Circuit Theory and Electronics Fundamentals

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Laboratory Report

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1 Introduction

In this laboratory assignement the objective is to study an amplifier together with some of its properties, namely the input and output impedances, the voltage gain and also the influence of the frequency on this gain. The specific circuit used in the Octave and Ngspice software is the one illustrated:

Figure 1: Amplifier circuit

The use of an amplifier generally means the ability to obtain an output signal with a greater amplitude in relation to its source signal. An example of using this type of circuit is the simplest microphones that can be found on the market.

2 Theoretical Analysis

In this section we will detail the theoretical study of the Amplifier Circuit conducted during this lab. The circuit was divided into two seperate ones: the gain stage and the outrput stage. The first one increased the gain, but it had a drop of current considered undesirable due to the output impedance. The latter one corrects this effect while having a gain near one, as to not decrease the voltage previously gained.
The entire circuit can be seen in the following image:

Figure 2

One must note that Vin and Rin constitute the thevenin equivalent of the circuit that the amplifier is connected to.
The capacitator connected to Rin will enforce that only the AC part of the voltage is taken into account. The DC part is suplied by a constant 12V voltage source. With this arquitecture, we can ensure that the transistors are in foward active region (FAC), for the

height

Table 1: Operating point analysis using Octave

Then, gain, input and output impedances were also obtained for two different states, namely for the gain stage and the output stage. The equations used to compute the results for the Gain stage are as follows:

$$\frac{v_o}{v_i} = -g_m(\frac{1}{R_C} + 1]r_o)v_{pi}\text{(1)}$$

where:

$$v_{pi} = \frac{\frac{1}{r_{pi}} + \frac{1}{R_{B1}} + \frac{1}{R_{B2}}}{R_S + (\frac{1}{r_{pi}} + \frac{1}{R_{B1}} + \frac{1}{R_{B2}})} v_s \tag{2}$$

$$Z_I = frac1R_{B1} + frac1R_{B2} + \frac{1}{r_{pi}} \tag{3}$$

$\text{Z}_O = \frac{1}{R_C} + \frac{1}{R_o}$
(4)

In parallel, the equations involved in computing for the Output stage are as follows:

$\text{v}_o\frac{}{v_i=\frac{g_m}{g_{pi}+g_E+g_o+gm}}$(5)
where g's are the admitances.

$\text{Z}_I = \frac{g_{pi}+g_E+g_o+gm}{g_{pi}(g_{pi}+g_E+g_o)}$(6)

$\text{Z}_O = \frac{1}{g_{pi}+g_E+g_o+gm}$(7)
Using the Octave software, the following values were obtained:

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Table 2: Voltage gain, Input and Output Impedances for Gain Stage

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Table 3: Volatge gain, Input and Output Impedances for Output Stage

Finally, a study was carried out in the frequency domain for the incremental circuit of voltage gain, then obtaining the graph in dB or SOMETHING LIKE THIS:

Figure 3: Frequency response of Voltage gain in Gain stage

3 Simulation Analysis

In the simulation study of an amplifier circuit, the Ngspice software was used, where some modifications were made to the script initially made available in order to obtain the best merit in this work. For this and also as a requirement, the NPN and PNP models were used for the transistors, referring to the Gain stage and the Output stage, respectively.

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Table 4: Voltages

4 Comparisons

In this section we proceed to a comparsison of the results obtained between Ngspice and Octave. Looking at the table down bellow we see a difference in values.

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Table 5: Ripple and DC voltages from Theoretical Anallysis

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Table 6: Ripple and DC voltages from Simulation Analysis

Finally looking at the values in Table 3 and Table 4, of which the values were broken down in the Simulation Analysis, we then confirm the difference referred to in the previous paragraph.

5 Conclusion

We then concluded our laboratory work, corresponding to all the criteria initially proposed. It is true that there are discrpancies between the two different set of results, but these are discussed in the section of comparisons.

References

[1] K. Mayaram (1988) in 'DC and transient analyses' *CODECS: A Mixed-Level Circuit and Device Simulator, Memorandum No. UCB/ERL M88/71* Berkeley , p.23
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