EPITA / InfoS1 January 2024

Surname: ………………………………………… First name:……………………………… Group: …………

Exam Electronics

Study of Sinusoidal steady state [SI-S1-ELEC-2-ERS]

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.

Exercice 1. MCQ (4 points – No negative score)

For each question, choose the right answer:

1. In a capacitor, what is the phase shift of the voltage with respect to the current?

   a. $+\frac{\pi}{2}$

   b. $-\frac{\pi}{2}$

   c. $-\pi$

   d. $\pm\frac{\pi}{2}$ depending on frequency

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

   a. Siemens b. Hertz c. Amperes d. Ohms

3. What is the modulus of the complex amplitude if a sinusoidal signal?

   a. The ratio between peak values

   b. The signal instantanoeus value

   c. The signal RMS value

   d. The phase at time's origin

4. What is the argument of the complex impedance of a dipole?

   a. The ratio between peak values.

   b. The phase shift of the current with respect to the voltage.

   c. The phase shift of the voltage with respect to the current.

   d. The phase at time's origin.

Consider a 1st order filter. We note $\underline{T}(\omega)$ its transfer function, $A(\omega)$, its amplification and $G(\omega)$, its gain in dB.

5. What is the ratio of the complex amplitude of the output voltage over the complex amplitude of the input voltage?

   a. The gain $G(\omega)$

   b. The amplification $A(\omega)$

   c. The transfer function $\underline{T}(\omega)$

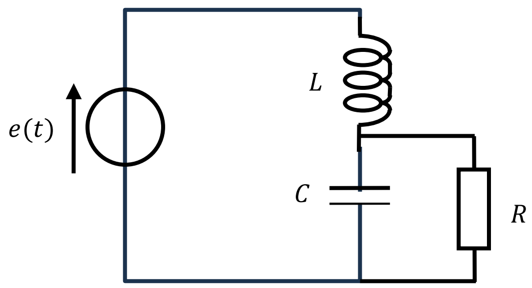
   d. None of this

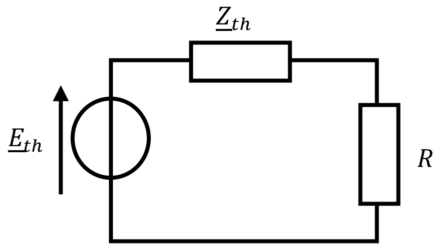
6. $arg\ (\underline{T}(\omega))$ is the phase shift of the output voltage with respect to the input voltage.

   a. TRUE

   b. FALSE

Consider the diagram on the left where $e(t) = E.\sqrt{2}.\sin(\omega t)$. We want to find the Thevenin equivalent seen by the resistor R. In complex representation, we obtain the diagram on the right (Q7&8)





7. What is the formula for $\underline{E}_{th}$?

   a- $\underline{E}_{th} = \frac{L}{C(1-LC\omega^2)}E$

   b- $\underline{E}_{th} = E$

   c- $\underline{E}_{th} = \frac{1}{1-LC\omega^2}E$

   d- $\underline{E}_{th} = -\frac{LC\omega^2}{1-LC\omega^2}E$

8. What is the formula for $\underline{Z}_{th}$?

   a- $\underline{Z}_{th} = \frac{LC}{L+C}$

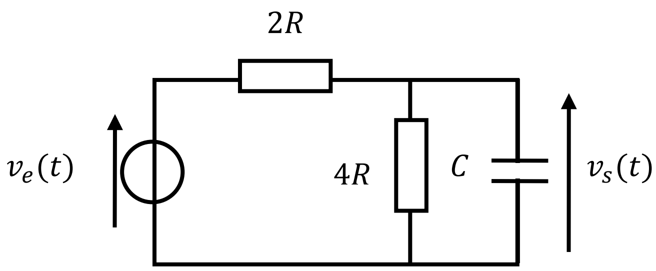
   b- $\underline{Z}_{th} = \frac{jL\omega}{1+LC\omega^2}$

   c- $\underline{Z}_{th} = \frac{1-LC\omega^2}{jC\omega}$

   d- $\underline{Z}_{th} = \frac{jL\omega}{1-LC\omega^2}$

Exercice 2. Sinusoidal steady state: Study of a filter (7 points)

Consider the diagram below:



1. Qualitative study:

   a. Draw the equivalent scheme of the filter at Very Low Frequencies (VLF). Deduce the limit of filter amplification $A(\omega)$ at VLF.

b. Draw the equivalent scheme of the filter at Very High Frequencies (VHF). Deduce the limit of filter amplification $A(\omega)$ at VHF.

c. Conclude on the filter type.

2. <u>Quantitative study:</u>

Determine the transfer function. Deduce the cut-off pulsation.

Exercice 3. Sinusoidal steady state: Study of a filter (9 points)

Consider the diagram below:

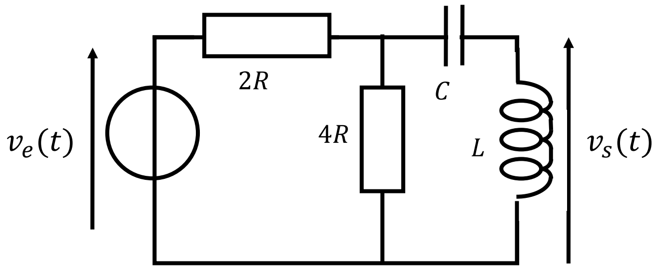


Figure 1

1. Qualitative study:
   a. Draw the equivalent scheme of the filter at Very Low Frequencies (VLF). Deduce the limit of the output voltage v_s at VLF.

   b. Draw the equivalent scheme of the filter at Very High Frequencies (VHF). Deduce the limit of the output voltage v_s at VHF.

   c. Conclude on the filter type and order.

d. What type of filter is obtained filtre when coil and capacitor positions are inverses? Justify your answer.

2. Quantitative study:

a. Find $\underline{E_{th}}$ and $\underline{Z_{th}}$ so that the previous diagram (Figure 1) is equivalent to the diagram on the opposite. Detail your solution.

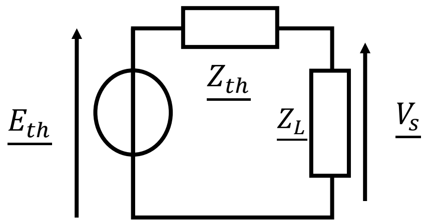


Figure 2

b. Using the diagram in la figure 2, give the expression of the complex amplitude $\underline{V_S}$ associated to the voltage $v_s(t)$ in terms of $\underline{E_{th}}$ and $\underline{Z_{th}}$, then, in terms of R, L, C, ω and $\underline{V_E}$.

Deduce the filter transfer function.

c. Put the transfer function under standardized form and deduce the pulsation ω_0 and the damping coefficient σ. You will find the filter transfer functions in appendix.

Standardized forms of transfer functions

Filter type	Order 1	Order 2
Low Pass	$\underline{T}(\omega) = A_{Max}.\frac{1}{1 + j\frac{\omega}{\omega_c}}$ with : $A_{Max} = A_{VLF}$, $\omega_c =$ Cut-off pulsation	$\underline{T}(\omega) = A_0.\frac{1}{1 + 2j\sigma\frac{\omega}{\omega_0} - \left(\frac{\omega}{\omega_0}\right)^2}$ with : $A_0 = A_{VLF}$
High Pass	$\underline{T}(\omega) = A_{Max}.\frac{j\frac{\omega}{\omega_c}}{1 + j\frac{\omega}{\omega_c}}$ with : $A_{Max} = A_{VHF}$, $\omega_c =$ Cut-off pulsation	$\underline{T}(\omega) = A_0.\frac{-\left(\frac{\omega}{\omega_0}\right)^2}{1 + 2j\sigma\frac{\omega}{\omega_0} - \left(\frac{\omega}{\omega_0}\right)^2}$ with : $A_0 = A_{VHF}$
Band Pass		$\underline{T}(\omega) = A_0.\frac{2j\sigma\frac{\omega}{\omega_0}}{1 + 2j\sigma\frac{\omega}{\omega_0} - \left(\frac{\omega}{\omega_0}\right)^2}$ with : $A_0 = A_{Max}$