Title (proposal) : (Design and Analysis) Waveform Generator using IC741 (OP-AMP)

PRESENTED BY

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BE/ EXTC (3rd year)

1) THEORY : This project presents the design and simulation of a waveform generator circuit using a Schmitt trigger and an integrator, implemented in eSim. The objective of this circuit is to generate two fundamental waveforms a square wave and a triangular wave which are widely used in signal processing, communication systems, and control applications.

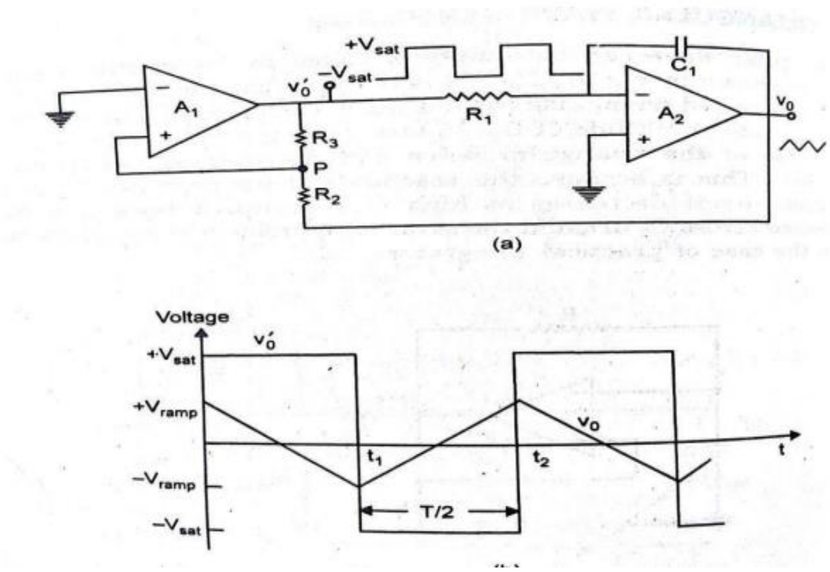
The circuit operates by combining two basic building blocks: an operational amplifier (op-amp) configured as a Schmitt trigger and another op-amp configured as an integrator. The Schmitt trigger provides regenerative feedback , ensuring a stable square-wave output. This output is then fed into the integrator, which produces a corresponding triangular waveform by integrating the square wave.

2) WORKING PRINCIPLE :

The given circuit generates square wave and triangular wave outputs using operational operational amplifiers configured as a Schmitt Trigger and an Integrator.

- **Schmitt Trigger (Op-Amp U1):**
  - The first op-amp is configured as a Schmitt trigger with positive feedback.
  - It converts the continuously varying input signal from the integrator into a bistable square wave.
  - The output of the Schmitt trigger switches between +Vsat and –Vsat, depending on whether the input voltage crosses the upper or lower threshold set by the resistors.
  - This square wave is available at OUT1.
- **Integrator (Op-Amp U2):**
  - The square wave output of the Schmitt trigger is applied to the integrator circuit made using the second op-amp, resistor, and capacitor.
  - The integrator continuously integrates the square wave, producing a triangular waveform at its output.
  - The slope of the triangular wave depends on the amplitude of the square wave and the RC time constant of the integrator.
  - This triangular wave is available at OUT2.

3) DESIGN OF WAVEFORM GENERATOR



ASSUME: fo = 2KHz   VOUT2=7Vp-p (Triangular Wave) +Vsat = -Vsat = 14v (VOUT1)

1)VOUT1 or Vo = (2*R2/R3)*Vsat

Therefore , 7 = (2*R2/R3)* 14

Assume R3= 10K ohm

After calculation we get R2 = 2.5K ohm

2) fo = R3/4*R1*C1*R2

Assume C1 = 0.1uF

2 Khz = 10 K ohm / 4* R1* 0.1uF * 2.5K ohm

After calculation we get R1 = 5K ohm

4) PROPOSED CIRCUIT IN eSIM SOFTWARE

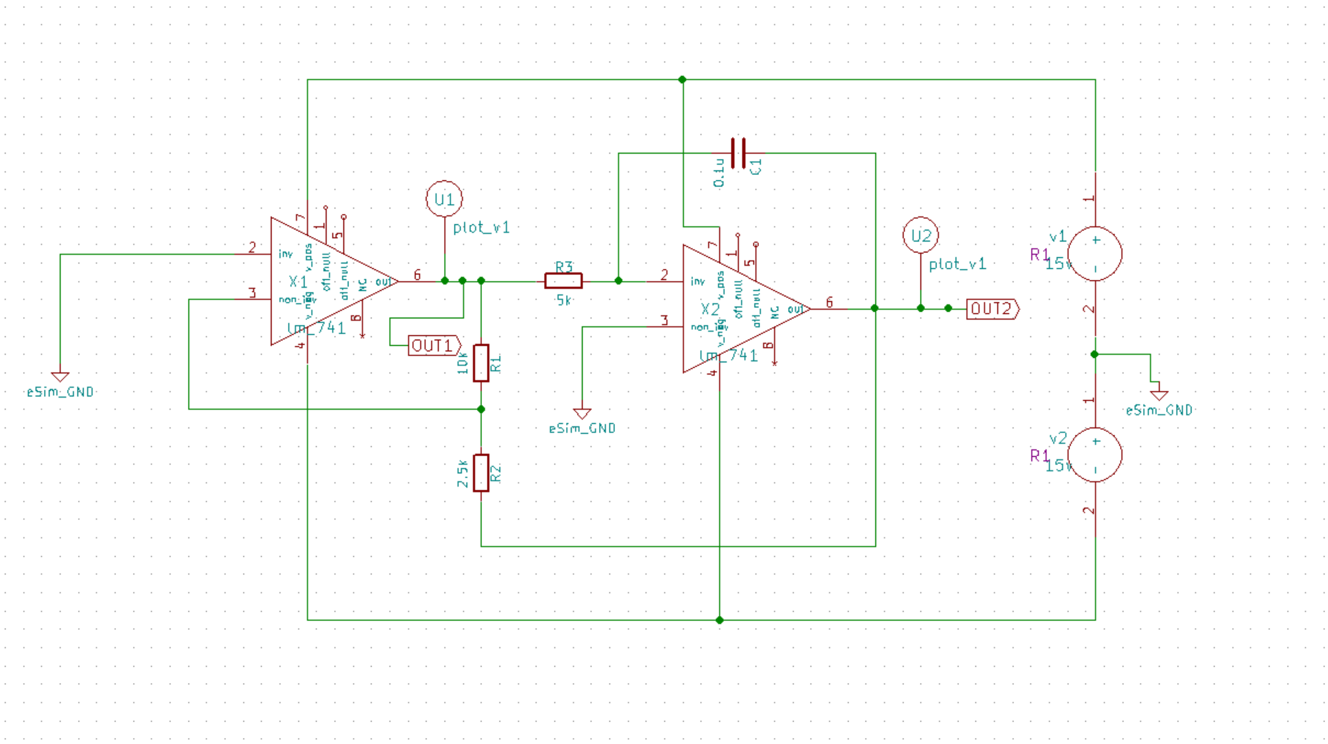


Fig 1 : Waveform generator circuit in eSim software

5) SIMULATION RESULTS

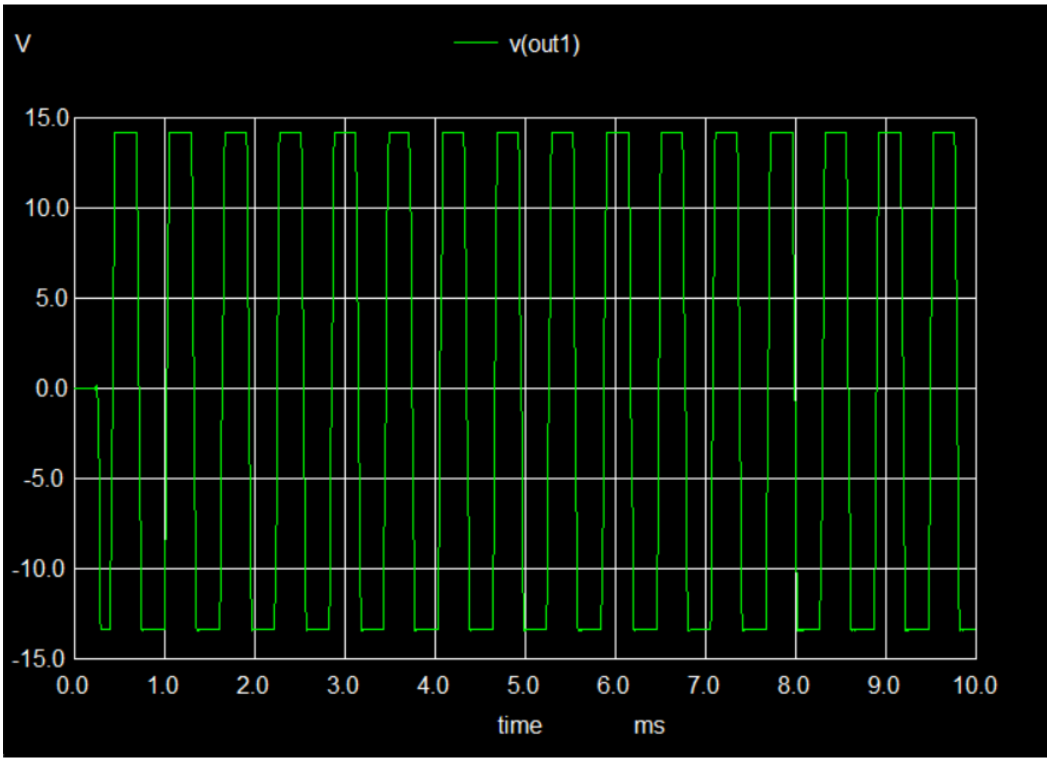


Fig 2 : Square waveform through Vout1 (asper calculations/assumptions)

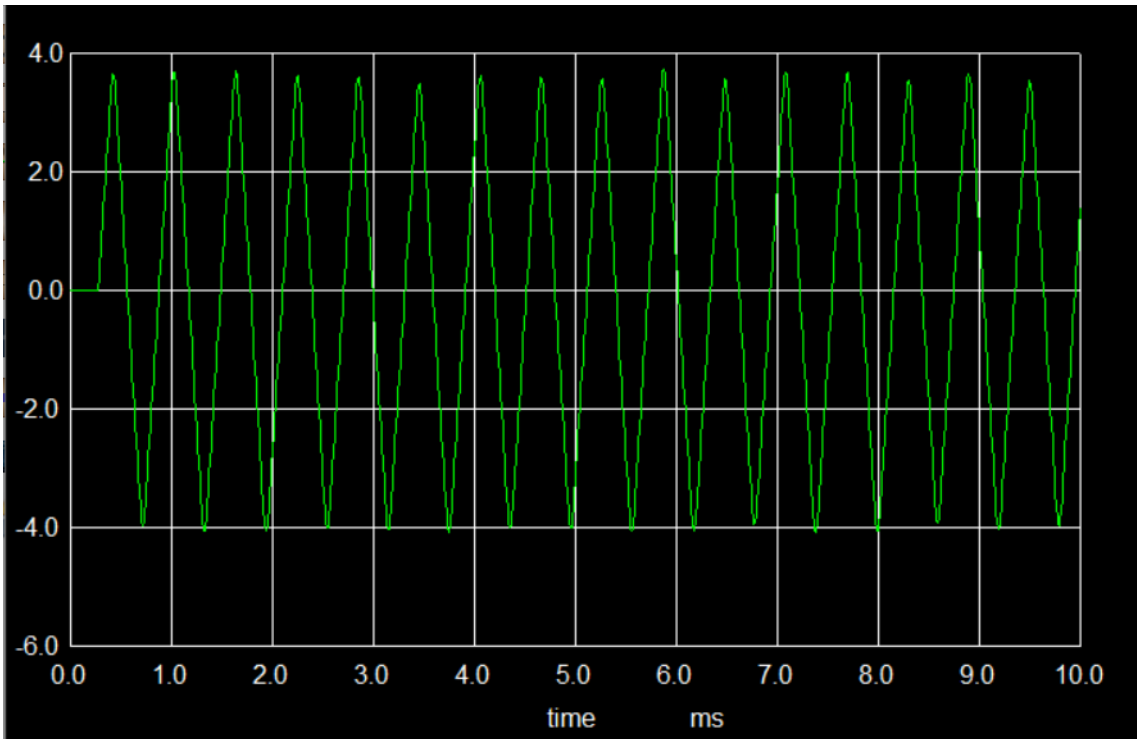


Fig 3 : Triangular Waveform through Vout2

6) CONCLUSION :

The designed waveform generator circuit successfully produces both square and triangular waveforms using two operational amplifiers configured as a Schmitt trigger and an integrator. The Schmitt trigger provides a stable square wave with well-defined switching thresholds, while the integrator converts this square wave into a triangular waveform. The simulation results confirm that the frequency and amplitude of the generated waveforms can be controlled by selecting appropriate resistor and capacitor values.

7) REFERENCE :

Textbook :Ramakant A. Gayakwad, "Op-Amps and Linear Integrated Circuits", Pearson Prentice Hall, 4th Edition.