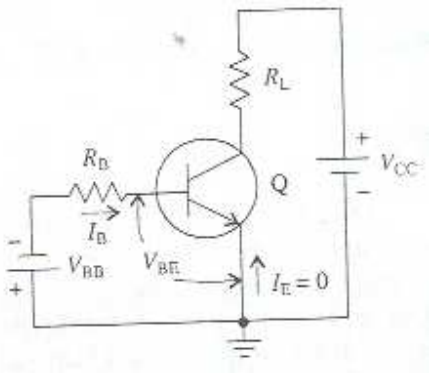
**Breakdown mechanism** :




Due to $V_{CE}$ current flowing through collector Junction is M $I_{CO}$ . this current will flows through $R_B$ .

If $V_{CE}$ is increases at a particular instant Voltage drop across emitter junction is equals to its Cut in voltage.

Due to this large amount of current Is flowing through the transistor and breakdown is attained.

After attaining breakdown , current flowing through $R_B$ is zero .hence once again base is replaced with on open circuit. Therefore now breakdown voltage is $BV_{CEO.}$

**Expression for $BV_{CEX}$ :**

As per the above analysis ,when ever voltage across the emitter junction is equal to the cut in voltage then breakdown is attained.

So the necessary condition for breakdown is

$$MI_{CO}R_B - V_{BB} = V_\gamma$$

So $$M = \frac{I_{CO}R_B}{V_{BB} + V_\gamma}$$

From equation (1),

$$\frac{I_{CO}R_B}{V_{BB} + V_\gamma} = \frac{1}{1 - \left(\frac{V_{CB}}{BV_{CBO}}\right)^n}$$

$$V_{CB} = BV_{CBO}\sqrt[n]{1 - \frac{I_{CO}R_B}{V_{BB} + V_\gamma}}$$

Same as our previous derivation here also at break down $V_{CB} = BV_{CEX}$

Therefore ,

$$BV_{CEX} = BV_{CBO}\sqrt[n]{1 - \frac{I_{CO}R_B}{V_{BB} + V_\gamma}} \text{ ----(4)}$$

After certain time $BV_{CEX} = BV_{CEO}$ ---(5)

From equations (4) &(5) , $BV_{CEO} < BV_{CEX} < BV_{CBO}$

So $-V_{BB}$ is essential in base circuit to increase the breakdown voltage of a transistor.

**Saturation parameters of a transistor :**

To analyze transistor switch in saturation mainly we have three parameters.

Those are $V_{CE(Sat)}$ , $h_{FE}$ , $V_{BE(Sat)}$

**$V_{CE(Sat)}$ :** it is the voltage between collector and emitter when the transistor is in saturation region. Small value of $V_{CE(Sat)}$ is preferable practically.

Because the total voltage swing at the transistor switch is $V_{CC} - V_{CE(Sat)}$ .if $V_{CC}$ is fixed

Then in order make the output swing as large as possible it is necessary that $V_{CE(Sat)}$ be as

small as possible.

Saturation voltage $V_{CE(Sat)}$ depends on

(i) Operating point of a transistor

(ii) semiconductor material used

(iii) type of transistor construction

in a transistor switch , transistor is operated at a particular value of base current ($I_B$).

if base current is large then $V_{CE(Sat)}$ is small(from the output characteristics of a transistor in CE configuration). So to reduce the value of $V_{CE(Sat)}$ base current must be high.

Germanium transistors have lower values for $V_{CE(Sat)}$ than silicon since the conductivity of germanium is more compared to silicon.

Transistor construction types are

(i) Alloy junction method

(ii) Epitaxial transistor type

(iii) Grown junction method

Alloy junction transistors and epitaxial transistors give the lowest values for $V_{CE(Sat)}$,

Where as grown junction transistors yield the highest.

**DC current gain ($h_{FE}$) :** the ratio between collector current and base current is known as DC current gain(or) DC beta .

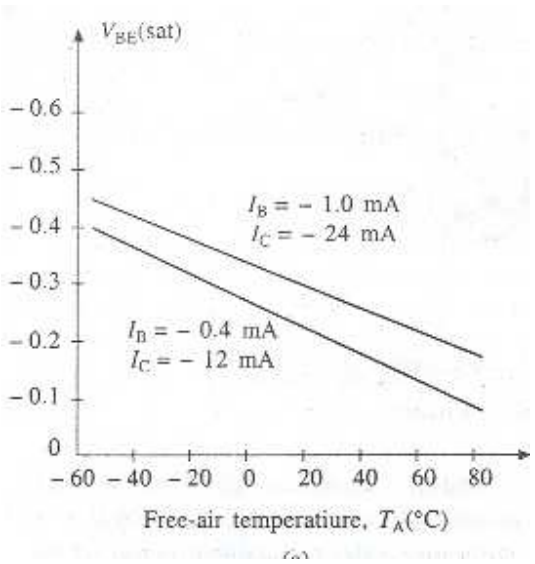
**$V_{BE(Sat)}$ :** the voltage across the emitter junction of a transistor when ever it is in saturaion region is known as $V_{BE(Sat)}$

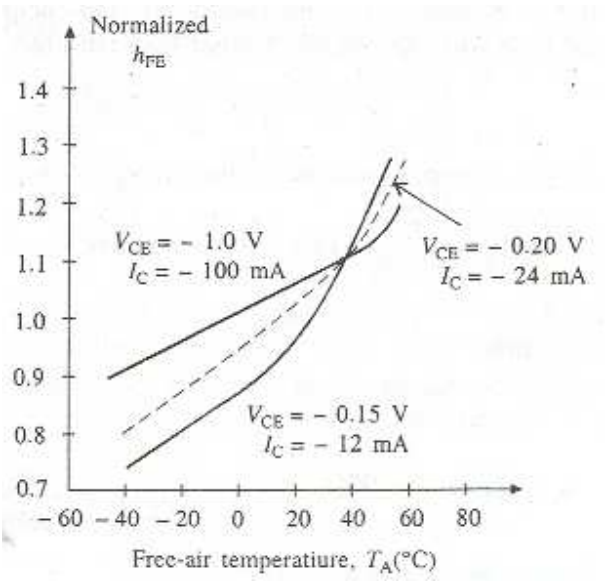
**Temperature variation of saturation parameters :**

**Effect of temperature on $V_{BE(Sat)}$ :** we know that if temperature increases voltage drop

across Forward biased pn junction is deceases. So that if temperature increases $V_{BE(Sat)}$

Is also decreases as shown in figure below.




**Effect of temperature on $h_{FE}$ :** the temperature dependence of $h_{FE}$ is shown in above figure.

At small and moderate currents $h_{FE}$ increases Substantially with temperature. Since collector current Increases with temperature.

At high currents $h_{FE}$ may become rather insensitive to temperature.

**Effect of temperature on $V_{CE(Sat)}$ :**

In saturation, the transistor consists of two forward biased junctions back to back ,series opposing.

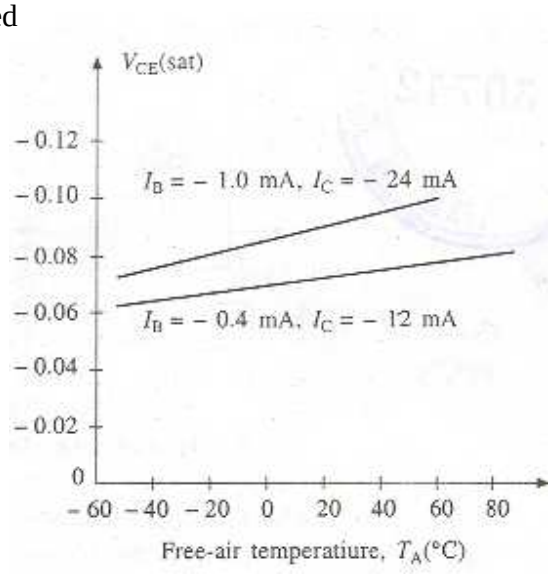
It is consequently to be anticipated that the temperature

induced voltage change in one junction will be canceled in some measure by the change in the other junction.

We do indeed find such to be the case for $V_{CE(Sat)}$.

At small and moderate transistor currents the compensation may be very good.

At high currents the voltage drops across the body resistance of the emitter and collector may become comparable to or even larger than the drops across the junctions.




Since the ohmic drops are additive, the cancellation is not possible at these high currents.