EE230: Analog Circuits Lab
Lab No.3

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1 Full Wave Rectifiers

1.1 Centre Tapped Full-Wave Rectifier

1.1.1 Aim of the experiment

Verifying the functioning of the centre tapped full-wave rectifier using a transformer and diodes.

1.1.2 Design

Designed the circuit using 1N4007 diodes, R=22kohm

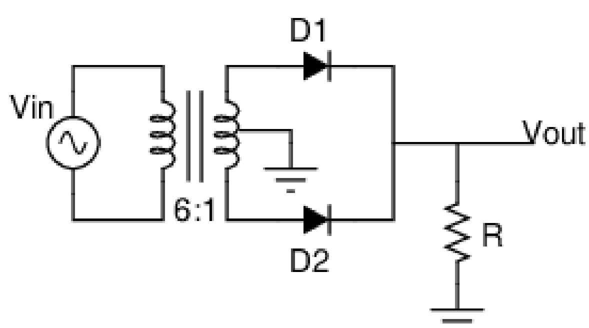

Figure 1: Circuit Diagram

1.1.3 Simulation results

DSO graphs of results

Figure 2: Inverting Amplifier

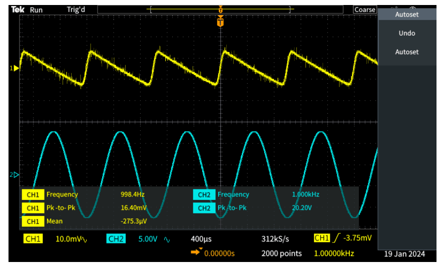

Figure 3: Maximum and Minimum of output

1.1.4 Experimental results

The output voltage is rectified to be constantly positive and is flat instead of sinusoidal when the input voltage is close to zero. The calculated and measured ripple output voltages were as follows:
Calculated= 182mV
Measured= 76mV

1.1.5 Conclusion and Inference

There is a drop of around 0.7V due to a forward-biased diode drop. Current flows only through a forward-based diode resulting in constant positive output. And, the output gets shifted below by 0.7V due to the forward voltage drop by the diode. In case of a reverse bias, there is no current flowing through the diode, and it acts like an open switch, thus rectifying the output of the circuit.

1.1.6 Experiment completion status

Complete

1.2 Full-Wave Precision Rectifier

1.2.1 Aim of the experiment

Verifying the functioning of the full-wave precision rectifier using a half-wave rectified circuit and inverting summer circuit.

1.2.2 Design

Designed the circuit using 1N4007 diodes and IC 741 OpAmp

$$V_o = -\frac{10k}{10k}V_{in} + -\frac{10k}{5k}V_{half_wave} \tag{1}$$

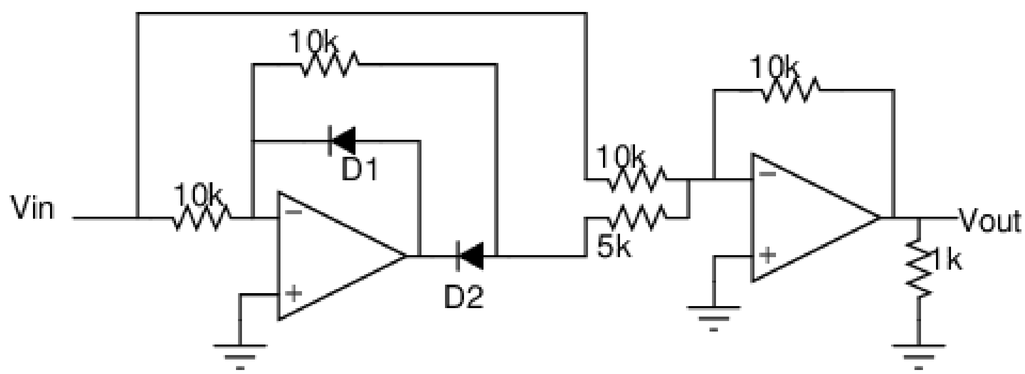

Figure 4: Circuit Diagram

1.2.3 Simulation results

DSO graphs of results

1.2.4 Experimental results

The output voltage is rectified to be constantly positive, with no voltage drop compared to input voltage.

1.2.5 Conclusion and Inference

The correction due to the Op-Amp based circuit ensures no diode drop in the half-wave rectifier, and the Inverting Summer takes a ratio of input and

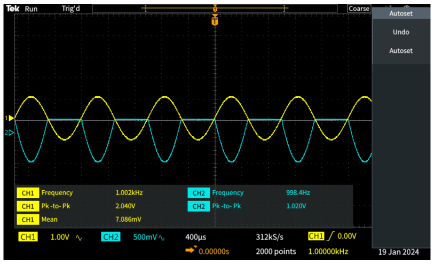

Figure 5: Half Wave Rectifier

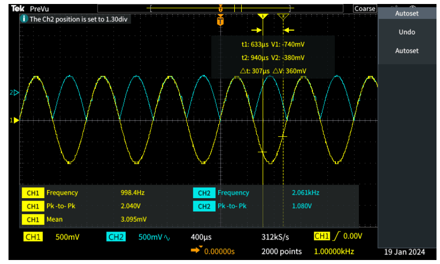

Figure 6: Full Wave Rectifier

output such that output has equivalent amplitude and is always positive. The reason for no diode drop is that the Op Amp compensates for any loss of voltage across the diode, and the output of the Op Amp is 0.7V higher than that of the actual output, thus compensating for the diode drop. This explains the fact that a precision rectifier is different from a normal rectifier, and hence the output is exactly the same as the input in the positive cycle, while a perfect negative of the input in the negative cycle.

1.2.6 Experiment completion status

Complete

2 Multivibrators

2.1 Astable Multivibrator

2.1.1 Aim of the experiment

Constructing and verifying the working of an astable multivibrator.

2.1.2 Design

Designed the circuit using OpAmp 741 and Zener Diodes (4.7V).

$$Timeconstant = RC \tag{2}$$

$$V_{TH} = V_{out} * \frac{R_1}{R_1 + R_2} = 6.875V \tag{3}$$

$$V_{TL} = -V_{out} * \frac{R_1}{R_1 + R_2} = -6.875V \tag{4}$$

$$Chargingtime : e^{t/RC} = 1 - \frac{6.875}{15} \tag{5}$$

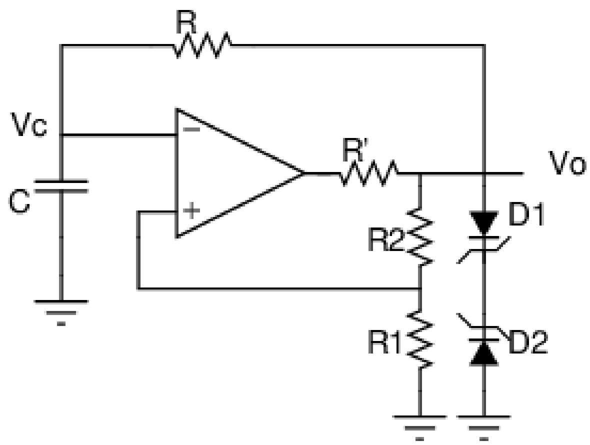

Figure 7: Circuit Diagram

2.1.3 Simulation results

DSO graphs of results

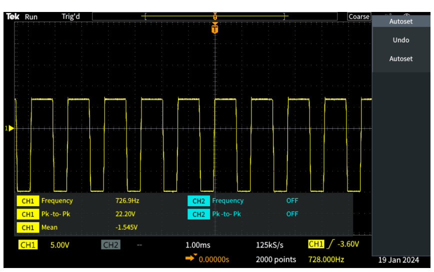

Figure 8: Astable multivibrator (without Zener diodes)

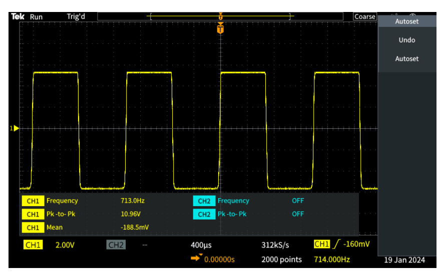

Figure 9: Astable multivibrator (with Zener diodes)

2.1.4 Experimental results

The frequency of the waveform obtained at Vo is 755 Hz, while the calculated one was 877.9 Hz. In case of Vi, the measured frequency was 601.5 Hz.

2.1.5 Conclusion and Inference

Output voltage keeps changing voltage every time Capacitor finishes charging/discharging to the value at the positive terminal of OpAmp. There is no stable state of the Op Amp and so it constantly fluctuates between two possible states, thus giving a waveform as seen in the figures. When we have a Zener diode with it, the output can't be more than 5.4V, and so the points of switching change and thus the frequencies. The resistor R' limits the current flowing out of the OpAmp into the diodes, and thus cannot be replaced with a short. If replaced, the diodes might burn because of excess current flowing through them. The voltage at V_O1 is the maximum/minimum output voltage of OpAmp and at V_O is the total drop across both forward and reversed biased Zener diodes. Therefore, they are different, while one of them replicates the supply voltage of the Op-Amp, the other has the forward and reverse bias voltages added, of the Zener diodes.

2.1.6 Experiment completion status

Complete

2.2 Monostable Multivibrator

2.2.1 Aim of the experiment

Constructing and verifying the working of a monostable multivibrator.

2.2.2 Design

Designed the circuit using OpAmp 741, Zener Diodes (4.7V) and 10uF electrolytic capacitor.

$$timeconstant = RC \tag{6}$$

$$t_{charge} = -\frac{R_2}{R_1} V_{in}(given|Vo| < 15V) \tag{7}$$

2.2.3 Simulation results

DSO graphs of results

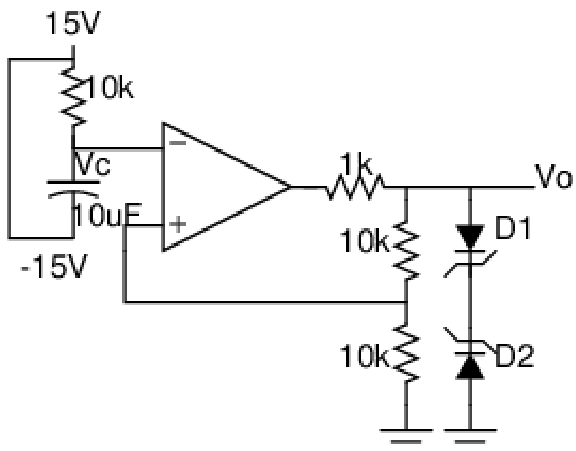

Figure 10: Circuit Diagram

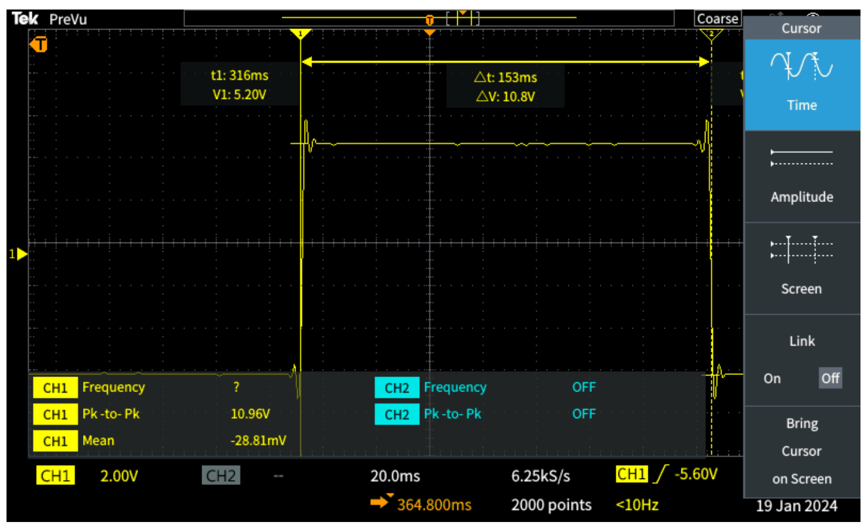

Figure 11: Monostable multivibrator

2.2.4 Experimental results

The output wave has a pulse width of 92ms.

2.2.5 Conclusion and Inference

The capacitor is short-circuited to discharge it nearly instantly. Using a switch, the trigger we can provide is much more than 92ms, so we started to use just two wires and were touching those so that a current flows and the capacitor discharges nearly instantly. The calculated pulse width was 89ms, using the capacitor charging time constant and the fact that it will discharge almost instantly and go to 0 on touching the wires(or turning on the switch) The circuit has just 1 stable state, with a value of Vout = 5.4V

2.2.6 Experiment completion status

Complete