Analog Electronics

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1st **semester**

Chapter 5

BJT Amplifiers
Lec. 11

The BJT as an Amplifier

- **Amplification** is the **process of increasing** the **power**, **voltage**, or **current** by **electronic** means it is one of the **major properties of a transistor**.

- As you learned, a **BJT** exhibits **current gain** (called β).
- When a **BJT** is **biased in the active** (or linear) region,

the **BE junction** has a **low resistance due to forward bias** and

the **BC junction** has a **high resistance due to reverse bias**.

The DC Operating Point

- Bias establishes a transistor amplifier's operating point (Q-point); the **AC signal moves** above and below **this point**.
- If an **amplifier is not biased** with **correct DC voltages** on the input and output, it can go into **saturation** or **cutoff** when an **input signal** is **applied**.
- **Improper biasing** can cause **distortion in the output signal**.

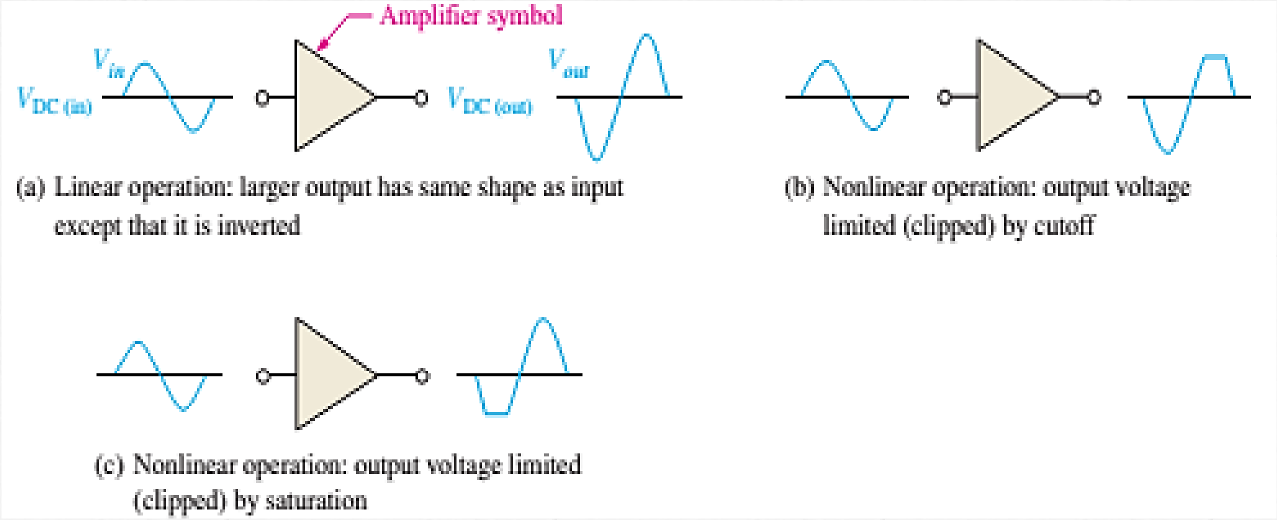

Figure: Examples of linear and nonlinear operation of an inverting amplifier.

- **The point** at which the load line intersects a characteristic curve represents the **Q-point** for that **particular value of I_B**.
- **The region along the load line,** including **all points** between **saturation** and **cutoff,** is known as **the linear region of the transistor's operation**; the transistor is operated in this region.

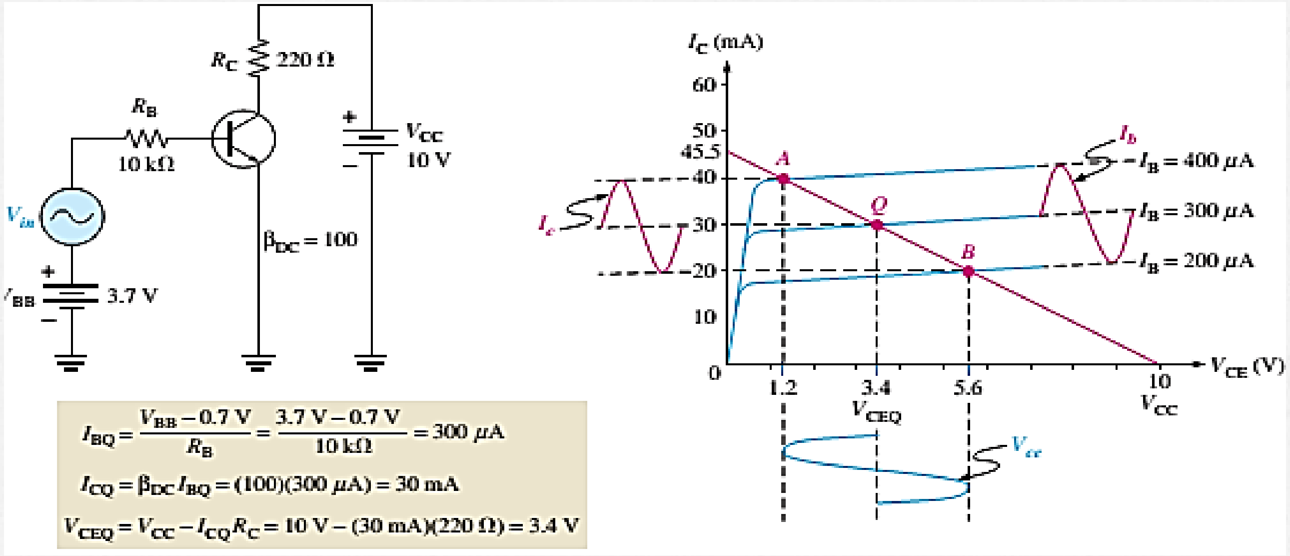

Figure: Variations in IC and VCE as a result of a variation in base current.

- **Points A, Q, and B represent** the **Q-point for I_B** 400µA, 300µA and 200 µA, respectively.
- **Assume sinusoidal voltage**, Vin, is superimposed on V_{BB} varying between 100µA to 300µA. It makes the **collector current varies** between **10 mA and 30 mA**. As a **result of the variation** in **I_C,**
- **the V_{CE}** varies between 2.2V and 3.4V.
- **Under certain input signal conditions,** the **location** of the **Q-point** on the load line can **cause one peak of the** V_{ce} waveform to be limited or clipped, as shown in the Figure below. For example, the bias has established a low Q- Q-point. As a result, the signal will be clipped because it is too close to cutoff.

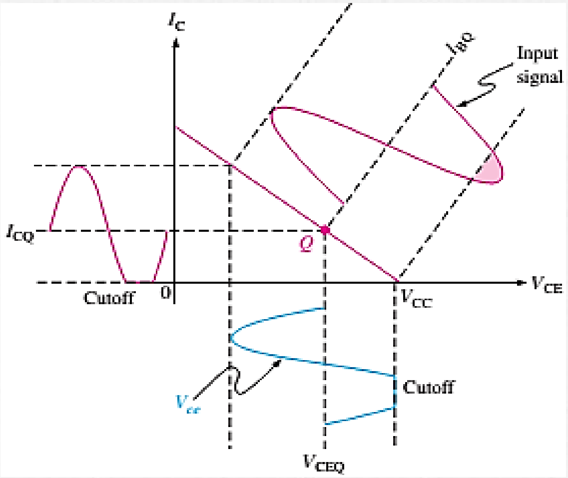

Figure: Graphical load line illustration of a transistor being driven into cutoff.

Voltage-Divider Bias

- A **practical** way to **establish a Q-point** is to form a **voltage-divider from V_{CC}**. This is the most widely used biasing method.
- A **DC bias voltage** at the base of the transistor can be developed by a resistive voltage divider that consists of R_1 and R_2, as in Figure 16.
- R1 and R2 are selected to establish V_B.
- If the divider is **stiff**, I_B is **small compared** to I_2.

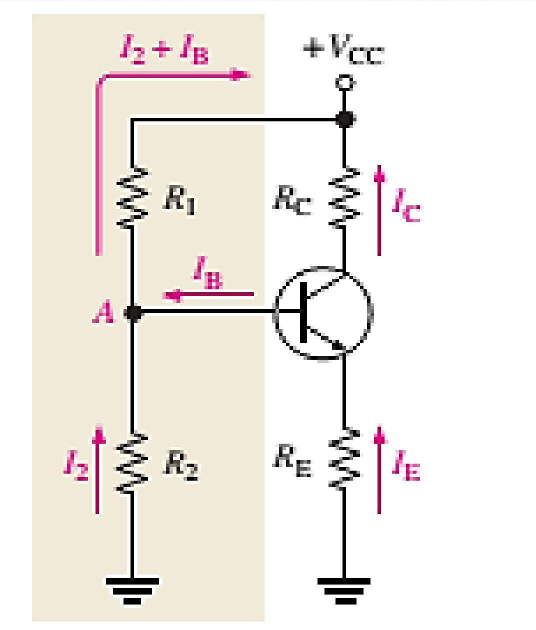

Figure 16: Voltage-divider bias.

- To **analyze a voltage-divider circuit** in which I_B is small compared to I_2, **first** calculate the voltage on the base:

$$V_B \cong \left(\frac{R_2}{R_1 + R_2}\right) V_{CC}$$

Once you know the **base voltage**, you can find the voltages and currents in the circuit, as follows:

$$V_E = V_B - V_{BE}$$

And

$$I_C \cong I_E = \frac{V_E}{R_E}$$

Then

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

Once you know V_C and V_E, you can determine V_{CE}.

$$V_{CE} = V_C - V_E$$

A practical biasing technique that uses a single biasing sources instead of separate V_{CC} and V_{BB}.

A dc bias voltage at the base of the transistor can be developed by a resistive voltage divider that consists of R_1 and R_2.