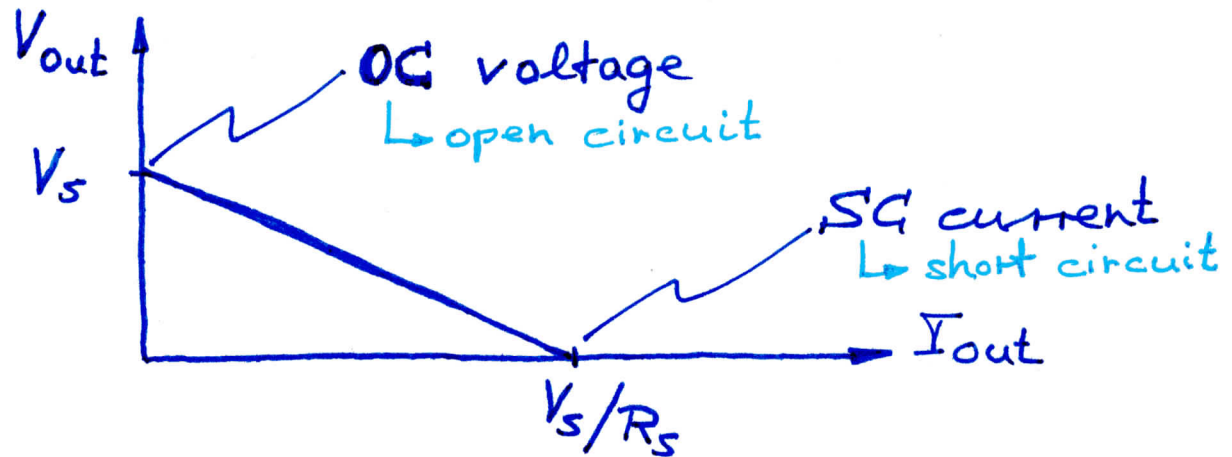# ITE — Homework 01 — Solution

Problem 1: Voltage source and current source

(a) Output voltage of voltage source

$$V_{out} = V_{source} - I_{out} R_{source}$$
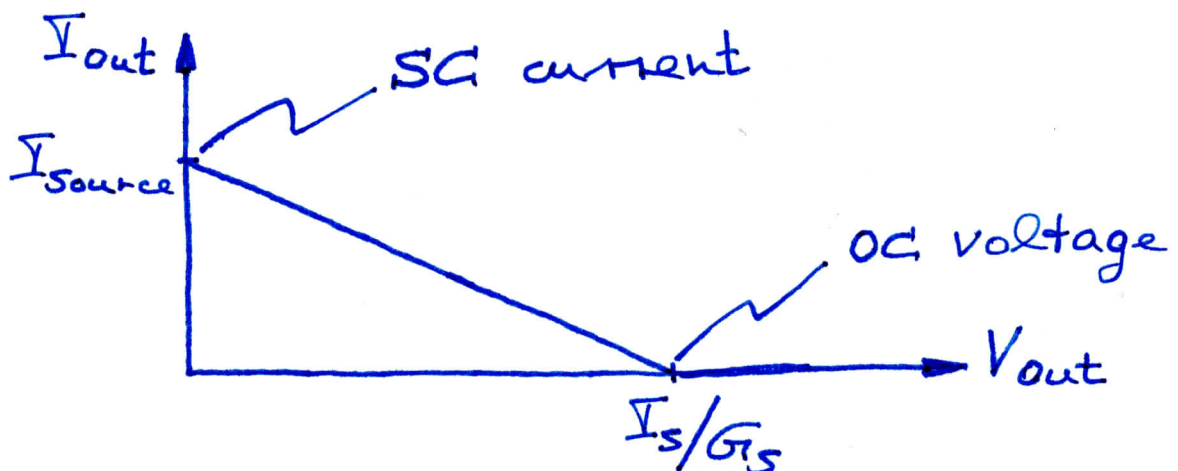
Sketch

OC voltage ↳ open circuit

SC current ↳ short circuit

(b) Output current of current source

$$I_{out} = I_{source} - V_{out} G_{source}$$

Sketch

SC current

OC voltage

Note: $V_{source} = V_s$ $I_{source} = I_s$

(c) The two functions are two straight lines. Yes, the two straight lines can be identical

(d) Two straight lines are identical if two points are identical

(e) If the OC voltage and the SC current are identical, then the two staight lines are identical and the two sources are equivalent

Problem 2 : Linear and non-linear circuits

(a) A linear circuit is a circuit that, when stimulated, gives a response that is proportional to the stimulus.

$$\text{Response} \propto \text{Stimulus}$$
$$\text{Effect} \propto \text{Cause}$$
$$\text{Output} \propto \text{Input}$$

(b) A non-linear circuit is a circuit that, when stimulated, gives a response that is _not_ proportional to the stimulus.

$$\text{Response} \not\propto \text{Stimulus}$$
$$\text{Effect} \not\propto \text{Cause}$$
$$\text{Output} \not\propto \text{Input}$$

(c) —⌇⌇— R   —‖— C   —⌇⌇⌇— L
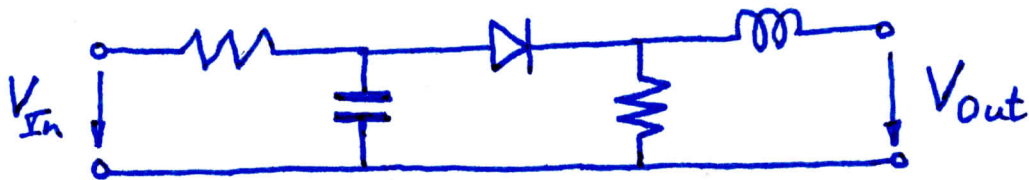
(d) —▷|— Diode   Transistors

(e) Yes. A circuit that includes a voltage source fits the definition of a linear circuit (given above).

(f) Yes. A circuit that includes a current source meets the definition of a linear circuit (given above).

(g) Example of linear circuit

V_{In} V_{out}

(h) Example of non-linear circuit

V_{In} V_{out}

(i) The analysis of linear circuits is generally simpler. This is because a system of linear equations is generally simpler to solve than a system of non-linear equations (quadratic, exponential..)

Problem 3: Superposition principle

(a) A circuit must be a linear circuit to allow for the application of the superposition principle.

(b) The total output of a linear circuit is the sum (superposition) of multiple individual outputs with each individual output being caused by an individual input.

(c) Individual inputs and outputs

$$\text{Input 1} \Rightarrow \text{Output 1}$$
$$\text{Input 2} \Rightarrow \text{Output 2}$$
$$\text{Input } i \Rightarrow \text{Output } i$$

Then

$$\text{Output} = \Sigma_i \text{ Output } i$$

(d) We cannot apply the Superposition Principle to non-linear circuits.