Introduction to Electronics – CIE212

Course Project: Full-wave Rectifier – Step Down Circuit

By: Omar Elsayed – 202100597

Table of Contents:

1. Circuit Design:

For the Full wave-rectifier-stepdown circuit, the following model design is proposed:

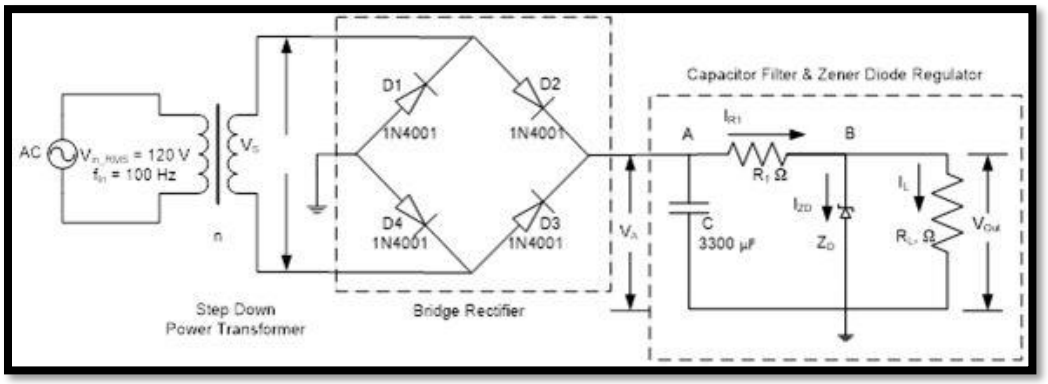

Figure 1: Full wave rectifier regulated circuit [1]

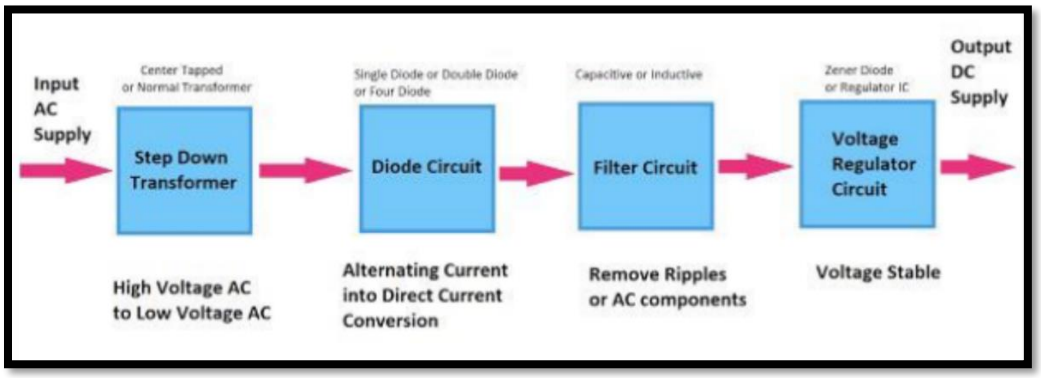

Figure 2: Given Full wave rectifier regulated system model

As it can be observed this design matches the given model provided in the project document.

Step-Down Transformer compartment can be identified as the first part of our circuit design given in Figure 1, in our realistic application it inputs an AC source (220V, 50Hz) and it's step downed using an inductive transformer with a coil ratio of (48000:41) to approximately (6V, 50Hz).

The **Diode Circuit** compartment can then be identified as the next step, containing 4 diodes model 1N914, connected in a bridge fashion to rectify the alternating direction of the input into a mono-direction due to the alteration of combination of forward and reverse biases of each diode in both the -ve and +ve regions of the input, outputting a magnitude-alternating signal propagating in the same direction for each half-period.

The **Filter Circuit** is then followed containing a capacitive component. As it's used to hold onto the maximum values of the tipples provided from the Diode compartment, to

approximate these ripples to a DC constant voltage. Provided the ripple ratio won't exceed 2%. It can be identified in Figure 1 as the Capacitor-Resistor combination given after the diode bridge circuit.

The **Voltage regulator** compartment is implemented using a Zener diode connected in parallel to the resistive load of our circuit regarded as the output of the whole system. The Zener diode is implemented to regulate the voltage magnitude reaching the load, as it is only connected in a forward connection once the voltage exceeds the breakdown voltage of the Zener diode, therefore connected in parallel (shunt) with the resistive load or the system total output.

---

2. Circuit Transient Analysis Results:

The previous circuit in Figure 1 is implemented in LTSpice as follows:

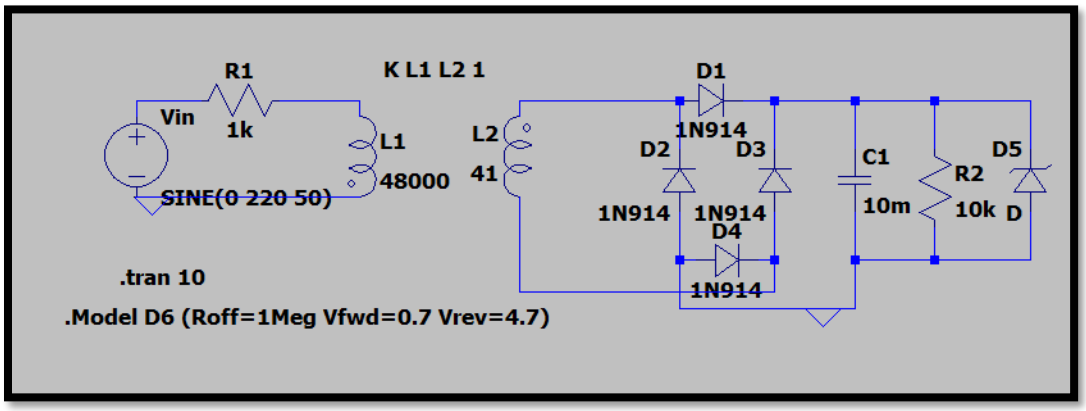

Figure 3: LTSpice implementation of the proposed circuit

And the following figure represents the input and output voltages of the stepdown transformer graph given the frequency of the input was 1Hz for illustrative reasons (Green for input, Blue for output):

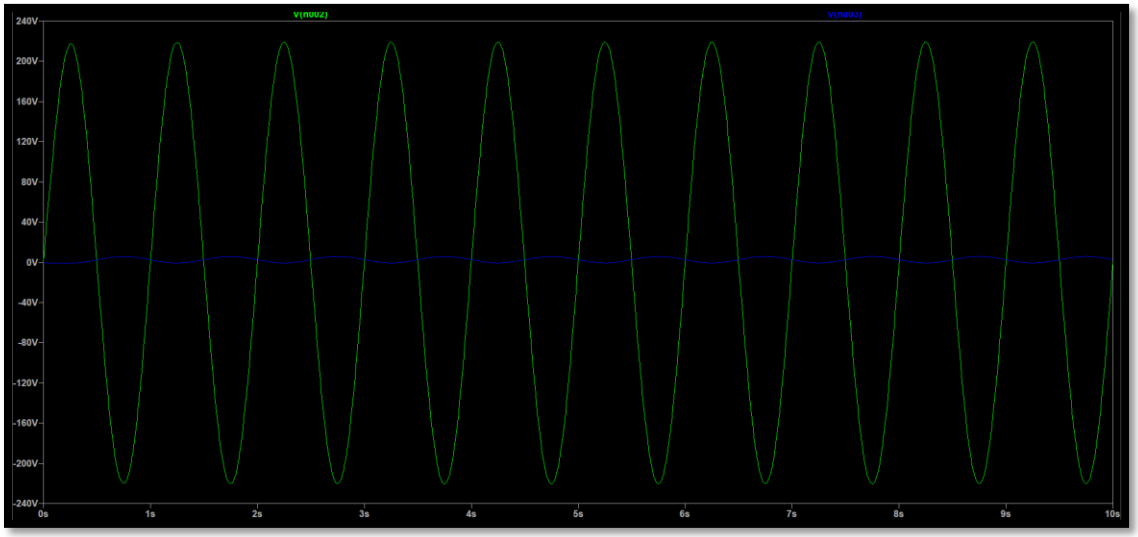

Figure 4: Step-down transformer input and output voltages vs time ~ 10s

As it can be observed, the magnitude of the step-down varied drastically as the input's maximum is at 220V and the output maximum is at nearly 5.7V given the same frequency.

The following figure represents the output voltage of the whole system given the refined values of the resistors and capacitors through trial and error (Input frequency 50Hz):

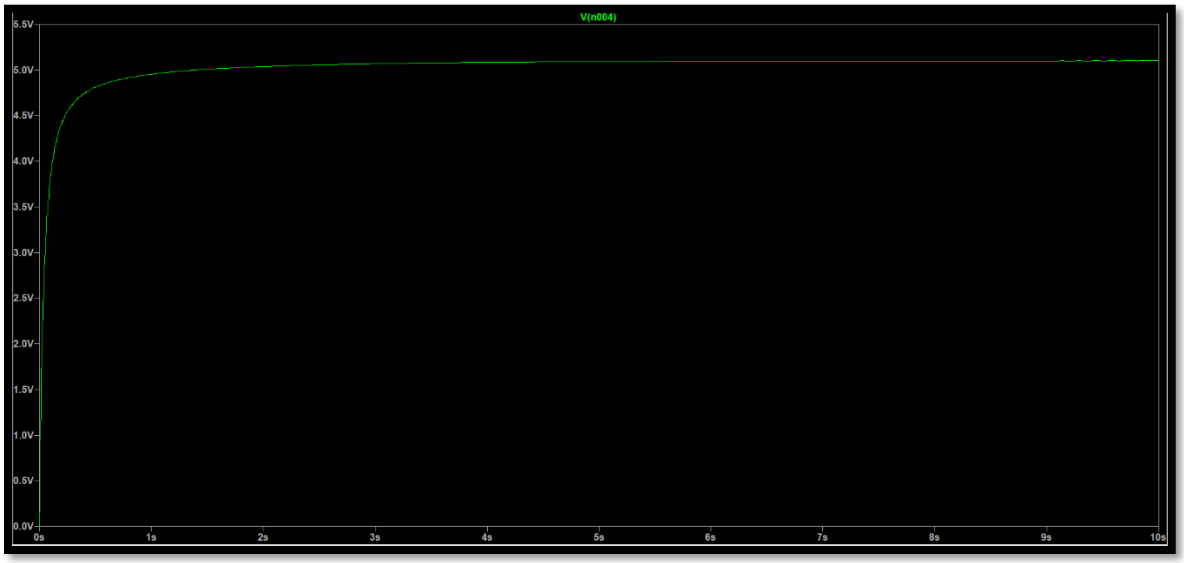

Figure 5: The total output of the system given an input (220V, 50Hz) recorded in 10s

3. Hardware Implementation (Bonus):

The Hardware implementation was made by:
Omar Elsayed 202100597, **Ahmed Yasser 202200477**, **Mahmoud Radwan 202200313**

The Following 3 figures represent the implementation of only the Diode circuit rectification to check its output:

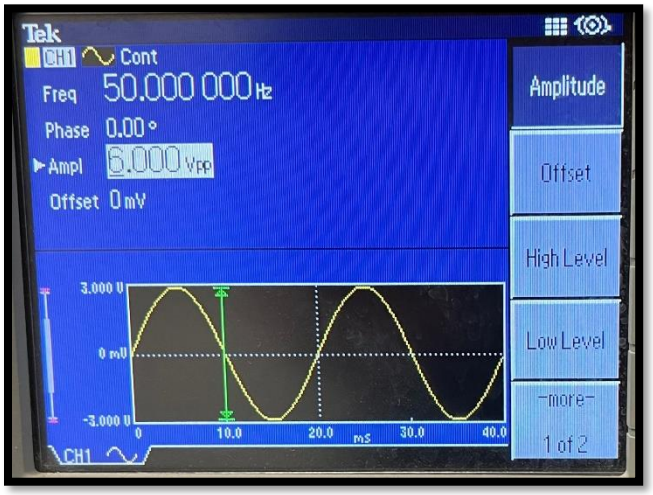

Figure 6: Generated input for the Diode Circuit

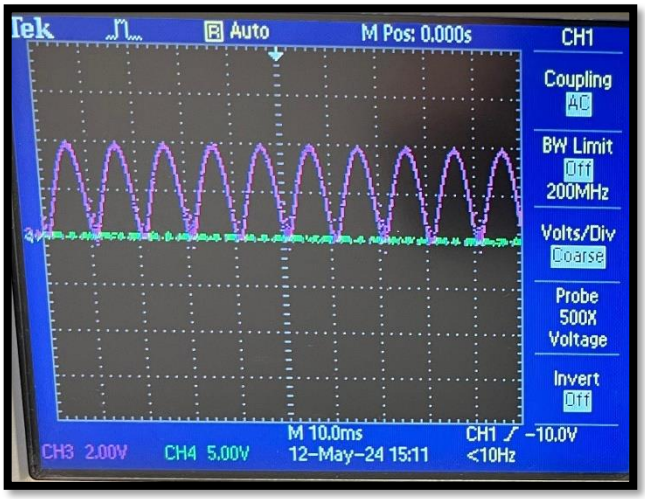

Figure 7: Received output

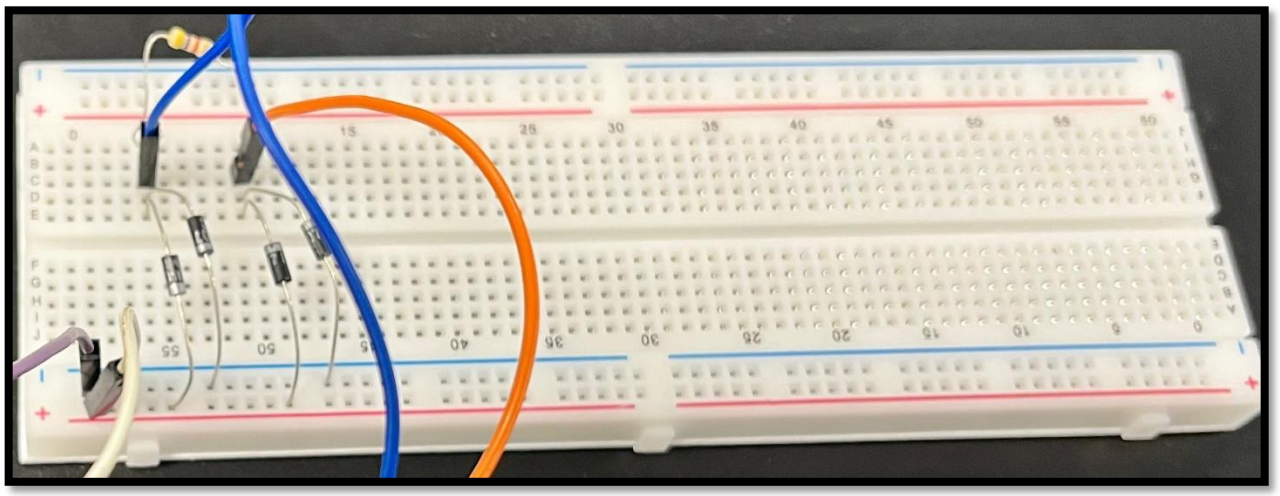

Figure 8: The diode circuit model compartment hardware implementation

The input voltage from the function generator is then fine tuned to get an output of 5V from the Diode Circuit.

The following 2 figures represent the addition of the capacitive filter to the circuit:

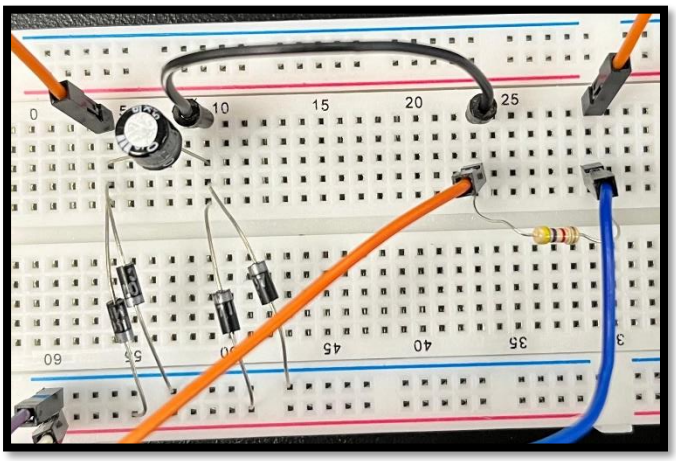

Figure 9: Capacitive filter addition

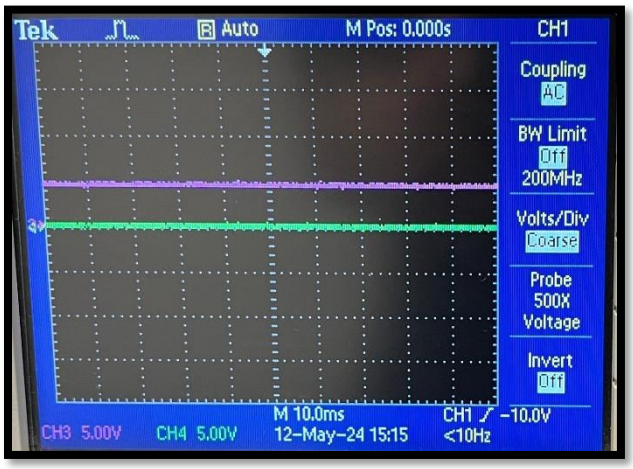

Figure 10: Signal output of the filter

The last 3 figures represent the addition of the voltage-regulator circuit and its total whole output:

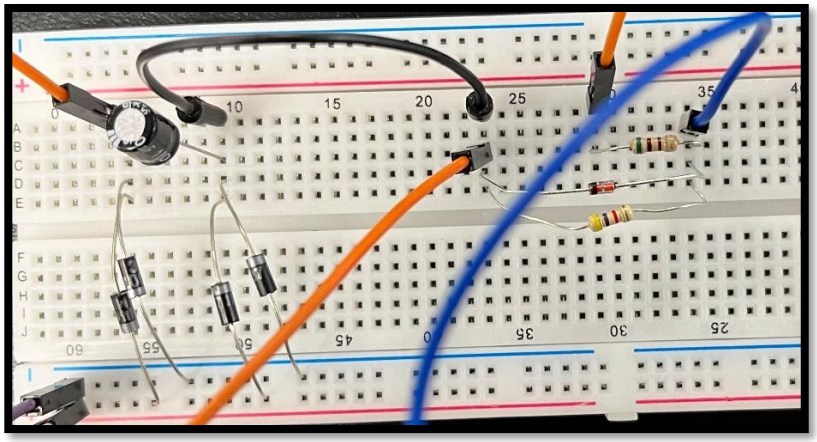

Figure 11: Whole full-wave rectifier circuit implementation

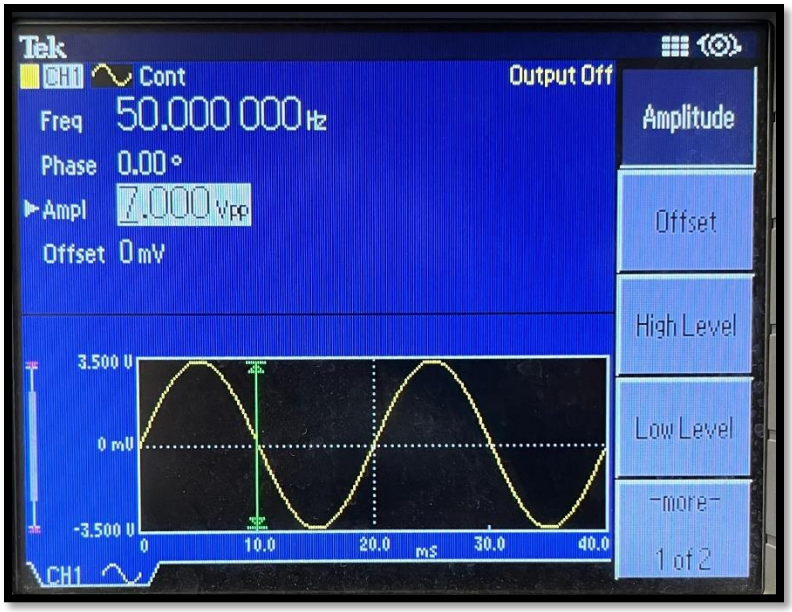

Figure 12: The total system input

It can be observed that the voltage amplitude of the input generator is 7V, as the maximum input magnitude by the generator is 10V, just for illustration.

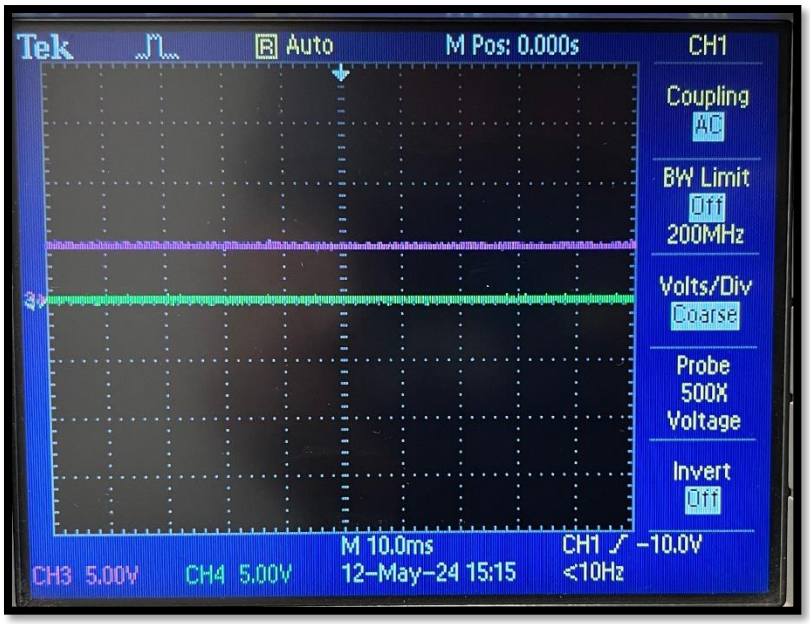

Figure 13: The total system output

Finally, as observed the total output signal is a DC (0 Hz) voltage of magnitude 5V rectified and regulated.

4. References:

[1] https://www.geeksforgeeks.org/full-wave-rectifier