Final exam of Electronics

Calculators and documents are not allowed. The number of points per question is indicative.
Answers to be written on this document only.

Exercise 1. (4 points – no negative point)

For each of the following questions, our chacune des questions ci-dessous, choose the right answer(s).

1. We consider the sinusoidal signals $s(t) = S.\sqrt{2}.sin(\omega t + \theta)$. The complex amplitudes $\underline{S}$ is:

   a. $\underline{S} = S.e^{j\omega.t+\theta}$
   b. $|\underline{S}| = Se^{j\theta}$
   c. $\underline{S} = S.e^{j\theta}$
   d. $\underline{S} = S.\sqrt{2}.e^{j\theta}$

We want to identify a two-terminal element. To do so, we measure the current $i(t)$ going through it and the voltage $u(t)$ at its terminals, and we get:

$$u(t) = 20\,cos(\omega t) \text{ and } i(t) = 5.10^{-3}\,sin(\omega t + \phi) \text{ where } \omega = 1000\,rad.s^{-1}$$

2. If $\phi = 0$, this two-terminal element is :

   a. A resistor $R = 4k\Omega$
   b. An inductor $\mathrm{L} = 4\ \mathrm{H}$
   c. A capacitor $\mathrm{C} = 0{,}25\mu\mathrm{F}$
   d. None of this

3. If $\phi = \frac{\pi}{2}$, this two-terminal element is :

   a. A resistor $R = 4k\Omega$
   b. An inductor $\mathrm{L} = 4\ \mathrm{H}$
   c. A capacitor $\mathrm{C} = 0{,}25\mu\mathrm{F}$
   d. None of this

4. What is the unit of the product $C\omega$?

   a. Farad
   b. Siemens
   c. No unit
   d. Ohms

The normalized expression of a 2nd order filter transfer function is:

$$\underline{T} = A_0 . \frac{\underline{Num}(\omega)}{1 + 2.j.z.\frac{\omega}{\omega_0} - \left(\frac{\omega}{\omega_0}\right)^2}$$

5. For a high-pass filter, $\underline{Num}(\omega) =$

   a. 1 b. $2.j.z.\frac{\omega}{\omega_0}$ c. $\left(\frac{\omega}{\omega_0}\right)^2$ d. $-\left(\frac{\omega}{\omega_0}\right)^2$

6. For a band-pass filter, $\underline{Num}(\omega) =$

   a. 1 b. $2.j.z.\frac{\omega}{\omega_0}$ c. $\left(\frac{\omega}{\omega_0}\right)^2$ d. $-\left(\frac{\omega}{\omega_0}\right)^2$

7. For a high-pass filter, A_0 represents:

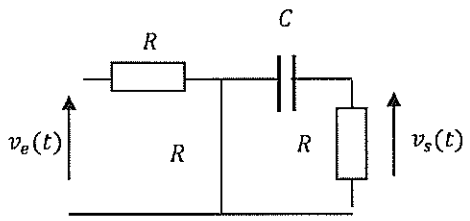
   a. the amplification at VLF
   b. the amplification at VHF
   c. the maximum amplification
   d. the cut-off amplification

8. For a band pass filter, A_0 represents:

   a. the amplification at VLF
   b. the amplification at VHF
   c. the maximum amplification
   d. the cut-off amplification

Exercise 2. 1st Order Filter (8 points)

We consider the following circuit:



1. Qualitative Study : Determine the limits of the gain for $f \to 0$ and $f \to \infty$ and therefore determine the type of filter. What is the maximum amplification?

2. Determine its transfer function. Then determine the cut-off angular velocity

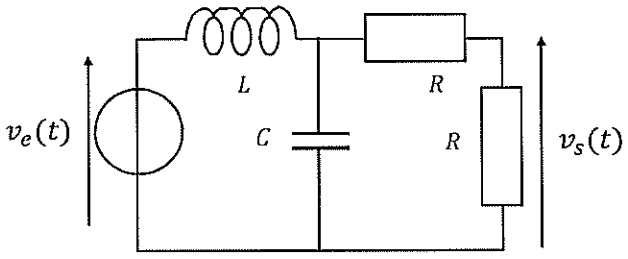
3. Plot the asymptotic bode diagram of the gain and of the phase. Precise the limits of the gain at very low and very high frequencies, and give the equation of the non-horizontal asymptote (the slope) for the gain.

4. Which type of filter would we get if we replaced the capacitor by an inductor? Explain your answer. (We do not ask you an exhaustive study here).

5. if $v_e(t) = V_E sin(\omega t)$, what is the expression of $v_s(t)$:

Exercise 3. 2nd order filter (8 points)

We consider the following circuit:



1. Qualitative study: Determine the limits of the gain for f $\rightarrow$ 0 and f $\rightarrow$ ∞ and give the type of filter.

2. Determine the transfer function and express it with its normalized equation. Express A_0, ω_0 and z.

3. Plot the asymptotic bode diagram of the gain and of the phase. Precise the limits of the gain and the phase at very low and very high frequencies, and give the equation of the non-horizontal asymptote (the slope) for the gain.

4. Which type of filter do we get if we swap C and L? Explain your answer. (We do not ask you an exhaustive study).