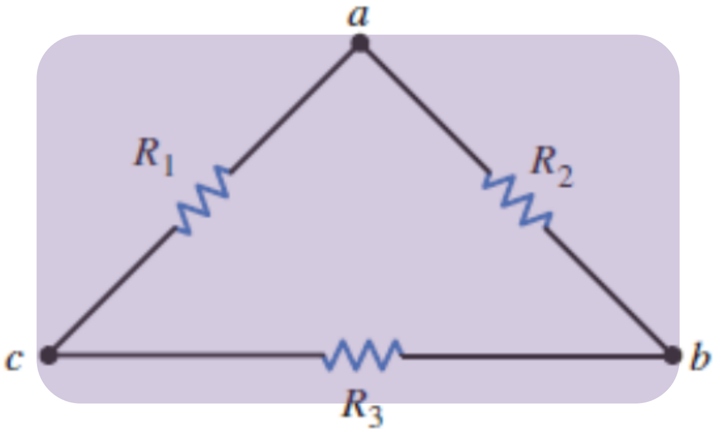
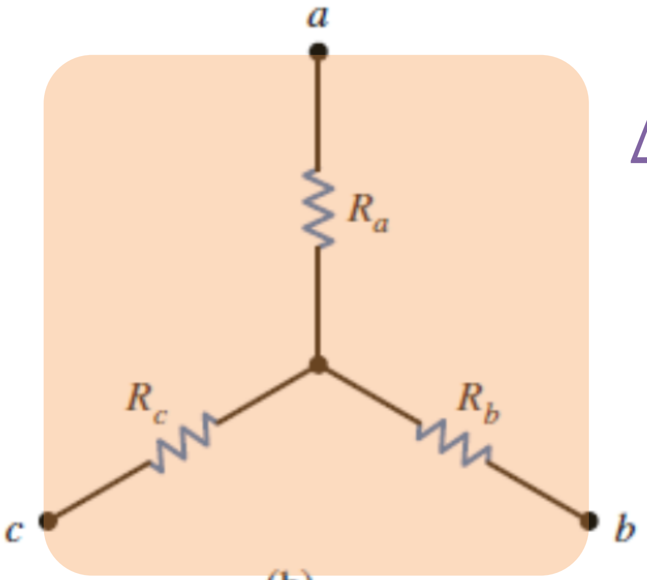
Last Lecture $\rightarrow$ Wye $\leftrightarrows$ Delta Transformation



(a)



(b)

$\Delta \leftarrow Y$

$$R_1 = \frac{R_aR_b + R_bR_c + R_aR_c}{R_b}$$

$$R_2 = \frac{R_aR_b + R_bR_c + R_aR_c}{R_c}$$

$$R_3 = \frac{R_aR_b + R_bR_c + R_aR_c}{R_a}$$

$Y \leftarrow \Delta$

$$R_a = \frac{R_1R_2}{R_1 + R_2 + R_3}$$

$$R_b = \frac{R_2R_3}{R_1 + R_2 + R_3}$$

$$R_c = \frac{R_1R_3}{R_1 + R_2 + R_3}$$

assuming

$$R_a = R_b = R_c = R_Y$$

$$R_1 = R_2 = R_3 = R_\Delta$$

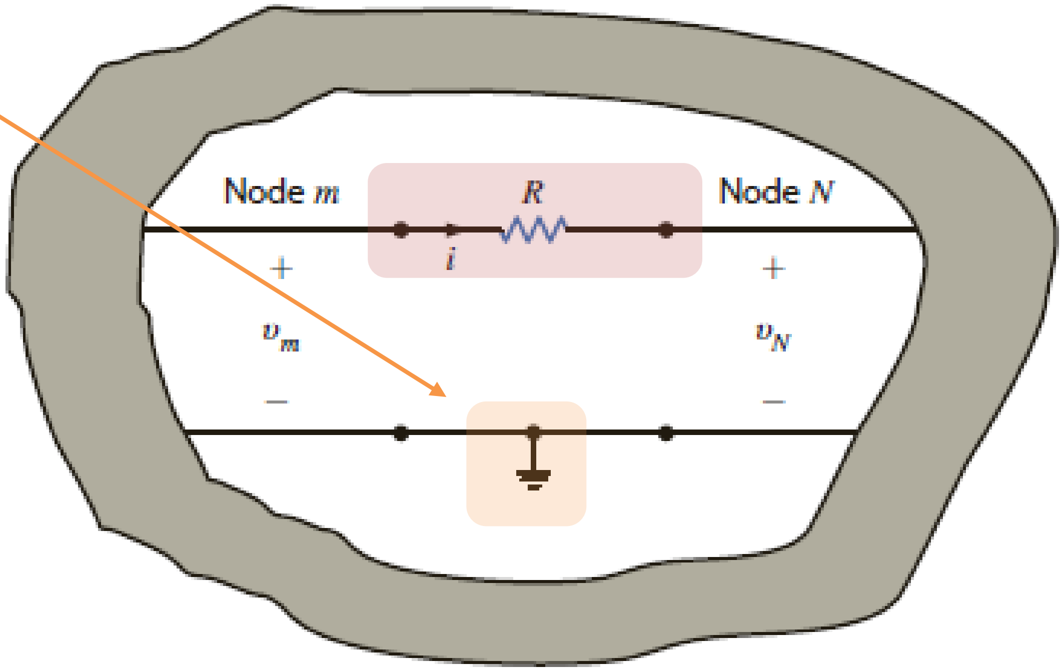
$$R_\Delta = 3R_Y \qquad R_Y = \frac{1}{3}R_\Delta$$

Nodal and Loop Analysis → Chapter #3

- **Solve circuits with multiple nodes using nodal analysis**
- **Solve circuits with multiple loops using loop analysis**
- **Identify the most appropriate analysis technique that should be utilized to solve a particular problem**

Nodal Analysis

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



Ohm's Law:

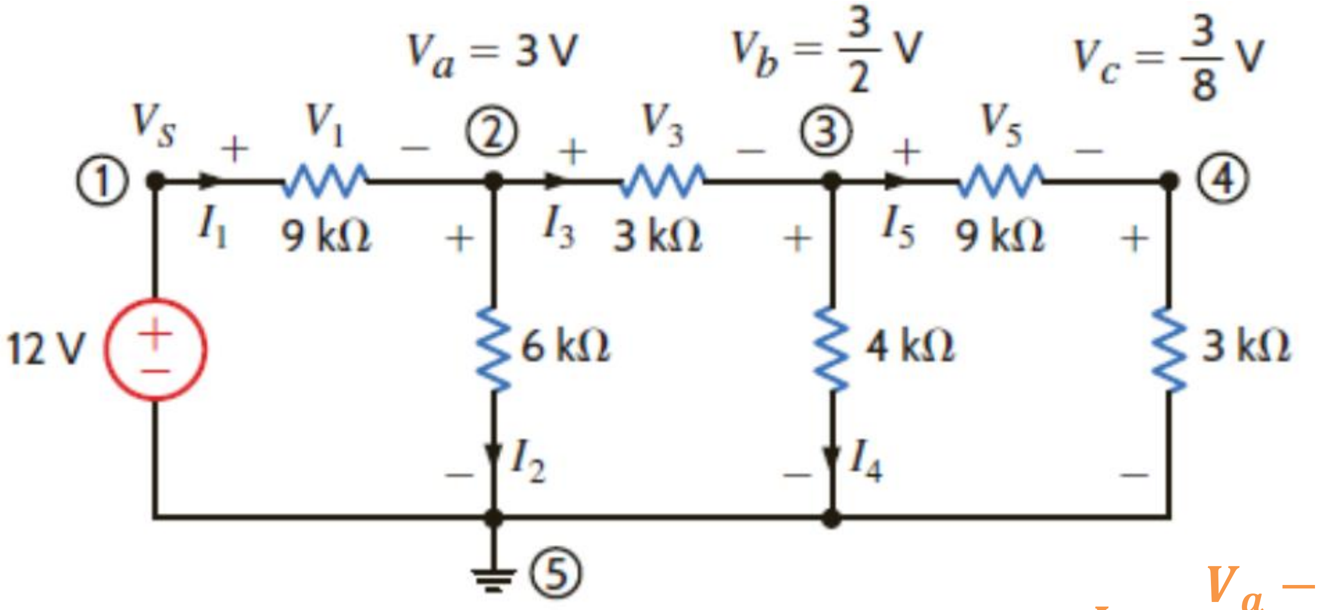
$$i = \frac{v_m - v_n}{R}$$

- Current defined by Ohm's law
- Variables are node voltages
- Voltages are defined with respect to a common point (the reference)

N-1 independent simultaneous equations!

Nodal Analysis → known node voltages

- **Define node voltages to be positive with respect to the reference node**
- **Define currents with respect to node voltages**



- **Voltage across resistors**

$$V_1 = V_S - V_a = 9V$$
$$V_3 = V_a - V_b = {}^3/_2\,V$$
$$V_5 = V_b - V_c = {}^9/_8\,V$$

- **Current in resistors**

$$I_1 = \frac{V_1}{9k} = \frac{V_S - V_a}{9k} = 1mA$$
$$I_3 = \frac{V_3}{3k} = \frac{V_a - V_b}{3k} = {}^1/_2\,mA$$
$$I_5 = \frac{V_5}{9k} = \frac{V_b - V_c}{9k} = {}^1/_8\,mA$$
$$I_2 = \frac{V_a - 0}{6k} = {}^1/_2\,mA$$
$$I_4 = \frac{V_b - 0}{4k} = {}^3/_8\,mA$$

Nodal Analysis → with Independent Current Sources

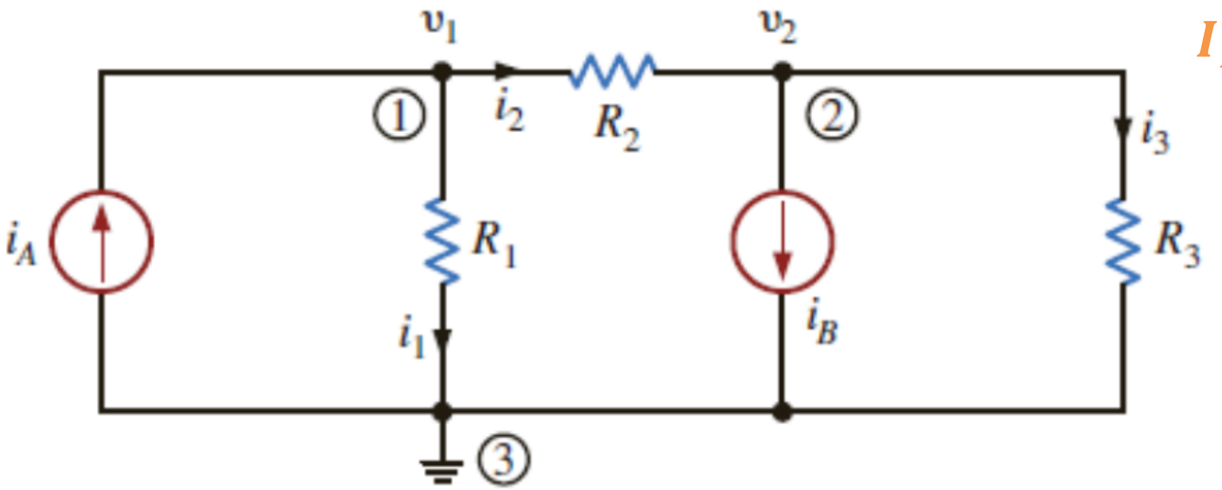
1) **Identify #of nodes:** 3 node circuit
2) **Select reference node:** bottom node, 3
3) **Label other node voltages:** v_1, v_2
4) **Identify branch currents:** i_1, i_2, i_3
5) **Apply KCL to nodes:** 1, 2 → 2 independent equations

assume: $I_A = 1mA$, $I_B = 4mA$, $R_1 = 12k\Omega$, $R_2 = 6k\Omega$, $R_3 = 6k\Omega$

KCLs:

$$I_A = I_1 + I_2 = \frac{V_1}{R_1} + \frac{V_1 - V_2}{R_2} = V_1\left[\frac{1}{R_1} + \frac{1}{R_2}\right] - V_2\left[\frac{1}{R_2}\right]$$

$$I_B = I_2 + I_3 = \frac{V_1 - V_2}{R_2} - \frac{V_2}{R_3} = V_1\left[\frac{1}{R_2}\right] - V_2\left[\frac{1}{R_2} + \frac{1}{R_3}\right]$$



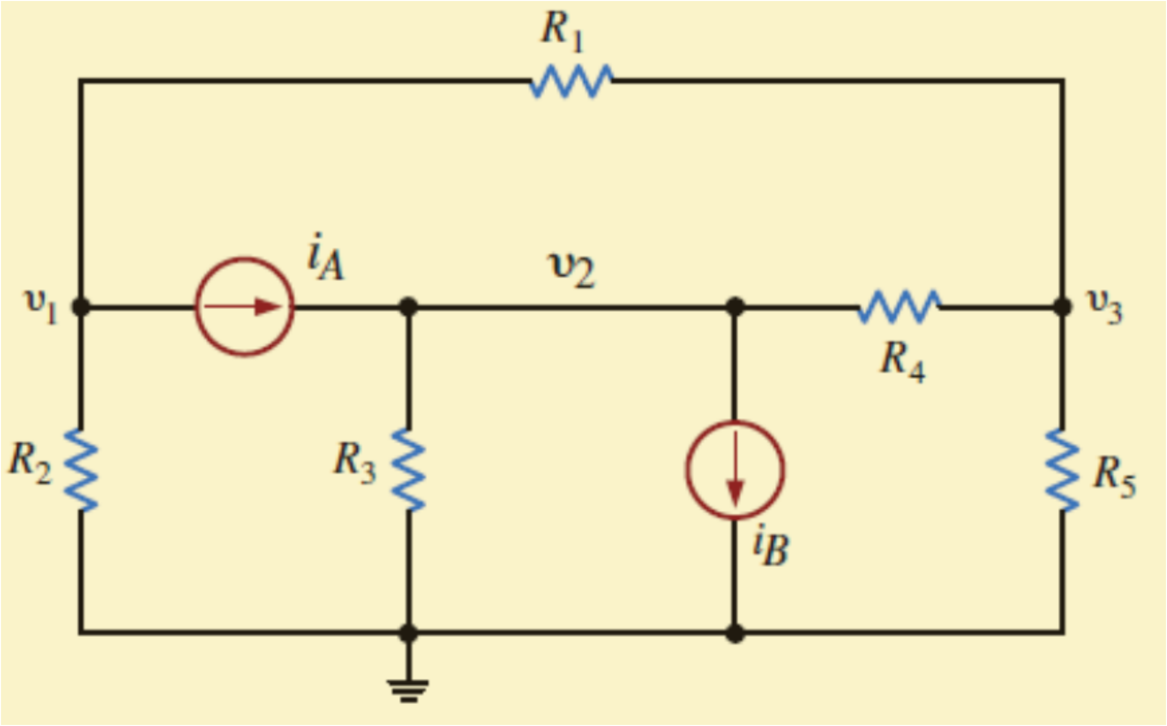
matrix eq.

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

Nodal Analysis → 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.

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



matrix eq.

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

Exam #1 → Tuesday February 5, 2018 @ 3:30pm

Concepts Chapter #1:

- **Current/Charge Relationship**
- **Power/Energy/Current/Voltage Relationships**
- **Conservation of Energy**

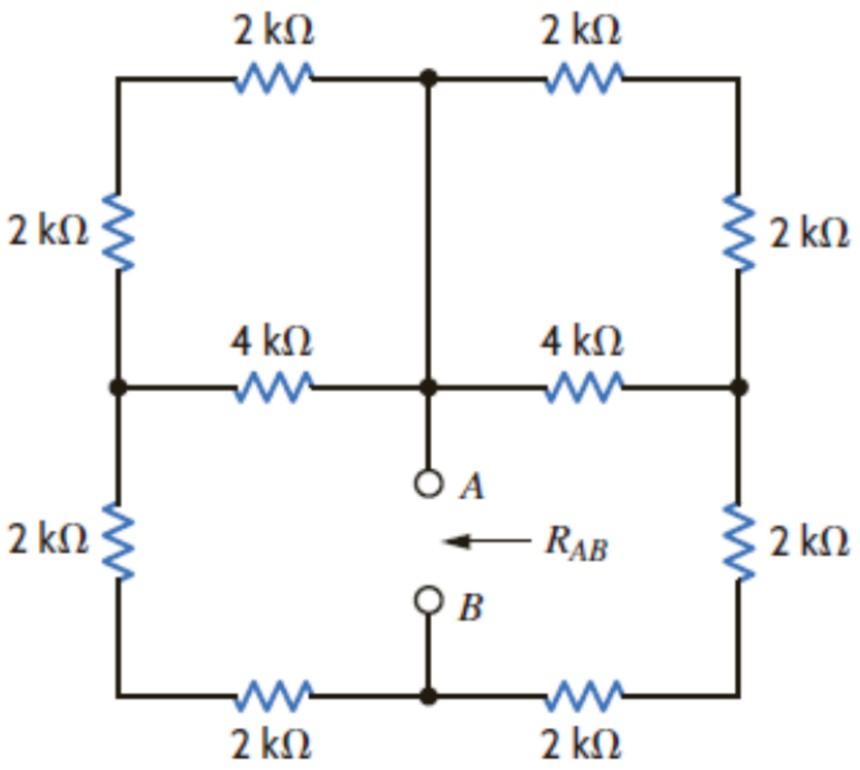
Concepts Chapter #2:

- **Ohm's Law (passive sign convention)**
- **Kirchhoff's Current Law (KCL)**
- **Kirchhoff's Voltage Law (KVL)**
- **Voltage/Current Divider**
- **Equivalent Resistance**
- **Wye/Delta Transformations**
- **Solving Circuits**

***** "Bate": bring your own set of equations (no problems, photocopies, solutions, etc)… subject to approval by the professor**

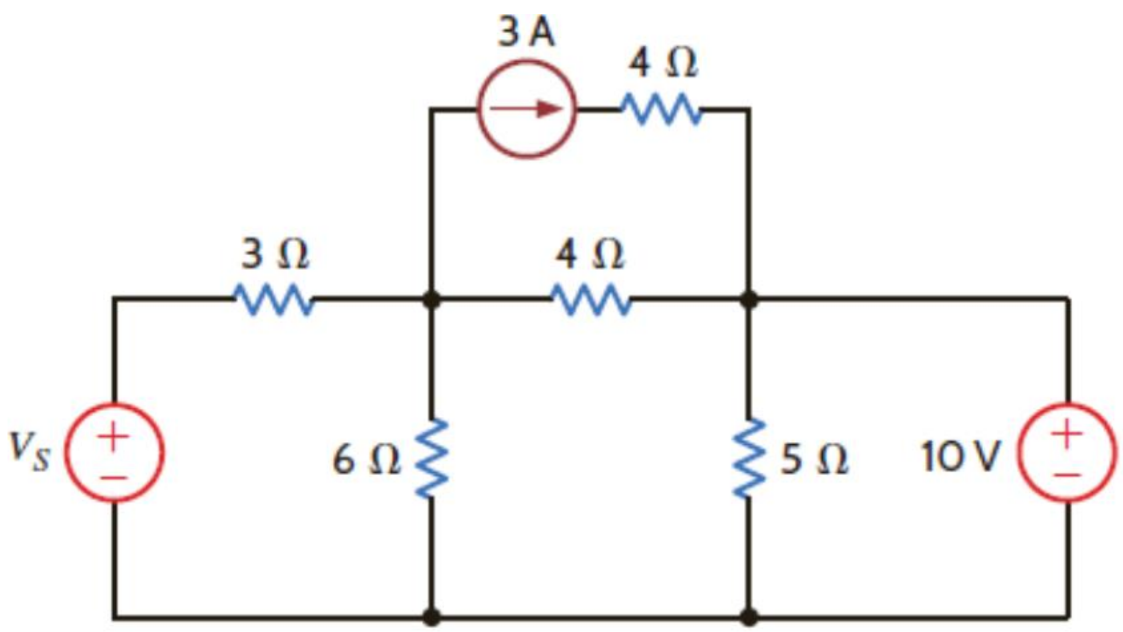
Problem 2.65

Find R_{AB} in the circuit provided.



Learning Assessment E2.33

If the power supplied by the 3A current source is 12W, find V_S and the power supplied by the 10V source.



Problem 2.121

Find V_0 in the provided network.