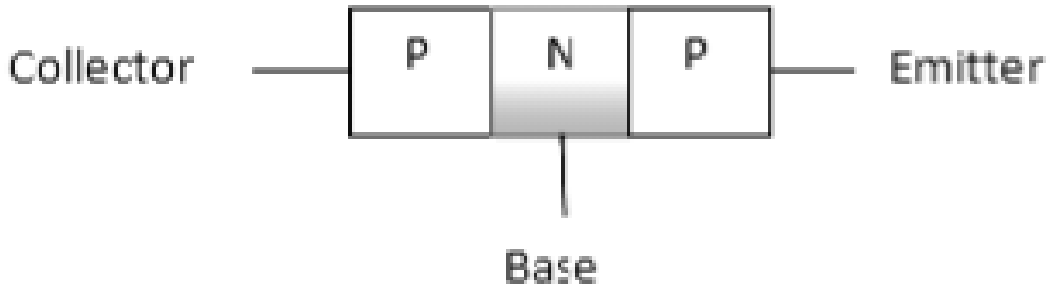
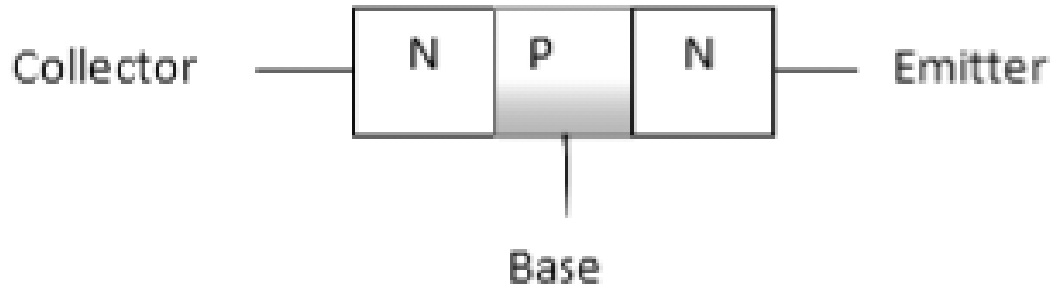
TOPIC => BIPOLAR JUNCTION TRANSISTOR

Question No.1:-

(i) Introduction :- The transistor was invented by Dr. William Shockley and Dr. John Bardeen at Bell Laboratory in America in 1951. First time, in 1952 transistor was used in telephone switching circuit. Since then, it has revolution in the field of electronics.

The transistor has replaced the bulky vacuum tube in most of the electronic circuit. The transistor is a basic building block of all modern electronic system. It is a three terminal device. The output voltage , current or power are controlled by the input current in a transistor. Therefore, it is also called a current controlled device.





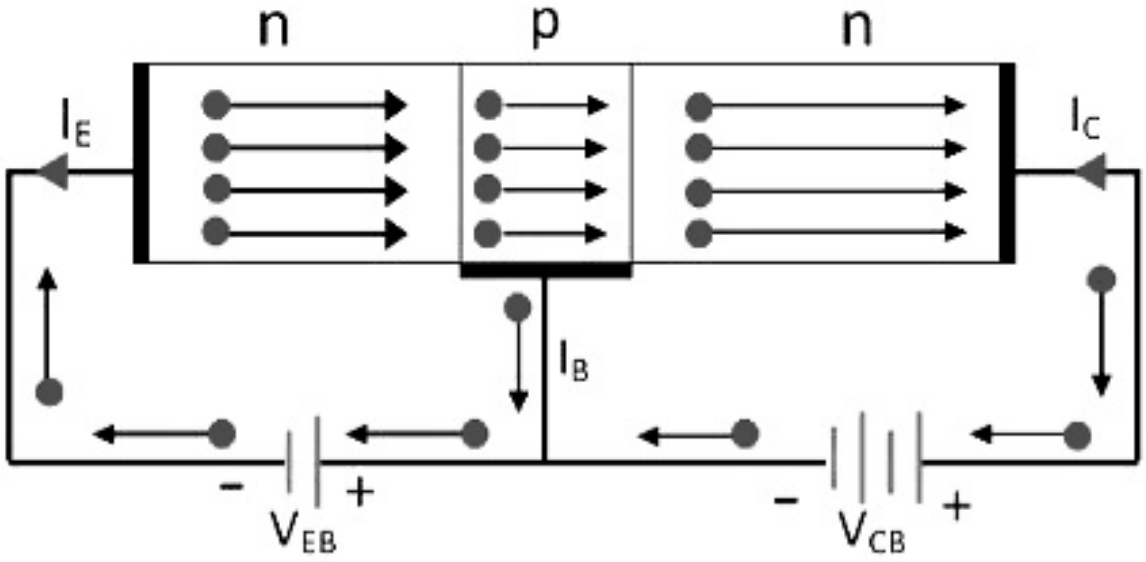
(a) NPN Transistor
(b) PNP Transistor

In short transistor is also called as BJT. BJT stands for bipolar junction transistor because the transistor operation is carried out by two type of charge carriers and minority carriers.

The transistor has a very important property that it can raise the strength of an input weak signal. This property is called Amplification. Due to this quality, the transistor is one of the widely used semiconductor devices.

(ii)

(a) Working of a transistor :- To explain the working of a transistor, we consider an NPN transistor Which is biased for active operation. That means, emitter-base junction is forward biased by battery V_{EB} and collector base junction is reverse-biased by battery V_{CB}.



Working of Transistor

The forward biased voltage is small and reverse-biased voltage is quite large. The forward bias on the emitter-base junction pushes a large number of free electrons in the N-type emitter towards the base. This makes the emitter current (I_E). A very few holes also pass from the base region to the emitter region. This flow of electron and holes constitute emitter current (I_E). Since, the electron current is useful in the action of transistor, it is made larger and larger than the hole current by doping the base region more lightly than emitter region. Hence, only a very small portion nearly 0.5% of the emitter current is due to the holes passing from the base to the emitter. The direction of a conventional current is always taken opposite to the flow of electrons.

After reaching the base region, the electrons tend to combine with holes. But since the base is very thin and lightly doped, only a very few electrons combine with holes. To constitute the base current (I_B). The remaining electrons pass on to the collector which is a positively biased N-region. These electrons are collected by the collector to constitute the collector current.

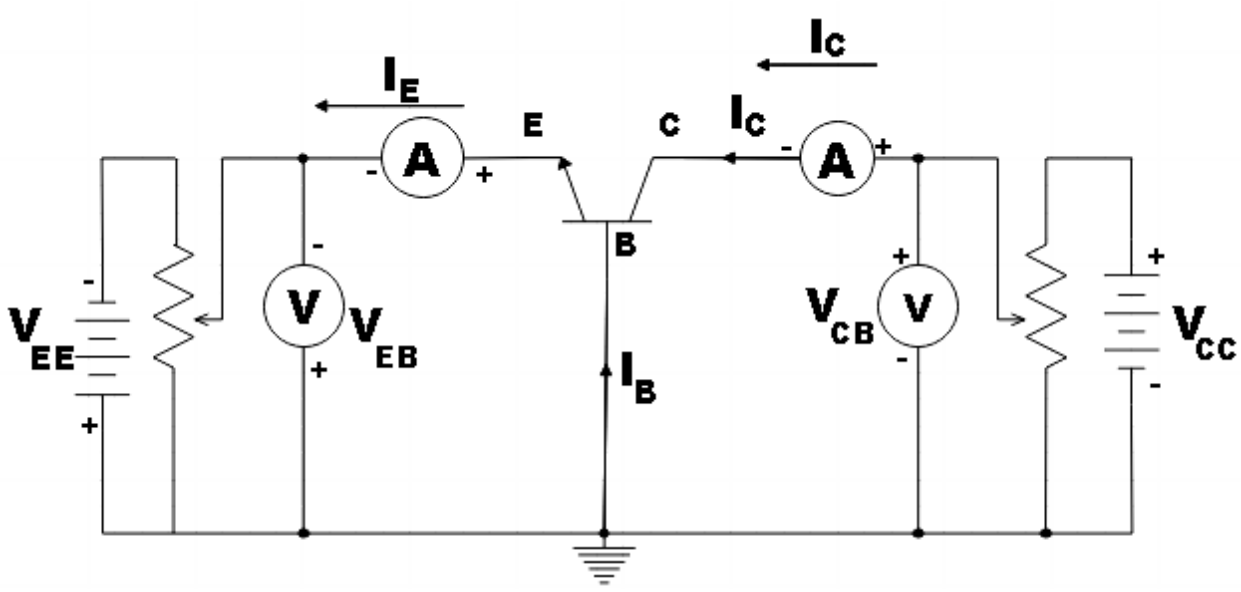
There is one another component of collector current due to the thermally generated minority carriers (holes in this case) which pass towards the base.

(b) Characteristic Curve of Transistor:- We know about some parameters of transistor such as α and β and current. They give a small idea of transistor behavior. The complete behavior of transistor may be observed with the help of some types of curve known as characteristics curve. These characteristics curve relate the transistor current and voltage. There are two types of characteristics curves.

1. Transistor Characteristics in Common-Base Configuration:- In common-base configuration, two types of characteristics are:

(A)Input Characteristic Curve:- Input characteristic curve relate the input or emitter current I_E and input or emitter-to-base voltage V_{EB} keeping output or collector-to-base voltage V_{CB} constant.

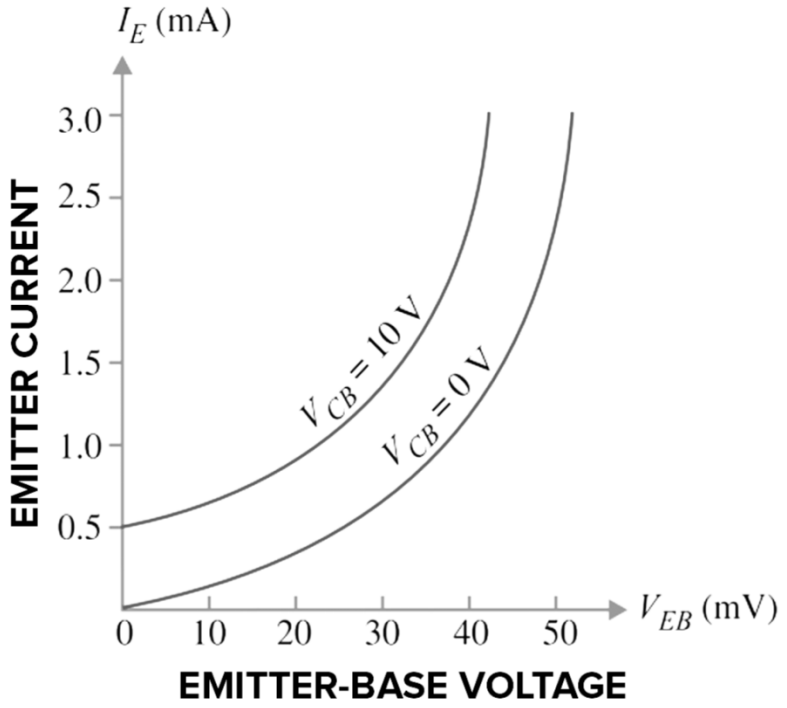
(B)Output Characteristic Curve:- Output characteristic curve relate the output or collector current Ic and output or collector-to-base voltage V_{CB} keeping the input or emitter current I_E constant.



Current arrangement for input and output characteristics curve in CB configuration

1.1. Transistor Input Characteristics in Common-Base Configuration:-

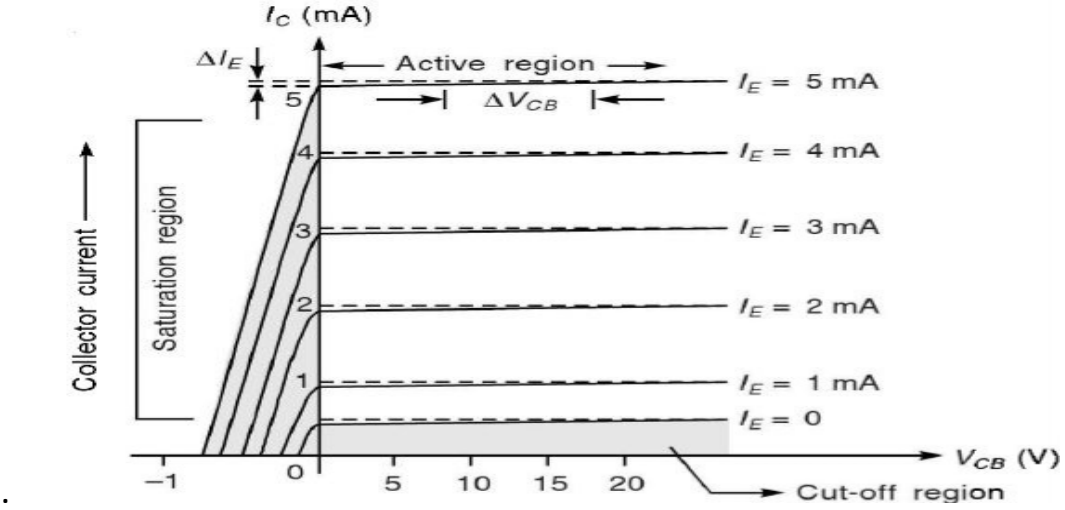
The input characteristic in CB configuration are plotted between emitter current I_E and the emitter-base voltage V_{CB}.



Input characteristics in common-base configuration

1.2. Transistor Output Characteristics in Common-Base Configuration:-

The output characteristic curve in CB configuration can be obtained with the help of same circuit arrangement shown in figure. Collector-to-base voltage V_{CB} is increased and corresponding changes in collector current are noted and a graph is plotted

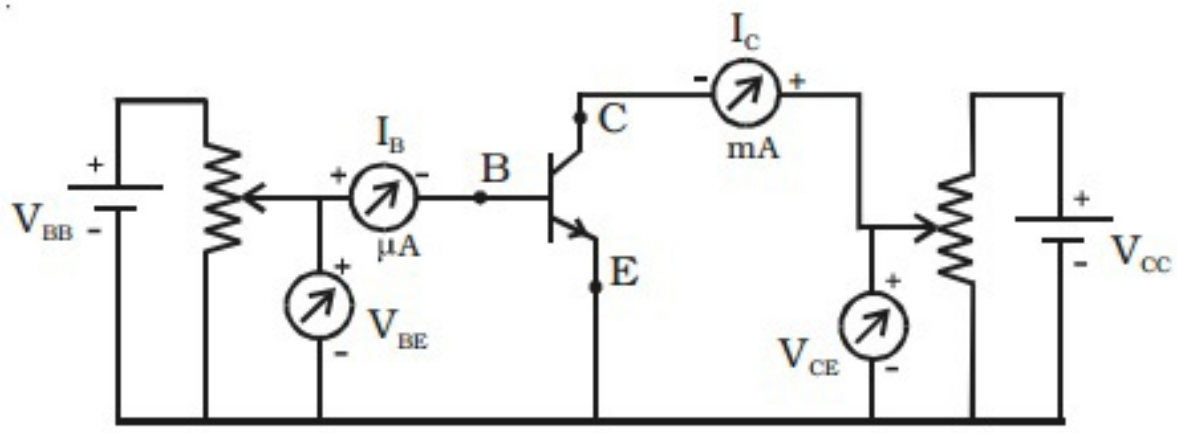


Output characteristics in common-base configuration

2. Transistor Characteristics in Common-Emitter Configuration:- In common-emitter configuration, a transistor has two types of characteristics namely input characteristics and output characteristics.

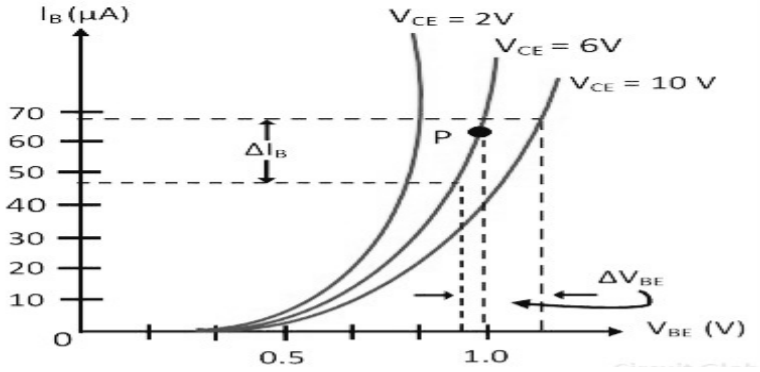
(A) Input Characteristics Curve:- Input characteristics curve relate the base current I_B and the base-to-emitter voltage V_{BE} keeping collector-to-emitter voltage V_{CB} constant.

(B) Output Characteristics Curve:- Output characteristics curve relate the collector current Ic and collector-to-emitter voltage V_{CE} keeping base current I_B constant.



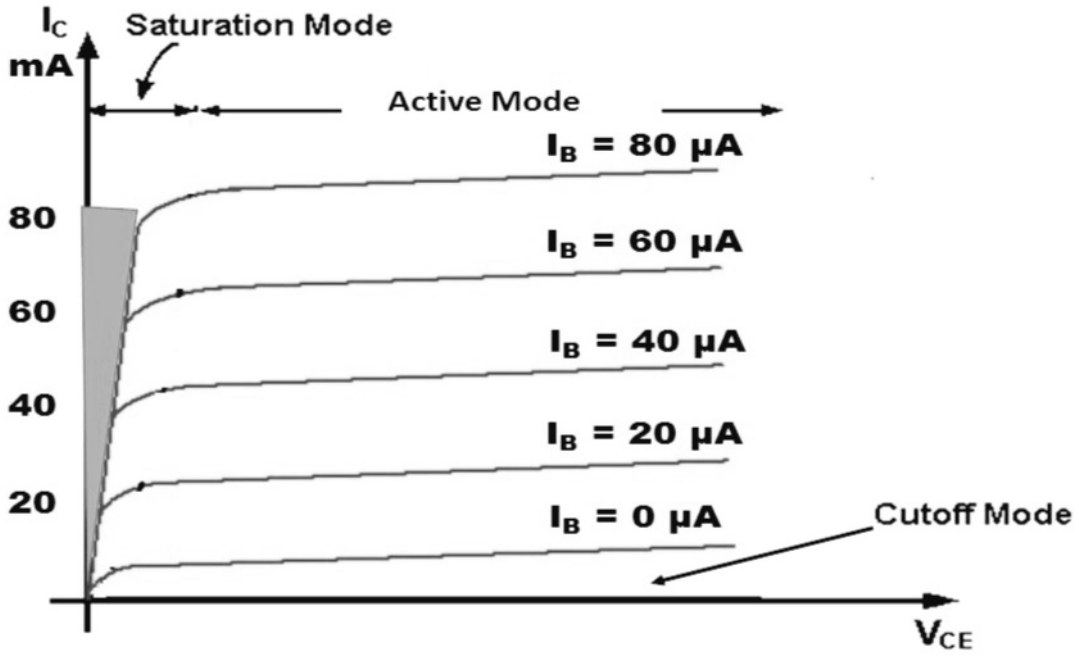
Circuit arrangement for input and output characteristics

2.1. Input Characteristics in Common-Emitter Configuration:- Input characteristics curve may be obtained with the help of circuit arrangement shown in figure, by increasing the V_{BE} in step and recording the corresponding values of I_B while keeping V_{CE} constant. In figure, the typical characteristics curves relate I_B and V_{BE} for various values of V_{CB}.



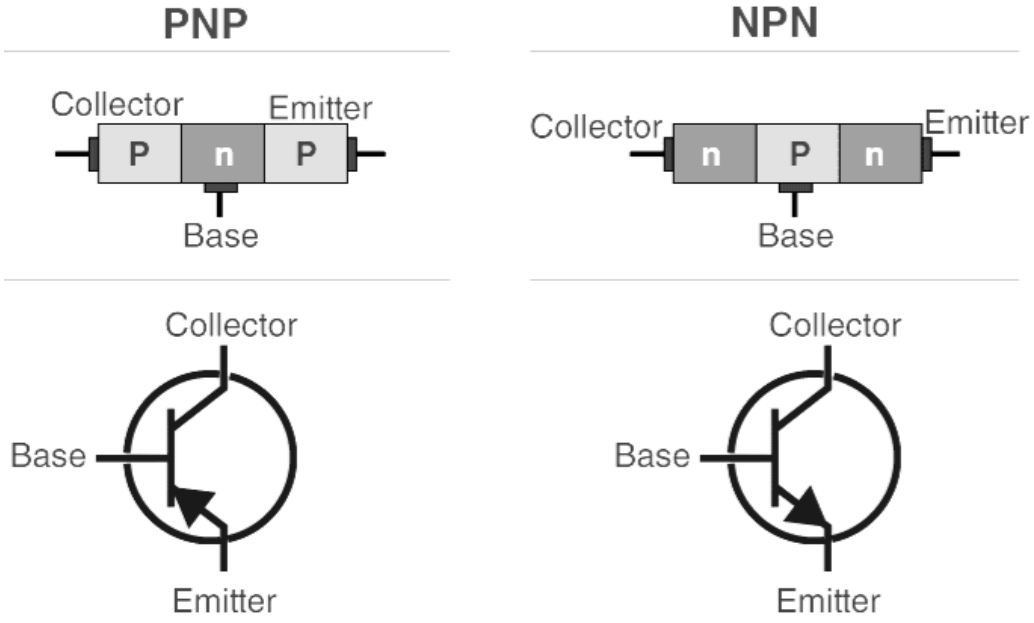
Input characteristics in common-emitter configuration

2.2. Output Characteristics in Common-Emitter Configuration:- Output characteristics in CE configuration can be plotted with the help of circuit arrangement shown in figure . The related output current Ic to the collector-to-emitter voltage for different values of input current Iв.



Output characteristics in common-emitter configuration

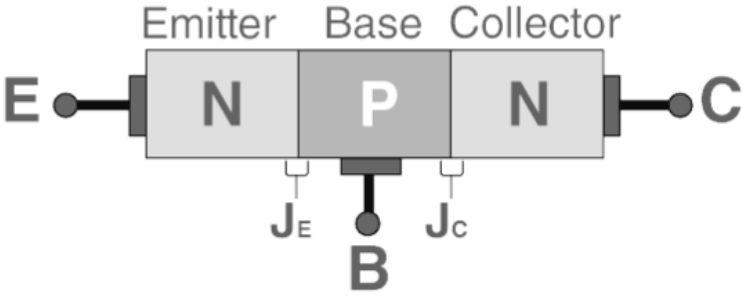
(c)Transistor Symbol:- There are two types of transistors known as NPN and PNP. When the transistor is used as a circuit in any electronics circuit, it is always represent by its symbol in figure (a) and (b).



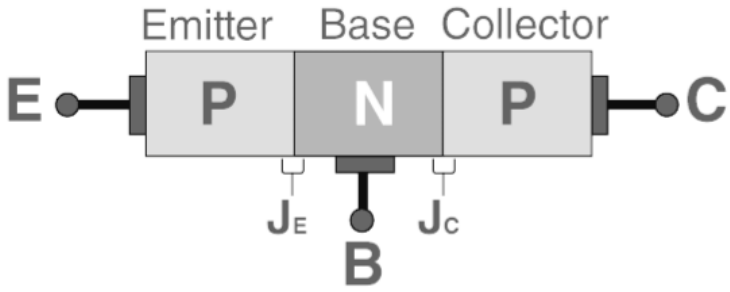
(a) (b)

(d) Types of BJT:- There are two types of Bipolar Junction Transistor:

1. NPN BJT:- In NPN BJT, the p-type semiconductor is sandwiched between two n-type semiconductor.



2. PNP BJT:- In PNP BJT, the n-type semiconductor is sandwiched between two p-type semiconductor.



(e) Applications of BJT:- At present, transistor is used in almost every field of electronics.

1. Transistor is used in control system.
2. BJT is used as a detector or also known as a demodulator.
3. Logic circuit and switch circuit use BJT.
4. In digital computer electronics, the transistor is used as high speed electronics switch.
5. In communication system, it is widely used as the premium component in the amplifier.