M4

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regulates

Introduction of BJT

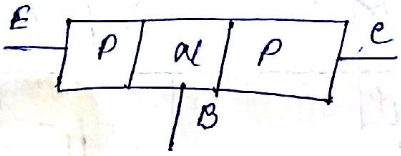
A transistor is a 3 terminal semiconductor device that generates current or voltage flow & acts as a switch or gate of signals.

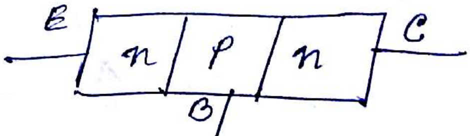
Uses of transistor:

- Transistor acts as an amplifier, when signal strength has to be increased
- Transistor acts as a switch to choose between available options
- Transistor also regulates the incoming current & voltage of signa[l]

Construction

- Transistor is a three terminal device which is formed by connecting two diodes back to back. Hence it has got two PN junctions.
- Three terminals are drawn out of 3 semiconductor materials present in it. This type of connection offers two types of transistor
  - → PNP type
  - → NPN type.





- Three terminals are Emitter (E), Base (B), Collector (C).

Emitter:

- The left hand side of above fig shows Emitter terminal
- This has a moderate size & is heavily doped as its main function is to supply a number of majority carriers, i.e either e⁻ or holes.
- As this emits electrons, it is called as Emitter - E.

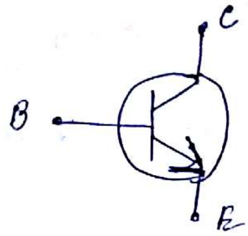
Base:

- The middle material in above figure is Base - B
- This is thin & lightly doped.
- Main function is to pass the majority carriers from the emitter to the collector

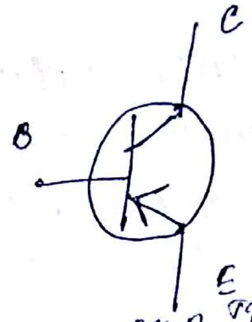
Collector:

- The right side material in above fig is collector - C
- The name implies its function of collecting the carriers.
- This is a bit larger in size than emitter & base.
- moderately doped..

Symbols.



npn transistor



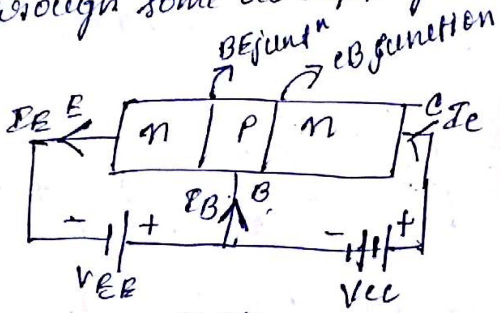
pnp transistor.

arrow head in figure indicated as emitter of a transistor. As collector of a transistor has to dissipate much greater power it is made large. Due to specific functions of emitter & collector. they are not interchangeable.

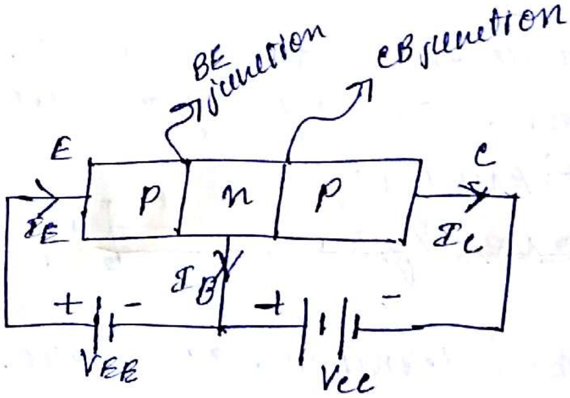
- Transistor has 2 junctions
  - Emitter Base Junction & - Collector Base Junction.

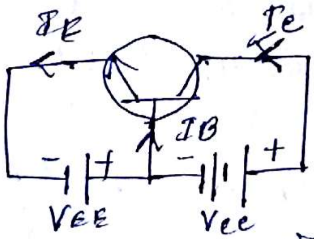
Biasing is controlling the operation of ckt by providing power supply.

- The functn of both PNP & NPN is controlled by providing bias to ckt through some dc supply.

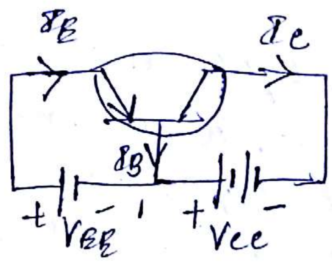


npn





npn transistor



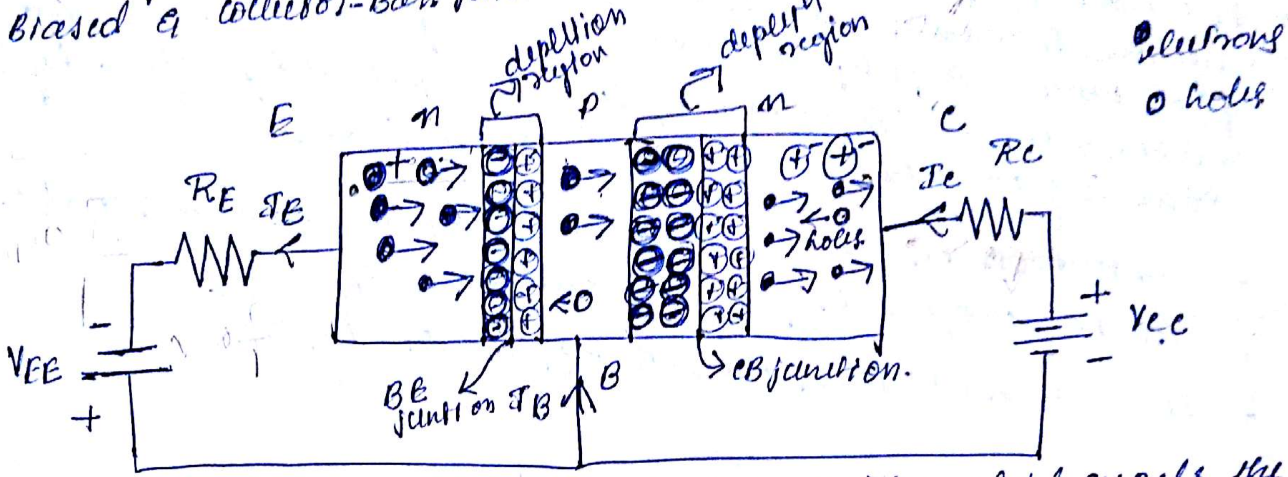
pnp transistor

- The n type material is provided negative supply & p type material is given positive supply to make ckt forward bias.
- The n type material is provided positive supply & p-type material is given negative supply to make ckt reverse bias.

- By applying power, the emitter base junction is forward biased as emitter resistance is small. - collector base junction is reverse biased & its resistance is bit higher. A small forward bias is sufficient as BE junctn whereas high reverse bias has to be applied at collector-Base junctn ie direction of current in circuit indicates the conventional current is the movement of holes current which is opposite of electron current.

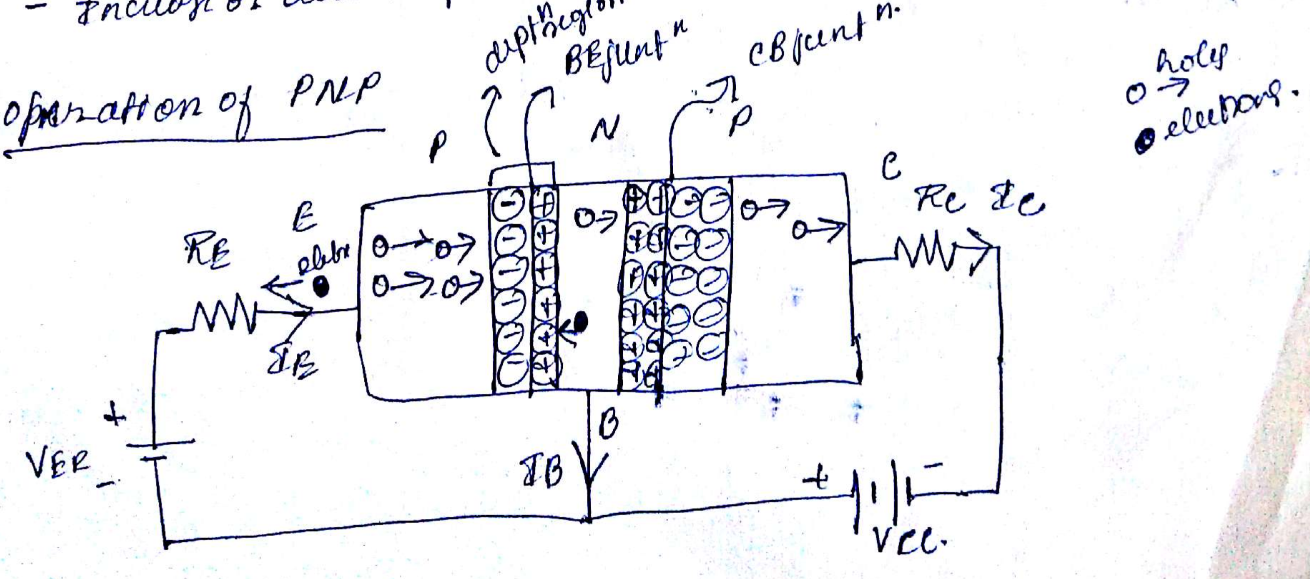
Operation of NPN transistor

- The fig is as shown, in which emitter base junction is forward biased & collector-base junction is reverse biased.



- V_{EE} provides a negative potential at the emitter which repels the electrons in the N-type material & these electrons cross the emitter base junct^n, to reach the base region. a very low percent of electrons recombine with free holes of p region. This provides very low current which constitute base current I_B. remaining holes cross the collector
- base junction to constitute the collector I_C.
- As electrons reach out collector terminal, & enter the positive terminal of battery, an electron from negative terminal of battery VEE enters emitter region.
  - conduction of NPN transistor takes place through electrons.
  - collector current is higher than emitter current.
  - Increase or decrease of I_E current affects the I_C

Operation of PNP



- The voltage V_{EE} provides positive potential at emitter which rep[illegible] holes in p type & these holes cross the E-B junction, to reach Base.
- very low percent of holes re-combine with free electrons of N region.
- This provides low current $-I_B$. Remaining holes cross the EB junction to constitute I_C, which is hole current.
- As a hole reaches the collector terminal, an electron from the battery [illegible] negative terminal fills space in collector. This flow slowly increases & electron minority current flows through emitter. when each electron [illegible] entering the +ve terminal of V_{EE}, is replaced by a hole by moving towards emitter junction. This constitute I_E.

- Conduction in PNP transistor takes place through holes.
- collector current is slightly less than I_E.
- Increase & decrease in I_E affects the I_C.

Advantages of transistor.

- high voltage gain.
- low supply voltage is sufficient
- Most suitable for low power applications.
- smaller & lighter in weight
- mechanically stronger than vacuum tubes.
- very suitable to integrate with resistors & diodes to produce IC's

There are few disadvantages such as they cannot be used for high power applications due to lower power dissipation. they have lower input impedance & they are temperature dependent.

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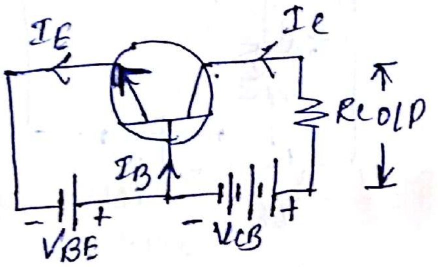
Transistor configuration

- Transistor has 3 terminals Emitter, Base, collector. Using these 3 terminals, transistor can be connected in a ckt with one terminal common to both i/p & o/p in 3 different possible configurations.

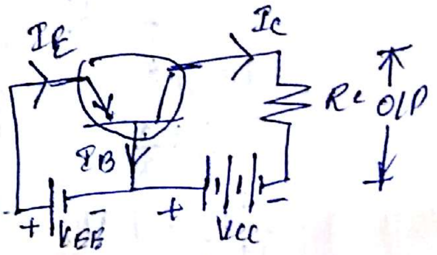
- 3 types of configuration.
  - common Base
  - common Emitter
  - common collector.

common Base configuration

- Base terminal is taken as common terminal for both input & output of transistor.
- The common base connection for NPN is as shown.



NPN Transistor.



PNP

characteristics

- provides voltage gain but no current gain.
- Being V_{CB} constant, with a small increase in EB voltage V_{EB}, I_E gets increased
- I_E is independent of V_{CB}
- $R_i = \Delta V_{EE} / \Delta I_E \Big|_{V_{CB} = \text{constant}}$ $R_O = \dfrac{\Delta V_{CE}}{\Delta I_C}\Big|$ at I_E constant
- V_{CB} can affect I_C only at low voltg when V_{EB} constant.
- R_i is low, a small value of V_{EB} is enough to produce large I_E
- R_O is high large V_{CB} change produces a little I_C.
- configuration provides good stability against increase in temperature
- used for high frequency applications.

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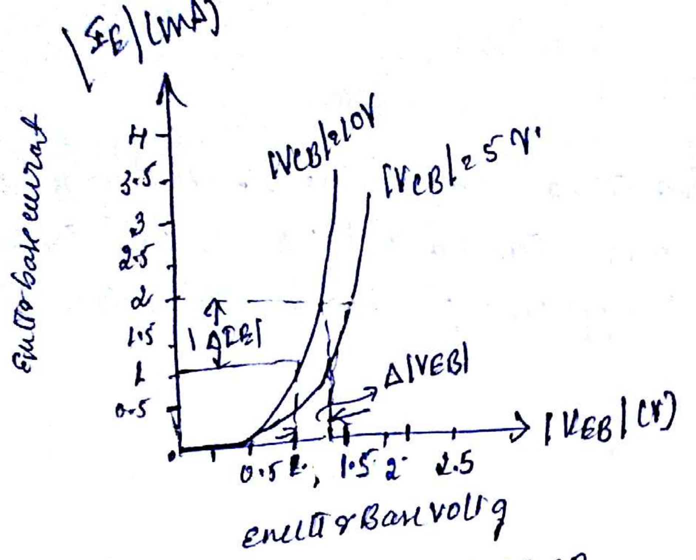
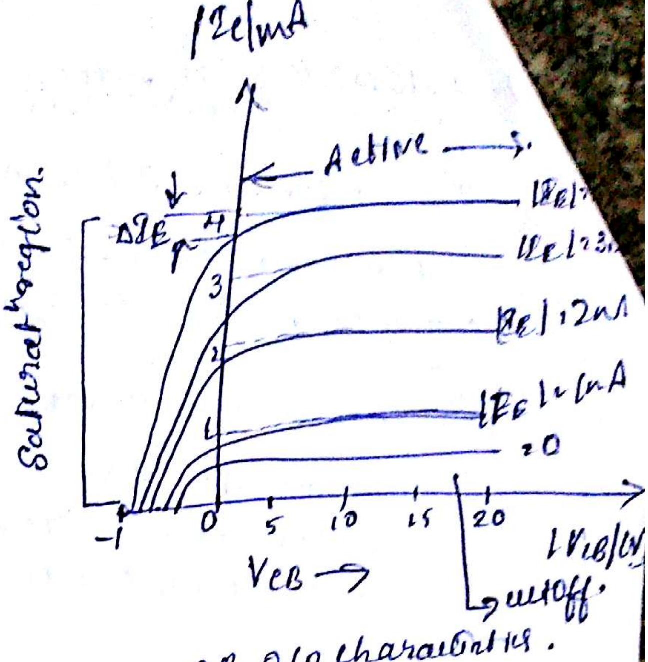
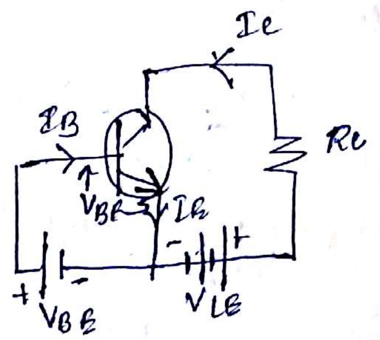


I/p characteristics for CB

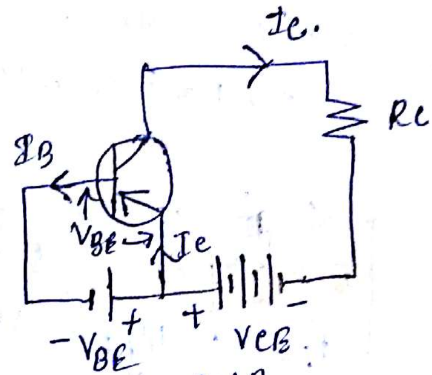


CB O/p characteristics.

Common Emitter configurations



npn



pnp

characteristics

- configuration provides good current gain & voltage gain.
- keeping V_{CE} constant with small increase in V_{BE}, I_B increases rapidly.
- $I_C \approx \beta I_B$ for any value of V_{CE} above knee voltage.
- $R_i = \frac{\Delta V_{BE}}{\Delta I_B}\Big|_{V_{CE}=const}$ is low, hence small V_{BE} enough to produce large I_B
- $R_o = \frac{\Delta V_{CE}}{\Delta I_C}\Big|_{I_B\ const}$ is less than that of CB ckt
- used for bias stabilization methods & audio frequency applications.

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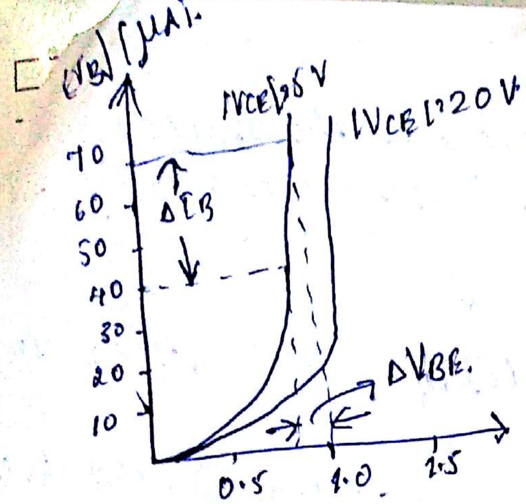
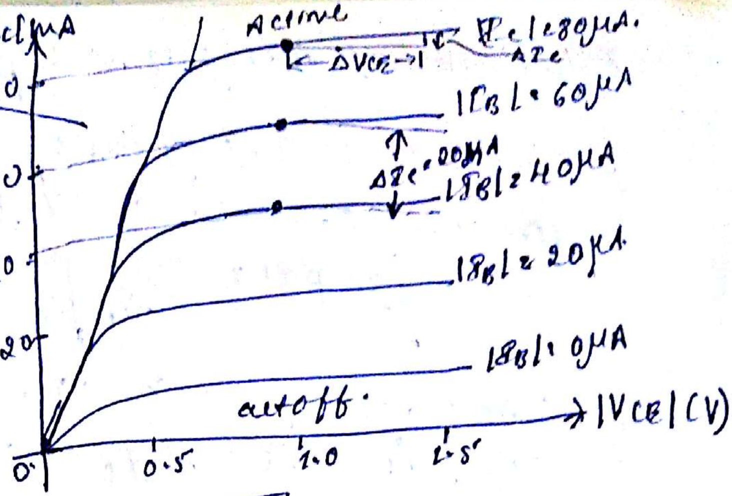
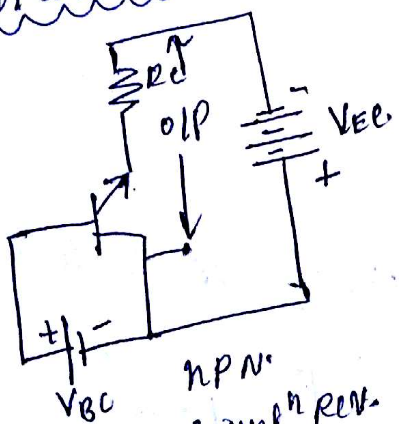
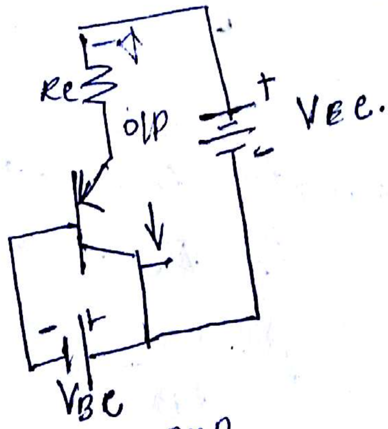




Common collector



npn



pnp

E junction FB & C junction Rev.

Characteristics

- provides current gain but no voltage gain
- I/P resistance is high & O/P resistance is low
- voltage gain provided by this ckt is less than 1
- $I_C + I_B = I_E$.
- I/P & O/P signals are in phase.
- works as non inverting amplifier.
- It mostly used for impedance matching. to drive low impedance load from high impedance source.