

# **Multi-Vibrator (MV)**

## **Lecture – 1**

**TDC PART – I**  
**Paper - II (Group - B)**

**Chapter - 3**

**by:**

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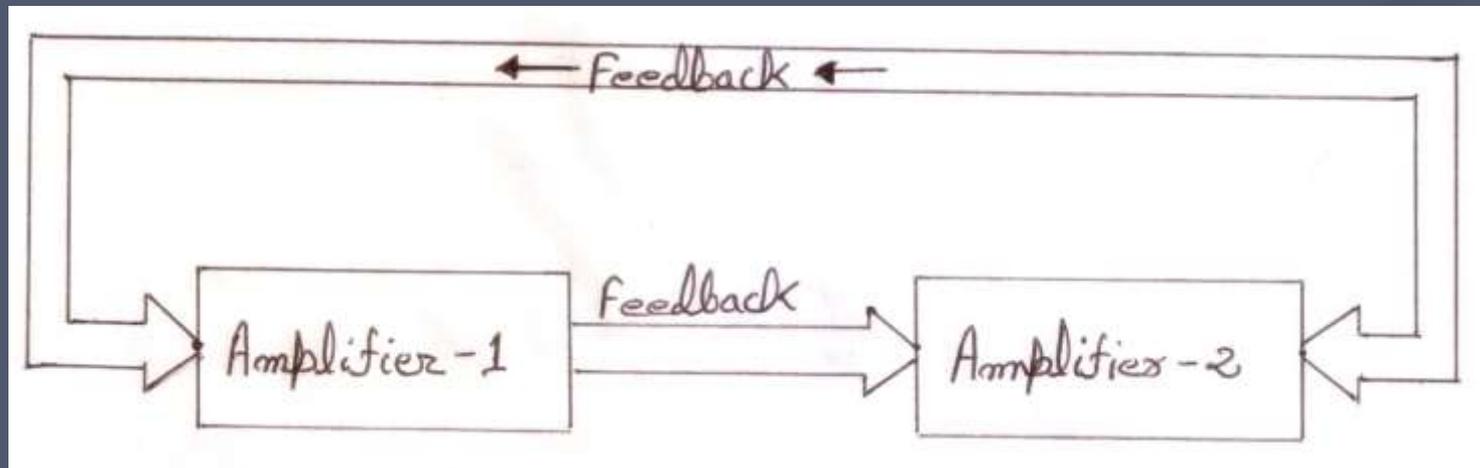
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# Introduction of Multi-vibrator

- Multi-vibrator are basically **two-stage amplifiers with positive feedback from the output of one amplifier to the input of the other**. This feedback, shown in **Fig (1)**, is supplied in such a manner that one transistor is driven to **saturation** and the other to **cut-off**. It is followed by new set of conditions in which the **saturated** transistor is driven to **cut-off** and the **cut-off** transistor is driven to **saturation**.



- **Fig (1)** Shown Feedback is supplied in such a manner that one transistor amplifier is driven to saturation and the other to cut-off.

- Multi-vibrator is a **switching circuit** and may be defined as an electronic circuit that generate **Non-sinusoidal waves**, such as **rectangular waves**, **sawtooth waves**, **square waves** etc. Hence an **electronic circuit** that **generates** Non-sinusoidal waves such as rectangular, saw-tooth, square waves etc. is known as a **multi-vibrator**.
- Multi-vibrator are very useful as **pulse generating**, **storing** and **counting circuits**. These devices are capable of storing binary numbers, counting pulses, synchronising arithmetic operations and performing other essential functions used in **digital systems**.

- **Multi-vibrator circuits refer to the special type of electronic circuits used for generating pulse signals. These pulse signals can be rectangular or square wave signals. Ordinarily square-waves can be generated by introducing a switch in a DC circuit as shown in Fig (2) below. Square-wave will be generated by turning the switch ON and OFF at regular intervals. Hence a multi-vibrator is essentially a switching circuit.**

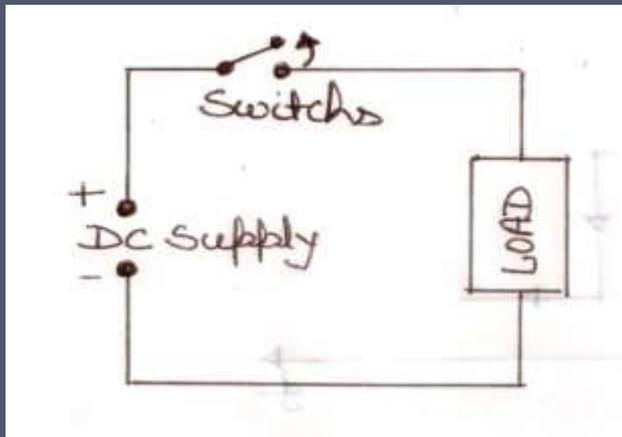


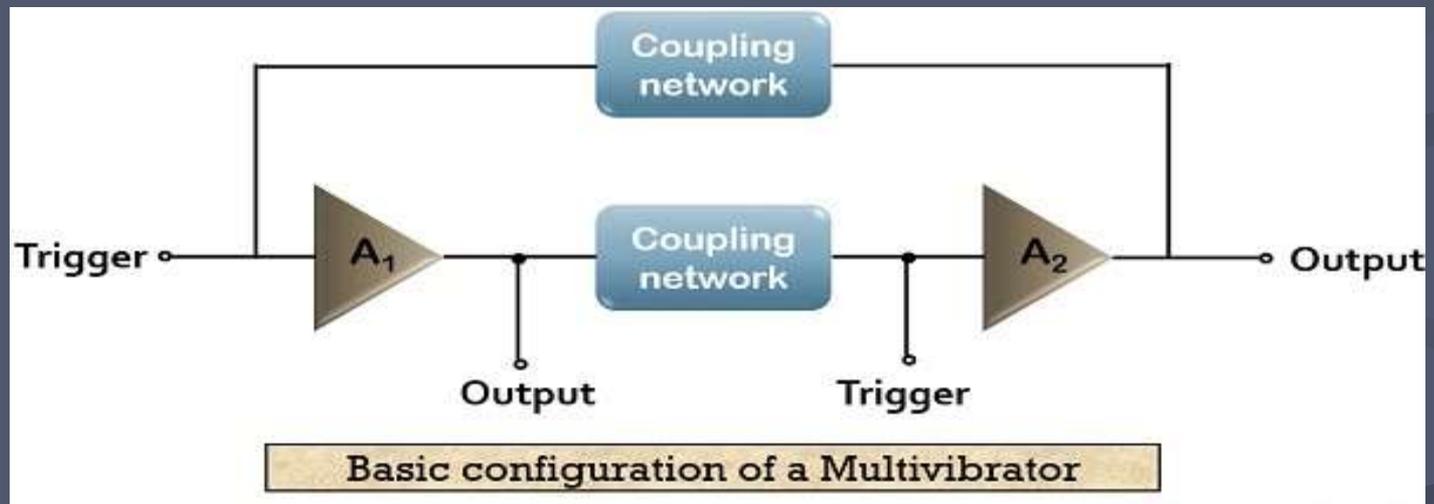
Fig (5) (a)



Fig (5) (b)

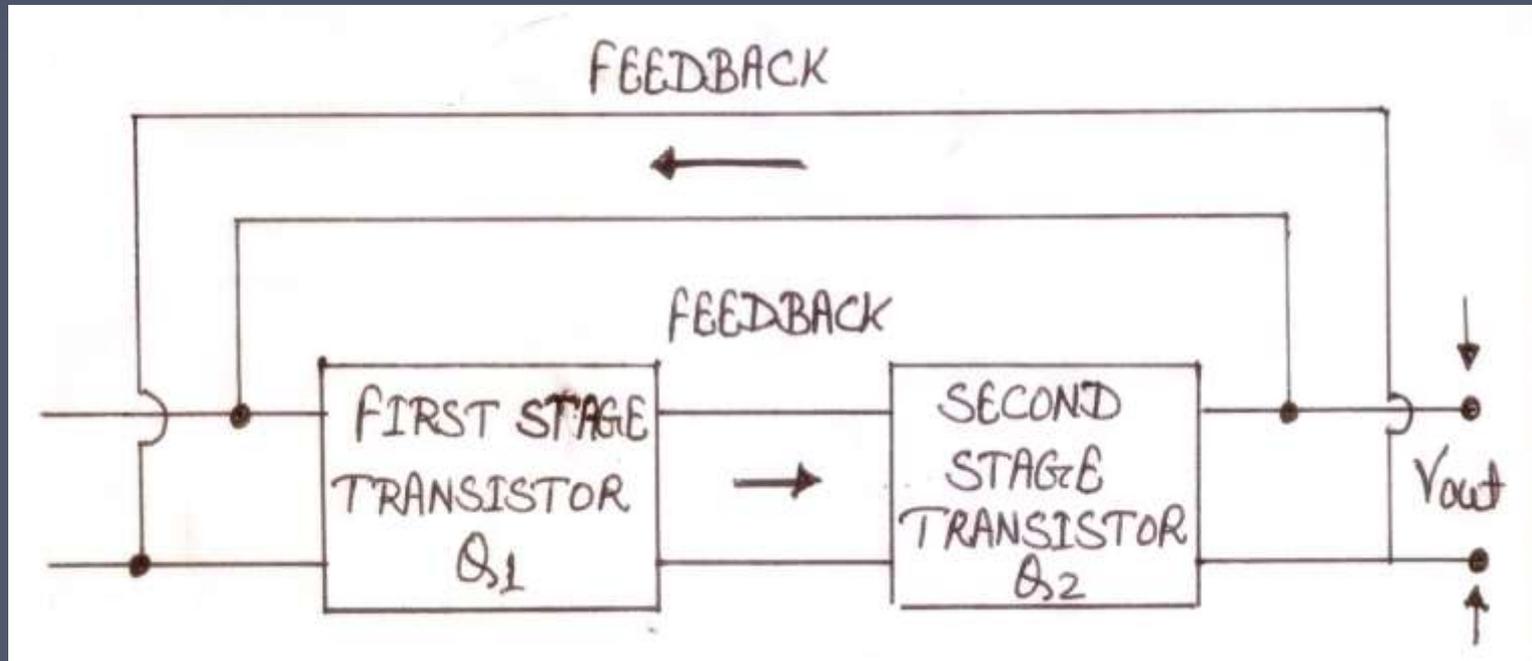
- **Fig (2) (a) Shown Ordinary Square-Wave Generating Circuit.**
- **Fig (2) (b) Shown Square Wave.**

- According to the definition, A Multi-vibrator is a two-stage resistance-capacitor (RC) coupled amplifier with 100% positive feedback from the output of one amplifier A2 to the input of the other amplifier A1.
- A multi-vibrator is basically a two stage R-C coupled amplifier with 100% positive feedback from the output of second stage amplifier A2 to the input of the first stage amplifier A1 via Coupling Network, as illustrated in Fig (3) below.



- Fig. (3) Shown basic configuration of a multi-vibrator with two stages R-C coupled amplifier with positive feedback.

- A multi-vibrator is a switching circuit which depends its operation on **positive feedback**. It is basically a two-stage amplifier with output of **Second stage Transistor amplifier Q2** feedback to the input of the **First stage Transistor amplifier Q1** as shown in **Fig. (4)** below.

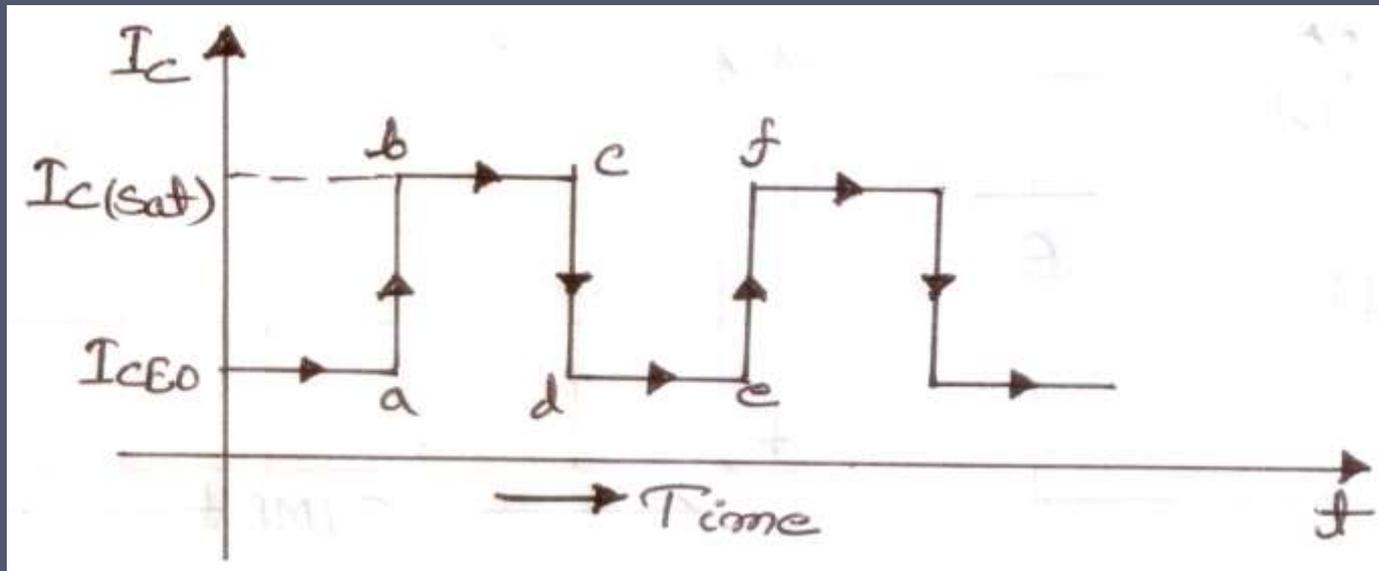


- **Fig. (4)** Shown feedback two-stage Transistor amplifier with output of second stage feedback to the input of the first stage.

- A **Transistor** basically **functions** as an **amplifier** in its **linear region**. If a transistor **amplifier output stage** is **joined** with the **previous amplifier stage**, such a connection is said to be **coupled**. If a **resistor** and **capacitor** are used in **coupling two stages** of such an amplifier circuit, it is called as **two stage R-C coupled amplifier**. A specific characteristic of multi-vibrators is the use of passive elements like resistor and capacitor (R-C) to determine the output state.
- The **two stage R-C coupled amplifier** circuit **operates** in two states viz. **ON** and **OFF** controlled by circuit condition. The operation of the two stages R-C coupled amplifier circuit is such that when one amplifier is **cut-off (OFF)** the **positive feedback loop maintains the other amplifier in a conducting or ON state**. When a **trigger** causes one amplifier to change state, the **coupling network acts to change the state of the second amplifier**. They generally produce output in two states: **HIGH (ON)** or **LOW (OFF)**. The outputs are opposite in sense, one indicating a transition from an **OFF state** to an **ON state** and the other the opposite transition. The condition in which the multi-vibrator may remain indefinitely until the circuit is triggered by some external signal is termed as the **stable state**.

- **In other word**, the circuit operates in two states (viz **ON** and **OFF**) controlled by circuit conditions. Each Transistor amplifier stage supplies **positive feedback** to the other in such a manner that it will drive the transistor amplifier of one stage to **saturation (ON state)** and the other to **cut off (OFF state)**.
- After a certain time controlled by circuit conditions, the **action is reversed** i.e. **saturated stage** is driven to **cut off** and the **cut off stage** is **driven to saturation**. The **output** can be **taken across** either stage and may be **rectangular or square wave** depending upon the **circuit conditions**.

- **Fig (4)** shows the **block diagram of a multi-vibrator**. It is a **two-stage Transistor amplifier with 100% positive feedback**. Suppose output is taken across the transistor **Q2**. At any particular instant, one transistor is **ON** and conducts **collector current  $I_C(\text{sat})$**  (also known as **transistor saturation current**) while the other transistor is **OFF**. Suppose transistor **Q2** is **ON** and transistor **Q1** is **OFF**, The collector current in transistor **Q2** will be  **$I_C(\text{sat})$**  as shown in **Fig (5)** below.



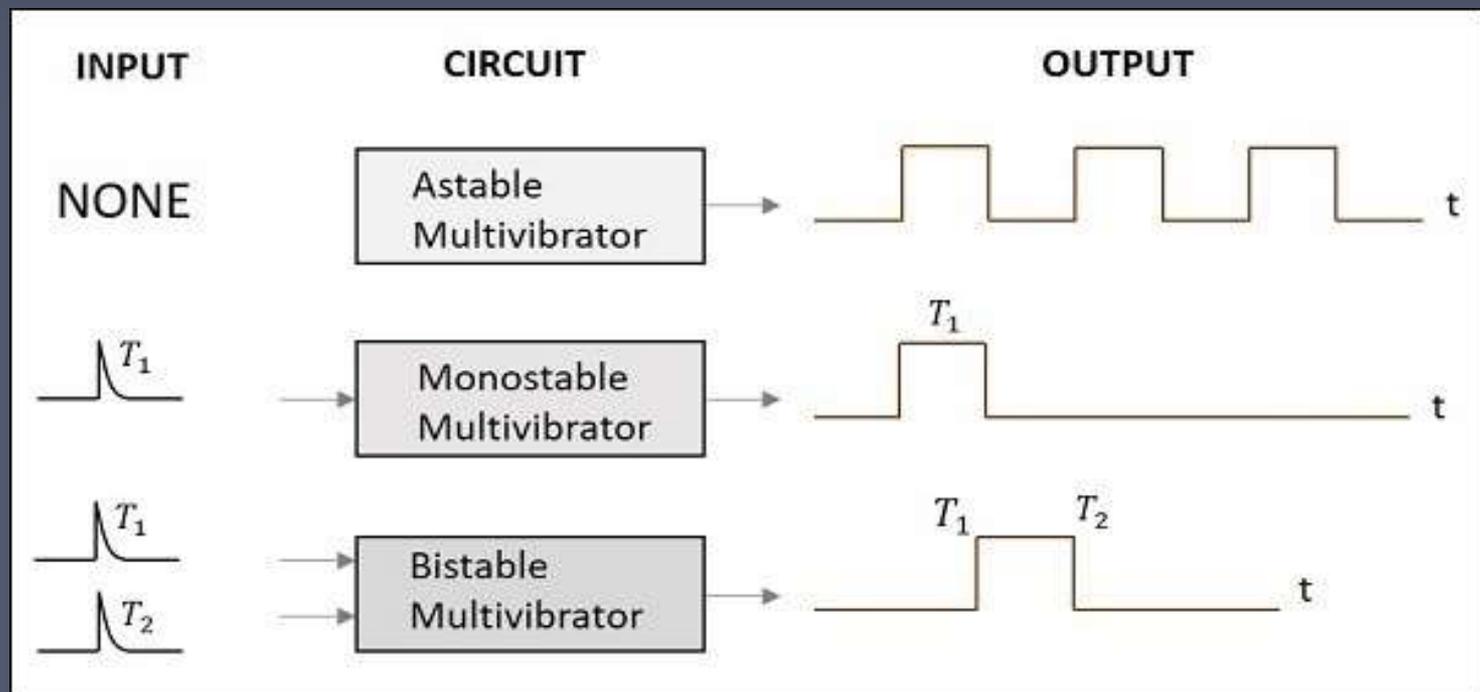
- **Fig (5)** Shown Transistor **Q2** output collector current  **$I_C$**  as a Square wave.

- This condition will prevail for a time (  $b c$  in this case ) determined by circuit conditions. After this time, **transistor Q2** is **cut off** and **transistor Q1** is turned **ON**. The collector current in **transistor Q2** is now **ICEO** (also known as **transistor leakage current**) as shown in **Fig (5)** in previous slide no 9. The circuit will stay in this condition for a time  $d e$ . Again **transistor Q2** is turned **ON** and **transistor Q1** is driven to **cut off**. In this way, the output will be a **Square Wave**.
- Hence There are only two possible states of a multi-vibrator and are as follows:-
  - **First State** : The **transistor Q1** turns **ON** while the **transistor Q2** turns **OFF**.
  - **Second State** : The **transistor Q1** turns **OFF** while the **transistor Q2** turns **ON**.
- These two states are interchanged for certain time periods depending upon the circuit conditions.

# Types of Multi-vibrators

- Depending upon the type of **coupling network** employed and the manner in which the two stages are **interchanged their states** the multi-vibrators are classified into the following **three categories**:-
  - (1). **Astable multi-vibrator (AVM)**,
  - (2). **Monostable multi-vibrator (MMV)**,
  - (3). **Bistable multi-vibrator (BMV)**.

- The first one is the **non-driven type** whereas the other two are the **driven type** (also called **triggered oscillators**). Fig (6) shows below the input/output relations for the three types of multi-vibrators.



- Fig (6) shows the input/output relations for the three types of multi-vibrators.

# (1). Astable Multi-Vibrator (AMV)

- It is also called free-running relaxation oscillator. It has no stable state but only two quasi-stable (half-stable) states between which it keeps oscillating continuously of its own without any external excitation. Thus it is just an oscillator since it requires no external pulse for its operation. Of course, it does require a source of **d.c. power**. Because it continuously produces the square-wave output it is often referred to as a free running multi-vibrator. In this circuit, neither of the two transistors reaches a stable state. When one is **ON**, the other is **OFF** and they continuously switch back and forth at a rate depending on the RC time constant in the circuit. Hence, it oscillates and produces pulses of certain mark-to-space ratio. Moreover, two outputs ( $180^\circ$  out of phase with each other) are available. It has **two energy-storing elements i.e. two capacitors**.

## (2). Monostable Multi-Vibrator (MMV)

- It is also called a **single-shot** or **single swing** or a **one-shot multi-vibrator**. Other names are: **delay multi-vibrator** and **uni-vibrator**. It has
  - 1) One absolutely stable (stand-by) state and
  - 2) One quasi-stable state.
- The monostable or one-shot multi-vibrator has one state stable and one quasi-stable (i.e. half-stable) state. The application of external input pulse triggers the circuit into its quasi-stable state, in which it remains for a period determined by circuit constants. After this period of time, the circuit returns to its initial stable state, the process is repeated upon the application of each external trigger pulse. Since the monostable multi-vibrator produces a single output pulse for each input trigger pulse, it is generally called one-shot multi-vibrator. **It has one energy-storing element *i.e.* one-capacitor.**

### **(3). Bistable Multi-Vibrator (BMV)**

- It is also called **Eccles-Jordan** or **flip-flop multi-vibrator**. It has two absolutely stable states. It requires the application of an external triggering pulse to change the operation from either one state to the other. It can remain in either of these two states unless an external trigger pulse switches it from one state to the other. Thus one pulse is used to generate half-cycle of square wave and another pulse to generate the next half-cycle of square wave. It is also known as a flip-flop multi-vibrator because of the two possible states it can assume. Obviously, it does not oscillate. **It has no energy storage element.**
- Detailed discrete circuits for the above MVs are discussed in **next lecture – 2** .

**to be Continued .....**