

# Op-Amp Based Asymmetric Astable Multivibrator for PWM Motor Control

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## Abstract

This paper presents the design and application of an asymmetric astable multivibrator using an operational amplifier (op-amp) for pulse width modulation (PWM) in motor control. The circuit generates a non-symmetrical square wave with an adjustable duty cycle, enabling precise control over the motor's speed by varying the pulse duration. By leveraging the stability and control provided by an op-amp, this design offers a cost-effective and efficient solution for PWM applications in motor control systems. This approach is particularly beneficial in robotics and automation, where adjustable speed and smooth motor operation are essential. The paper explores the circuit configuration, design parameters, and performance in real-world motor control applications.

**Keywords:** Duty Cycle Modulation, Frequency Stability, Oscillator Configuration, Signal Conditioning, Waveform Synthesis

## I. INTRODUCTION

In modern electronics, precise control over waveforms and pulse durations is essential for various applications, particularly in motor control for automation and robotics. Pulse Width Modulation (PWM) is a widely used technique for controlling motor speed by varying the duty cycle of a square wave signal. An asymmetric astable multivibrator, configured using an operational amplifier (op-amp), offers a simple and efficient solution for generating such non-symmetrical square waveforms with adjustable on-off timing. This paper explores the design of an op-amp-based asymmetric astable multivibrator circuit tailored for PWM in motor control applications. By leveraging the op-amp's stability and flexible configuration, the circuit enables precise motor speed control, making it ideal for systems requiring dynamic response and adjustability. The following sections detail the circuit design, implementation, and effectiveness of this approach in real-world motor control environments.

## THE PURPOSE OF AN ASYMMETRIC ASTABLE MULTIVIBRATOR

**1. Timing and Clock Signals:** Provides adjustable timing pulses in circuits requiring non-symmetrical timing, suitable for digital clock applications.

**2. Pulse Width Modulation (PWM):** Controls power delivery to devices such as motors and LEDs by varying the duty cycle, ideal for speed control in motors or dimming in LEDs.

**3. Signal Generation for Testing:** Produces test signals with variable pulse widths for calibration and testing of electronic components and systems.

**4. Audio and Tone Generation:** Used in audio circuits for generating tones of different frequencies and duty cycles, useful in alarms and sound effects.

**5. Frequency Control Applications:** Used in frequency modulation and switching applications where varying the signal frequency is beneficial, such as in communication and signal processing.

## WORKING PRINCIPLE

An **asymmetric astable multivibrator** generates a continuous, non-symmetrical square wave using an op-amp, resistors, and capacitors. The circuit alternates between two unstable states, with the capacitor charging and discharging through resistors. When the voltage across the capacitor reaches a threshold, the op-amp switches its output state. The frequency and duty cycle of the output wave are determined by the resistor and capacitor values. The circuit produces a square wave with unequal high and low durations, making it suitable for applications requiring pulse width modulation (PWM) and timing signals.

## CIRCUIT DIAGRAM

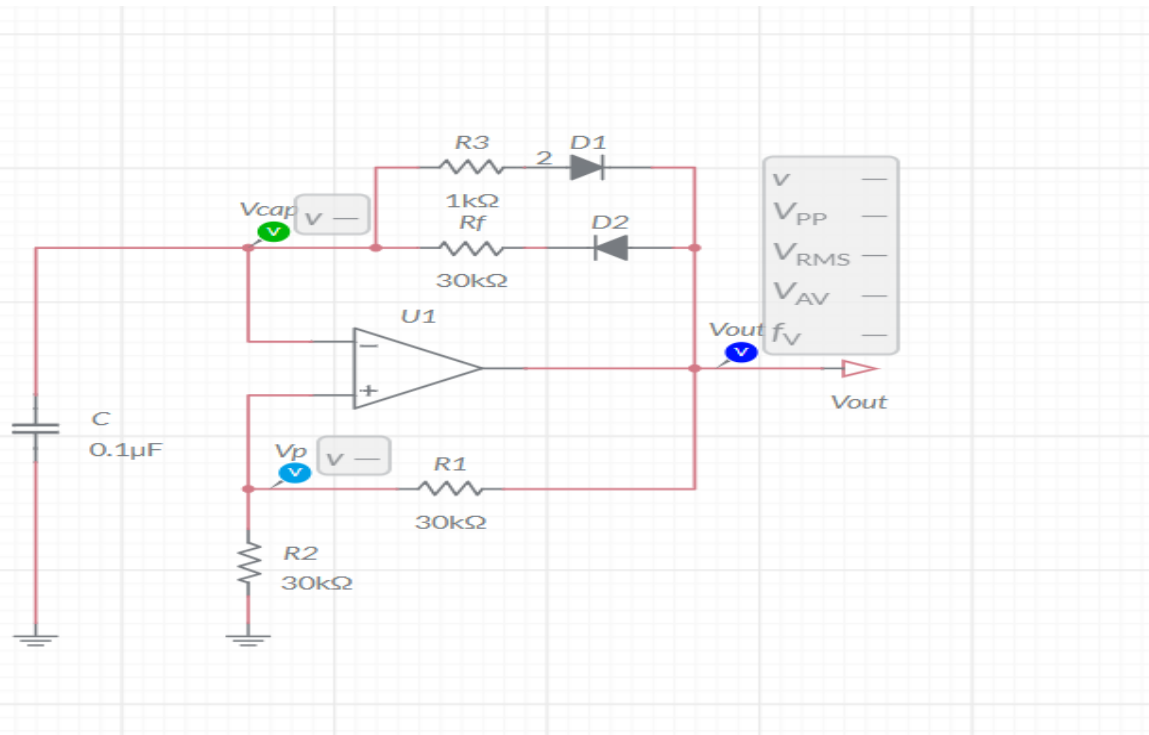
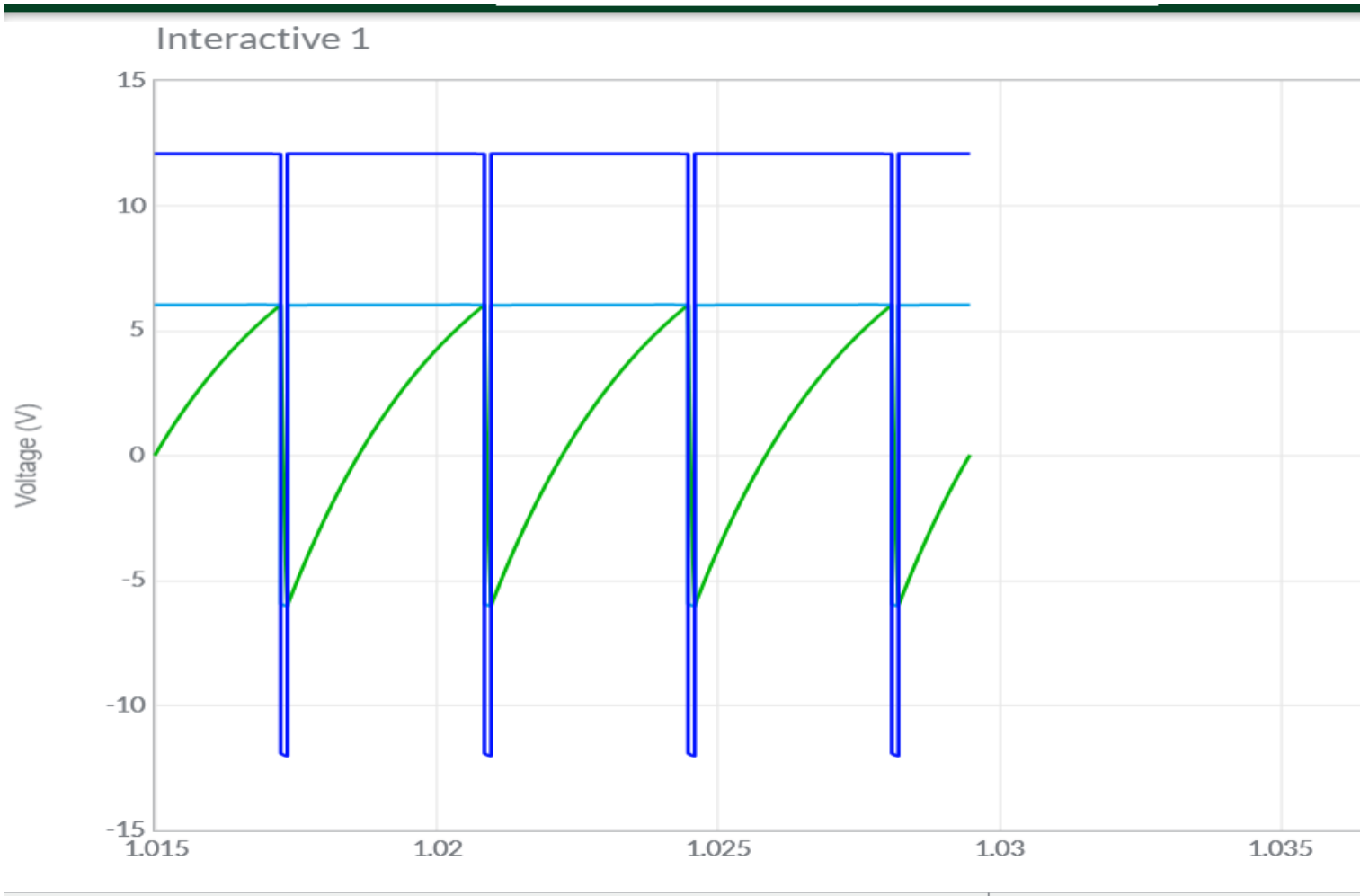


Fig 1: Asymmetric Astable Multivibrato



**Fig 2: Output Of An Asymmetric Astable Multivibrator**

**PROPOSED SYSTEM**

The proposed system involves designing an asymmetric astable multivibrator using an operational amplifier (op-amp) to generate a continuous, non-symmetrical square wave with adjustable frequency and duty cycle. The circuit utilizes resistors and capacitors to control the charging and discharging of the capacitor, which in turn determines the timing of the high and low states of the output. By adjusting the resistor and capacitor values, the system allows for precise control over the pulse width modulation (PWM), making it suitable for motor control, signal generation, and other timing-related applications. The system will provide a stable and efficient solution for generating asymmetric square waves with a customizable duty cycle for various practical uses.

ESIM CIRCUIT

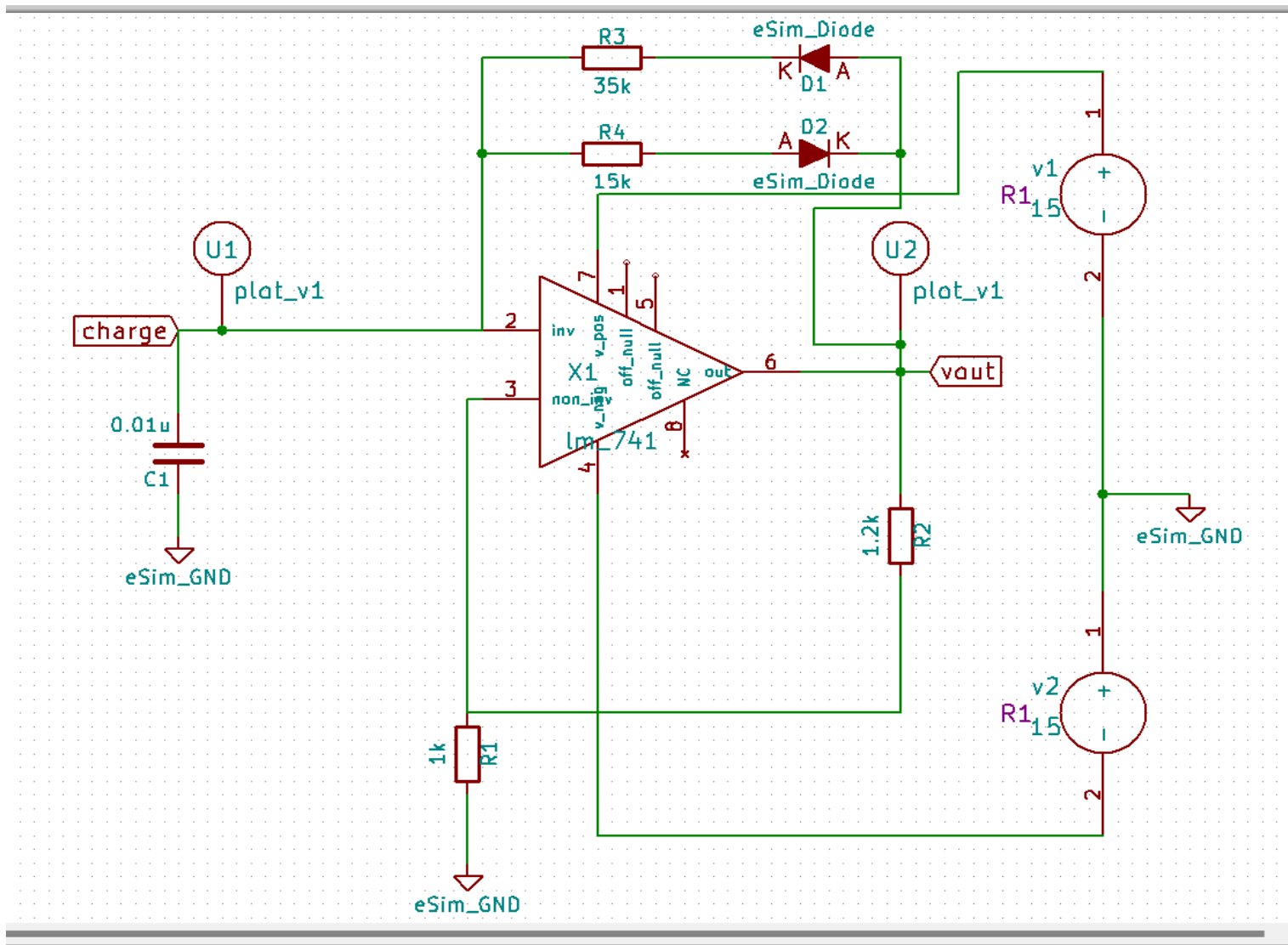
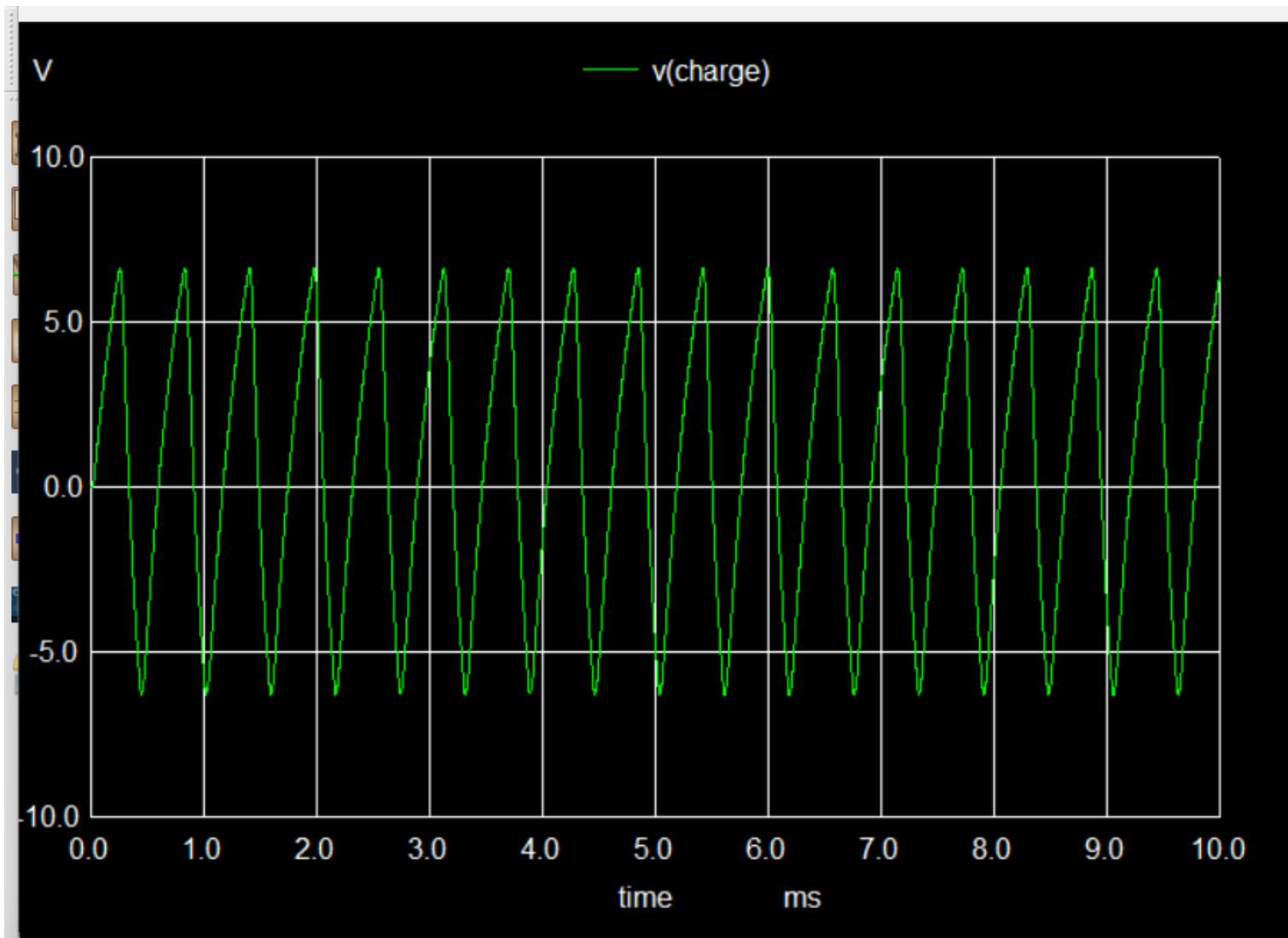


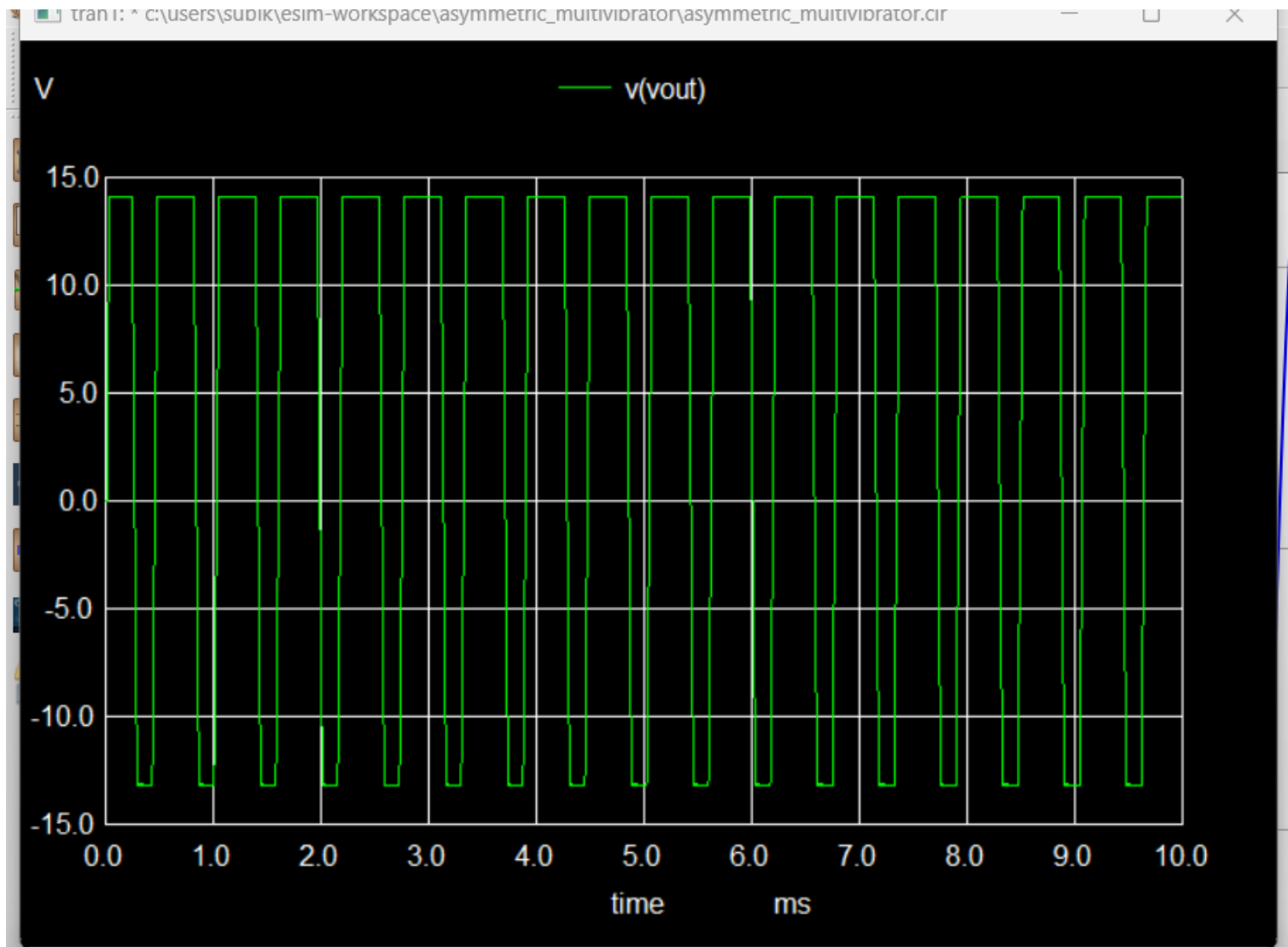
Fig 3: This diagram shows the op-amp-based circuit used to generate a non-symmetrical square wave with adjustable frequency and duty cycle.

## INPUT WAVEFORM



**Fig 4:** This figure shows the input signal provided to the asymmetric astable multivibrator circuit, which triggers the op-amp to generate a non-symmetrical square wave output.

## OUTPUT WAVEFORM



**Fig 5 :** This figure illustrates the output waveform generated by the asymmetric astable multivibrator, showing a non-symmetrical square wave with adjustable duty cycle and frequency

PYTHON PLOT

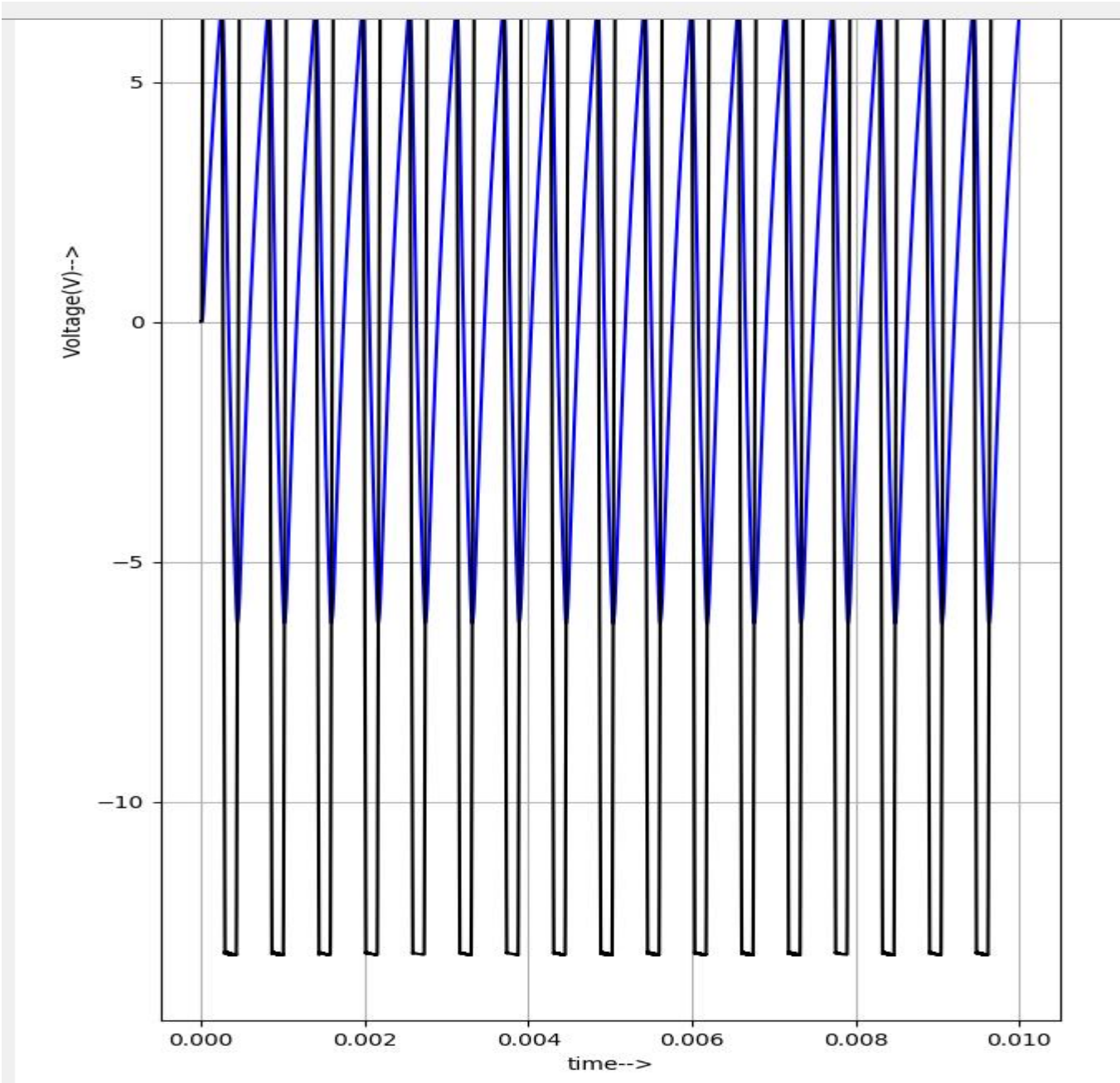


Fig 6:Output Python Plot

### **Advantages of Asymmetric Astable Multivibrator:**

1. Adjustable Duty Cycle
2. Simple Design
3. Low Power Consumption
4. Wide Frequency Range
5. Stable Operation

### **Disadvantages of Asymmetric Astable Multivibrator:**

1. Limited Precision
2. Non-Ideal Waveform
3. Op-Amp Limitations

### **Applications**

1. **Pulse Width Modulation (PWM)** for motor speed and LED brightness control.
2. **Timing circuits** for delays and clock generation.
3. **Signal generation** in function generators and test equipment.
4. **Tone generation** in audio and alarm systems.
5. **Frequency modulation** for communication systems.

### **Conclusion:**

In conclusion, the Asymmetric Astable Multivibrator is a simple, efficient circuit that generates adjustable square wave signals with varying frequency and duty cycle. It is widely used in applications like PWM, timing, and signal generation due to its low power consumption and versatility, making it a valuable component in many electronic systems.

### **REFERENCES**

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