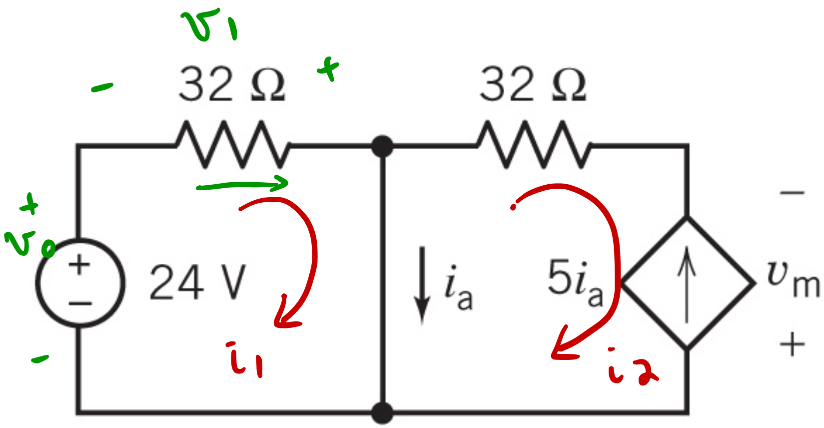
Example 4.7-1

- Determine v_m.



KVL

mesh 1: $v_0 + v_1 = 0$

$24 - i_1 \cdot 32 = 0 \Rightarrow i_1 = \frac{24}{32} = \frac{3}{4}$ A

mesh 2: $-32 i_2 + v_m = 0$ ✓

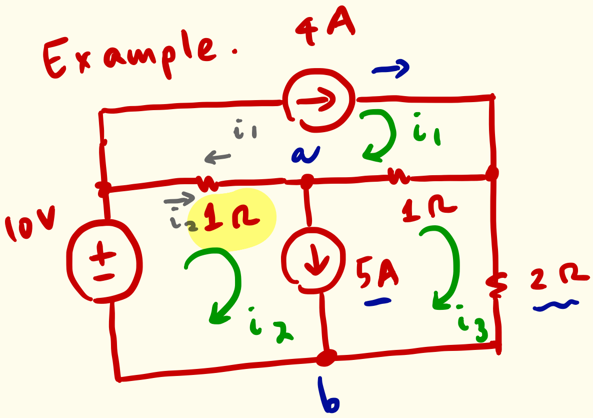
$5 i_a = -i_2 = 5(i_1 - i_2)$

$\Rightarrow 4 i_2 = 5 i_1$

$\Rightarrow i_2 = \frac{5}{4} i_1 = \frac{15}{16}$ A

$v_m = 32 i_2 = 30$ V

Example.



$i_1 = 4A$ ✓

$i_2 - i_3 = 5A$ ✓ (1)

$v_{ab} = v_a - v_b$

KVL

mesh 2: $10 - (i_2 - i_1)\cdot 1 - v_{ab} = 0$ (2)

mesh 3: $v_{ab} - (i_3 - i_1)\cdot 1 - i_3 \cdot 2 = 0$ (3)

From (1), (2), (3)

$\Rightarrow \quad i_2 = \frac{33}{4} A$

$i_3 = \frac{13}{4} A$

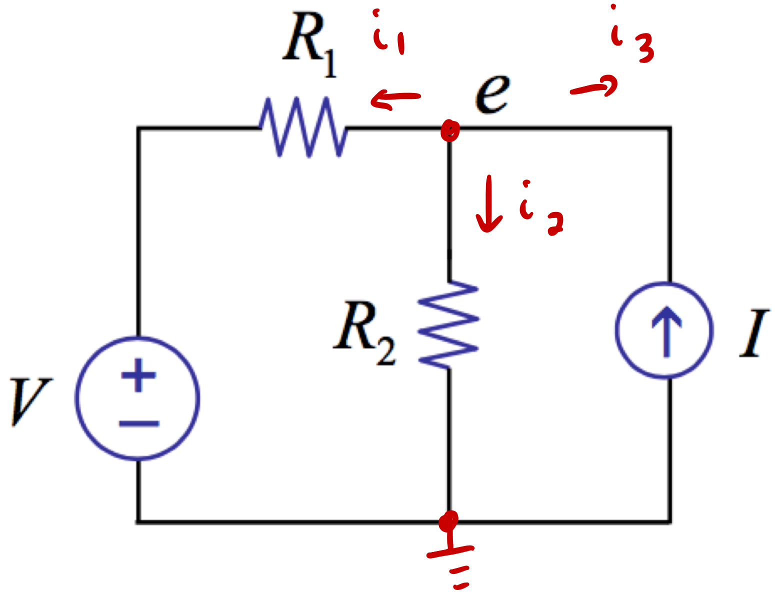
Chapter 5 Circuit Theorems

linear networks

- Superposition
- Thevenin's
- Norton's

Linearity

- Consider this circuit



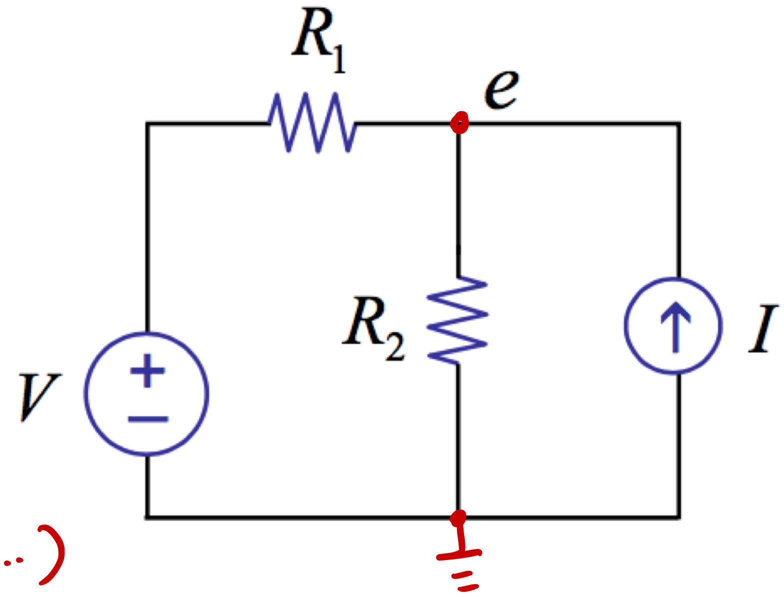
- Write node equation.

Linearity

- Node equation

$$\frac{e-V}{R_1}+\frac{e}{R_2}-I=0$$ linear in e, V, I

(no e^2, V^2, $\sqrt{e}$, $e \cdot I$, $\exp I$, ...)



$$\Rightarrow \quad e = \frac{\frac{V}{R_1}+I}{\frac{1}{R_1}+\frac{1}{R_2}} = \frac{R_2}{R_1+R_2}\cdot V + \frac{R_1 \cdot R_2}{R_1+R_2} I = a \cdot V + b \cdot I$$

where a, b constant

Linearity

- Linearity
  - ✓ Homogeneity
  - ✓ Superposition

Method 5: Superposition

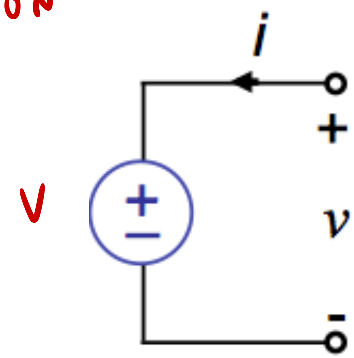
1. Find the partial responses of the circuit to each source acting along.
2. Sum the individual responses.

- Dependent sources remain active at all time. Only the independent sources are turned ON and OFF.

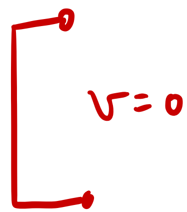
Each Source Acting Along Means…

- Voltage source

ON



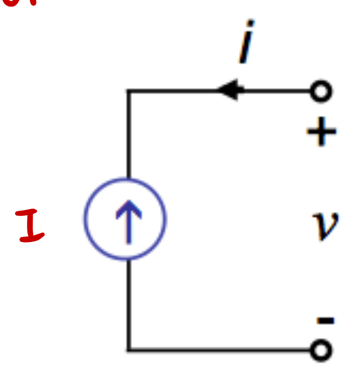
OFF



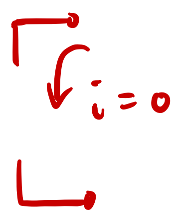
short circuit

- Current source

ON



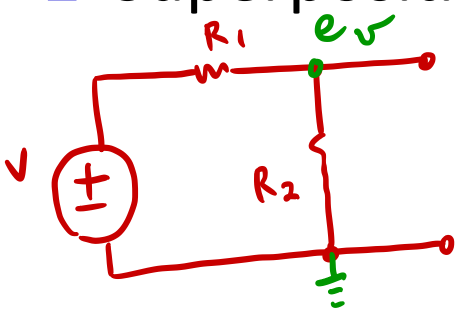
OFF



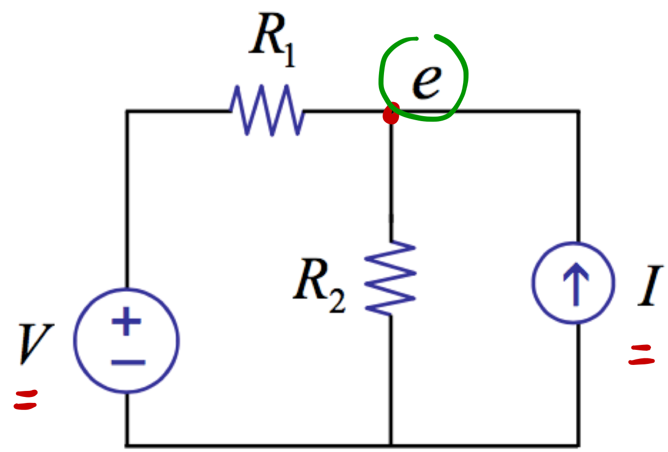
open circuit

Example – Analysis Using Superposition

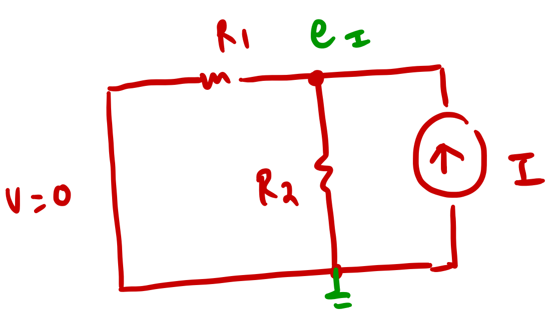
- Superposition – with V acting alone



$(I=0) \quad e_v = \frac{R_2}{R_1+R_2}\cdot V$



- Superposition – with I acting alone

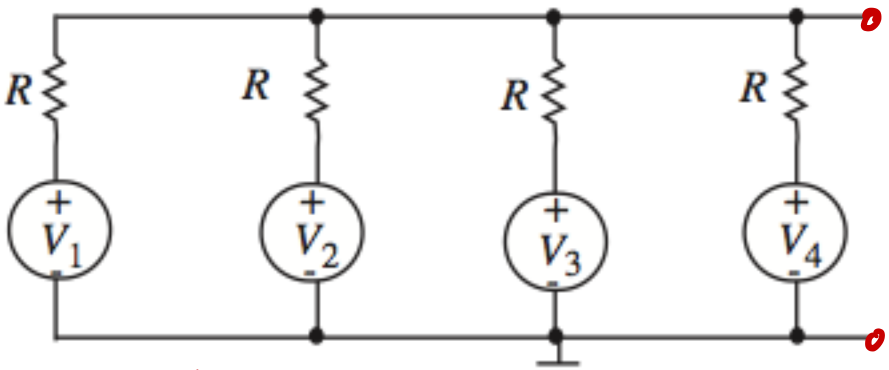


$e_I = I\cdot(R_1 \parallel R_2) = \frac{R_1\cdot R_2}{R_1+R_2}\cdot I$

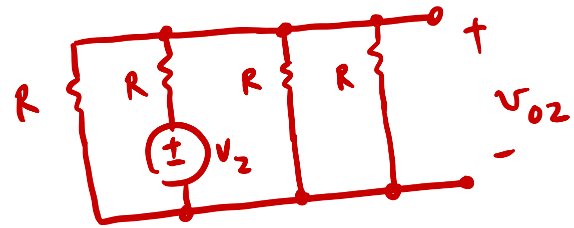
- Sum two partial responses

Total response $= e_v + e_I = \frac{R_2}{R_1+R_2}\cdot V + \frac{R_1\cdot R_2}{R_1+R_2}\cdot I$

Example – Resistive Adder Circuit

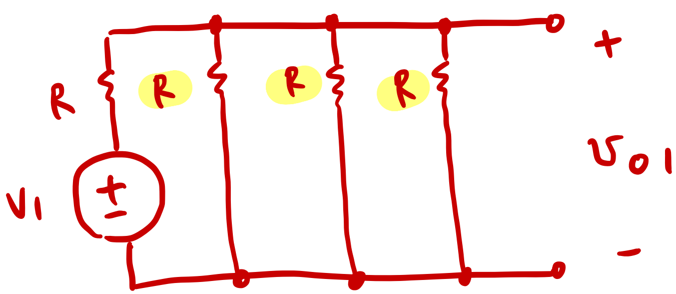


2) Partial response due to V_2, $v_{o2} = \frac{1}{4} V_2$



(v_{o1})

1) Partial response due to V_1 ($v_2 = v_3 = v_4 = 0$)

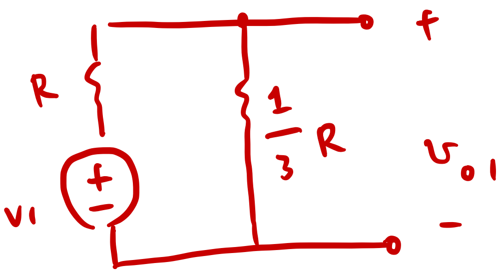


3) $v_{o3} = \frac{1}{4} V_3$

4) $v_{o4} = \frac{1}{4} V_4$

Total $v_o = v_{o1} + v_{o2} + v_{o3} + v_{o4}$

$= \frac{1}{4}(V_1 + V_2 + V_3 + V_4)$



$$v_{o1} = \frac{\frac{1}{3}R}{R + \frac{1}{3}R} \cdot V_1 = \frac{1}{4} V_1$$

Yet Another Method?

- Arbitrary linear network

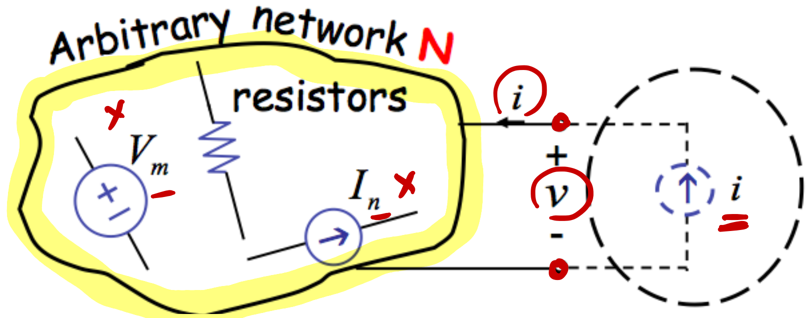
$$v = \sum_m \alpha_m V_m + \sum_n \beta_n I_n + Ri$$

depends only on the network N. independent of i.

where all $V_m = 0$, $I_n = 0$

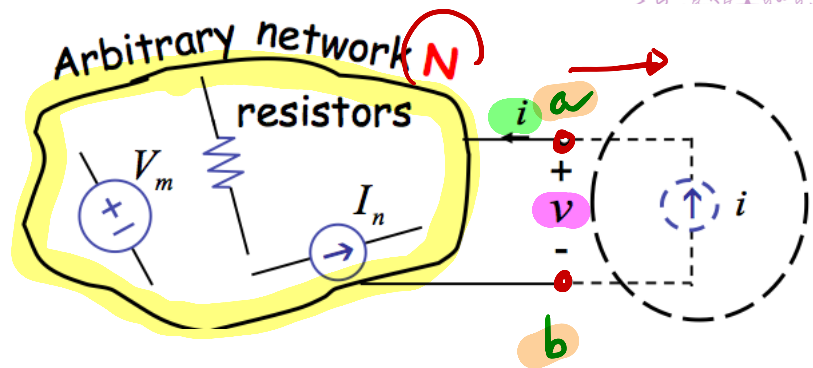
α : no unit

β : Ω



1. Independent of external excitation and behave like a voltage.
   - Let's call it 'v_{TH}'
2. Independent of external excitation and behave like a resistor.
   - Let's call it 'R_{TH}'

Arbitrary Network



$$v = \sum_m \alpha_m V_m + \sum_n \beta_n I_n + Ri$$

$$v = v_{TH} + R_{TH} \cdot i$$

- In other words, as far as the external world is concerned (for the purpose of the *i*-*v* relation), 'arbitrary network N' is indistinguishable from: