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## Experiment 12: Design And Analysis of Astable Multi Vibrator using 555 Timer

**Aim:** To design and setup Astable Multivibrator using IC 555 and

- (i) Plot the output waveform
- (ii) Measure the frequency of oscillation

### Theory:

The 555 timer is a highly stable device for generating accurate time delay .The internal structure of 555 is shown in which there are two comparators, a flip flop, an output stage, a voltage divider network and a transistor. The comparator is a device whose output is high when the non-inverting input voltage is greater than inverting input voltage and output is low when inverting input voltage is greater than non-inverting input voltage. The voltage divider network consist of three  $5\text{K}\Omega$  resistors and provides a trigger voltage level of  $1/3V_{CC}$  and threshold voltage level of  $2/3V_{CC}$ .The control voltage is used for changing the threshold and trigger voltages externally.

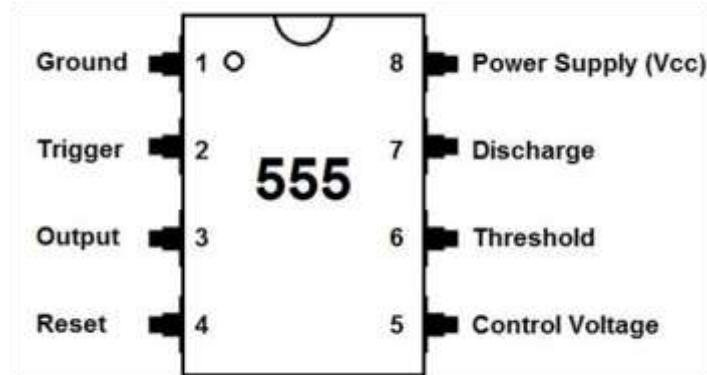
**555 as Astable multivibrator:** Astable multivibrator means it has no stable states. It has two quasi stable states (high and low).In the figure given , there are 2 external resistors  $R_A$  and  $R_B$  and a capacitor  $C$ . When the power is given to the circuit the capacitor  $C$  will charge towards  $V_{CC}$  through  $R_A$  and  $R_B$  ,when the capacitor voltage exceeds the level of  $2/3V_{CC}$  (threshold voltage) the output of the comparator I goes high which resets the flip flop so the output  $Q$  of the flip-flop becomes low and becomes high. Now the transistor which is connected to it becomes ON. The capacitor  $C$  started to discharge through  $R_B$  and transistor exponentially. When voltage across the capacitor reaches just below  $1/3V_{CC}$  (trigger voltage) the output of the comparator II becomes high and sets the flip flop, turning OFF the transistor since it is connected to the flip flop. The capacitor  $C$  will begin to charge towards  $V_{CC}$  through  $R_A$  and  $R_B$ . When the capacitor voltage exceeds the level of  $2/3V_{CC}$ , the output of the comparator I goes high which resets the flip-flop so the output  $Q$  of the flip flop becomes Low and becomes high. The cycle continues which gives a square wave at the output (pin 3) and charging and discharging waveform across the capacitor (pin 2 & 6).

**555 as astable multivibrator:** Asymmetrical astable multivibrator means the multivibrator has unequal ON time & OFF time (duty cycle other than 50%).In the circuit diagram the charging of capacitor towards threshold voltage ( $2/3V_{CC}$ ) takes place through the resistor  $R_A$  and  $R_B$ , discharging towards trigger voltage ( $1/3V_{CC}$ ) is through the resistor  $R_B$ . Since charging and discharging process of the capacitor takes place through different resistance path, the charging time and discharging time of the capacitor will be different, which results in asymmetrical output wave.

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### 555 Pin Diagram:



### Astable Multivibrator:

For 55% duty cycle choose  $R_B = 100K$

$$T_{HIGH} = T_c = 0.693 (R_A + R_B)C$$

$$T_{LOW} = T_d = 0.693 R_B C$$

$$T = T_{HIGH} + T_{LOW} = 0.693 (R_A + 2R_B)C$$

$$f = 1/T = 1.44 / (R_A + 2R_B)C$$

$$\% \text{ duty cycle}, D = T_c / T * 100 = (R_A + R_B) / (R_A + 2R_B) * 100$$

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## Prelab Session

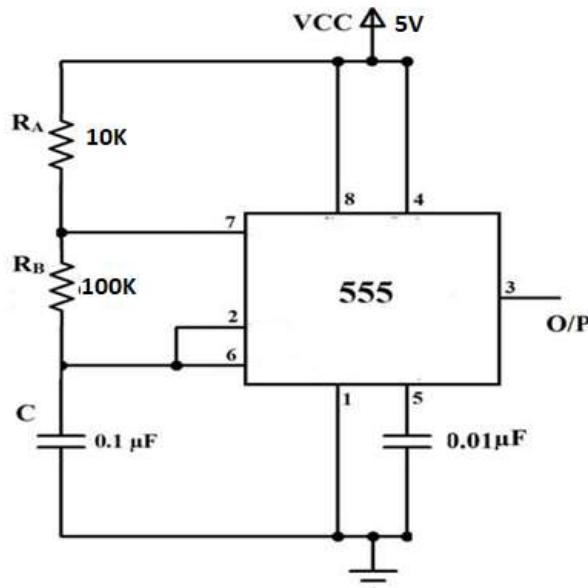
- 1) What are the different operating modes of the 555 Timer IC?**
  
  - 2) Explain the working of the 555 Timer in astable mode.**
  
  - 3) What is the function of the discharge pin (Pin 7) in the 555 Timer?**
  
  - 4) How is the duty cycle controlled in an astable configuration?**

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## In lab Session

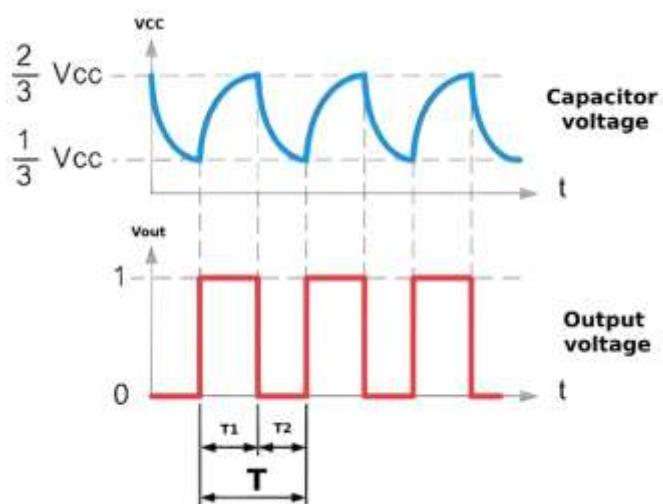
### Circuit Diagram:



### Procedure:

1. Connect the circuit as shown in the circuit diagram Fig 2.
2. Observe the output waveform at pin 3 and measure capacitor voltage across it at pin 6.
3. Theoretically calculate the Time period as  $T = 0.69 R_B C + 0.69 (R_A + R_B)C$ .
4. Compare it with experimental values.
5. Plot the graph for the input and output waveforms

### Model Graph:



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### Viva-Voce

**1) In astable mode, the 555 timer produces:**

- A) A single pulse
- B) Continuous square wave
- C) Continuous triangular wave
- D) DC output

**2) In the astable configuration, the capacitor charges through:**

- A) R1 only
- B) R2 only
- C) R1 and R2 both
- D) Discharge pin

**3) The capacitor in a 555 astable circuit discharges through:**

- A) R1
- B) R2
- C) R1 and R2
- D) Discharge pin and R2

**4) The duty cycle of the 555 timer in astable mode is always:**

- A) Exactly 50%
- B) Less than 50%
- C) More than 50% unless modified
- D) Independent of R1 and R2

**5) The output of the 555 timer in astable mode is high when:**

- A) The capacitor voltage is below  $1/3 V_{cc}$
- B) The capacitor is charging
- C) The capacitor is discharging
- D) The reset pin is low

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### Post-Lab Session

By adding a **diode in parallel with R2**, we can **separate the charge and discharge paths**, thus making it possible to reduce the duty cycle (even close to 50% or below)

#### Result:

Studied the Astable Multivibrator using 555 IC

<b>Evaluator Remark (if Any):</b>	<b>Marks Secured: _____ out of 50</b>
	<b>Signature of the Evaluator with Date</b>

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