WIEN BRIDGE OSCILLATOR

BINDU SRI BHUKYA
Dept of Electronics and Communication Engineering
BVRIT HYDERABAD College of Engineering for Women - 50009

ABSTRACT :

The Wien Bridge Oscillator is a sinusoidal oscillator widely used for generating low-distortion sine waves in audio and low-frequency applications. It employs a Wien bridge RC network along with an operational amplifier to produce stable oscillations without requiring an external input signal. The frequency of oscillation is determined by resistors and capacitors in the feedback network. By properly controlling the amplifier gain, the Wien Bridge Oscillator provides excellent frequency stability and low harmonic distortion. In this work, a Wien Bridge Oscillator circuit is designed and simulated using the eSim tool, and stable sinusoidal output is observed.

INTRODUCTION :

Oscillators are electronic circuits that generate periodic waveforms such as sine, square, or triangular waves without any external input signal. Among various sinusoidal oscillators, the Wien Bridge Oscillator is preferred for low-frequency applications due to its simplicity and high stability.

The Wien Bridge Oscillator uses an RC bridge network to determine the frequency of oscillation and an amplifier to satisfy the Barkhausen criteria. The circuit provides both positive and negative feedback. Positive feedback is responsible for sustaining oscillations, while negative feedback controls the gain and stabilizes the output amplitude. Due to its low distortion and stable operation, the Wien Bridge Oscillator is commonly used in function generators and audio signal generators

PURPOSE OF WIEN BRIDGE OSCILLATOR :

The main objectives of designing a Wien Bridge Oscillator are:

• To generate a pure sinusoidal waveform
• To achieve stable oscillation frequency
• To minimize harmonic distortion
• To operate efficiently at low frequencies

• To provide automatic amplitude stabilization
• To implement a simple and reliable oscillator circuit

WORKING PRINCIPLE :

The Wien Bridge Oscillator operates based on the **Barkhausen criterion**, which states that for sustained oscillations:

• The loop gain must be unity
• The total phase shift must be 0° or 360°

The circuit consists of a Wien bridge network made of a series RC circuit and a parallel RC circuit. At a particular frequency, known as the resonant frequency, the phase shift introduced by the RC network becomes zero, and the maximum voltage is fed back to the amplifier input.

The operational amplifier is configured in a non-inverting mode. The gain of the amplifier is set to **3**, which is the minimum gain required to sustain oscillations. When power is supplied, noise present in the circuit initiates oscillations. These oscillations are amplified and selectively reinforced at the resonant frequency by the Wien bridge network, resulting in a stable sinusoidal output.

FREQUENCY OF OSCILLATION :

The frequency of oscillation of a Wien Bridge Oscillator is given by:

$$f_r = \frac{1}{2\pi RC}$$

Where:
R = Resistance (Ω)
C = Capacitance (F)

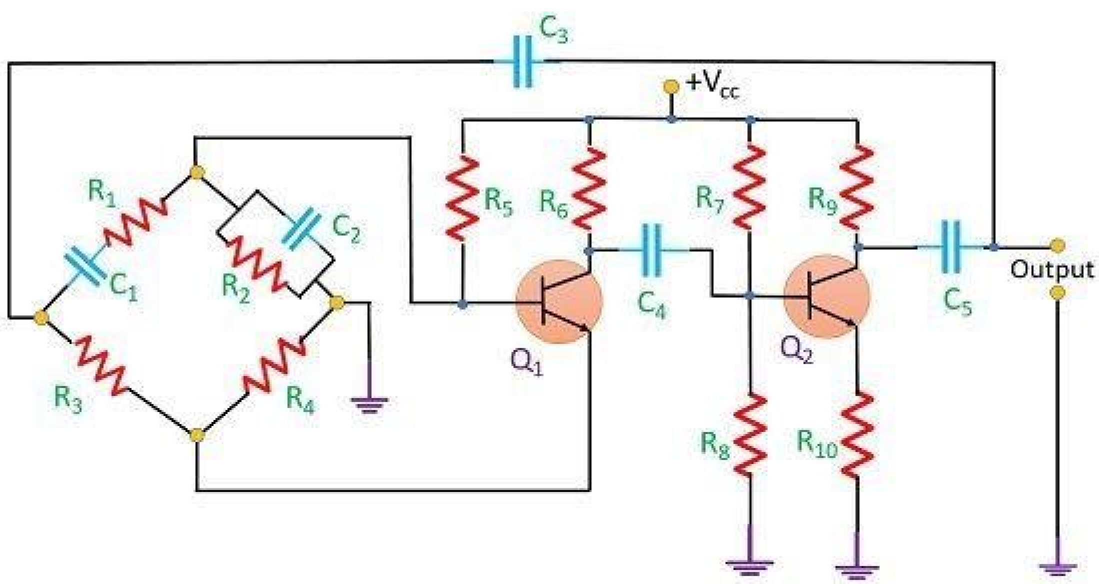
The frequency can be easily varied by changing the values of R or C.

CIRCUIT DIAGRAM :

The circuit diagram of the Wien Bridge Oscillator consists of:

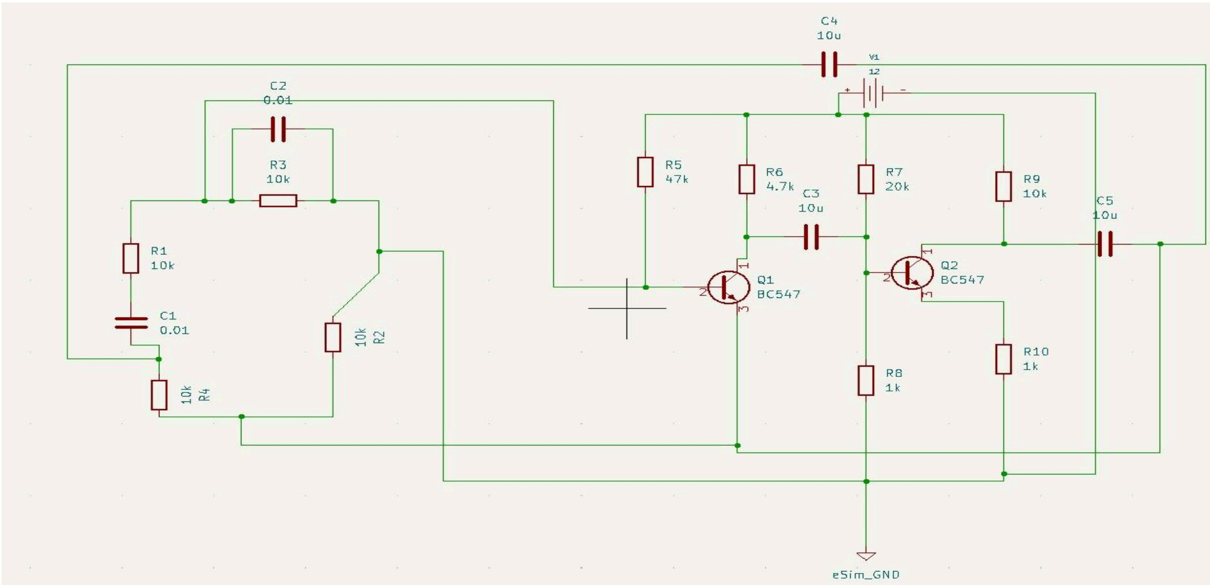
- Operational amplifier
- Two resistors (R1, R2)
- Two capacitors (C1, C2)
- Feedback resistors for gain control

The Wien bridge network provides positive feedback, while the resistive network connected to the inverting terminal provides negative feedback.

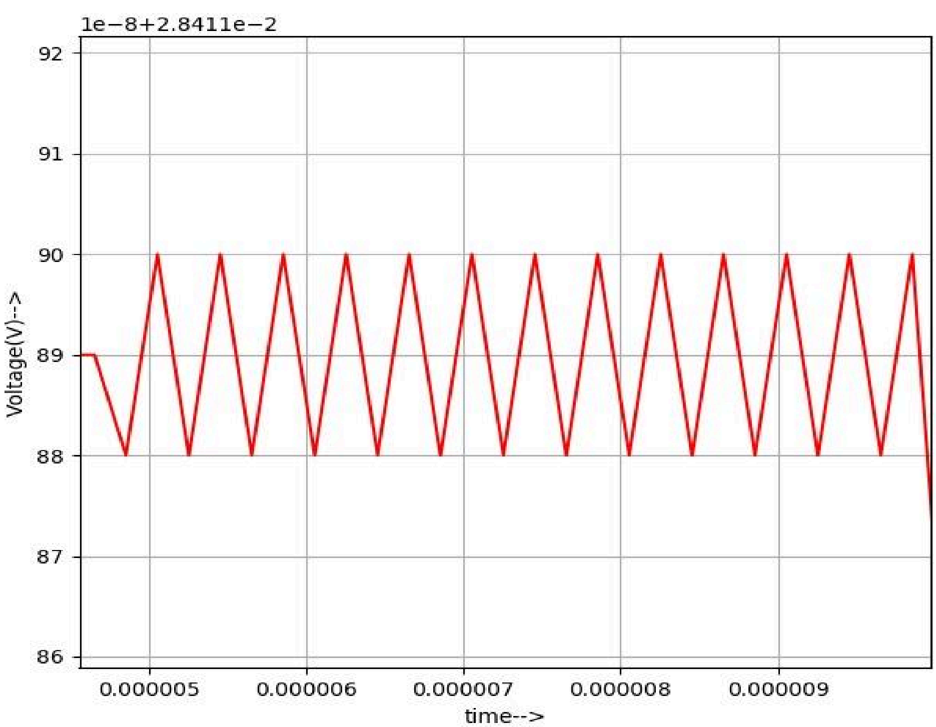


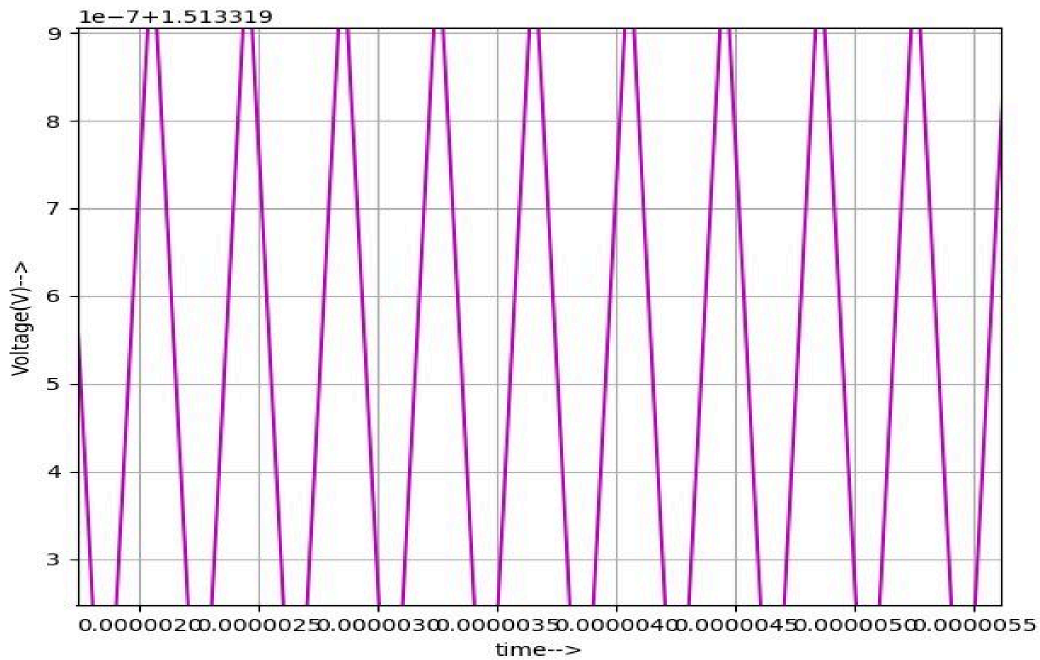
eSIM SIMULATION RESULTS :

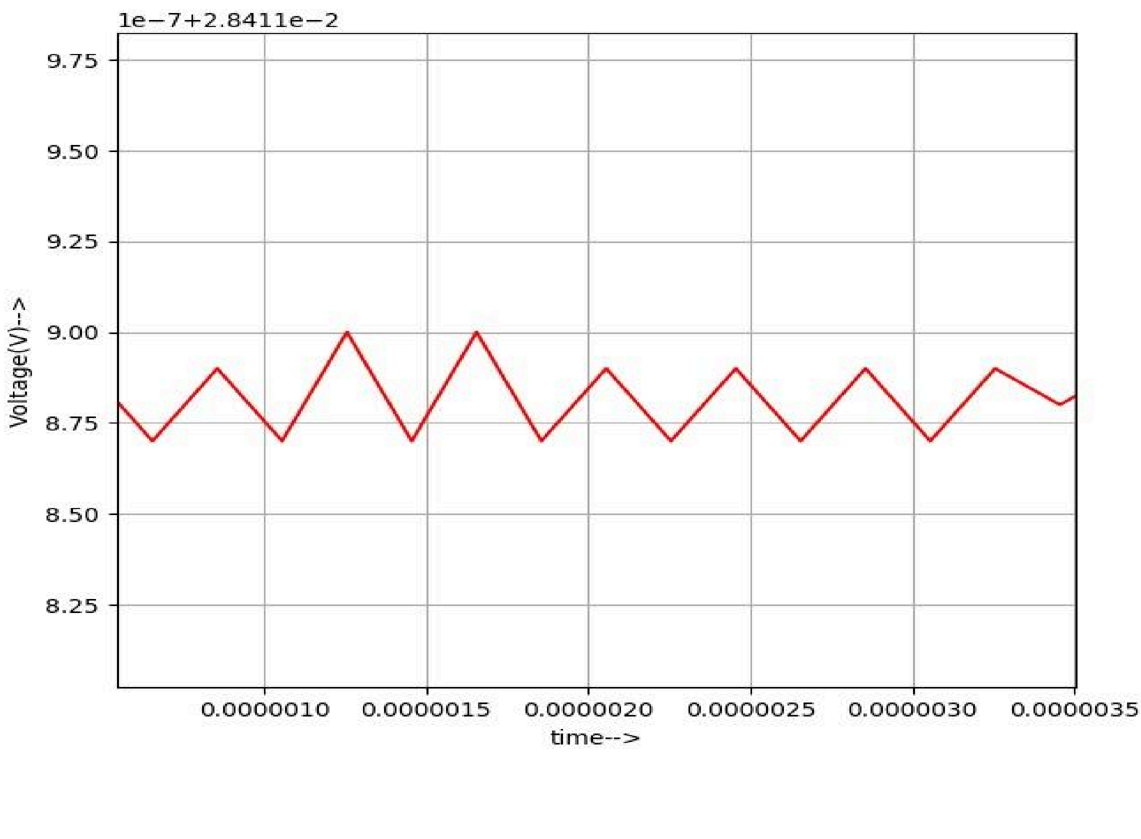
The simulation results show that the Wien Bridge Oscillator produces a stable sinusoidal waveform. The output waveform confirms that the frequency and amplitude remain constant after initial startup transients. The results validate the theoretical operation of the circuit.



OUTPUT WAVE FORMS :




1e−7+1.513319
9
8
7
6
5
4
3
Voltage(V)-->
0.0000020
0.0000025
0.0000030
0.0000035
0.0000040
0.0000045
0.0000050
0.0000055
time-->


1e−7+2.8411e−2
9.75
9.50
9.25
9.00
8.75
8.50
8.25
Voltage(V)-->
0.0000010
0.0000015
0.0000020
0.0000025
0.0000030
0.0000035
time-->

APPLICATIONS OF WIEN BRIDGE OSCILLATOR

1. Audio signal generators
2. Function generators
3. Testing and measurement equipment
4. Communication systems
5. Musical tone generators
6. Instrumentation circuits
7. Calibration of analog systems
8. Low-frequency oscillator applications

CONCLUSION

In this work, a Wien Bridge Oscillator was first designed using an operational amplifier. Although the op-amp based oscillator generated a sine wave, the output was not stable and contained noise and distortion. This happened due to gain instability and non-ideal behavior of the operational amplifier, which affected proper amplitude control.

To solve this , I have redesigned the circuit as Wien Bridge Oscillator using a BJT-based amplifier circuit. The transistor-based design provided better control over gain and feedback, resulting in a more stable and cleaner sine wave output. The noise and distortion were significantly reduced compared to the op-amp based circuit.

Simulation results using the eSim tool confirm that the BJT-based Wien Bridge Oscillator produces a stable sinusoidal waveform with improved performance. Hence, the BJT implementation is more suitable for low-frequency sine wave generation and audio signal applications.

References :

Reference(s) :

1. “Wien Bridge Oscillator – Theory & Design”, Electronics Tutorials, 2025.

https://www.electronics-tutorials.ws/oscillator/wien_bridge.html

2. E. Lindberg, “The Wien Bridge Oscillator Family,”

https://www.researchgate.net/publication/233860816_The_wien_bridge_oscillator_family