Universidade do Vale do Itajaí
Computer Engineering
Basic Electronics

Sixth Assignment for Basic Electronics

Student: Lucas Mateus Gonçalves
Teacher Advisor: Walter Antonio Gontijo

September
2021

Universidade do Vale do Itajaí
Computer Engineering
Basic Electronics

Sixth Assignment for Basic Electronics

Sixth Assignment for Basic Electronics presented for the class of the Tenth of September, 2021.

Student: Lucas Mateus Gonçalves

Teacher Advisor: Walter Antonio Gontijo

September
2021

Conteúdo

1 Objective

The analysis of multiple electrical circuits containing rectifiers and filter circuits.

2 Introduction

This paper has the purpose of demonstrating and explaining more complex rectifiers and filter circuits.

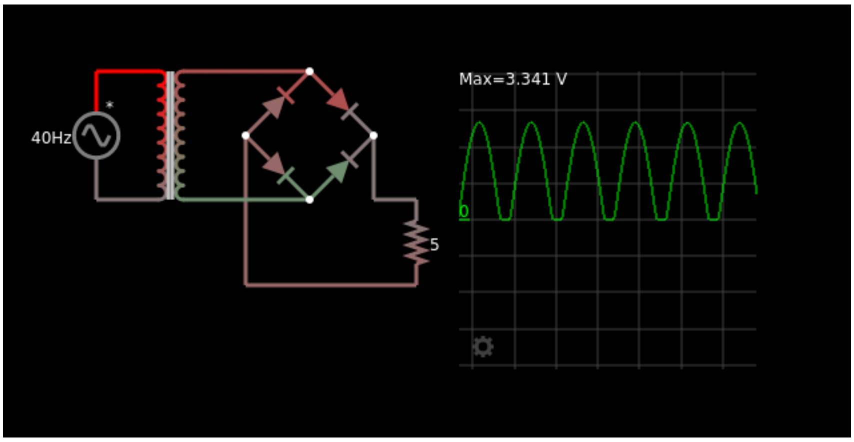
2.1 Filter Circuits

Filter circuits serve to make the output of the rectifier more stable, making it a single constant peak regardless of the state of the input `AC` signal.

Filter circuits are usually composed of a capacitor bank connected in parallel to the load and sometimes an inductor connected in series to the load.

3 Development

3.1 Full Bridge Rectifier



$V1_{AC_{peak}} = 311V$ —— $Ratio = 60 : 1$
Diodes `1N4004` used.

This is a full bridge rectifier circuit without a filter on it's output. The main distinction from the tapped transformer rectifier is that the output voltage is not divided by the number of outputs.

As such, the output voltage is the input voltage multiplied by the ratio minus the diode forward voltage and linear resistance. However, since there are two diodes at play at any time the transformer voltage is above zero, both forward voltages and linear resistance must be accounted for.

The peak voltage before the rectification is as follows.

$$n = \frac{1}{60} = 0.0166$$
$$V_{AC_{peak}} = 311 \times 0.0166 = 5.163V$$

After rectification.

$$V_{DC_{peak}} = 5.163 - 1.4 = 3.76V$$

The above equation only takes into account a simplified model, the simulation takes into account the linear resistance of the diodes.

The diodes must handle a voltage of at least.

$$PIV = 5.163 + 0.7 = 5.86V$$

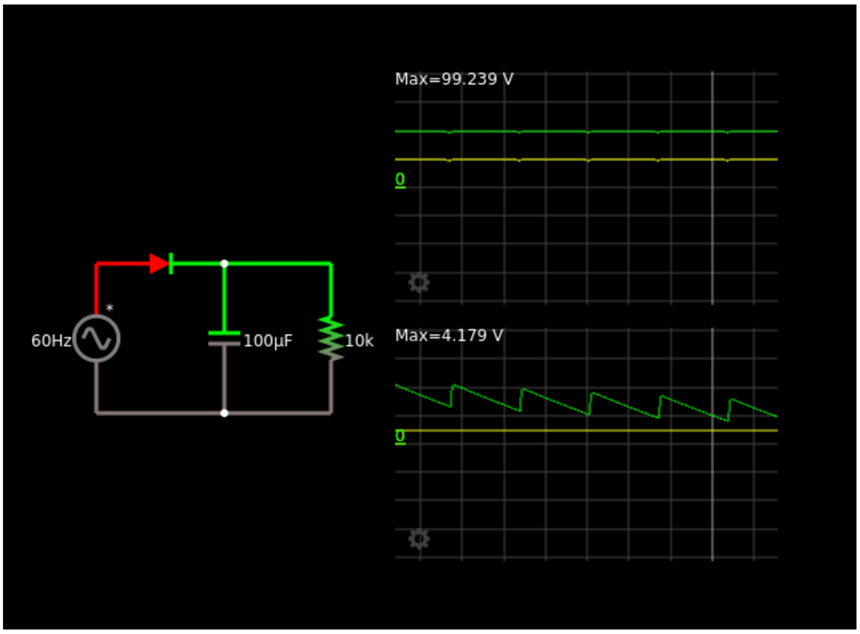
The average voltage is as follows.

$$V_{DC_{avg}} = \frac{2 \times 3.76}{\pi} = 2.395V$$

With it the average current can be calculated on the load.

$$I_{avg} = \frac{2.395V}{5\Omega} = 0.48A$$

3.2 Half Wave Rectifier with Filter



$V1_{AC_{peak}} = 100V$
Diode `1N4004` used.
The oscilloscopes have a division of $50\frac{V}{div}$ and $2\frac{V}{div}$ respectively.

This circuit implements a simple filter circuit to maintain the peak voltage even as the cycle reaches zero volts.

However the peak is not maintained perfectly stable, as the load drains the capacitor the peak falls until the cycle recharges the capacitor. That repetition is called ripple, and the difference between the peak and valley is called ripple voltage.

The ripple voltage can be calculated as follows.

$$V_r = \frac{V_p}{fRC}$$

The ripple voltage in this circuit is as follows.

$$V_{peak} = 100 - 0.7 = 99.3V$$

$$V_r = \frac{99.3V}{60Hz \times 10000\Omega \times 0.0001F} = 1.65V$$

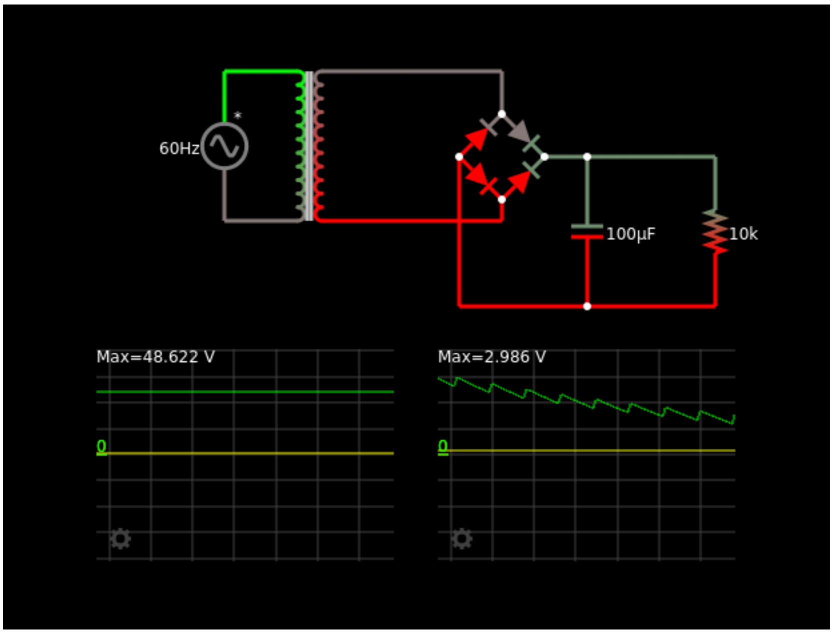
The final `DC` voltage on the load can be calculated as follows.

$$V_{DC} = V_p - \frac{V_r}{2}$$

Which returns as follows to this circuit.

$$V_{DC} = 99.3 - \frac{1.65}{2} = 98.475V$$

3.3 Full Bridge Rectifier with Filter



$V1_{AC_{peak}} = 100V$ —— $Ratio = 1:05$
Diode 1N4004 used.
The oscilloscopes have a division of $20\frac{V}{div}$ and $1\frac{V}{div}$ respectively.

The equations for for the full bridge and the single diode rectifier are the same save for the double frequency as the negative cycle is also used, and the forward voltage and series resistance of two diodes instead of only one.

The values for this circuit are as follows.

$$V_{AC_{peak}} = 100V \times 0.5 = 50V$$

$$V_{DC_{peak}} = 50V - 1.4V = 48.6V$$

$$V_r = \frac{48.6V}{120Hz \times 10000\Omega \times 0.0001} = 0.405V$$

$$V_{DC_{avg}} = 48.6 - \frac{0.405}{2} = 48.397V$$

$$I_{resistor} = \frac{38.397V}{10000\Omega} = 0.00483A$$

4 Conclusion