TRANSISTOR BIASING

Fixed Bias or Base Bias:

In order for a transistor to amplify, it has to be properly biased. This means forward biasing the base emitter junction and reverse biasing collector base junction. For linear amplification, the transistor should operate in active region (If I_E increases, I_C increases, V_{CE} decreases proportionally).

The source V_{BB}, through a current limit resistor R_B forward biases the emitter diode and V_{CC} through resistor R_C (load resistance) reverse biases the collector junction as shown in **fig. 1.**

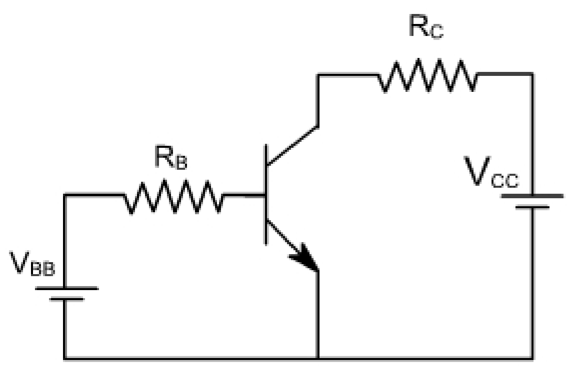

Fig. 1

The dc base current through R_B is given by

$I_B = (V_{BB} - V_{BE}) / R_B$

or $\quad V_{BE} = V_{BB} - I_B R_B$

Normally V_{BE} is taken 0.7V or 0.3V. If exact voltage is required, then the input characteristic (I_B vs V_{BE}) of the transistor should be used to solve the above equation. The load line for the input circuit is drawn on input characteristic. The two points of the load line can be obtained as given below

For $I_B = 0$, $\quad V_{BE} = V_{BB}$.

and For $V_{BE} = 0$, $I_B = V_{BB}/ R_B$.

The intersection of this line with input characteristic gives the operating point Q as shown in **fig. 2**. If an ac signal is connected to the base of the transistor, then variation in V_{BE} is about Q -point. This gives variation in I_B and hence I_C.

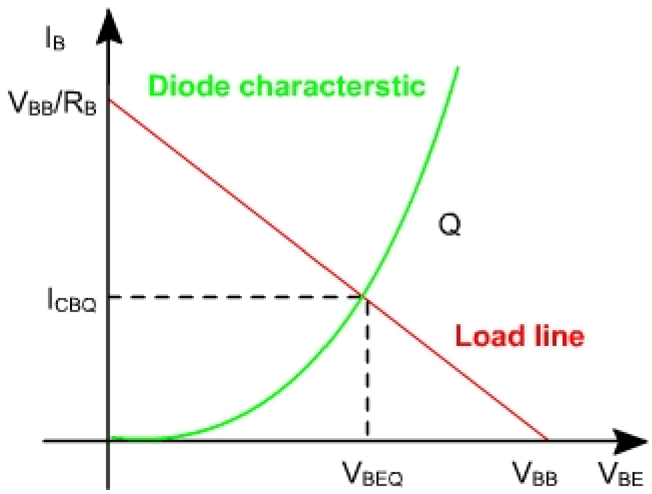

Fig. 2

In the output circuit, the load equation can be written as

$V_{CE} = V_{CC} - I_C R_C$

This equation involves two unknown V_{CE} and I_C and therefore can not be solved. To solve this equation output characteristic (I_C vs V_{CE}) is used.

The load equation is the equation of a straight line and given by two points:

$I_C = 0$, $V_{CE} = V_{CC}$

& $V_{CE} = 0$, $I_C = V_{CC} / R_C$

The intersection of this line which is also called dc load line and the characteristic gives the operating point Q as shown in **fig. 3**.

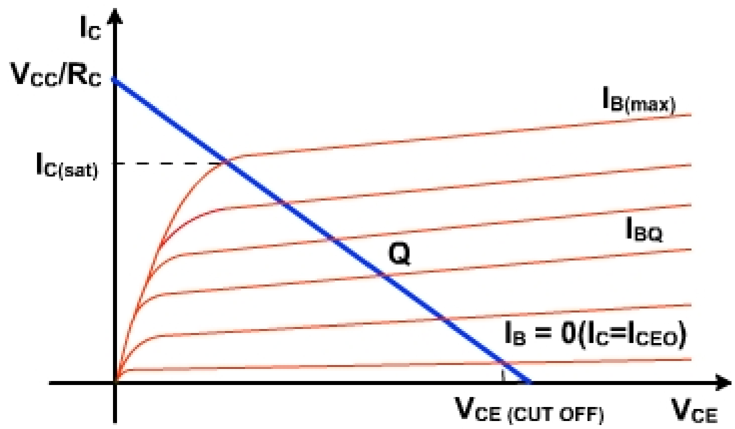

Fig. 3

The point at which the load line intersects with I_B = 0 characteristic is known as cut off point. At this point base current is zero and collector current is almost negligibly small. At cut off the emitter diode comes out of forward bias and normal transistor action is lost. To a close approximation.

V_{CE} (cut off) » V_{CC} (approximately).

The intersection of the load line and $I_B = I_{B(max)}$ characteristic is known as saturation point . At this point $I_B= I_{B(max)}$, $I_C= I_{C(sat)}$. At this point collector diodes comes out of reverse bias and again transistor action is lost. To a close approximation,

$I_{C(sat)}$ » V_{CC} / R_C(approximately).

The $I_{B(sat)}$ is the minimum current required to operate the transistor in saturation region. If the I_B is less than $I_{B\,(sat)}$, the transistor will operate in active region. If $I_B > I_{B\,(sat)}$ it always operates in saturation region.

If the transistor operates at saturation or cut off points and no where else then it is operating as a switch is shown in **fig. 4**.

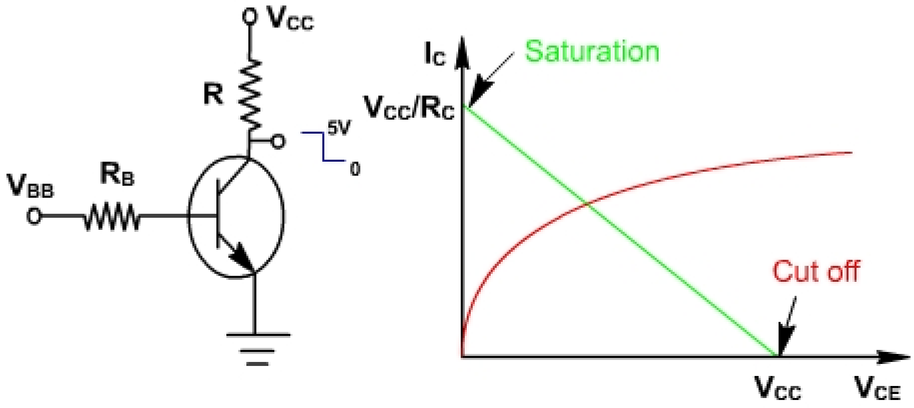

Fig. 4

$V_{BB} = I_B R_B + V_{BE}$

$I_B = (V_{BB} – V_{BE}) / R_B$

If $I_B > I_{B(sat)}$, then it operates at saturation, If $I_B = 0$, then it operates at cut off.

If a transistor is operating as an amplifier then Q point must be selected carefully. Although we can select the operating point any where in the active region by choosing different values of R_B & R_C but the various transistor ratings such as maximum collector dissipation $P_{C(max)}$ maximum collector voltage $V_{C(max)}$ and $I_{C(max)}$ & $V_{BE(max)}$ limit the operating range.

Once the Q point is established an ac input is connected. Due to this the ac source the base current varies. As a result of this collector current and collector voltage also varies and the amplified output is obtained.

If the Q-point is not selected properly then the output waveform will not be exactly the input waveform. i.e. It may be clipped from one side or both sides or it may be distorted one.