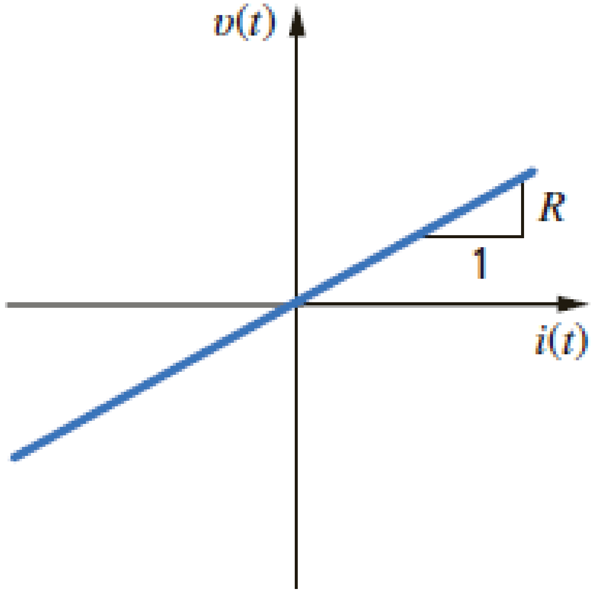
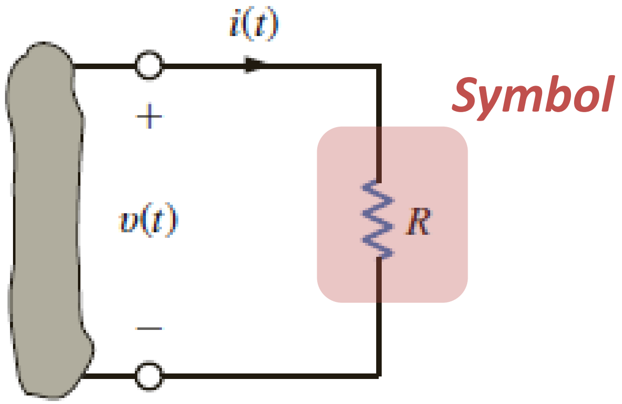
Last Lecture → Ohm's Law

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





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

- ***Resistance [Ω = V/A]***

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

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

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

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

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

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

Last Lecture → Kirchhoff's Laws

KCL- the algebraic sum of the all the currents entering any node is zero

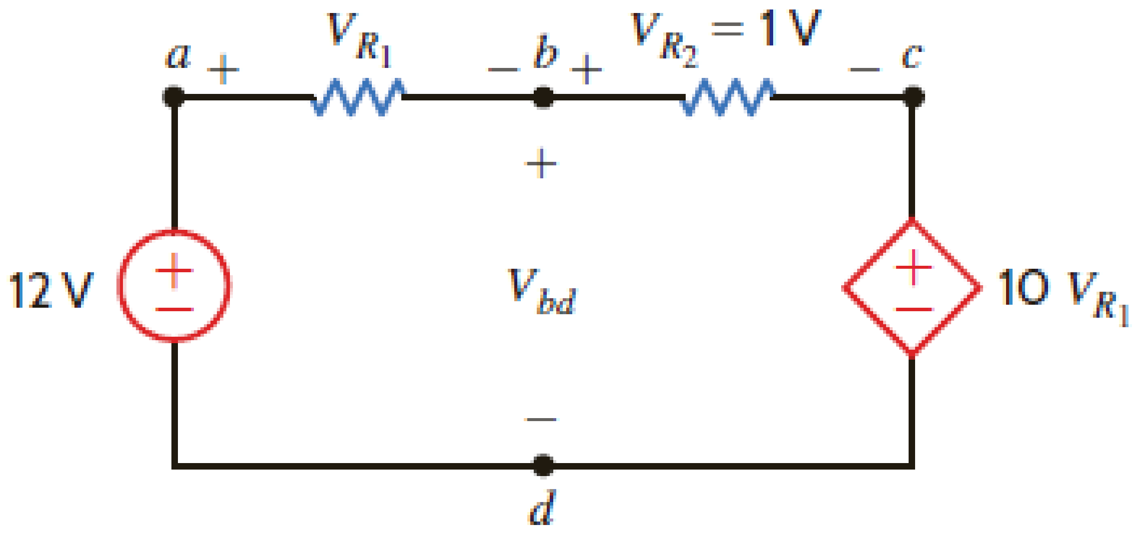
$$\sum_{h=1}^{K} i_h^{in}(t) = 0 \Longrightarrow \sum_{j=1}^{N} i_j^{in}(t) = \sum_{i=1}^{M} i_i^{out}(t)$$

KVL- the algebraic sum of the voltages around any loop is zero

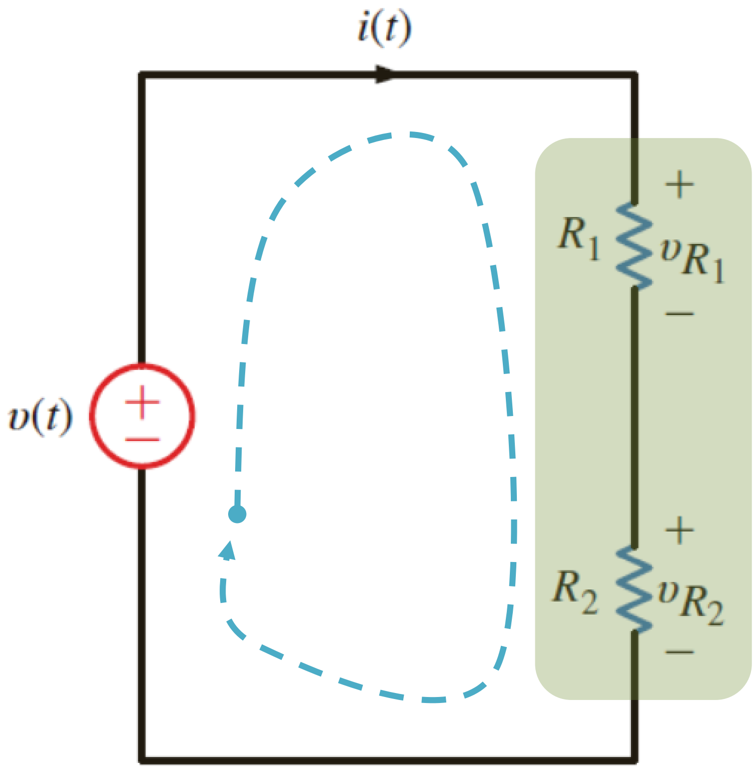
$$\sum_{h=1}^{K} v_h(t) = 0 \Longrightarrow \sum_{j=1}^{N} v_j^{\uparrow}(t) = \sum_{i=1}^{M} v_i^{\downarrow}(t)$$

Learning Assessment E2.9

... find the voltage V_{bd}.



Single Loop Circuits → Voltage Division



$v_{R_1} = ?$ $v_{R_2} = ?$

- **KVL:** $v(t) = v_{R_1} + v_{R_2}$
- **Ohm's:** $v_{R_1} = R_1 \cdot i(t)$

  $v_{R_2} = R_2 \cdot i(t)$

$\therefore\ i(t) = \dfrac{v(t)}{R_1 + R_2}$

$$\therefore v_{R1} = \frac{R_1}{R_1 + R_2} \cdot v(t)$$

$$v_{R2} = \frac{R_2}{R_1 + R_2} \cdot v(t)$$

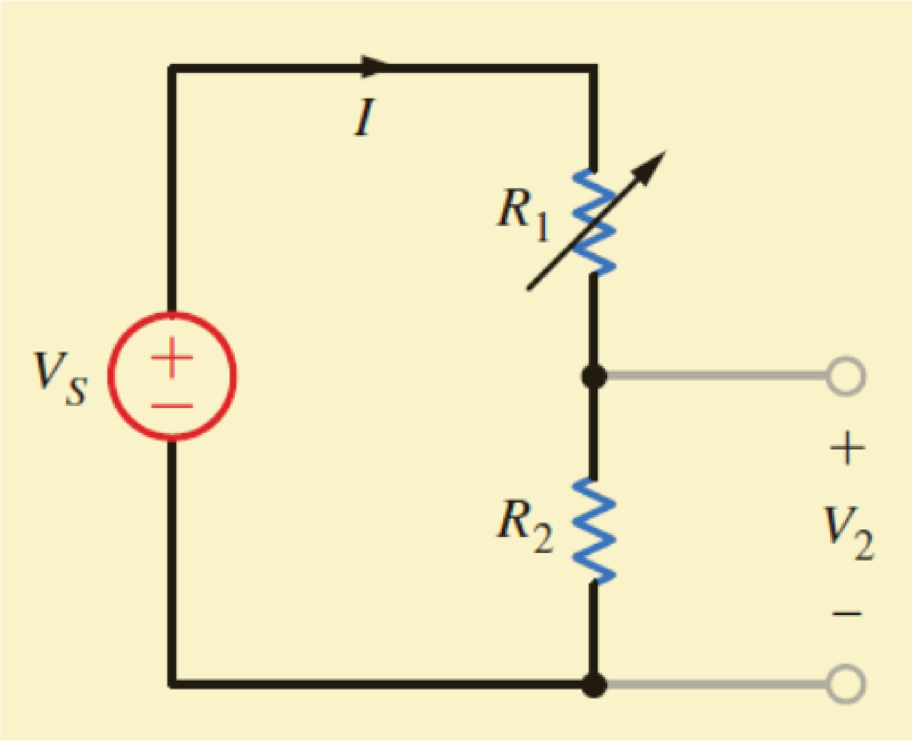
** $I_{R1} = I_{R2} = i(t)$*

∴ R_1 and R_2 are in series

The source voltage v(t) is divided between the resistors R_1 and R_2 in direct proportion to their resistances.

Example 2.13

Assuming V_s=9V, R_1=90kΩ, and R_2=30kΩ, examine the change in both the voltage across R_2 and the power absorbed in the resistor as R_1 is changed from 90kΩ to 15kΩ.



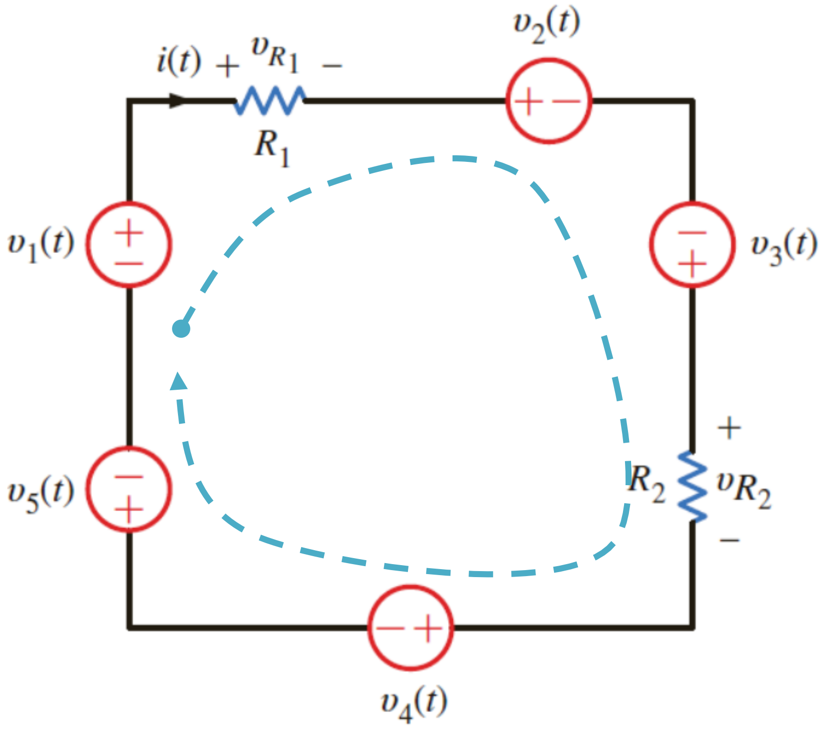
Single Loop Circuits → Multiple Source/Resistor Networks

- **KVL:** $v_1(t) - v_{R1} - v_2(t) + v_3(t) - v_{R2} - v_4(t) - v_5(t) = 0$

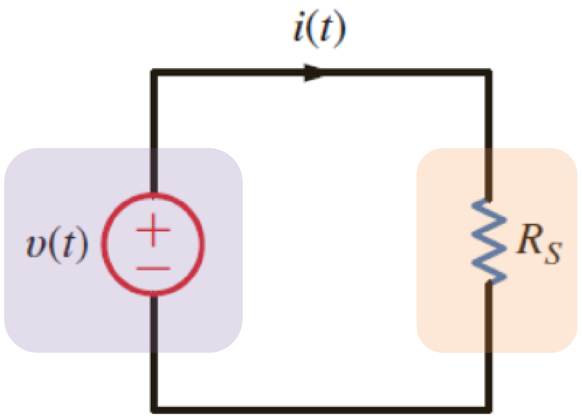
$$v_1(t) - v_2(t) + v_3(t) - v_4(t) - v_5(t) = v_{R1} + v_{R2}$$

$$v_1(t) - v_2(t) + v_3(t) - v_4(t) - v_5(t) = i(t) \cdot [R_1 + R_2]$$

$v(t)$ R_s



Equivalent Circuit

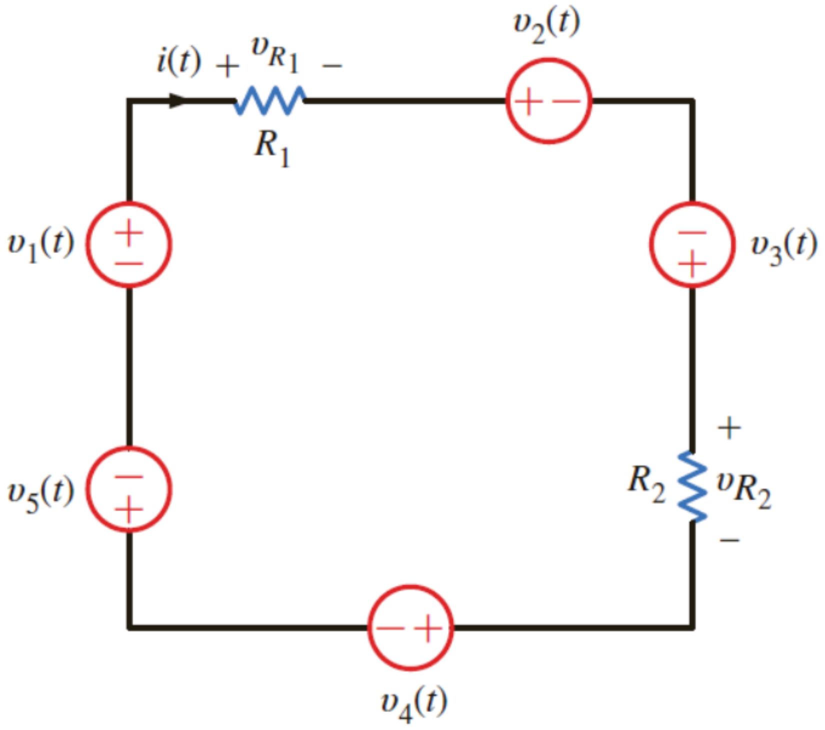


Single Loop Circuits → Multiple Source/Resistor Networks

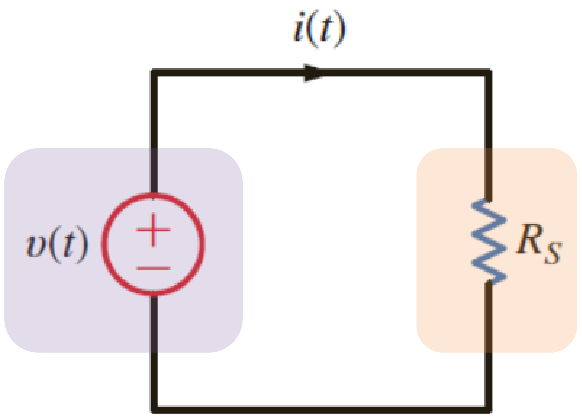
∴ **The sum of several <u>voltage source in series</u> can be replaced by one source whose value is the algebraic sum of the individual source**

∴ **The equivalent resistance of <u>N resistors in series</u> is simply the sum of the individual resistances.**

$$R_S = \sum R_1 + R_2 + \cdots + R_N$$



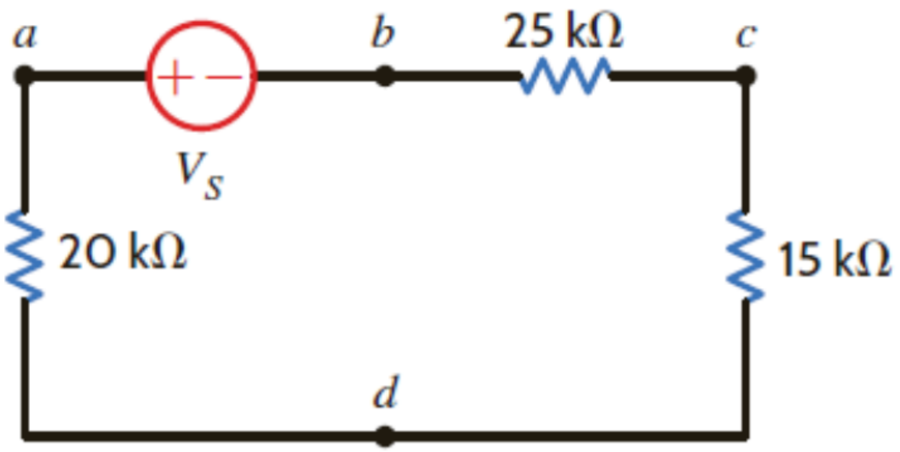
Equivalent Circuit



Circuits 1

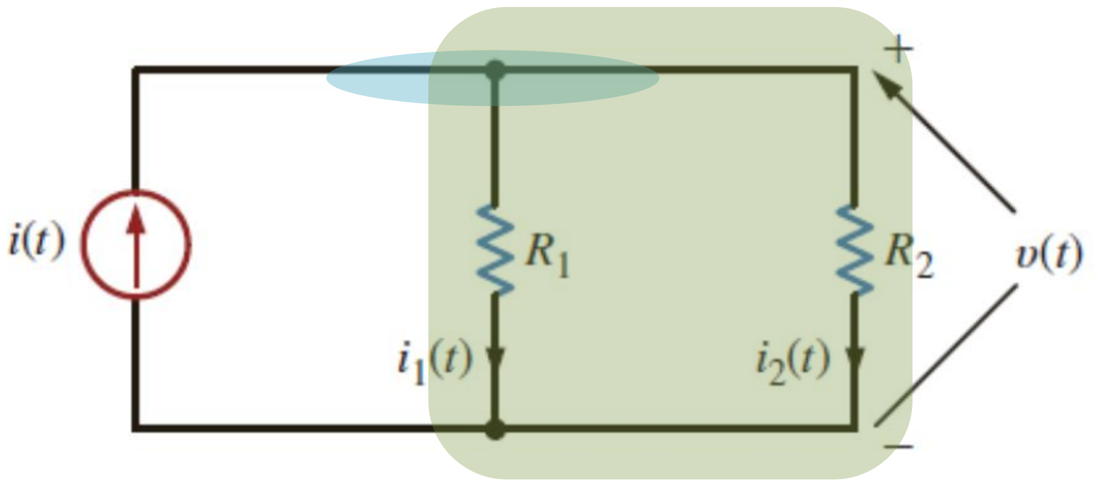
Learning Assessment E2.11

In the network provided, if V_{ad} is 3V, find V_s.



Current Division

$i_1 = ?$ $i_2 = ?$



- KCL: $i(t) = i_1(t) + i_2(t)$
- Ohm's: $i_1(t) = \frac{v(t)}{R_1}$

  $i_2(t) = \frac{v(t)}{R_2}$

$\therefore v(t) = i(t) \cdot \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$

$$\therefore i_1(t) = \frac{R_2}{R_1 + R_2} \cdot i(t)$$

$$i_2(t) = \frac{R_1}{R_1 + R_2} \cdot i(t)$$

** $V_{R1}=V_{R2}=v(t)$*

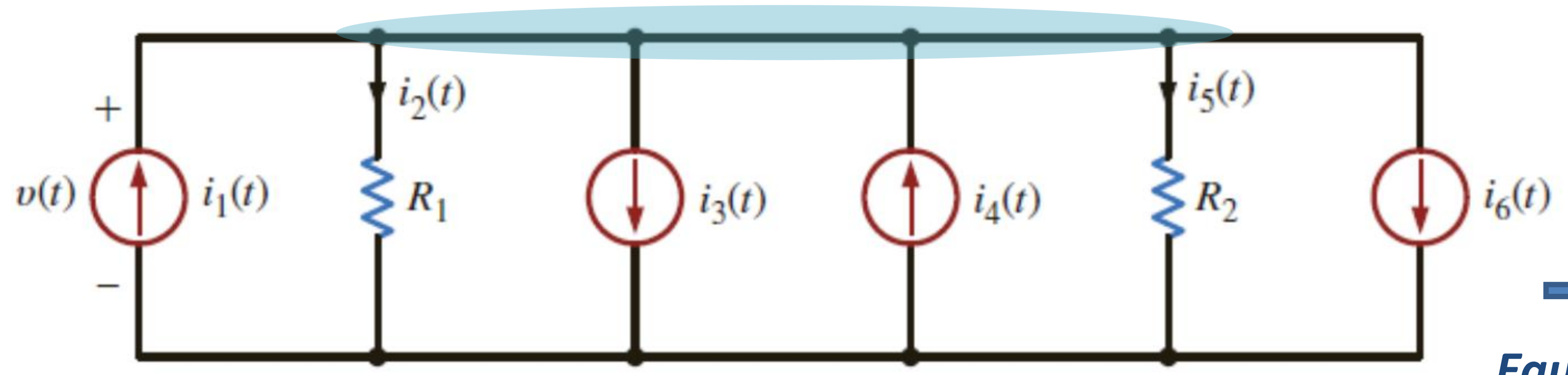
$\therefore$ R_1 and R_2 are in parallel

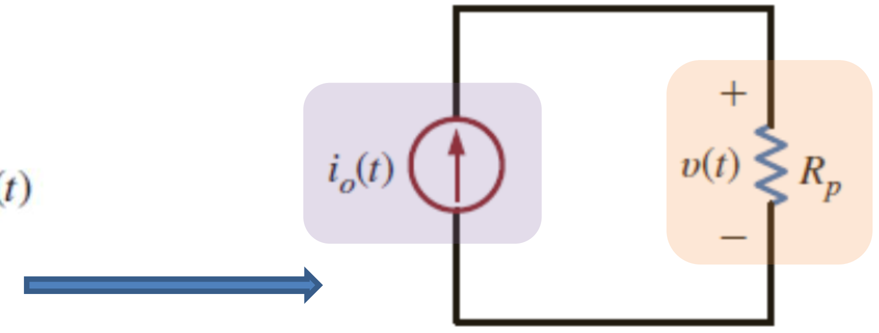
Single Loop Circuits → Multiple Source/Resistor Networks

- **KCL:** $i_1(t) - i_2(t) - i_3(t) + i_4(t) - i_5(t) - i_6(t) = 0$

$$i_1(t) - i_3(t) + i_4(t) - i_6(t) = i_2(t) + i_5(t)$$

$$\underbrace{i_1(t) - i_3(t) + i_4(t) - i_6(t)}_{i_0(t)} = v(t) \cdot \underbrace{\left[\frac{1}{R_1} + \frac{1}{R_2}\right]}_{1/R_p}$$





Equivalent Circuit

Single Loop Circuits → Multiple Source/Resistor Networks

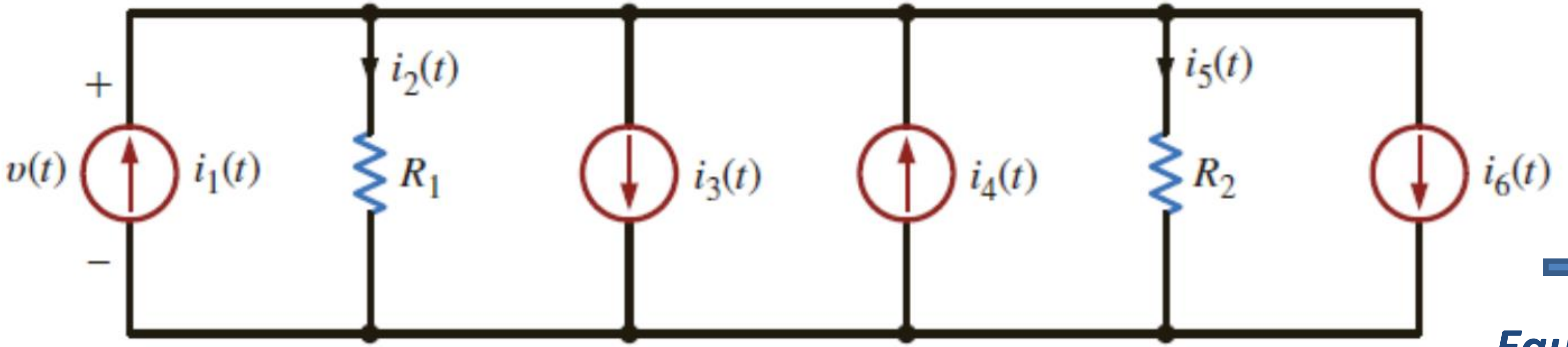
∴ The sum of several current sources in parallel can be replaced by one source whose value is the algebraic sum of the individual source

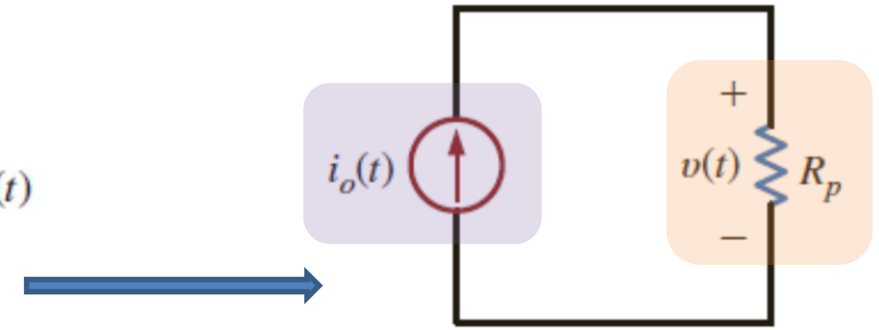
∴ The reciprocal of the equivalent resistance of N resistors in parallel is equal to the sum of the reciprocal of the individual resistances.

$$\frac{1}{R_p} = \sum \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}$$

For 2 resistances in parallel R_p can be expressed as…

$$R_p = \frac{R_1 \cdot R_2}{R_1 + R_2}$$

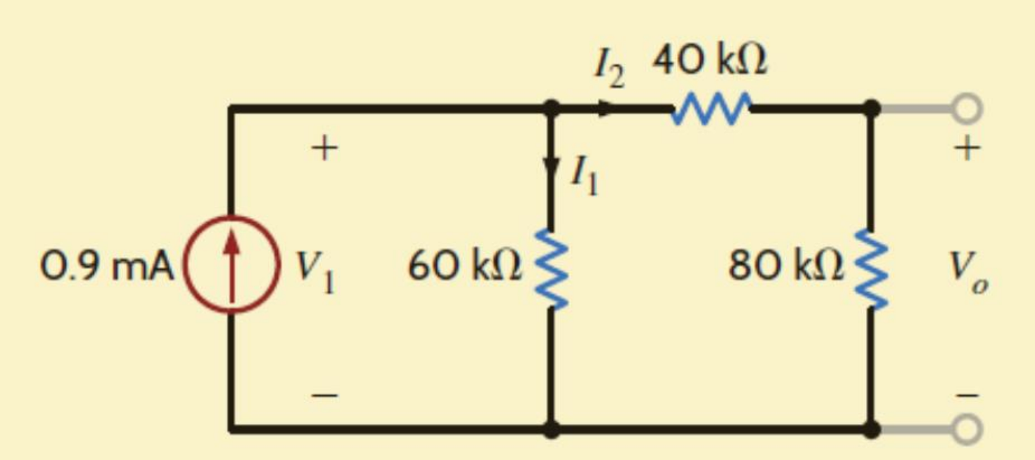




Equivalent Circuit

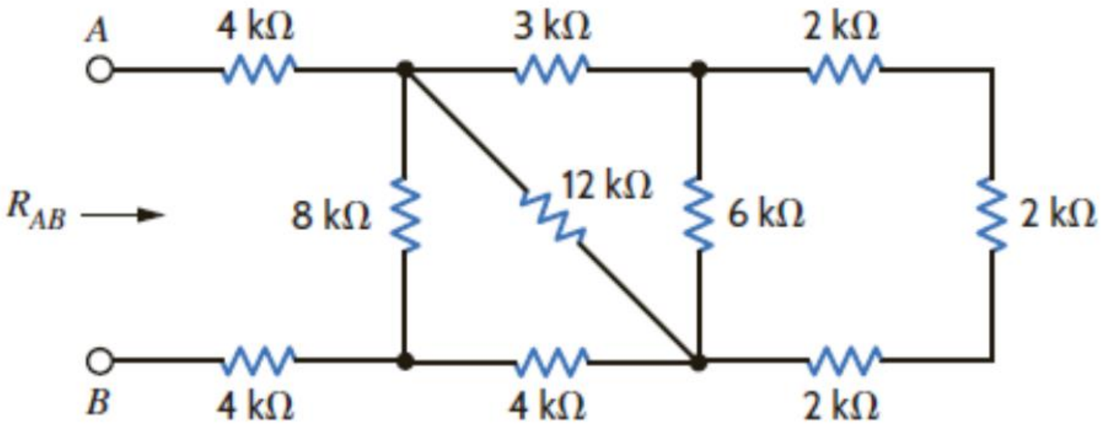
Example 2.17

For the given network find I_1, I_2, and V_0.



Series/Parallel Resistor Combinations

E2.16: Find R_{AB} in the provided network.



- Series: $R_S = R_1 + R_2 + \cdots + R_N$
- Parallel: $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \cdots + \frac{1}{R_N}$

Learning Assessment E2.22

Find V_0, V_1, and V_2 in the network provided.