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Circuit Theory and Electronics Fundamentals

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4º Laboratory Report

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Contents

1 Introduction

The objective of this laboratory assignment is to chose the architecture of the gain and output amplifier. By doing this we will design a audio amplifier circuit and bear in mind that cost is a very important factor and we should make the circuit as budget friendly as possible while keeping a good or great efficiency, provided the output has no visible distortion of the input sine waves.

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 the following subsections, we will explain the theoretical analysis made to predict the output voltages and impedance in the Gain and Output, designed by the teacher previously. It's important to mention that the gain stage and output parameters are in the same table and the gain stage and output stage results as well.

2.1 Gain Stage

In the table below we have the most important values used to design the circuit for the gain stage:

Name	Value [mA]
VT	0.025000
BFN	178.700000
VAFN	69.700000
RE1	0.100000 K
RC1	1.000000 K
RB1	80.000000 K
RB2	20.000000 K
VBEON	0.700000
VCC	12.000000
RS	0.100000 K
BFP	227.300000 K
VAFP	37.200000
RE2	0.100000 K
VEBON	0.700000
C I	1000.000000 u
C E	1000.000000 u
C O	1.000000 u

Table 1: Octave Parameters

The circuit is constituted by tow stages, an initial stage with an high input and output impedance, and a second stage a high input impedance, low output impedance and with a gain close to one. The results we obtained, by the method described above, are present in the following table

Name	Value [mA]
V eq	2.400000 K
I B	0.050044 m
I c 1	8.942891 m
I e 1	8.992935 m
V E	0.899293
V Output 1	3.057109
VCE	2.157816
V Input 2	3.057109
I c 2	82.067853 m
I e 2	82.428908 m
V Output	3.757109

Table 2: Octave operating point results

If we pay attention to the values obtained, we notice that the output impedance is too high, so the circuit cannot be connected to an 80hm load and, therefore, we need an output stage.

2.2 Output Stage

As mentioned previously, we need the output stage to induce a low impedance to the load and the parameters for this circuit are shown below:

Name	Value [mA]
VT	0.025000
BFN	178.700000
VAFN	69.700000
RE1	0.100000 K
RC1	1.000000 K
RB1	80.000000 K
RB2	20.000000 K
VBEON	0.700000
VCC	12.000000
RS	0.100000 K
BFP	227.300000 K
VAFP	37.200000
RE2	0.100000 K
VEBON	0.700000
C I	1000.000000 u
C E	1000.000000 u
C O	1.000000 u

Table 3: Octave parameters

As seen before, the operating point and incremental analysis were acquired in order to find the output impedance and gain. The results can be seen below:

Name	Value [mA]
V eq	2.400000 K
I B	0.050044 m
I c 1	8.942891 m
I e 1	8.992935 m
V E	0.899293
V Output 1	3.057109
VCE	2.157816
V Input 2	3.057109
I c 2	82.067853 m
I e 2	82.428908 m
V Output	3.757109

Table 4: Octave operating point results

Our objective was to get a gain for the output stage as close to one as possible and a low output impedance, which is exactly what we accomplished and it also means that its ideal to connect the load.

2.3 Total Results

Lastly, we will analyze the frequency response of the gain and plot it into a graphic as the one below.

The graphics of the voltage deviation is:

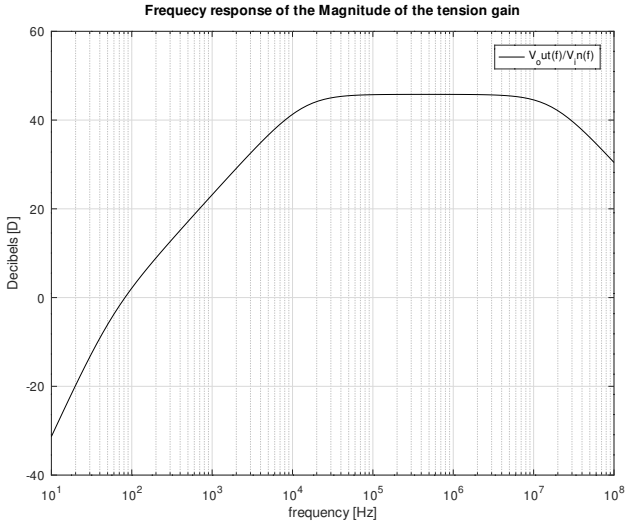

Figure 1: Voltage deviation plot

The results (of higher importance) obtained for the total circuit are shown in the next table:

Name	**Value [mA]**
V eq	2.400000 K
I B	0.050044 m
I c 1	8.942891 m
I e 1	8.992935 m
V E	0.899293
V Output 1	3.057109
VCE	2.157816
V Input 2	3.057109
I c 2	82.067853 m
I e 2	82.428908 m
V Output	3.757109

Table 5: Total circuit results

Just by observing this results, we can understand that both stages can be connected without any major signal loss and the reason is that the output impedance is significantly smaller than the input impedance of the output stage.

3 Simulation 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.

Firstly, we produced the graphic of the output voltage in the gain stage in function of time and by analyzing i, no visual distortion can be seen:

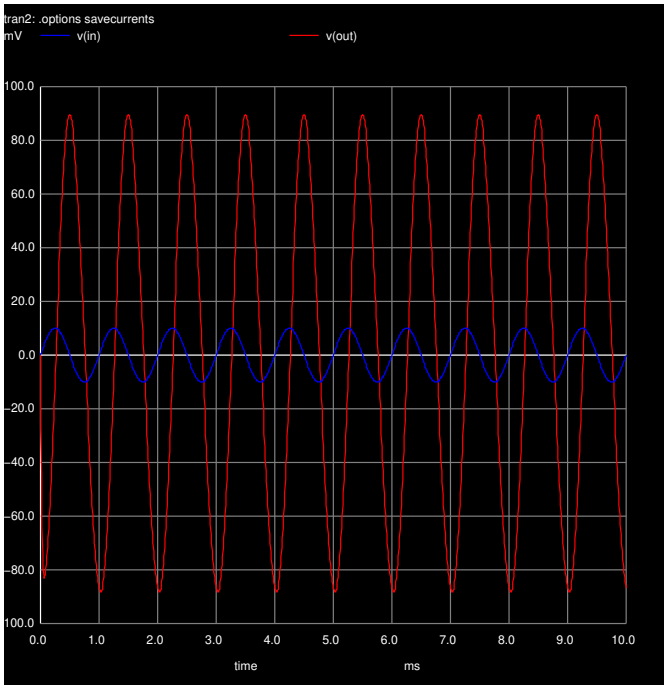

Figure 2: Frequency response - output voltage (gain stage)

Secondly, the frequency response of the output voltage in both the gain and output stage can be seen in the next tow figures, respectively:

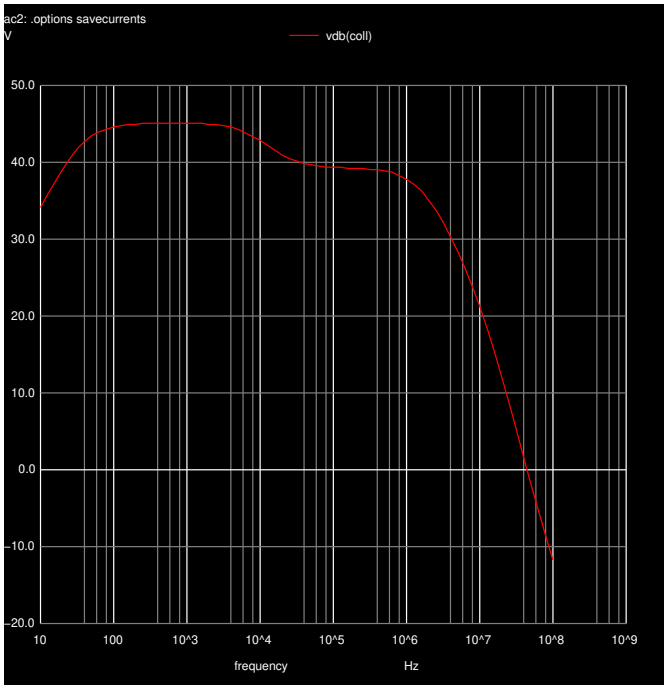

Figure 3: Frequency response - Gain

In the figure below, we have the gain generated by the circuit:

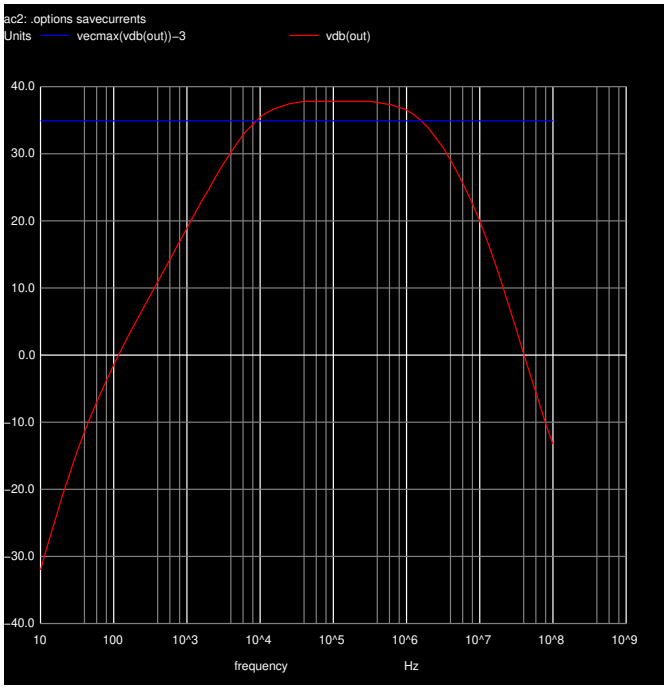

Figure 4: Frequency response - Gain

Lastly, the simulated values obtained can be seen in the following table:

Name	**Value [mA]**
V Gain	37.904
Bandwidth	1.59486E+06
CO Freq	8880.42
Cost	2102.2
merit	3.23818

Table 6: simulated results

Name	**Value [mA]**
Output Impendence	1.0612

Table 7: simulated results

Name	**Value [mA]**
Input Impendence	56.3853

Table 8: simulated results

4 Conclusion

To summarize, there were some deviations between the theoretical and simulated vales,which directly affect our merit (3,23818), 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 (the cost was 2102,2 monetary units), 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.