Exam #1 → Tuesday Aug. 10, 2019 @ 7:00pm

Location: Chardon 124

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

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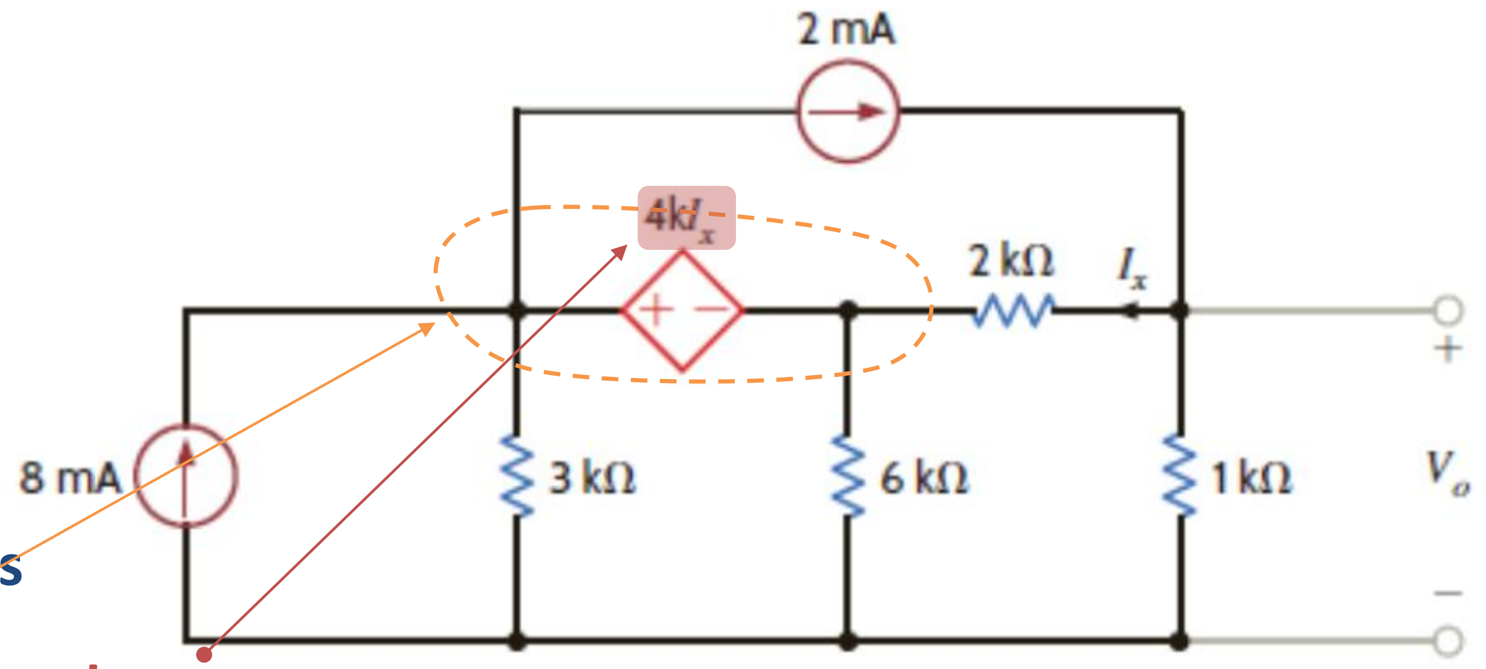
Location: Chardon 124

Concepts Chapter #3:

1) Nodal Analysis
    - Select node as reference
    - # of Eq. = # of nodes – 1
    - variables → voltages
    - KCL → equations
    - voltage source → constraint eq. (express in terms of variables)
    - voltage source between 2 non-reference nodes → supernode
2) Loop Analysis
    - # of Eq. = # of independent loops
    - variables → currents (assign a loop current to each independent loop)
    - KVL → equations
    - current source → constraint eq. (express in terms of variables)

Last Lecture → Nodal Analysis



Analysis Procedure

1) Identify #of nodes
2) Select reference node
3) Label other node voltages
4) Identify branch currents
5) Identify supernode / dependent sources
6) Apply KCL to nodes and supernodes
7) Write constraint equation - supernodes → $V_1 - V_2 = 4k \cdot I_x$
8) Write controlling equation – dependent sources → $I_x = \frac{V_0 - V_2}{2k}$
9) Solve equation system

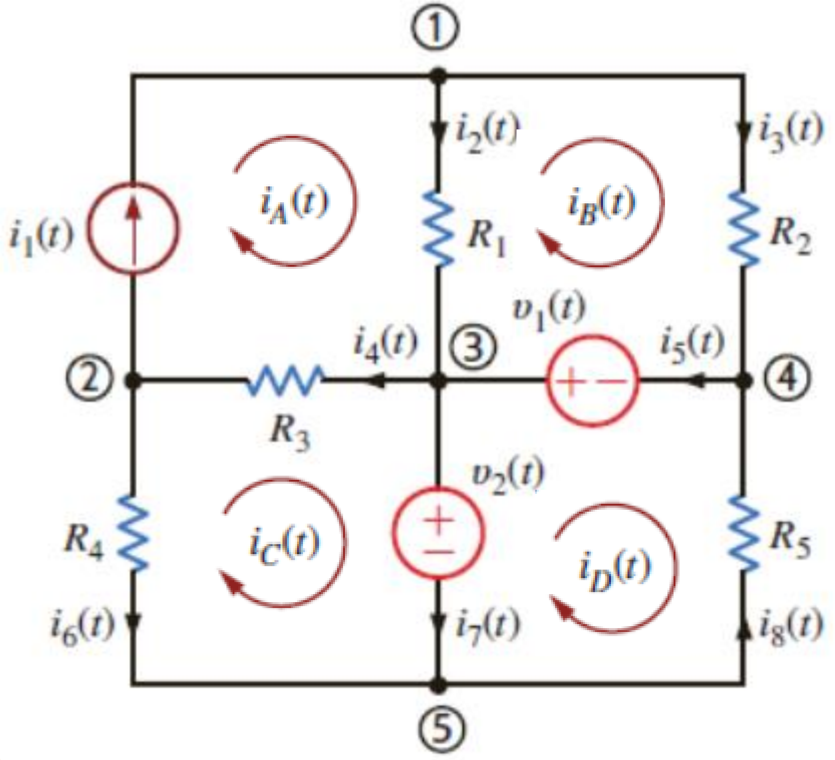
Mesh Analysis

Alternative # 1

- *B → # of branches*
- *N → # of nodes*
- *B-N+1 → # independent simultaneous equations*

Alternative # 2

- *M → # of independent loops in a planar circuit*
- *M → # independent simultaneous equations*



B = 8 M = 4
N = 5
 # Eq. = 4

Stablish the currents around the loops

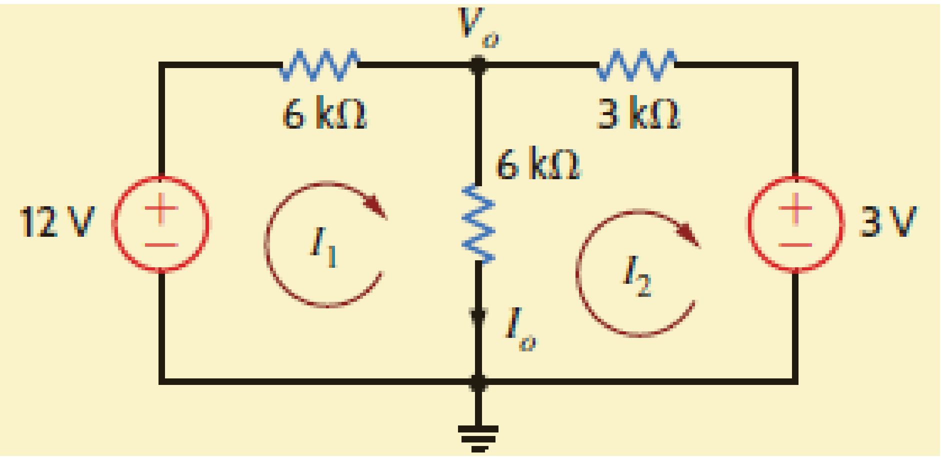
$i_A(t) = i_1(t)$
$v_1 = V_{R_1} + V_{R_2}$
$-v_2 = V_{R_3} + V_{R_4}$
$v_2 - v_1 = V_5$

Express voltages in terms of currents: $i_A(t)$, $i_B(t)$, $i_C(t)$, and $i_D(t)$

KVLs according to the current around the loop

Loop Analysis → with Independent Voltage Sources

*****Use passive sign convention with respect the loop currents**



M = 2

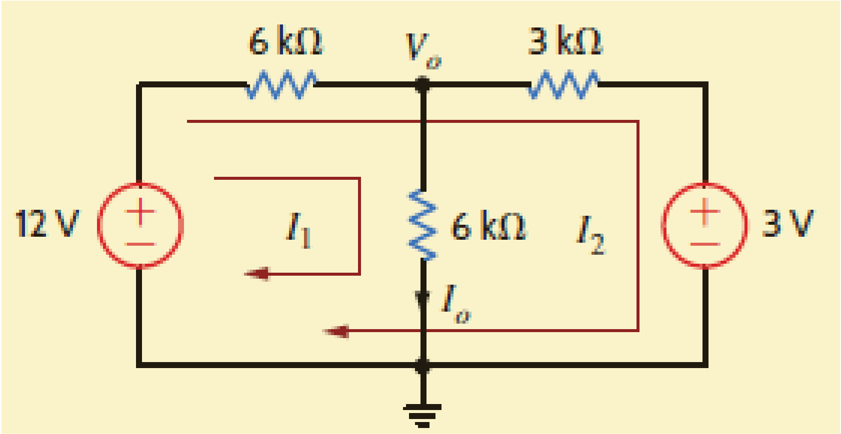
 # Eq. = 2

- **KVLs in terms of I_1 and I_2**

$$12 = 6k \cdot I_1 + 6k \cdot (I_1 - I_2)$$
$$-3 = 6k \cdot (I_2 - I_1) + 3k \cdot I_2$$

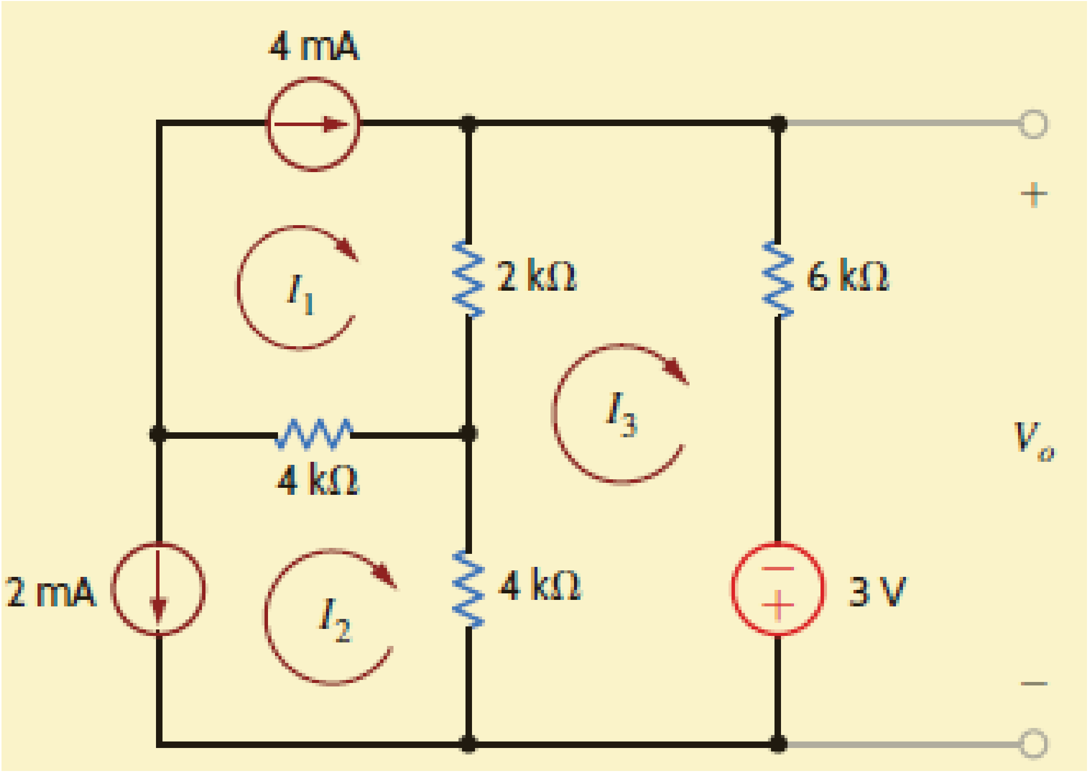
$$I_1 = \frac{1}{2} mA$$
$$I_2 = \frac{5}{4} mA$$

using the outer loop…



Loop Analysis → with Independent Current Sources

***** The current source will determine loop current**



M = 3

 # Eq. = 3

- **Independent CS**

  $I_1 = 4mA$

  $I_2 = -2mA$

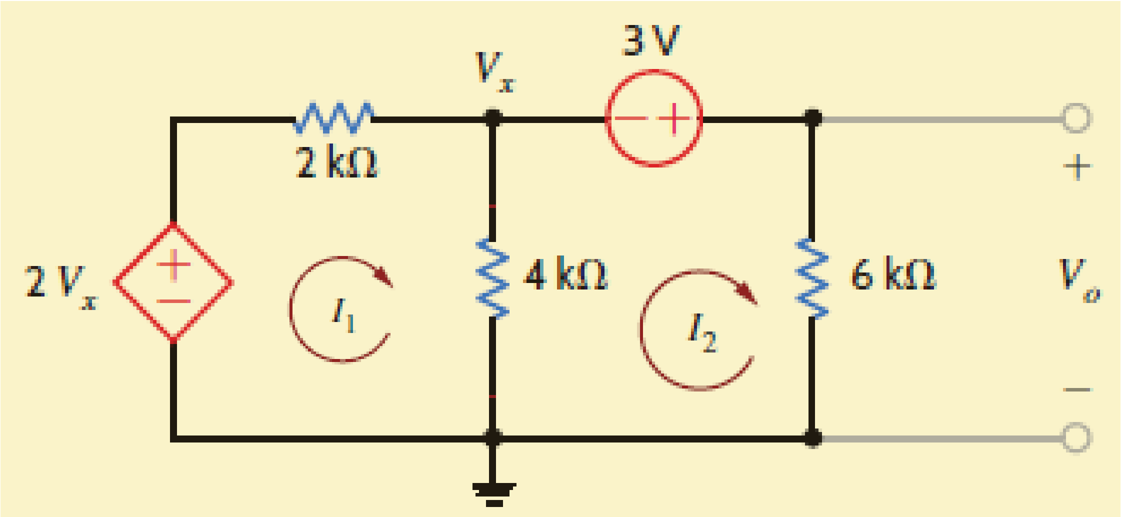
- **KVLs in terms of I_1, I_2, and I_3**

$$3 = 4k \cdot (I_3 - I_2) + 2k \cdot (I_3 - I_1) + 6k \cdot I_3$$

$$I_1 = \frac{1}{4} mA$$

Loop Analysis → with Dependent Voltage Sources

***** After the KVLs, write the controlling equation for the dependent sources**



M = 2

 # Eq. = 2

- **KVLs in terms of I_1 and I_2**

- **Controlling Eq.**

$$V_x = 4k \cdot [I_1 - I_2]$$

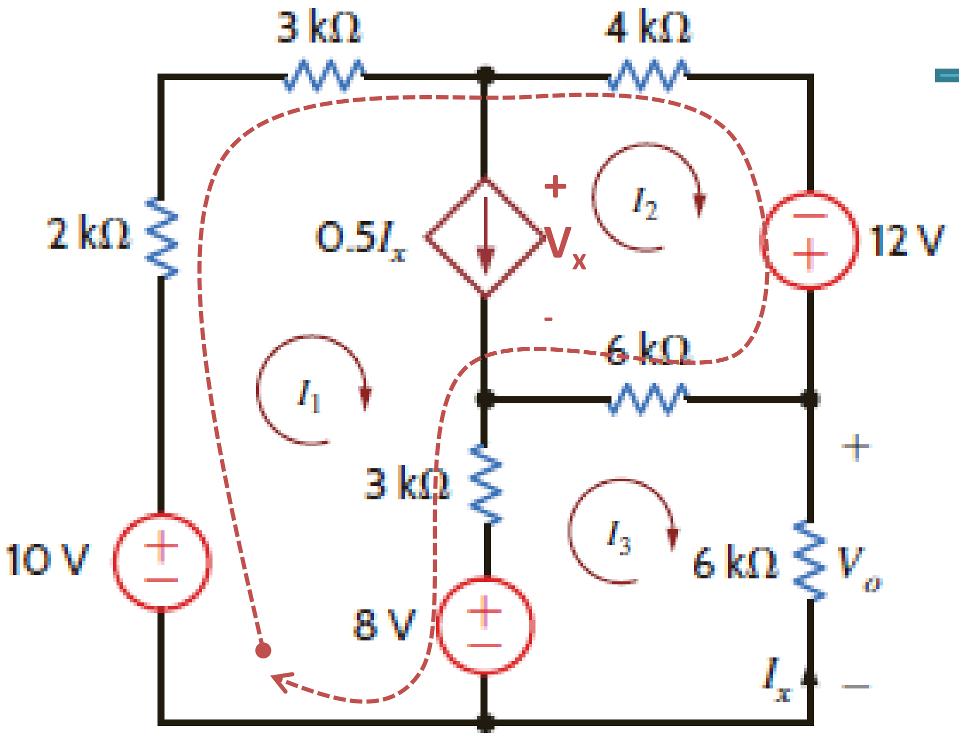
$$I_1 = 3mA$$

$$I_2 = \frac{3}{2} mA$$

$$V_0 = 9V$$

Loop Analysis → Super-mesh

Learning Assessment – E3.23: Find V_o.



M = 3

 # Eq. = 3

- **KVLs in terms of I_1, I_2 and I_3**

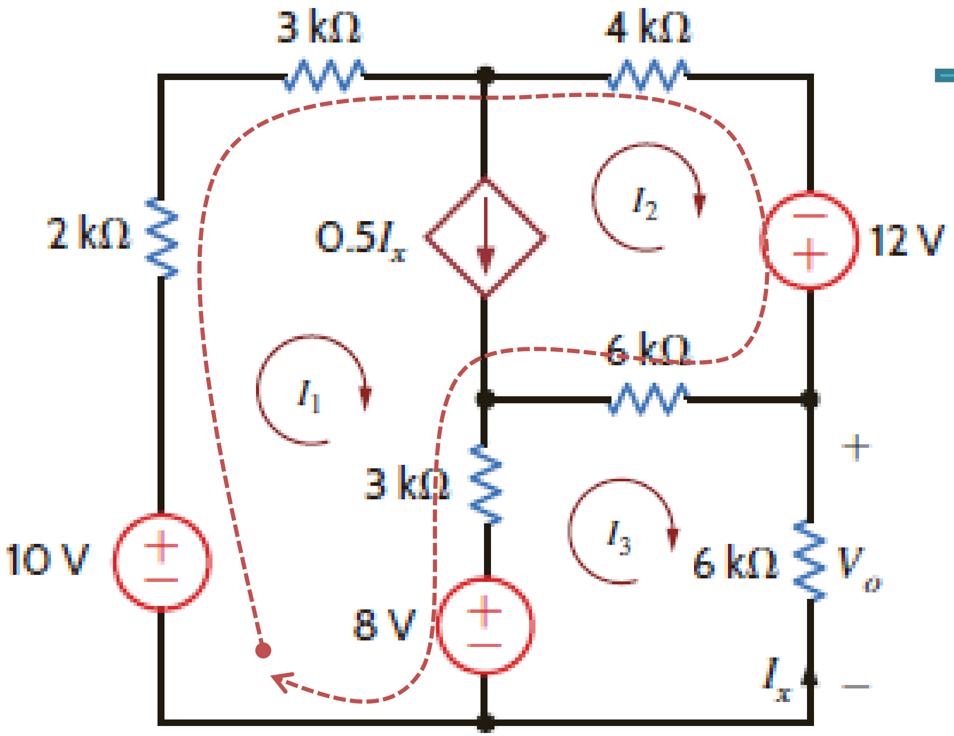
$$10 - 5k \cdot I_1 - V_x - 3k \cdot (I_1 - I_3) - 8 = 0$$
$$12 - 6k \cdot (I_2 - I_3) + V_x - 4k \cdot I_2 = 0$$

- **KVLs @ Super-mesh**

$$10 - 5k \cdot I_1 - 4k \cdot I_2 + 12 - 6k \cdot (I_2 - I_3) - 3k \cdot (I_1 - I_3) - 8 = 0$$

Loop Analysis → Super-mesh

Learning Assessment – E3.23: Find V_o.



M = 3

 # Eq. = 3

- **KVLs in terms of I_1, I_2 and I_3**

$$14 = 8k \cdot I_1 + 10k \cdot I_2 - 9k \cdot I_3$$

$$8 = -3k \cdot I_1 - 6k \cdot I_2 + 15k \cdot I_3$$

- **Controlling Eq.**

$$I_x = -I_3$$

- **Constraint Eq.**

$$I_1 - I_2 = \frac{1}{2} I_x$$

$$I_1 = \frac{10}{9} mA$$

$$I_3 = \frac{3}{2} mA$$

$$V_0 = 9V$$

Problem → 3.124

Find I_0 using both nodal and mesh analysis