Date:
Expt No: 3

ASTABLE MULTIVIBRATOR USING OP-AMP AND IC 555

AIM:

To design and set up an astable multivibrator using op-amp 555 timer IC.

COMPONENTS AND EQUIPMENTS REQUIRED:

Sl.No.	Components/Apparatus	Specification	Quantity
1	Op-amp	LM741	1
2	IC	NE/SE 555	1
2	Resistors	10k 4.7k	2 1
3	Capacitors	0.01μF 0.1μF	1 2
4	Diode	IN4001	2
5	Breadboard		
6	DC Power Supply		
7	CRO		

THEORY:

A multivibrator is an electronic circuit used to implement a variety of simple two state systems such as oscillators, timers and flip flops. An astable multivibrator has two states, neither one stable. The circuit therefore behaves as an oscillator with the time spent in each state controlled by the charging or discharging of a capacitor through a resistor.

The astable multivibrator may be created directly with transistors or with use of integrated circuits such as operational amplifiers (op amps) or the555 timer. Most operational amplifiers are powered by a positive and negative rail voltage, the output never able to

exceed these rail voltages. Depending upon initial conditions, the op amp's output will drive to either positive or negative rail. Upon this occurrence, the capacitor will either charge or discharge through the resistor R2, its voltage slowly rising or falling. As soon as the voltage at the op amp's inverting terminal reaches that at the non-inverting terminal (the op amp's output voltage divided by R1 and R2), the output will drive to the opposing rail and this process will repeat with the capacitor discharging if it had previously charged and vice versa. Once the inverting terminal reaches the voltage of the non-inverting terminal the output again drives to the opposing rail voltage and the cycle begins again. Thus, the astable multivibrator creates a square wave with no inputs.

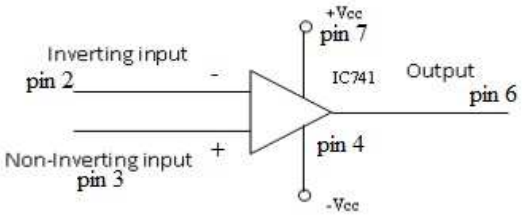
Period of astable multivibrator is

$$T = 2C_1R_3 \ln(1+2\frac{R_2}{R_1})$$

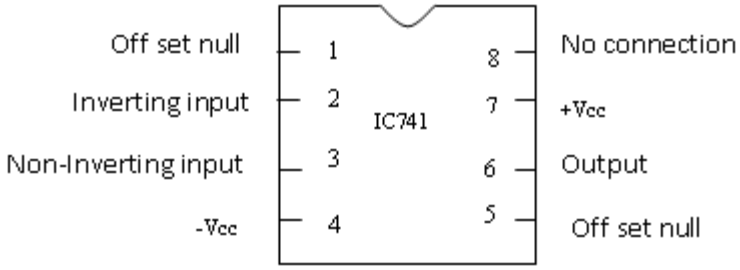
$\beta = \frac{R_2}{R_1 + R_2}$ The positive feedback comparator circuit increases the gain of the op-amp, which helps to switch very fast between the two states of a multivibrator. The positive feedback also provides hysteresis to the circuit. A capacitor 'C' is connected to the inverting terminal of the Op-Amp with its other end grounded. The capacitor along with the resistor 'R' acts as a RC integrator. The voltage across the capacitor is given by *Vc*.

Operational amplifier, consisting of a comparator circuit having a positive feedback with a feedback factor. Now, the op-amp has a voltage of *'Vc*' at the inverting terminal and $\frac{R_2}{R_1 + R_2}$ Vo at the non-inverting terminal, giving rise to a voltage equal to *+Vsat* or *-Vsat* at the output.

SYMBOL:

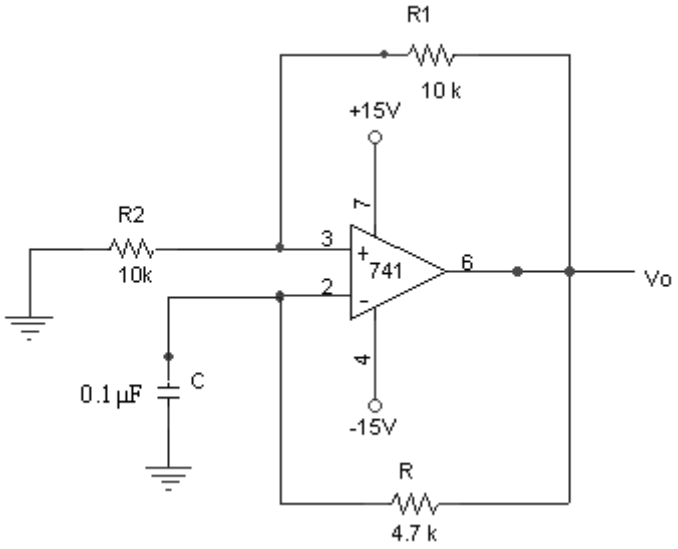


PIN CONFIGURATION:

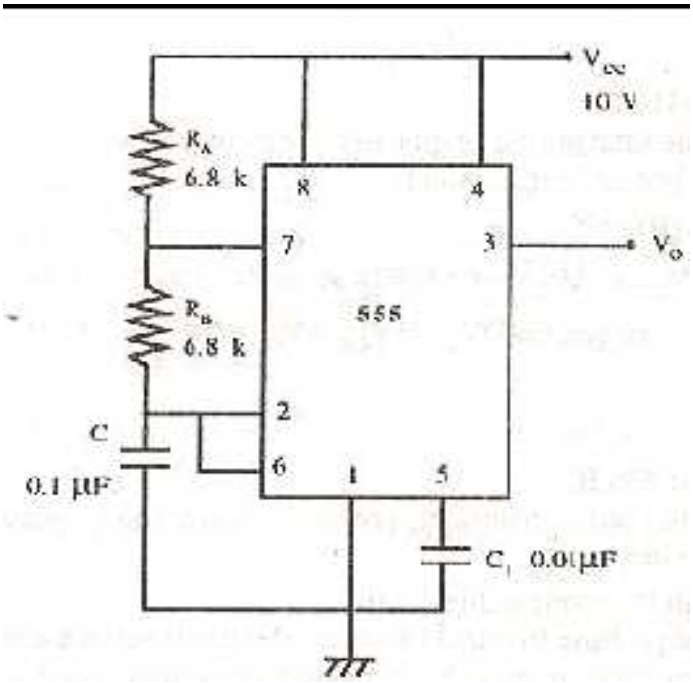


CIRCUIT DIAGRAM:

Using Op amp



Using 555 IC



DESIGN

Using LM 741C

Required period of oscillation T = 1ms with duty cycle 50%.

Time period $T= T_1+T_2 =2RC \ln (1+\beta)/(1-\beta)$

where β, the feedback factor = $R_2/(R_1+R_2)$

Take $\beta = 0.5$ and $R_2 = 10k$. Then $R_1 =10k$.

When $\beta = 0.5$, T=2.2 RC.

Let C be 0.1μF. Then R= 4.7k.

Using 555 IC

Take $V_{cc} = 10$ V,

$t_c= 1ms = t_{on}$,

$t_d = 0.5ms = t_{off}$,

R_A and R_B should be in the range of 1k to 10 k to limit the collector current of the internal transistor.

We know, $t_c = 0.69(RA+ R_B) C$ and $t_d= 0.69R_BC$.

Let C = 0.1μ F

$R_B = t_d / (0.69 * C) = 0.5m / (0.69 \times 0.1\mu) = 7.24\ k\Omega$

Take $R_B = 6.8\ k\Omega$ std.

$R_A = [t_c / (0.69 * C)] - R_B = [1m/(0.69 \times 0.1\mu)] – 7.24k = 7.252k\Omega$

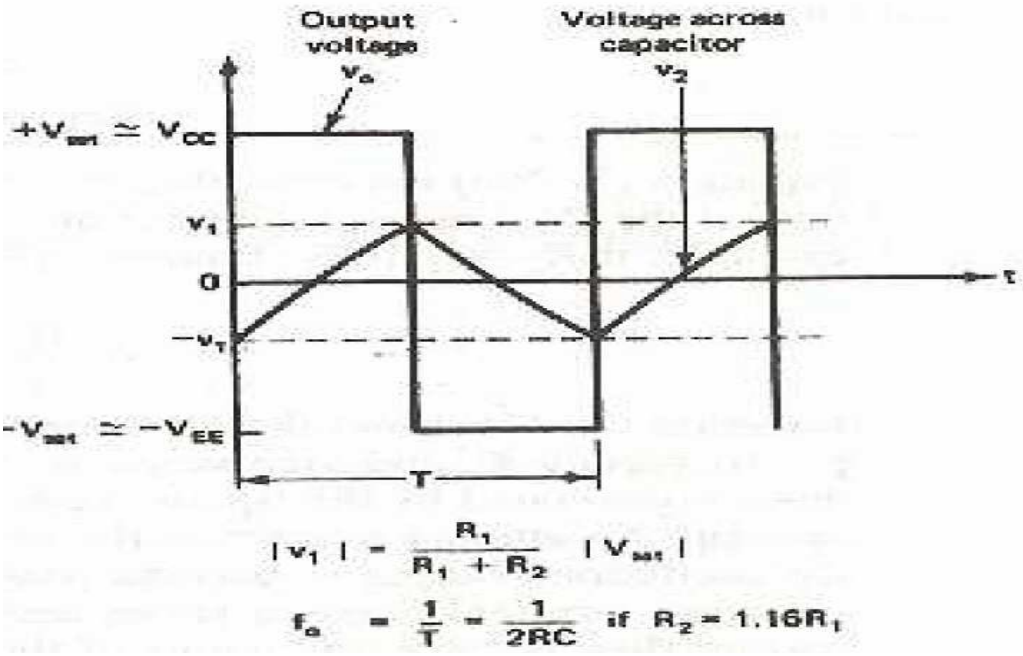
Take $R_A = 6.8\ k\Omega$ std.

Take $C_1 = 0.01\ \mu F$.

PROCEDURE

1. Verify whether the op-amp is in good condition by wiring it as ZCD or voltage follower.
2. Set up the astable multivibrator and observe the waveforms at pin nos. 6 and 2 of op-amp on CRO and note down their amplitudes and frequencies.
3. Set up the circuit using 555 IC after checking the components.
4. Observe and plot the waveforms at pins 3 and 6 of the IC.

EXPECTED WAVEFORMS



RESULT:

Frequency of oscillation = …….

INFERENCE: