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Circuit Theory and Electronics Fundamentals

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5º Laboratory Report

June 8, 2021

Contents

1 Introduction

The objective of this laboratory assignment is to dimension and implement a BandPass Filter (BPF) with a central frequency of 1kHz and a gain at central frequency of 40dB. In order to build the circuit, we used 4 resistors, 2 capacitors and a 741 OPAMP.

In section 2, a theoretical analysis of the circuit is presented. In section 3, the circuit's simulation analysis results are expressed in graphics and commented. Finally, in section 4, we will compare the simulation and theoretical values and in this way conclude our study.

2 Theoretical Analysis

In this section we will do the theoretical analysis of our circuit. The transfer function corresponds to the following equation:

$$T(s) = (R_1C_1s/(1 + R_1C_1s)) * (1 + R_3/R_4) * (1/(1 + R_2C_2s))) \tag{1}$$

in which, $s = (2\pi * f) * j$ The frequency of the low pass filter is:

$$f_L * 2\pi = 1/R_2C_2 \tag{2}$$

The frequency of the high pass filter is:

$$f_H * 2\pi = 1/R_1C_1 \tag{3}$$

taking into account the equations above, the central frequency can be expressed as:

$$f_c = \sqrt{f_L * f_H} \tag{4}$$

The equations for the input impedance is the following:

$$Z_in = R_1 + 1/jw_cC_1 \tag{5}$$

The output impedance can be expressed as:

$$Z_out = 1/(jw_cC_2 + (1/R_2)) \tag{6}$$

In the following graphics, we plotted the output voltage gain and phase functions:

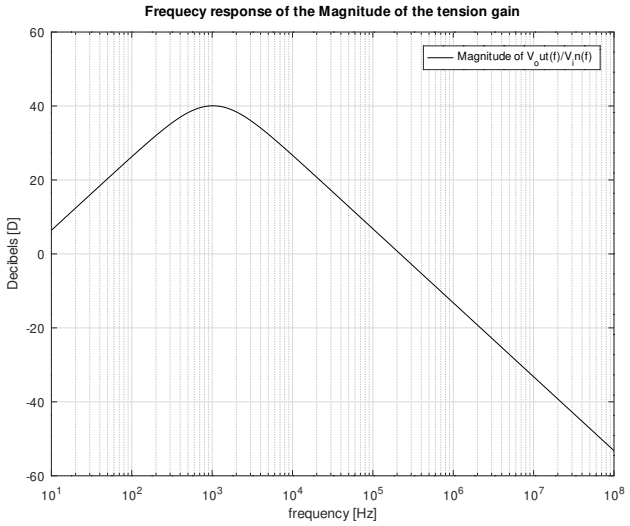

Figure 1: Output voltage gain plot

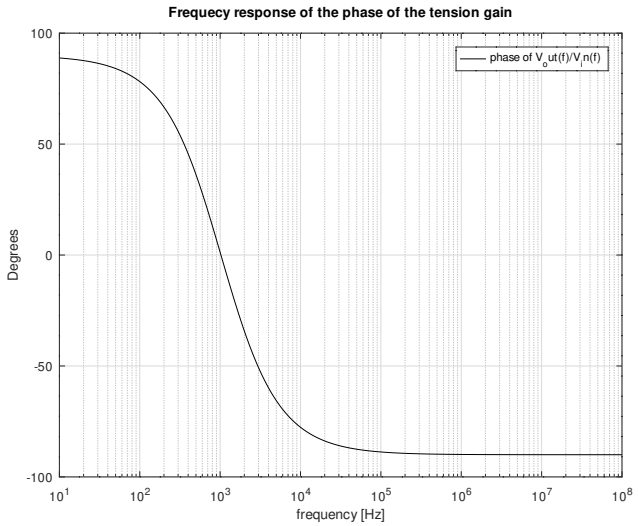

Figure 2: Phase plot

In the next table, we have, the frequencies, gain and impedances mentioned above, as well as, the merit figure:

Name	Value [mA]
Theorical Input Impedance	1.000000 -0.723432 i KOhm
Theorical Output Impedance	0.676732 -0.467724 i KOhm
Voltage Gain at central freq	100.643363 V
Voltage Gain at central freq in decibels	40.055703 V
Center of freq	1023.884633 Hz
Deviation of center of freq	23.884633 Hz
Cust	13626.952090
Cut-off frequency	407.531343 Hz
Bandwidth	2164.883661
Cust	13626.952090 M.U.
Merit	2.991846 u

Table 1: octave results

3 Simulation Analysis

3.1 Frequency analysis

the simulated values we obtained are represented in the graphics and tables present along this section and allow us to understand and estimate the behavior of the circuit. We will add some comments to the results and in the conclusion we will compare them to the theoretical analysis, which was done in order to obtain the gain of the circuit.

In the following graphics, we obtained V_out, in dB, in function of the frequency, as well as, the phase function:

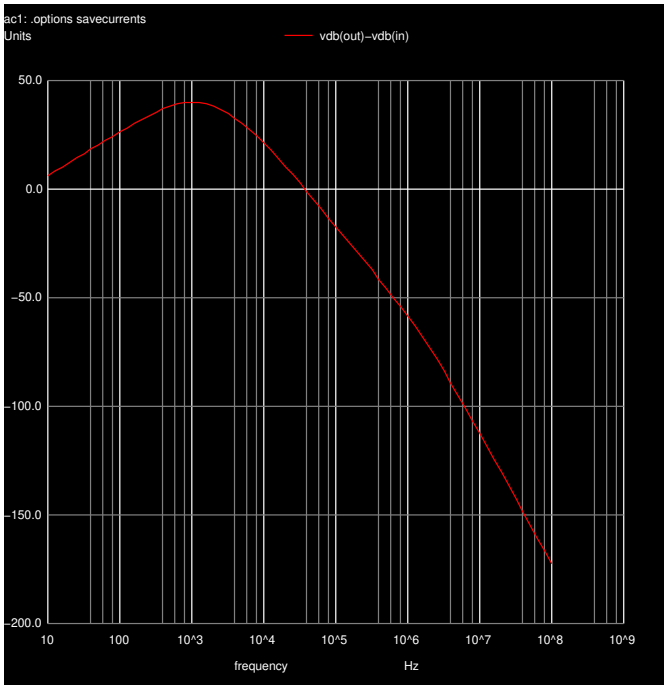

Figure 3: Vout (dB)

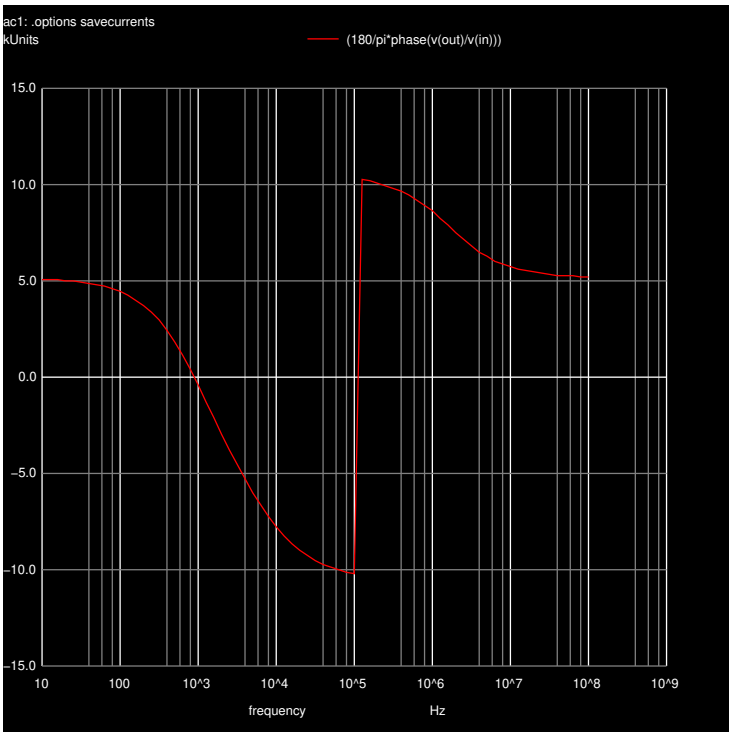

Figure 4: Phase

We can also express V_out in function of time for a frequency of 1KHz, shown in the table below:

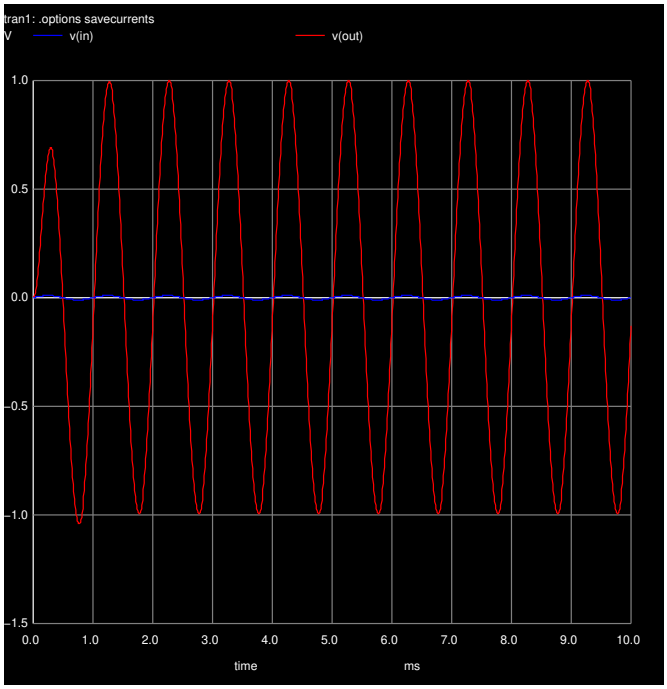

Figure 5: Vout (dB) in function of time

From this analysis, we obtained the simulated values for the output voltage gain, the central frequency, the input and output impedance, as well as, the values for the upper, lower cut off and central frequencies. The merit figure is also present in the first table:

Name	**Value [mA]**
V Gain (1KHz)	98.8719
Bandwidth	1982.56
Central frequency	981.37
frequency desviation	18.6301
Central gain deviation	1.12814
Cost	13627
merit	3.71409E-06

Table 2: Resultados

Name	**Value [mA]**
Input Impendence	0.999979 + -0.723583 i KOhm

Table 3: input impedance

Name	Value [mA]
Output Impendence	0.68172 + -0.46675 i KOhm

Table 4: output impedance

4 Conclusion

To summarize, there were some deviations between the theoretical and simulated vales,which directly affect our merit, making it lower than we anticipated. However, this doesn't mean our methods aren't a good approximation or that they cannot be used to simulate the circuit used in this lab assignment. The deviations mentioned before directly The errors we obtained are most likely due to some mistakes made when writing the code and the circuit equations in octave and can be fixed. we should also mention that the cost we obtained for our circuit was slightly higher than we hoped for, but it was necessary. In conclusion, some compromises were made, but we still obtained good results and accomplished the objective of this lab assignment, as well as having both methods being able to amplify the as asked by the professor.