Title: Design of Function Generator using using op amp

Objective

To design and implement a function generator circuit using operational amplifiers (Op-Amps) capable of generating basic waveforms such as sine, square, and triangular waves. The output should have adjustable frequency and amplitude, suitable for testing and analysis of electronic circuits.

Theory

A **function generator** is an essential piece of test equipment in electronics, used to generate different types of electrical waveforms over a wide range of frequencies. The most commonly generated waveforms are:

- **Sine wave** – smooth periodic oscillation
- **Square wave** – sharp transitions between high and low states
- **Triangular wave** – linear rising and falling signals

The function generator using op-amps is generally designed in three stages:

1. **Square Wave Generator:**
   An op-amp configured as a comparator with positive feedback (Schmitt trigger) generates a square wave. A capacitor and resistor set the frequency of oscillation.

2. **Triangular Wave Generator:**
   The square wave is then fed into an **integrator circuit** (op-amp integrator), which converts the square wave into a triangular waveform due to the integration of constant high and low levels.

3. **Sine Wave Shaping Circuit**
   To approximate a sine wave from a triangular wave, **non-linear wave shaping** circuits (diode-resistor networks or op-amp-based filters) are used.

The **frequency** of the generated waveforms depends on the RC components used, and the **am4 plitude** can be controlled via feedback resistors or potentiometers.

Mathematically:

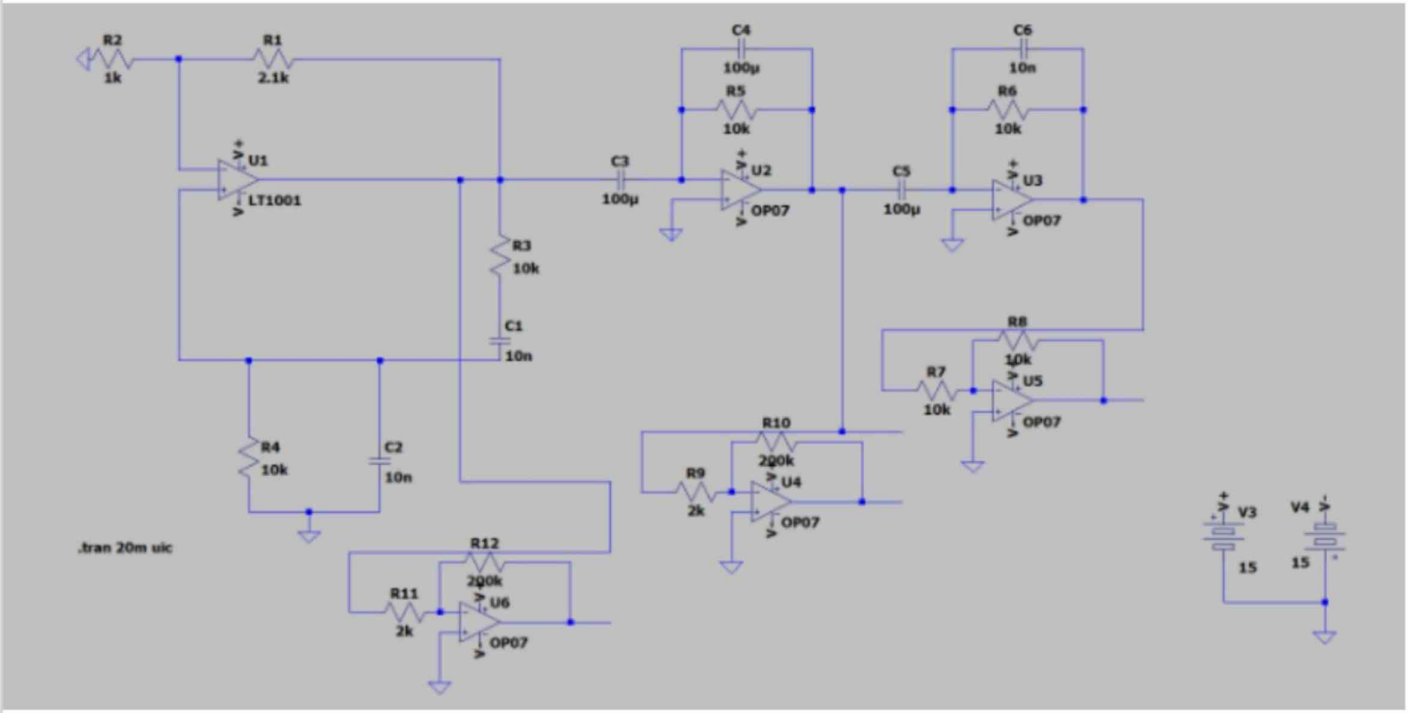
$V_{out}(t)=-1/RC \int V_{in}(t)dt$

If the input is a **square wave**, the integrator outputs a **triangular wave**, because the integration of a constant voltage (from the square wave) results in a ramp (linear slope up or down).

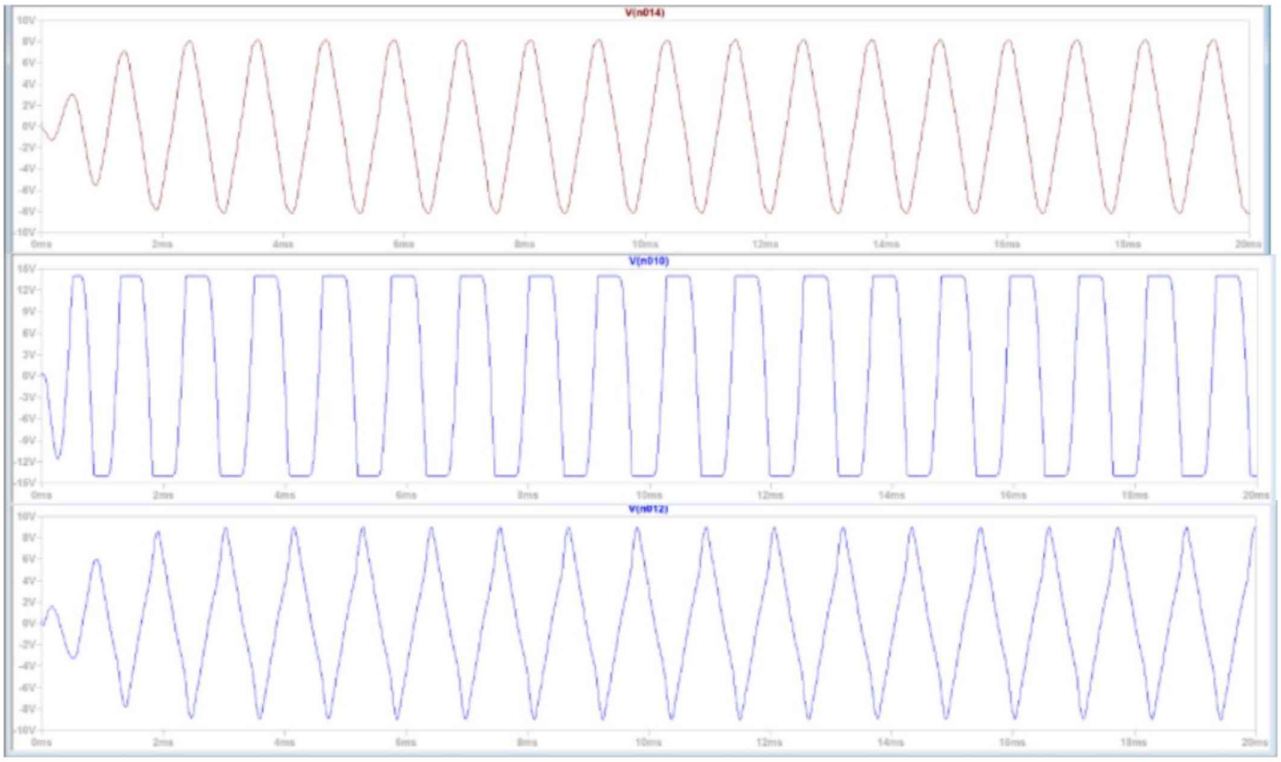
Materials Required

1. Operational Amplifier mA 741 IC
2. Resistors
3. Capacitors
4. Dual Power supply(0-20V)
5. Multimeter
6. CRO and Probes.
7. Bread board
8.Connecting wires

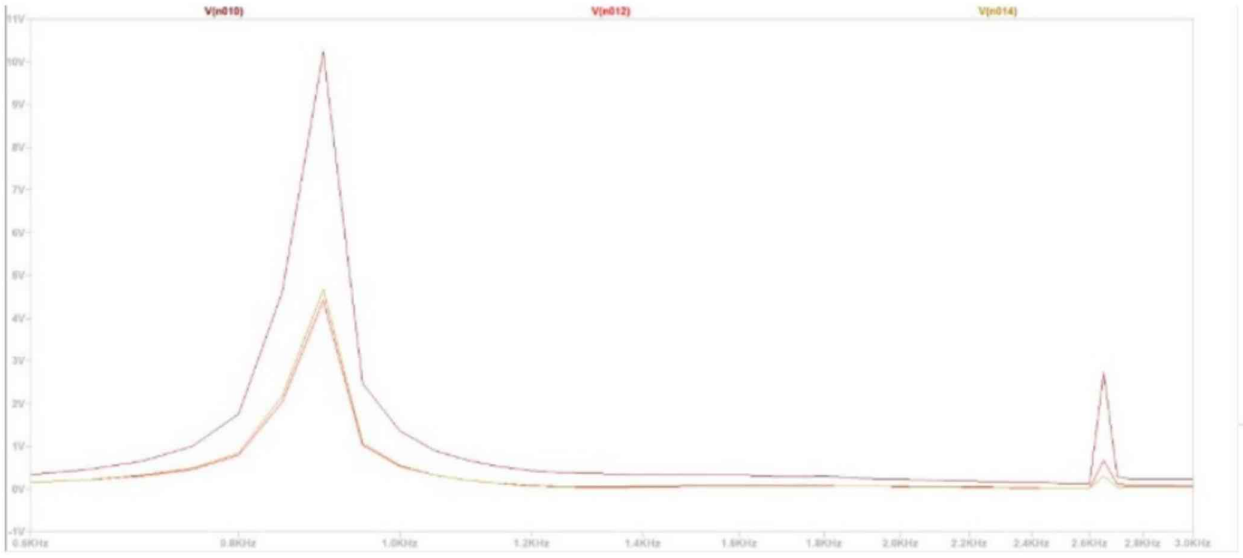
Circuit Diagram



GENERATED WAVEFORMS :



Fourier Transform:



Waveform	Sine	Square	Triangular
Frequency (Hz)	873.58	869.23	861.24
Peak-to-peak voltage (V)	-8.54 7.28	-13.88 13.98	-8.94 9.04

Components	Value	Quantity
Resistance	2.1k	1
Resistance	1k	1
Resistance	10k	6
Resistance	2k	2
Resistance	200k	2
Capacitance	10n	3
Capacitance	100u	3

Conclusion

The function generator circuit was successfully designed and implemented using operational amplifiers. The generator was capable of producing **square**, **triangular**, and (optionally) **sine** waveforms by utilizing key building blocks such as a comparator (for square wave generation) and an integrator (for triangular wave generation).

The output frequency and amplitude could be controlled by varying resistor and capacitor values in the circuit. The triangular waveform was observed as a result of integrating the square wave, confirming the theoretical operation of the integrator stage.

This project demonstrates the versatility of op-amps in waveform generation and their significance in signal processing and testing applications. The function generator is a cost-effective and educational alternative to commercial waveform generators, especially for laboratory and learning purposes.