BIPOLAR JUNCTION TRANSISTOR

- The transistor was developed by Dr.Shockley along with Bell Laboratories team in 1951
- The transistor is a main building block of all modern electronic systems
- It is a three terminal device whose output current, voltage and power are controlled by its input current
- In communication systems it is the primary component in the amplifier
- An amplifier is a circuit that is used to increase the strength of an ac signal
- Basically there are two types of transistors
    - Bipolar junction transistor
    - Field effect transistor
- The important property of the transistor is that it can raise the strength of a weak signal
- This property is called amplification
- Transistors are used in digital computers, satellites, mobile phones and other communication systems, control systems etc.,
- A transistor consists of two P-N junction
- The junction are formed by sand witching either p-type or n-type semiconductor layers between a pair of opposite types which is shown below

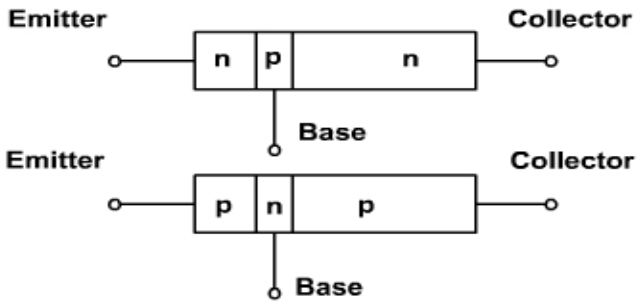


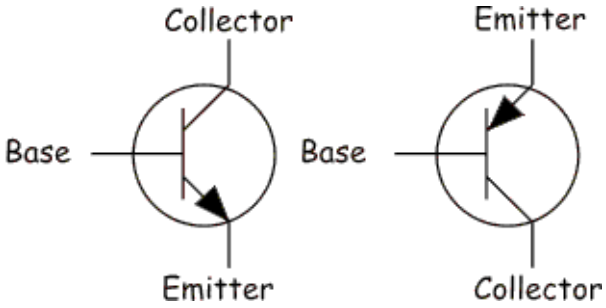
Fig: transistor

TRANSISTOR CONSTRUCTION

- A transistor has three regions known as emitter, base and collector

- **Emitter:** it is aregion situated in one side of a transistor, which supplies charge carriers (ie., electrons and holes) to the other two regions
- Emitter is heavily doped region
- **Base:** It is the middle region that forms two P-N junction in the transistor
- The base of the transistor is thin as compared to the emitter and is alightly doped region
- **Collector:** It is aregion situated in the other side of a transistor (ie., side opposite to the emitter) which collects the charge carrirs
- The collector of the transistor is always larger than the emitter and base of a transistor
- The doping level of the collector is intermediate between the heavy doping of emitter and the light doping of the base

TRANSISTOR SYMBOLS



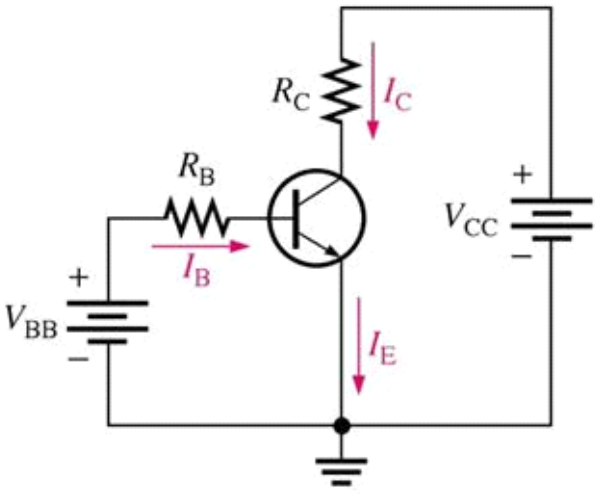
- The transistor symbol carries an arrow head in the emitter pointing from the P- region towards the N- region
- The arrow head indicates the direction of a conventional current flow in a transistor
- The direction of arrow heads at the emitter in NPN and PNP transistor is opposite to each other
- The PNP transistor is a complement of the NPN transistor
- In NPN transistor the majority carriers are free electrons, while in PNP

transistor these are the holes

UNBIASED TRANSISTORS

- A transistor with three terminals (Emitter, Base, Collector) left open is called an unbiased transistor or an open – circuited transistor
- The diffusion of free electrons across the junction produces two depletion layers
- The barrier potential of three layers is approximately 0.7v for silicon transistor and 0.3v for germanium transistor
- Since the regions have different doping levels therefore the layers do not have the same width
- The emitter base depletion layer penetrates slightly into the emitter as it is a heavily doped region where as it penetrates deeply into the base as it is a lightly doped region
- Similarly the collector- base depletion layer penetrates more into the base region and less into the collector region
- The emitter- base depletion layer width is smaller than the that of collector base depletion layer
- The unbiased transistor is never used in actual practice. Because of this we went for transistor biasing

OPERATION OF NPN TRANSISTOR



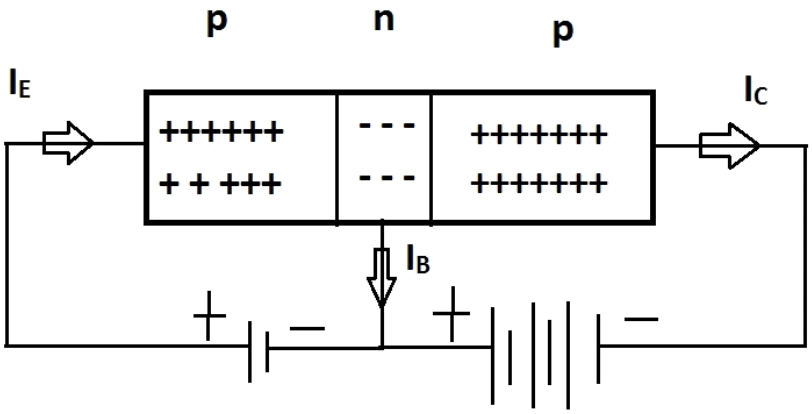
(a) *npn*

- The NPN transistor is biased in forward active mode ie., emitter – base of

transistor is forward biased and collector base junction is reverse biased

- The emitter – base junction is forward biased only if V is greater than barrier potential which is 0.7v for silicon and 0.3v for germanium transistor
- The forward bias on the emitter- base junction causes the free electrons in the N –type emitter to flow towards the base region. This constitutes the emitter current . Direction of conventional current is opposite to the flow of electrons
- Electrons after reaching the base region tend to combine with the holes
- If these free electron combine with holes in the base, they constitute base current ().
- Most of the free electrons do not combine with the holes in the base
- This is because of the fact that the base and the width is made extremely small and electrons do not get sufficient holes for recombination
- Thus most of the electrons will diffuse to the collector region and constitutes collector current . This collector current is also called injected current, because of this current is produced due to electrons injected from the emitter region
- There is another component of collector current due to the thermal generated carriers.
- This is called as reverse saturation current and is quite small

OPERATION OF PNP TRANSISTOR



p-n-p transistor

- Operation of a PNP transistor is similar to npn transistor
- The current within the PNP transistor is due to the movement of holes where as, in an NPN transistor it is due to the movement of free electrons
- In PNP transistor, its emitter – base junction is forward biased and collector base junction is reverse biased.
- The forward bias on the emitter – base junction causes the holes in the emitter region to flow towards the base region
- This constitutes the emitter current ( ).
- The holes after reaching the base region, combine with the electrons in the base and constitutes base current.
- Most of the holes do not combine with the electrons in the base region
- This is due to the fact that base width is made extremely small, and holes does not get sufficient electrons for recombination.
- Thus most of the holes diffuse to the collector region and constitutes collector region
- This current is called injected current, because it is produced due to the holes injected from the emitter region
- There is small component of collector current due to the thermally generated carriers
- This is called reverse saturation current.

TRANSISTOR CURRENTS

- We know that direction of conventional current is always opposite to the electron current in any electronic device.
- However, the direction of a conventional current is same as that of a hole current in a PNP transistor
- Emitter current
- Base current
- Collector current

- Since the base current is very small

TRANSISTOR CONFIGURATIONS

- A transistor is a three terminal device, but we require four terminals (two for input and two for output) for connecting it in a circuit.
- Hence one of the terminal is made common to the input and output circuits.
- The common terminal is grounded
- There are three types of configuration for the operation of a transistor

- **Common base configuration**
  - This is also called grounded base configuration
  - In this configuration emitter is the input terminal, collector is the output terminal and base is the common terminal
- **Common emitter configuration(CE)**
  - This is also called grounded emitter configuration
  - In this configuration base is the input terminal, collector is the output terminal and emitter is the common terminal
- **Common collector configuration(CC)**
  - This is also called grounded collector configuration
  - In this configuration, base is the input terminal, emitter is the output terminal and collector is the common terminal.