Aim ↬ To design and test the performance of the RC Phase Shift Oscillator for the given frequency.

Equipment Required ↬

Bipolar Junction Transistors, resistors, variable resistor, capacitors, power supply, DSO, breadboard, and connecting wires.

Theory ↬

An RC Phase Shift Oscillator is a type of electronic oscillator that generates a continuous, stable sinusoidal waveform using a combination of resistors and capacitors to create the necessary phase shift for oscillation. The primary purpose of this oscillator is to generate low-frequency signals, and it is widely used in applications such as audio signal generation and as a test signal source. The key feature of this circuit is the use of three or more RC stages in the feedback path to achieve the required phase shift, along with a transistor that amplifies the signal to maintain continuous oscillation.

The basic structure of the RC Phase Shift Oscillator involves a single-stage amplifier, typically using a Bipolar Junction Transistor (BJT), and a feedback network composed of resistors and capacitors. The amplifier is responsible for inverting the input signal by 180 degrees, while the RC network provides an additional 180-degree phase shift. Together, these shifts create a total phase shift of 360 degrees, which is necessary for the circuit to sustain oscillations. The Barkhausen criterion for oscillation is satisfied when the total phase shift around the loop is 360 degrees, and the loop gain is equal to or greater than one.

In this circuit, the oscillation frequency is determined by the values of the resistors and capacitors in the RC network. The frequency is given by the equation:

$$f = \frac{1}{2\pi\sqrt{6}RC}$$

where f is the oscillation frequency, R is the resistance in each RC section, and C is the capacitance in each section. Using multiple RC stages ensures that the correct phase shift is achieved, and by carefully selecting the values of R and C, the desired oscillation frequency can be obtained.

During the experiment, a power supply is connected to the circuit, and the input signal is fed into the base of the BJT. As the signal passes through the transistor, it is amplified and inverted. This amplified signal is then fed back into the RC network, where it undergoes a phase shift of 180 degrees before being fed back into the transistor. This feedback loop sustains the oscillation by continuously feeding the phase-shifted signal back into the input. The output of the oscillator is typically a sinusoidal waveform with low distortion, and the frequency of the waveform is primarily controlled by the RC components in the feedback network.

The expected result of the RC Phase Shift Oscillator is a stable sinusoidal waveform at the calculated frequency. By varying the values of the resistors or capacitors, the frequency of oscillation can be adjusted, allowing for fine-tuning of the output signal. Additionally, the variable resistor in the circuit allows for real-time frequency adjustment, making the oscillator versatile for different applications.

Overall, the RC Phase Shift Oscillator is an efficient and reliable method for generating low-frequency sinusoidal waveforms. It is simple to design and implement, requiring only basic components such as resistors, capacitors, and a transistor. The oscillator's frequency stability depends on the accuracy of the component values, and the circuit provides a straightforward approach to creating oscillations in the desired frequency range.

Circuit Diagram ↬

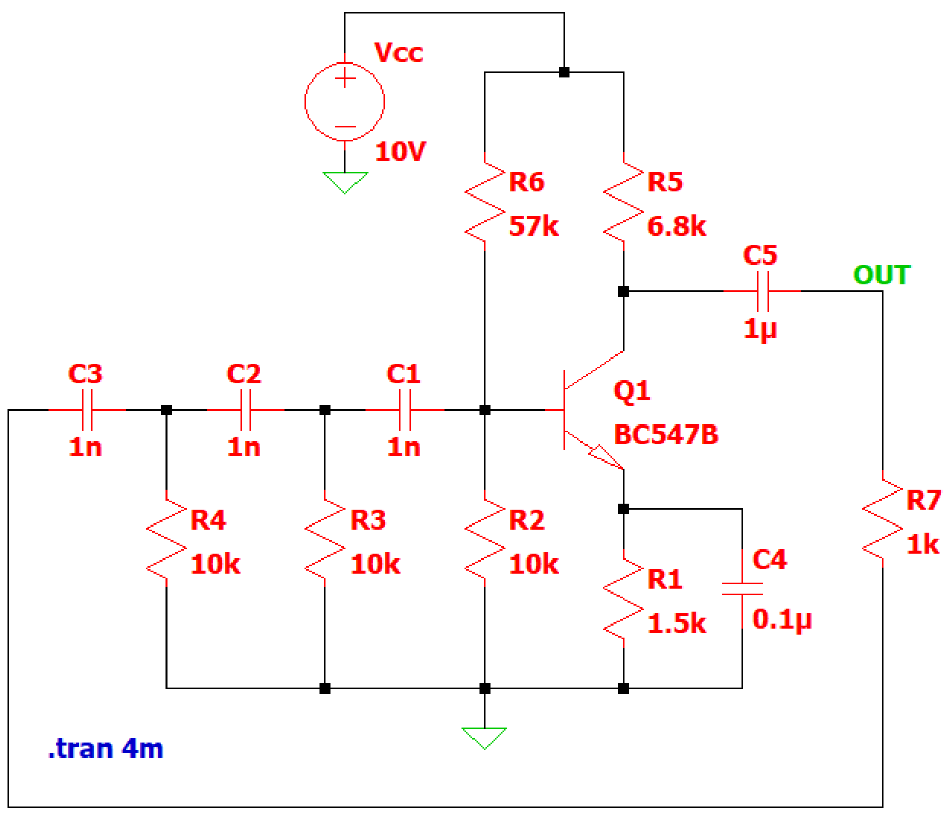

Fig. i) Circuit in LTSpice

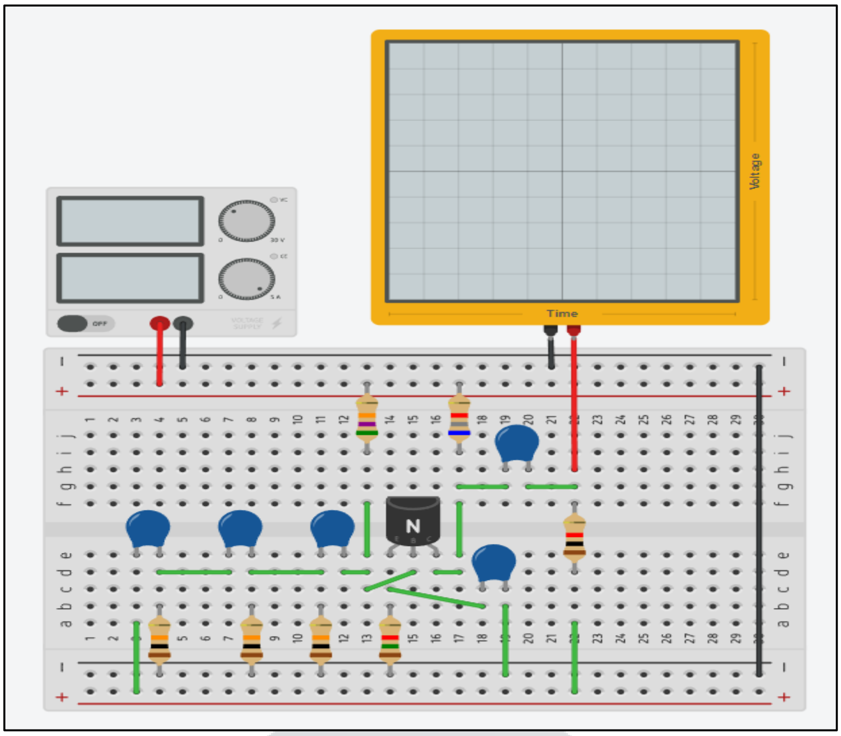

Fig. ii) Circuit in TinkerCad

Graphs ↬

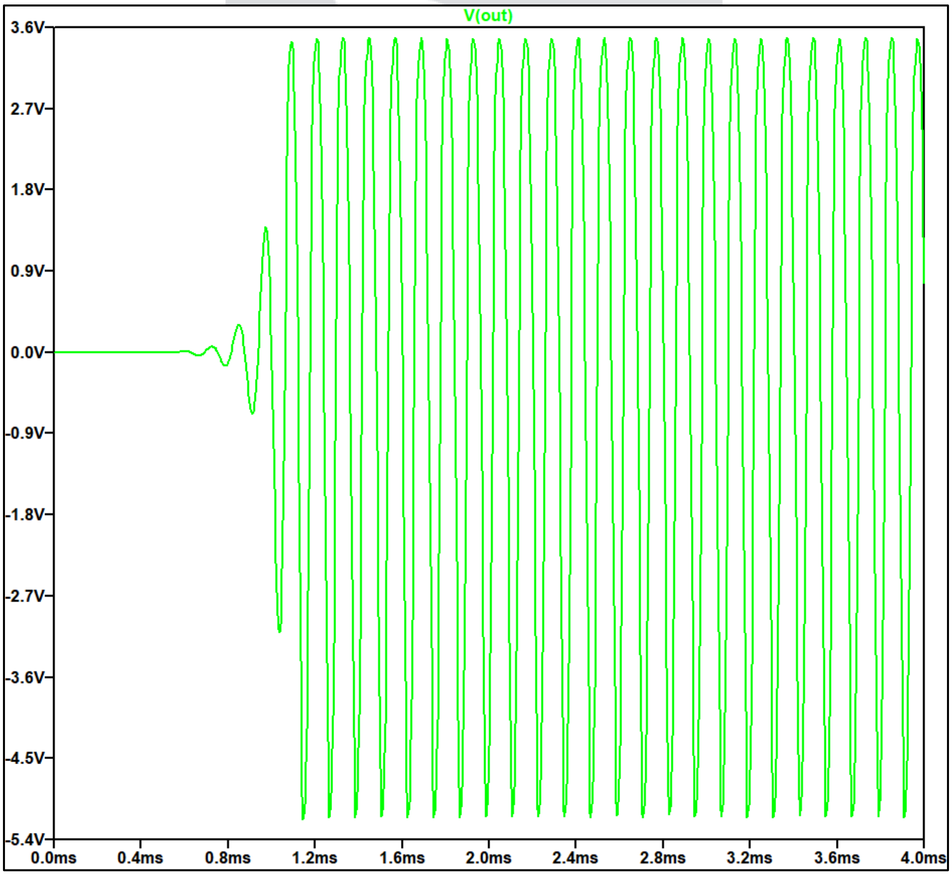

Fig. iii) Output sine wave

Calculation ↬

$$f = \frac{1}{2\pi\sqrt{6}RC}$$

$$f = \frac{1}{2 \times 3.14 \times \sqrt{6} \times 10 \times 10^3 \times 1 \times 10^{-9}}$$

$$f = 6.497\ kHz$$

Result ↬

The RC Phase Shift Oscillator generated a stable sinusoidal waveform at the expected frequency, closely matching the calculated value. The frequency remained stable across a range of adjustments using the variable resistor.

Conclusion ↬

The oscillator was successfully designed and tested, demonstrating consistent sinusoidal waveform generation at the desired frequency. The results aligned with theoretical predictions, proving the circuit's effectiveness for low-frequency signal generation.

Precautions ↬

- Ensure all connections are secure to avoid any open circuits, which may disrupt the feedback loop.
- Verify the polarity of electrolytic capacitors, as reversing the polarity can damage the component.
- Ensure the transistor operates within its specified voltage and current limits to prevent overheating or failure.
- Carefully adjust the variable resistor to fine-tune the oscillation frequency, ensuring that the loop gain remains sufficient for sustained oscillation.