Last Lecture → Chp. #1

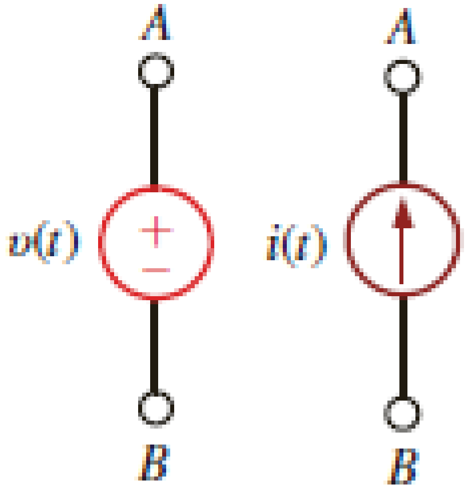
- ✓ System of Units
- ✓ Basic Electrical Quantities
- ✓ Independent Sources
- ✓ Circuit Analysis

$$w(t) \quad [J = N \cdot m]$$

$$i(t) = \frac{dq(t)}{dt} \quad [A = C/s]$$

$$v(t) = \frac{dw(t)}{dq} \quad [V = J/C]$$

$$p = \frac{dw}{dt} = v \cdot i \quad [W = J/s]$$



<u>passive sign convention:</u> *positive power is defined as the current i(t) entering the positive reference v(t) of the element*

- *Power positive – power being absorbed*
- *Power negative – power being supplied*

- ***Independent Sources***

Dependent Source

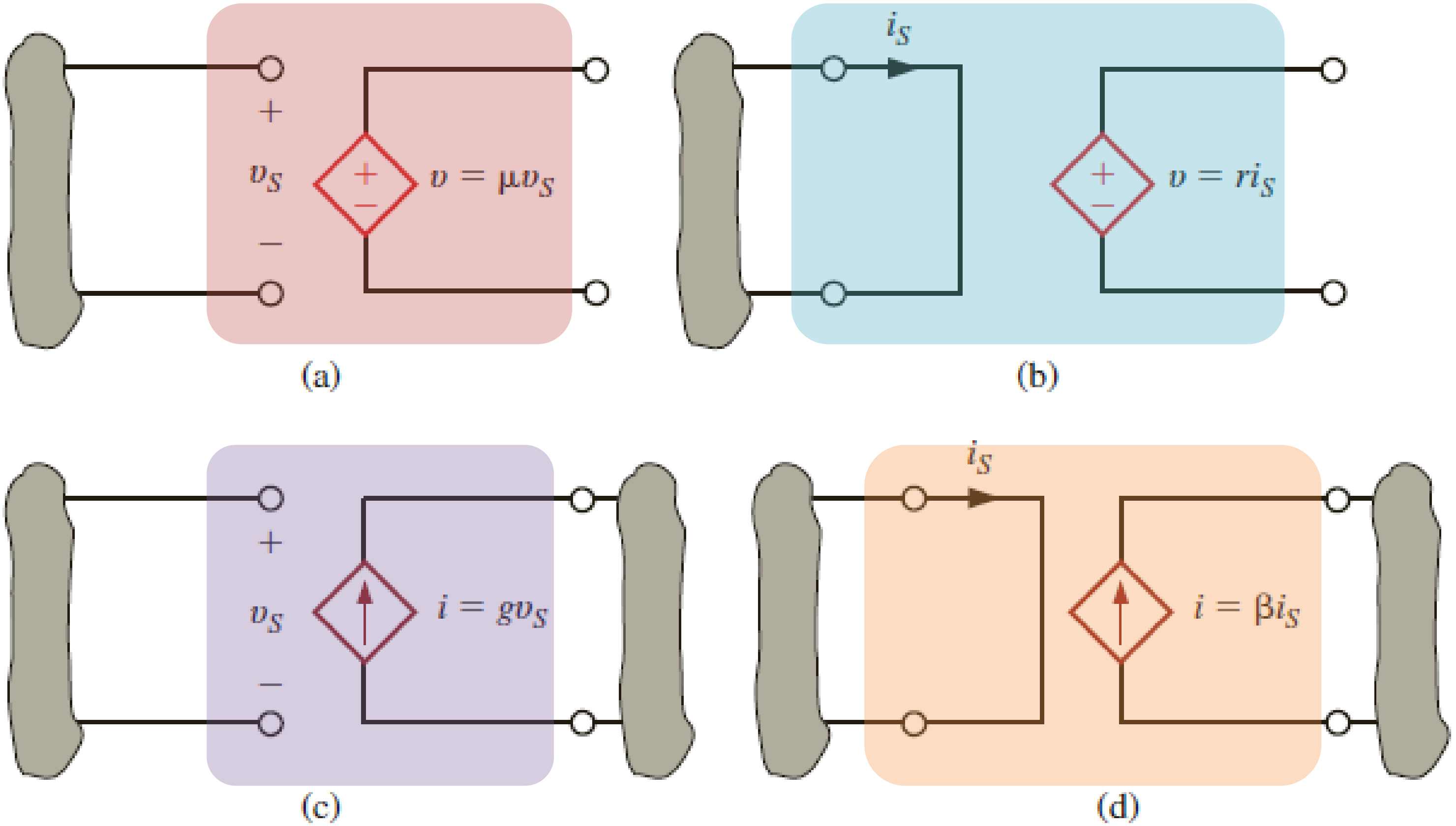
Generate a voltage or current that is determined by another voltage or current at specified location in the circuit.

Voltage Controlled Voltage Source (VCVS)

Current Controlled Voltage Source (CCVS)

Voltage Controlled Current Source (VCCS)

Current Controlled Current Source (CCCS)



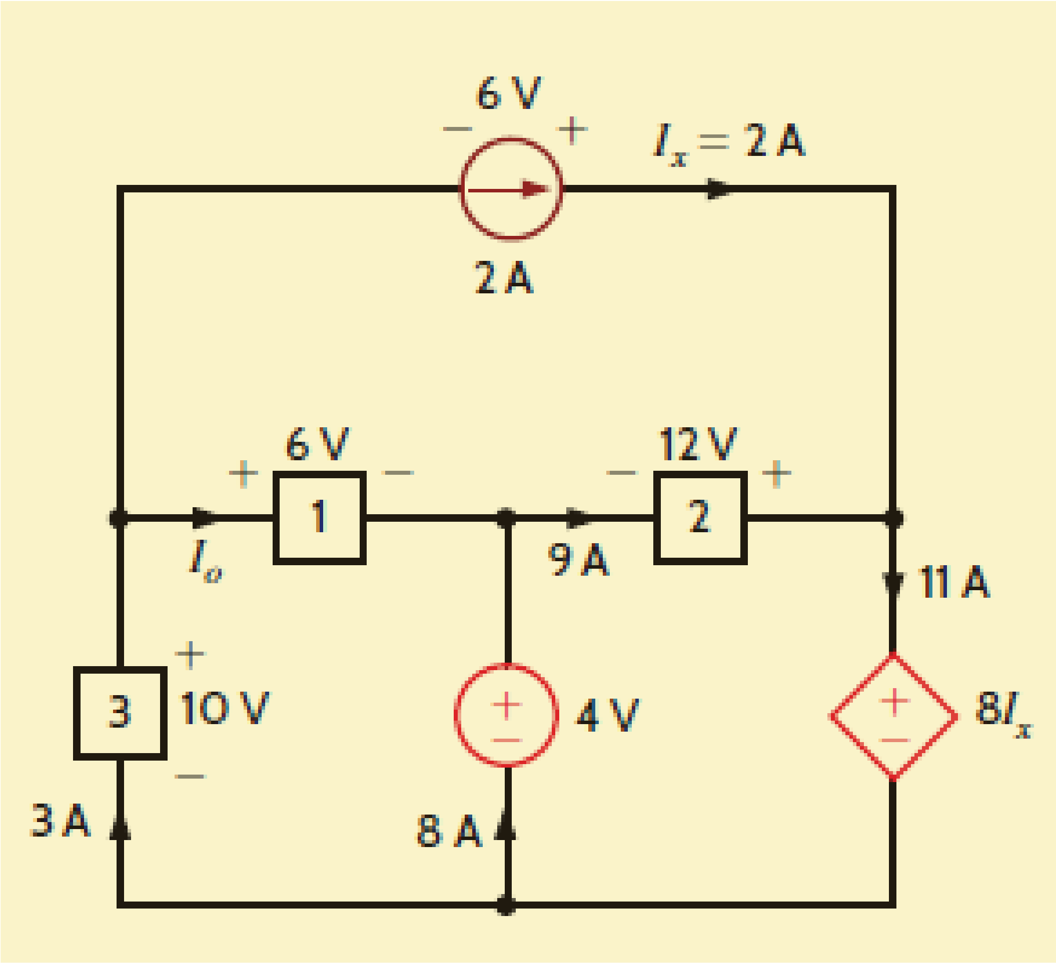
Example 1.7

Use Tellegen's theorem to find the current I_0 in the network provided.

- $P_1 = 6 \cdot I_0$
- $P_2 = 12 \cdot (-9) = -108\ W$
- $P_3 = 10 \cdot (-3) = -30\ W$
- $P_{VS} = 4 \cdot (-8) = -32\ W$
- $P_{CS} = 6 \cdot (-2) = -12\ W$
- $P_{CCVS} = 8I_x \cdot 11 = 176\ W$

$$\sum_{i}^{N} P_i = 0 \Rightarrow P_1 = 6 \cdot I_0 = 6W$$

$$\therefore I_0 = 1A$$

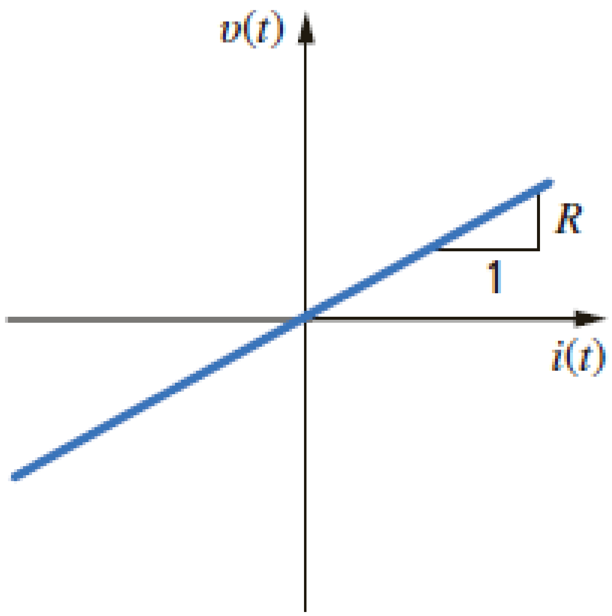


Resistive Circuits → Chp. #2

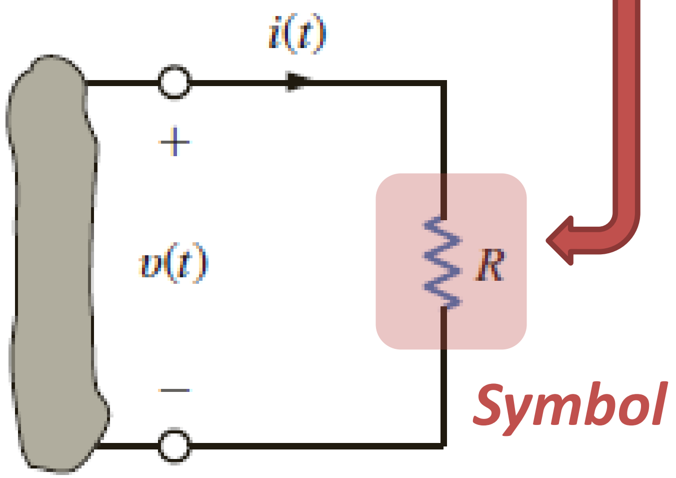
- **Ohm's Law**
- **Kirchhoff's Current and Voltage Law**
- **Basic Circuit Analysis**
- **Equivalent Resistance**
- **Voltage and Current Division**
- **Wye and Delta Resistor Networks**
- **Circuit Analysis with Dependent Sources**
- **Basic Electrical Quantities**
- **Independent & Dependent Sources**
- **Circuit Analysis**

Ohm’s Law

States that the voltage across a resistance is directly proportional to the current flowing through it.



A circuit element whose electrical characteristic is primarily resistive is called a resistor (R) .



resistance → Ohms (Ω)

$$v(t) = R \cdot i(t)$$

Ohm's Law

- ***Resistance [Ω = V/A]***

$$R = \frac{v(t)}{i(t)}$$

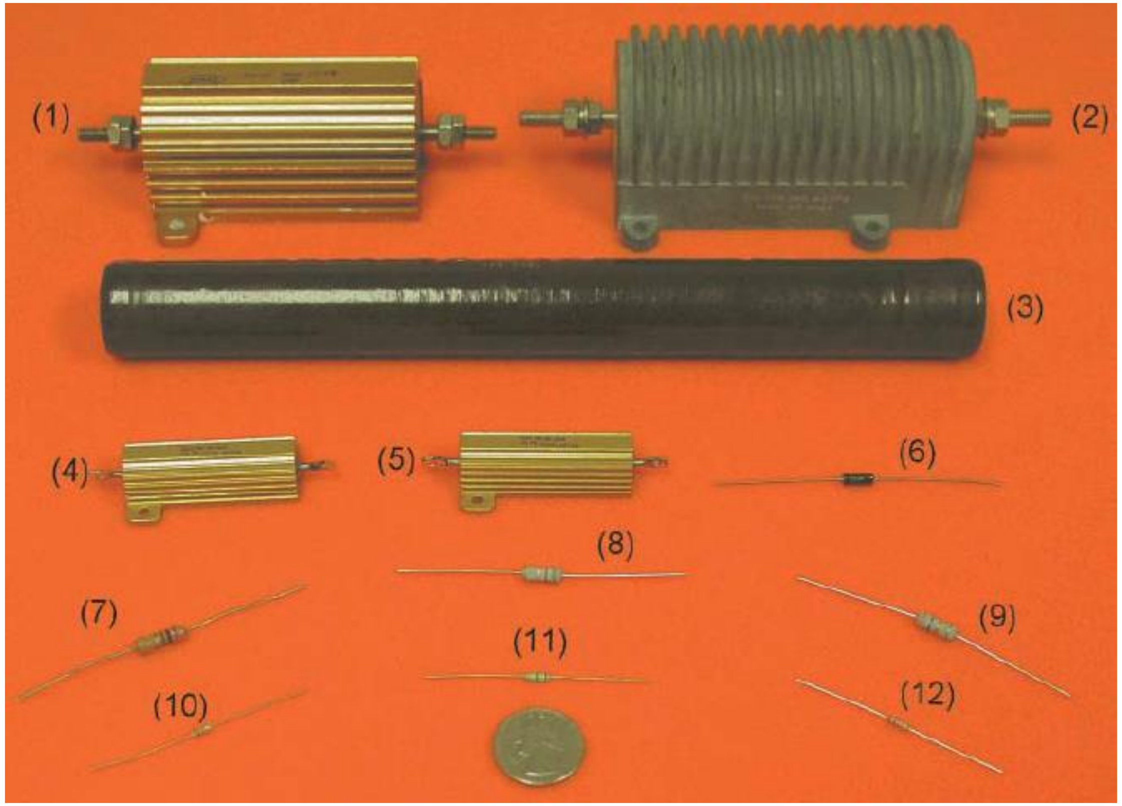
siemens

- ***Conductance [S = A/V]***

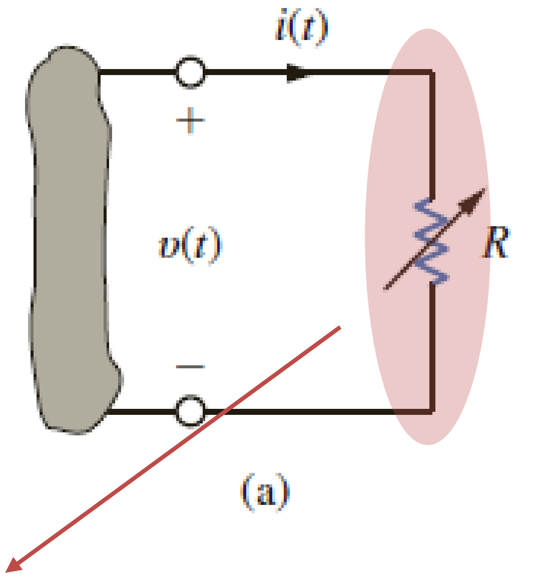
$$G = \frac{1}{R} = \frac{i(t)}{v(t)}$$

- ***Power Dissipation [W]***

$$p(t) = v(t) \cdot i(t) = R \cdot i(t)^2 = \frac{v(t)^2}{R}$$



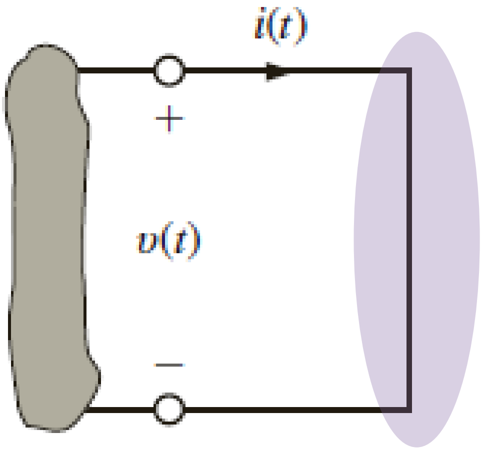
Short Circuit / Open Circuit



(a)

variable resistor [potentiometer]

$$v(t) = R \cdot i(t)$$

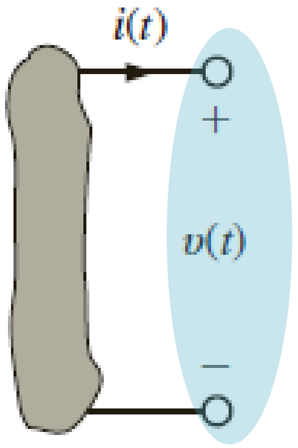


(b)

for $R \to 0$

$$v(t) = R \cdot i(t) = 0$$

$\therefore$ **short circuit!**



(c)

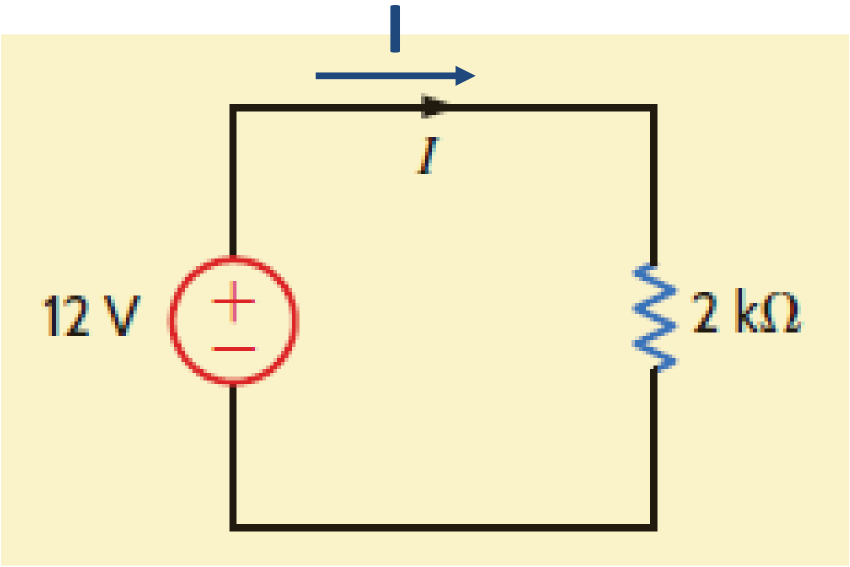
for $R \to \infty$

$$i(t) = \frac{v(t)}{R} = 0$$

$\therefore$ **open circuit!**

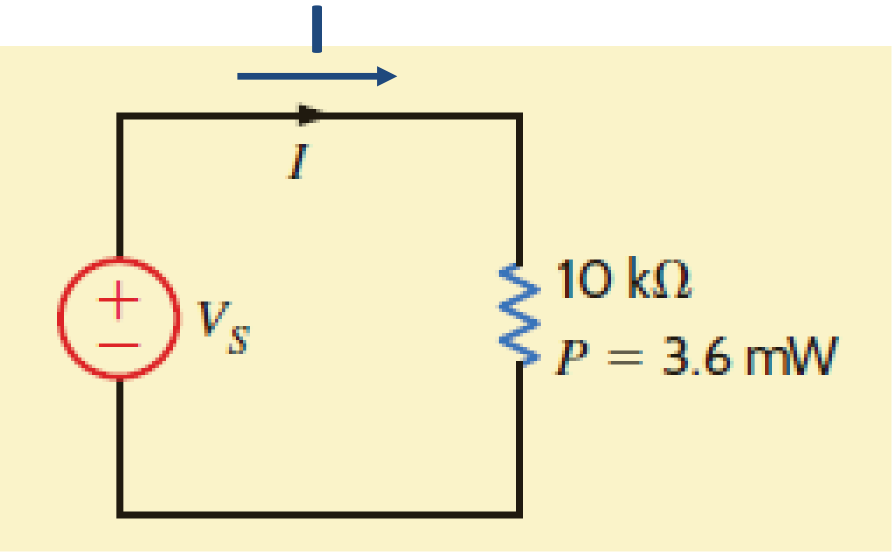
Example 2.1

Determine the current I and the power absorbed by the resistor.



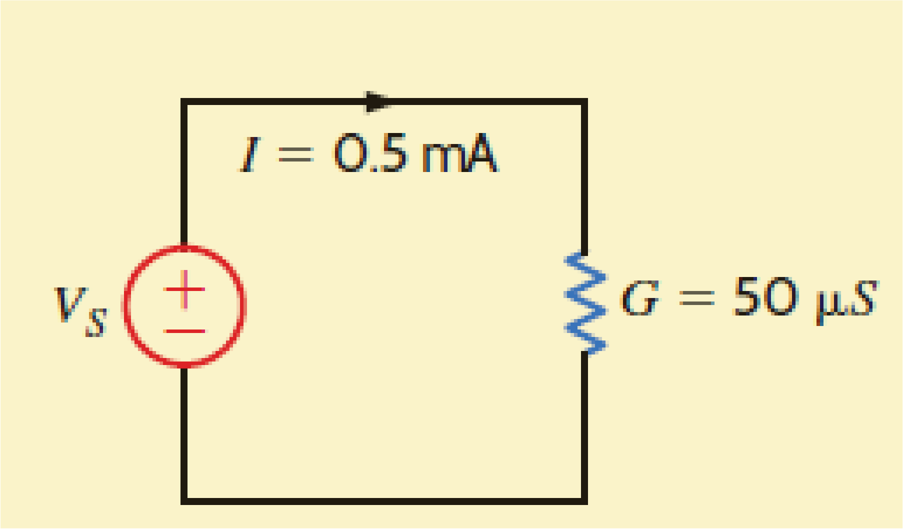
Example 2.2

Determine the voltage source V_s and the current I in the circuit.



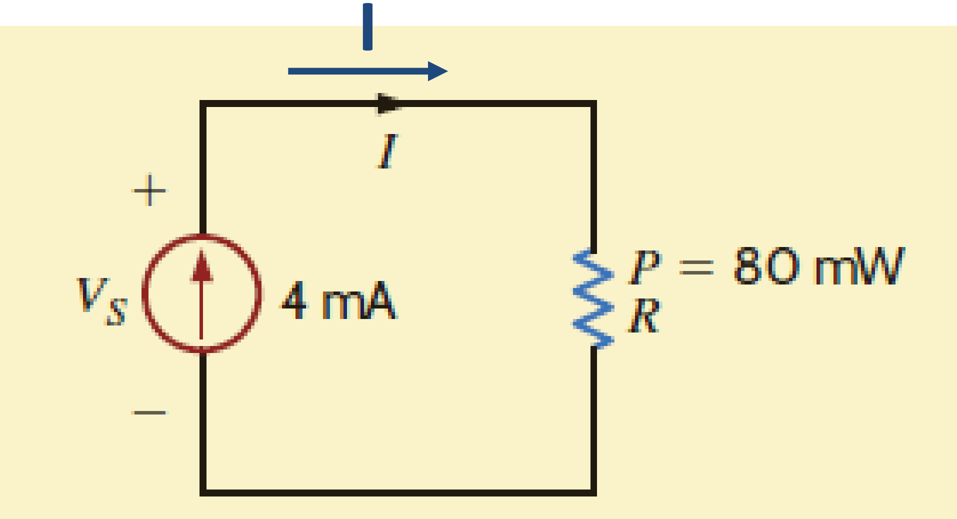
Example 2.3

Find the value of the voltage source V_s and the power absorbed by the resistance.



Example 2.4

Find the value of the resistance R and the voltage across the current source V_s.

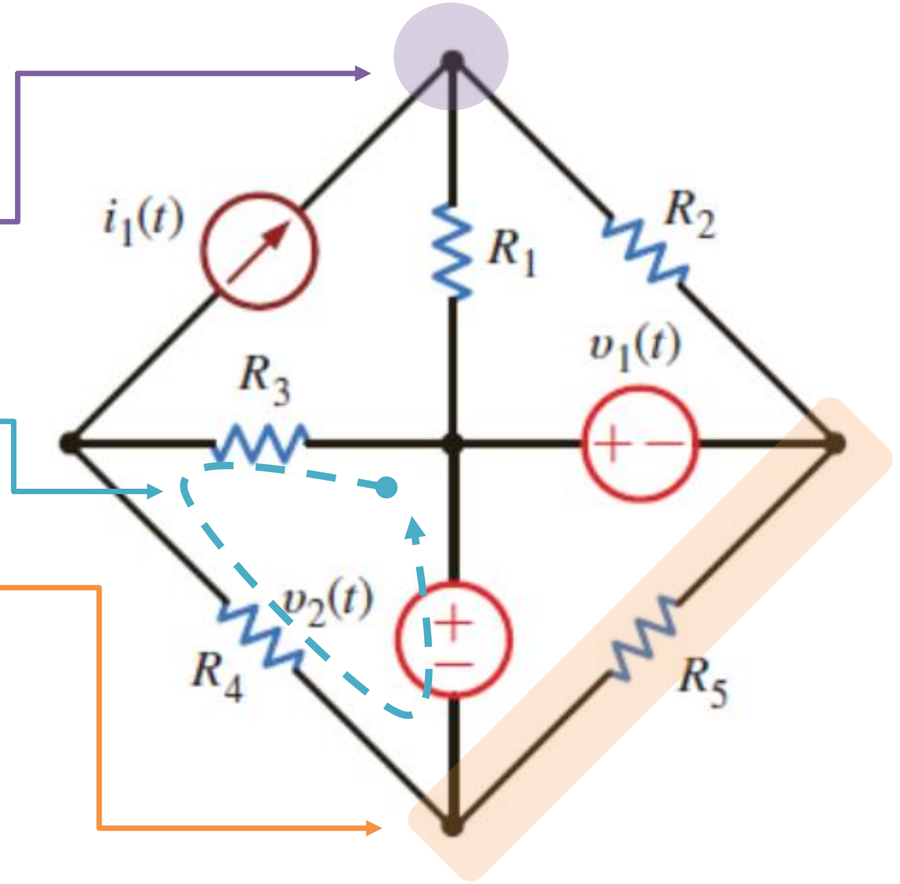


Kirchhoff's Law

- **Kirchhoff's Current Law (KCL)**
- **Kirchhoff's Voltage Law (KVL)**

**assumption – interconnection is performed by electrical conductors (wires) that have zero resistance*

- Node: *a point of connection of two or more circuit elements*
- Loop: *any closed path through the circuit in which no node is encountered more than once*
- Branch: *a portion of the circuit containing a single element and the node at each end of the elements*

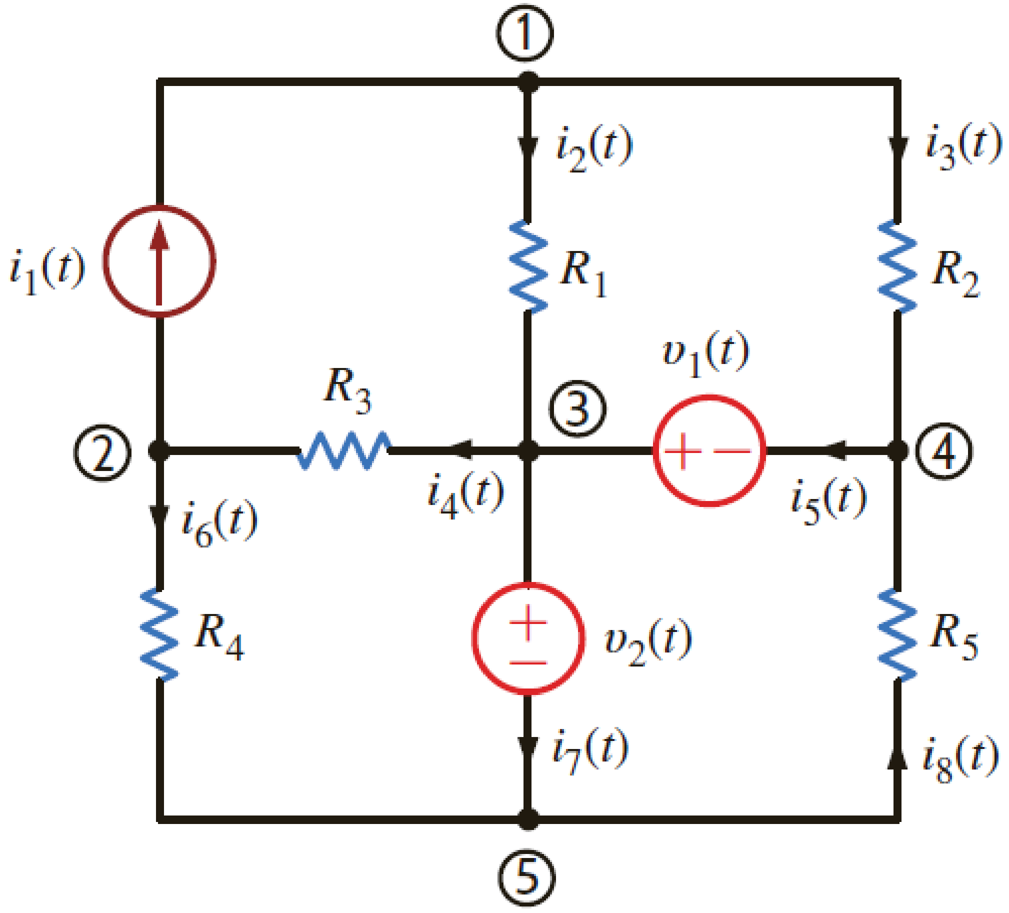


Kirchhoff's Current Law

… the algebraic sum of the all the currents entering any node is zero

$$\sum_{h=1}^{K} i_h^{in}(t) = 0$$

$$\longrightarrow \sum_{j=1}^{N} i_j^{in}(t) = \sum_{i=1}^{M} i_i^{out}(t)$$



KCL (1): $i_1(t) - i_2(t) - i_3(t) = 0$

KCL (2): $i_4(t) - i_1(t) - i_6(t) = 0$

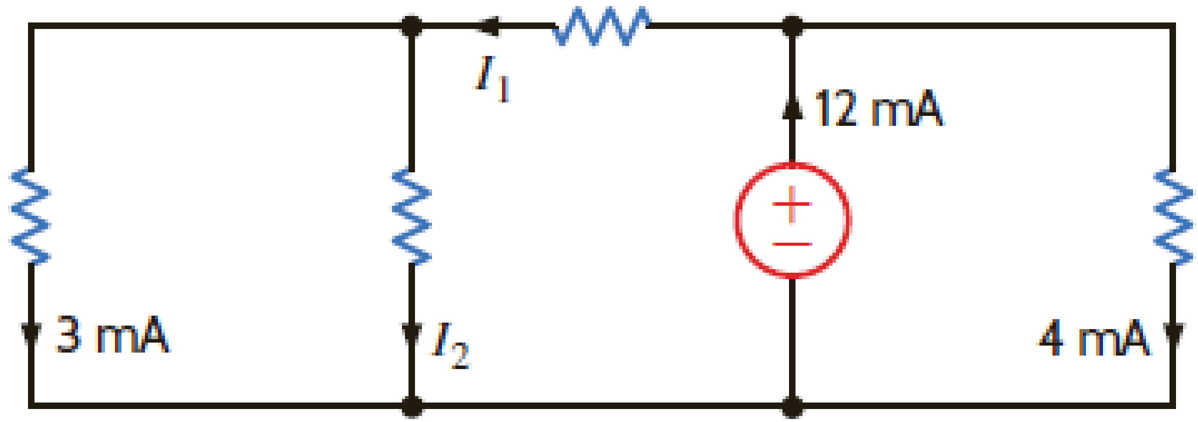
KCL (3): $i_2(t) + i_5(t) - i_4(t) - i_7(t) = 0$

KCL (4): $i_3(t) + i_8(t) - i_5(t) = 0$

KCL (5): $i_6(t) + i_7(t) - i_8(t) = 0$

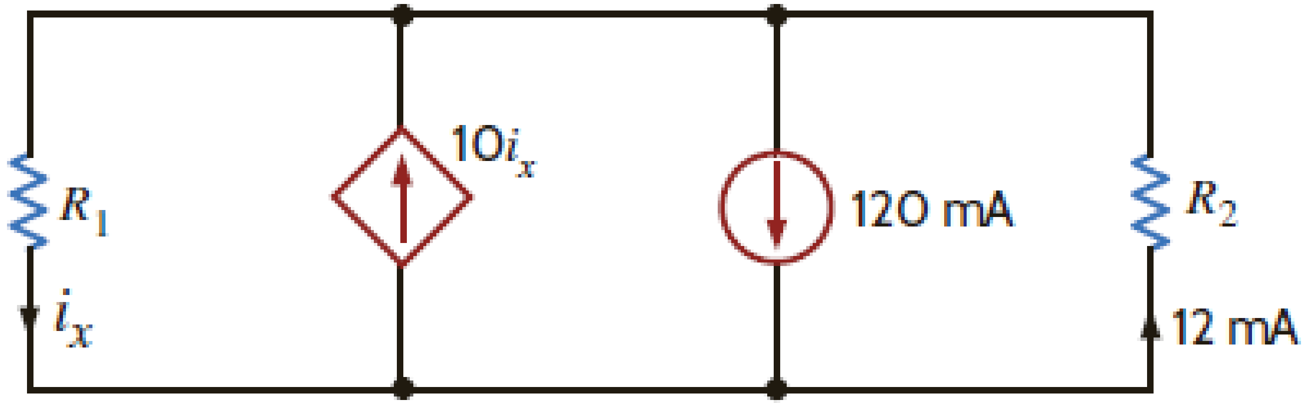
Learning Assessment E2.5b

… find I_1, and I_2 in the circuit provided.



Learning Assessment E2.6b

… find I_x in the circuit provided.



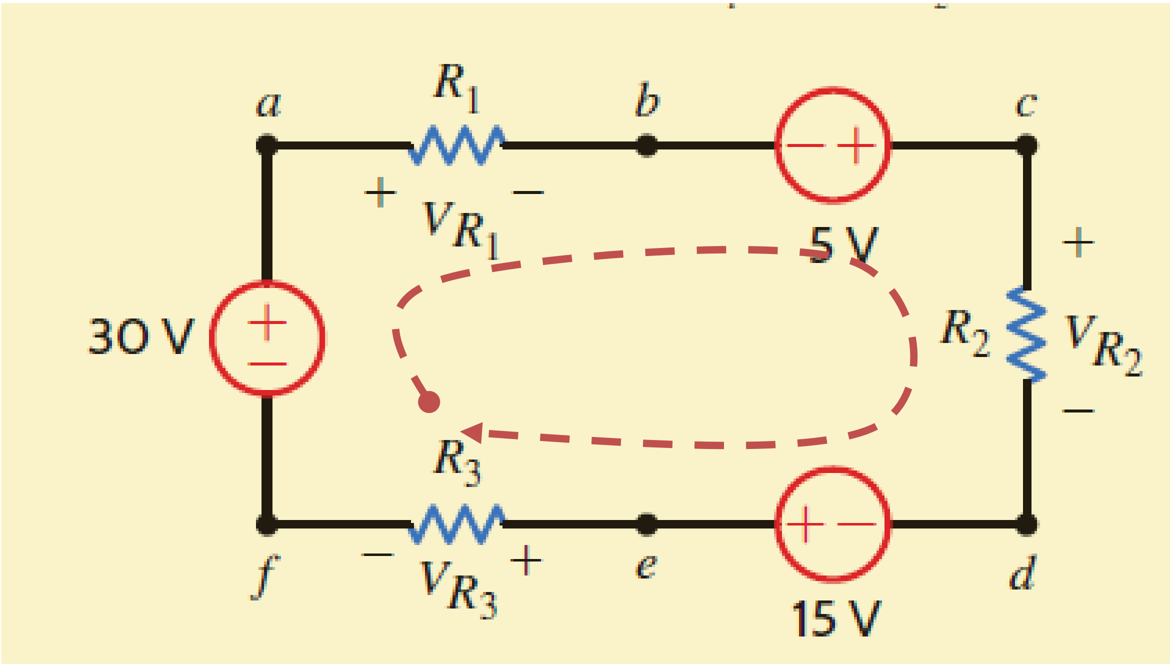
Kirchhoff's Voltage Law

… the algebraic sum of the voltages around any loop is zero

$$\sum_{h=1}^{K} v_h(t) = 0$$

$$\sum_{j=1}^{N} v_j^{\uparrow}(t) = \sum_{i=1}^{M} v_i^{\downarrow}(t)$$

KVL: $30 - V_{R1} + 5 - V_{R2} + 15 - V_{R3} = 0$



*Adopt a sign convention for the voltages across the elements:

- Increase in energy level → positive
- Decrease in energy level → negative

Example 2.12

… write the KVL equation for:

1) abda
2) dbcd
3) dabcd