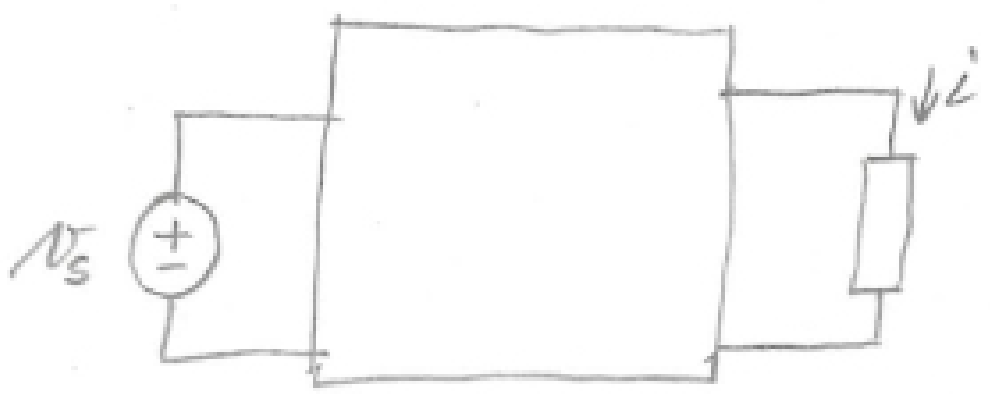
A. A linear circuit must satisfy two properties

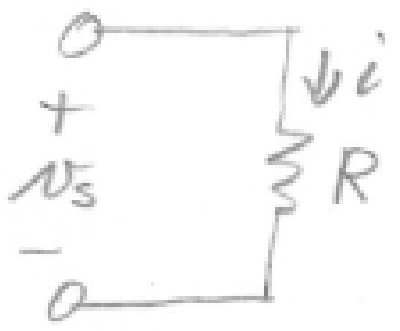
1. The homogeneity property (scaling proportionality)
2. The additive property (superposition)

B. Homogeneity

1. If the input (excitation) of a circuit is multiplied by a constant
2. Then the output (response) of the circuit is multiplied by the same constant.



a) If v_s produces i
b) Then $k v_s$ produces $k i$
c) example



$$i = \frac{v_s}{R} = \frac{1}{R} v_s$$

$$k i = \frac{k v_s}{R}$$

C, Addetive property

1. The response to a sum of inputs is the same as the sum of the responses due to the individual inputs.

a) For v_1:

$$\text{Let } i_1 = \frac{v_1}{R}$$

b) For v_2:

$$\text{Let } i_2 = \frac{v_2}{R}$$

c) Then for $v_1 + v_2$

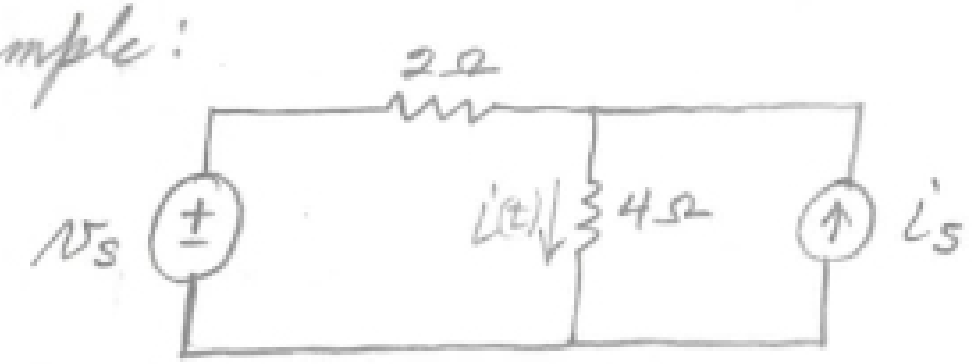
$$i = \frac{v_1 + v_2}{R} = \frac{v_1}{R} + \frac{v_2}{R}$$

$$= i_1 + i_2$$

G. Superposition

1. The complete response is the summation of the responses due to the individual independent sources.

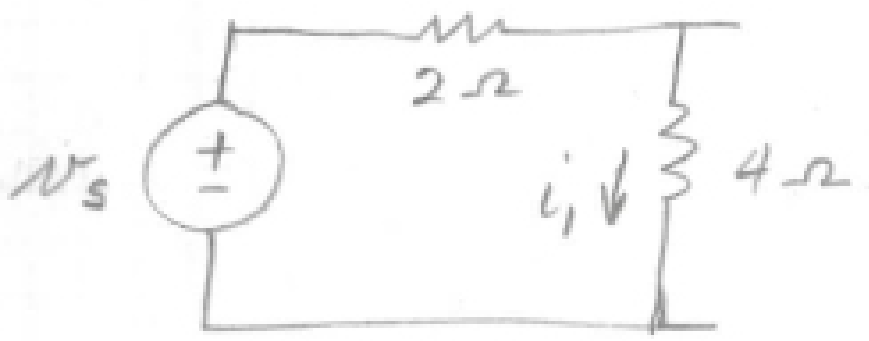
2. Example:



Find $i(t)$

a) Open current source

a) $\therefore i_s = 0$



$$-v_s + 2i_1 + 4i_1 = 0$$

$$6i_1 = v_s$$

$$i_1 = \frac{v_s}{6}$$

b) Eliminate voltage source

a) 0 V is a short circuit

Current division:

$$i_2 = i_s\left(\frac{2}{2+4}\right)$$

$$= \frac{i_s}{3}$$

c) But $i = i_1 + i_2$

$$\therefore \quad i = \frac{v_s}{6} + \frac{i_s}{3}$$