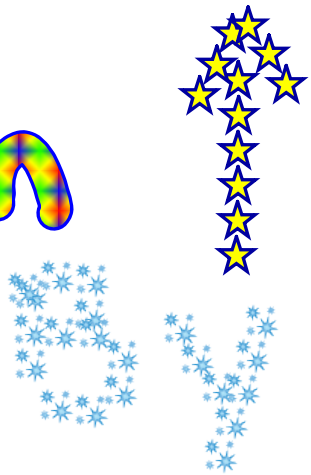
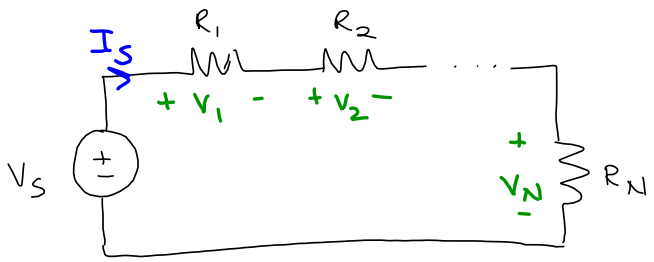
Quiz 1 Thur.

Solutions on Canvas



Hint: $I_S = 1.889$ A

Voltage Division



$$I_S = \frac{V_S}{R_1 + R_2 + \dots + R_N}$$

$$V_1 = I_S R_1$$

$$V_2 = I_S R_2$$

$$\vdots$$

$$V_N = I_S R_N$$

$$V_1 = \left(\frac{V_S}{R_1 + R_2 + \dots + R_N} \right) R_1$$

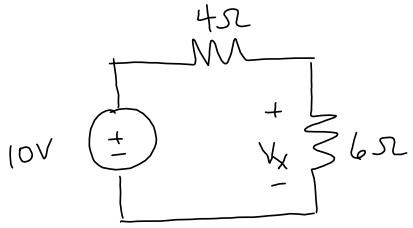
$$V_1 = V_S \left(\frac{R_1}{Req} \right)$$

$$V_2 = V_S \left(\frac{R_2}{Req} \right)$$

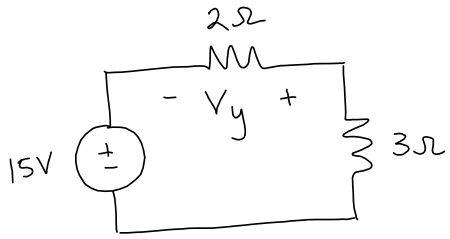
Let $Req = R_1 + R_2 + \dots + R_N$

$$V_i = V_S \left(\frac{R_i}{\Sigma R} \right)$$

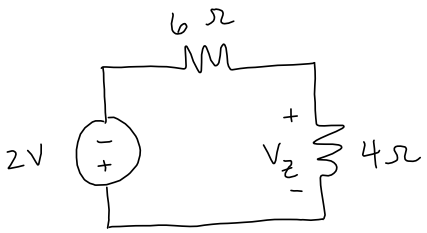
Voltage divider



$$V_x = 10\left(\frac{6}{4+6}\right) = 6\,V$$

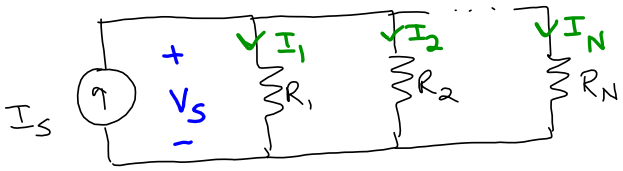


$$V_y = -(15)\left(\frac{2}{3+2}\right) = -6\,V$$



$$V_z = -(2)\left(\frac{4}{10}\right) = -0.8\,V$$

Current Division



$$V_S = I_S \left(\frac{1}{\left(\frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}\right)} \right)$$

$$R_1 \| R_2 \| \cdots \| R_N$$

$$\rightarrow V_S = I_S \left(R_1 \| R_2 \| \cdots \| R_N \right)$$

by Ohm's Law

$$I_1 = \frac{V_S}{R_1}$$

$$I_2 = \frac{V_S}{R_2}$$

$$I_N = \frac{V_N}{R_N}$$

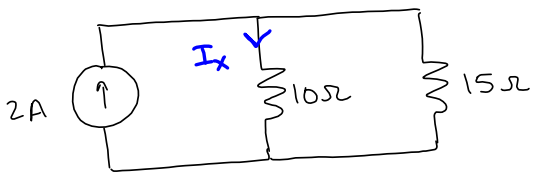
$$I_1 = \frac{I_S \left(R_1 \| R_2 \| \cdots \| R_N \right)}{R_1}$$

let $R_{eq} = (R_1 \| R_2 \| \cdots \| R_N)$

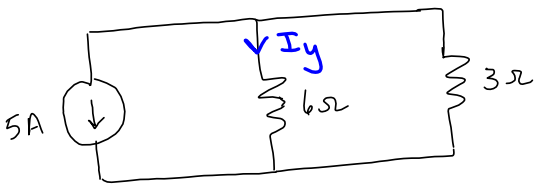
$$I_1 = I_S \left(\frac{R_{eq}}{R_1} \right)$$

$$I_2 = I_S \left(\frac{R_{eq}}{R_2} \right)$$

$$I_i = I_S \left(\frac{R_{eq}}{R_i} \right) \Rightarrow \text{current division}$$



$$I_x = 2 \left(\frac{10 \| 15}{10} \right) = 1.2\,A$$



$$I_y = -5 \left(\frac{6 \| 3}{6} \right) = -1.67\,A$$

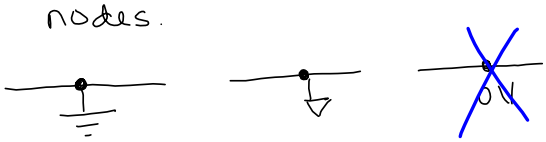
Nodal Analysis

- Streamlined version of KCL
- Write KCL in terms of node voltage variables

Steps

① Identify nodes w/ 3 or more connections

② Ground one of those nodes.



Call this node ≡ reference node

③ Assign a node voltage variable to the remaining nodes from ①

V_1, V_2 ...

V_A, V_B ...

④ Write KCL at each node from ③

Σ currents leaving node.

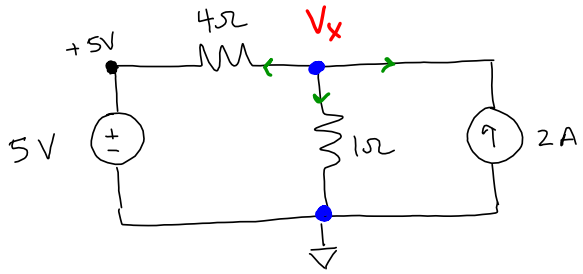
⑤ Solve

Hierachry of writing currents

① Current source

② Resistor $\frac{V}{R}$

③ Label a current variable / reference



KCL = Nodal equations

$$-(2) + \frac{V_x - 0}{1} + \frac{V_x - 5}{4} = 0$$

$$V_x\left(\frac{1}{1} + \frac{1}{4}\right) = 2 + \frac{5}{4}$$

$$V_x(1.25) = 3.25$$

$$\boxed{V_x = 2.6\,V}$$

Sources : $P = VI$

2A : $P = V_x(2) = 5.2\,W$, Del

5V : $P = 5\left(\frac{V_x - 5}{4}\right) = -3\,W$, Abs

or = $\boxed{+3\,W, \text{Del}}$

Resistors I^2R

1Ω : $P = \frac{V_x^2}{1} = 6.76\,W$, Abs

4Ω : $P = \frac{(V_x - 5)^2}{4} = 1.44\,W$ Abs

$\Sigma P_{del} = 8.2\,W$ $\Sigma P_{abs} = 8.2\,W$ ∴