Circuit Analysis

* Kirchhoff's Laws (KCL, KVL)
  Ohm's Law
* Equivalent Resistor

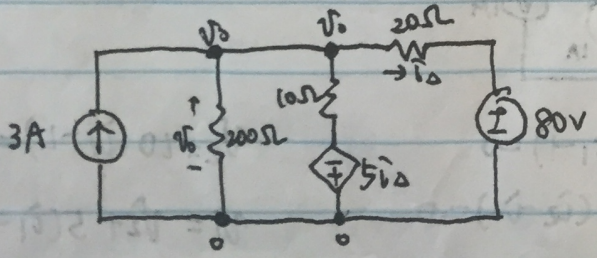
] basic tools

* Node Voltage Method
* Mesh Current Method

] more powerful methods

Node Voltage Method

- Find essential nodes
- Set reference node (ground)
- Node voltage : rise from ground
- State KCL at essential nodes
- A voltage source between 2 essential nodes
  ⇒ supernode



Find V_o and i_o

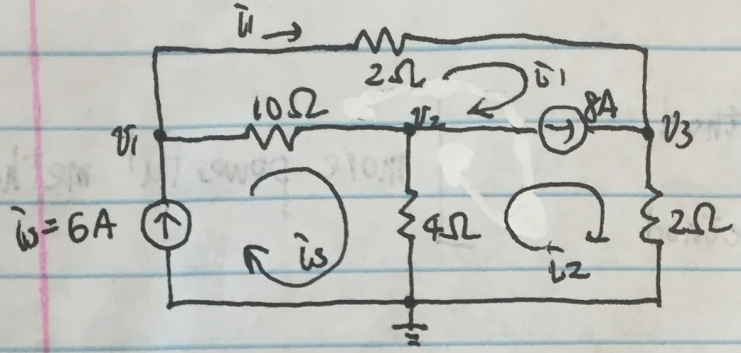
$$-3 + \frac{V_o}{200} + \frac{V_o - (-5i_o)}{10} + \frac{V_o - 80}{20} = 0 \quad \text{—①}$$

$$V_o = 80 + 20i_o \quad \text{—②}$$

$$\Rightarrow i_o = -1.5\,A,\ V_o = 50\,V$$

Mesh Current Method

- Find meshes
- State KVL at each mesh
- Supermesh (current source)



Find i_1.

Then find v_1, v_2, and v_3

Supermesh:

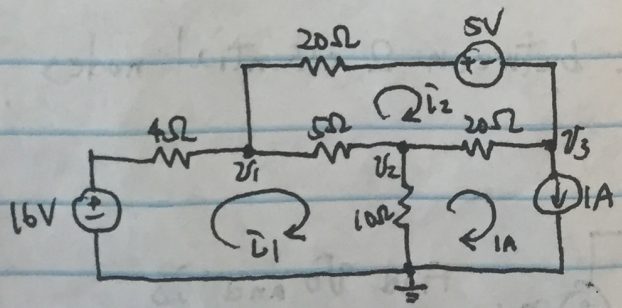
$$\left.\begin{aligned} &2i_1 + 2i_2 + 4(i_2-6) + 10(i_1-6) = 0 \\ &-i_1 - 8 + i_2 = 0 \Rightarrow i_2 = i_1 + 8 \end{aligned}\right\} \Rightarrow 18i_1 = 36 \Rightarrow i_1 = 2\,A$$

$$i_2 = 10\,A$$

$$v_2 = (6-10)\cdot 4 = -16\,V$$

$$v_3 = 10\cdot 2 = 20\,V$$

$$v_1 = v_2 + (6-2)\cdot 10 = 24\,V$$



Find i_1, i_2, v_1, v_2, and v_3

$$\begin{cases} -16 + 4i_1 + 5(i_1 - i_2) + 10(i_1 - 1) = 0 \\ 20i_2 + 5 + (i_2 - 1)\cdot 20 + 5(i_2 - i_1) = 0 \end{cases}$$

$$\Rightarrow \begin{cases} 19i_1 - 5i_2 = 26 \\ 5i_1 - 45i_2 = -45 \end{cases} \Rightarrow \begin{cases} i_1 = 1.5\,A \\ i_2 = 0.5\,A \end{cases}$$

$$v_2 = 10(i_1 - 1) = 5\,V$$

$$v_1 = v_2 + 5(i_1 - i_2) = 10\,V$$

$$v_3 = v_2 + 20(i_2 - 1) = 15\,V$$