Experiment 04

Aditya Tripathy - ee24btech11001, Durgi Swaraj Sharma - ee24btech11018

Abstract
In Experiment-04, we try to capture LC oscillations.

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1 Objective

To study the response of a series RLC circuit with a precharged capacitor.

2 Apparatus

- LM 358
- Two $10k\Omega$ resistors
- Two PN - junction diodes
- Oscilloscope
- Function Generator

3 Theory

The half wave rectifier implemented with a series connection of a resistor and a PN-junction diode is suboptimal in its working due to the threshold voltage required for the flow of current in the positive half cycle of the input wave.

To implement a better half wave rectifer free from the above mentioned problem we use the following circuit which makes use of an op-amp and a couple of diodes commonly known as a precision half wave rectifier or a superdiode.

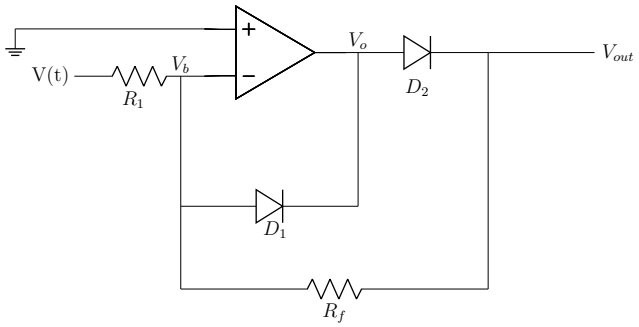

Figure 1: Precision Rectifier

Initially all voltages are at 0V. When $V(t) > 0$, V_o will also become positive. Thus, the flow of current will be as shown:

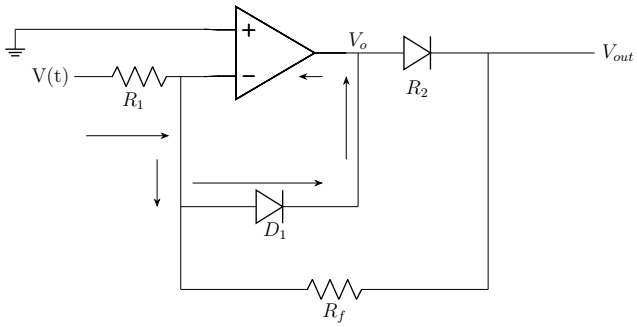

Figure 2: Current flow for positive half cycle

It is evident that the voltage at the V_{out} is zero since the voltages at $t = 0$ were all zero. When the input voltage is negative, the flow of current will be as follows:

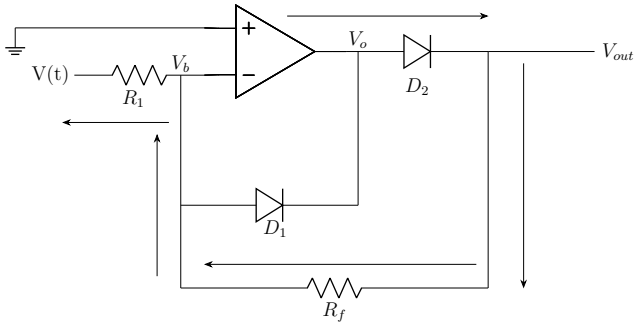

Figure 3: Current flow for negative half cycle

The voltage at V_{out} will approximately be equal to

$$V_{out} \approx \frac{-R_f}{R_1} V(t) \tag{1}$$

The advantage of the superdiode is that for the current to start flowing, the input voltage need to be close to ratio of threshold voltage and open loop gain(a very large number)

$$V(t) \approx \frac{V_{th}}{A}, \text{where A = open loop gain} \tag{2}$$

as opposed to the threshold voltage in the resistor-diode-only approach. Thus a superdiode can be used to rectify signals of amplitude $\approx 100mV$.

4 Procedure

1. Connections
    - Connect the inductor and capacitor in series.
    - Connect the 5V DC Voltage source in parallel to the capacitor.
    - Complete the circuit by adding a switch.

- Connect the probe across the inductor to capture the voltage response.

2. Device Setup
   - To capture the response for the first few cycles, set an appropriate trigger level, set "Sweep = Normal" under "Mode Coupling" and press the "Single" button on the oscilloscope.
3. To capture the RLC oscillations, remove the wires connecting DC power supply to capacitor and press the button switch.

5 Results

Experimental value of $w_d = \frac{2\pi}{2.96\mu s} = 2122697.738912022\ rad/s$

Experimental value of $\beta = \frac{\frac{1}{\Delta T_2}\ln\frac{V_1}{V_2}+\frac{1}{\Delta T_3}\ln\frac{V_1}{V_3}+\frac{1}{\Delta T_4}\ln\frac{V_1}{V_4}+\frac{1}{\Delta T_5}\ln\frac{V_1}{V_5}+\frac{1}{\Delta T_6}\ln\frac{V_1}{V_6}}{5} = 30759.2043\ \Omega/H$

6 Response captured