Title of the experiment:

Implementation of Bistable Multivibrator using Transistors

Theory:

Bistable Multivibrator is an oscillator which has two stable conducting states. The states are switched using external trigger pulse given to the base of one of the transistors by a method known as Asymmetrical Base Triggering. Let Q1 and Q2 be the two transistors of similar "hfe" values. If we assume Q2 to be conducting first due to slightly higher value of "hfe", then the output at the collector of Q2 has a voltage of ~0.3V which is the saturation voltage of Q2. This is directly fed back to the base of Q1 through a resistor. Since this voltage of 0.3V is insufficient to forward bias the base-emitter junction of Q1, Q1 remains in the OFF state. Hence the collector voltage of Q1 raises to $Vcc\text{-}IcR_1$ (IcR_1, drop across collector resistor of Q1; Vcc, supply voltage) and is also fed back to the base of Q2, which drives Q2 to more saturation. Thus we obtain the first stable state: Q1 OFF and Q2 ON. In order to change this stable state, a trigger pulse is applied to the base of Q1. The amplitude of the pulse must overcome the negative bias, -Vbb voltage present at the base, if so, the base-emitter junction of Q1 becomes forward biased and hence Q1 turns ON. The output at the collector of Q1 is now ~0.3V, since Q1 is in saturation. This voltage is in turn fed back to the base of Q2 via a resistor, but this low voltage makes the transistor Q2 to go to cutoff state. Since Q2 is cutoff, all of the $Vcc\text{-}IcR_2$ (IcR_2, drop across collector resistor of Q2) is available as output at the collector of Q2 and is fed back to the base of Q1 which drives it to more saturation. Thus we obtain the second stable state: Q1 ON and Q2 OFF. Now when trigger pulse switches to negative state again Q1 turns OFF and Q2 turns ON, thereby returning back to original state. In other words, the output obtained at the collector terminals of Q1 and Q2 are always complementary to each other. The capacitors in feedback path are commutating/speed-up capacitors which help improve the transient response of the circuit. This multivibrator is also known as Flip-Flop Multivibrator.

Schematic Diagram:

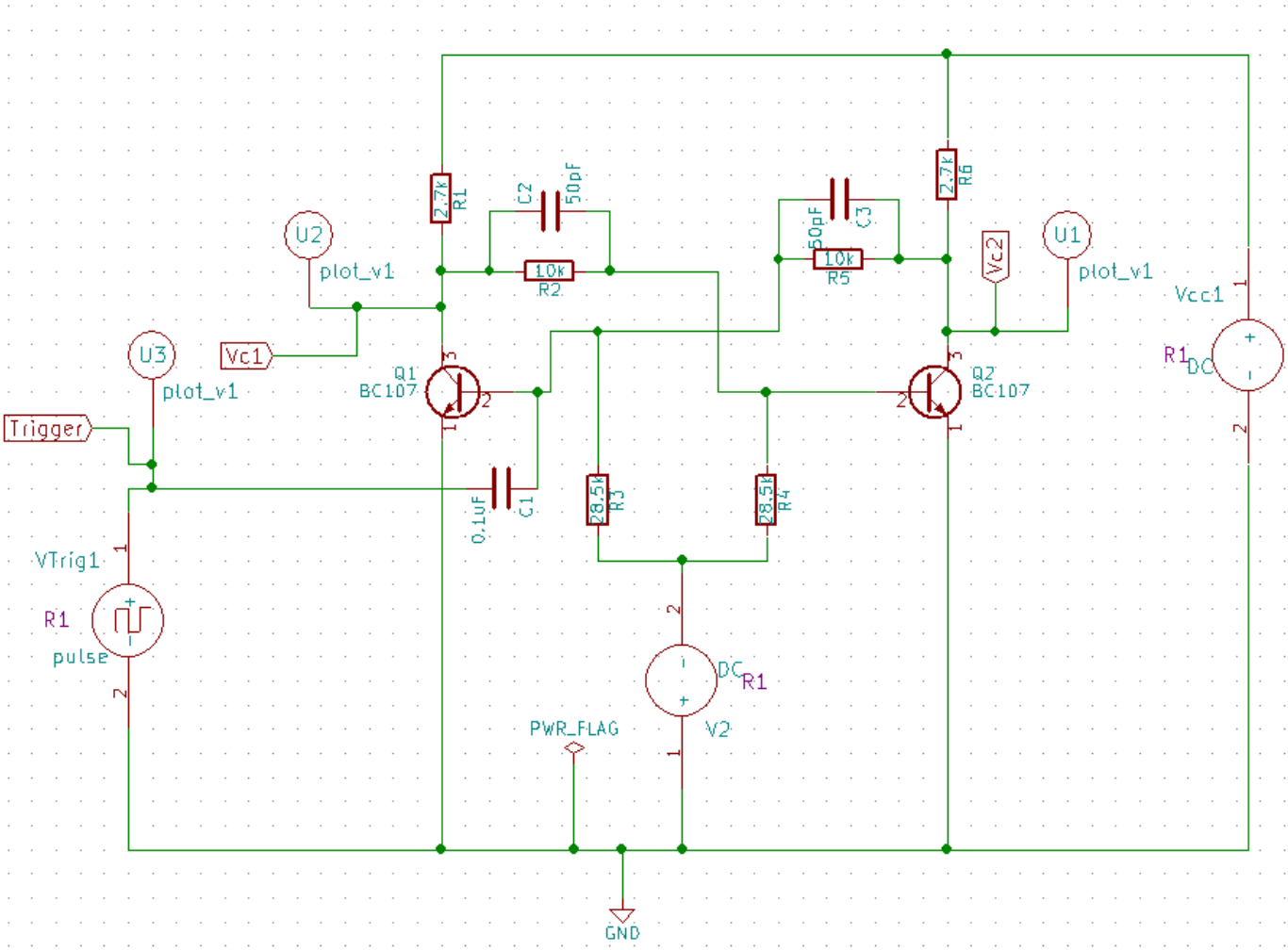

Fig.1 Bistable multivibrator

Simulation Results:

1. Ngspice Plots

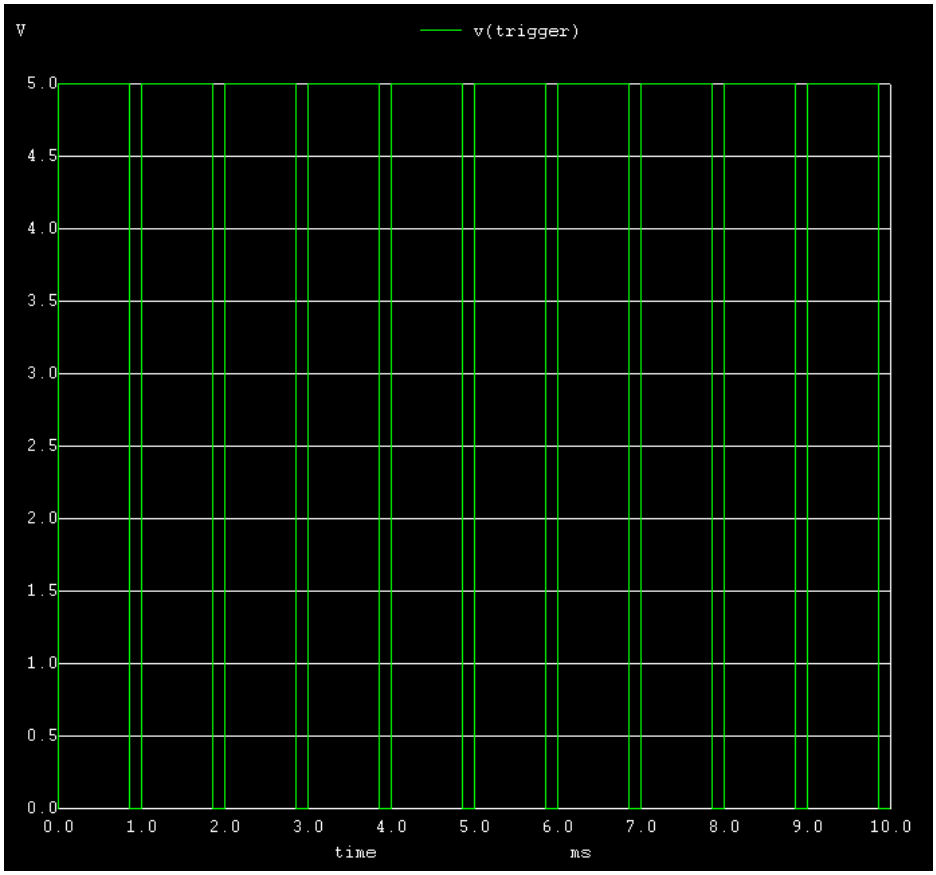

Fig 2. Input Trigger Pulse

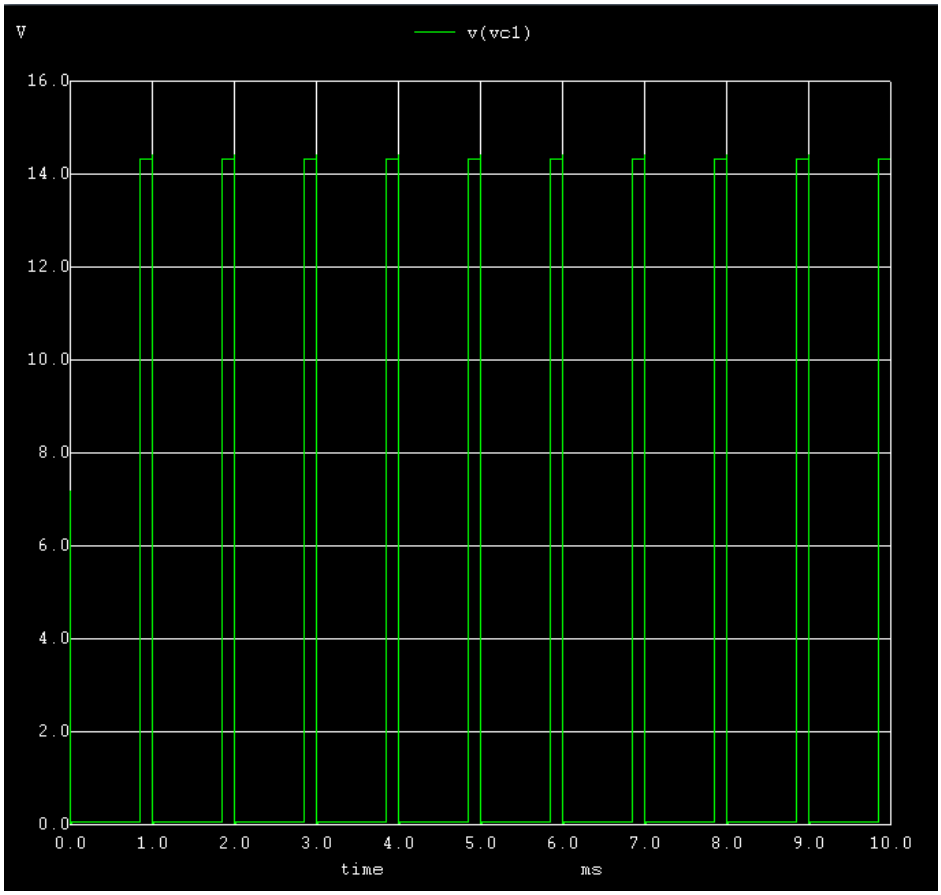

Fig.3 Output at collector of Q1

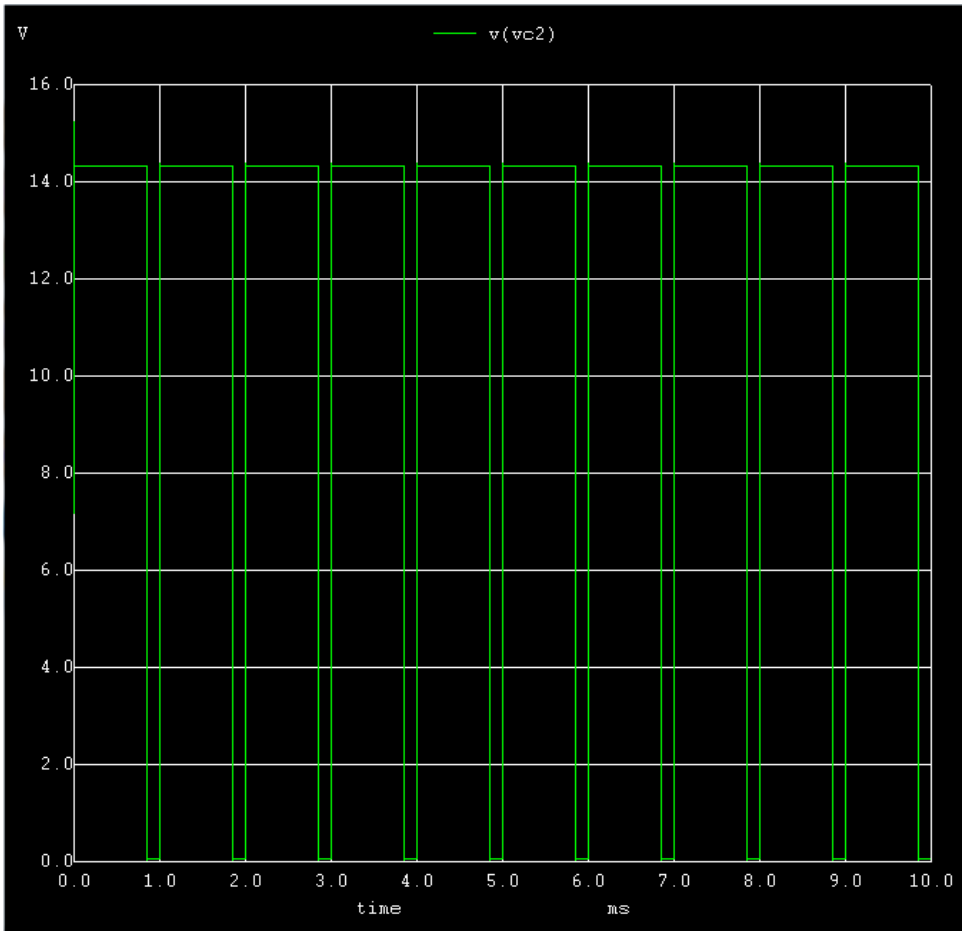

Fig.4 Output at collector of Q2

2. Python Plots:

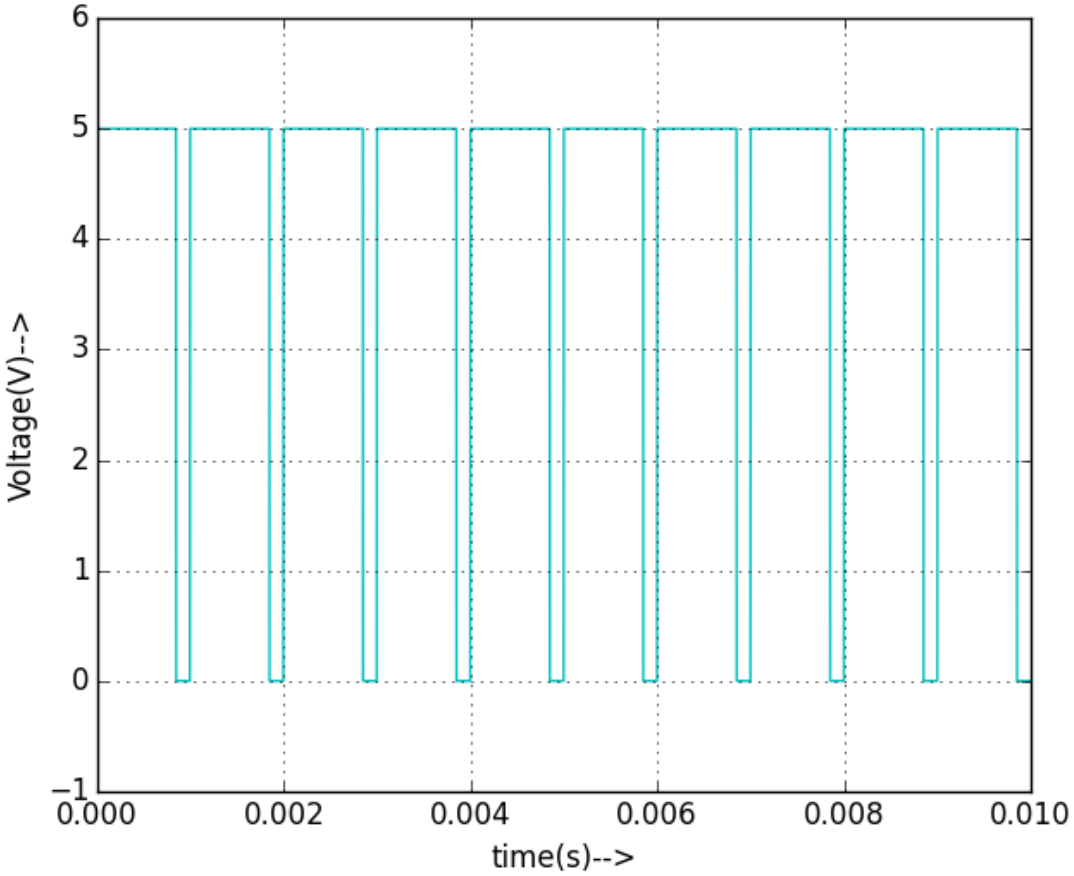

Fig 5. Input Trigger Pulse

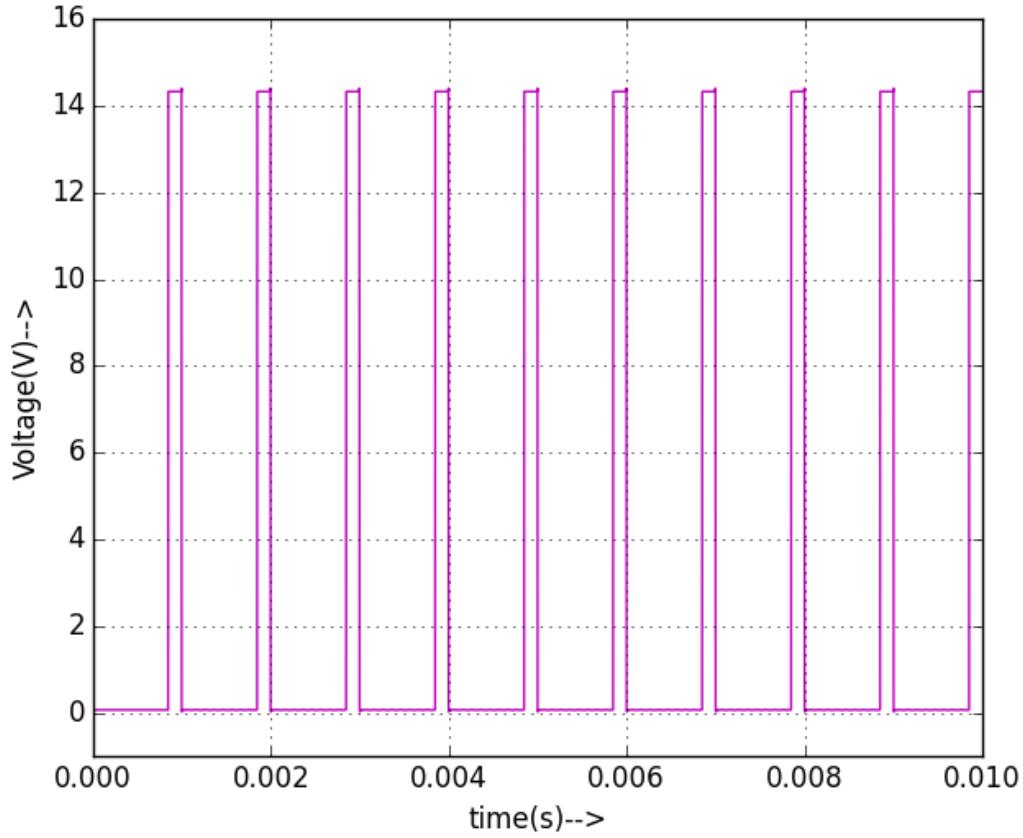

Fig.6 Output at collector of Q1

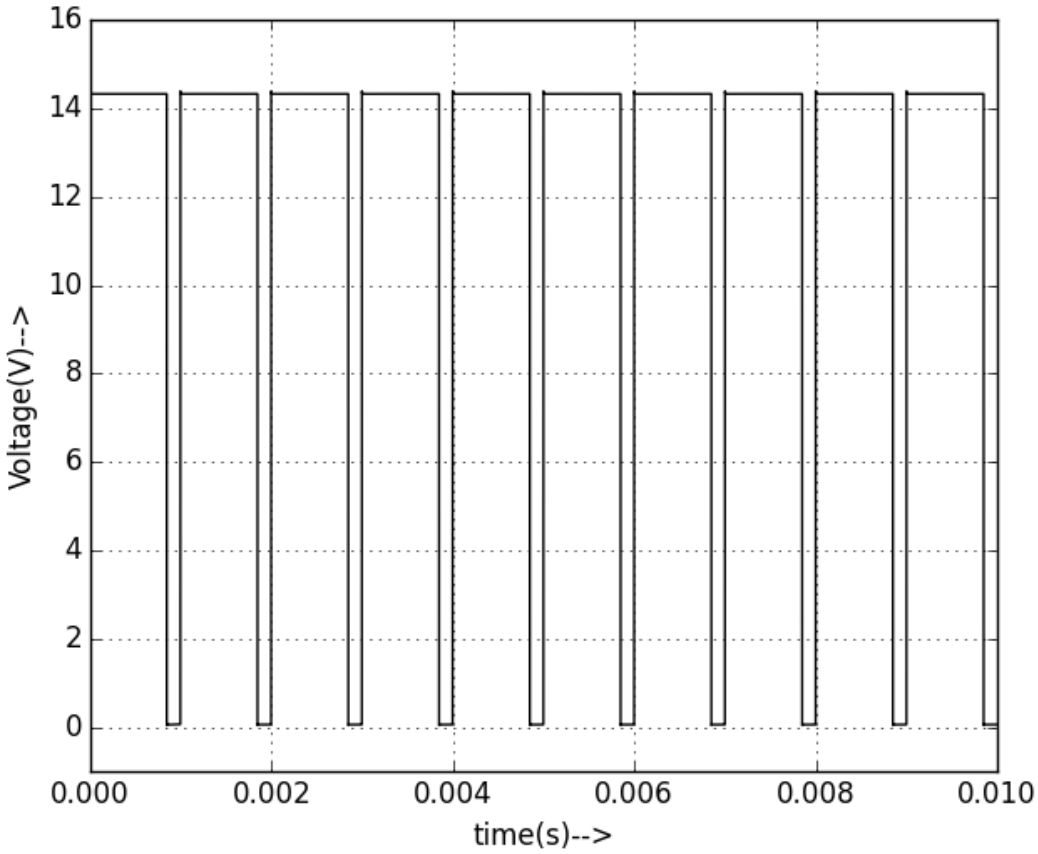

Fig.7 Output at collector of Q2

Conclusion:

Thus we have studied the operation of Bistable Multivibrator implemented using BC107 transistor.

References:

https://www.studyelectronics.in/bistable-multivibrator/

https://www.electronics-tutorials.ws/waveforms/bistable.html