

Nirma University

2EC102 – Analog Electronics

Project Report

Designing Wein-Bridge Oscillator

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1 Specifications

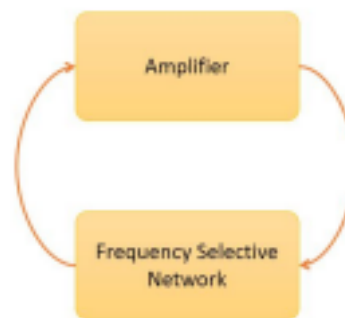
We had to design, simulate, improve and implement on PCB the Wien Bridge oscillator for the given specifications:-

- The oscillator should output 18KHz frequency.
- Use diodes 1N4007 for amplitude stabilization.
- Use amplifier 741.

2 Introduction

Oscillator is an electronic device which provides single frequency oscillating signal at the output at a time. A basic oscillator comprises of an amplifier with a frequency selective positive feedback loop. As we all know, any electronic circuit contains different types of noises (Thermal noise, White noise, shot noise, etc.) and when these noises pass through an amplifier, its magnitude increases.

This amplified-frequency-mixed signal passes through a frequency selective network and all other frequency components except one frequency component are canceled out. This leaves us with one frequency component only, which proceeds into the cycle and gets amplified again by the amplifier. This process repeats on many times a second and we get a single frequency wave at the output.



The amplifier we are going to use in this project is an op-amp 741. The advantage of using an op-amp is that we can put the gain control circuit on the negative feedback and the frequency selective circuit on the positive feedback. Thus, making it easy to control the gain of the amplifier without disturbing the frequency selective network. There are no inputs to the circuit, only supply voltages are provided to the amplifier for it to operate.

The frequency selective network we are going to use is a typical RC circuit which resonates at

the frequency given by

$$f_{oscillation} = \frac{1}{2\pi RC}$$

The idea of a frequency selective network is to cut-out all the frequency components except one particular. Resonating circuits exactly do this by always oscillating at the resonance frequency given a range of frequencies at the input. The modern Wien Bridge Oscillator is consequence of the circuit originally designed by William Hewlett in 1939. In this circuit he uses a frequency selective network as a positive feed back to the Op-Amp and uses a electric lamp for amplitude stabilization. When the voltage across the lamp increases, the lamp heats up

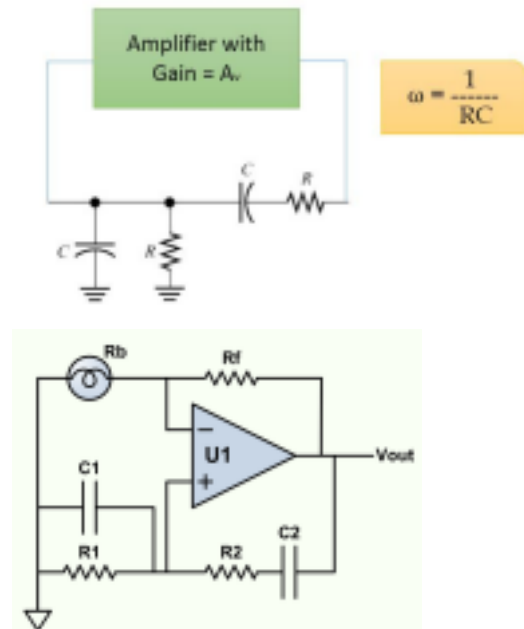


Figure 1: Original Wien Bridge Oscillator Circuit

and its resistance increases resulting in decreased loop gain and when the voltage across the lamp is less, the resistance of the lamp is less due to less heating of the filament and the loop gain increases.

3 Designing

In order to design a stable oscillator we should follow a number of steps and tackle numerous problems in the following manner

3.1 Choosing the Right Capacitor for Frequency selective Network

Since we are considering with the frequency of approx. 21 KHz, it will be wise for us to go with the capacitor meeting the following criteria:-

- It should be very cheap.
- Readily Available in the market.
- Small in size.
- Ceramic capacitor.
- For the given frequency, the value of the resistors should be in KΩ

range.

The capacitor of 1.5nF met all the requirements.

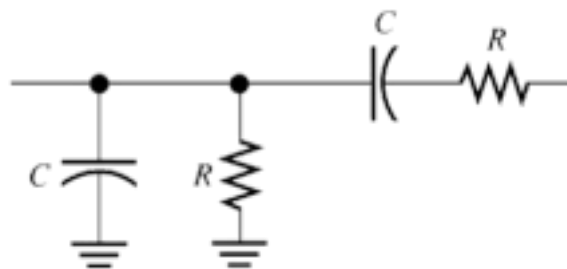


Figure 2: Frequency Selective Network

3.2 Finding the Resistor Values for Appropriate Gain

For this we need to consider the fact that the open loop gain should be more than 3 for the oscillation to start.

$$A_v = R_4 + R_1$$

$$R_1 > 3 \text{ (5)}$$

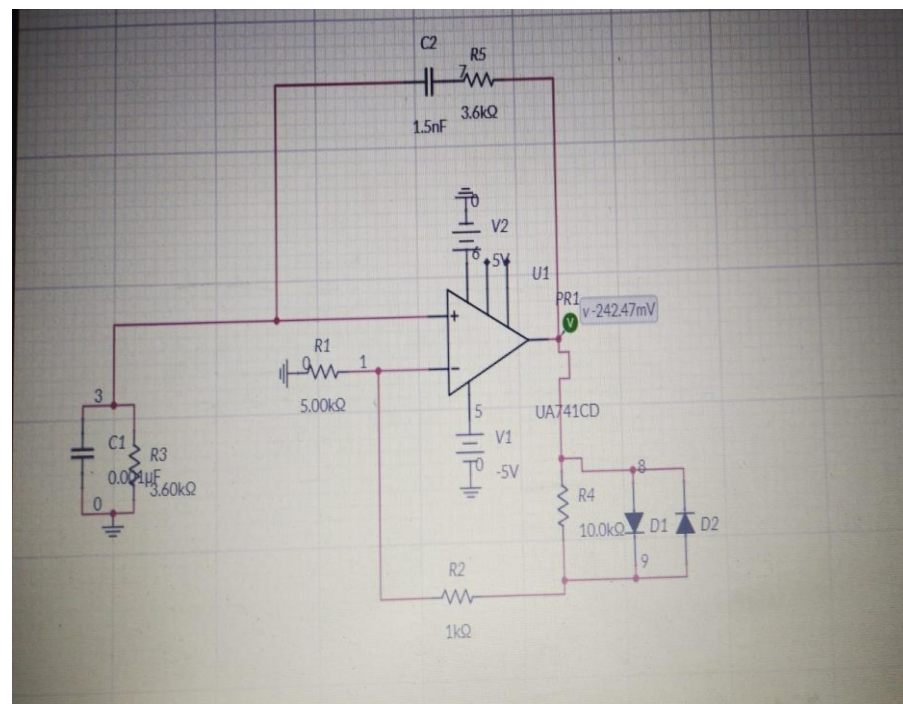
S.No.	R1	R4	Gain	Oscillation
1	5K	5K	2	No Oscillation
2	5K	10K	3	No Oscillation
3	5K	15K	4	Oscillation Present
4	5K	20K	5	Oscillation Present



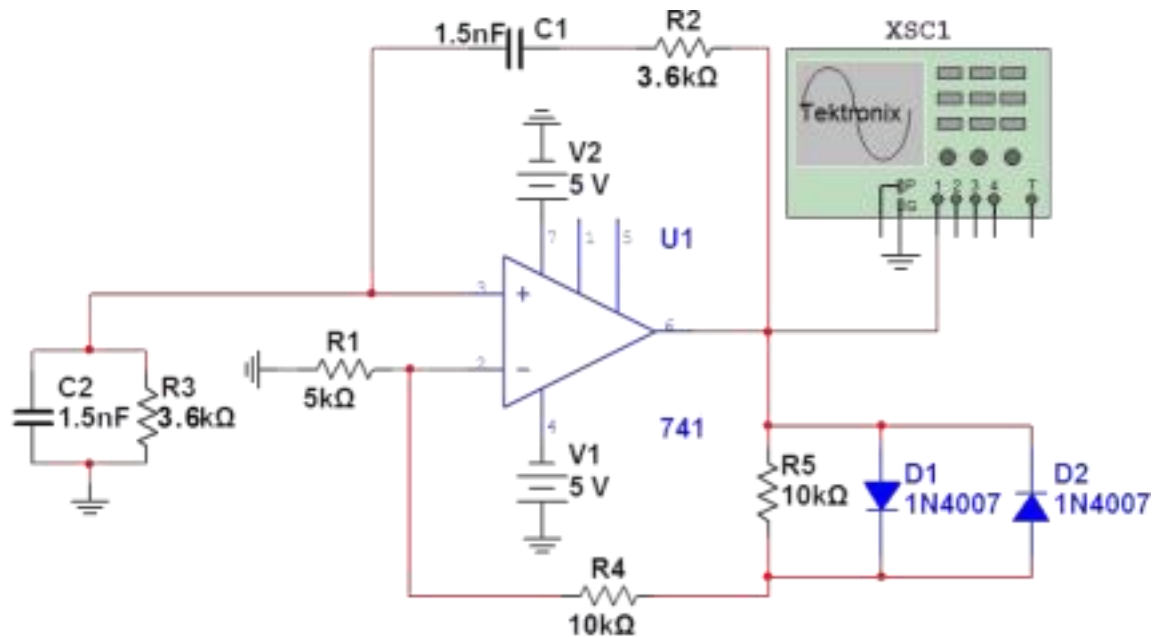
Figure 3: Calculating open loop gain

4 Simulation

After designing the circuit, we simulated it in Multi-Sim software before implementing the design. This is a good practice as Multi-Sim simulates close to real components and it takes into account some tolerance of components and adds some noise into the circuit for better realistic simulation. The simulation was setup as shown below:-



4.1 Circuit Diagram :



5 List of Equipment Used

- Breadboard.
- Oscilloscope.
- Wires.
- Resistors and Capacitors.
- Function Generator.
- Function generator cables.
- Crocodile Clip Cables.
- 741 OP-AMP IC.
- Soldering Iron.
- Soldering Wire.
- Solder sucker.

6 Results and Discussions

6.1 Oscilloscope output

After we built the Breadboard, and connected to the oscilloscope it was giving us output frequency of around 18 KHz. We got the following result.

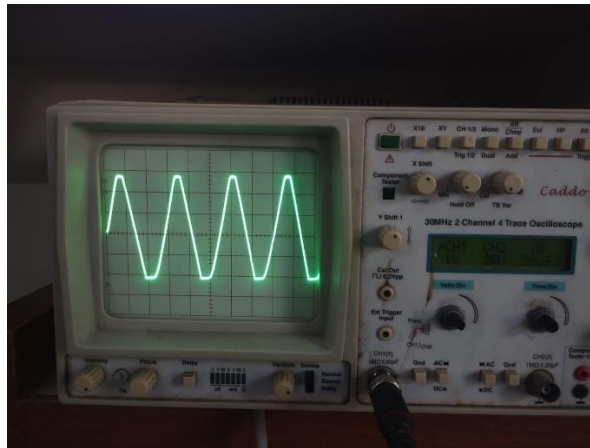


Figure : This is the output from the oscilloscope directly from the Breadboard output terminal. Here we can see that the output frequency is 18.0 KHz. The wave is appearing somehow triangular because the time divisions are too large.

6.2 General Purpose Board (GPB) :

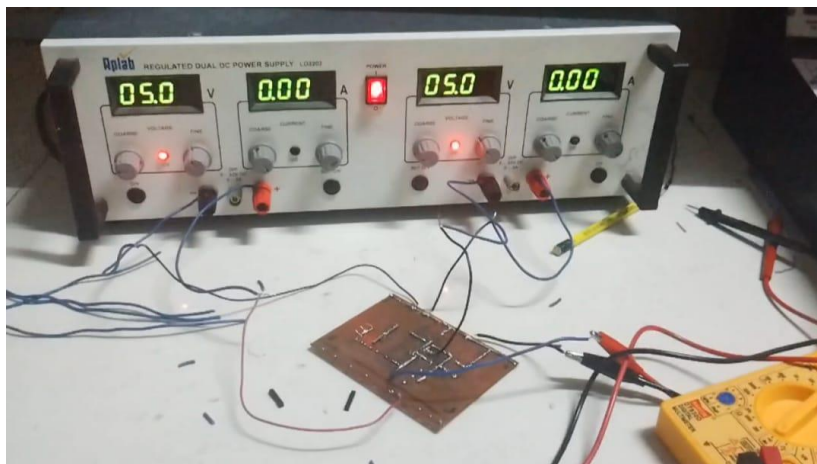
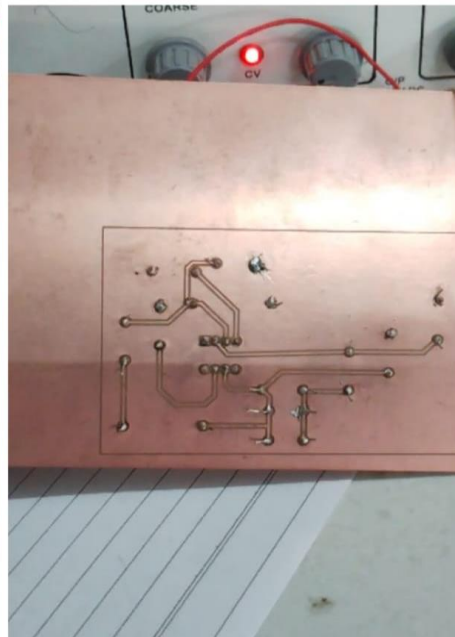
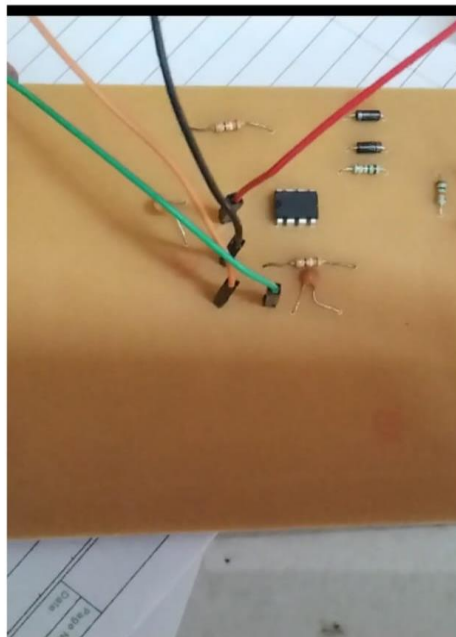
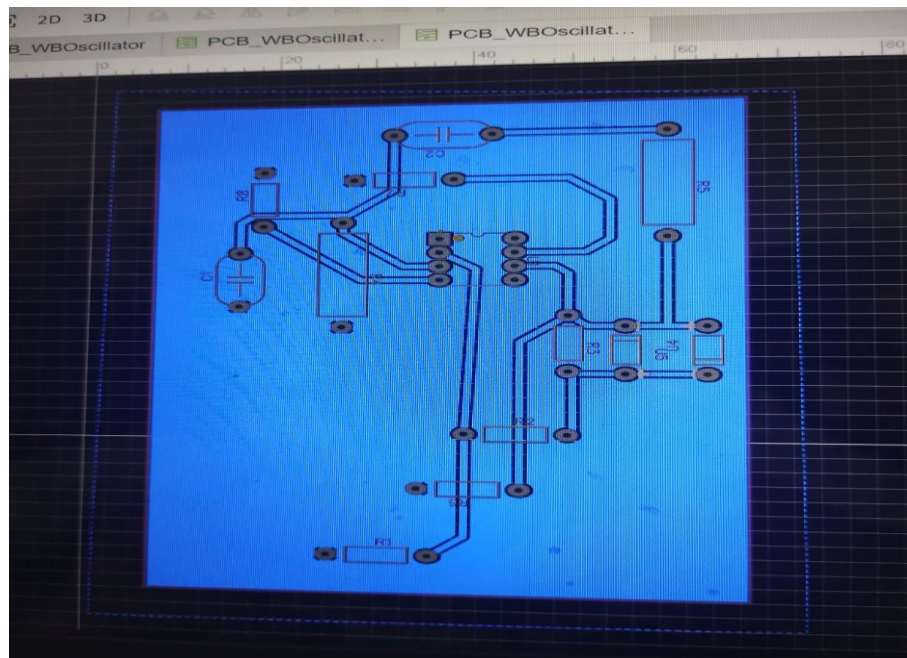


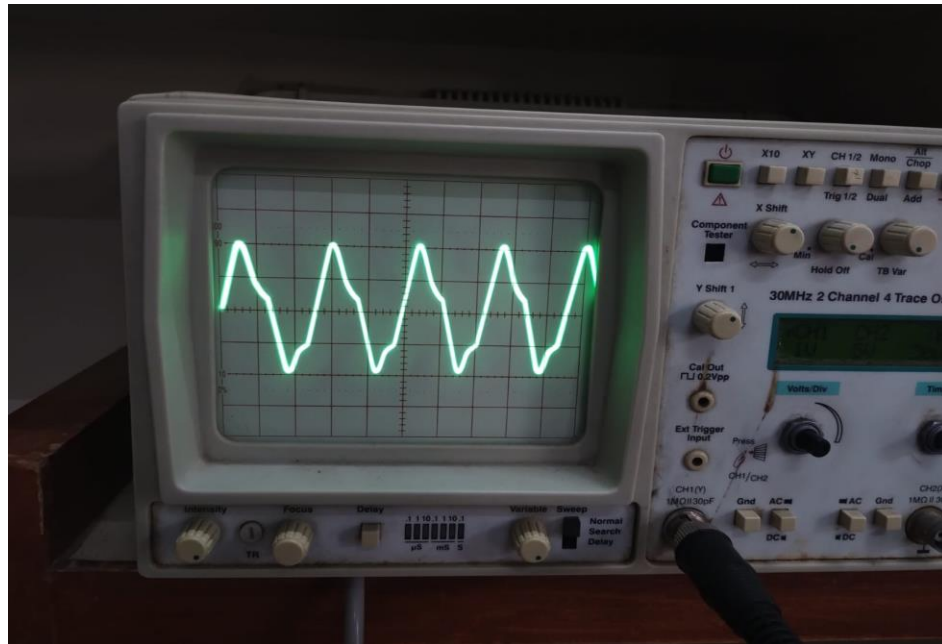
Figure : This is the General Purpose Board, the input to the circuit is from the right terminal block where the center input is ground and the other are positive and negative supply for the op-amp. The output is from the left terminal block bottom one being the ground and

the top one being the signal.

6.3 Special Purpose Board (PCB) :



6.4 PCB Output :



7 Cost of Equipment

Sr.No.	Item	No. of Items	Cost
1	Breadboard	1	80₹
2	Op-Amp IC	3	25₹
3	3.6K Resistors	2	5₹
4	1.5 nF Capacitors	2	20₹
5	PCB and GPB	2	80₹
6	10K Resistors	2	5₹
7	1N4007 Diodes	2	5₹

	TOTAL AMOUNT		
	220₹ /-		

8 Conclusion

- Electronic resonating circuits have low accuracy than the crystal oscillators which are readily available in the market. For generating highly accurate and precise frequency, we can replace the feed back frequency selective network with a crystal oscillator. Crystal oscillator contains a crystal which has piezo-electric properties and can resonate to one particular frequency.
- Oscillators made up of Op Amp are usually limited to the lesser end of the frequency spectrum, mainly due to the reason that they do not possess the required bandwidth to attain low phase shift on higher frequencies. The Op Amps with current feedback have larger bandwidth in comparison to the voltage feedback Op Amps. However there remains a difficulty in practical usage of these due to their sensitivity of the feedback capacitance.
- Wien bridge oscillator frequency depends on the supply voltage.
- MULTISIM simulates close to real components and takes into account some probabilities.
- Amplifier gain should be above 3 for an oscillation to happen.
- Distortion happens if the input voltages ($-V$ and $+V$) are not equal.
- Op Amps with voltage feedback are restricted to a few hundred kHz as a maximum, due to their low frequency roll off. While cascading the bandwidth is reduced because of the multiple contribution of phase shift.
- The Wien-bridge oscillator has a small number of parts and fine frequency stability, nevertheless the fundamental circuit has high output deformation.
- Wein bridge oscillator as a solution the problems we face. AGC improves the deformation significantly, predominantly in the lesser frequency range. Nonlinear feedback offers the paramount presentation over the mid- and upper-frequency ranges.

THANK YOU !