Circuit Theory and Electronics Fundamentals

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RC circuit

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Contents

1 Introduction

The objective of this laboratory assignment is to build an AC/DC converter, with a transformer, envelope detector and voltage regulator. The AC voltage of 230V and frequency 50Hz will be transformed into a DC voltage of 12V.

In Section 2, a theoretical analysis of the circuit is presented. In Section 3, the circuit is analysed by simulation, and the results are compared to the theoretical results obtained in Section 2. The conclusions of this study are outlined in Section 4.

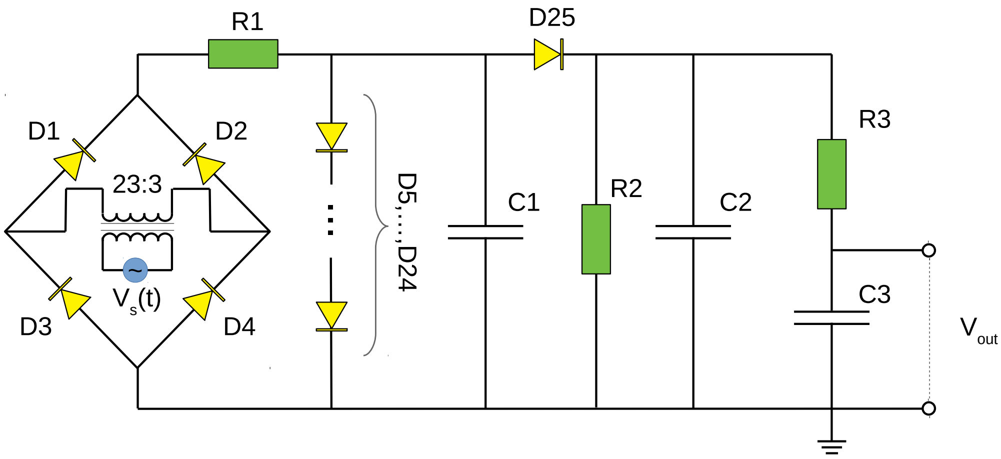
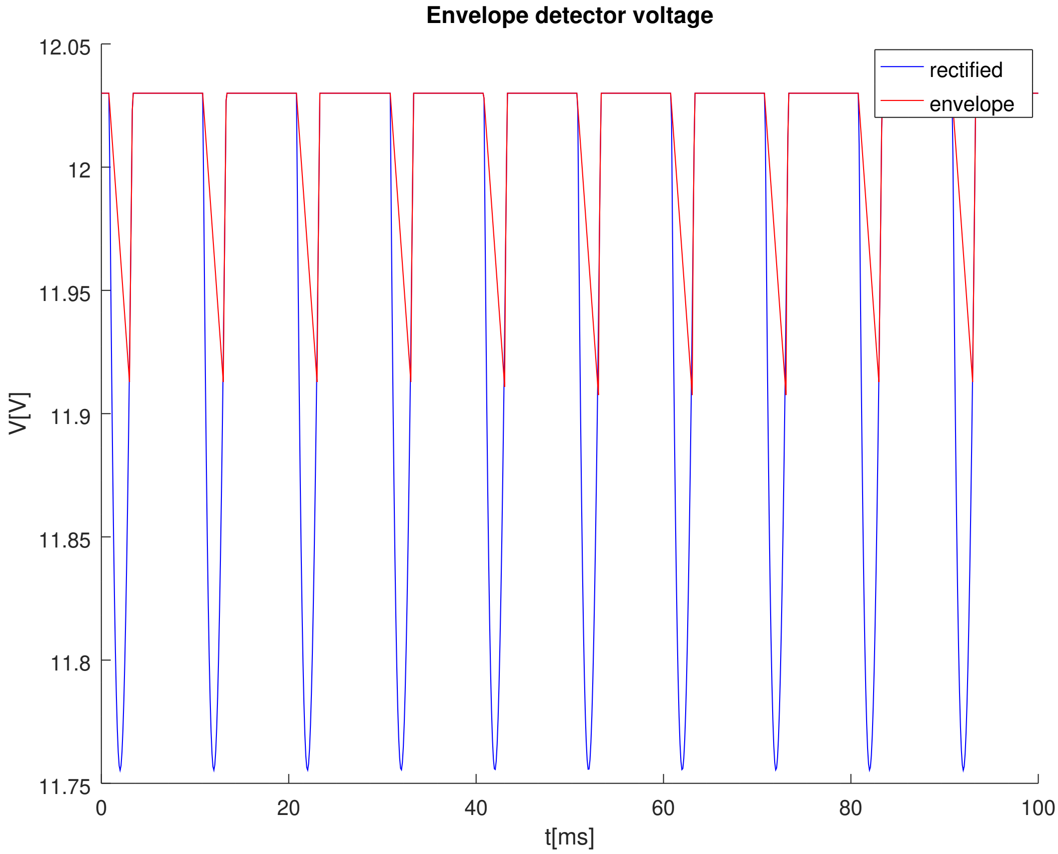


Figure 1: AC/DC Converter

2 Theoretical Analysis

For the theoretical simulation, we used the ideal diode model for the full-wave bridge rectifier, obtaining the absolute value of the initial signal.

For the limiter circuit associated with a first-order low-pass filter, we performed fourier analysis on the previously obtained signal, in order to use phasors to solve for the voltage on the capacitor. The vON diode model was used in this stage, such that any voltage above n*vON (n being the number of diodes in this part of the circuit) was limited. This is visualised in the below fig-

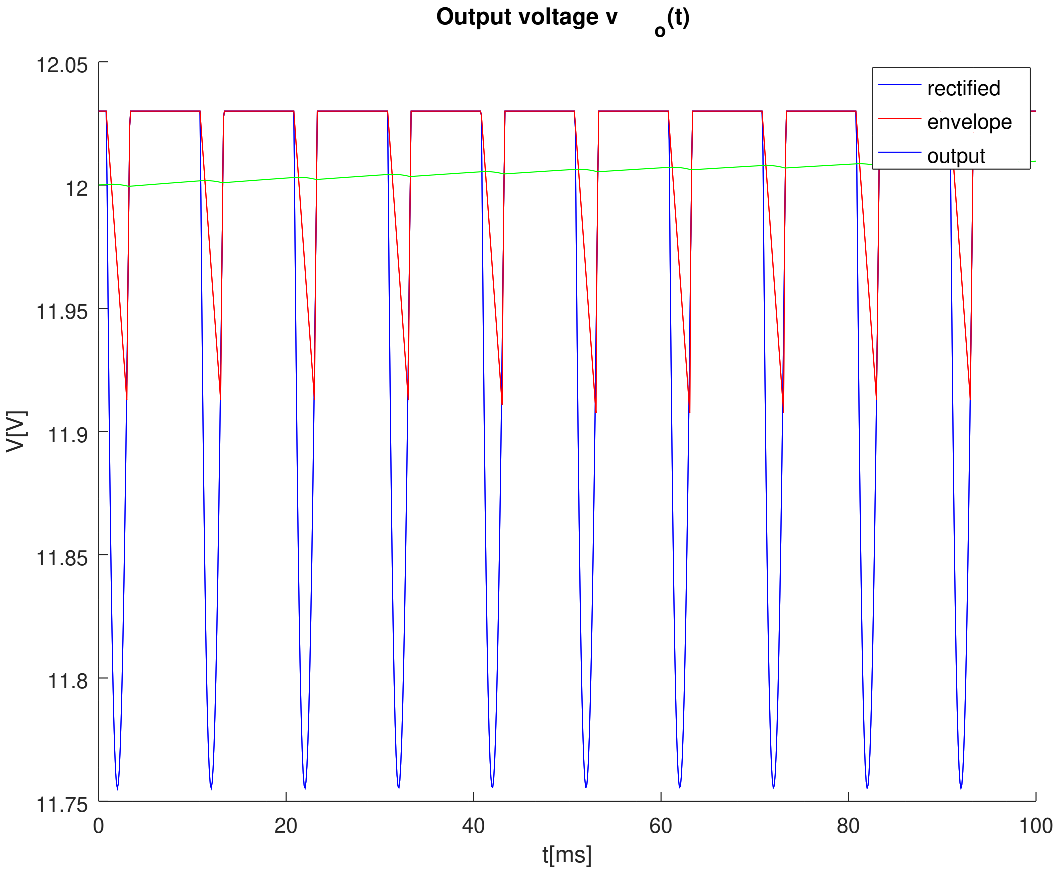


ure:

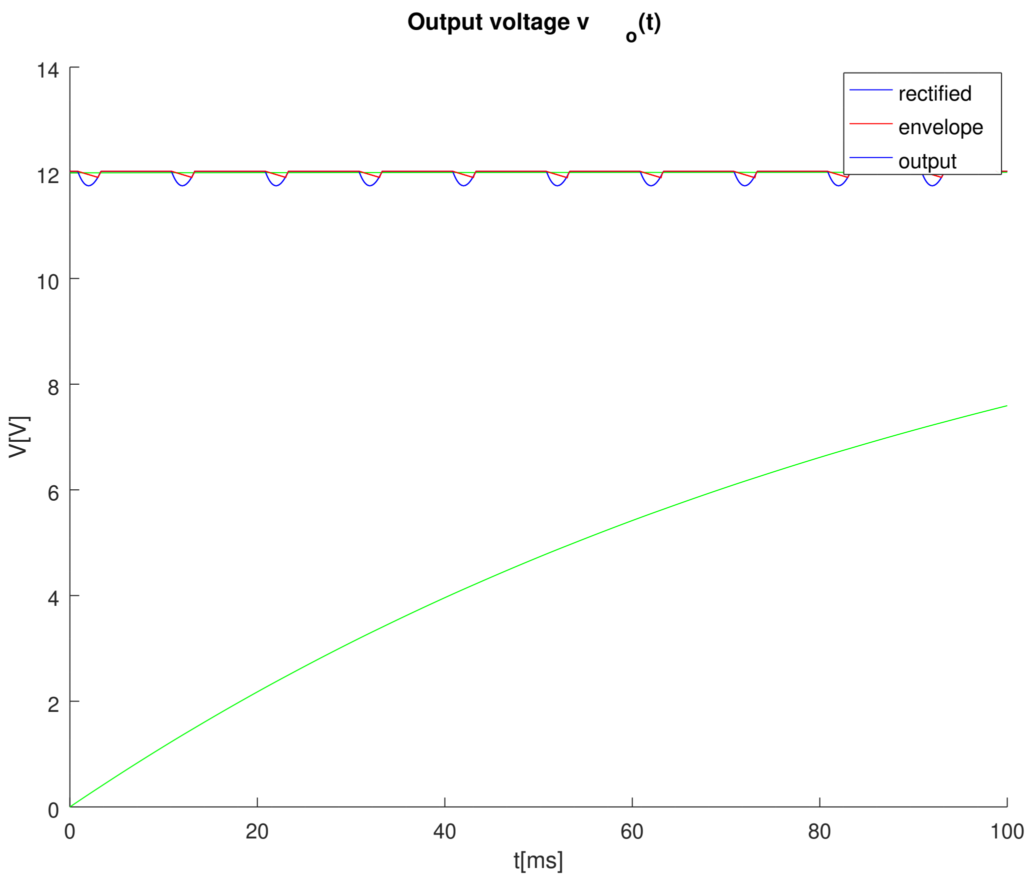
The envelope detector was analysed with the tOFF method, with its value being determined by the below equation:

$$\frac{dVs}{dt} = -\frac{Vs}{RC} \tag{1}$$

After time tOFF the output voltage of this part of the circuit was modeled using an exponecial, until it crossed the input voltage once more. We see this effect below:



For the low-pass filter at the end, we used the Euler method to solve the differencial equation for an RC circuit, thus obtaining the final output voltage:



2.1 Envelope detector

2.2 Voltage regulator

3 Simulation Analysis

3.1 Envelope detector

Table 1 shows the simulated operating point results for the circuit at times $t < 0$.

Name	Value [A or V]

Table 1: Operating point. A variable preceded by @ is of type *current* and expressed in Ampere; other variables are of type *voltage* and expressed in Volt.

Table 2 shows the simulated operating point results for the circuit given that $V_s = 0$ and replacing the capacitor with a voltage source imposing the voltage on the terminals of said capacitor as calculated in the earlier analysis.

Name	Value [A or V]

Table 2: Operating point. A variable preceded by @ is of type *current* and expressed in Ampere; other variables are of type *voltage* and expressed in Volt.

This is necessary so as to provide initial conditions for the analyses made below given that V_s at time $t = 0$ is equal to 0 but the voltage difference in the terminals of the capacitor stays constant for very short time intervals.

4 Conclusion

In this laboratory assignment the objective of building an AC/DC converter circuit by using a tranformer, envelope detetcor and a low-pass filter was achieved. The ripple The estabilization time The merit

The results from both the theoretical analysis using octave and the circuit simulation using ngspice appear to match.