EE 230: Analog Circuits Lab
Lab No. 3
Rectifiers and Multivibrators

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January 23, 2024

Section - A (Full Wave Rectifiers)

1. Center Tapped Full Wave Rectifier

1.1 Aim of the experiment

Construct a Center Tap Full Wave Rectifier and analyse the output voltages.

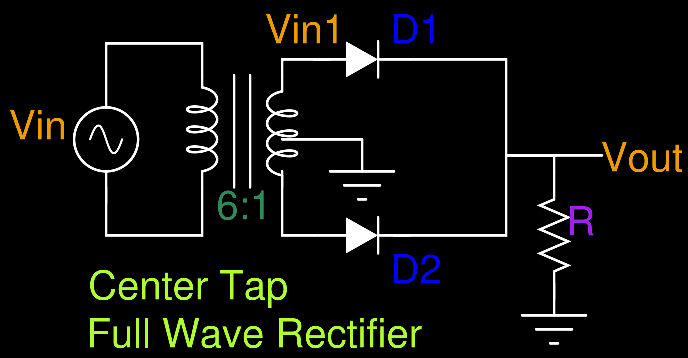
1.2 Design

For a transformer, the relation between output voltage on the secondary coil and input voltage on the primary coil is given by the below equation:

$$\frac{V_P}{V_S} = \frac{N_P}{N_S} \tag{1}$$

where V_P represents the voltage across the primary coil, V_S is the voltage across the secondary coil. N_P is the number of turns in the primary coil, and N_S is the number of turns across the secondary coil. For our case the ratio of turns between the primary coil and the secondary coil is 6 is to 1.

$$V_{ripp} = \frac{V_{in1} - V_D}{2fRC} \tag{2}$$



Here, V_{ripp} is the amplitude of the ripple voltage and rest values are as per the diagram. For this experiment, we are taking the resistance to be R = 22kΩ, capacitance C = 1μF and we are using 1N4007 diodes.

1.3 Simulation results

The green curve represents the V_{in} input voltage, the blue curve represents the V_{in1} and the red curve represents the V_{out} voltage. The below image follows the same convention.

1.4 Experimental results

Reason for voltage difference between the peak voltage of V_{in1} and V_{out}:
For the experiment, we are using 1N4007 diodes, which has a forward bias of 0.7V, this leads to a potential difference between V_{in1} and V_{out}, which turns out to be roughly 0.7V.

1.5 Experiment completion status

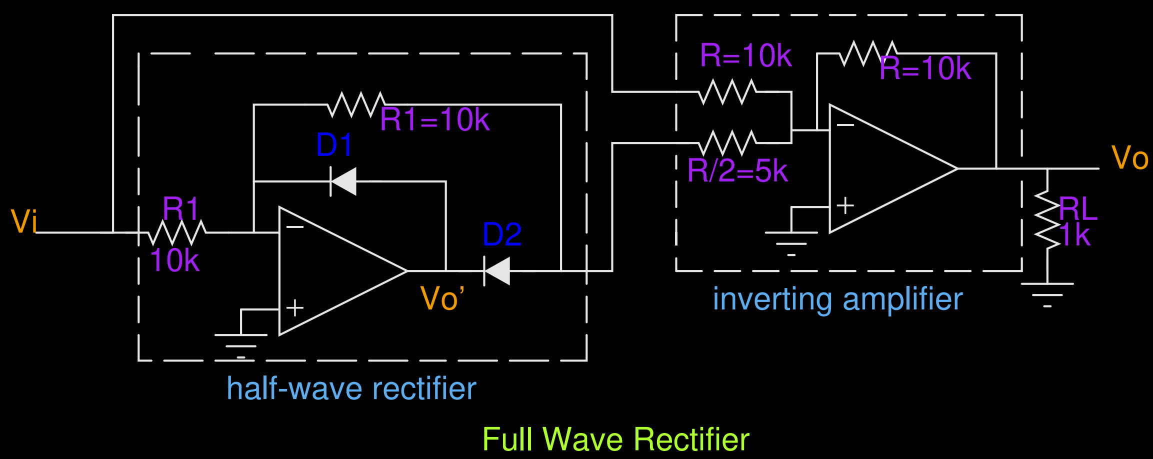
The experiment was completed during lab hours and the hand written report for the same was also submitted during lab hours.

2. Full Wave Precision Rectifier

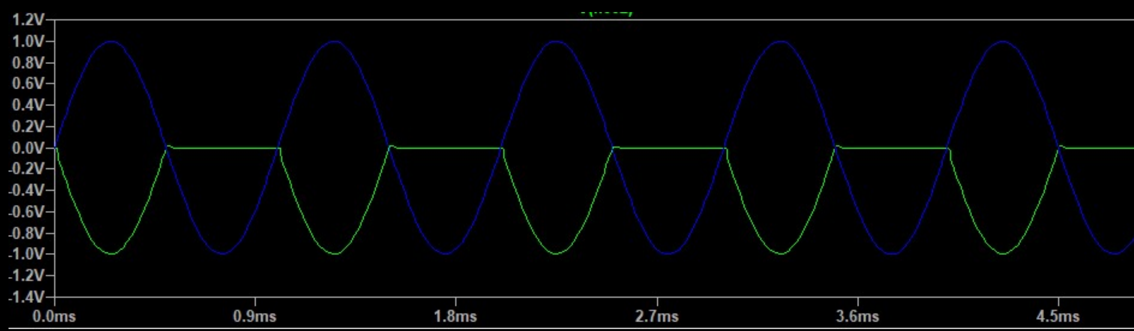
2.1 Aim of the experiment

The experiment aims to realise a full wave precision rectifier using half wave rectifier and inverting summer circuit using OpAmp.

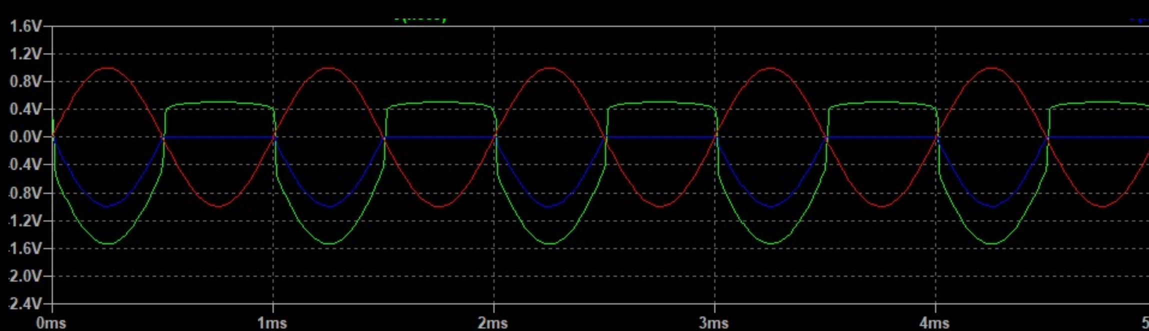
2.2 Design



2.3 Simulation results



In the above figure, blue wave represents input V_i and green wave represents output voltage. In the below image, red wave represents input V_i, the blue wave represents output voltage and the green wave represents the voltage V_o'



The below figure represents the final output V_o by green wave and the input V_i by red wave.

2.4 Experimental results

Compare waveforms of the half wave rectifiers from first lab:
Here the usage of two diodes act as a switch but in Lab 1, we used only one diode which lead to a drop in the output voltage. This the reason, this circuit is called a precision half wave rectifier.

Compare waveforms of full wave rectifiers from previous question:
The two diodes are used in a fashion that they act as a switch in this portion thus, there is no drop in the peak to peak voltage but in the previous portion, we were using only one diode effectively, thus leading to a drop in the peak to peak values of the output voltage.

2.5 Experiment completion status

The experiment was completed during lab hours and the hand written report for the same was also submitted during lab hours.

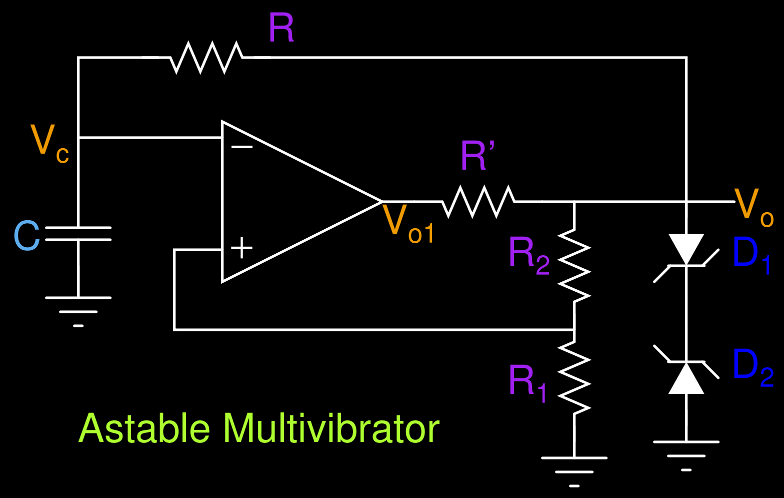
Section - B (Multivibrators)

3. Astable Multivibrator

3.1 Aim of the experiment

The experiments aims to realise a astable multivibrator circuit and study its properties.

3.2 Design



Astable Multivibrator

For our experiment, we are using R = 47kΩ, R_1 = 33kΩ and R_2 = 39kΩ, C = 0.01μF and $R^{'}$ = 1kΩ.

3.3 Experimental results

Construct circuit without $R^{'}$ and diodes and find frequency of waveform obtained at V_o:

The frequency of the waveform obtained at V_o is around 988Hz.

Now add all the components and find frequency of waveform obtained at V_o:

The frequency of the waveform obtained at V_o is around 894Hz.

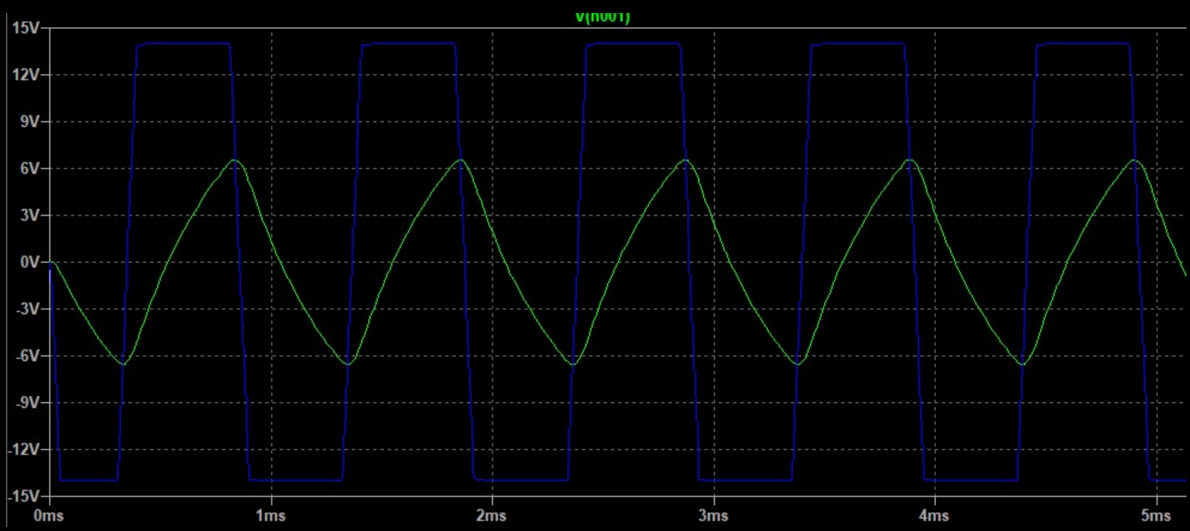
Reason why only $R^{'}$ can't be shorted without removing diodes:

Since there is a voltage difference between V_{o1} and V_o, removal of $R^{'}$ can lead to short circuit and infinite current between the two points. This can also damage the diodes. Hence, it's advised not to remove $R^{'}$ alone.

Explain why the voltage across V_{o1} and V_o is different:

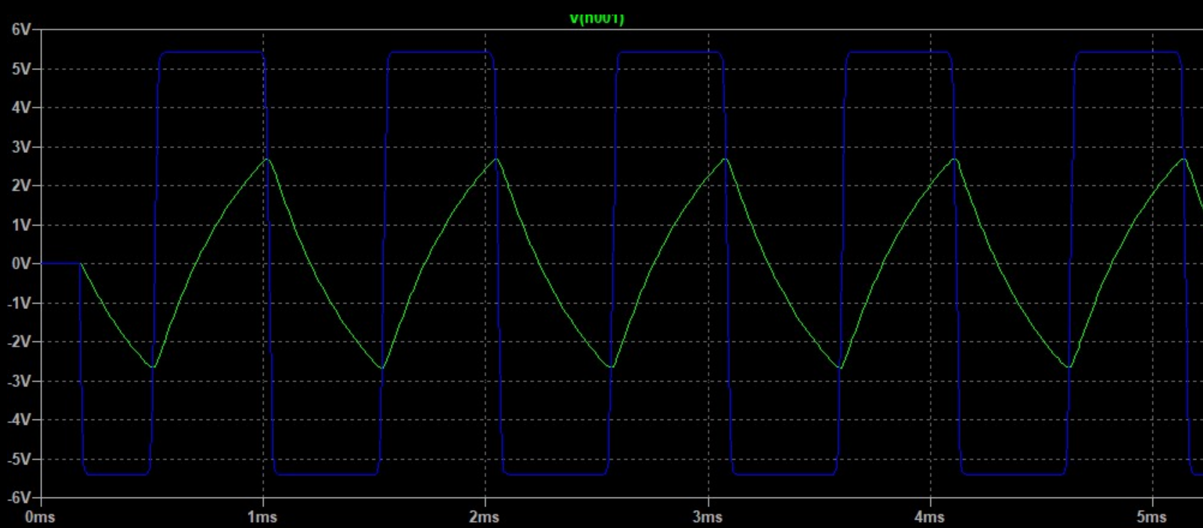
Since there is a voltage difference between V_{o1} and V_o, removal of R' can lead to short circuit and infinite current between the two points. This can also damage the diodes. Hence, it's advised not to remove R' alone.

3.4 Simulation results

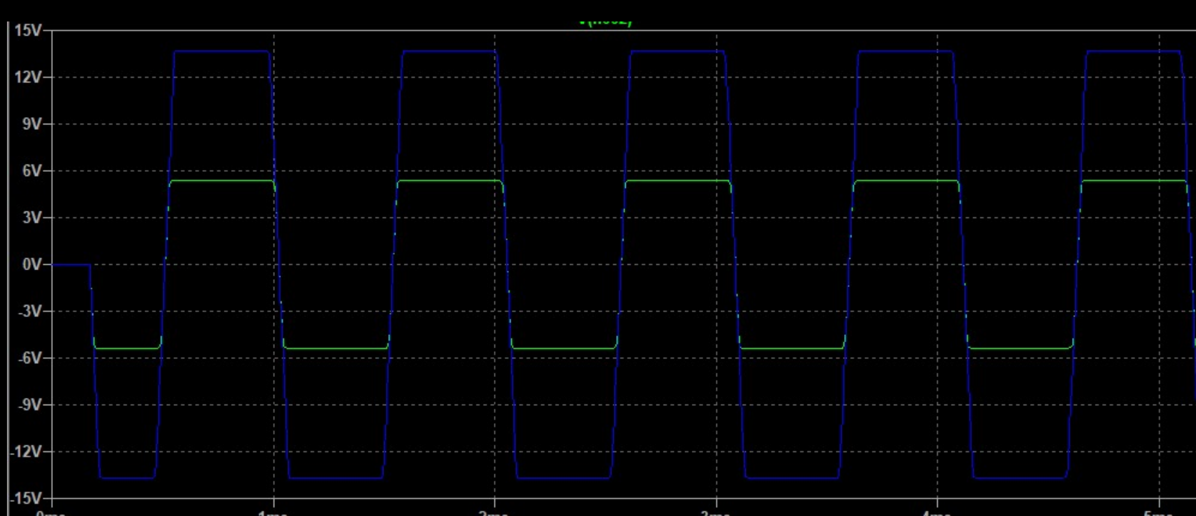


In the above figure, green wave represents V_C and blue wave represents the voltage at V_o when we are not using the following components - R', D_1 and D_2.

In the below figure, green wave represents V_C and blue wave represents the voltage at V_o when we are using all the mentioned components with their right values and we observe some delay in the output.



In the below image, the green wave represents the final output V_o while the blue wave represents the output V_{o1}



3.5 Experiment completion status

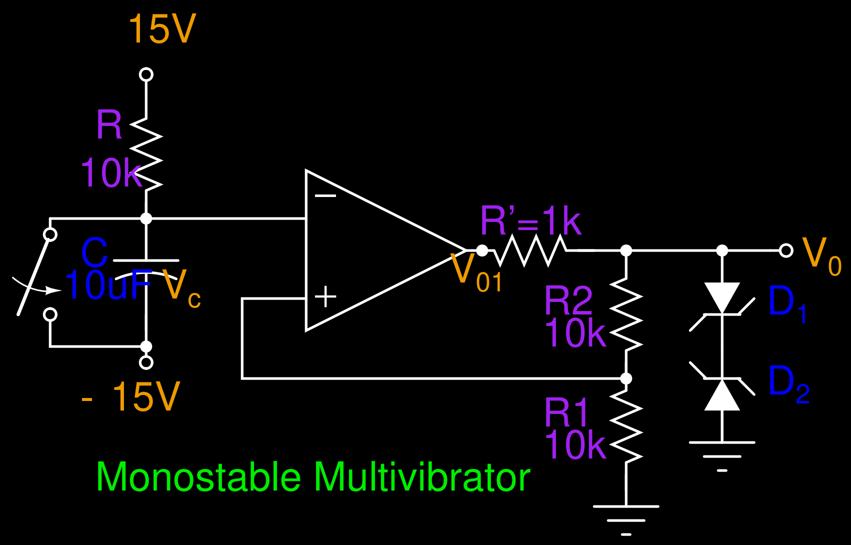
The experiment was completed during lab hours and the hand written report for the same was also submitted during lab hours.

4. Monostable Multivibrator

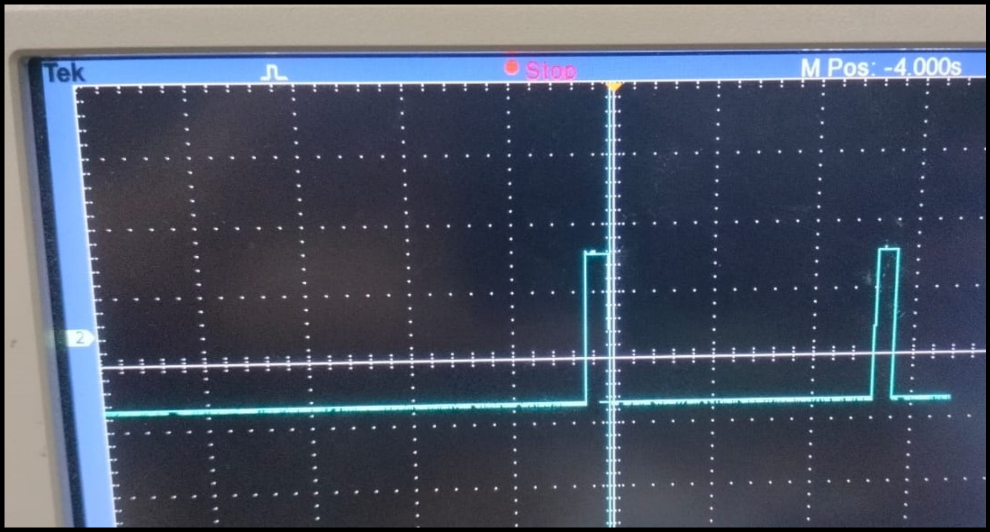
4.1 Aim of the experiment

The experiment aims to study the circuit of monostable multivibrator circuit and study its important properties.

4.2 Design



4.3 Simulation results



4.4 Experimental results

We follow the following equation:

$$T_{pulse} = T_{switchpress} + \frac{ln(\frac{30}{30-(V_i+15)})}{10} \tag{3}$$

Here $T_{switchpress}$ is around 100ms and V_i is around 2.7V. Plugging in the values we get, $T_{pulse} = 189.16$ms and the measured time of the pulse is 186ms which is very close to the expected value. The monostable multivibrator has a single stable state which is around -5V and when the switch is presed it goes into unstable state which is around 5V and then it returns back to -5V after 186ms.

4.5 Experiment completion status

The experiment was completed during lab hours and the hand written report for the same was also submitted during lab hours.