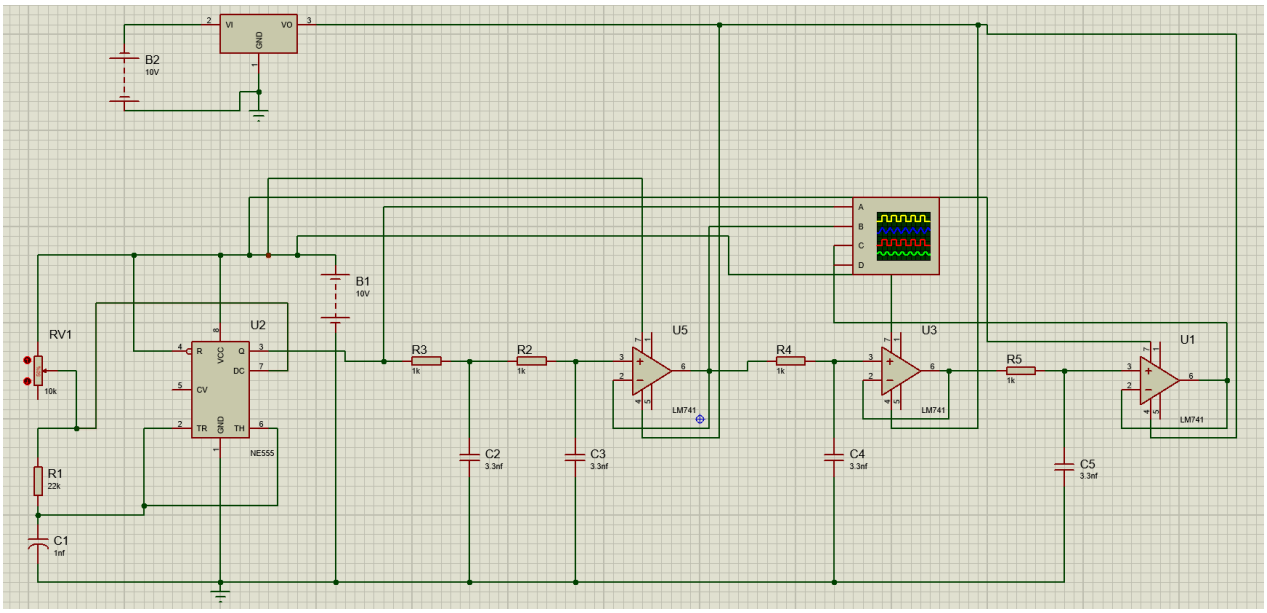
Function Generator (TIMER 555)



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Objective:

The goal of this project is to design and construct a function generator capable of producing three distinct waveforms **square**, **triangle**, and **sin**.

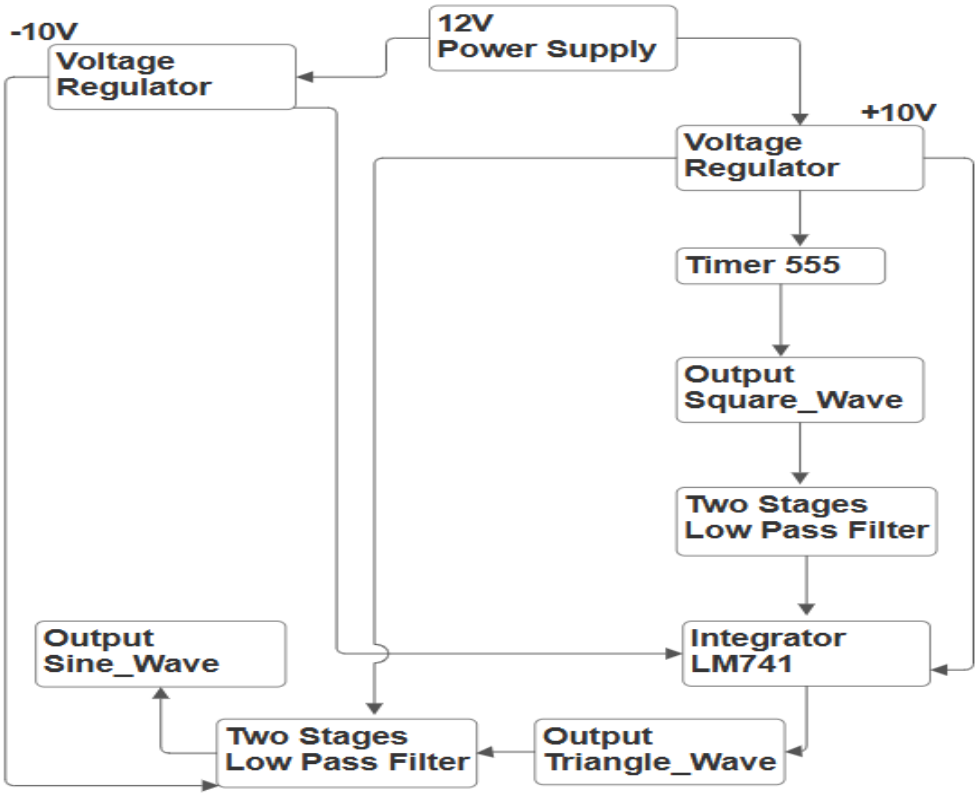
Using an NE555 timer as the square wave source, an **integrator** op-amp to convert the square wave to a triangle wave, and a series of low-pass filter stages using LM741 op-amps to transform the triangle wave into a sine wave.

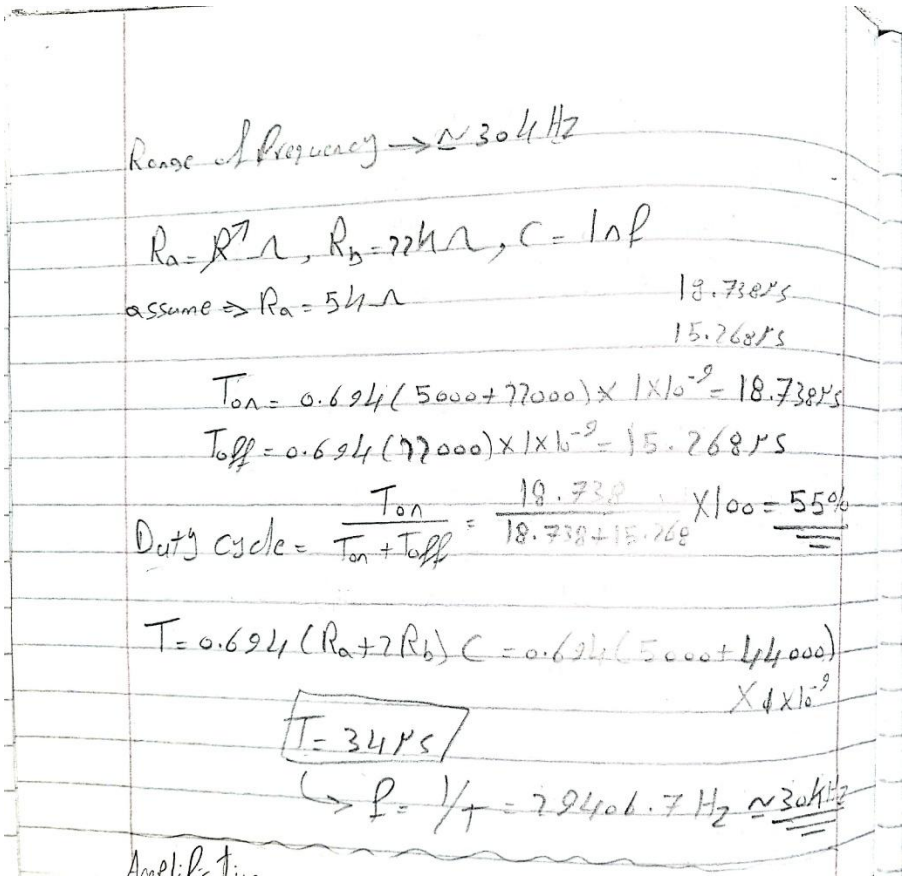
The generator will operate at an adjustable frequency around 30 kHz with an output amplitude of approximately ±10 V, suitable for educational demonstrations, signal testing, and basic electronic applications.

System Overview:

The function generator consists of three main stages:

1. **Square Wave Generation**: An NE555 timer configured as an astable multivibrator produces a square wave with a peak amplitude of ±10 V and an adjustable frequency around 30kHz.
2. **Triangle Wave Generation**: An LM741 op-amp configured as an integrator converts the square wave into a triangle wave by integrating the input signal.
3. **Sine Wave Generation**: Two additional LM741 op-amps, configured as low-pass filters in a Sallen-Key topology, smooth the triangle wave into a sine wave by attenuating higher harmonics.





Range of Frequency → ≈ 30 kHz

$R_a = R\,\Omega$, $R_b = 77k\Omega$, $C = 1nF$

assume ⇒ $R_a = 5k\Omega$

18.738 μs

15.268 μs

$T_{on} = 0.694(5000 + 77000) \times 1 \times 10^{-9} = 18.738\,\mu s$

$T_{off} = 0.694(77000) \times 1 \times 10^{-9} = 15.268\,\mu s$

$\text{Duty cycle} = \frac{T_{on}}{T_{on} + T_{off}} = \frac{18.738}{18.738 + 15.268} \times 100 = 55\%$

$T = 0.694(R_a + 2R_b)C = 0.694(5000 + 144000) \times 1 \times 10^{-9}$

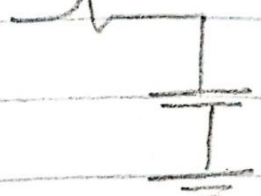
$T = 34\,\mu s$

$\hookrightarrow f = 1/T = 29406.7\,Hz \approx 30kHz$

Amplitude:

RC filter (low pass)

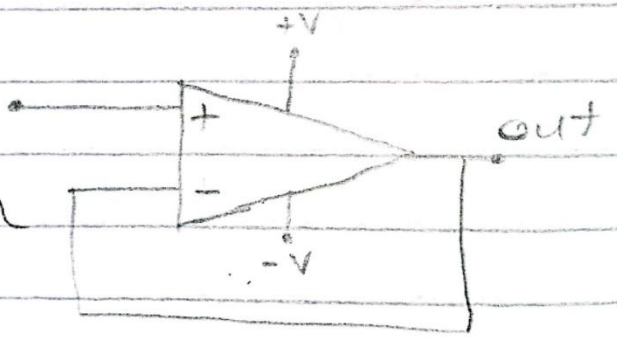
$$f = \frac{1}{2\pi RC}$$



assume $R = 1k\Omega$ at $f = 41.2kHz$

$$\boxed{C = 3.86nf}$$

LM741



$R_2 = R_1 = 0\Omega$

$\boxed{G = 1}$

unity gain

first stage ⟶ integrator

second " ⟶ low pass filter

third " ⟶ low pass filter

Power Calculations:

Power Calculations

1) LM 7810 Regulator:

$V_{in} = 12V$, $V_o = 10V$, Typical of signal generation

The load current = 100mA

From Datasheet

Quiescent Current = 8mA

$P_{in} = 12 \times (0.1 + 0.008) = 1.296$ Watt

$P_{out} = 10V \times 0.1 = 1$ Watt

$P_{diss} = 1.296 - 1 = 0.296$ Watt

2) Timer

Typical Current for No load = 3mA

$P = 10V \times 0.003 = 0.03$ Watt

3) LM741 OP-AMP

Supply → ±10V

From Data sheet Power Cons. = 85m Watt
↳ in Max.

Power for 3 op. amps = 3 × 85mW = 0.255 Watt

Total Power Consumption = 1.296 + 0.03 + 0.255
= 1.581 watt