Electronics exam – Operational Amplifiers

[SI-S4-ELEC-4-AOP]

Calculators and documents are forbidden. Scoring scale is given as a guide

Answers exclusively on the subject. If you need more space, you can use the back of the pages.

In all exercises, the operational amplifiers are considered ideal and their output voltages limited by the saturation voltages $-V_{sat}$ and $+V_{sat}$.

Exercise 1 : MCQ (3 points: no negative scoring)

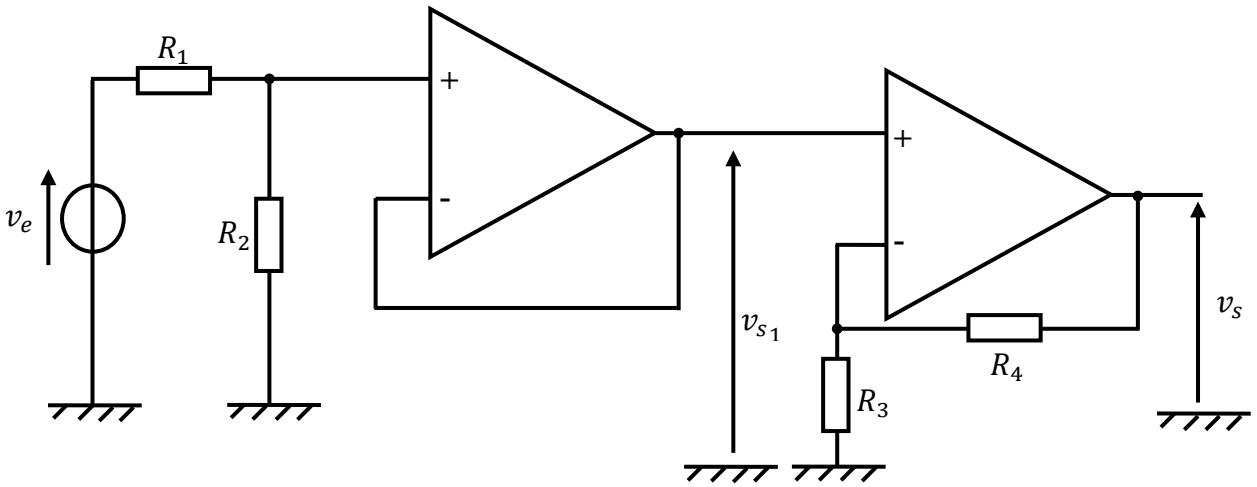
1. The input impedance of an ideal op-amp is infinite, we always have $i^+ = i^- = 0$
   a. TRUE
   b. FALSE

2. What is the characteristic of an op-amp operating in linear mode?
   a. $V_s = \epsilon$
   b. $V^+ = V^-$
   c. $V_s = \pm V_{Sat}$
   d. $V^+ = V^- = 0$

3. The output current of an ideal op-amp is null
   a. TRUE
   b. FALSE

Exercise 2 : Circuits using operational amplifiers (7 points)

Consider the diagram below.



1. The op-amps operate in linear mode? Justify your answer.

2. Give the expression of v_{s_1} in terms of v_e, R_1 and R_2.

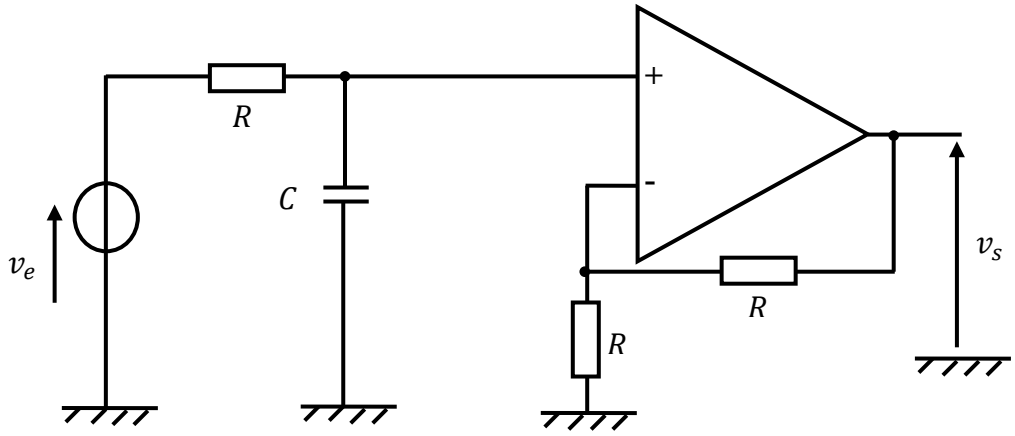
3. Give the expression of v_s in terms of v_{s_1}, R_3 aand R_4.

4. Deduce the expression of v_s in terms of v_e and the resistances.

5. Let's set $R_1 = 10k\Omega$, $R_2 = 20k\Omega$ and $R_3 = 100k\Omega$, calculate R_4 so that $v_s = 2.v_e$.

Exercise 3 : Active Filter (6 points)

Consider the active filter below.



1. The op-amp operates in linear mode? why?

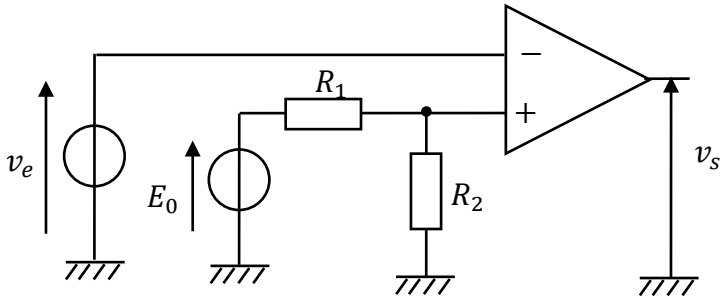
2. Give the expression of the transfer function $\underline{T}(\omega)$ of this active filter.

3. Which type of filter it is? Justify your answer.

Exercise 4 : Comparator (4 points)

Consider the scheme on the opposite:

Let's set $E_0 = 10\ V, V_{sat} = 12V, R_1 = 64K\Omega$ and $R_2 = 16K\Omega$.



1) The op-amp operates in linear mode? Why?

2) The input voltage v_e is a sinusoidal signal with period T and amplitude $6V$.
After having given the expressions of V^+ and of V^-, represent, **justifying it**, the curve $v_s = f(t)$ for $0 \leq t \leq 2T$ on the graph below representing the voltage $v_e(t)$.