BRAC University
School of Engineering and Computer Science
CSE-350, EXP-6

Name of the Experiment: To design and simulate an Astable Multivibrator circuit.

Objective: The objective of this experiment is to analyze an astable multivibrator.

Equipment:

1. Trainer board
2. Transistor: 2(unit)
3. Resistors: 4(unit)., R2=R3 = 4.7K, R1 = R4 = 1K
4. Capacitor: 2(unit) = 4.7uF

Circuit Diagram:

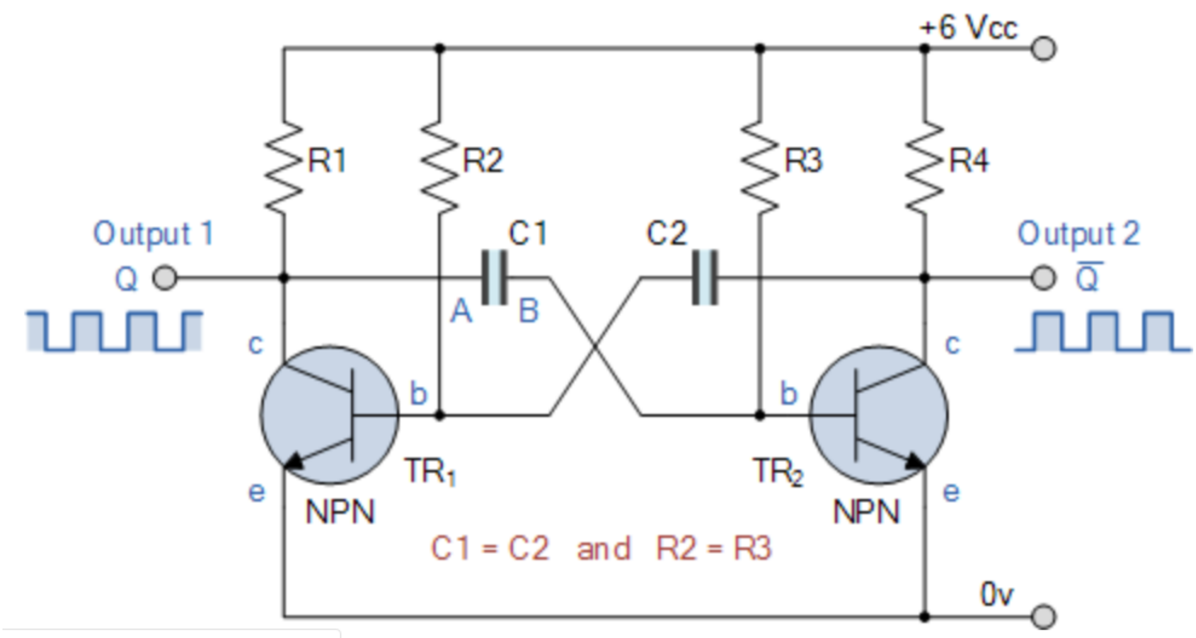

Figure 1: Astable multivibrator circuit

Working Principle:

First, due to some imbalance of the transistors of the circuit, one transistor is off (cut off) and another one is turned on (in saturation mode). Let's assume TR1 is off and TR2 is on.

1. As TR1 is off, VC1 rises towards Vcc. So, plate A of capacitor C1 is also rising towards Vcc. Also, since TR1 is in cut-off mode, TR1 conducts no current. So, no voltage drop across R1.
2. Since, TR2 is on, base voltage of transistor TR2 is almost equal to 0.6V. So, plate B of C1 is at 0.6V. So, C1 has a potential difference of 5.4V.
3. On the other hand, since, transistor TR2 is in cut-off state, the collector voltage of TR2 is almost equal to 0.6V.

So, at this situation, voltage at output 1 is at 6 V
and voltage at output 2 is at 0.6 V

4. From now on, capacitor C2 starts to charge up through resistor R2 with a time constant R2 * C2. But, as soon as voltage across C2 rises to more than 0.6V, it biases TR1 into conduction and into saturation mode. So, TR1 is on.
5. As TR1 turns on, the voltage at output 1 is at almost at 0.6V. Hence, the voltage on the capacitor plate A of C1 falls down to 0.6 v immediately. But, this charge cannot dissipate anywhere so fast. So, this extra charge (6-0.6=5.4V) of plate A is transferred to plate B. So, the charge at plate B is now -5.4V.
6. However, this negative -5.4 V is applied at the base of TR2 and turns TR2 off. This is the first unstable state.

At this stage, the voltage at output 1 is 0.6V
and the voltage at output 2 is 6 V (since TR2 is off)

7. However, as TR2 is off, C1 starts to charge in opposite direction through R3 and gradually base voltage at TR2 increases with a time constant equal to C1 * R3. As soon as the voltage increases up to 0.6V. TR2 is again on, and the circuit has returned to its initial state.
8. Now, the circuit starts operating again with the exception that, now capacitor C2 takes the base of transistor TR1 to voltage -5.4 v charging up via resistor R2 and so enters the second unstable state.

So, ultimately, the circuit alternates between one unstable state in which transistor TR_1 is "OFF" and transistor TR_2 is "ON", and a second unstable in which TR_1 is "ON" and TR_2 is "OFF" at a rate determined by the RC values. This process will repeat itself over and over again as long as the supply voltage is present. As the transistors are switching both "ON" and "OFF", the output at either collector will be a square wave with slightly rounded corners because of the current which charges the capacitors.

The time taken for the voltage across a capacitor to fall to half the supply voltage, 0.5Vcc is equal to 0.69 time constants of the capacitor and resistor combination. Then taking one side of the astable multivibrator, the length of time that transistor TR_2 is "OFF" will be equal to 0.69T or 0.69 times the time constant of C1 x R3. Likewise, the length of time that transistor TR_1 is "OFF" will be equal to 0.69T or 0.69 times the time constant of C2 x R2 and this is defined as,

$$T = t1 + t2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$t1 = 0.69*R3*C1$$

$$t2 = 0.69*R2*C2$$

If the value of the capacitor C1 equals the value of the capacitor, C2, C1=C2=C and also the value of the base resistor R2 equals the value of the base resistor, R3, R2=R3=R then the total length of time of the **Multivibrators** cycle is given below for a symmetrical output waveform,

$$T = 1.38*R*C$$

So, the frequency is

$$F = 1/T \text{ Hz}$$

This is known as the "Pulse Repetition Frequency". So **Astable Multivibrators** can produce TWO very short square wave output waveforms from each transistor or a much longer rectangular shaped output either symmetrical or non-symmetrical depending upon the time constant of the RC network.

Wave Forms:

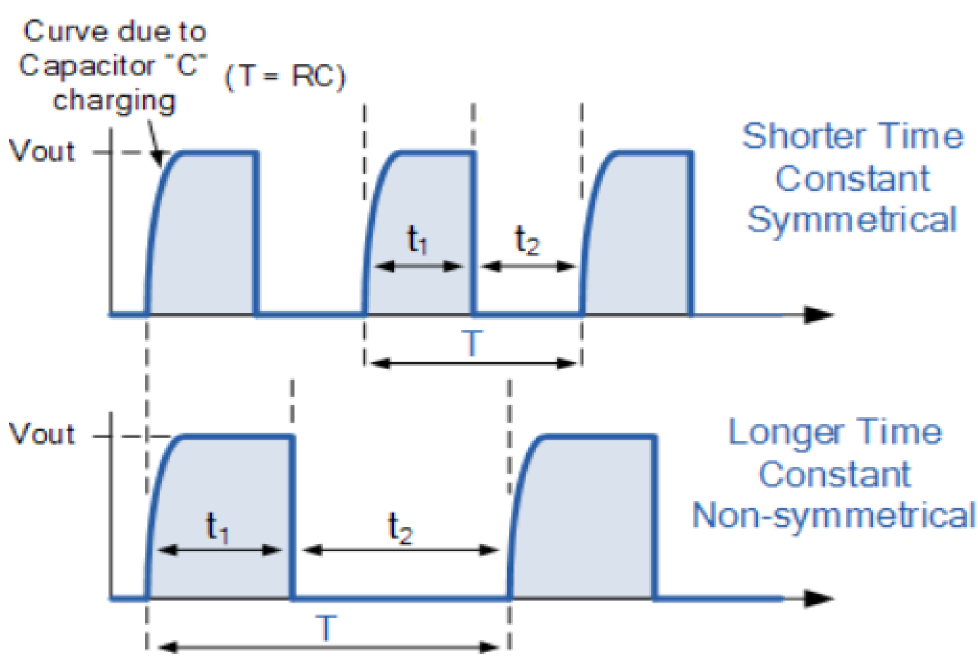

Figure 2: Output waveforms of astable multivibrator circuit

Procedure:

- Construct the circuit as shown in the above figure.
- Check the output in the Oscilloscope.
- Measure the T of the output wave shape.
- Theoretically calculate the time period with the formula no. 1.
- Compare the time periods.

Report:

1. Draw the output waveforms that you achieved in the laboratory experiment. (Attach the image too).

2. Is there any deviation in the experimental output wave shape from the desired (ideal) wave? If so, what might be the reason?

3. Is the time period of the experimental wave similar to the calculated wave? (Compare the theoretical time period with the time period measured in the laboratory)

4. Why should the resistances R_2, R_3 be greater than R_1, R_2? What happens if the condition isn't met?

5. Can it be possible to use the above multivibrator to create variable frequency square wave generator? Justify your answer.

6. How may the duty cycle of the output waves be changed?

7. How would the output waves change (**in terms of duty cycles and magnitudes**) if one capacitance (say C_1) is made higher than the other (that is, $C_2 > C_1$)?