

Biassing is the process of providing DC voltage which helps in the functioning of the circuit. A transistor is biased in order to make the emitter base junction forward biased and collector base junction reverse biased, so that it maintains in active region, to work as an amplifier.

Transistor Biassing

The proper flow of zero signal collector current and the maintenance of proper collector emitter voltage during the passage of signal is known as **Transistor Biassing**. The circuit which provides transistor biassing is called as **Biassing Circuit**.

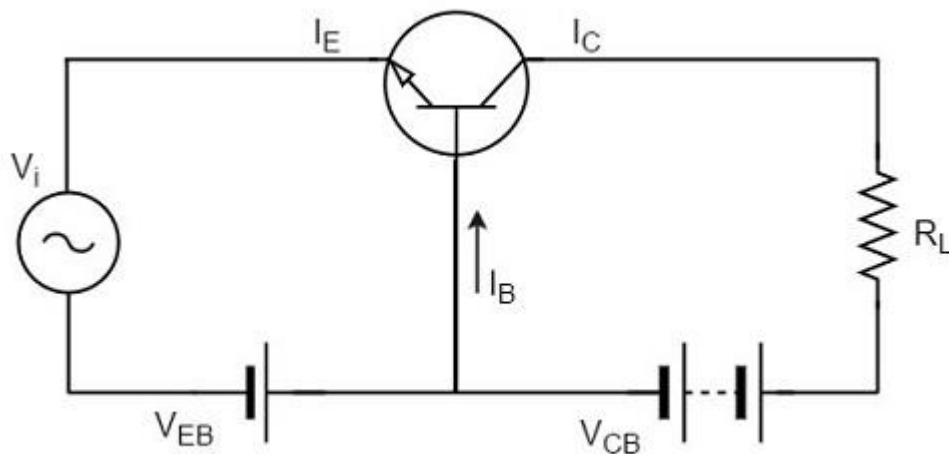
Need for DC biassing

If a signal of very small voltage is given to the input of BJT, it cannot be amplified. Because, for a BJT, to amplify a signal, two conditions have to be met.

- The input voltage should exceed **cut-in voltage** for the transistor to be **ON**.
- The BJT should be in the **active region**, to be operated as an **amplifier**.

If appropriate DC voltages and currents are given through BJT by external sources, so that BJT operates in active region and superimpose the AC signals to be amplified, then this problem can be avoided. The given DC voltage and currents are so chosen that the transistor remains in active region for entire input AC cycle. Hence DC biassing is needed.

The below figure shows a transistor amplifier that is provided with DC biassing on both input and output circuits.



For a transistor to be operated as a faithful amplifier, the operating point should be stabilized. Let us have a look at the factors that affect the stabilization of operating point.

Factors affecting the operating point

The main factor that affects the operating point is the temperature. The operating point shifts due to change in temperature.

As temperature increases, the values of I_{CE} , β , V_{BE} gets affected.

- I_{CBO} gets doubled (for every 10° rise)
- V_{BE} decreases by 2.5mV (for every 1° rise)

So the main problem which affects the operating point is temperature. Hence operating point should be made independent of the temperature so as to achieve stability. To achieve this, biasing circuits are introduced.

Stabilization

The process of making the operating point independent of temperature changes or variations in transistor parameters is known as **Stabilization**.

Once the stabilization is achieved, the values of I_C and V_{CE} become independent of temperature variations or replacement of transistor. A good biasing circuit helps in the stabilization of operating point.

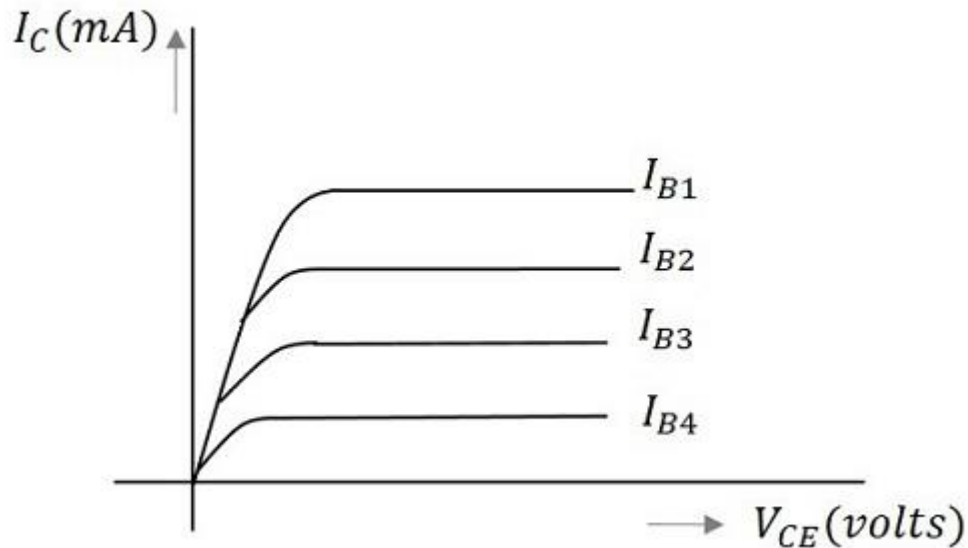
Need for Stabilization

Stabilization of the operating point has to be achieved due to the following reasons.

- Temperature dependence of I_C
- Individual variations
- Thermal runaway

Output Characteristics

When the output characteristics of a transistor are considered, the curve looks as below for different input values.



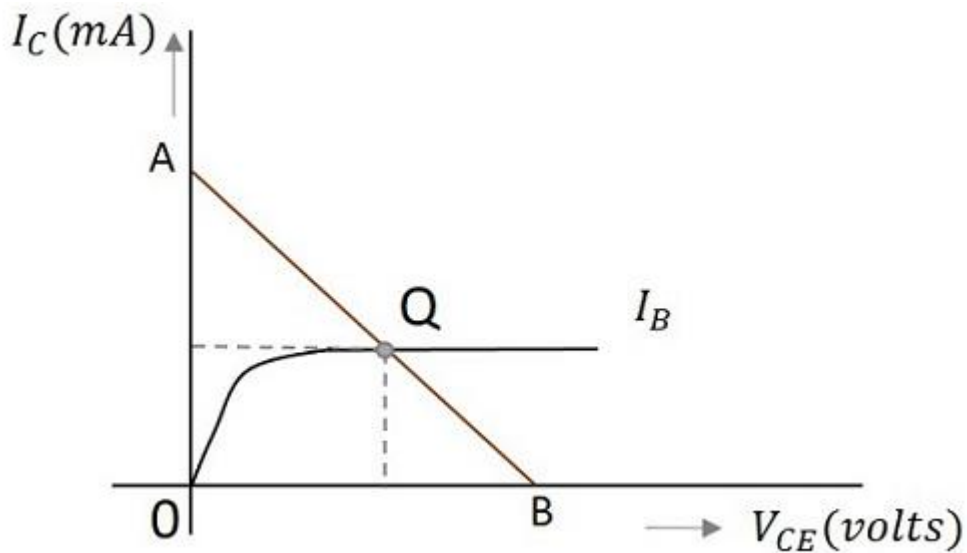
In the above figure, the output characteristics are drawn between collector current I_C and collector voltage V_{CE} for different values of base current I_B . These are considered here for different input values to obtain different output curves.

Operating point

When a value for the maximum possible collector current is considered, that point will be present on the Y-axis, which is nothing but the **saturation point**. As well, when a value for the maximum possible collector emitter voltage is considered, that point will be present on the X-axis, which is the **cutoff point**.

When a line is drawn joining these two points, such a line can be called as **Load line**. This is called so as it symbolizes the output at the load. This line, when drawn over the output characteristic curve, makes contact at a point called as **Operating point**.

This operating point is also called as **quiescent point** or simply **Q-point**. There can be many such intersecting points, but the Q-point is selected in such a way that irrespective of AC signal swing, the transistor remains in active region. This can be better understood through the figure below.

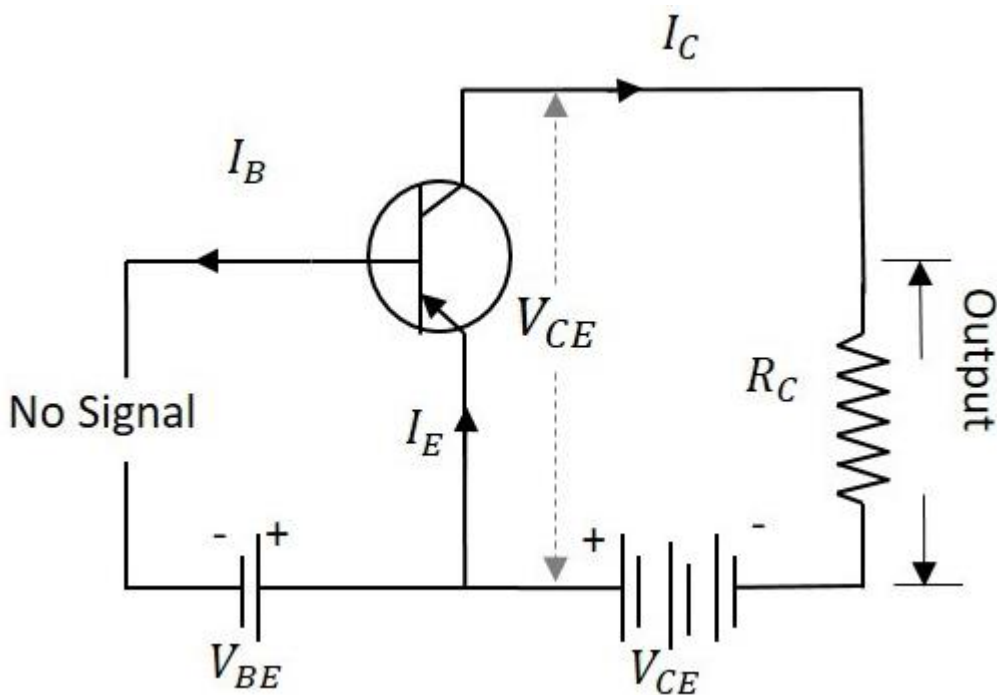


The load line has to be drawn in order to obtain the Q-point. A transistor acts as a good amplifier when it is in active region and when it is made to operate at Q-point, faithful amplification is achieved.

Faithful amplification is the process of obtaining complete portions of input signal by increasing the signal strength. This is done when AC signal is applied at its input.

DC Load line

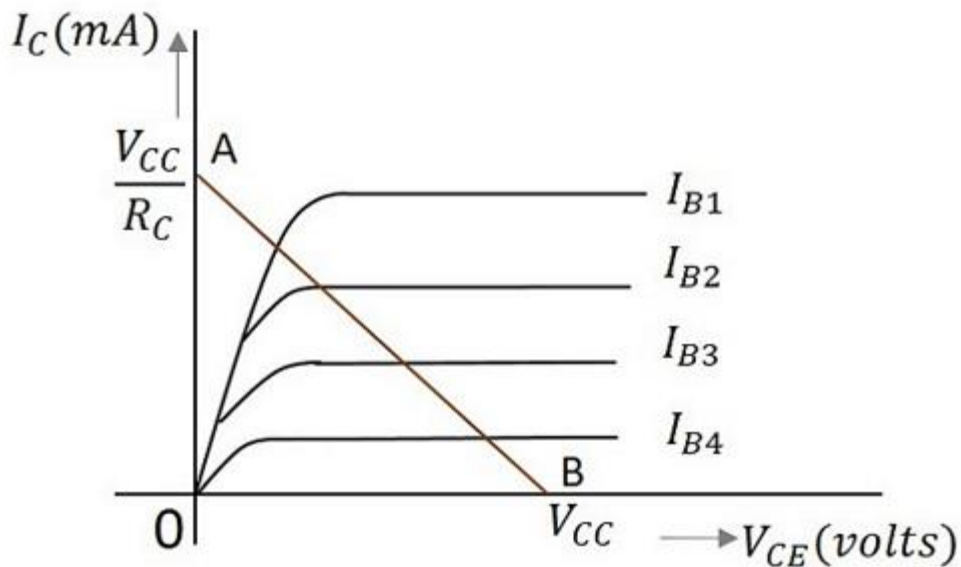
When the transistor is given the bias and no signal is applied at its input, the load line drawn at such condition, can be understood as **DC** condition. Here there will be no amplification as the signal is absent. The circuit will be as shown below.



The value of collector emitter voltage at any given time will be

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

As V_{CC} and R_C are fixed values, the above one is a first degree equation and hence will be a straight line on the output characteristics. This line is called as **D.C. Load line**. The figure below shows the DC load line.



To obtain the load line, the two end points of the straight line are to be determined. Let those two points be A and B.

To obtain A

When collector emitter voltage $V_{CE} = 0$, the collector current is maximum and is equal to V_{CC}/R_C . This gives the maximum value of V_{CE} . This is shown as

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

$$0 = V_{CC} - I_C R_C$$

$$I_C = V_{CC}/R_C$$

This gives the point A ($OA = V_{CC}/R_C$) on collector current axis, shown in the above figure.

To obtain B

When the collector current $I_C = 0$, then collector emitter voltage is maximum and will be equal to the V_{CC} . This gives the maximum value of I_C . This is shown as

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

$$= V_{CC}$$

(As $I_C = 0$)

This gives the point B, which means ($OB = V_{CC}$) on the collector emitter voltage axis shown in the above figure.

Hence we got both the saturation and cutoff point determined and learnt that the load line is a straight line. So, a DC load line can be drawn.

The importance of this operating point is further understood when an AC signal is given at the input.