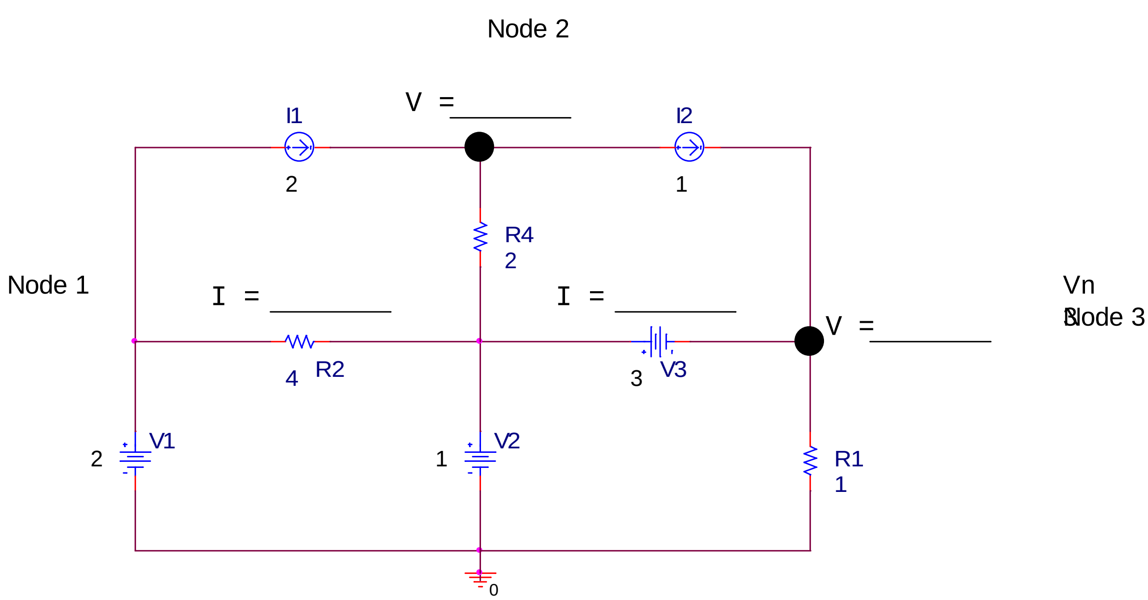
Questions:
What do I need to know about this class?
What is voltage? What is a voltage difference/voltage drop?
What is current?
What is polarity?
How do we define power?
What is a circuit model?
What is a ground?
What is the IV characteristic of an open circuit? a short circuit? an ideal voltage source? an ideal current source? a resistor? a diode?
What is Ohm's Law?
What is a node in a circuit?
What is a closed loop in a circuit?
How do we apply Kirchhoff's Voltage Law (KVL)? Kirchhoff's Current Law (KCL)?



$R_{1a} := 1\Omega$

$R_{2a} := 4\Omega$

$R_{4a} := 2\Omega$

$I_{1a} := 2A$

$I_{2a} := 1A$

$V_{1a} := 2V$

$V_{2a} := 1V$

$V_{3a} := 3V$

Finding I (left)

Current goes to the right

$V_{R2a} := V_{1a} - V_{2a}$

$V_{R2a} = 1\,V$

$I_{R2} := \dfrac{V_{R2a}}{R_{2a}} = 250 \cdot mA$

Find V (right) (KVL clockwise loop)

$-V_{2a} + V_{3a} + V_{n3} = 0$

$V_{n3} := V_{2a} - V_{3a}$

$V_{n3} = -2\,V$

Finding I (right) (KCL)

Node 3

$$\frac{-V_{n3}}{R_{1a}} - I_{n3} + I_{2a} = 0$$

$$I_{n3} := -\left(-I_{2a} + \frac{V_{n3}}{R_{1a}}\right)$$

$$I_{n3} = 3\,\text{A}$$

Finding V (top) KCL

$$I_1 - I_2 - I_{n2} = 0$$

$$I_{n2} := -\left(-I_{1a} + I_{2a}\right)$$

$$I_{n2} = 1\,\text{A}$$

$$I_{n2} \cdot R_{4a} + V_{2a} = 3\,\text{V}$$

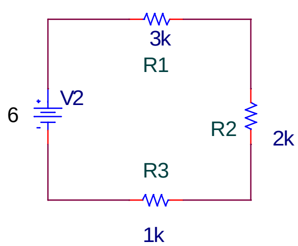
b)

Assign polarities to each resistor and apply KCL or KVL to obtain three independent expression for the voltage across each resistor

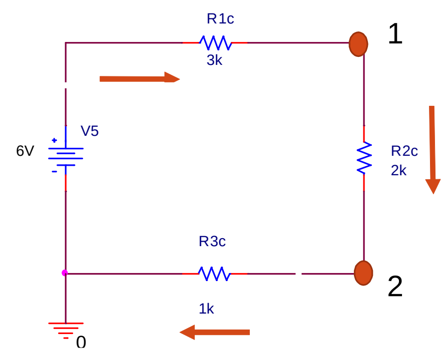
VR1 = VR2 = VR3 = 6V

c)

Node 1



Node 2



Ask about polarity

Assign polarities to each resistor and apply KCL or KVL to obtain three independent expressions for the voltage across each resistor

$$R_{1c} := 3\text{k}\Omega$$

$$R_{2c} := 2\text{k}\Omega$$

$$R_{3c} := 1\text{k}\Omega$$

Do KVL

$$-6 + V_{R1c} + V_{R2c} + V_{R3c} = 0$$

Then do KCL at nodes

Node 1

$$i_{1c} - i_{2c} = 0$$

substitute ohms law

$$\frac{V_{R1c}}{R_{1c}} - \frac{V_{R2c}}{R_{2c}} = 0$$

Node 2

$$i_{2c} - i_{3c} = 0$$

$$\frac{V_{R2c}}{R_{2c}} - \frac{V_{R3c}}{R_{3c}} = 0$$

solve for VR1c and VR3c (get in terms of VR2c

$$V_{R1c} = \frac{V_{R2c}}{R_{2c}} \cdot R_{1c}$$

$$V_{R3c} = \frac{R_{3c} \cdot V_{R2c}}{R_{2c}}$$

Put in KVL equation

$$-6 + \frac{R_{1c} \cdot V_{R2}}{R_{2c}} + \frac{R_{3c} \cdot V_{R2}}{R_{2c}} + V_{R2} = 0$$

$$\frac{6 \cdot R_{2c}}{R_{1c} + R_{2c} + R_{3c}} = 2 \qquad V_{R2c} := 2$$

Do the matrix!

$$V_{R1c} + V_{R2c} + V_{R3c} = 6$$

$$\frac{1}{R_{1c}} \cdot V_{R1c} - \frac{1}{R_{2c}} \cdot V_{R2c} + 0 = 0$$

$$0 + \frac{1}{R_{2c}} \cdot V_{R2c} - \frac{1}{R_{3c}} \cdot V_{R3c} = 0$$

$$M_1 := \begin{pmatrix} 1 & 1 & 1 \\ \frac{1}{3 \cdot 10^3} & \frac{-1}{2 \cdot 10^3} & 0 \\ 0 & \frac{1}{2 \cdot 10^3} & \frac{-1}{1 \cdot 10^3} \end{pmatrix}$$

$$C_1 := \begin{pmatrix} 6 \\ 0 \\ 0 \end{pmatrix}$$

$$X_1 := M_1^{-1} \cdot C_1$$

$$X_1 = \begin{pmatrix} 3 \\ 2 \\ 1 \end{pmatrix}$$

$$V_{R1c} = 3$$
$$V_{R2c} = 2$$
$$V_{R3c} = 1$$

To find VR3

$$V_{R3c} := \frac{R_{3c}}{R_{2c}} \cdot V_{R2c}$$

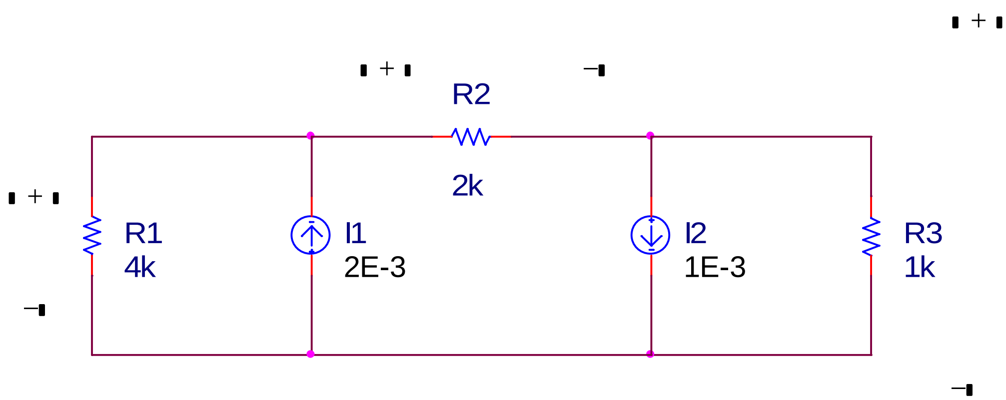
$$V_{R3c} = 1$$

To find VR1

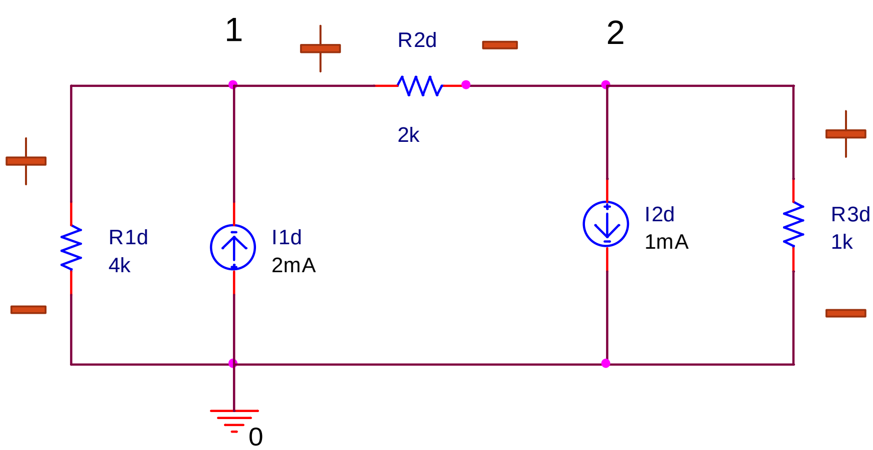
$$V_{R1c} := \frac{R_{1c} \cdot V_{R2c}}{R_{2c}}$$

$$V_{R1c} = 3$$

d)



Assign polarities to each resistor and apply KCL and/or KVL to obtain three independent expression for the voltage across each resistor



$R_{1d} := 4k\Omega \quad R_{2d} := 2k\Omega \quad R_{3d} := 1k\Omega \quad I_{1d} := 2mA$

$I_{2d} := 1mA$

At node 1

(1) $-I_{R1d} + I_{1d} - I_{R2d} = 0$ or $-\frac{V_{R1d}}{R_{1d}} + I_{1d} - \frac{V_{R1d} - V_{R3d}}{R_{2d}} = 0$

AT node 2

(2) $I_{R2d} - I_{2d} - I_{R3d} = 0$ or $\frac{V_{R1d} - V_{R3d}}{R_{2d}} - I_{2d} - \frac{V_{R3d}}{R_{3d}} = 0$

Solve first equation for VR1d

$$V_{R1d} = \frac{R_{1d} \cdot V_{R3d} + I_{1d} \cdot R_{1d} \cdot R_{2d}}{R_{1d} + R_{2d}}$$

Put in (2) equation

$$\frac{-V_{R3d} + \frac{R_{1d} \cdot V_{R3d} + I_{1d} \cdot R_{1d} \cdot R_{2d}}{R_{1d} + R_{2d}}}{R_{2d}} - I_{2d} - \frac{V_{R3d}}{R_{3d}} = 0$$

Solve for VR3

$$-\frac{I_{2d} \cdot R_{1d} \cdot R_{3d} - I_{1d} \cdot R_{1d} \cdot R_{3d} + I_{2d} \cdot R_{2d} \cdot R_{3d}}{R_{1d} + R_{2d} + R_{3d}} = 285.714 \cdot mV$$

$V_{R3d} := 285.7mV$

Put VR3d in equation (3)

$$V_{R1d} := \frac{R_{1d} \cdot V_{R3d} + I_{1d} \cdot R_{1d} \cdot R_{2d}}{R_{1d} + R_{2d}}$$

$V_{R1d} = 2.857\,V$

To find the voltage across R2d you subtract the node 1 from node 2 voltages.

$V_{R1d} - V_{R3d} = 2.571\,V$

Also need loop to solve matrix equation!

(3) $-V_{R1d} + V_{R2d} + V_{R3d} = 0$

So put all equations together

$$-V_{R1d} + V_{R2d} + V_{R3d} = 0$$

$$-\left(\frac{1}{R_{1d}} + \frac{1}{R_{2d}}\right) \cdot V_{R1d} + 0 + \frac{1}{R_{2d}} \cdot V_{R3d} = -2$$

$$\frac{1}{R_{2d}} \cdot V_{R1d} + 0 - \left(\frac{1}{R_{2d}} + \frac{1}{R_{3d}}\right) \cdot V_{R3d} = 1$$

$$M_2 := \begin{bmatrix} -1 & 1 & 1 \\ -\left(\frac{1}{4 \cdot 10^3} + \frac{1}{2 \cdot 10^3}\right) & 0 & \frac{1}{2 \cdot 10^3} \\ \frac{1}{2 \cdot 10^3} & 0 & -\left(\frac{1}{2 \cdot 10^3} + \frac{1}{1 \cdot 10^3}\right) \end{bmatrix}$$

$$C_2 := \begin{pmatrix} 0 \\ -2 \cdot 10^{-3} \\ 1 \cdot 10^{-3} \end{pmatrix}$$

$$X_2 := M_2^{-1} \cdot C_2 \qquad X_2 = \begin{pmatrix} 2.857 \\ 2.571 \\ 0.286 \end{pmatrix}$$