

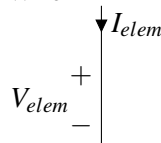
# EECS 16A      Designing Information Devices and Systems I

## Fall 2022      Discussion 4A

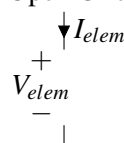
### 1. Circuit Components and Ohm's Law

(a) We will look at the  $I - V$  characteristics of different circuit components. For each of the components listed below, plot the  $I_{elem} - V_{elem}$  characteristic curves.

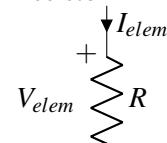
i. Wire



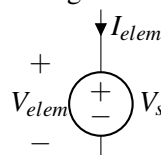
ii. Open Circuit



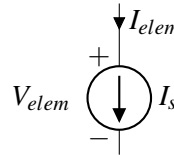
iii. Resistor



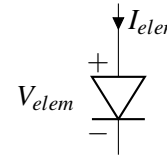
iv. Voltage Source



v. Current Source

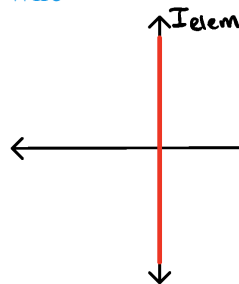


vi. Diode

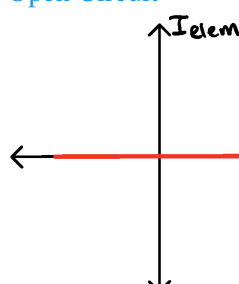


**Answer:**

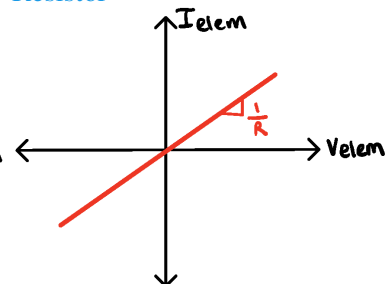
i. Wire



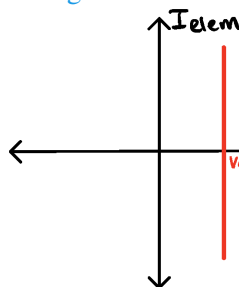
ii. Open Circuit



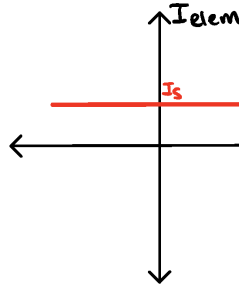
iii. Resistor



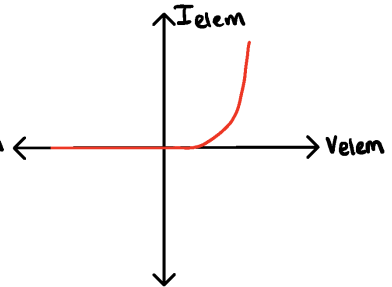
iv. Voltage Source



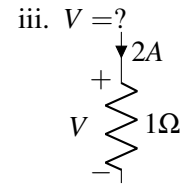
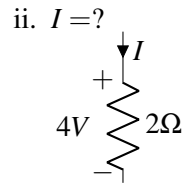
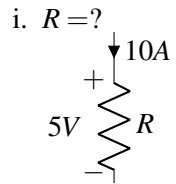
v. Current Source



vi. Diode



(b) Use Ohm's Law to find the missing component values in the circuits below.



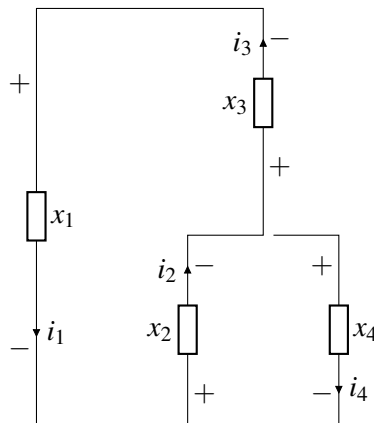
**Answer:**

i.  $R = \frac{5V}{10A} = 0.5\Omega$

ii.  $I = \frac{4V}{2\Omega} = 2A$

iii.  $V = 2A \times 1\Omega = 2V$

## 2. Label the Nodes

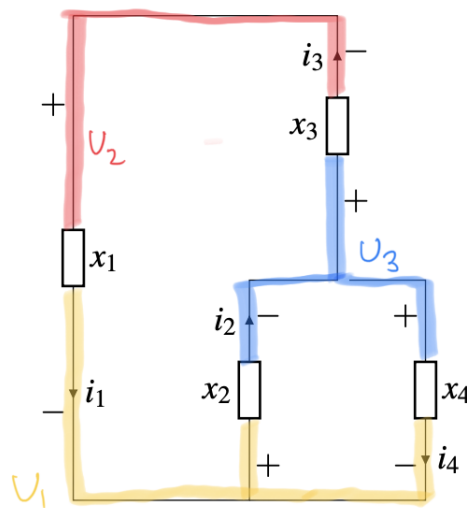


- (a) In the circuit shown above, identify and label all the nodes.

**Answer:**

Here are the nodes marked with different colors on the circuit diagram.

There are three nodes. We've labeled them as  $u_1$ ,  $u_2$ , and  $u_3$ , but you can label them with any variables you want.



- (b) Choose a node to be the reference node and find all the potentials across elements in the circuit in terms of the node potentials you labeled in the previous part

**Answer:** You can choose any node to be the reference node, but we will use  $u_1$  in the diagram as ours in the example solution, so  $u_1 = 0$ . To find the voltage potential across an element, we subtract the node potential on the positive side of element by the node potential on the negative side of the element. Therefore, we get the following 4 equations:

$$V_{x_1} = u_2 - 0 = u_2$$

$$V_{x_2} = 0 - u_3 = -u_3$$

$$V_{x3} = u_3 - u_2$$

$$V_{x4} = u_3 - 0 = u_3$$

(c) Write as many KCL equations as you can for the circuit.

**Answer:** There are 3 possible KCL equations, one for each node. To find each equation, for each node, add the current if it is going out of the node and subtract if it is going into the node. Adding all the currents this way will sum up to 0.

$$-i_1 + i_2 - i_4 = 0$$

$$-i_2 + i_3 + i_4 = 0$$

$$i_1 - i_3 = 0$$

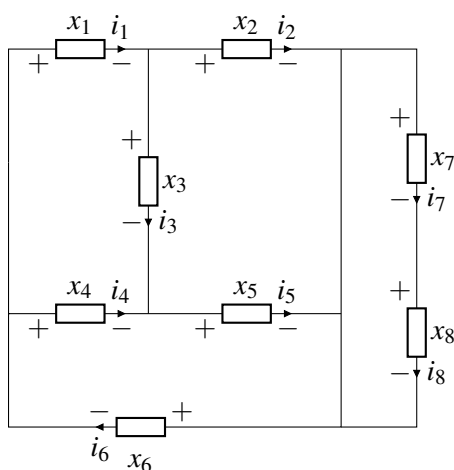
(d) Write as many KVL equations as you can for the circuit.

**Answer:** There are 3 possible KVL equations in the circuit. We will go in a counterclockwise loop, but going the other direction will also give you the same relations.

$$V_{x1} + V_{x3} + V_{x2} = 0$$

$$V_{x1} + V_{x3} - V_{x4} = 0$$

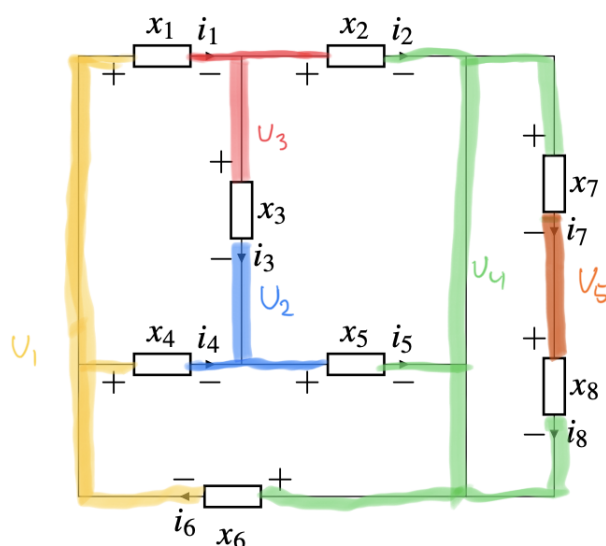
$$-V_{x2} - V_{x4} = 0$$



(e) In the circuit shown above, identify and label all the nodes.

**Answer:** Here are the nodes marked with different colors on the circuit diagram.

There are five nodes. We've labeled them as  $u_1$ ,  $u_2$ ,  $u_3$ ,  $u_4$  and  $u_5$ , but you can label them with any variables you want.



(f) Choose a node to be the reference node. What is the potential across the elements  $x_6$  and  $x_7$  in terms of node potentials you labeled in the previous part?

**Answer:** Once again, you can choose any node to be the reference node. We will choose  $u_1$  again in our diagram. To find the voltage potential across an element, we subtract from the node potential on the positive side of element by the node potential on the negative side of the element.

For  $x_6$ , we have  $V_{x_6} = u_4 - 0 = u_4$

For  $x_7$ , we have  $V_{x_7} = u_4 - u_5$

- (g) Write a KCL equation involving  $i_1$  and a KCL equation involving  $i_5$ .

**Answer:** There are 2 possible KCL equations for each current.

For  $i_1$ , we have:

$$i_1 + i_4 - i_6 = 0$$

$$-i_1 + i_2 + i_3 = 0$$

For  $i_5$ , we have:

$$-i_3 - i_4 + i_5 = 0$$

$$-i_2 - i_5 + i_6 + i_7 - i_8 = 0$$

- (h) Write a KVL equation involving  $V_{x_3}$  and a KVL equation involving  $V_{x_6}$ .

**Answer:** There are many possible KVL equations for each. As long as you follow a loop in the same direction, you will get a valid equation.

One possible KVL equation for  $V_{x_3}$  is

$$V_{x_3} - V_{x_2} + V_{x_5} = 0$$

One possible KVL equation for  $V_{x_6}$  is

$$-V_{x_6} - V_{x_5} - V_{x_4} = 0$$