TÉCNICO LISBOA

Circuit Theory and Electronics Fundamentals

Lab 3 - AC/DC Converter

Aerospace Engineering

Laboratory Report

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Contents

1 Introduction

This report is being made for the subject of Circuit Theory and Electronics Fundamentals and is related to the third laboratory being its objective to develop an AC/DC converter circuit using an envelope detector and an voltage regulator. The display of this circuit can be seen in Figure 1. In Section 2 a theoretical analysis will be made. Secondly, in Section 3 it will be simulated the circuit using ngspice. Following with both results from Section 2 and Section 3 being compared and commented in Section **??**

The conclusions of this study are outlined in Section 4.

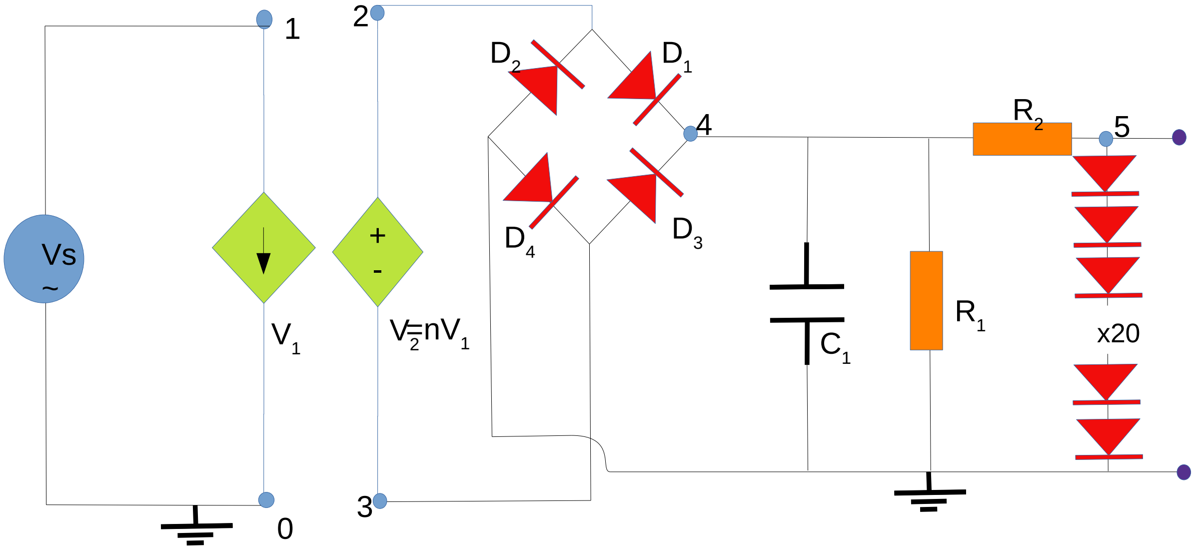

Figure 1: AC/DC converter circuit

2 Theoretical Analysis

In this section, the output voltage, voltage ripple and envelope detector output of the circuit shown in Figure 1 will be analysed theoretical.

2.1 Natural Solution with node analysis for t$\geq$ 0

The aim of this section is to calculate the natural solution of $v_{6n}(t)$. Hence, the graph of V_{6n} in function of the time, in the interval [0;20] ms is represent in 2. The result is no suprise, as it shows below, being a negative exponential graph.

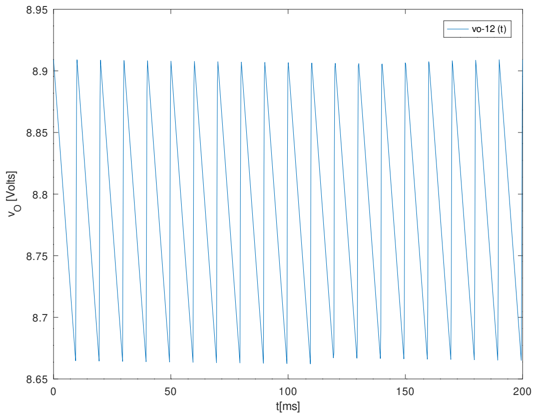

Figure 2: Natural solution $v_{6n}(t)$

2.2 Natural and Forced Superimposed

In this subsection, we determine the final total solution for the value of v_6 for the given

In Figure 3 we plotted the graphs of $v_6(t)$ and $v_s(t)$ in the interval [-5;20] ms. We can clearly divide the solutions in three parts:

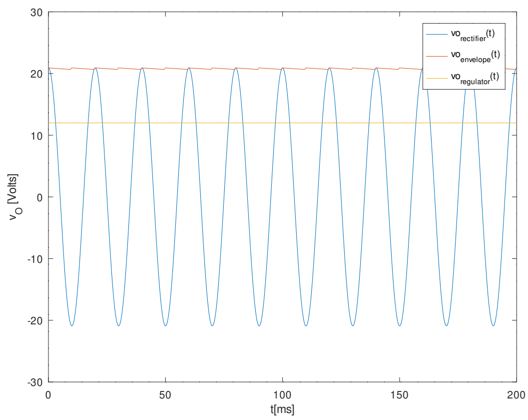

Figure 3: $v_s(t)$ and the final solution of $v_6(t)$ in the interval [-5;20]ms for the frequency of 1000Hz

3 Simulation Analysis

This section covers the circuit simulation using the Ngspice tool, where the ac/dc converter was simulated for 10 periods using the default diode model.

Firstly, the transformer was replaced by an ideal model using an dependent current source and an dependent voltage source. Then, by trial and error the values of the resistors, capacitor and n parameter were adjusted reaching a good accuracy. The goal was to reach the closest value to 12V in the output voltage.

As asked in the lab assignment, the input voltage of the the secondary circuit, the output voltage of the envelope detector, the output voltage of the voltage regulator and (v(5)-12) were computed and ploted.

Later in this report, we will compare this results with the theoretical ones but for now we will just show them.

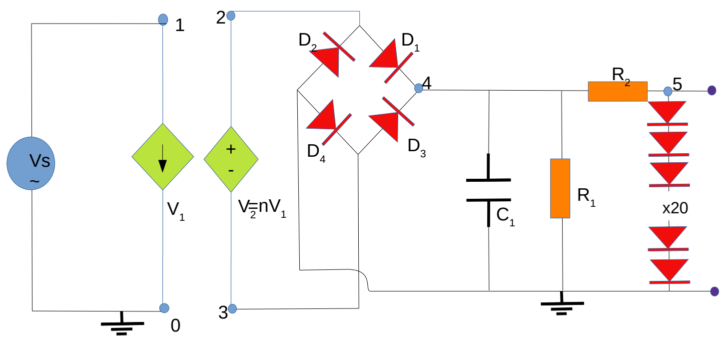

Figure 4: AC/DC converter circuit

The Table 1 shows the output voltages results for the circuit described in Figure 4.

Name	Value [A or V]
maximum(v(4))-minimum(v(4))	1.556516e-01
mean(v(4))	1.286552e+01
maximum(v(5))-minimum(v(5))	3.715695e-02
mean(v(5))	1.121846e+01

Table 1: Outpu voltages results in Volts

The Table 2 show the merit value obtained by the group.

Name	Value [A or V]
1/((maximum(v(5))-minimum(v(5)))*(mean(v(5)))+10e-6)	2.398923e+00

Table 2: Merit values

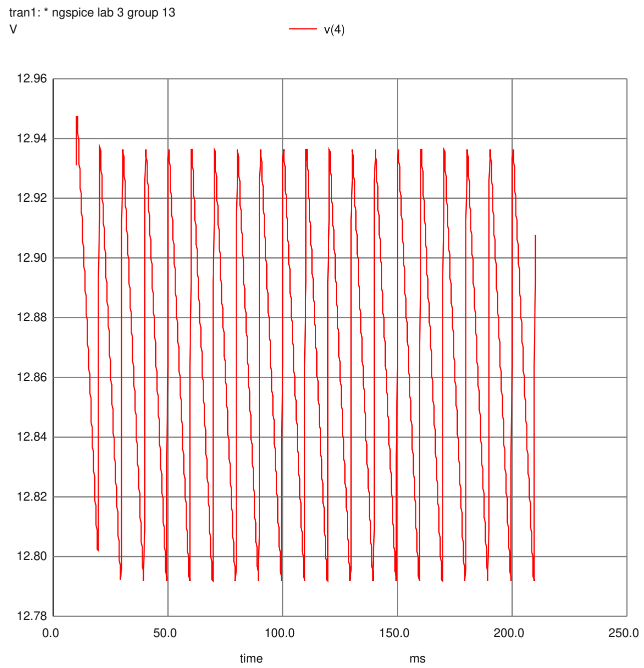

Figure 5: Output Voltage of the envelope detector v(4)

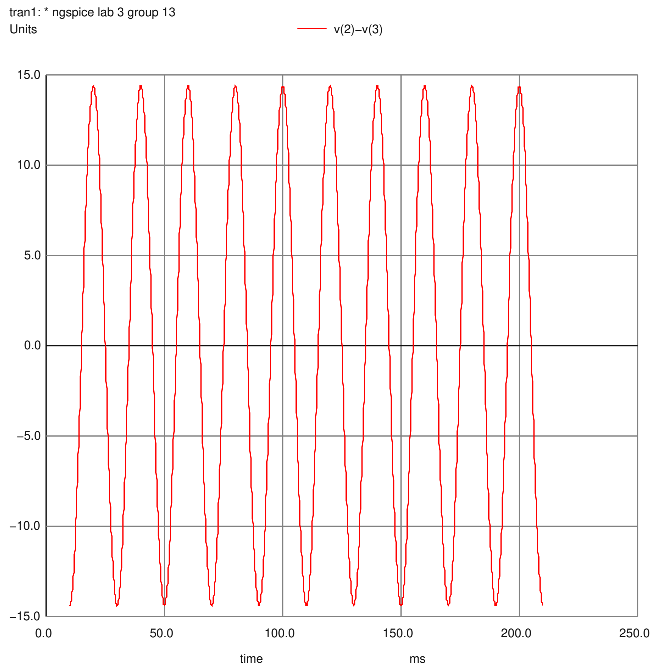

Figure 6: Input Voltage of the secondary circuit (v(2)-v(3))

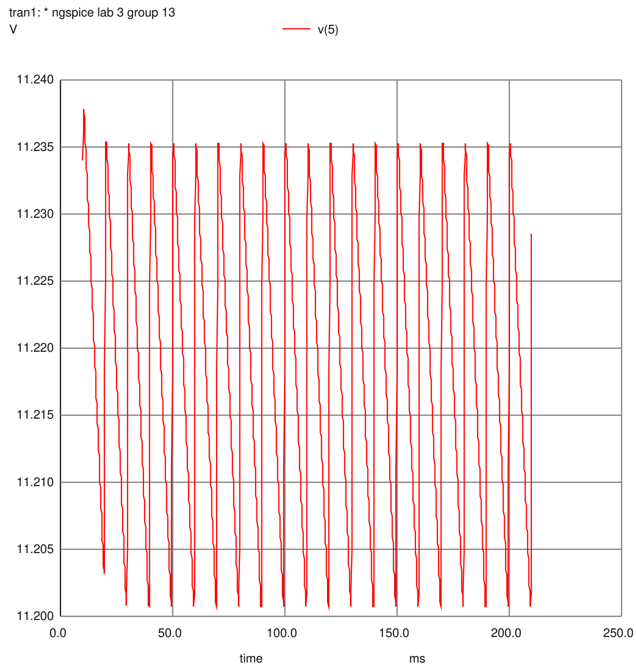

Figure 7: Output Voltage of the voltage regulator v(5)

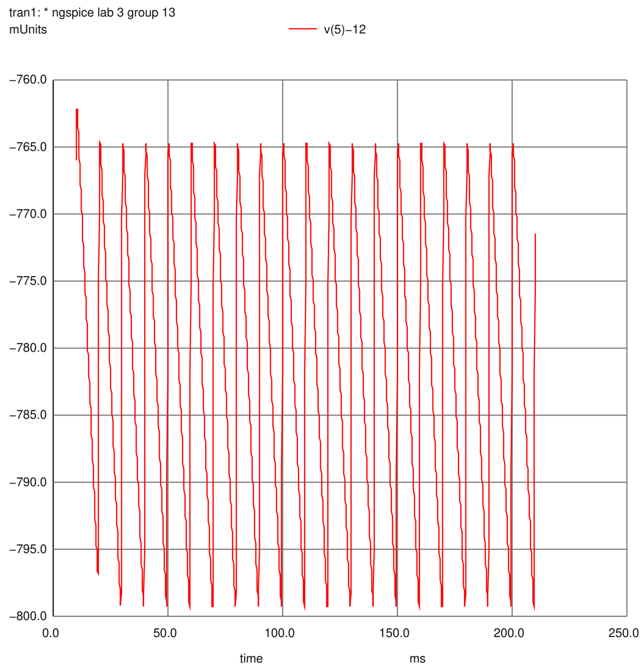

Figure 8: SImulatet voltage output error (v(5)-12)

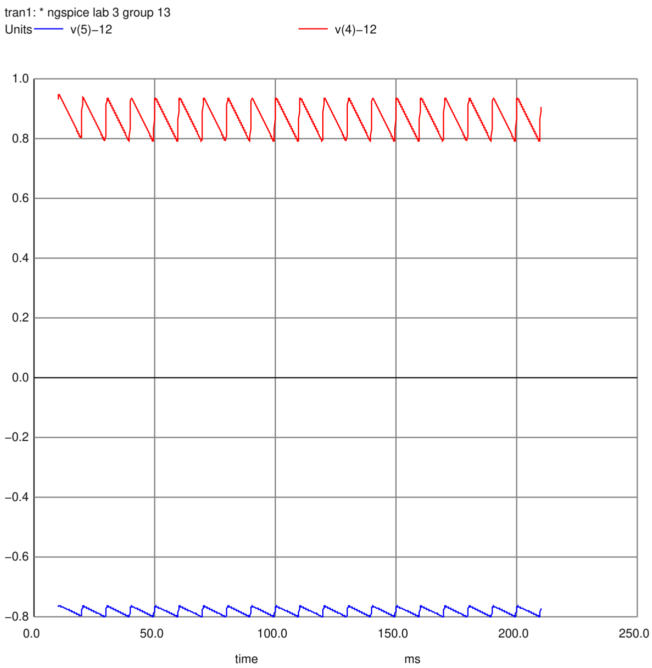

Figure 9: Total Response of V_6 and V_s

4 Conclusion

The objective of this laboratory assignment is to analyse the circuit and solve it. After discussing with all members of the group we can conclude that this goal was achieved.

As presented the results obtained by the Octave math tool and Ngspice simulation tool are the same. This perfect match was achieved in all the analysis done (operationg, transient and frequency) as presented in Section **??**.

Also, all the components used in this circuit (resistors, branches, nodes,...) are perfect this means they don't dissipate energy by heating.This is one of the advantages of simulating rather than doing it on the laboratory, the other one being the elimination of "humam error". It's known that this type of error can influence the experimental results causing considerable relative errors, which in our case weren't made.

Finally, this similarity proves the efficiency and precision of the methods that were used.