frac{4\Omega}{8\Omega + 4\Omega} \cdot 4\Omega$

$= 2.67A$

Exercise 4 - Nodal analysis and Mesh analysis



By using **nodal analysis and mesh analysis**, determine i_1, i_2 and i_3.

Pick Up a Reference Node.

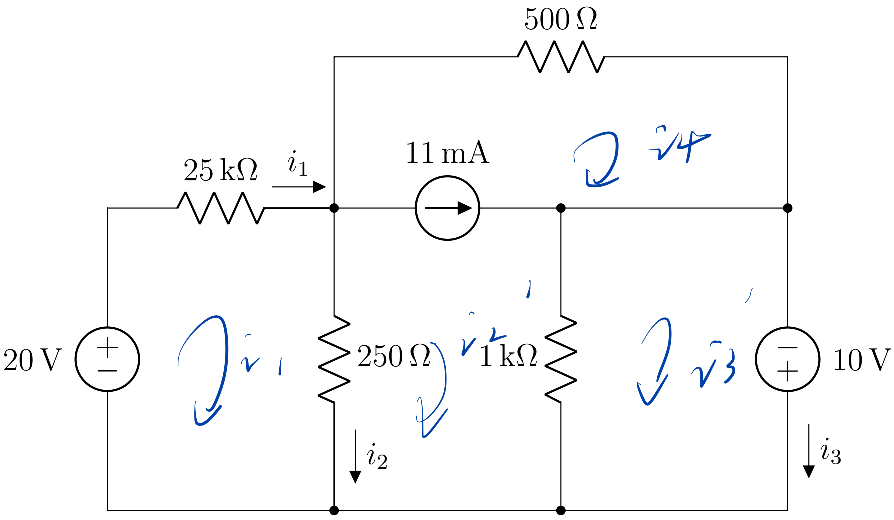
$$\begin{cases} V_2 = -10\,V \\ \dfrac{20V - V_1}{25k\Omega} = 11\,mA + \dfrac{V_1}{250\,\Omega} + \dfrac{V_1 - V_2}{500\,\Omega} \end{cases}$$

$V_1 = -5\,V \quad V_2 = -10\,V$

$$i_1 = \frac{20V - V_1}{25k\Omega} = 1mA. \qquad i_2 = \frac{V_1}{250\,\Omega} = -20\,mA$$

$$i_3 = \frac{-V_2}{1k\Omega} + 11mA + \frac{V_1 - V_2}{500\,\Omega} =$$

Exercise 5 - Node analysis and Mesh analysis



By using **nodal analysis and mesh analysis**, determine i_1, i_2 and i_3.

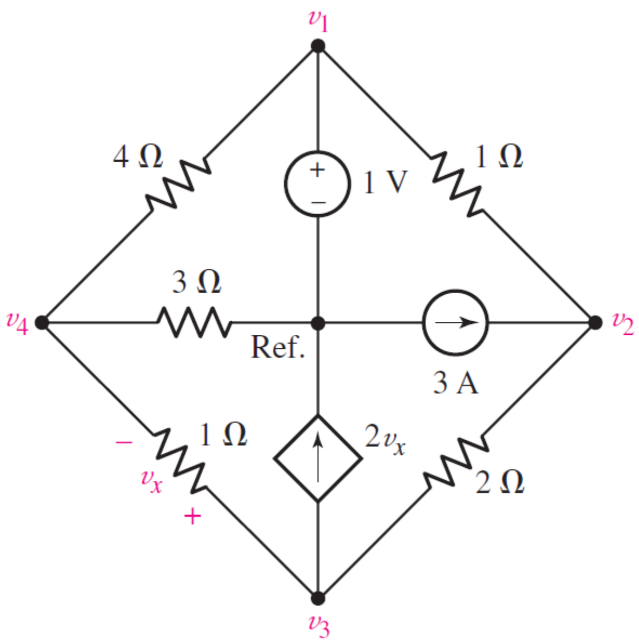
$$\begin{cases} -20V + 25k\Omega \cdot i_1 + (i_1 - i_2')250\Omega = 0 \\ 500\Omega \cdot i_4 + (i_2' - i_3)k\Omega + (i_2' - i_1)\cdot 250\Omega = 0 \\ -10V + k\Omega\,(i_3 - i_2') = 0 \end{cases}$$

$$11mA = i_2' - i_4$$

$$\Rightarrow \begin{cases} i_1 = 1\ mA \\ i_2' = 21\ mA \\ i_3 = 31\ mA \\ i_4 = 10\ mA. \end{cases}$$

$$i_2 = \begin{cases} i_1 - i_2' = -20\ mA \end{cases}$$

Exercise 6 - Supernode



Determine all four nodal valtages.

$$V_1 = 1V$$

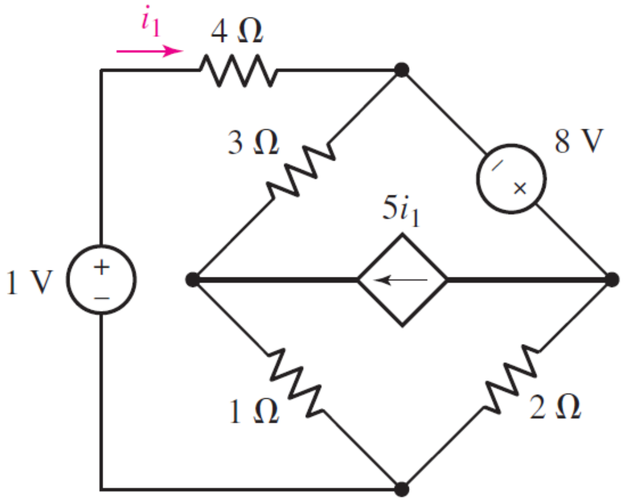
$$3A = \frac{V_2 - V_1}{1\Omega} + \frac{V_2 - V_3}{2\Omega}$$

$$2V_x = \frac{V_2 - V_3}{2\Omega} + \frac{V_4 - V_3}{1\Omega}$$

$$\frac{V_4 - V_1}{4\Omega} + \frac{V_4}{3\Omega} + \frac{V_4 - V_3}{1\Omega} = 0$$

$$V_x = V_3 - V_4$$

Exercise 7 - Supermesh



Determine the power supplied by the 1 V source.

It should be a negative ~~number~~

Cuz its supplying power.

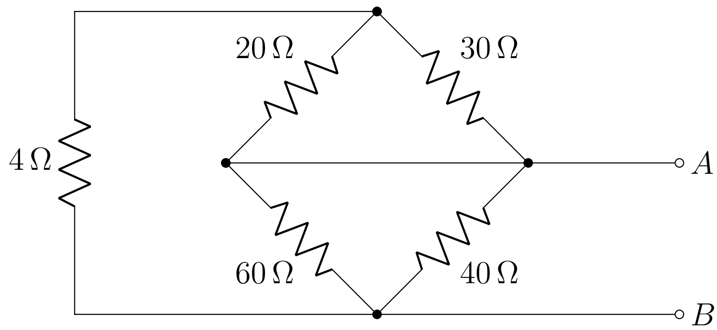
$-1V + 4\Omega \cdot i_1 + 3\Omega(i_1 - i_2) + 1\Omega(i_1 - i_3)$

$-8V + 2\Omega \cdot i + 1\Omega(i_3 - i_1) + 3\Omega(i_2 - i_1) = 0$

$i_2 - i_3 = 5i_1$

$i_1 = 19A$

Exercise 8 - Equivalent resistance 1



Determine the **equivalent resistance** between the terminals A and B.

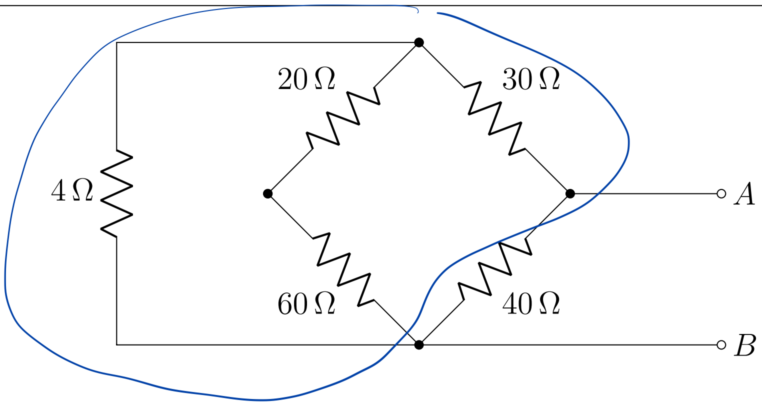
Thevenin Equivalence.
Add a source.

$20\,\Omega \,//\, 30\,\Omega + 4\,\Omega = 16\,\Omega$

$R_{ab} = R_1 \,//\, 60\,\Omega \,//\, 40\,\Omega = \dfrac{1}{\frac{1}{R_1} + \frac{1}{60\,\Omega} + \frac{1}{40\,\Omega}}$

$= 9.6\,\Omega$

Exercise 9 - Equivalent resistance 2



Determine the **equivalent resistance** between the terminals A and B.