3. BJT CHARACTERISTICS & PARAMETERS

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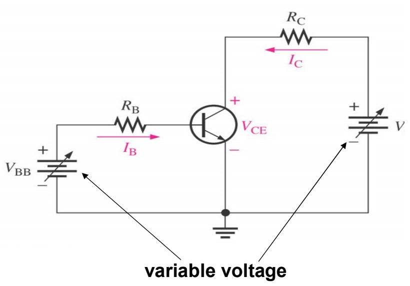
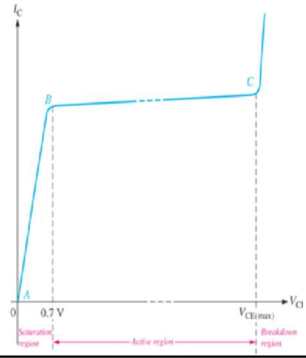
Collector Characteristic Curve:

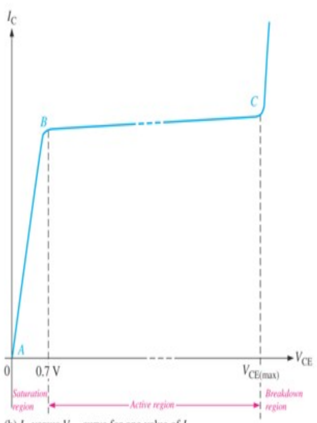
➢Using a circuit as shown in below, we can generate a set of collector characteristic curve that show how the collector current, *Ic* varies with the *V_{CE}* voltage for specified values of base current, *I_B*.



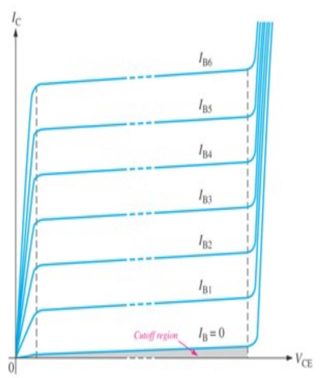


3. BJT CHARACTERISTICS & PARAMETERS

Collector characteristic curve:



(b) I_C versus V_{CE} curve for one value of I_B



(c) Family of I_C versus V_{CE} curves for several values of I_B ($I_{B1} < I_{B2} < I_{B3}$, etc.)

3. BJT CHARACTERISTICS & PARAMETERS

Collector Characteristic Curve:

➢Assume that V_{BB} is set to produce a certain value of I_B and V_{CC} is zero.

➢At this condition, *BE* junction and *BC* junction are forward biased because the base is approximately 0.7V while the emitter and the collector are zero.

➢I_B is through the *BE* junction because of the low impedance path to ground, therefore I_C is zero.

➢When both junctions are forward biased – transistor operate in *saturation region*.

➢As V_{CC} increase, V_{CE} is increase gradually, I_C increase – indicated by point A to B.

➢I_C increase as V_{CC} is increased because V_{CE} remains less than 0.7V due to the forward biased *BC* junction.

➢When V_{CE} exceeds 0.7V, the *BC* becomes reverse biased and the transistor goes into the *active* or *linear region* of its operation.

3. BJT CHARACTERISTICS & PARAMETERS

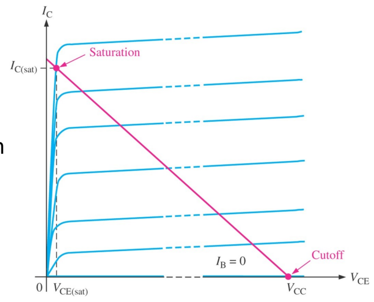
Collector Characteristic Curve:

- Once BC junction is R_B, IC levels off and remains constant for given value of IB and VCE continues to increase.
- Actually I_C increases slightly as V_{CE} increase due to widening of the *BC* depletion region
- This result in fewer holes for recombination in the base region which effectively caused a slight increase in $I_C = \beta_{DC} I_B$ indicated in point B and C.
- When V_{CE} reached a sufficiently high voltage, the reverse biased *BC* junction goes into breakdown.
- The collector current increase rapidly – as indicated at the right point C
- The transistor cannot operate in the breakdown region.
- When I_B=0, the transistor is in the cutoff region although there is a very small collector leakage current as indicated – exaggerated on the graph for purpose of illustration.

3. BJT CHARACTERISTICS & PARAMETERS

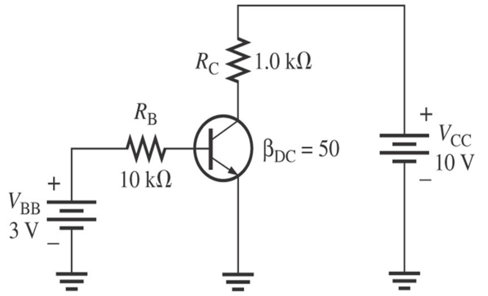
DC Load Line:

- Cutoff and saturation can be illustrated in relation to the collector characteristic curves by the use of a load line.
- DC load line drawn on the connecting cutoff and saturation point.
- The bottom of load line is ideal cutoff where I_C=0 & V_{CE}=V_{CC}.
- The top of load line is saturation where I_C=$I_{C(sat)}$ & V_{CE} =$V_{CE(sat)}$
- In between cutoff and saturation is the active region of transistor's operation.



Example 2

- Determine whether or not the transistor in figure below is in saturation. Assume $V_{CE(sat)}$ = 0.2V



Solution Example 2

- First, determine $I_{C(sat)}$,

$$I_{C(sat)} = \frac{V_{CC} - V_{CE(sat)}}{R_C} = \frac{10 - 0.2}{1.0k\Omega} = 9.8mA$$

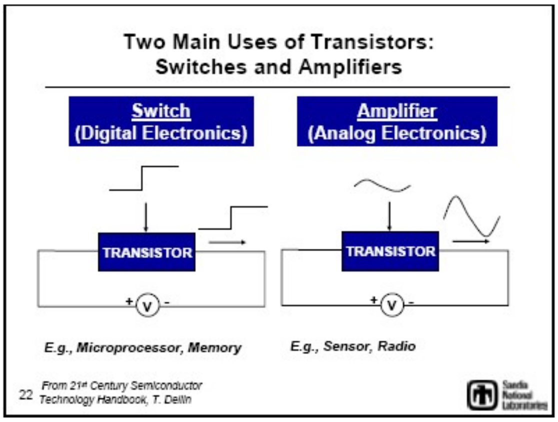
- Now, see if I_B is large enough to produce $I_{C(sat)}$,

$$I_B = \frac{V_{BB} - V_{BE}}{R_B} = \frac{3 - 0.7}{10k\Omega} = 0.23mA$$

$$I_C = \beta_{DC} I_B = 50(0.23) = 11.5mA$$

- With specific β_{DC}, this base current is capable of producing I_C greater than $I_{C(sat)}$. Thus, transistor is saturated and I_C = 11.5mA is never reached. If further increase I_B, I_C remains at its saturation value.

Main Applications of Transistors



3.TRANSISTOR CIRCUIT CONFIGURATION

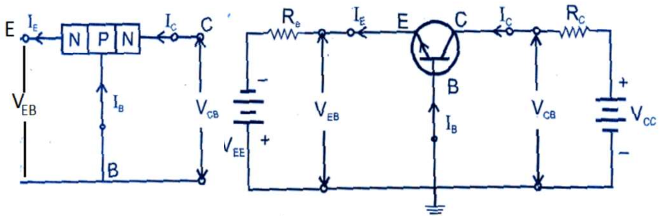
Basically three types of circuit connections for operating a transistor,

1. Common base (CB)configuration.
2. Common emitter (CE)configuration.
3. Common collector (CC)configuration.

'common' denotes an electrode that is common to input and the ou tput circuit, because the common electrode is generally grounded.

3.1 COMMON BASE CONFIGURATION

- In this configuration the base terminal is common to input to output.



- **The current gain:** The ratio of collector current to emitter current is called as current gain or dc alpha $\alpha_{dc} = -I_C/I_E$ or $I_C = -\alpha_{dc} I_E$

For simplicity $I_C = \alpha I_E$

we know $I_B = I_E - I_C$

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

$\alpha_{ac} = -\frac{\Delta I_C}{\Delta I_E}$ It refers to change in collector current to change in emitter current

Characteristic of configuration

Two types of characteristics are available in each configuration circuit.

1.Input characteristics.

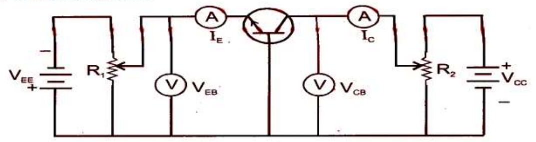
The input characteristics is output voltage constant and relation between input voltage and current.

2. Output characteristics.

The output characteristics is input current constant and relation between output voltage and current.

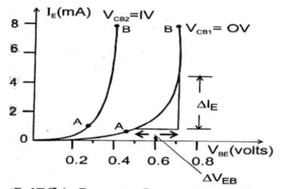
Characteristics of CB configuration

a) Input Characteristics



This characteristic may be used to find the input resistance of the transistor. Its value is given by the reciprocal of its slope.

$$R_{in} = \frac{\Delta V_{EB}}{\Delta I_E} \text{ when } V_{CB} \text{ constant}$$



5.47(b): Input characteristics

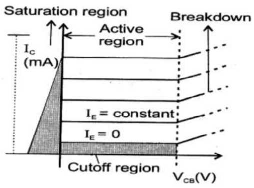


Figure 5.47(c): Output characteristics

1.Input characteristics:

- ❖ Collector –base voltage constant.(V_{CB})
- ❖ Ratio between $\mathbf{V_{EB}}$ and $\mathbf{I_E}$ is called as input resistance.

$$R_{in} = \frac{\Delta V_{EB}}{\Delta I_E} \text{ when } V_{CB} \text{ constant}$$

2.Output characteristics

- ❖ The emitter current should be in constant.
- ❖ Ratio between $\mathbf{V_{CB}}$ and $\mathbf{I_C}$ is called as output resistance.

$$R_{out} = \frac{1}{\Delta I_C / \Delta V_{CB}} = \frac{\Delta V_{CB}}{\Delta I_C}$$