Last Lecture → Nodal Analysis

- **N - nodes**
- **One node is selected as the reference node**
- ***KCL is applied to the remaining N-1 nodes***

Solution of the N-1 equations

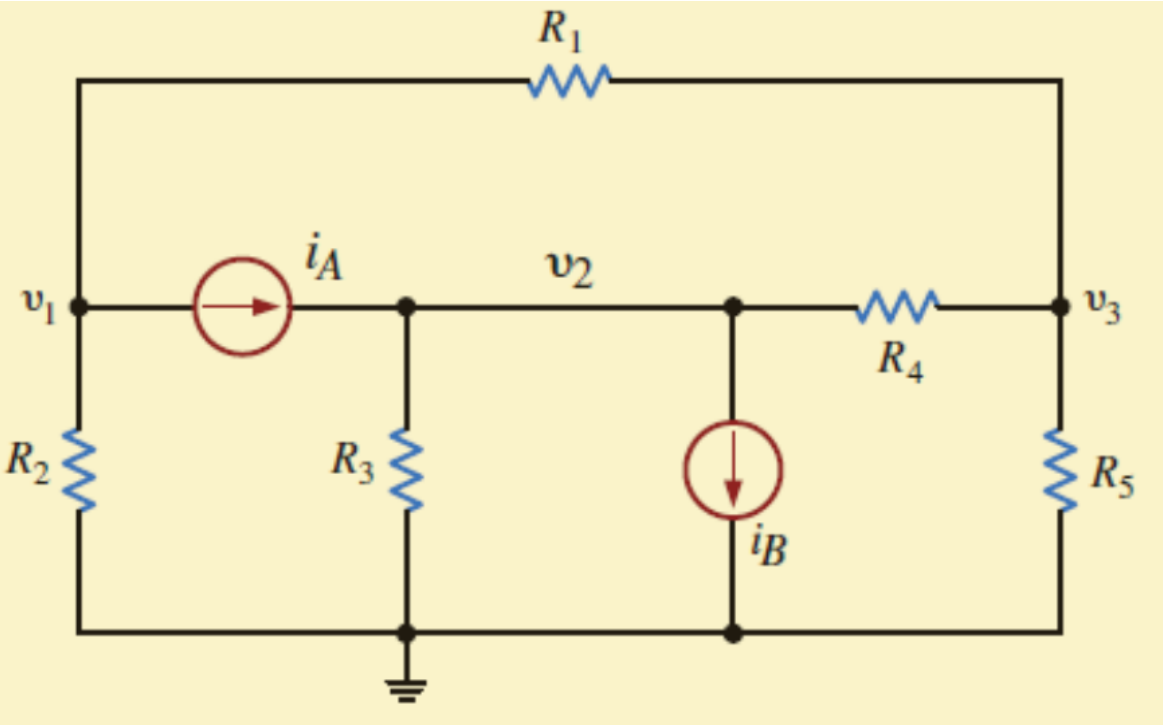
- ***N-1 unknown voltages***
- ***All currents in the circuit***

Analysis Procedure

1) **Identify #of nodes**
2) **Select reference node**
3) **Label other node voltages**
4) **Identify branch currents**
5) **Apply KCL to nodes**
6) **Matrix Format**

Last Lecture → Example 3.2

Write the equations in matrix form for the provided circuit. Assume R_1=R_2=2kΩ, R_3=R_4=4kΩ, R_5=1kΩ, i_A=4mA, and i_B=2mA.

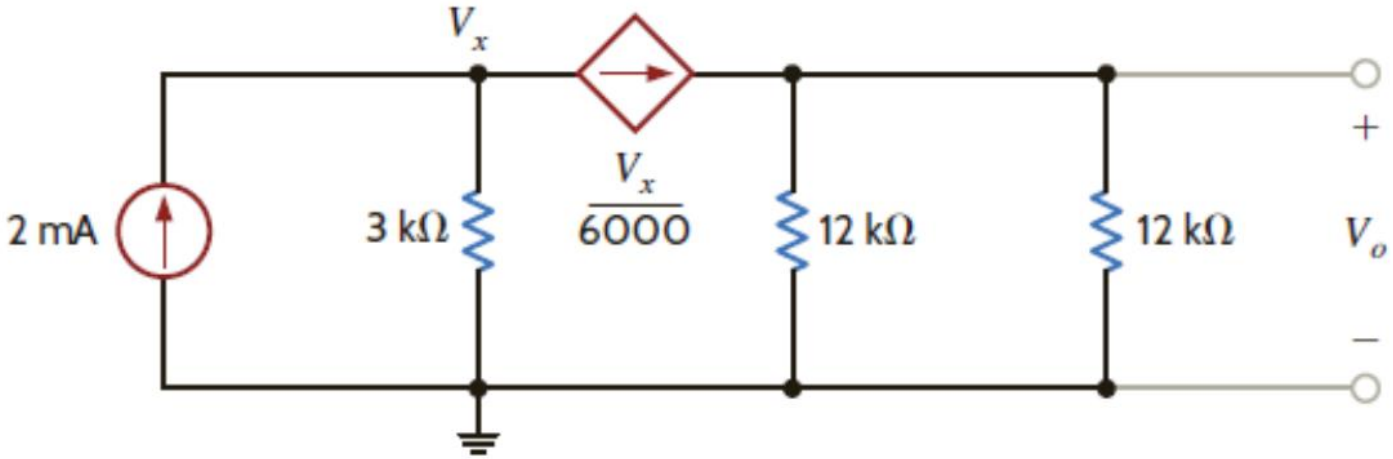


matrix eq.

$$\begin{bmatrix} I_A \\ I_A - I_B \\ 0 \end{bmatrix} = \begin{bmatrix} -\frac{1}{R_1 \| R_2} & 0 & \frac{1}{R_1} \\ 0 & \frac{1}{R_3 \| R_4} & -\frac{1}{R_4} \\ \frac{1}{R_2} & \frac{1}{R_4} & -\frac{1}{R_1 \| R_4 \| R_5} \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix}$$

Nodal Analysis → with Dependent Current Sources

E3.3: Find the voltage V_o in the network provided.



$$KCL\ @\ Vx \rightarrow 2m - \frac{V_x}{3k} - \frac{V_x}{6k} = 0$$

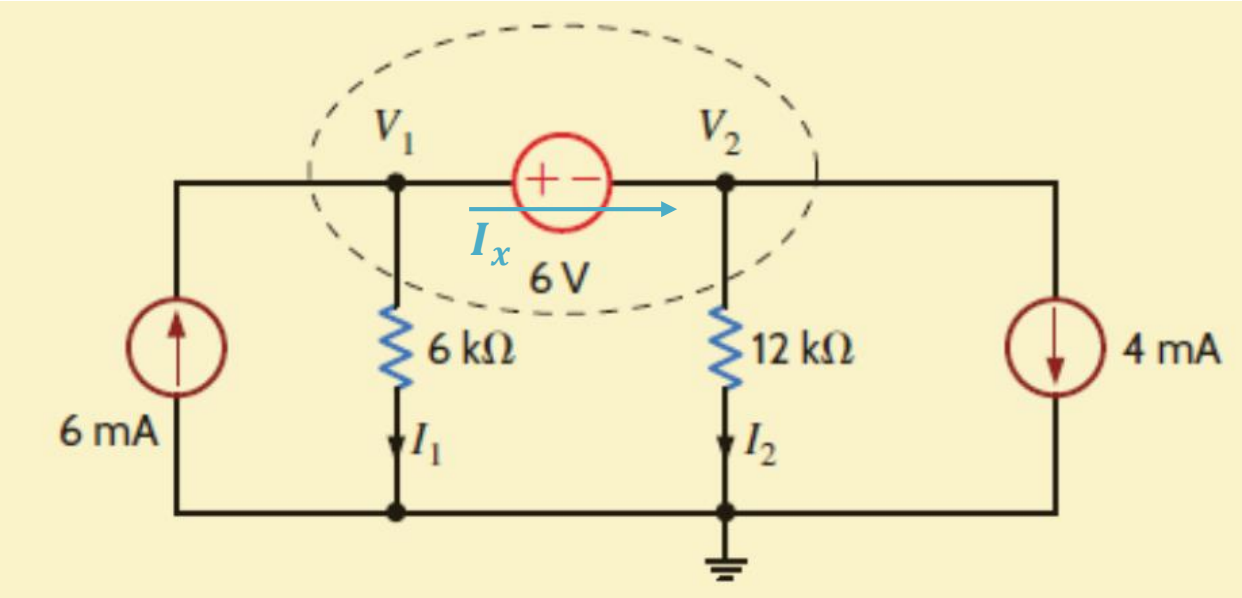
$$KCL\ @\ V_0 \rightarrow \frac{V_x}{6k} - \frac{V_0}{12k} - \frac{V_0}{12k} = 0$$

$$V_x = 4\ V$$

$$V_0 = V_x = 4\ V$$

Nodal Analysis → with Independent Voltage Sources

Supernode: KCL at the surface (dashed) around the voltage source.
Constraint equation: establishes the difference in potential between two nodes.



$$V_1 = 10\,V$$
$$V_2 = 4\,V$$

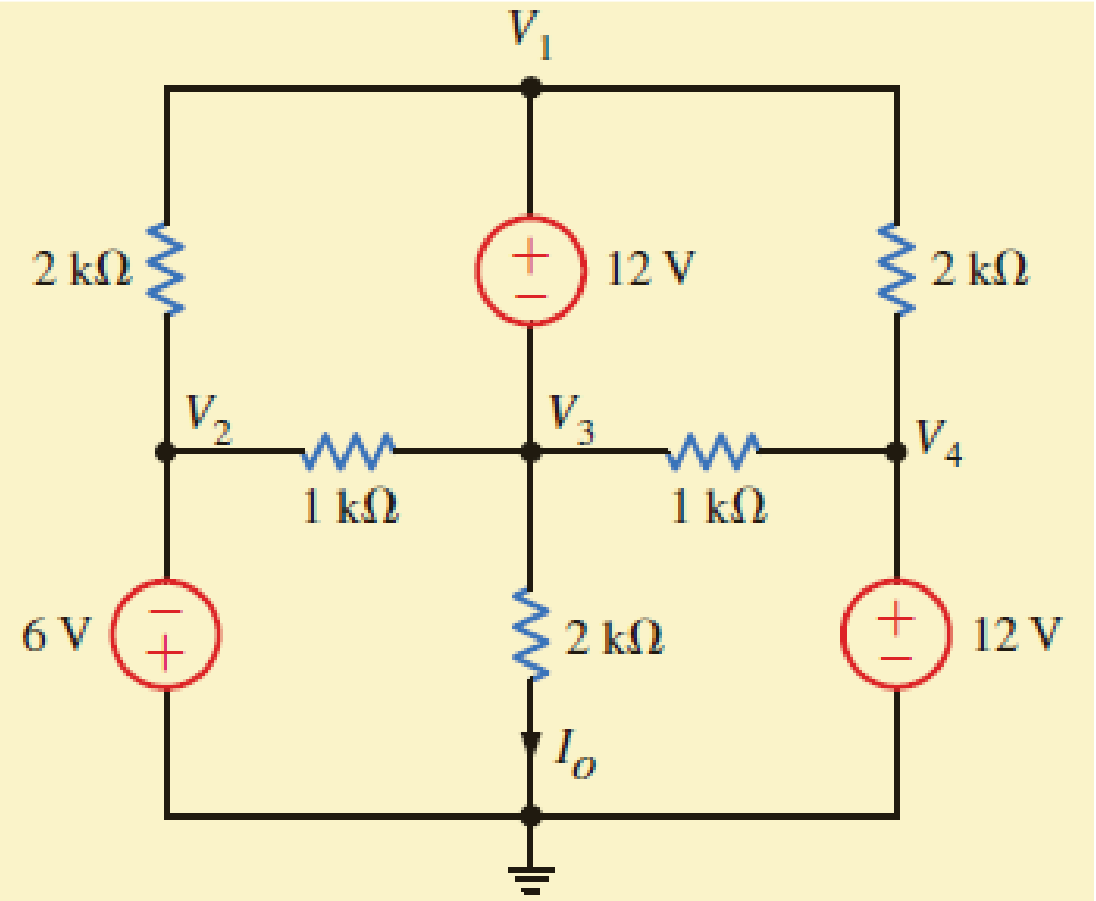
$$Constraint\ Eq. \rightarrow 6 = V_1 - V_2$$

$$KCL\ @\ V_1 \rightarrow 6m - \frac{V_1}{6k} - I_x = 0$$
$$KCL\ @\ V_2 \rightarrow I_x - \frac{V_2}{12k} - 4m = 0$$

$$KCL\ @\ Supernode \rightarrow 6m - \frac{V_1}{6k} - \frac{V_2}{12k} - 4m = 0$$

Nodal Analysis → with Independent Voltage Sources

Example 3.7: Determine the current I_0 in the provided network.



KCL @ supernode

$$\frac{-6-V_1}{2k}+\frac{-6-V_3}{1k}=\frac{V_1-12}{2k}+\frac{V_3-12}{1k}+\frac{V_3}{2k}$$

Constraint

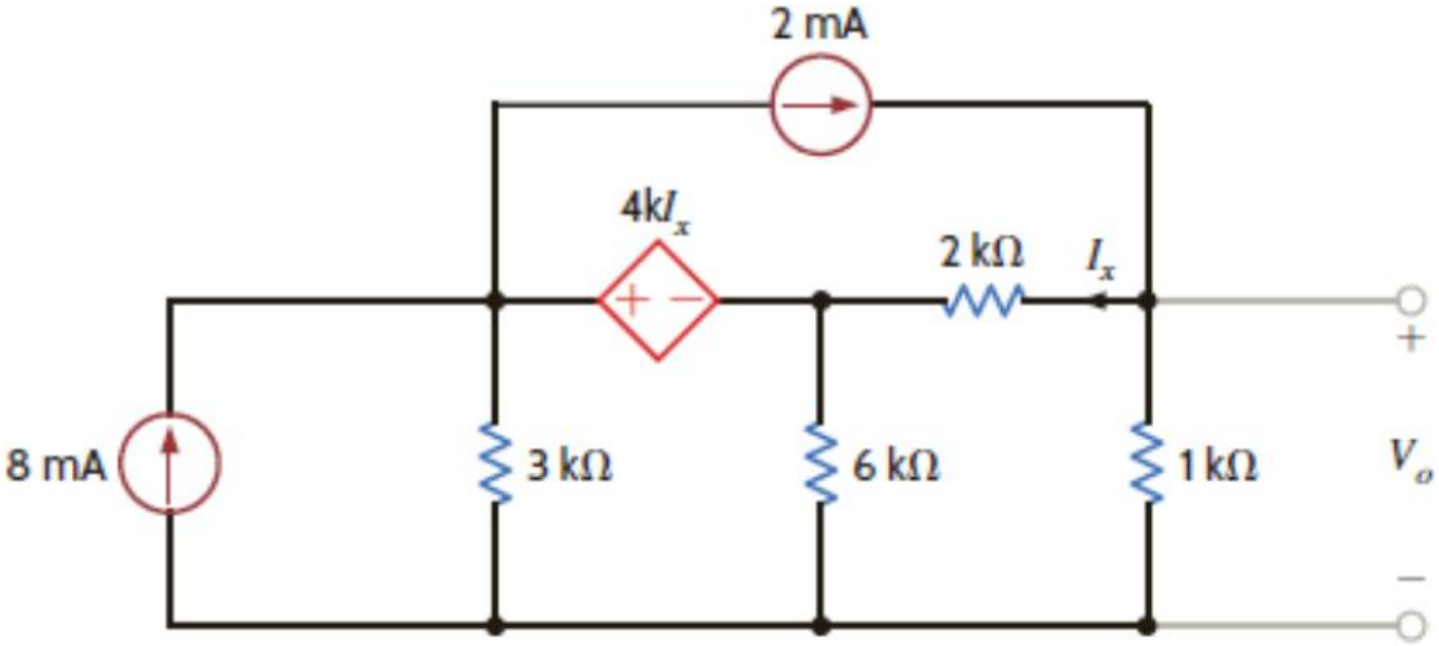
$$12 = V_1 - V_3$$

$$V_3 = -\frac{6}{7}\,V$$

$$I_0 = \frac{V_3}{2k} = -\frac{3}{7}\,mA$$

Nodal Analysis → with Dependent Voltage Sources

E3.12: Determine the current V_0 in the provided network.



KCL @ supernode

$$8m - 2m = \frac{V_1}{3k} + \frac{V_2}{6k} + \frac{V_2 - V_0}{2k}$$

KCL @ node 2

$$2m = \frac{V_0}{1k} - \frac{V_2 - V_0}{2k}$$

Constraint

$$I_x = \frac{V_0 - V_2}{2k}$$

Dependent Source

$$V_1 - V_2 = 4k \cdot I_x$$