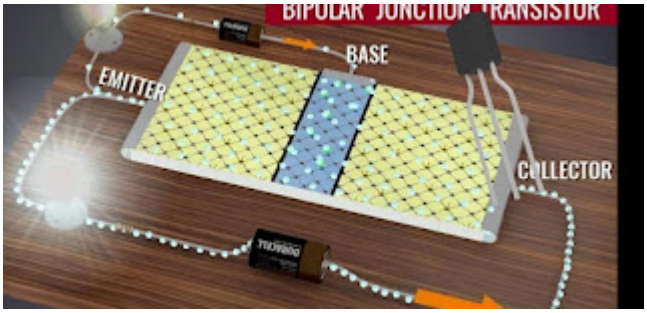
BJT

The BJT by Ajay Singh negi

December 23, 2022



The BJT

what is BJT transistor :

Bjt is the solid device which flow current in the circuit which control the flow through third terminal in the circuit .Bipolar junction transistor (BJT) is the type of transistor and three-terminal semiconductor device, which has two p-n junctions. They are mainly used as amplifiers in electronic circuits. Both the electrons and holes will act as the charge carriers in the Bipolar junction transistor. Usually, the BJT transistors do not require any external DC current. This article explains transistors and types, characteristics and working principles Bjt is also knows as bipolar junction diode. Which has 3 terminal semiconductors device which is made up of 2 pn junction which amplify the current.

A digital transistor is a bipolar transistor that integrate resistor.

the contuction-

A transistors has three region suituated in one side of transistor

1) emitter :it is a outer most region situated in one side of transistor. the Emitter: It is an outer. The function of emitter is to inje charge carriers (electrons in case of NPN transistor and holes in case of PNP transistors) into the base Sin emitter has to supply a large number of charge carrie so it is heavily doped.

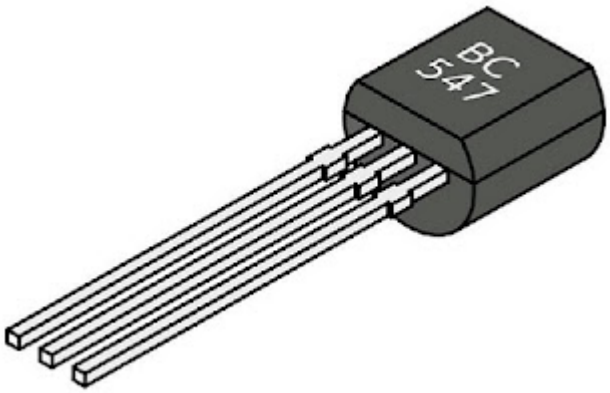
2) base : Base: It is the middle region of the transis The base is a very thin and lightly doped

2) base : Base: It is the middle region of the transis The base is a very thin and lightly doped region. The function of this region is to pass all the charge car electrons or holes) onto the collector.

2)Collector : It is the other outer region sitosted in the other side of transistor. The doping of collector is between the heavy doping of emitter and light deping of Base. The function of ener to collect charge carriers (electrons or boles: The collector region is physically larger than the emitter regon. The reason for this is that the collector has to dissipate more heat. Hence, it so clear that although a BJT has two same type of outer regions, their function cannot be interchanged.

A transistor has two PN-junctiona. One junction is formed between the emitter and the hare This is known as emitter-base junction. Another junction is formed between the base and the collector This is known as collector-base junction.

Characteristic of BJT :



1)BJT has three terminal and 2 pn junction

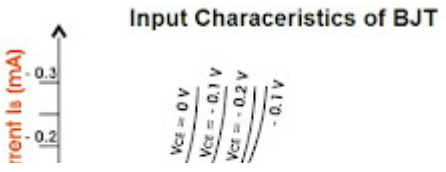
(Terminal) base, collector , emitter less current flow only in base and emitter terminal

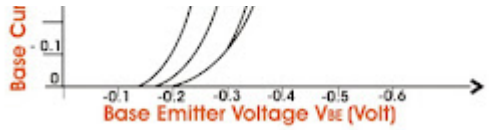
2) large current flow in collector and emitter

3)BJT works as digital switch in morden technology

4) transistor used for switching operation either for opening or closing of the circuit

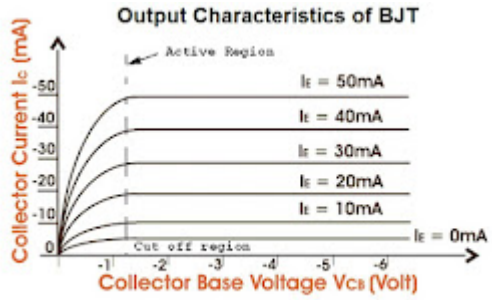
Input characteristics :





1) ib Vs base emitter vBE give input character (base current)
2) base junction is a diode iB Vs vbe graph resemble a diode curve
3) when a collector emitter voltage Vce2 is > Vce1 base

Output characteristics :



- For zero base current, for example, $I_B = 0$, as V_{CE} is increased, a small leakage (collector) current exists as shown in the figure.
- As the base current is increased from $I_B = 0$ to I_{B1}, I_{B2} etc, collector current also rises as which is shown in figure.
- Change in emitter current IE result in the changing value of collector current ic .

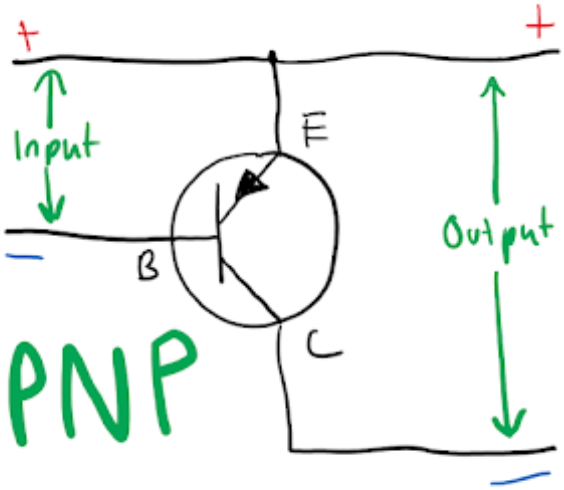
Types :

There are two types pnp transistor, non transistor

Pnp transistor :

In PNP transistors, one n-type semiconductor is between the two p-type semiconductors and creates two p-n junctions. The PNP transistors are used to control current flow through the circuit. Usually, the p-n junction is considered a

diode. So, the transistors look like two crystal diodes connected in series. . The right side diode is known as the collector-base diode.In the PNP transistor, the left side diode is known as the emitter-base diode

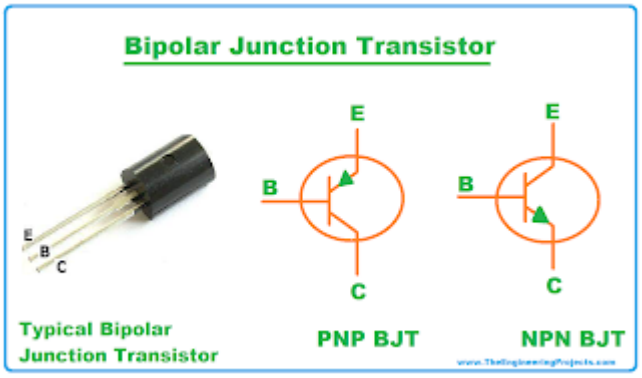


Npn transistor :

NPN transistors, one p-type semiconductor is placed between two n-type semiconductors and it forms the two p-n junctions. . In the NPN transistors, the current flow will be usually from the emitter to the collector region. These NPN transistors are widely used in many electronic devices

Symbols :

On following diagram :



Symbols :

Symbols :

Consist of
1) base

2)collector
3)emitter

Notation :

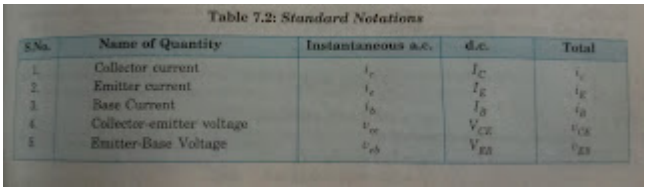
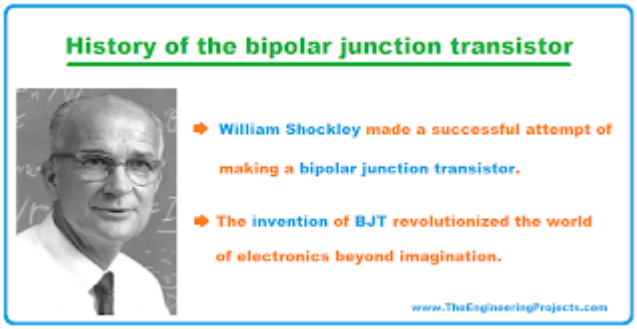


Table 7.2: *Standard Notations*

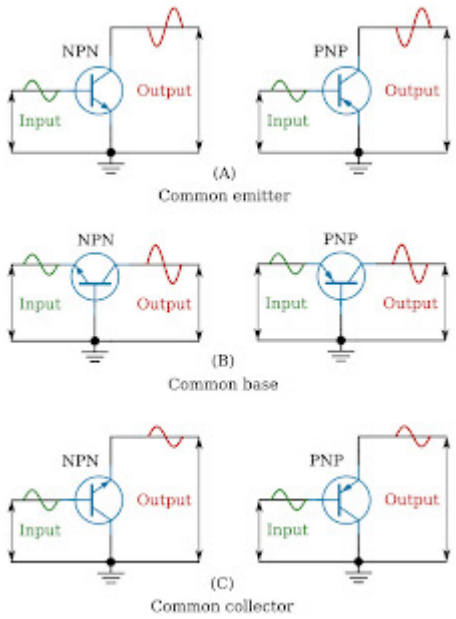
S.No.	Name of Quantity	Instantaneous a.c.	d.c.	Total
1.	Collector current	i_c	I_C	i_C
2.	Emitter current	i_e	I_E	i_E
3.	Base Current	i_b	I_B	i_B
4.	Collector-emitter voltage	v_{ce}	V_{CE}	v_{CE}
5.	Emitter-Base Voltage	v_{eb}	V_{EB}	v_{EB}

History of BJT :



1)vacuum tubes were used in electronic circuits which were highly expensive in those time back in the day
2)Major drawback was the increase in complications related to current, voltage and whatnot just by increasing the number of vacuum triodes in the circuit.So when scientists stop controlling electrons inside a vacuum and it was unruly behavior, they started making another way to run and control the circuit. tube and its make contact device which is different from Morden bipolar junctions transistors but it was the foundation of the construction if a solid -state transistors which was vacuum.
4) Williams was the first which make a history attempt of making a bipolar junctions transistor by pressing together the semiconductors of wafers which led them to Nobel prize for achievements in 1956.

bipolar junctions configuration :

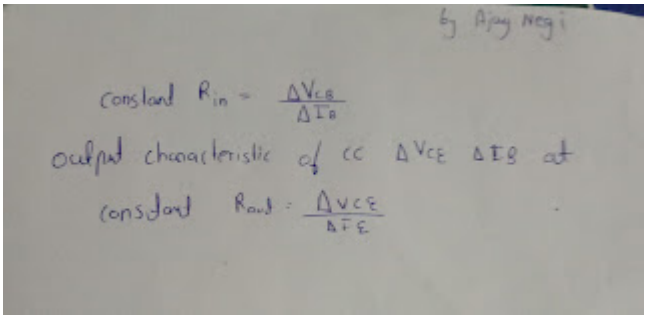


1) common base configuration :In common base configuration, the basr of the transistor is made common. The input is applied between the emitter and band the the collector and

2)common emitter configuration :common-eimiter of the transister is made common. The input is applied base and emitter and the taken between collector and emitter. This configuration is mostt widely used

In the common base characteristics, the base of the transistor is grounded, then the emitter turns as input and the collector turns as output.

3)common collector configuration :In common collector configuration, the collector is made ammen. The input is applied between base and collector and the output is taken between emitter and collector



BJT Working Principle :(in detail)

1)The NPN transistor is a biased active region. Here, the base-emitter junction is forward biased and the collector-base junction is reversed biased. So, the width of the depletion region of the base-emitter junction is small, while compared to the

width of the collector-base junction. The forward biased BE junction will reduce the barrier potential and help the current to flow from the emitter to the base.
2)Npn transistors is always thin and lightly doped so few holes will absorbed with the electrons in the emitter
3) the base current continue to flow as the recombination of holes in the base with electron in the region of emitter.
flow will remain opposed to the flow of electrons.

4)Large no. Of electron which remain in the emitter will pass the reverse baised collector junctions in the form of collector current.

According to Kirchhoff's Current Law, the emitter current is equal to the sum of collector current and base current. Generally, the base current I_B will remain small when compared to the emitter current I_E and the collector current I_C
$I_E = I_C + I_B$

The only major difference between the NPN and PNP transistors are their majority charge carriers. The majority charge carriers of NPN transistors are electrons and the majority charge carriers of PNP transistors are holes. All other working principles and their doping ratio will remain the same for both NPN and PNP transistors.

In the transistor, if the collector current increases, then the collector junction temperature will increase. So, the resistance provided by the collector also gets reduced. As a result the collector current increases. This phenomenon is known as the thermal runway in BJT transistors.

Advantage of bjt :

1) better gain and high current density
2)low forward voltage ⚡
3)operate in low and high power
4) large gain bandwidth
5) better performance at high frequency

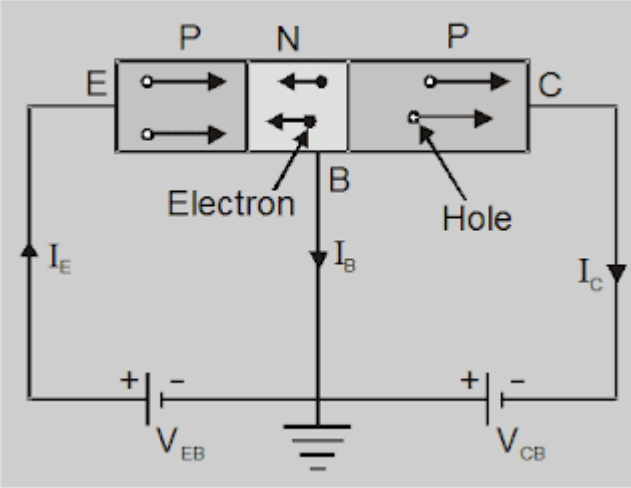
Disadvantages of BJT:

1)thermal stability is low.
2)effective radiation
3)low switch frequency
4)transitor produce loud noise

4)transitor produce loud noice
5)complex control
6)switching time is low as compared to high
Alternate frequency of current and voltage .
⚡

Physics behind the working of a transistors

1)Emitter has the highly doping level than a collector and base has many holes as it because this is an npn transistor.
current will not flow only in one battery because of the reversed and forward basied will cancel the circuits to flow current we have to introduced or apply new battery.
because of the new battery the electrons will flow to the positive terminal and few electrons will fall on base because of kinetic energy in which hole is present which eventually break potential barrier because of electrons kinetics energy .
2) and highly electron charge will fall on collector
and which allowed electrons to flow on the circuits to the positive terminal.
3) if the base is thickness so the electrons will not flow straight and will deflected towards the second applied battery 🔋 terminal so that why
we do not make base thicker
4) if doping level is thicker then the electrons will not flow toward collector because base will absorbed almost all electrons through first battery circuit.
5) so base current is directly propational emitter current.



transistors as amplifier:

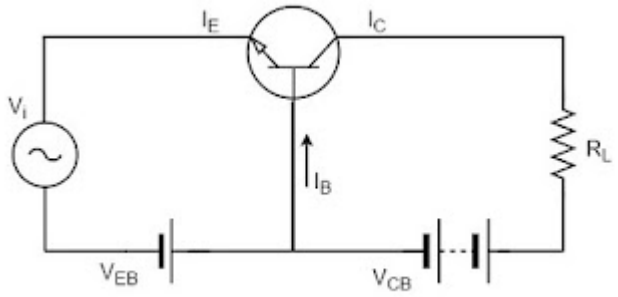
1) transistors works as an Amplifier

1)take as very weak signal through the base junction and rasing the sthregh of weak signal and this signal is release as weak signal.

2)When the transistor is use as an amplifier, the input signals cause the emitter current to flow, which later

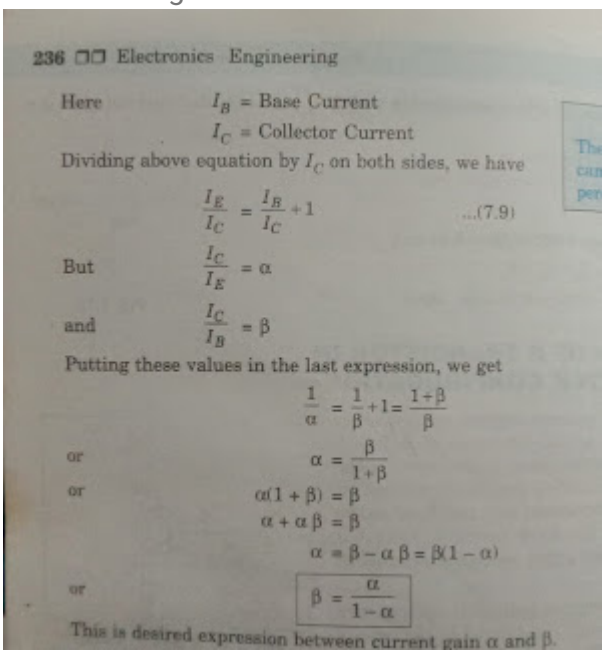
Be part toto the collector current. This current when flows through the load resistor, it results in a large voltage drop across. This shows that a transistor acts as an amplifier.

3)An amplifier is a circuit which magnifies or increases the amplitude of a signal waveform applied it. However, it may be noted that only amplitude is changed and shape of the waveform remain unchanged.



Relationships BTW current gain a and b

a relationship between the two current gains a and B We know that the emitter current Ig of a transistor is given as ie=ib +ic



236 ❐❐ Electronics Engineering

Here I_B = Base Current

I_C = Collector Current

Dividing above equation by I_C on both sides, we have

$$\frac{I_E}{I_C} = \frac{I_B}{I_C} + 1 \qquad ...(7.9)$$

But $\frac{I_C}{I_E} = \alpha$

and $\frac{I_C}{I_B} = \beta$

Putting these values in the last expression, we get

$$\frac{1}{\alpha} = \frac{1}{\beta} + 1 = \frac{1+\beta}{\beta}$$

or $$\alpha = \frac{\beta}{1+\beta}$$

or $$\alpha(1+\beta) = \beta$$

$$\alpha + \alpha\beta = \beta$$

$$\alpha = \beta - \alpha\beta = \beta(1-\alpha)$$

or $$\boxed{\beta = \frac{\alpha}{1-\alpha}}$$

This is desired expression between current gain α and β.

Why baising: is required :

The transistor is used in a wide number of applications. The most basic application of a

transistor is amplification. Amplification means to rase the strength or amplitude of a weak signal without any change in its original shape. However, ler faithful amplification two things are necessary. Firstly, the transistor must operate in active region. It means that the emitter-base junction is forward- bas and collector-base junction is reverse bias. Active region for amplification is must because amplification is a linear process and transistor operates linearly only in active region. Secondly, we should get a fixed de collector current at a fixed de collector voltage. These fixed values of de collector current and de collector voltage are expressed by a term called operating point or quesont point or Q-point. The basing the circuit used for transistor basing are simply called basing circuit.

Therefore, the primary aim of biasing is to stain a fixed collector current at a fixed collector

Requirements of basing circuit :

(a) A biasing circuit must set the operating point in the middle of the active region of the transistor characteristics.

(6) A biasing circuit must stabilize the collector current against temperature variations.

(e) A biasing circuit must ensure that the operating point is independent of the transistor parameters such as B so that operating point is not shifted if the transistor is replaced by another transistor of same type.

summary :

A transistor is a three terminal device. The output voltage, current or power are controlled ter the input current in a transistor Therefore, it is also called a current-controlled device

2. A transistor is also called a BJT. BJT stands for Ripelar junction transistor.

3. A transistor has a very important property that

it can raise the strength of an input weak signal

4. A transistor has three regions namely emitter,

base and collector.

5. When no battery is connected across the different terminals of a transistor then the transistor is said to be in an unbiased state or in an open-circuit state.

When de voltages are applied across the different terminals of a transistor, then this process is called biasing.

7. There are two junctions in a transistor namely emitter-base junction and collector-base

7. There are two junctions in a transistor namely emitter base junction and collector base junction. 8. There are four possible ways of biasing a

transistor. They are as under:

(i) active region, (ii) saturation region

(ii) cut-off region,

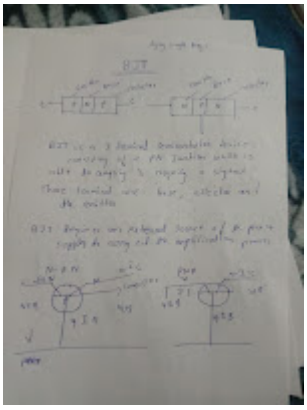
(iv) inverted region.

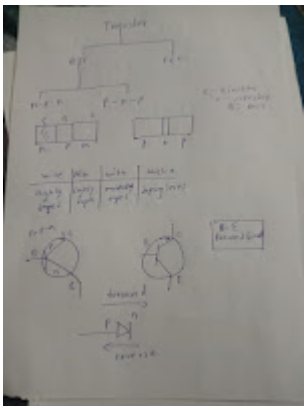
9. A transistor can be treated as a two-port network. 10. There are three transistor configurations

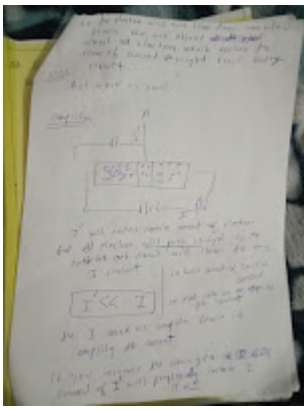
namely Common-Base (CB) configuration,
Common-Emitter (CE) configuration and
Common-Collector (CC) configuration. is given by

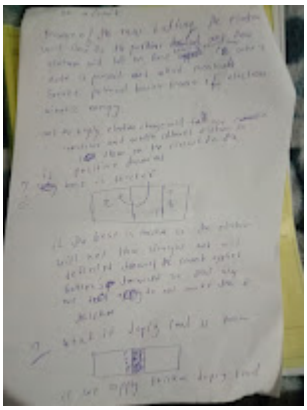
10. There are 3 types of configuration cb, ce, cc
11.transitor is use as an amplifier
12 cb configuration DC current is x=Ic/Ie
13) cb configuration the AC current is given by
x=IC/ie

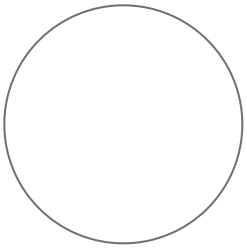
Hand written Notes by (Ajay Singh negi) :











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