Department of CSE

<table>
<tr><td colspan="3">Project</td></tr>
<tr><td colspan="3">Course Code and Name: CSE251, Electronic Circuits</td></tr>
<tr><td colspan="3">Project name: Design of a Triangular wave generator using Operational Amplifier for a specified input.</td></tr>
<tr><td>Semester: Fall-23</td><td colspan="2">Group No : 01</td></tr>
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<tr><td>Date of Report Submitted:
26 December, 2023</td><td>Project Marks</td><td></td></tr>
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Problem Statement

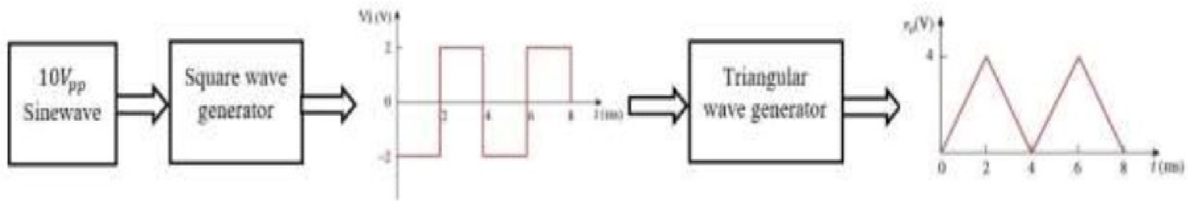


Fig. 1

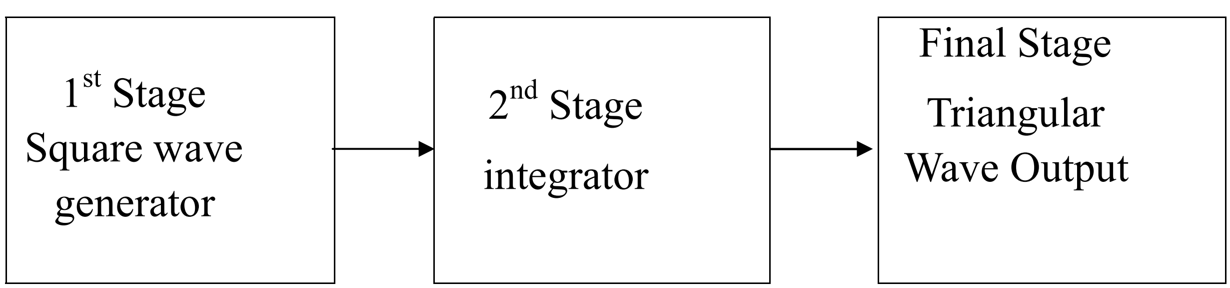
Fig.1 shows a design process of a Triangular wave generator circuit. The design process includes two design segments (a square wave generator & a triangular wave generator) to get the final output v_o (V). Use a $10V_{pp}$ sinusoid as input and operational amplifiers to design. Design the circuit components and finally simulate to test the circuit. [Note that, for design purpose, the values of the resistors should not exceed more than 10kΩ.]

Design Details

Op-amp Triangle Wave Generator:

Triangle wave generator using op-amp has two stages. An integrator can produce a triangle wave when integrating input.

Therefore the first stage is a square wave generators (using comparator) and second stage is the integrator.



Square Wave Explanation:

Amplitude (V_m): The given sinusoid has a peak-to-peak (pp) value of 10V. The amplitude (V_m) of a sinusoid is half of the peak-to-peak value. Therefore, $V_m \frac{10V}{2} = 5V$.

Time Period (T) and Frequency (f): The time period of the sinusoid is stated as 4ms.The frequency (f) can be calculated using the formula $f = \frac{1}{T}$, where T is the time period. Substituting the given value, $f = \frac{1}{4ms} = 250Hz$.

Power Supply Voltages ($+V_{cc}$ and $–V_{cc}$): The problem states that the required square wave will have a peak-to-peak value of 4V. In a comparator circuit, the power supply voltages determine the range within which the comparator operates. The chosen values are $+V_{cc} = 2V$ (positive voltage limit) and $–V_{cc} = -2V$ (negative voltage limit).

Triangle Wave Explaination:

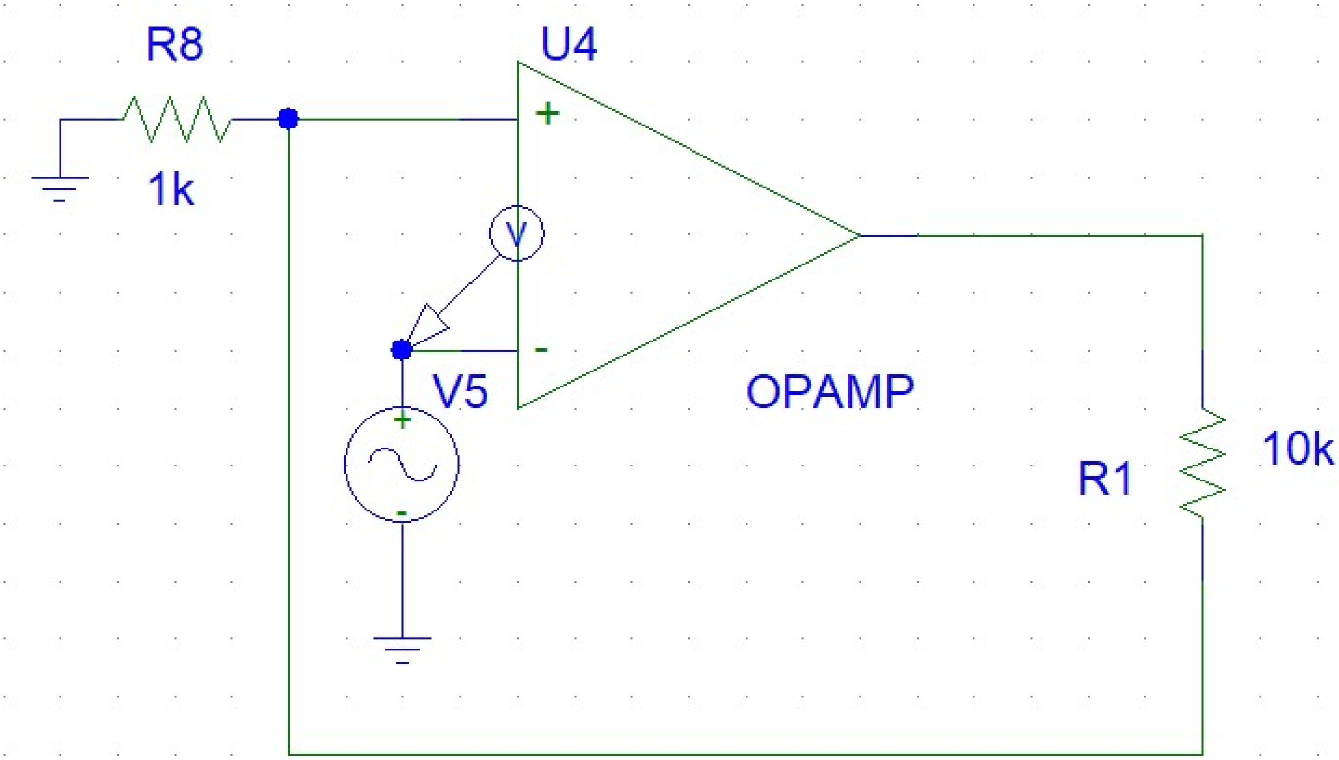
1. Condition 1 (0 ms < t < 2ms):

- Input Voltage: $V_{in} = -2v$
- Output Expression: $V_{out} = \frac{2 \times 2}{R_2 \times C_2}$ mV
- Design Parameters: $R_2 = 10\ k\Omega$, $C_2 = 0.1\ \mu F$
- Peak Value of Triangular Wave: 4 V

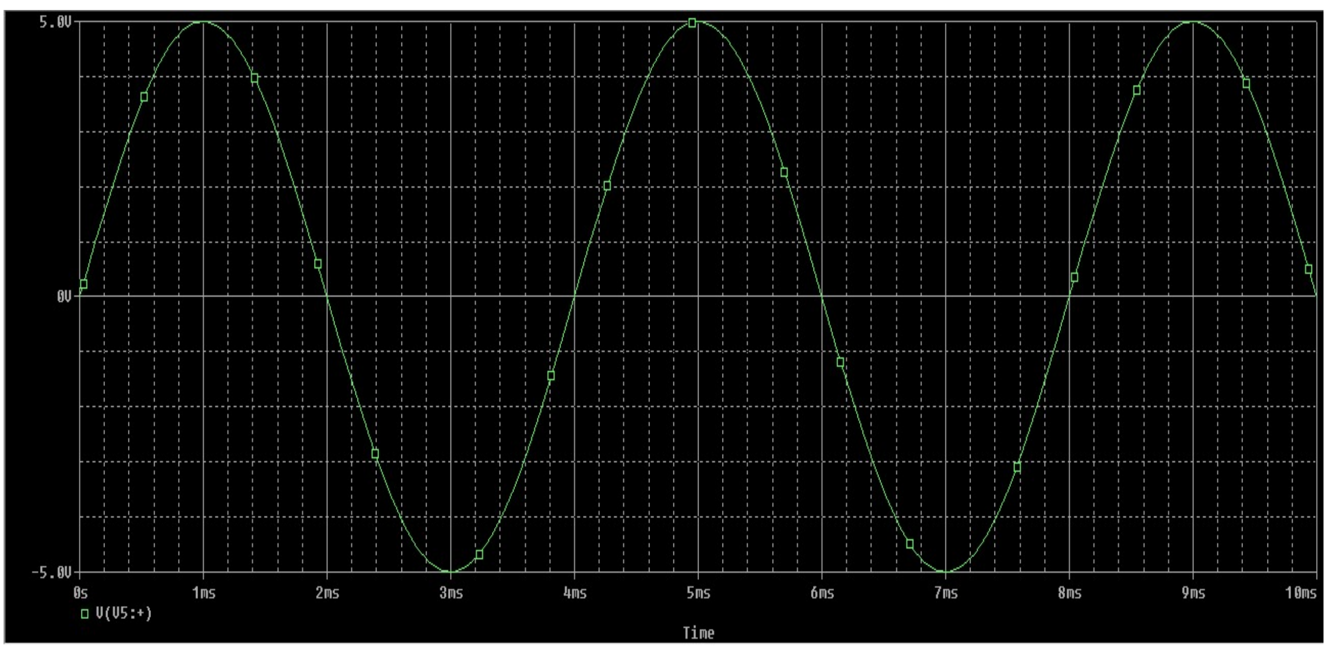
2. Condition 2 (2ms < t < 4ms):

- Input Voltage: $V_{in} = 2$ V
- Output Expression: $V_{out} = - \frac{2 \times 2}{R_2 \times C_2}$ mV
- Design Parameters: $R_2 = 10\ k\Omega$, $C_2 = 0.1\ \mu F$
- Peak Value of Triangular Wave: 4 V

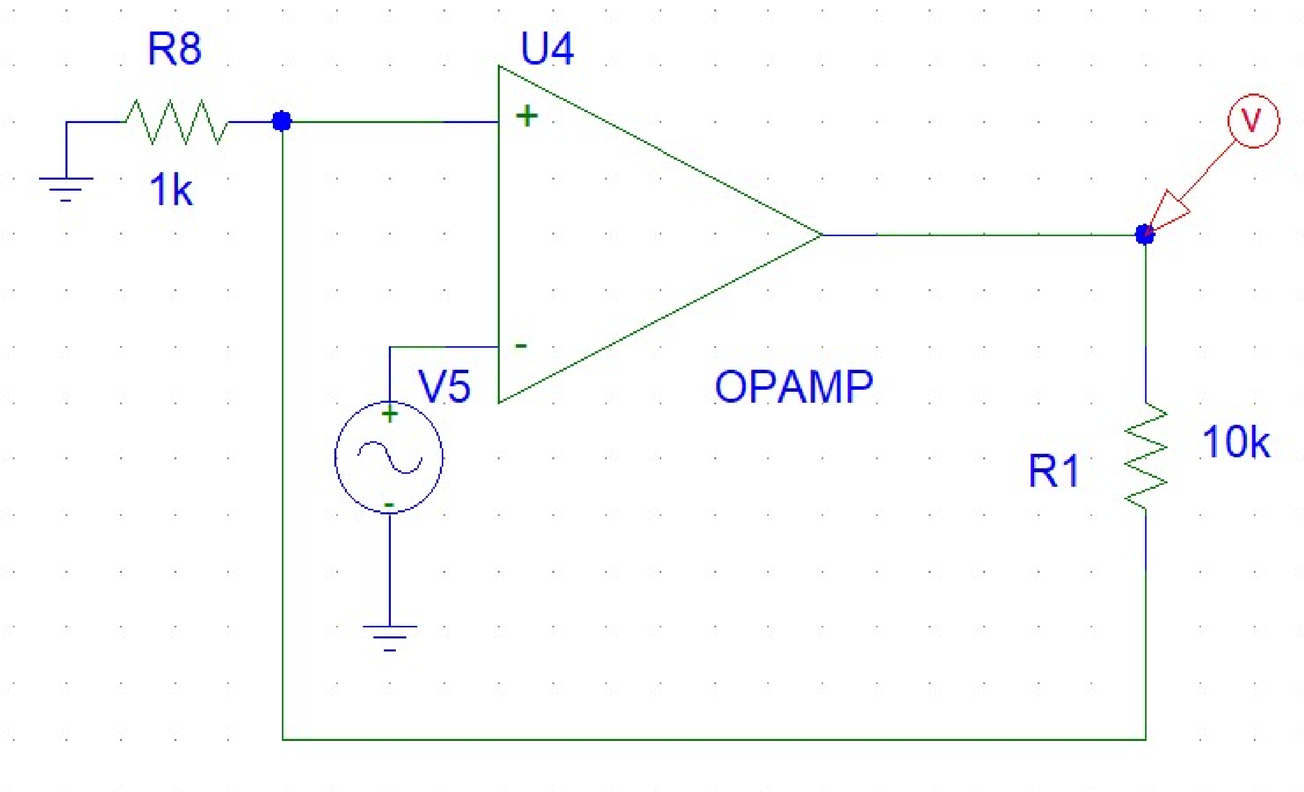
Sinusoidal Wave Circuit



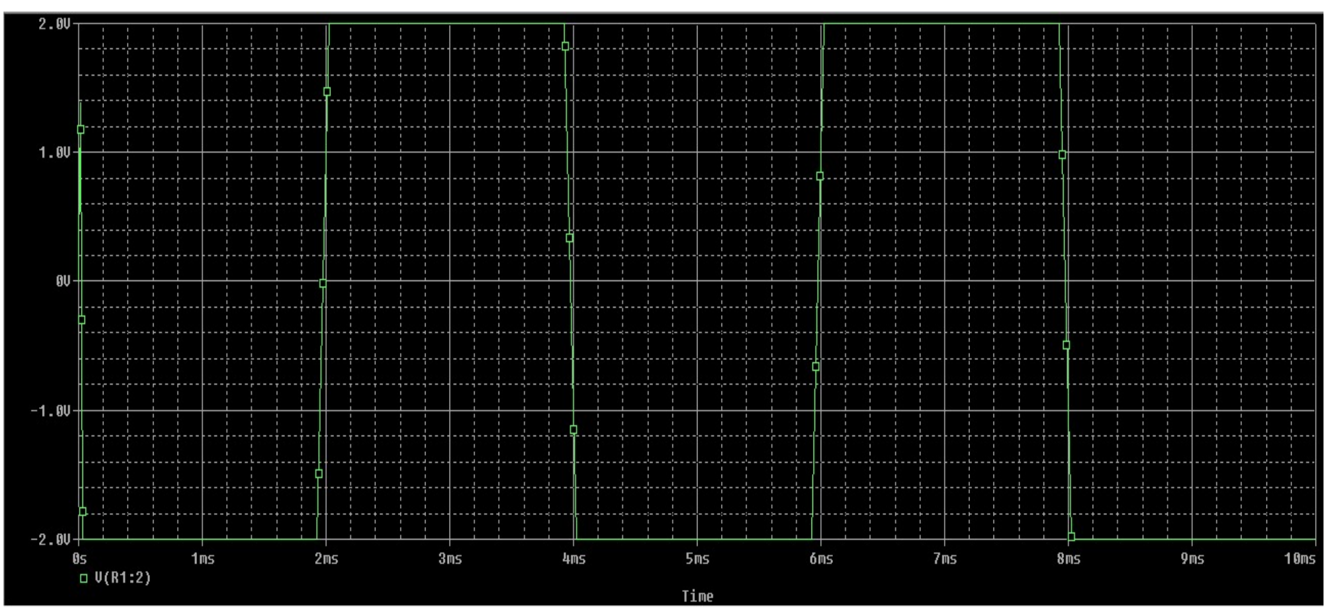
Sinusoidal Wave Graph



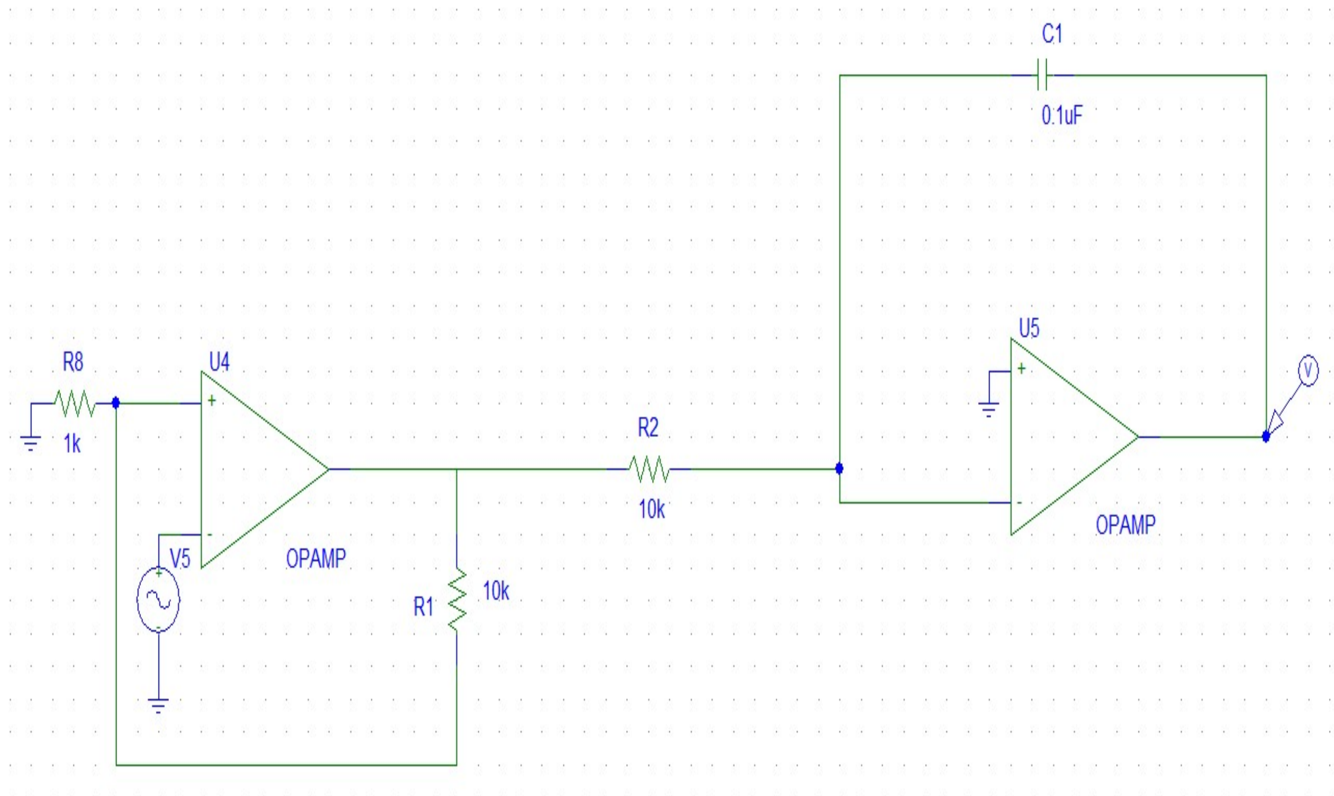
Square Wave Circuit



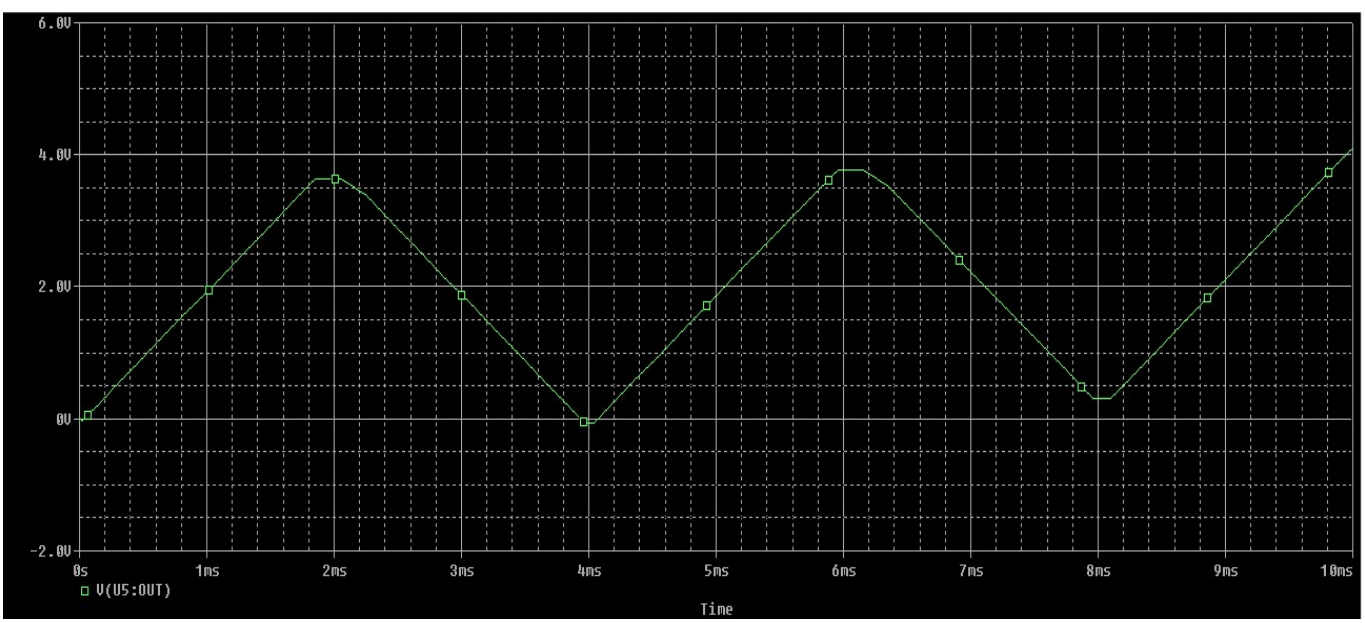
Square Wave Graph



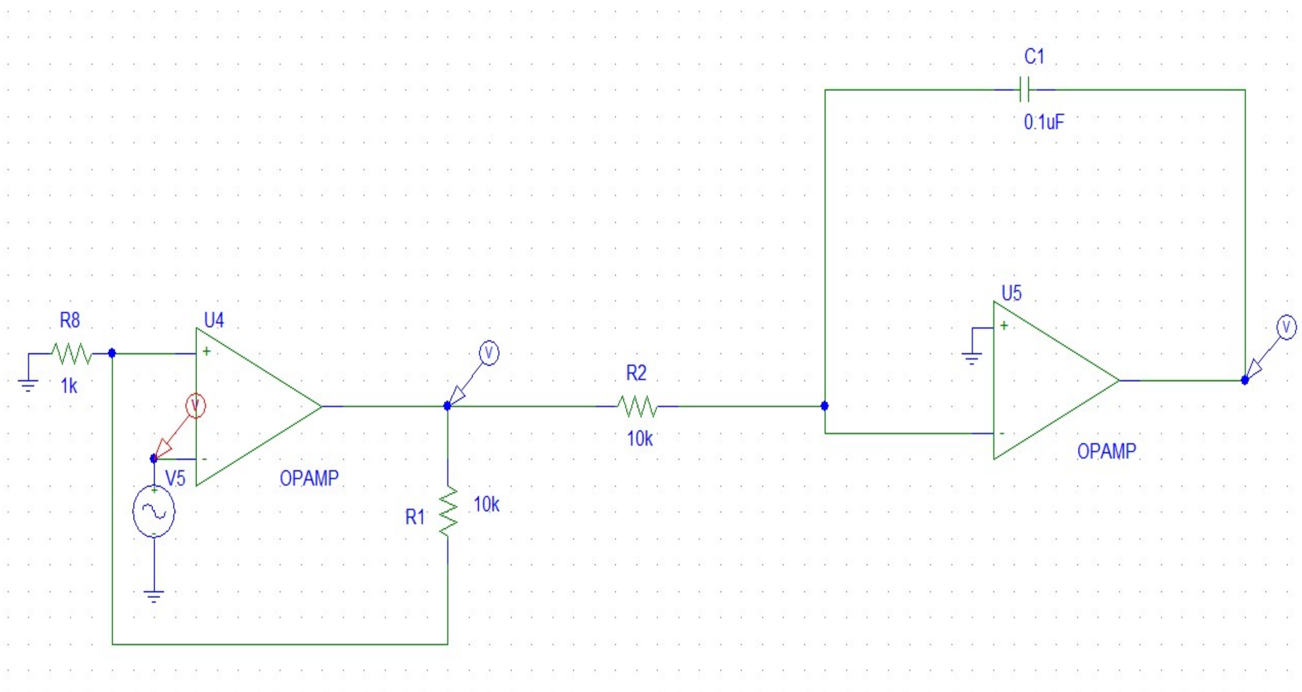
Triangle Wave Circuit



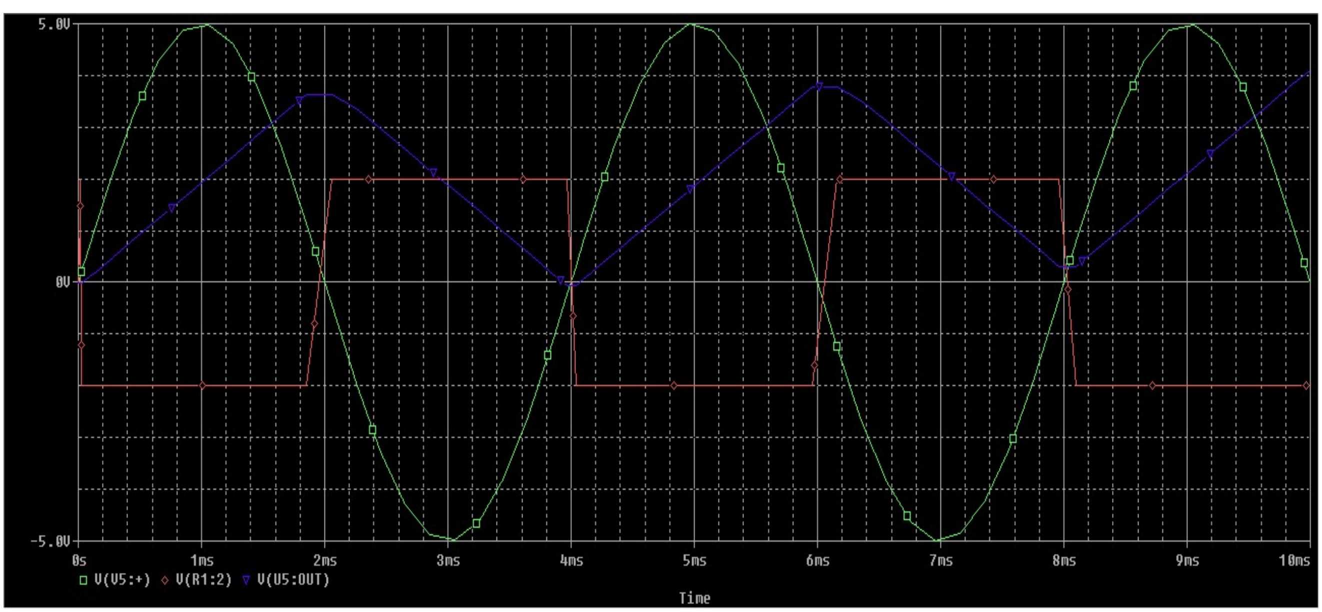
Triangle Wave Graph



Circuit Diagram



Simulation Results



<u>Conclusion:</u> Taking a 10 V_{pp} sine wave and turning it into a triangle involves a few steps. First, we change the sine wave into a clean square wave using a special comparator. This square wave becomes the starting point. Then, we use a circuit with an amplifier and a capacitor to turn that square wave into the triangle shape we want. This whole process is super important in electronics. It helps create different kinds of waves we use in lots of tech stuff, making it really handy to understand for working with signals in electronics.