# UNIT II BIPOLAR JUNCTION TRANSISTORS

## 2.1 TRANSISTOR

A transistor is a type of a semiconductor device that can be used to both conduct and insulate electric current or voltage. A transistor basically acts as a switch and an amplifier. A transistor is a miniature device that is used to control or regulate the flow of electronic signals.

A typical transistor is composed of three layers of semiconductor materials or more specifically terminals which helps to make a connection to an external circuit and carry the current. A voltage or current that is applied to anyone pair of the terminals of a transistor controls the current through the other pair of terminals. There are three terminals for a transistor.

Emitter

Base

Collector

The very basic working principle of a transistor is based on controlling the flow of current through one channel by varying intensity of a very smaller current that is flowing through a second channel.

**BIPOLAR JUNCTION TRANSISTOR (BJT)**

The three terminals of BJT are base, emitter and collector. A very small current flowing between base and emitter can control a larger flow of current between the collector and emitter terminal.

There are two types of BJT.

**P-N-P Transistor**

It is a type of BJT where one n-type material is introduced or placed between two p-type materials. In such a configuration, the device will control the flow of current. PNP transistor consists of 2 crystal diodes which are connected in series. The right side and left side of the diodes are known as the collector-base diode and emitter-base diode respectively.

**N-P-N Transistor**

This transistor one p-type material that is present between two n-type materials. N-P-N transistor is basically used to amplify weak signals to strong signals. In NPN

transistor, the electrons move from the emitter to collector region resulting in the formation of current in the transistor. This transistor is widely used in the circuit.

**NPN TRANSISTOR**

An NPN transistor is the most commonly used bipolar junction transistor, and is constructed by sandwiching a P-type semiconductor between two N-type semiconductors. An NPN transistor has three terminals a collector, emitter and base. The NPN transistor behaves like two PN junction diodes connected back to back.

The Emitter is a region is used to supply charge carriers to the Collector via the Base region. The Collector region collects most of all charge carriers emitted from the Emitter. The Base region triggers and controls the amount of current flows through the Emitter to Collector.

**Symbol of NPN Transistor**

The NPN transistor has two junctions and three terminals. The arrowhead shows the conventional direction of Collector current (IC), Base current (IB) and Emitter current (IE).

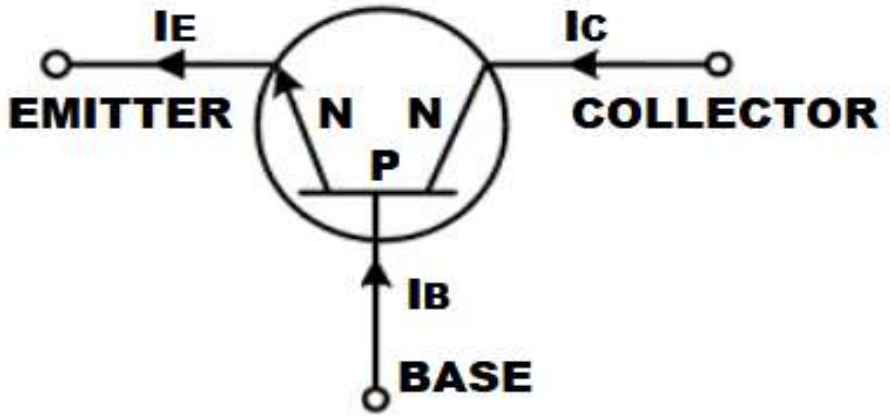


**Fig:2.1.1 Symbol of NPN Transistor**

**Construction of NPN Transistor**

The emitter and collector layers are wider compared to the base. The emitter is heavily doped. Therefore, it can inject a large number of charge carriers to the base.

The base is lightly doped and very thin compared to the other two regions. It passes most of all charge carriers to the collector which is emitted by the emitter.

The collector is moderately doped and collects charge carriers from the base layer.

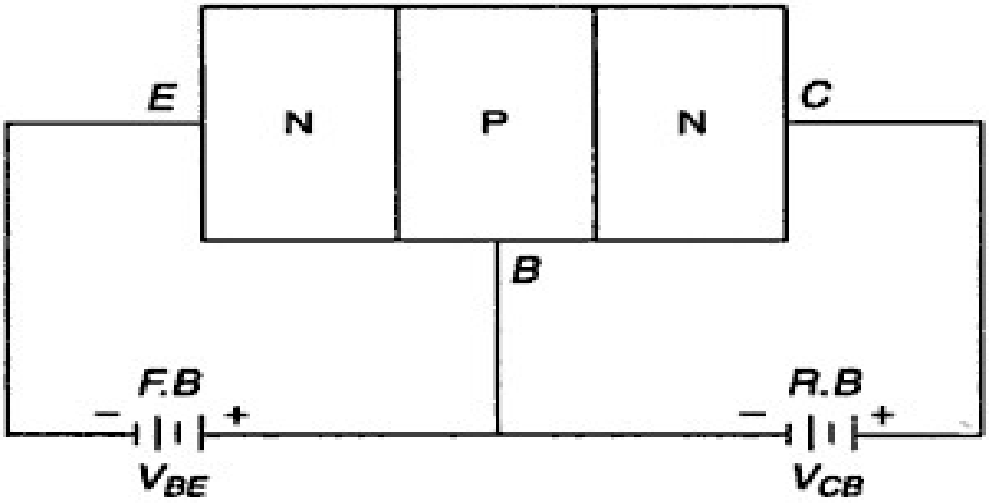


**Fig:2.1.2 Construction of NPN Transistor**

**Working of NPN Transistor**

The base-emitter junction is connected in the forward bias condition by supply voltage VEE. And the collector-base junction is connected in the reverse bias condition by supply voltage VCC.

In forward bias condition, the negative terminal of supply source (VEE) is connected to the N-type semiconductor (Emitter). Similarly, in a reverse bias condition, the positive terminal of the supply source (VCC) is connected to the N-type semiconductor (Collector).

The depletion region of the emitter-base region is thin compared to the depletion region of the collector-base junction (The depletion region is a region where no mobile charge carriers are present and it behaves like a barrier that opposes the flow of the current).

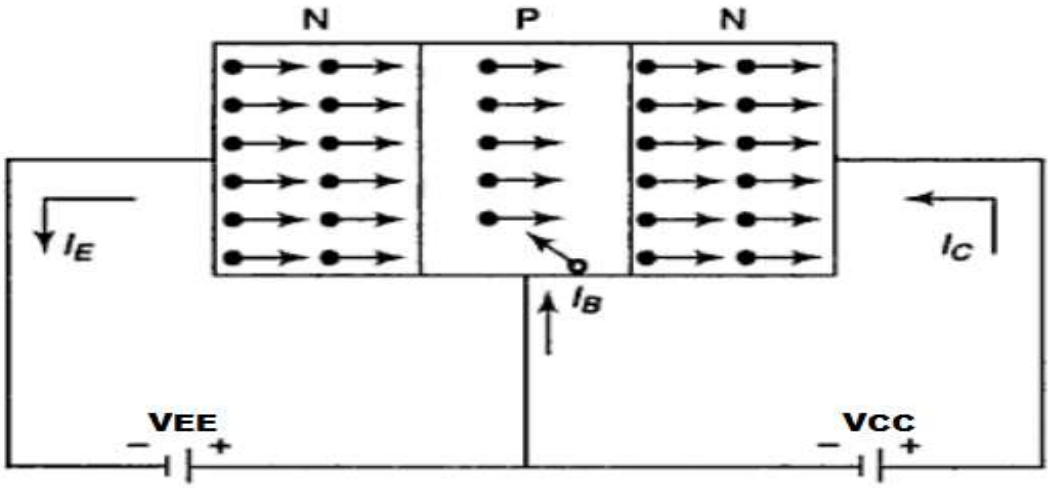


**Fig:2.1.2 Working Principle of NPN Transistor**

In N-type emitter, the majority charge carrier is electrons. Therefore, electrons start flowing from N-type emitter to a P-type base. And because of electrons, the current will start flowing the emitter-base junction. This current is known as emitter current IE.

These electrons move further to the base. The base is a P-type semiconductor. Therefore, it has holes. But the base region is very thin and lightly doped. So, it has a few holes to recombine with the electrons. Hence, most of the electrons will pass the base region and few of them will recombine with the holes.

Because of the recombination, the current will flow through the circuit and this current is known as base current IB. The base current is very small compared to the emitter current. Typically, it is 2-5% of the total emitter current.

Most of the electrons pass the depletion region of a collector-base junction and pass through the collector region. The current flowing by the remaining electrons is known as the collector current IC. The collector current is large compared to the base current.